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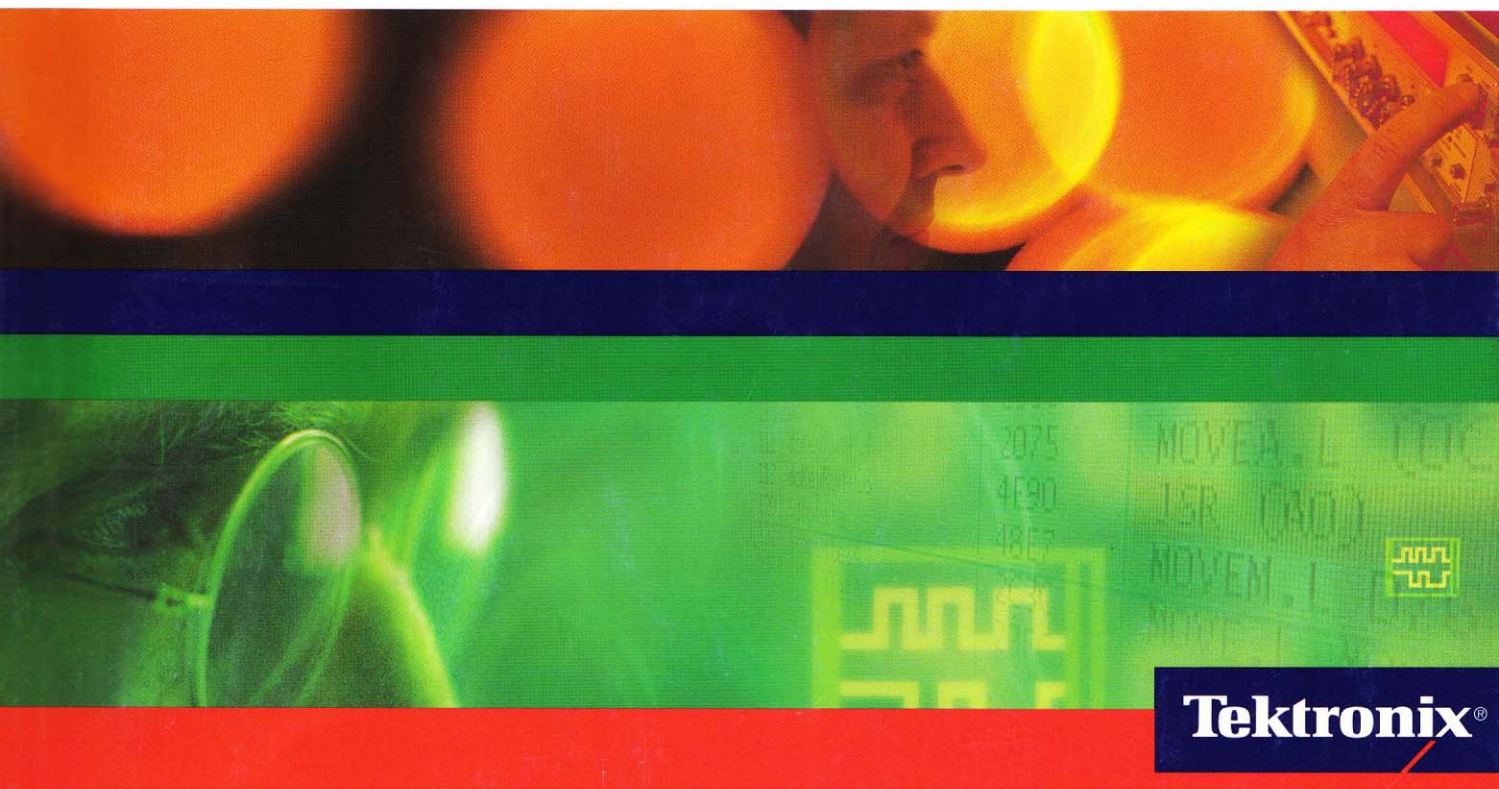

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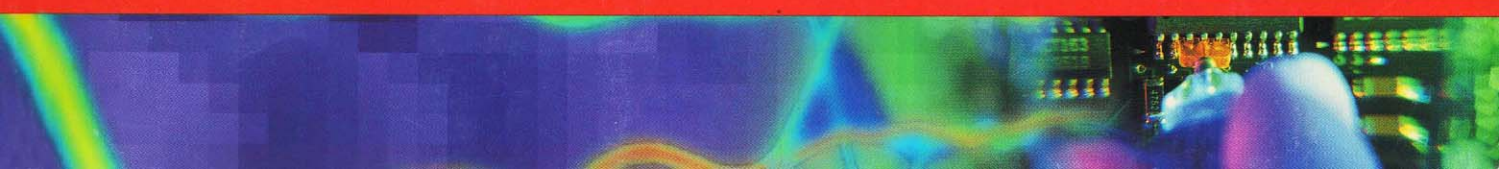

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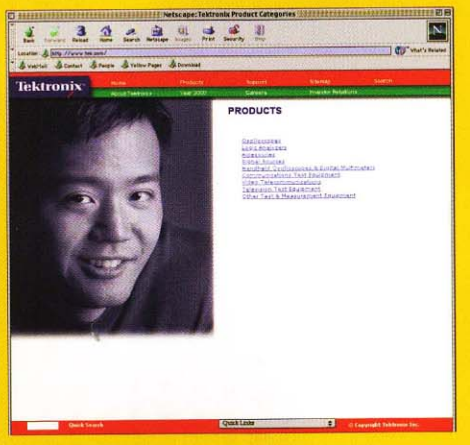

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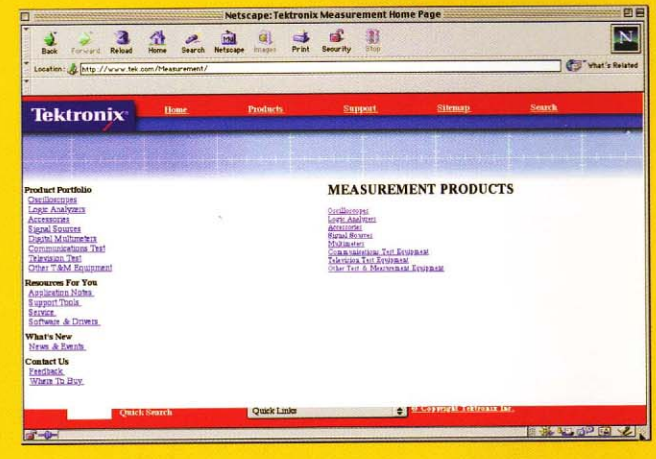

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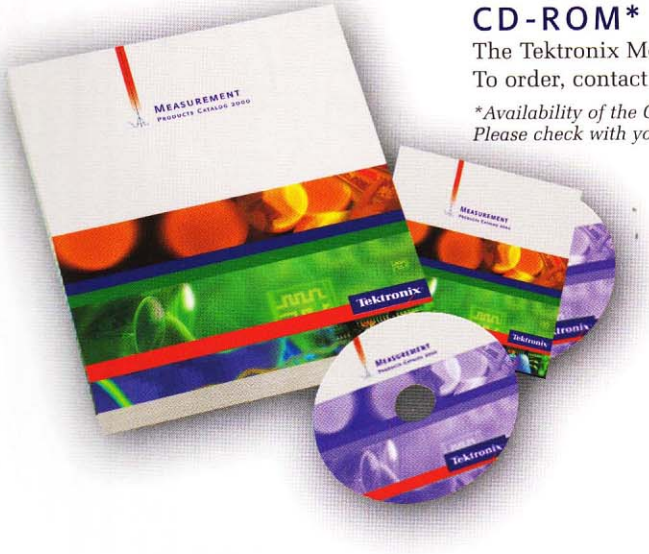

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All prices, specifications and characteristics set forth in this catalog are subject to change without notice. Prices current at the time an order is accepted by Tektronix will apply. Check with your local Tektronix representative for current price and specification information.

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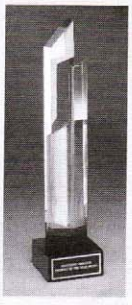
Your feedback is important to us!
In the back of the catalog is a mini-survey to let us know how we are doing and what we can provide to meet your changing needs. Just complete, mail, fax, or provide your input through the Tektronix www.tektronix.com site.



Electronic Products Product of the Year Award







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YEAR 2000 INFORMATION AND READINESS DISCLOSURE ACT NOTICE

The statements and information provided by Tektronix on this web site, and any previous statements by Tektronix concerning Year 2000 readiness of its products, are designated as 'Year 2000 Readiness Disclosures,' pursuant to the Year 2000 Information and Readiness Disclosure Act (P.L. 105-271). This is Tektronix' primary, official source of information on the company's Year 2000 program. Because the contents of this site are subject to change without notice, we urge you to register to receive email update notices.

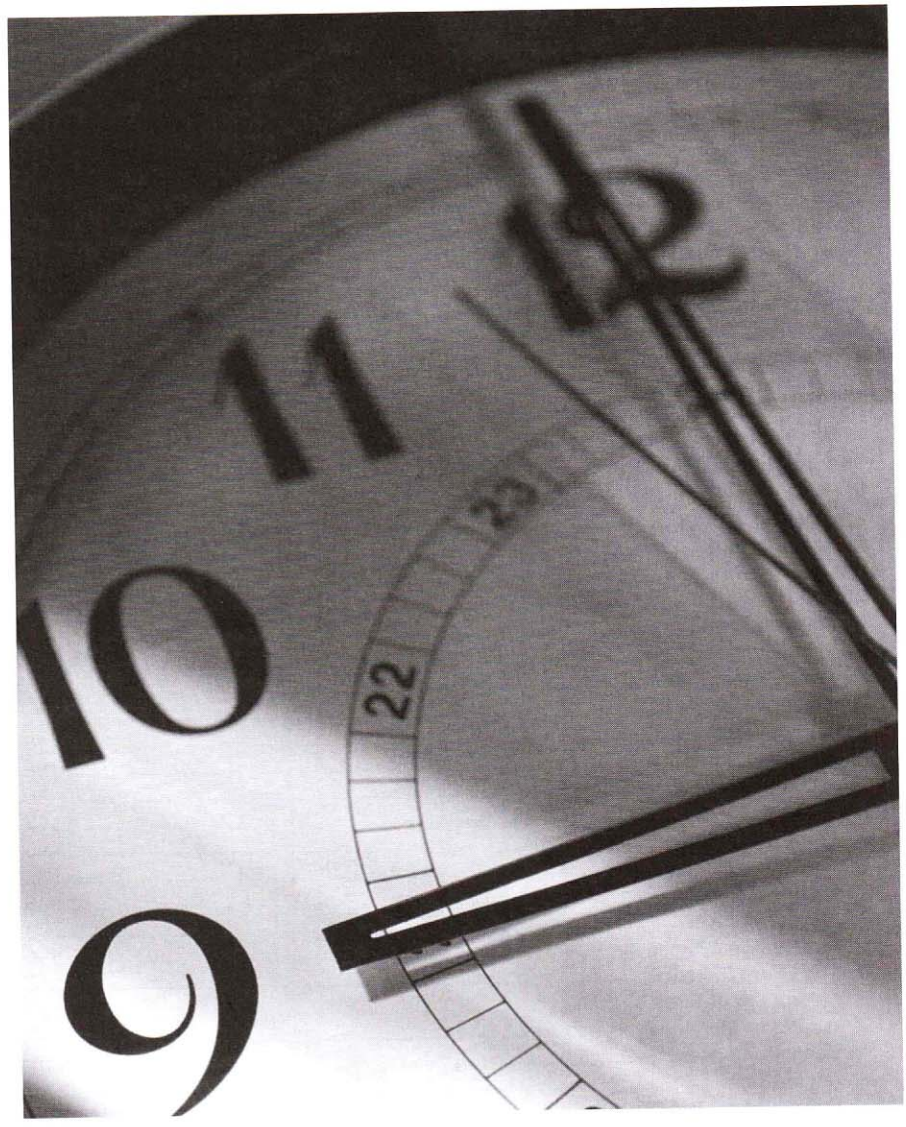
TEKTRONIX' COMMITMENT

Tektronix has made a corporate commitment to have its products and support systems, both internal and external, ready for the year 2000. To carry out that commitment, we have established a comprehensive program, directed through a Year 2000 Program Office, and overseen by senior management.

TEKTRONIX' YEAR 2000 PROGRAM

Tektronix' Year 2000 program consists of four phases:

- Strategy & Planning: inventorying potential Year 2000 threats and performing risk assessments
- Product Readiness: analyzing each product to determine if date logic is present and, if so, determining if the product is Year 2000 Ready
- Operational Readiness: performing remediation and compliance testing of internal systems, suppliers, and other third party service providers
- Contingency Planning: developing contingency strategies that can be implemented quickly if a threat is realized or a disruption occurs



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CUSTOMER SUPPORT

No other test and measurement supplier can match the remarkable depth of customer support offered by Tektronix. We offer technical support, service training, and service warranties. For additional information and the Tektronix representative nearest you, see the listing in the back of this catalog.

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You can now receive information via fax—ideal for technical information you need immediately. Product information or application notes are available any time of the day via Tektronix TekFAX. See the General Customer Information Section for information.

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In 1993 Tektronix became the exclusive distributor of Advantest test and measurement products in North America. Featured in this catalog are a wide-range of Advantest products in the RF/Microwave and Telecommunications areas. These exciting products are highly complementary to the Tektronix instrument portfolio. So look for the Advantest logo throughout this catalog to identify new high-performance, high-quality products from another leading company in the Test and Measurement industry.

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In 1993 Tektronix became the exclusive, marketing distribution service and support for Rohde & Schwarz Test and Measurement products in North America.

SONY Tektronix

In 1965, Sony/Tektronix was created as one of the first Japanese/American joint ventures in Japan. Since then, the company has been distributing every Tektronix products to Japanese customers including Test and Measurement instruments, Color Printers, Video Networking products, Computer Graphic Terminals. Beside these activities, Sony/Tektronix has originally designed, manufactured and distributed innovative T&M products to worldwide customers through Tektronix sales channel. These instruments such as Arbitrary Waveform Generators, Data Generators and Curve Tracers can be seen throughout this catalog.

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Tektronix has a variety of quality, previously used products at prices significantly lower than our catalog prices. These products have been fully refurbished, tested and calibrated. Each comes with a warranty equivalent to our new products. See the General Customer Information Section for information.

WORLD WIDE WEB

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TEKTRONIX' MEASUREMENT SOLUTIONS

With a comprehensive family of more than 1,400 test and measurement products, Tektronix is at the forefront of enabling new technologies and is often first to market with innovative products that support evolving standards.

Tektronix is poised to meet the increasing demands for quality testing imposed by the digital information age. As technologies converge, adapting to change forces companies to solve today's problems even as they evolve in anticipation of future changes. Tektronix products can help ease the transition and uncertainty.

By leveraging its expertise in computers, communications and video, Tektronix is in a unique position to lead the way as these markets converge and demand for new tools and measurements emerges.

Tektronix continues to earn its leadership position by focusing on solving customer problems. Because of Tektronix' acknowledged expertise and proven success in video, customers can count on Tektronix to help them meet new demands. In addition, Tektronix' experience in signal testing – from source to destination – will enable customers to grow and prosper wherever the information highway leads.

TEST AND MEASUREMENT PRODUCTS

Electronic Design Engineering/ Performance Products

- Oscilloscopes
- Logic Analyzers
- Spectrum Analyzers
- Curve Tracers
- Signal Sources
- VXI Instrumentation

Value Electronic Design Engineering

- Oscilloscopes
- Power Supplies
- Digital Multimeters
- Function Generators
- Counters

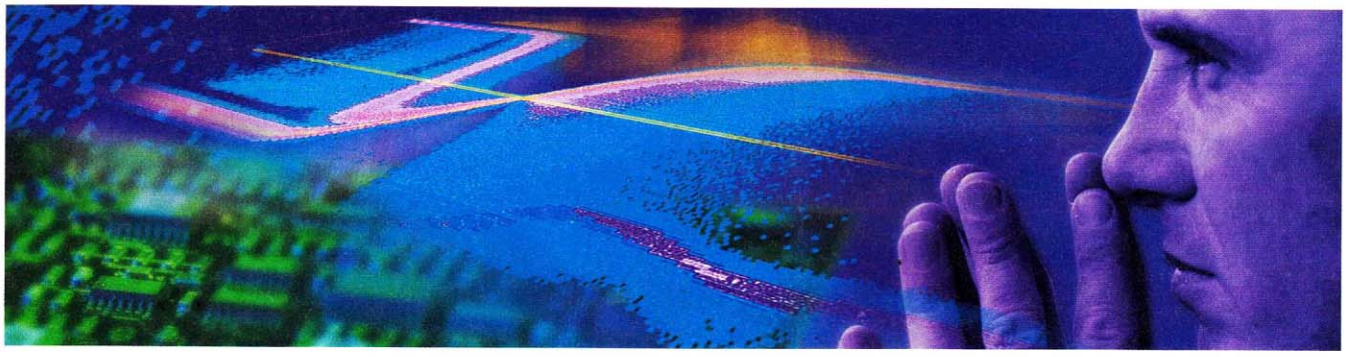
Communications Test

- OTDRs/TDRs
- ISDN Testers
- SDH/SONET Testers/Analyzers
- Optical-to-Electrical Converters
- SDH/SONET Reference Receivers
- Bit Error Rate Tester
- Protocol Testers

TV Test

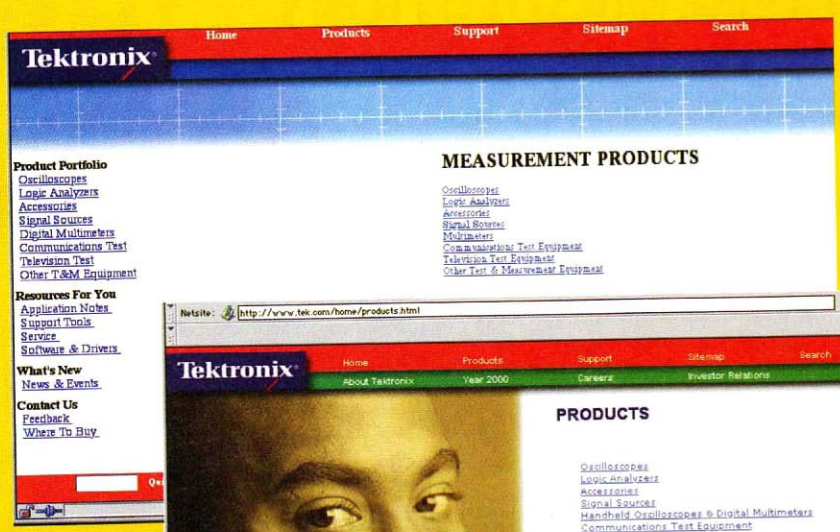
- Video Measurement Test Sets
- MPEG Testers
- Waveform, Audio and Digital Monitors
- Vectorscopes
- Generators
- Inserters
- Audio Measurement Testers
- Demodulators

TEKTRONIX PRODUCTS FOR EVERY SIGNAL TYPE



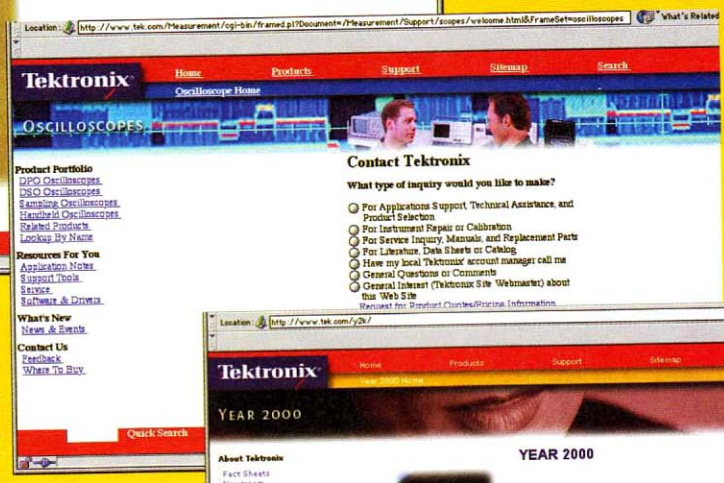
www.tektronix.com

Detailed information on Test and measurement products at your fingertips



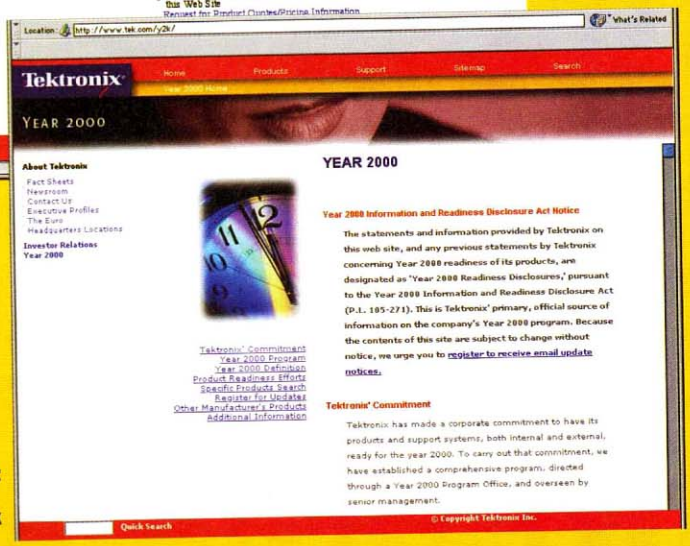
The World Wide Web has become an invaluable source of up-to-date information about Tektronix products. You can also find online support, press releases and application notes on the latest research.





Contact Tektronix at:

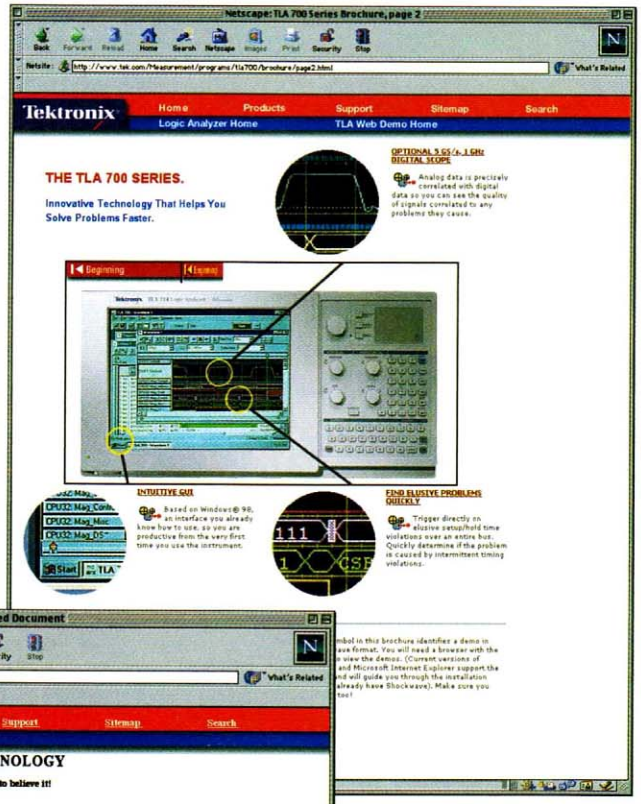
www.tektronix.com/Measurement/Feedback/welcome_new.html

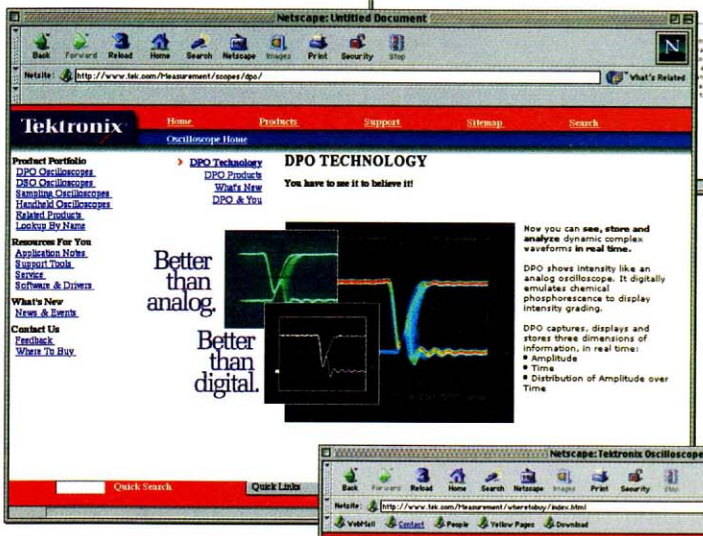


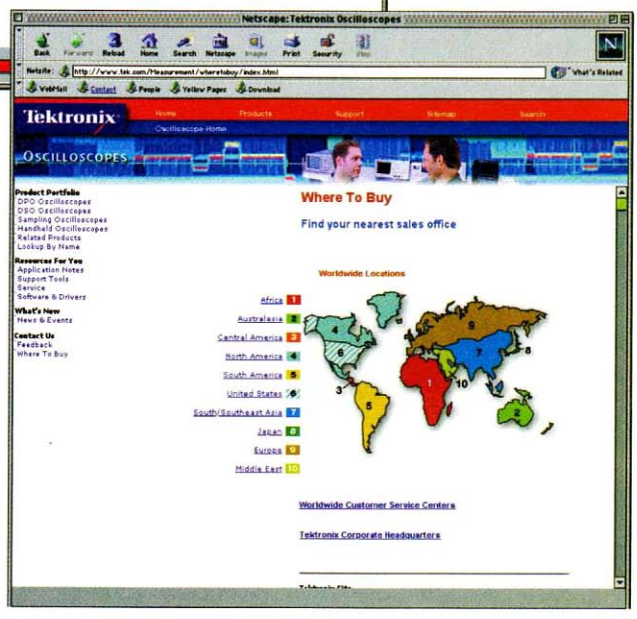
Find the latest Y2K information at:

www.tektronix.com/y2k

Find material that will make you more productive with the instrument you already own.







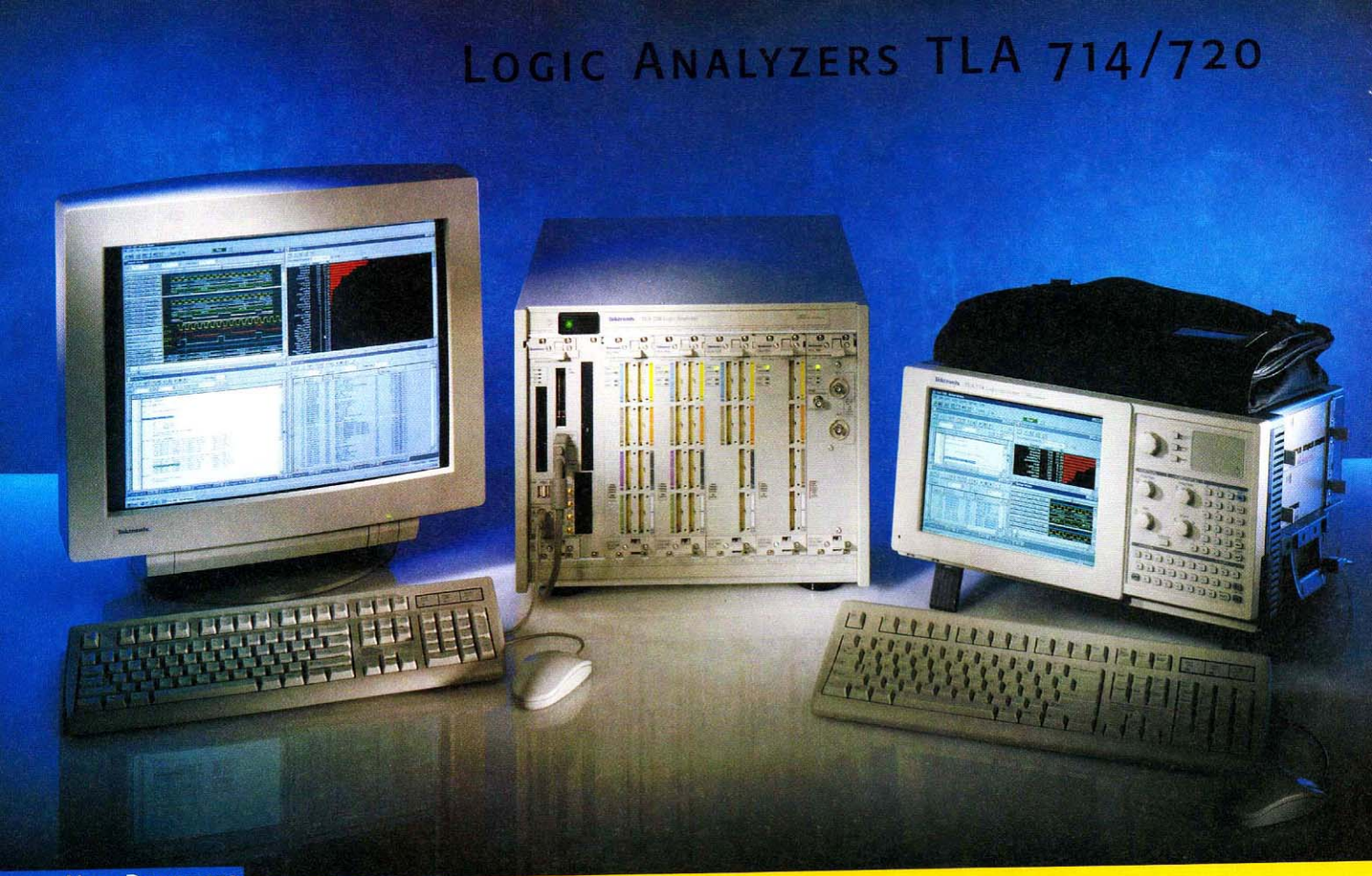
Welcome to our site, bringing you the latest news, interactive demos, and application information, or register for a seminar.

www.tektronix.com/Measurement

Where to Buy

Contact your nearest sales office from one of our worldwide locations.

Logic Analyzers TLA 714/720



NEW PRODUCTS

The Tektronix TLA 714/720 Logic Analyzers, including Microprocessor Support and our Embedded Systems Tools Partners

Leading-edge Designs

Taking on Today's Digital Designers

Can you answer yes to even one of these design challenges? Accelerated technological changes. Extreme time-to-market pressures. Measurement and analysis design challenges for next-generation microprocessors like RAMBUS. Elusive problems ranging from analog signals to HLL source code.

If so, whether you are a hardware developer, a software developer or a hardware/software integrator, you will find our newest logic analyzers – the TLA 714 and TLA 720 – answer the need for your entire digital design team.

Tektronix new logic analyzers offer an industry-leading combination of acquisition speed, channel width and memory depth, all of which are essential for supporting next-generation microprocessor designs. Now offering up to 16M, the TLA 714/720 have the deepest memory configuration in the industry plus an innovative hardware-assisted display system to simplify the management of such a large memory. They are also the only logic analyzers that provide simultaneous 200 MHz state and 2 GS/s timing on the same probe.

And when you match our industry-leading product performance with our Embedded Systems Tools Partners Program and our Third-Party Microprocessor Support, hardware and software embedded systems designers now have the flexibility to choose the best tools to speed their development and debug efforts.

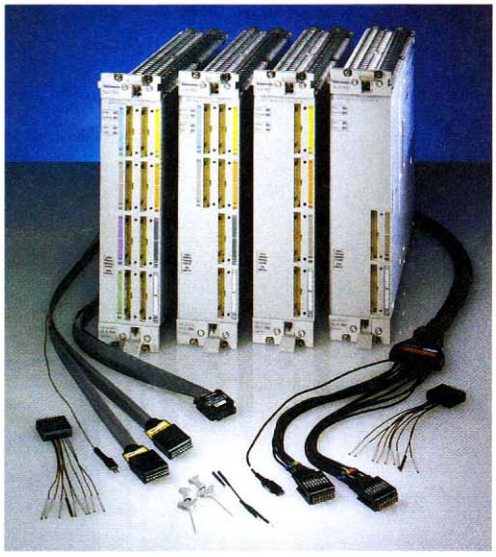
For further information see page 125, or on the web at www.tektronix.com/Measurement/logic_analyzers/

Logic Analyzers TLA 714/720

The TLA 700 Series addresses the needs of the entire digital design team. HW developers, HW/SW integrators and embedded SW developers will all find the TLA 700 provides solutions for those elusive problems ranging from analog signals to HLL source code that threaten their product development schedules.



TLA 720 – Both the portable TLA 714 and the benchtop TLA 720 combine impressive performance and a modern graphical user interface to simplify debugging complex system problems and enable engineering teams to meet or exceed their development schedules.

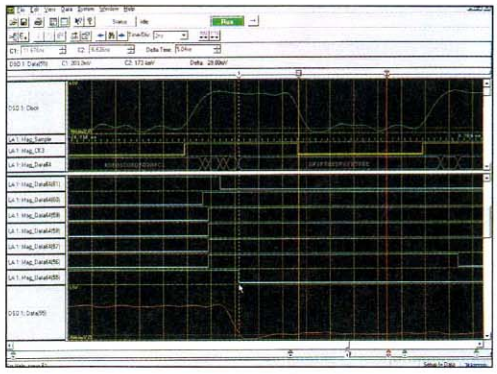


From right: The 34-CH, 68-CH, 102-CH, and 136-CH Logic Analyzer modules; available with depths up to 16 Mbits per channel with your choice of probes. A TLA 720 benchtop mainframe can hold up to five modules for a total of 680 channels.

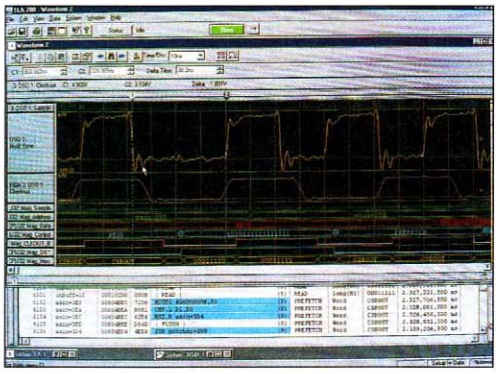
A New Family of Instruments

The TLA 700 Series is a new family of instruments developed specifically to address the fast-changing needs of today's digital design engineers. These products bring new technology to bear on the time and design pressures faced by digital system designers.

NEW PRODUCTS



MagniVu™ – A 64-Bit data bus and its clock signal acquired with MagniVu technology, showing that the bus takes about 3 ns to settle when the value changes. Some individual data signals are shown also, including the first and last to change. The clock signal and the slowest data signal are shown as acquired by the DSO.



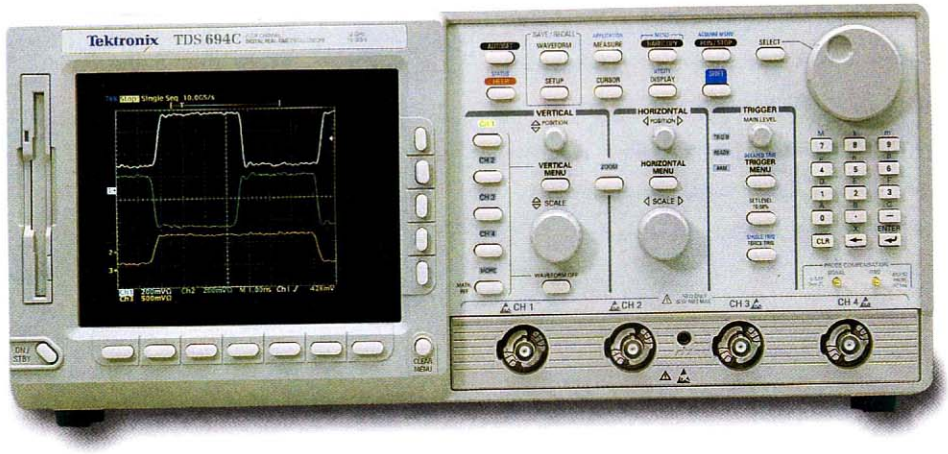
Data acquired by all instrument modules is precisely time correlated. You can now easily see when signal quality causes timing faults.

For further information see page 125, or on the web at www.tektronix.com/Measurement/logic_analyzers/

Digital Storage Oscilloscope TDS 694C

The Tektronix TDS 694C – A Cornerstone for digital systems testing–including Rambus, AGP, and other high-speed buses.

Provides 3-GHz Bandwidth Simultaneously Across All Four Channels to the Probe Tip.



Examine Your Signal Activity in Detail

Tektronix' TDS 694C digital storage oscilloscope (DSO) provides the highest bandwidth and sampling rates available for accurate measurement of high-speed digital signals. The four-channel, 3-GHz bandwidth DSO can simultaneously sample up to 10 GS/s on all channels. With the TDS 694C, digital design engineers can connect the powerful DSO to their device under test (DUT) and perform system characterization, verification and validation, as well as high-speed timing and jitter measurements.

The TDS 694C is ideal for characterizing signals in microprocessor systems and components such as motherboards, chip sets and graphics accelerators. The DSO also offers high-performance measurement for communications equipment design, including hubs, routers, disk arrays and other high-speed data transmission equipment. The TDS 694C can also be used to record data from single-shot events in quantum electronics, including fast analog pulses and components.

The DSO is Java-powered, extending the capabilities of the basic scope, enhancing the display for specific applications and offering a continued path for additional future capabilities of the scope. The available jitter measurement package is especially useful for automatically measuring and characterizing jitter in leading-edge digital designs.

- The TDS 694C provides the highest single-shot bandwidth and time measurement accuracy available on any oscilloscope.
- With 3 GHz bandwidth and 10 GS/s sample rate on each of its four channels simultaneously, the TDS 694C is capable of measuring the time difference between signals with ±15ps accuracy while displaying important signal details such as glitches, overshoot, and undershoot.

For further information see page 77, or on the web at www.tektronix.com/Measurement/scopes/

New Products

THE P6249, 4 GHz, FET PROBE

Measures 3.0 V Logic, RAMBUS DATA LINES, RISETIME on Gigabit Ethernet, Fibre Channel, IEEE 1394.

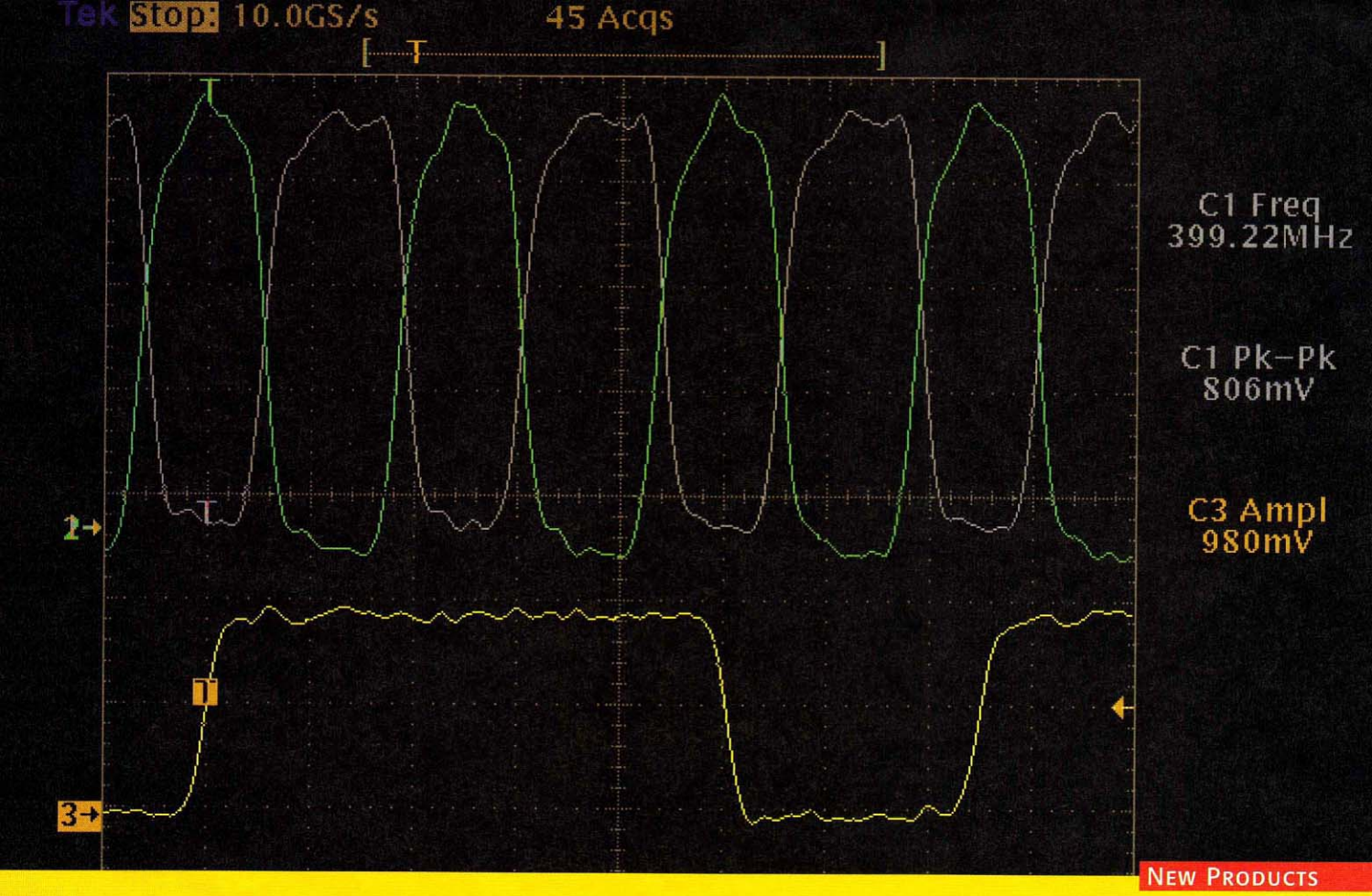
THE P6248, 1.7 GHz, DIFFERENTIAL PROBE

The P6248 enables users to make time domain or frequency domain measurements on high bandwidth signals commonly found in disk drive, digital IC design (RAMBUS), and communication applications (Gigabit Ethernet, IEEE 1394 Firewire and Fibre Channel).



P6249.

For further information see page 512, or on the web at www.tektronix.com/Measurement/accessories/



ENGINEERING RAMBUS INTEGRATION

Solving today's leading-edge digital design challenges, including Rambus and the next generation of microprocessors, requires an entire test and measurement solution. With this year's introduction of three cornerstone products, the Tektronix TDS 694C, the TLA 714/720 and the DG2040 – today's speed-driven engineers can swiftly integrate Rambus technology into their state-of-the-art designs.

THE RAMBUS CHALLENGE

Today, Rambus systems are driving state-of-the-art digital performance, with a sophisticated memory-to-processor architecture and a high-speed chip-to-chip interface, called Rambus DRAM (RDRAM). Although RDRAMs deliver a quantum leap in performance, they increase the complexity of the verification, debug and characterization of processor-based applications.

THE NEED FOR SPEED...AND ACCURACY

Couple the complexity of Rambus with today's rigorous time-to-market schedules and its clear how essential it is to choose measurement tools that not only deliver repeatable performance validation, but do it quickly. The right tools can literally save weeks in the design of a memory system, simply by revealing circuit performance details that elude lesser instruments or by making measurement results easier to comprehend and analyze.

THE TEKTRONIX SOLUTION

With this year's introduction of three new cornerstone products; the Tektronix TDS 694C, the TLA 714/720 and the DG2040, engineers now have a complete and robust suite of performance tools to swiftly– and effectively– integrate high-speed digital technologies, such as Rambus, into their designs

From board–level to system-level to code-level, Tektronix delivers the most comprehensive, performance solution for all of your high-speed digital designs needs.

New! TDS 694C Digital Storage Oscilloscope with complementary intelligent connection devices

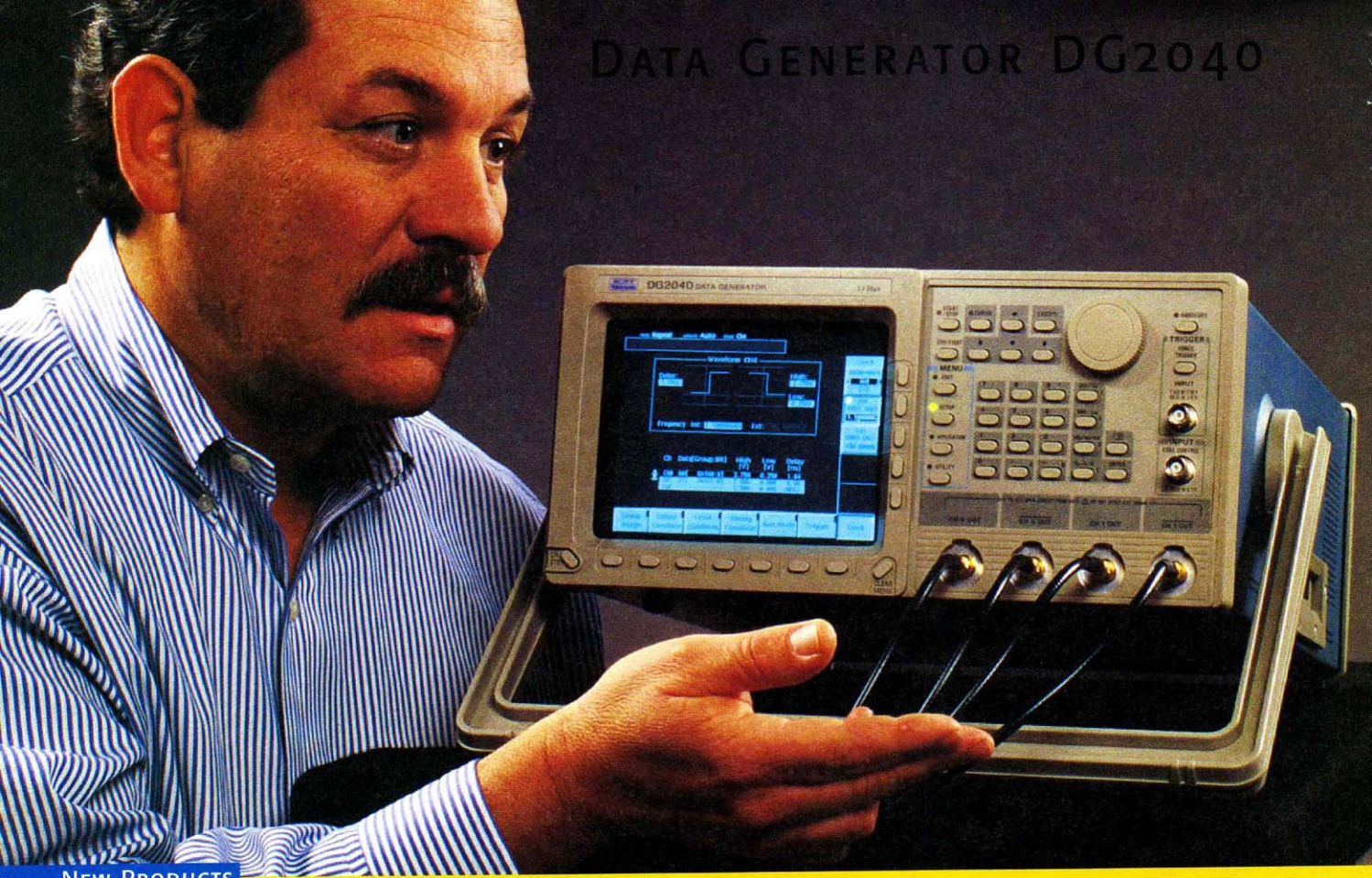
New! TLA 714/720 Logic Analyzer

New! DG2040 Data Generator

New! TDSJIT1 Software

New! TDSPSM1 Software

For further information see page 77, or on the web at www.tektronix.com/Measurement/scopes/



DATA GENERATOR DG2040

Our newest offering in the DG2000 Series Data Pattern Generator Family

ARBITRARY WAVEFORM GENERATOR AWG610

With 2.6 GS/s and 8 MB memory makes the AWG610 the fastest stimulus ideal for digital Read-channel simulation, 100 bast T and Avionics Testing and well-suited for the failure analysis of semiconductors and subsystems for magnetic and optical data storage products requiring characterization up to 800 Mbits per second.

An Important Component in Verifying Your System Design

The DG2040 is a high-speed, dual-channel 1.1 Gb/s data generator used for serial signal simulation. Electronic design engineers can use this flexible logic source to supply high-speed data or clock stimulus in the design, characterization and verification of semiconductors or digital logic circuits.

The DG2040 offers Edge Control, a unique feature that simulates jitter or wander conditions in serial data or clock signals that is likely to occur in a real operating environment. The Edge Control feature permits the design engineer to select all or specific edges in the serial data stream or clock to apply jitter. An external modulating signal up to 500 MHz provides dynamic control while front panel control provides precise, static timing shifts up to ±100 psec.

Data Rate 1.1 Gbps; Pattern Depth: 256 K/ch.; Rise & Fall Time (20% to 80%) 150 psecs.; two complementary output data channels and one complementary clock output.

AWG 610 Addresses the Challenging Needs Of the Disk Drive Market

The AWG 610 features high-speed clock rates up to 2.6 GS/s, making it the fastest stimulus available for Digital read channel simulations. Its deep 8-Mbyte output Memory also provides higher resolution for complete sector simulations and affords longer play times. The AWG 610 features an easy-to-use application focused Graphical User Interface that allows engineers to precisely Create, Modify and Output standard and custom waveforms. Real-world signals, such as precise timing and jitter impairments, can be simulated using the unique Region Shift capabilities of the AWG.

Semiconductor applications require high-performance, mixed signal, functional test and device characterization capabilities. The AWG 610 outputs analog and serial digital waveforms to meet these testing requirements. Although the removal of noise is a common goal, using the AWG 610 as a noise source is extremely useful for testing immunity to this type of signal impairment.

www.tektronix.com/Measurement/signal_sources/

Digital Phosphor Oscilloscope TDS 3000

Better Than Analog. Better Than Digital. And More...

With its compact, lightweight form factor, the TDS 3000 Series, with its optional battery pack, can bring the power of DPO anywhere you need it to go.

Mainstream Design

Last year Tektronix' introduced a new generation of award winning oscilloscopes to the marketplace, the Digital Phosphor Oscilloscope (DPO). This year, Tektronix is proud to introduce the newest member of the DPO family, the TDS 3000 Series. With its advanced connection, capture and measurement capabilities, the TDS 3000 Series offers design, manufacturing test and repair engineers, a new level of performance — all in one portable, affordable and state-of-the-art instrument.

You Have To See It To Believe It

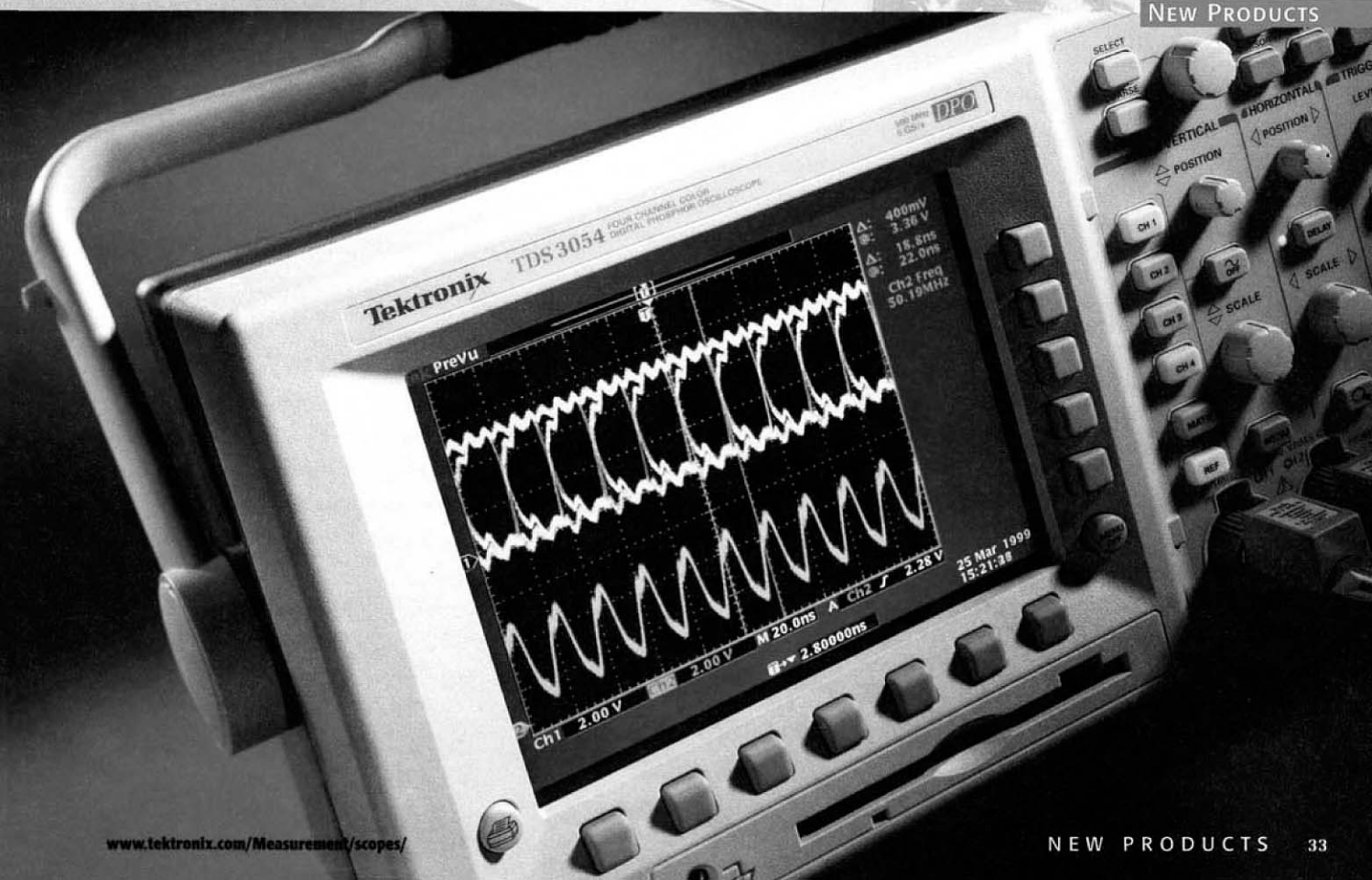
Combining the best features of analog and digital oscilloscopes, the TDS 3000 Series oscilloscopes can display, store and analyze three dimensions of signal information in real time. Ideal for analyzing complex signals, the TDS 3000 Series includes:

- 2-channel, 4-channel models
- 100 MHz, 300 MHz, 500 MHz bandwidths
- Real-time intensity-graded color display for analyzing waveform anomalies that can be elusive with traditional Digital Storage Oscilloscopes
- Modular add-on functionality for application specific measurements
- Built-in floppy disk drive
- QuickMenu interface

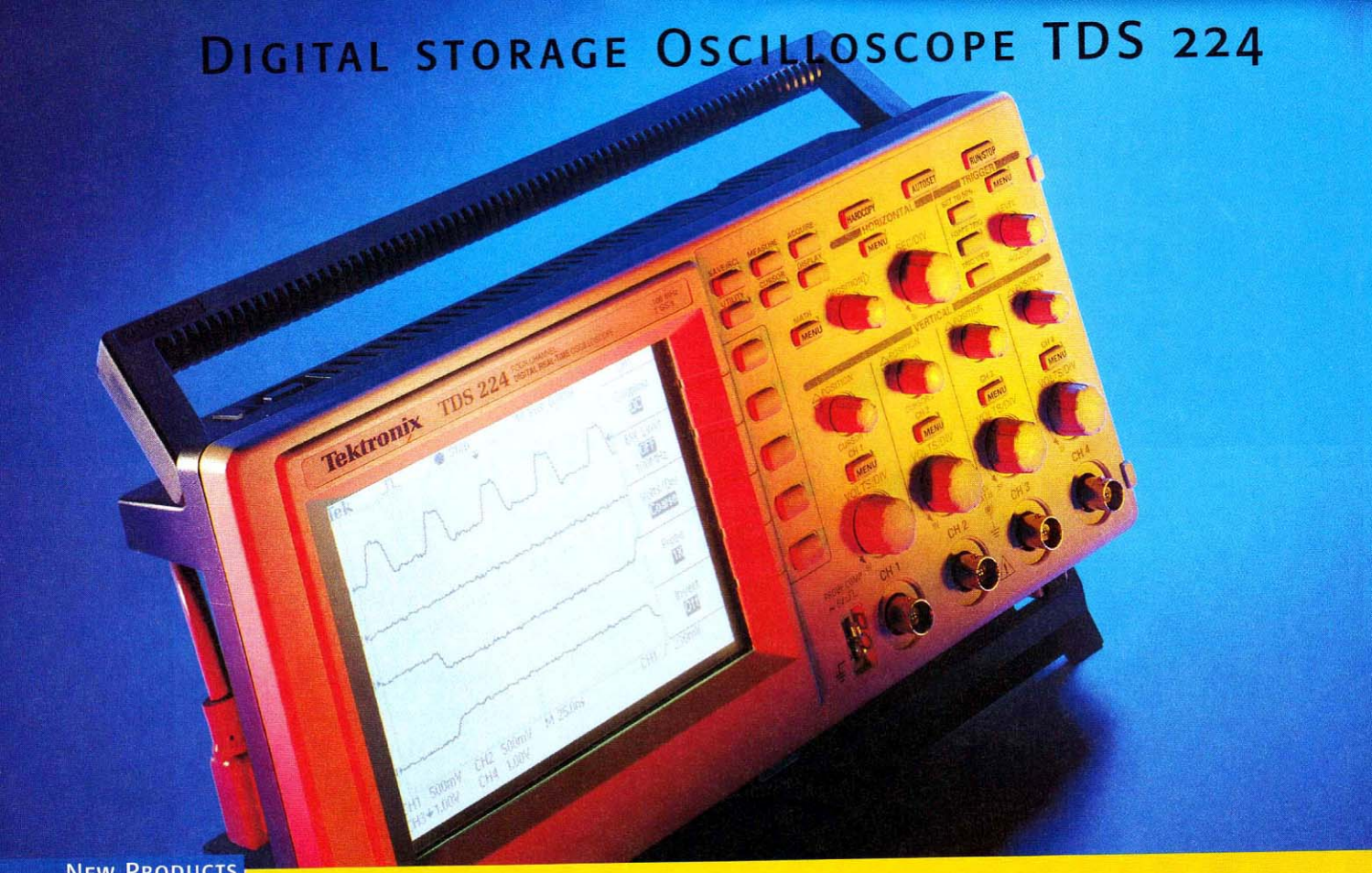
For further information see page 95, or on the web at www.tektronix.com/Measurement/scopes/

New in January 2000:

- Telecommunications Mask Testing App Module
- 10BaseT LAN Communication Module



Digital Storage Oscilloscope TDS 224



NEW PRODUCTS

A Tektronix Best-Seller ...Just Got Better

If your bench, production line or training lab needs include an affordable, yet high performance oscilloscope, a TDS 200 Series oscilloscope from Tektronix is the educated choice.

Mainstream Design

Introducing a new and improved TDS 224 Series Digital Storage Oscilloscope from Tektronix. Offering unbeatable combination of performance, reliability and versatility, the TDS 200 Series offers breakthrough digital and real-time advantages — at an affordable price — and now, the TDS 224 offers the power and flexibility of four channels.

The TDS 200 Series - An Ideal Choice For:

- Design/debug
- Service and repair
- Manufacturing test and quality control
- Education and training

The Four Channel Advantage

An ideal solution for today's exacting debug challenges, no other digital oscilloscope offers as much bandwidth and sample rate for the price. In fact, by sampling at 10 and 16 times their bandwidth on all channels, the TDS 200 Series oscilloscopes provide accurate real-time acquisition up to their full bandwidth.

For further information see page 101, or on the web at www.tektronix.com/Measurement/scopes/

RF Design and EMI/EMC Testing

3026 Real-time Spectrum Analyzer

The new 3026 real-time Spectrum Analyzer provides design engineers and manufacturing final test evaluators of communications equipment an affordable product that can be used to quickly evaluate a design or the final product for transient (BURST) phenomena that otherwise might not show up until it is in the end user's hands.

For further information see page 153, or on the web at www.tektronix.com/Measurement/commtest/



ESI EMI Test Receiver

The ESI family of EMI test receivers combines the flexibility and speed of spectrum analyzers with the large dynamic range required for EMI measurements in conformance with standards.

The ESI family comprises three models with different upper frequency limits:

- ESI7: 20 Hz to 7 GHz
- ESI26: 20 Hz to 26.5 GHz
- ESI40: 20 Hz to 40 GHz

All three models are characterized by:

- High sensitivity
- Excellent large-signal immunity
- Low measurement uncertainty
- High measurement speed

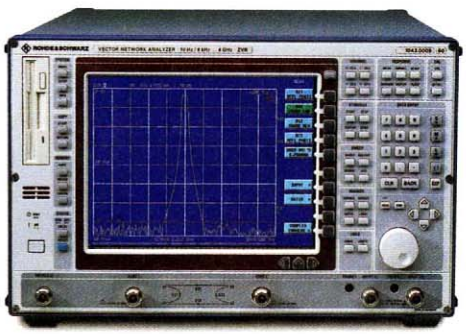
For further information see page 247, or on the web at www.tektronix.com/Measurement/commtest/



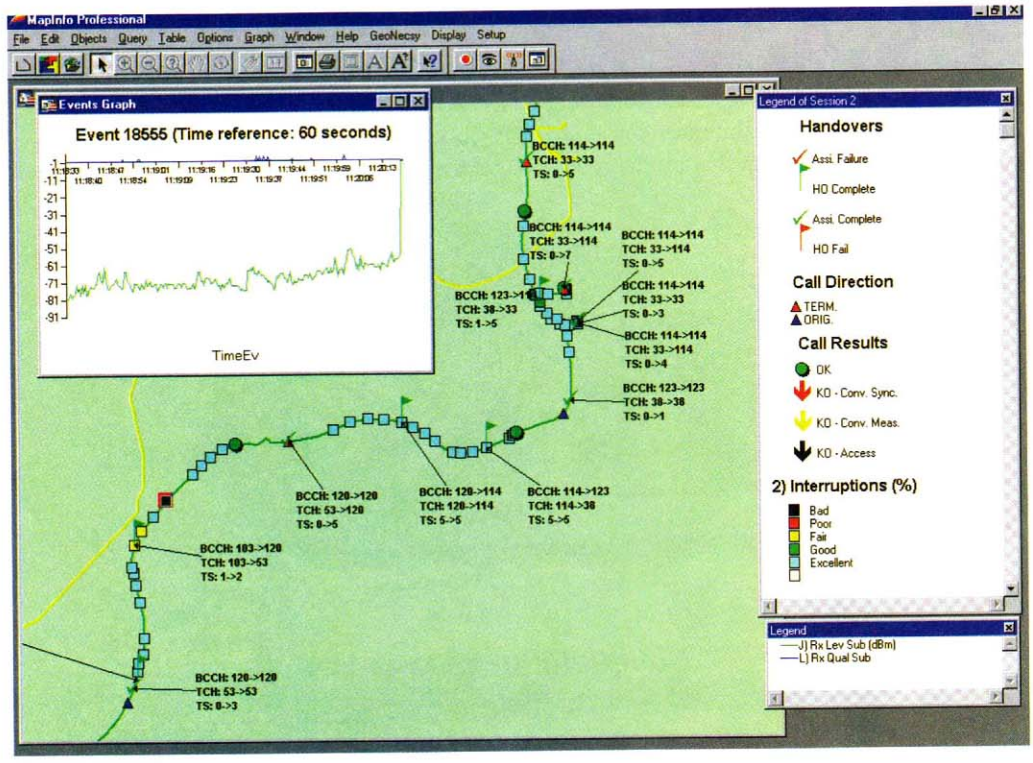
ZVR Network Analyzer

A seven-model family that sets new performance benchmarks. Each model delivers the highest dynamic range in its class, and executes measurements far more quickly than existing tools. In addition, the ZVR/ZVC family simplifies complex tasks such as intermodulation distortion (IMD) tests and calibration procedures.

For further information see page 201, or on the web at www.tektronix.com/Measurement/commtest/



Mobile Networks



Recently, market pressure is building for enhanced data delivery and telephony services, global roaming, internet access, e-mail, and even video.

- Existing 2G systems are experiencing great competitive pressure for assured Quality of Service (QoS)
- Interim technologies (2.5G) such as HSCSD and GPRS will emerge, offering enhanced data delivery over existing 2G networks
- New standards and formats are emerging and contending to become the worldwide 3G standard

What improvements are needed? Fundamentally, wireless users want even more services from their mobile sets:

- Much-enhanced data delivery and telephony services
- Global roaming
- Internet access, e-mail, and even video and more in the future.

The Tektronix strategy is self-explanatory: when a new wireless test requirement arises, a proper toolset should be there in advance to meet the need.

But for now, wireless network operators and equipment manufacturers need test solutions that will address two pressing issues: 1.) keeping pace with burgeoning 2G demand for capacity and innovative products, and 2.) ensuring superior quality of service (QoS) as wireless industry competition grows even more intense.

Tektronix offers a wide range of 2G test equipment, from integrated RF air interface analysis tools to signaling protocol analyzers.

TEKTRONIX 2G WIRELESS SOLUTION SET:

- The new 3066 Real-Time Spectrum Analyzer
- The M366plus GSM Quality Analyzer
- Tektronix' K1205 Protocol Analyzer

Mobile Networks

3086 Real-Time Spectrum Analyzer

The 3086 has been designed to serve the wireless industry throughout its transition to 3G. The 3086 is more than just the first spectrum analyzer on the market to offer a chip rate sufficient for the full range of W-CDMA-based technologies.

Its real-time acquisition makes it possible-even easy-for engineers to examine burst events and transient phenomena. The 3086 captures a full 30 MHz band of signal activity simultaneously, easily encompassing the full width of a W-CDMA channel.

The 3086 is a DC-to-3 GHz instrument whose wideband input mode delivers a 20.48 MChip/sec symbol rate. The Tektronix 3086 Real-Time Spectrum Analyzer has all the features needed to pave the way for 2.5G, transitional, and 3G technologies, and it is available now.

Unique features of the 3086 include the ability to analyze signals in the following domains:

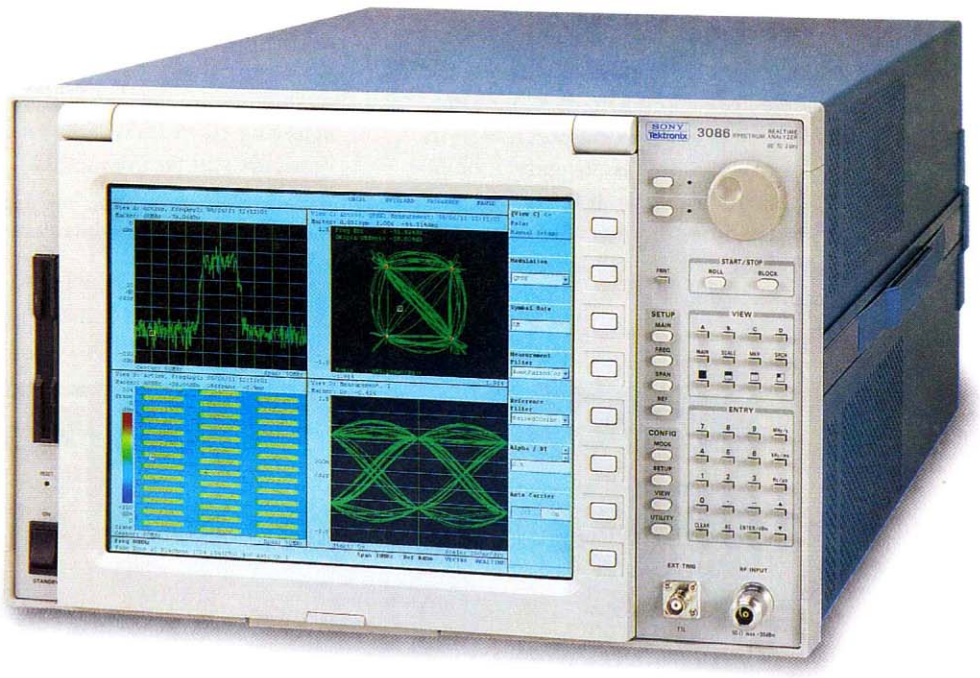
- Time vs. frequency
- Time vs. amplitude and phase
- Time vs. code power

Additional displays allow examination of:

- Constellation and vector
- Error vector magnitude vs symbol
- EVM on individual code channels
- Demodulation to bit level of all types of modulation

For further information see page 150, or on the web at www.tektronix.com/Measurement/commtest/

New Products



MOBILE NETWORKS

K1297 GPRS CAPABILITIES

Portable Multi-protocol Tester for Monitoring Simulation, emulation and Conformance Tests

Packet Simulation, Emulation and Monitoring for the GPRS Gb and G1 Interfaces

Packet Simulation and Monitoring for the GPRS Gr and Gs Interfaces

2G Tektronix

NEW PRODUCTS

MOBILE NETWORKS

A host of new Wideband-CDMA (W-CDMA) capabilities to the SMIQ platform, already established as a leading measurement tool for 3rd Generation wireless technologies.

The SMIQ-B is an integrated, configurable solution that addresses the design and manufacturing test of wireless components, mobile stations, and base stations.



K1297 GPRS MULTI-PROTOCOL TESTER

An example of the 2.5G trend is the design and deployment of a new GPRS (General Packet Radio System) overlay network. GPRS uses the existing circuit switched GSM network infrastructure for voice traffic and adds a new packet switched network consisting of GPRS support nodes for data traffic. The result is a much-improved data rate of up to 160 kb/sec (vs. the 9.6 kb/sec rate of standard GSM networks). It's no wonder that wireless customers are anxious to gain the benefit of GPRS enhancements!

The K1297 Protocol analyzer with new GPRS software allows monitoring at all new network interfaces (such as support nodes) in GPRS systems as well as the simulation of GPRS network elements. It is ideal for the monitoring of GPRS protocols and services, and verifying inter-operability of GPRS with adjacent networks.

Capabilities:

- Portable Multi-protocol tester for monitoring, simulation, emulation and conformance tests
- Packet simulation, emulation and monitoring for the GPRS Gb and G1 interfaces

For further information see page 401, or on the web at www.tektronix.com/Measurement/commtest/

SMIQ-B RF SIGNAL GENERATOR

The SMIQ-B offers a broad range of selectable modulation types, encompassing all of today's prevalent standards as well as W-CDMA. It also provides for user-designed custom modulation formats, a valuable feature in the emerging 3G realm where modulation standards are still far from stable.

For further information see page 227, or on the web at www.tektronix.com/Measurement/commtest/

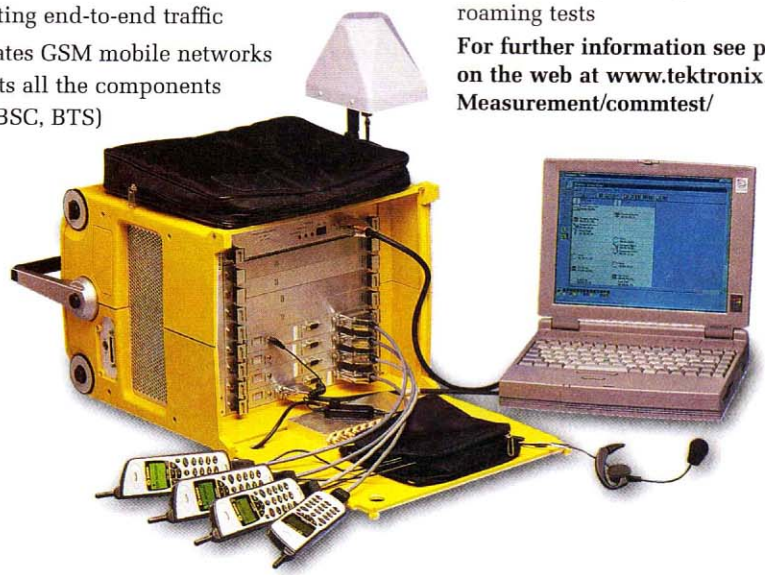


MCGS Mobile Call Generation System

The Mobile Call Generation System (MCGS), and air interface and signaling test system for GSM cellular networks.

- Air interface test system for GSM900, DCS 1800, PCS 1900 and dual band networks
- Generating end-to-end traffic
- Stimulates GSM mobile networks and tests all the components (MSC, BSC, BTS)
- Easy expandable and automatic recognition of system configuration
- Graphical and flexible call and traffic configuration
- Powerful analysis including protocol decoding
- Ideal product for load testing, automatic service testing, billing verification and roaming tests

For further information see page 269, or on the web at www.tektronix.com/Measurement/commtest/



Mobile Networks

Mobile Call Generation System

The new MCGS simulates end-to-end traffic at the radio interface for the GSM900, DCS1800, PCS1900 and dual-band (900/1800) networks. As the most complete air interface/signaling testing device available, the system provides equipment manufacturers and cellular operators with a means for software verification, load, roaming and system integration.

New Products

AMIQ Modulation Generator

The AMIQ is a powerful dual-channel arbitrary waveform generator with 14-bit vertical resolution and a 100 MHz sample clock rate. Designers who must evaluate and debug new W-CDMA components and test engineers who must qualify those components in production will need its 16.384 Mchips/sec rate. Instruments limited to lesser chip rates will not meet the requirements of the emerging high-capacity digitally modulated wireless technologies.

The AMIQ, paired with an SMIQ vector signal generator, produces a comprehensive and future-proof solution for all of the prevailing digital modulation formats: TDMA, CDMA, IS-95, and W-CDMA. The SMIQ vector signal generator family is renowned for its signal quality and includes four models ranging from economy to high performance. The SMIQ's front-panel controls can be used to operate the AMIQ, eliminating the need for a stand alone PC.

- 14-bit resolution
- 4,000,000 samples memory depth
- 100 MHz sample rate
- Integrated hard disk and floppy disk drive
- Optional BER measurement

For further information see page 233, or on the web at www.tektronix.com/Measurement/commtest/



Mobile Networks

The AMIQ Modulation Generator, a high-speed I/Q modulation generator which supplements the SMIQ vector signal generator family. The AMIQ provides Wideband-CDMA (W-CDMA) and other signal formats for use in testing RF wireless components.

Mobile Networks

The M366plus Release 5.0 GSM Quality Analyzer measures voice, data, and fax quality in GSM networks. The M366plus Release 5.0 analyzer includes a basestation and one or more mobile stations that generate end-to-end connections between PSTN, GSM, DCS and PCS networks. By testing specific parameters in the voice channel, the analyzer can identify trouble spots and provide objective measurements of voice quality.

M366 System

- Quality of service, O&M and network optimization for GSM 900, DCS 1800, dual band and for PCS 1900
- Voice quality measurements: clipping, echo delay, echo loss, loudness rating, impulse noise, psophometric noise
- Cellular data and fax quality test
- SMS verification
- Determination of subscriber satisfaction level
- Automatic generation of calls from a cellular phone to a fixed or cellular phone
- Simultaneous measurements on up to 4 different networks
- Run-time display of results on digital maps
- Post-processing of data obtained during measurement campaigns

The M366 system includes two units that generate automatic voice and data calls between each other. The M366plus/GSM basestation is a fixed unit that can be connected to as many as eight PSTN interfaces. The unit is able to simultaneously generate voice calls to the mobile unit, and serve as an answering device to receive calls from mobile units.

For further information see page 267, or on the web at www.tektronix.com/Measurement/commtest/



New Products

Mobile Networks

The FSIQ series of signal analyzers, offering fully integrated spectrum and modulation analysis for third-generation (3G) wireless technologies, particularly Wideband-CDMA (W-CDMA), and for today's leading wireless standards including GSM, IS-136, and W-CDMA.

FSIQ Series Spectrum Analyzers

The FSIQ series provides uncompromised adjacent channel power ratio (ACPR) measurements on W-CDMA equipment.

The FSIQ Series exceptionally low typical phase noise and low thermal noise floor delivers the dynamic range of 75 dB for measuring ACPR. For research and design and component test applications, the increased headroom makes it possible to characterize new 2G or 3G mobile phone and base station designs with greater accuracy and confidence than ever before. In manufacturing, the improved dynamic range allows narrower guardbands.

- High-speed synthesizer with 5 ms sweep time for FULL SPAN (FSIQ3/7)
- High display update rate up to 25 sweeps/s
- Large color display with high resolution (24 cm/9.5" TFT)
- Frequency, time and modulation domain in one box analysis
- 75 dB ACPR (Adjacent Channel Power Ratio) in 4.096 MHz integration bandwidth for alternate channel
- Integrated vector signal analyzer for W-CDMA
- Digital demonstration up to 6.4 Msymbol/s

For further information see page 156, or on the web at www.tektronix.com/Measurement/commtest/



K1205 Protocol Analyzer

The K1205 Protocol Analyzer is a low cost, lightweight signalling protocol analyzer for telecommunication network monitoring. It is the ideal tool to quickly and accurately monitor, decode, and troubleshoot signalling protocols in wired and mobile networks.

Capabilities:

- Network monitoring and analysis of CCS#7, GSM900, DCS1800, PCS1900, CDMA, ISDN D-channel and V5.x protocols
- Simultaneous connection of 16 – 2 Mbits/sec links with 32 time slots
- Decodes over 150 signalling protocols including country and manufacturer-specific protocols.

The V1.2 software also delivers Calltrace capabilities for all telephone user part (TUP) protocols and improves Calltrace capabilities for ISUP.

- Portable multi-protocol tester for monitoring at a variety of interfaces
- Simultaneous connection of up to 16 PCM30/PCM24 with up to 32 time slots
- Automatic recognition of the measuring configuration
- State-of-the-art modular design enables easy expansion
- Simple operation under Windows NT
- User-friendly help system
- Large number of country-specific and manufacturer-specific protocols

For further information see page 396, or on the web at www.tektronix.com/Measurement/commtest/



Mobile Networks

The low-cost and lightweight K1205 provides a cost-effective solution to quickly and accurately troubleshoot, maintain and manage wired and mobile networks.

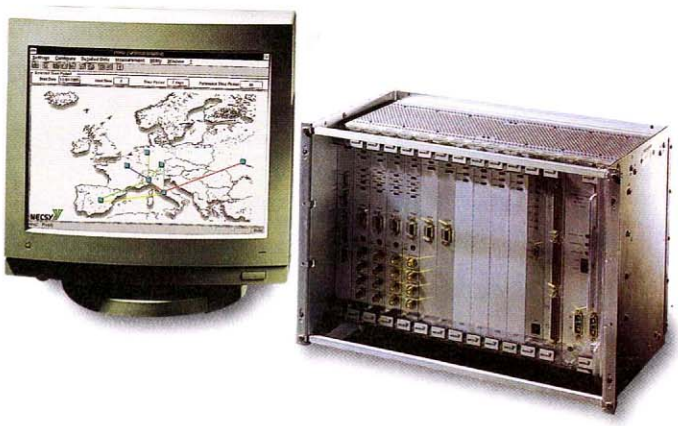
New Products

Net-C Monitoring System

Monitoring systems are designed to measure voice, data and fax transmission quality for fixed and mobile networks. Essential to providing quality service, these systems are used by network operators to assess the service and to identify problems and malfunctions within the network before they affect the customer.

Containing non-intrusive algorithms (INMD/ITU-T P.561), the product can be used by network operators to monitor and analyze the transmission quality of 2-Mb/s telephone systems. It can also be used to detect fraud and network misuse, such as call back, blue box, refile, GSM roaming fraud and cloning, estimated to cost telephone network operators up to $4 billion per year, according to industry experts.

For further information see page 389, or on the web at www.tektronix.com/Measurement/commtest/



Mobile Networks

The NET-C monitoring system, provides users with centralized control for assessing quality of service (QoS) and detecting fraud in real-time, mobile and fixed telecommunications networks.

Core Networks

Tektronix continues to broaden its photonics-test product portfolio with industry-leading solutions that address the latest requirements.

Significant increases in network capacity requirements have driven the demand for rapid deployment of new core network technologies. Consequently, test and measurement plays a key role in enabling the development and deployment of these networks.



New Products

Key Features and Benefits of the ST2400A Option 42

Receive Error Count

Transmit Error Insertion

Transmit and Receive Payload Patterns

Automatic Protection Switch (APS) Time Measurement

ST2400A SDH/SONET Test Set

The ST2400A SDH/SONET Test Set verifies the end-to-end integrity of 2.488-Gbit/s networks. Network operators installing high-speed packet-based networks will benefit most from the new capabilities of the ST2400A. The ST2400A can emulate the characteristics of an SDH or SONET network element. The ST2400A is optimized for testing the transmission quality of 2.488 Gbit/s STM-16 (SDH) or OC-48 (SONET) networks transported over DWDM systems.

To minimize test time, the Tektronix ST2400A can be used to economically test all channels of a DWDM system in parallel. One optical input signal is split multiple ways, and the test person deploys this set-up with the necessary number of ST2400As at the receive end. This enables the user to save time without incurring the high capital costs of parallel test. This approach also allows the user to allocate financial resources where they are most needed – at the receiver, where the data must be analyzed.

NEW RECEIVER AND TRANSMITTER CAPABILITIES

The variable receiver-decision threshold allows the tester to emulate system noise caused by optical amplifiers, and therefore better emulates the entire system. The ST2400A can emulate a legacy system by allowing the user to adjust and set the decision threshold in accordance with system characteristics. It will then produce an error result that more closely predicts the behavior of older systems.

The variable receiver-decision threshold may also provide an easy way to accelerate the measurement of a very low (e.g., $1x10^{-14}$) BER. This will save users significant test time at 2.488 Gbit/s.

New transmitter inputs of 1.544 Mbit/s, 2.048 MHz and 2.048 Mbit/s facilitate external timing synchronization of SONET and SDH systems. The ST2400A's Pseudo-Random Bit Sequence (PRBS) allows emulation of live-traffic transport under test conditions.

For further information see page 344, or on the web at www.tektronix.com/Measurement/commtest/

CTS 850 SDH, PDH, Jitter and Wander Test Set

The CTS 850 provides the most complete jitter and wander test solution. With its 300 UI jitter-measurement range, the CTS 850 can capture the pointer hits and counts useful for troubleshooting such time-sensitive services as 2-Mbit/s GSM and PBX. It can also measure frequency drift rates, enabling users to assess the existence and magnitude of timing impairments in video and GSM services. Available with a complete set of masks, the CTS 850 can also measure down to 0.1 Hz, with variable high-pass cut-off frequency, to fully characterize phase transients.

For further information see page 338, or on the web at www.tektronix.com/Measurement/commtest/



Core Networks

CTS 850 analyzes 2-Mbit/s to 622-Mbit/s digital broadband networks.

The CTS 850 is the first test set in the industry to incorporate the ITU-T Recommendation O.172, a standard proposed by the International Telecommunication Union for jitter and wander measuring equipment.

New Products

The Q7750 Optical Network Analyzer

The Q7750 Optical Network Analyzer. The Q7750 was developed for optical transmission design engineers and component manufacturers in the Dense Wavelength Division Multiplexing (DWDM) market.

By providing 600 data points in four seconds, the Q7750 Optical Network Analyzer rapidly yields optical carrier-frequency measurements for optical elements. In addition, the Q7750 analyzer, with its narrow group delay measurement range of 25 ns and maximum resolution of 0.1 ps, allows engineers to accurately measure the overall chromatic dispersion of optical components, modules, and systems.

The Q7750 Optical Network Analyzer quickly and accurately characterizes a variety of optical communication devices including arrayed waveguided gradients, fiber bragg grating filters, and dispersion compensators.

For further information see page 328, or on the web at www.tektronix.com/Measurement/commtest/



Core Networks

The Q7750 provides superior amplitude, chromatic dispersion, and group delay measurements for testing optical communication devices.

CORE NETWORKS

LPB SERIES

The LPB series of tunable laser diode sources help component designers and manufacturers fully characterize optical communications systems, particularly DWDM.

TUNABLE LASER DIODE SOURCES LPB1100, LPB1300, LPB1550

Features and benefits include:

- Mode-hop free for smooth and accurate wavelength tuning
- High power output for low noise measurements and real-life signal emulation
- Wide spectral range to fully characterize designs within the wavelength window of interest
- Amplitude modulation and mode-locked operation for non-continuous wave test requirements
- Fine tuning for precise wavelength (frequency) resolution
- Characterization of fiber optic components (splitters, couplers, Bragg grating, etc.)
- Characterization of optical amplifiers (EDFAs, etc.)
- Testing of optical communication transmission systems
- Emulation of DWDM optical signals

For further information see page 303, or on the web at www.tektronix.com/Measurement/commtest/



NEW PRODUCTS

CORE NETWORKS

D3186/D3286

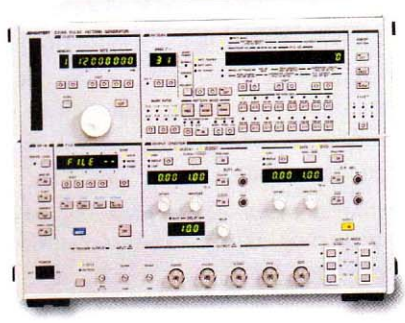
The D3186/3286 BERT provides designers with the ability to evaluate and analyze high-speed communications systems, such as DWDM and SONET/SDH.

D3186/D3286 12 GB/S BIT ERROR RATE TESTER (BERT)

The D3186/D3286 BERT, a high performance bit error rate tester (BERT) excels at characterizing and analyzing high-speed digital telecommunications network devices such as integrated circuits (ICs) and high-speed optical components, as well as dense-wavelength division multiplexing (DWDM) and high-speed SONET/SDH transmission systems. Designers and manufacturers can use the D3186/D3286 BERT to evaluate and analyze high-speed communications systems, including high-speed logic devices, multiplexers, repeaters, and digital transmission systems up to a frequency range of 12 Gb/s. For instance, the tester can be used to verify the integrity of a 10 Gb/s transmission system by enabling the user to simulate and detect errors in SONET/SDH traffic.

Compatible with optical transmission standards OC3/STM-1 (155.52 Mb/s) to OC192/STM-64 (9.95 Gb/s), the D3186/D3286 BERT operates at frequencies ranging from 150 Mb/s to 12 Gb/s. The product can also generate SDH and SONET frames that allow users to evaluate information under conditions virtually identical to real data. The cross-point position of the data waveform can easily be varied with a simple twist of a knob, located on the front of the tester, to enable users to compensate for waveform output and mark the ratio evaluation of high-speed logic IC and laser diodes. Finally, the D3186/D3286 BERT provides multi-channel outputs and 8 MB of memory to generate WORD, PRBS, and mixed patterns.

For further information see page 332, or on the web at www.tektronix.com/Measurement/commtest/



Modular Laser-Source Mainframe LPM5000

Features and benefits include:

- Modular form factor provides flexibility for multi-wavelength applications
- Large display and easy controls for adjusting the parameters of up to eight modules
- Mainframe form factor allows convenient rack mounting (19 in. rack)
- IEEE std-488.2 and RS-232-C compliant for automated test environments
- Internal and external amplitude modulation operation for noncontinuous wave test requirements

For further information see page 306, or on the web at www.tektronix.com/Measurement/commtest/



Core Networks

LPM SERIES

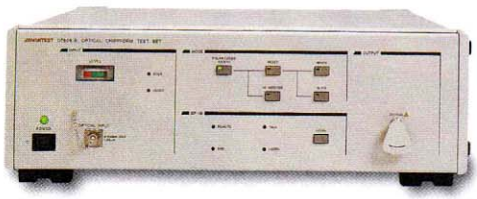
The LPM series of modular laser sources enable component designers and manufacturers to fully characterize optical communications systems, such as DWDM.

Q7606 Chirp Test Instrument

The Q7606 Chirp Test Instrument quickly calculates the alpha chirp value in under 45 seconds for optical communication signals transmitting 10 Gbps or less.

At these transmission speeds, the system can experience intersymbol interference because the optical signal's wavelength briefly shifts. This brief wavelength shift enlarges the width of optical signals in the time domain, creating what is referred to as chirp.

Until now, engineers could not quickly measure chirp with such excellent resolution and repeatability performance. The Q7606 chirp instrument decreases testing time from 20 minutes to under 45 seconds and provides the highest resolution for chirp measurements at <20 MHz. **See page 312.**



Q8163 Optical Polarization Scrambler

The Q8163 Optical Polarization Scrambler and Q82232 Optical Sensor – that, when used with the Q8221 Optical Power Meter and Q82203 Interface Plug-in, provide a complete system for measuring Polarization Dependent Loss (PDL) and associated PDL wavelength-dependency characteristics in optical devices. This system performs one PDL measurement per second with an accuracy of ±0.01 dB.

The Q8163 optical scrambler provides fast polarization variances of up to 500 Poincaré Sphere rotations per second. This enables users to quickly generate random optical polarization states, thus significantly reducing PDL measurement time. The Q8163 scrambler also provides an insertion loss of ≤ 3 dB. **See page 318.**



Core Networks

The Q7606 Chirp Test Instrument, provides engineers with a fast and reliable method for measuring chirp in high-speed DWDM and SDH/SONET systems.

The Q8163 Optical Polarization Scrambler and Q82232 Optical Sensor enable PDL measurements when combined with the Q8221 Optical Power Meter and Q82203 Interface Plug-in.

ACCESS NETWORKS

TELEPHONE PRODUCTS

If your job is to analyze and troubleshoot the access network for analog or digital services, the Tektronix TelScout® TS200 is built for you. Designed specifically for telephone access network applications, including xDSL, ISDN, and POTS.

The TelScout TS200 applies the newest technology to provide both ease-of-use and telephony performance that cannot be found in any other access network analyzer.

HANDHELD ACCESS NETWORK ANALYZER

Tektronix offers a full line of optical and metallic test products for access networks. The primary focus of our new access network products is on enabling mass deployment of digital services. Our objective is to provide products to assist customers in improving quality and reducing costs for these rapidly growing and highly competitive services.

TELSCOUT™ TS200

The TS200 is a handheld access network analyzer for use in clearing and testing outside plant for xDSL and ISDN services. The TelScout® TS200 also offers plain old telephone system (POTS) and time domain reflectometer (TDR) measurement capabilities to meet the communications industry's need to deliver analog and digital services supporting applications such as high-speed Internet access and video conferencing.

As telecommunications customers increasingly demand high-speed digital services over their existing outside plant, the measurement and qualification of the access network have become critical.

Features and benefits include:

- TestWizard™ - true one-button testing
- Full function TDR with automatic multiple event marking
- Flexible, upgradeable platform
- Complete on-line help and tutorials
- Rugged design - survives 2 m drop
- Automatic hazardous voltage safety warning
- Extra large, high-contrast, backlit display

For further information see page 373, or on the web at www.tektronix.com/Measurement/commtest/

NEW PRODUCTS

A helpful xDSL poster explaining and mapping the various services and a comprehensive telephone access network measurements book are available on the web at www.Tektronix.com To read or print these documents, go to the website and follow the instructions provided– or contact your local account manager for paper copies.



www.tektronix.com/Measurement/commtest/

CATV PRODUCTS

The DMA120 Series of portable field tools now provides comprehensive in-service performance verification measurements for both 64- and 256-QAM transmissions. Network operators activating digital transmission of video or downstream highspeed digital services on the RF Broadband System will use the DMA120 Series.



DMA120 SERIES

- Automated in-service measurements of signal level, adjacent channel levels, modulation error ratio (MER), estimated noise margin, error vector magnitude (EVM), and BER before – and estimated BER after – forward error correction (FEC). These measurements allow operators to determine acceptable transmission quality quickly and easily, without removing channels from service.
- At-a-glance troubleshooting. The constellation display mode provides a graphic view of view of phase and amplitude distortion caused by transmission impairments, without removing the channel from service. The spectrum display mode allows direct viewing of channel flatness and symmetry, and sidebands. The equalizer tap coefficients, which indicate linear impairments such as unflatness.
- Portable and battery-operated. Weighing just 2.1 kg (4.6 lbs.), the DMA120 Series is easy to carry up a pole or into difficult-to-reach locations. The battery is user-changeable.
- PCMCIA expansion slot. This accommodates a memory expansion card, which enables storage of a large number of measurement results for later analysis.

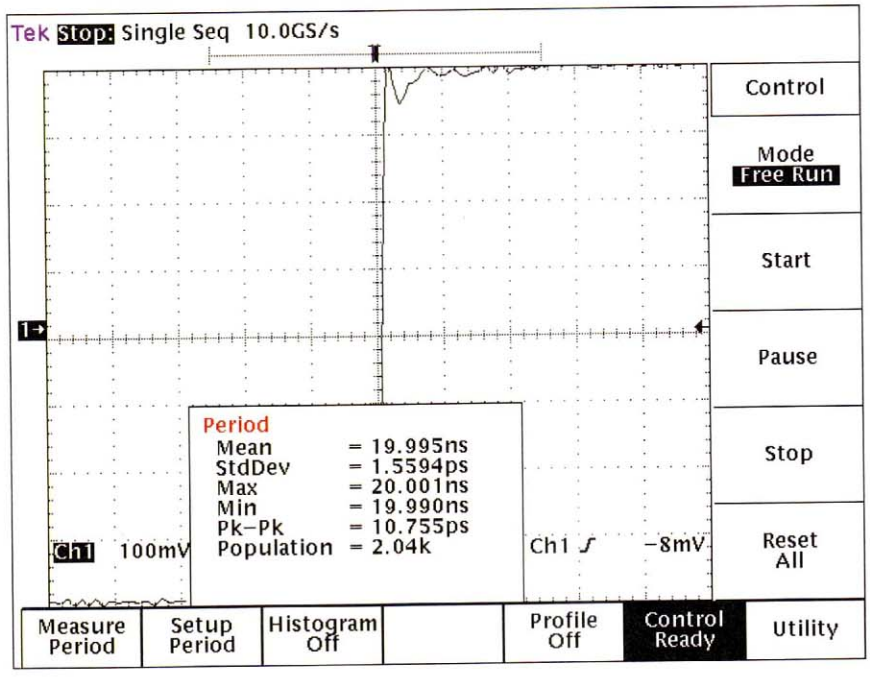
For further information see page 353, or on the web at www.tektronix.com/Measurement/commtest/

Oscilloscope Software

Java Powered™ Applications for the TDS500D600C/700D

Java Powered™

EmbeddedJava Technology allows Tektronix to deliver application specific measurements in a timely and cost-effective manner while building a library of utilities that enables the rapid development of additional applications.



TDSJIT1

TDSJIT1

TDSJIT1 Performs a suite of jitter measurement with unprecedented accuracy on single-shot waveforms. Jitter information can be displayed as statistics, histograms, or profiled.

TDSPSM1

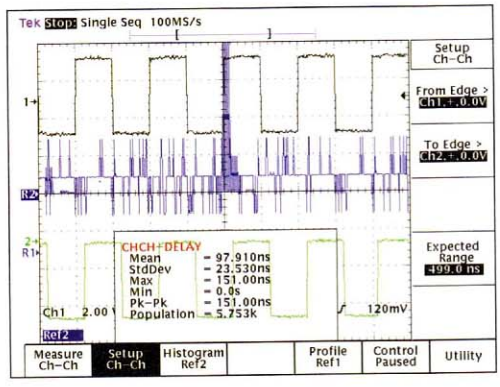
TDSPSM1 introduces a revolutionary way for making timing measurement by providing statistics on specific data and clock edges that are fully time-correlated. This application also performs automated AC timing measurements on all parameters in single-shot acquisitions.

TDSCEM1

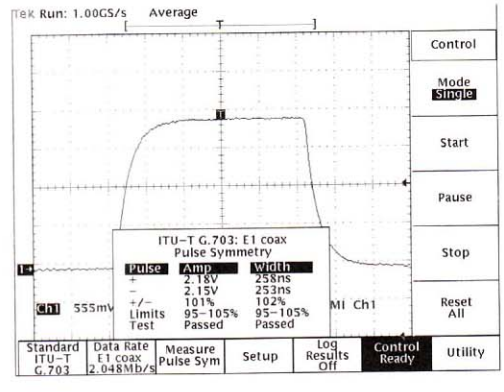
TDSCEM1 performs a suite of automated eye diagram measurements on SONET/SDH and Fibre Channel standards. These measurements include eye height, eye width and quality factor.

TDSCPM1

TDSCPM1 performs automated parametric measurement of pulse amplitude, spectral power, and pulse symmetry to standard requirements. Standards include ANSI T1.102, and ITU-T G.703.



TDSPSM1



TDSCPM1

NEW PRODUCTS

Sun, the Sun logo, Sun Microsystems, Java, EmbeddedJave and The Network Is The Computer are trademarks or registered trademarks of Sun Microsystems, Inc. in the United States and in other countries.

OSCILLOSCOPES

TDS Tektronix Digitizing Scope – An innovative advanced performance oscilloscope, featuring multi-processor speed and flexibility, advanced acquisition and triggering capabilities and a unique graphical user interface for intuitive operation.

TDS 800 Digital Sampling Oscilloscope – The TDS 820 provides design and test engineers with up to 8 GHz bandwidth for characterization of repetitive signals. The TDS 820 simplifies the use of a sampling oscilloscope without compromising features or performance.

TDS 700/500 Digital Phosphor Oscilloscopes – Digital Phosphor Oscilloscopes display, store and analyze complex signals in real-time, using three dimensions of signal information: amplitude, time and distribution of amplitude over time. The TDS 700/500 Series offer a well rounded package of high-fidelity acquisition, advanced triggering, automatic measurements and communication signal analysis. TDS 700/500 are the most powerful debug tools for electronic design applications.

TDS 600 Digital Storage Oscilloscopes – The TDS 600 Series provides design engineers the best tool for characterizing their digital designs. They offer the highest performance levels of real-time acquisition and a powerful set of triggering and measurement functions.

TDS 400 Digital Storage Oscilloscopes – For professionals who demand high precision and fidelity from their measurements, the TDS 400 combines excellent performance and a broad feature set, all at affordable prices.

TDS 3000 Digital Phosphor Oscilloscopes – The TDS 3000 Series are the newest Tektronix Digital Phosphor Oscilloscopes. They were specifically developed for mainstream design applications with their unmatched combination of real-time performance, triggering, and automatic measurements all in a small, light and battery operated package. With a color display, floppy drive, FFT analysis, and advanced triggering available, the TDS 3000 delivers advanced capabilities and performance.

TDS 200 Digital Storage Oscilloscopes – The world's most popular oscilloscope, the TDS 200 Series real-time Oscilloscopes are for engineers and technicians who need a compact, easy to use, low cost oscilloscope that will improve productivity and measurement quality. There is no better combination of performance, reliability, and affordability. The controls will be familiar to analog oscilloscope users both in function and format. Automatic measurements, stored waveforms, and other digital functions are controlled by on-screen menus in any of ten user-selectable languages.

THS 700 Digital Storage Handheld Oscilloscopes – The award winning THS 700 Series now includes: 200 MHz version – the highest performance handheld scope/DMM in the market. Power version – the first handheld scope to include automatic power measurements, statistics, and harmonics measurements. All four models in the new TekScope THS 700 Series feature Isolated Channels at full bandwidth with real-time sampling technology. A true RMS digital multimeter is a standard feature in the rugged, battery operated handheld package.

11800/CSA Sequential Sampling Oscilloscopes – The 11801C/CSA 803C series of oscilloscopes provide comprehensive measurement capabilities from DC to 50 GHz. The modular design of these oscilloscopes allows you to tailor the performance of your scope to meet specific application needs. You can select between a wide range of plug-in sampling heads that provide various different levels of bandwidth and noise performance.

ORDER ONLINE

Selected products will be available to order from our web site. For availability of this service see our web site at www.tektronix.com/Measurement/ebusiness

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From the highest performance to the most cost-effective solution, Tektronix offers a broad range of test and measurement instrumentation. Tektronix oscilloscopes provide the best connection to your device-under-test, the most accurate signal acquisitions, the sharpest waveform displays, and the most comprehensive on-board waveform measurements available.

It takes a broad range of oscilloscope products to satisfy the spectrum of measurement applications throughout the world today, and Tektronix delivers the product line breadth sought by customers worldwide.

Following Tektronix' tradition of bringing innovative products to the market with the introduction of the TDS 3000, Tektronix now has three families of Digital Phosphor Oscilloscopes including the TDS 500D and TDS 700D. Designed to keep pace with current and evolving needs in advanced electronic design and debug. DPOs deliver a new level of insight that must be seen to be believed. DPOs capture, store, display, and analyze, in real-time, three dimensions of signal information: amplitude, time and distribution of amplitude over time.



General Trends in Oscilloscope Development

Today you will find more and more special purpose oscilloscopes, such as the TDS 700D with their communications options, TDS 3000 with its video capability, CSA 803C and 11801C with bandwidth to 50 GHz and color graded display for thorough analysis of high-speed communication channels and standards testing.

Our TDS oscilloscopes include powerful digital signal processing engines which can give you simultaneous time and frequency domain displays with fast updates.

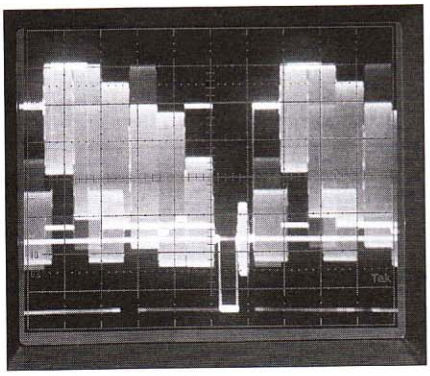
Our scopes are constantly getting easier to use. We've reversed the trend toward more buttons and menus. Our new models achieve a balance between performance and ease of use. We've done our homework, tested our ideas and greatly improved access to important new features without making the basic functions hard to find. Volts/division, time/division and trigger level have dedicated knobs so you can just grab and turn.

Measurement, trigger modes, hard copy setups and acquisition control lie within easy reach behind a graphic user interface (GUI). Information-packed displays are made easy to read with a high-resolution color monitor.

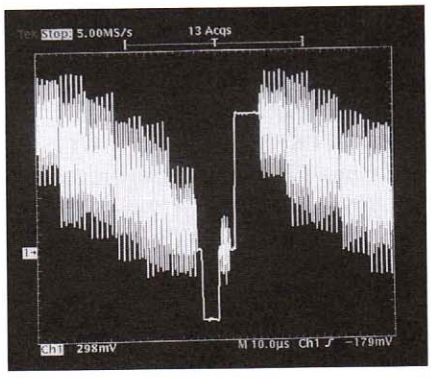
Tektronix Digital Phosphor Oscilloscopes, Digital Storage Oscilloscopes and Communication Signal Analyzers

These products include many innovative features designed to improve productivity and reduce operating costs. Tektronix oscilloscopes represent the best combination of performance features, human factors and price on the market today.

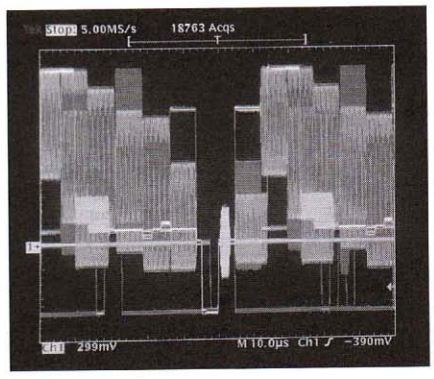
- Digital Phosphor Oscilloscopes go beyond analog real-time (ART) and digital storage oscilloscopes (DSO) by incorporating an information-rich, real-time display, that surpasses any analog or digital scope's capabilities. This new instrument delivers a new level of insight that makes dealing with complex signals straightforward, without loosing the full spectrum of digital acquisition, storage and analysis capabilities that engineers have come to expect in their oscilloscope solutions.
- Digital Phosphor Oscilloscopes make it possible to see, store and analyze complex signals, such as serial data streams that are seen in the telecommunications, data communications and computer/computer peripheral industries.
- Digital Phosphor Oscilloscopes provide three full dimensions of signal information-amplitude, time and distribution of amplitude over time, in real-time.
- Application specific measurements based on Java technology provide advanced analysis of acquired data, giving the user measurement results in familiar terms, specific to their industry.
- The TDS 700D DPO and CSA communication analyzers give an accurate assessment of noise, jitter and compliance to ITU and ANSI standards. Up to 50 GHz bandwidth with 2.0 ps RMS jitter (1.3 ps typically) is available in the CSA 803C.
- The High Bandwidth (50 GHz) 11801C offers the highest timing resolution and measurement repeatability. While the TDS 800 combines the sequential equivalent-time sampling technology of the 11801C with the mid-range TDS platform for DC-8 GHz bandwidth in a portable monolithic instrument.
- Using oversampling technology, DSOs offer single-event waveform capture to their full bandwidth. TDS 694C provides the highest accuracy delta time measurements at ±15 ps.
- The TDS 3000 DPO has specialized display, triggering and measurement capabilities for working with video signals.



Better than analog.



Better than digital.



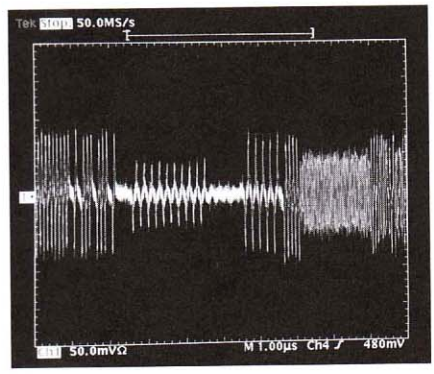
And more...

DIGITAL PHOSPHOR OSCILLOSCOPES

Digital Phosphor Oscilloscopes display, store and analyze complex signals in real-time, using three dimensions of signal information: amplitude, time and distribution of amplitude over time.

DPO goes beyond analog real-time (ART) and digital storage oscilloscopes (DSO) by incorporating an information-rich, real-time display, that surpasses any analog or digital scope's capabilities. This incredible new instrument delivers a new level of insight that makes dealing with complex signals straightforward – a level of insight engineers must see to believe. Of course, all of this is combined with the full spectrum of digital acquisition, storage and analysis capabilities that engineers have come to expect in their oscilloscope solutions.

Like the actual phosphor on an ART display, the DPO captures and remembers the frequency of events, resulting in a three-dimensional array that retains information for hundreds of millions of samples. Chemical phosphorescence creates a gray scale because of the decay in its energy over time. Digital phosphor replicates this decay in intensity by digitally controlling the replacement of data in the three dimensional array. As a result, a DPO can display, store and analyze three dimensions of signal information: amplitude, time and the distribution of amplitude over time.



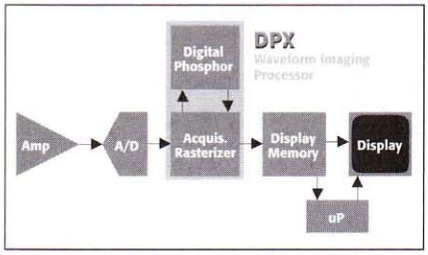
Disk Drive Signal seen in a TDS 784D Digital Phosphor Oscilloscope.

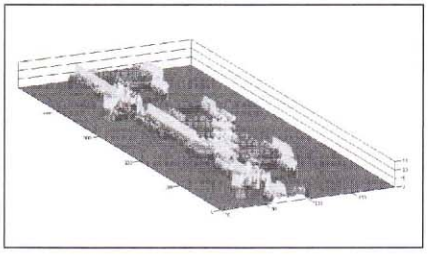
The DPO model takes a hardware-based approach to achieve this remarkable performance. Using advanced ASIC technology. It accumulates multiple images of signal information in a 500 x 200 array of integers. Each integer represents a pixel in the DPO's display and is used to control intensity. As a signal is acquired over time, this array is continuously updated with image after image of the signal. Unlike DSOs that decimate or throw away an enormous number of samples, the incoming samples are acquired at rates comparable to an analog scope and are all used to create the image. As a result, engineers are finally protected against aliasing because of the abundance of samples collected and used by DPO.

Creating this detailed image of a waveform's activity and intensity in hardware allows a real-time response similar to an ART. The acquisition engine continuously samples at the maximum rate, triggering and building image after image with minimal dead time between acquisitions. A new snapshot of the digital phosphor is sent to the display every 1/30th of a second, creating an image that responds to waveform activity in real time. Even when the display is updated, the digital phosphor continues to gather new samples. The parallel architecture and hardware-based processing enables the DPO to capture all the details and anomalies that occur in today's complex, dynamic signals and to display as fast as the human eye can assimilate them.

This real-time processing is what sets the DPO apart from post-processing modes, such as persistence, found in today's DSOs. The post-processing in a DSO is executed in software on the normally acquired waveforms, and it requires acquisition over a long period of time to build up the display, thus prohibiting instantaneous feedback. The time for creating this display is further exaggerated as multiple channels are turned on, since they use the same microprocessor. Plus during this processing time, the DSO is no longer acquiring new information and is forced to miss salient details on dynamic waveforms and important aperiodic events, often the very behavior an engineer is hoping to uncover and examine. DSOs consequently are limited to capturing infrequent snap shots of less than 1% of the available signals.

The benefits of using a DPO in electronic design, debug and test are dramatic. By providing a third dimension of information, engineers gain new and important insights into the behavior of complex signals, enabling them to accurately interpret signal dynamics, including the mode of changes in the signal and the frequency of occurrence of signal phenomena. Instead of using two instruments – an ART to see all the nuances on the waveform and a DSO to capture, measure and analyze signal behavior – they can use one powerful tool. This will undoubtedly lead to more effective debug and performance verification, helping to streamline the overall design and maintenance tasks.





DIGITIZING OSCILLOSCOPES

TDS SERIES

POWERFUL ACQUISITION

- Digital Phosphor Oscilloscopes
- 3 GHz real-time bandwidth (TDS 694C)
- XYZ mode (TDS 500D/700D)
- Four channels of 10 GS/s (TDS 694C)
- Record lengths of 8,000,000 points (TDS 500D/TDS 700D, Opt. 2M)
- Up to 8 GHz bandwidth (TDS 820, Opt. 1D)

ADVANCED TRIGGERING

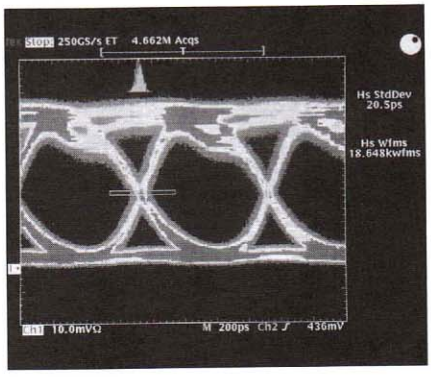
- Glitch triggering (TDS 500D/TDS 600C/TDS 700D)
- Exclusive runt triggering (TDS 500D/TDS 600C/TDS 700D/TDS 3000)
- HDTV video triggering (TDS 500D/TDS 600C/TDS 700D/TDS 3000)
- Setup and hold time violation triggering (TDS 500D/TDS 600C/TDS 700D/TDS 3000)
- Slew rate triggering (TDS 500D/TDS 600C/TDS 700D/TDS 3000)
- Communication standard triggering (TDS 500D/TDS 700D, Opt. 2C)

POWERFUL PROCESSING

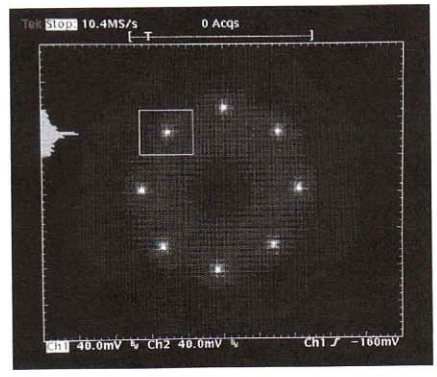
- Application specific measurements based on Java technology
- Histograms and statistical math
- FFT analysis
- Manufacturing pass/fail testing
- On-board mask compliance testing (TDS 500D/TDS 700D, Opt. 2C)
- Jitter measurements

TEKTRONIX QUALITY AND RELIABILITY

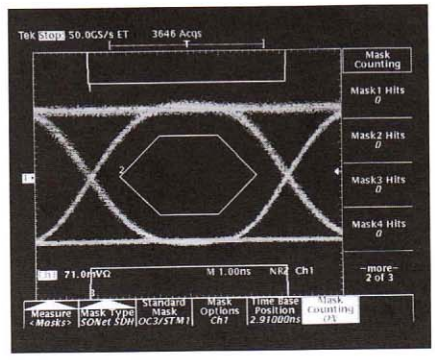
Tektronix' oscilloscope quality and reliability are unmatched. Designs are thoroughly scrutinized and tested to ensure compliance with all applicable safety and environmental standards. Calibration is traceable to national standards and conforms to military procedures. Our service network is designed to help you keep your oscilloscope calibrated and working with fast turnaround.



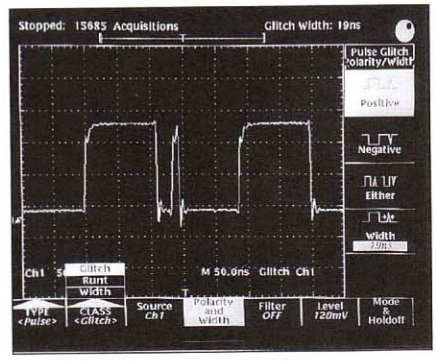
The TDS 794D with 2 GHz Bandwidth enables real time analysis of high frequency signals.



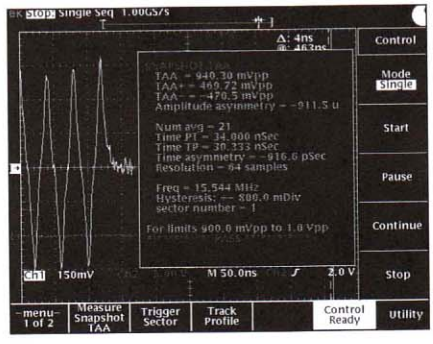
Tektronix TDS 500D/700D DPOs are the first digital oscilloscopes with XYZ mode.



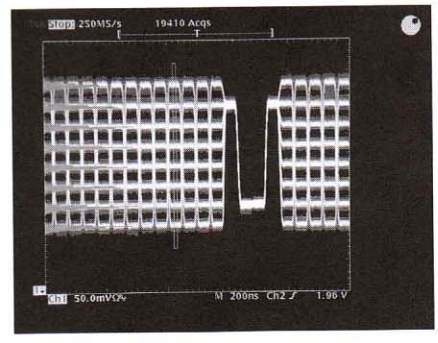
The optional Comm Trigger addresses the need to acquire a wide variety of AMI, CMI and NRZ communication signals. (TDS 500D/TDS 700D, Opt. 2C).



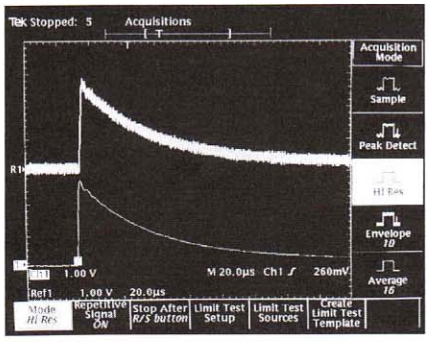
TDS triggering can capture glitches as narrow as 1 ns to help solve prototype circuit problems quickly.



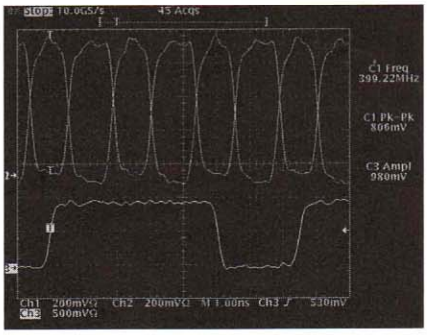
Application specific measurement packages enhance the DPOs ease of use.



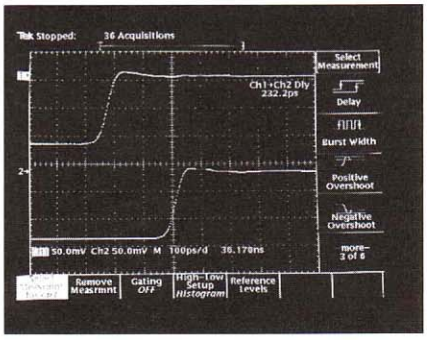
Histograms and statistical measurements are available in YT mode as well as XYZ mode.



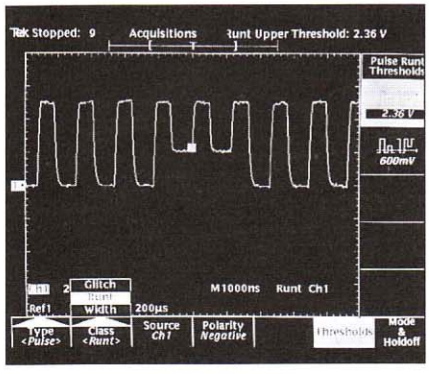
Hi-Res acquisition mode achieves extremely high signal to noise ratios (SNR) on single-shot events by oversampling the input signal.



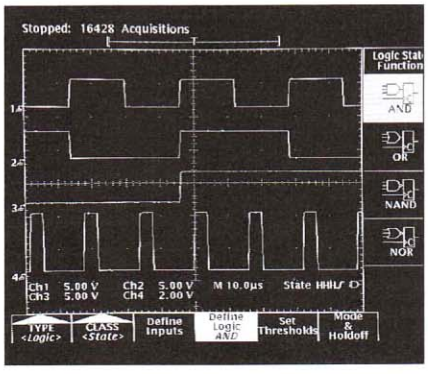
The TDS 694C provides four channels of 3 GHz, 10 GS/s acquisition to capture events with high single-shot resolution.



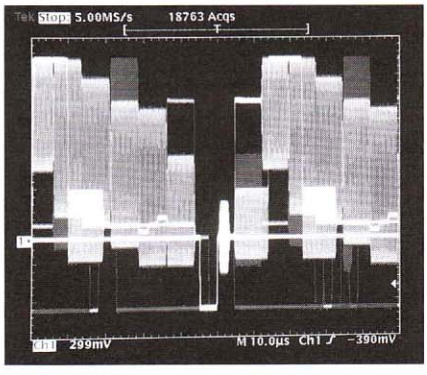
The TDS 820 provides 0.4 ps timing resolution and channel deskew capability to accurately measure delays in today's high-speed digital systems.



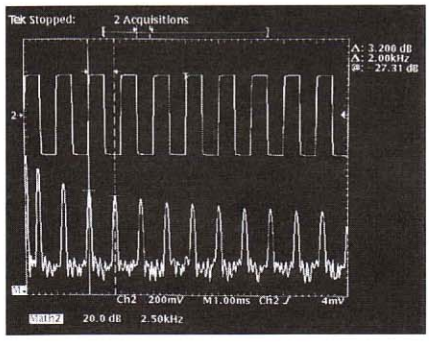
TDS exclusive runt triggering helps isolate invalid logic levels such as those caused by setup and hold violations.



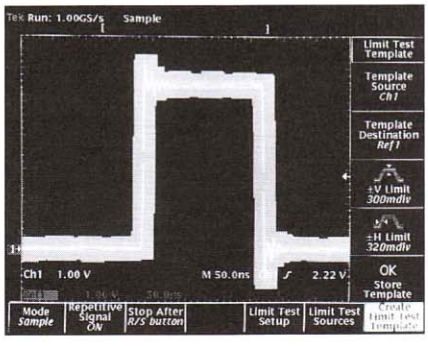
Logic timing analysis is clearly faster and easier with icon-driven state triggering.



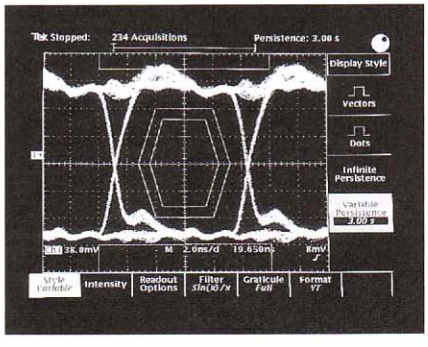
Optional Video Trigger combined with DPO acquisition allows you to see details in video signals.



FFT analysis provides an extra dimension of performance with simultaneous displays in the time and frequency domains.



Automatic on-the-fly limit testing makes manufacturing pass/fail testing an easy task (all TDS 400A, TDS 500D, 600C, 700D and 800 models).



On-board mask testing capability allows comparison of signals to standard masks in communication systems (TDS 820/TDS 500D/TDS 700D, Opt. 2C).

SELECTING AN OSCILLOSCOPE

The first step in selecting an oscilloscope is to know what you're expecting to see with the scope. In other words, what are the typical characteristics of the signals you need to capture and view. Are your signals of a complex nature? Are your signals repetitive or single shot? What is the bandwidth and/or rise time of the signals or transients you need to capture? On what signal characteristics will you need to trigger – runts, pulse widths, slew rates, glitches? How many signals do you need to display simultaneously? The answers to these questions will determine the type of scope you need. Which brings us to the actual oscilloscope and data sheet considerations: Digital Phosphor Oscilloscope, DSO, bandwidth, sample rate, waveform capture rate, record length, triggering and other capabilities.

THE "5 TIMES" RULE FOR BANDWIDTH

An Oscilloscope's bandwidth specification gives you an idea of the instrument's ability to handle high-frequency signals. If the bandwidth of your scope is inadequate, high frequency information will be filtered out and critical timing information may be displayed inaccurately. It's important to remember that a scope's bandwidth is derived from how well it reproduces a sine wave. If you're dealing with high-speed digital electronics, you may never see a sine wave. A good rule of thumb for determining the bandwidth you need is to use the "5 times rule": to figure out the bandwidth of the scope you need, multiply the highest frequency component of the signals you want to examine by five. This will typically give you better than 2% accuracy in your measurements.

In some applications you may not know the bandwidth of the signal of interest, but you will know the risetime. The frequency response of most scopes is designed so that a constant allows you to relate the bandwidth and risetime of the instrument using the equation:

–3 dB Bandwidth x Risetime = K

where: –3 dB Bandwidth is in Hertz, Risetime is the 10% to 90% risetime in seconds and K is a constant that depends on the oscilloscope input filter type.

As a general rule of thumb, when selecting an oscilloscope you can assume that the bandwidth to risetime relationship is about 0.4. Using this to calculate bandwidth will give you a ballpark figure that is sufficient for scope selection.

DPX WAVEFORM IMAGING PROCESSOR

Tektronix' DPOs are based on a new parallel processing architecture that integrates the acquisition and display systems. The proprietary DPX waveform imaging processor in the TDS 500D/700D was designed by Tektronix specifically for acquiring and managing the three dimensions of waveform information of the Digital Phosphor Oscilloscope. To ensure maximum throughput, it has distributed internal control and works independently of the other processors in the oscilloscope.

The DPX waveform imaging processor is completely dedicated to the acquisition and database management process. It includes an acquisition rasterizer and the digital phosphor three-dimensional database array that emulates the behavior of chemical phosphorescence to provide a real-time intensity-graded display. The basic operation of the DPX waveform imaging processor is drawing repeated images in the digital phosphor, controlling the rate of image decay, and periodically sending snap shots of that information to the oscilloscope's display system.

SAMPLE RATE

When considering digitizing oscilloscope characteristics and specifications, it's important to make a clear distinction between sample rate and waveform capture rate. A digitizing oscilloscope's sample rate is specified in Samples per Second and indicates how frequently the scope samples the input signal.

With higher sample rate, the signal is sampled more frequently allowing greater signal resolution.

The Importance of Adequate Sample Rate – The Nyquist sampling theorem states that the signal of interest must be sampled at least twice the rate of its highest frequency component to accurately reproduce it. While this is true "in theory," sometimes it isn't enough in practice. In reality, today's high speed digital signals should be sampled at least 5 times the rate of the highest frequency component (2.5 times the Nyquist rate) to be accurately reconstructed. Real-time sampling allows full bandwidth single shot acquisition and eliminates the need for repetitive sampling techniques.

TRIGGERING

Extended triggering capabilities offered in most Tektronix oscilloscopes allow you to capture complex signals for device characterization or troubleshooting. They also provide more selective trigger control than is available with conventional edge triggering. In addition, their sophisticated user interfaces allow rapid setup of trigger parameters to increase productivity.

Tektronix oscilloscopes allow you to trigger on pulses defined by amplitude (such as runt pulses), qualified by time (pulse width, glitch, slew rate, setup-and-hold and time-out), and delineated by logic state or pattern (logic triggering). Combinations of extended and conventional triggers also help display video and other difficult-to-capture signals. Advanced triggering capabilities such as these deliver a large degree of flexibility

SELECTION GUIDE

APPLICATION/PRODUCT		Type: Digital Phosphor	Type: Real-Time	Type: Sampling	Channels: 2-CH	Channels: 2+2-CH	Channels: 4-CH	Channels: IsolatedChannel™	Bandwidth: 100 MHz	Bandwidth: 200 MHz	Bandwidth: 400 MHz	Bandwidth: 500 MHz	Bandwidth: 1 GHz	Bandwidth: 2 GHz	Bandwidth: Over 2 GHz
Device Characterization	TDS 800			X	X				■	■	■	■	■	■	■
Design Debug/Comm Signal Analysis	TDS 700	X				X	X		■	■	■	■	■	■	
Design Characterization	TDS 600		X			X	X		■	■	■	■	■	■	■
Design Debug/Comm Signal Analysis	TDS 500	X				X	X		■	■	■	■	■		
Personal Lab Scope	TDS 400				X		X		■	■	■				
Design & Service	TDS 3000	X	X		X		X		■	■	■	■			
Test & Service	TDS 200		X		X		X		■						
Handheld Portable	THS 700		X		X			X	■	■					
Comm Signal Analysis/Device Characterization	11800/CSA			X	X		X		■	■	■	■	■	■	■

when setting up testing procedures and can greatly simplify measurement tasks.

RECORD LENGTH

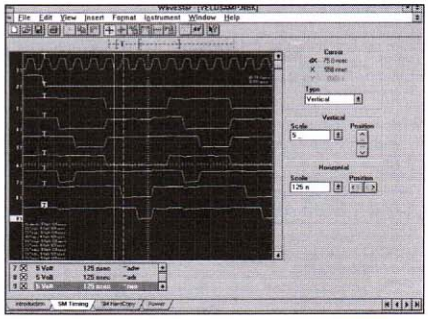
Maximum oscilloscope record lengths are available from 1 K points to 8 M points. Tektronix oscilloscopes provide adjustable record lengths that allow you to set the record length you need for a particular application – depending on the detail you need to see. If you are simply monitoring an extremely stable sinusoidal signal, for example, a 500 point record length may be adequate. But if you're trying to find the causes of timing anomalies in a complex digital data stream, a long record length is more appropriate. In addition, long record lengths provide the detail you need to capture and analyze single-shot events.

DATA MANAGEMENT AND CONNECTIVITY

DATA MANAGEMENT SOLUTIONS FOR OSCILLOSCOPES

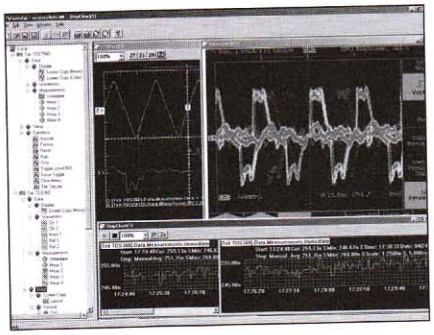
The new WaveStar™ Software for Oscilloscopes is a Windows 95/98/NT application bringing Tektronix oscilloscope measurement information to your PC desktop. WaveStar Software's familiar Windows features, such as drag and drop, provide the user a quick and simple means for inserting important instrument information into other Microsoft Office or Windows compatible applications. WaveStar Software allows users to easily capture, analyze and record instrument data, as well as professionally create, save and print documents. WaveStar Software also enables remote access and control of TDS or THS oscilloscopes on a PC, without the need for programming.

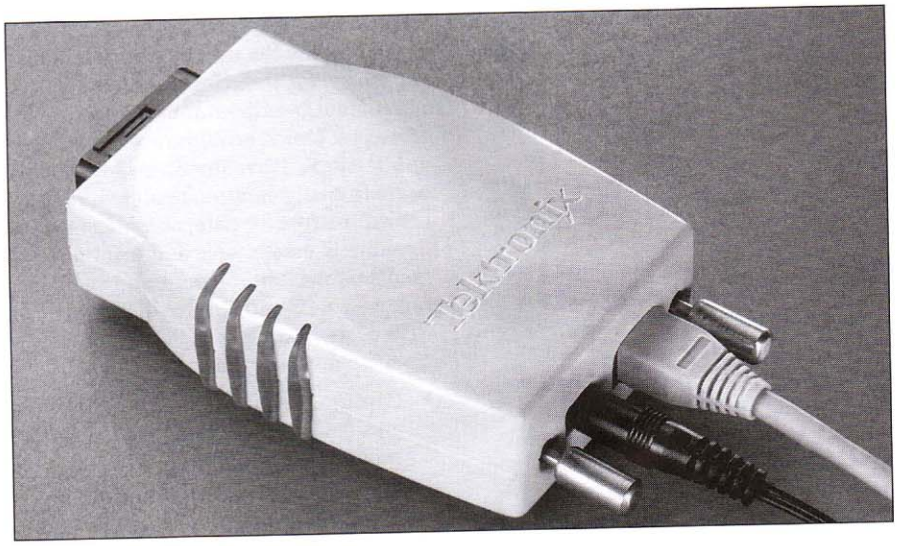
- Capture measurement waveforms and data easily, without the need for programming
- Data log from a single or multiple instruments
- Insert information seamlessly in Microsoft Office Applications or transfer to other Windows Applications, such as Mathcad™
- Communicate with TDS, THS, CSA/11800 oscilloscopes easily through an Instrument Connection Wizard



- Capture, EDIT, SAVE and RESTORE instrument settings
- Print banner function for hardcopy of long record lengths
- Control waveform information locally or over the network
- Step away from your desk and have WaveStar software automatically capture data changes
- For Windows 95/98/NT systems
- Use WSTRO free for 30 days

		Record Length							Triggering							Application Packages	Automatic Measurements	Waveform Math	FFT	Standard Mask & Template Testing	Harmonic	Floppy Disk	Hard Disk	Color Display
		1 K Max	2.5 K Max	15 K Max	50 K Max	120 K Max	500 K Max	8 M Max	Edge	Pulse	Logic	Video	Runt	Set-Up & Hold	Slew Rate									
DEVICE CHARACTERIZATION	TDS800								X								X	X	X					
DESIGN DEBUG/COMM SIGNALANALYSIS	TDS700								X	X	X	X	X	X	X	X	X	X	X	X		X	Opt.	X
DESIGN CHARACTERIZATION	TDS600								X	X	X	X	X	X	X	X	X	X	X			X	Opt.	X
DESIGN DEBUG/COMM SIGNALANALYSIS	TDS500								X	X	X	X	X	X	X	X	X	X	X	X		X	Opt.	
PERSONAL LAB SCOPE	TDS400								X			X					X	X	X			X		
DESIGN & SERVICE	TDS3000								X			X				X	X	X	X			X		X
TEST & SERVICE	TDS200								X			X					X	X	X			X		
HANDHELD PORTABLE	THS700								X	X		X					X	X			X			
COMM SIGNAL ANALYSIS/DEVICE CHARACTERIZATION	11800/CSA								X								X	X	X	X				X





AD007.

CONNECTIVITY SOLUTIONS FOR OSCILLOSCOPES

The AD007 GPIB – LAN Adapter Instrument to Local Area Network (LAN), allows you to control your Tektronix TDS oscilloscope from any networked PC, check on its status, or capture waveforms from your office, another site, or from anywhere using Tektronix WaveStar™ Software for Oscilloscopes application software or your own software. It also enables your TDS oscilloscope to print to a networked printer.

The Tektronix AD007 GPIB – LAN Adapter lets you take advantage of the fact that many of today's computers are connected together through an Ethernet 10BaseT LAN.

ACCESSORIES

PROBES AND ACCESSORIES

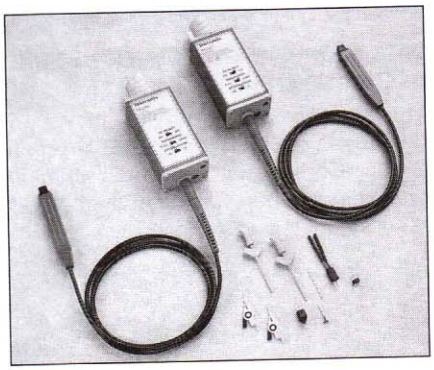
Tektronix continues to dedicate research and development resources to helping customers find ways to connect instrumentation to the changing variety of today's new devices and packages. You will find some innovative new probes and connecting schemes that quickly and cleanly couple to all kinds of devices.

P6248/P6247/P6246 HIGH SPEED DIFFERENTIAL

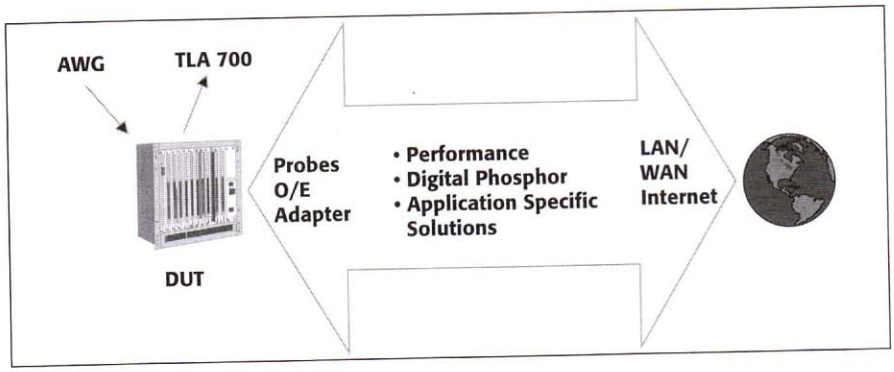
The P6248, P6246 and P6247 enable users to make time domain or frequency domain measurements on high bandwidth signals commonly found in disk drive, digital IC design and communication applications.

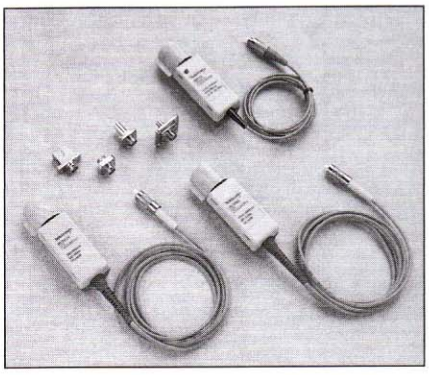
The small probe head geometry and assorted probe tip accessories allow these probes to easily accommodate manual probing of surface mount devices while maintaining high CMRR.

The P6248, P6246 and P6247 are ideal for design verification of disk drive read channel electronics, timing analysis or troubleshooting ground bounce problems associated with high speed logic. They can also be used for pulse shape or cross talk compliance testing at high speed communication signals.



P6247.

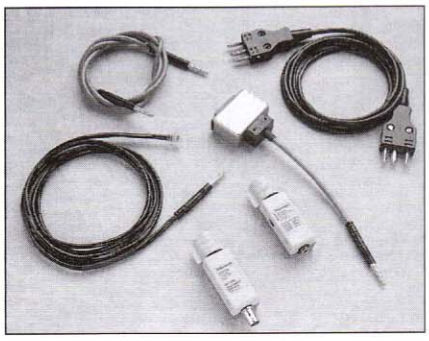




P6700.

P6700 O/E CONVERTERS

The Tektronix P6700 Series optical-to-electrical (O/E) converters change optical signals into electrical signals for convenient analysis on Tektronix TDS oscilloscopes equipped with the TEKPROBE® interface, or any other oscilloscope when used with the 1103 TEKPROBE power supply. The P6700 Series O/E converters are ideal for optical source characterization in the development, manufacture or service of optical communication systems and devices.



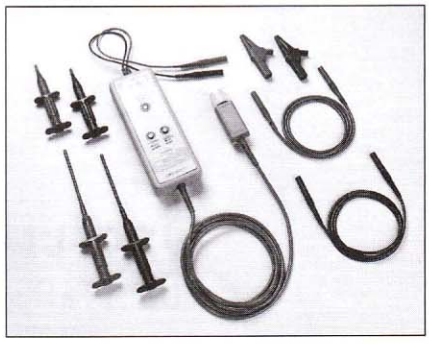
AFTDS, ATM75.

AFTDS DIFFERENTIAL SIGNAL ADAPTERS

The AFTDS Differential Signal Adapter and the AMT75 75 Ω Adapter provide an effective means for 50 Ω terminated instruments to connect to and analyze differential and high speed electrical communication signals as well as video signals.

Both adapters are rugged and have the TEKPROBE interface which provides convenient autoscaling of waveforms on Tektronix TDS Series oscilloscopes. Also the low VSWR (Return Loss) performance minimizes measurement errors commonly associated with interfacing with complex electrical signals.

Ideal for use in pulse shape compliance testing of high speed electrical communication signals.



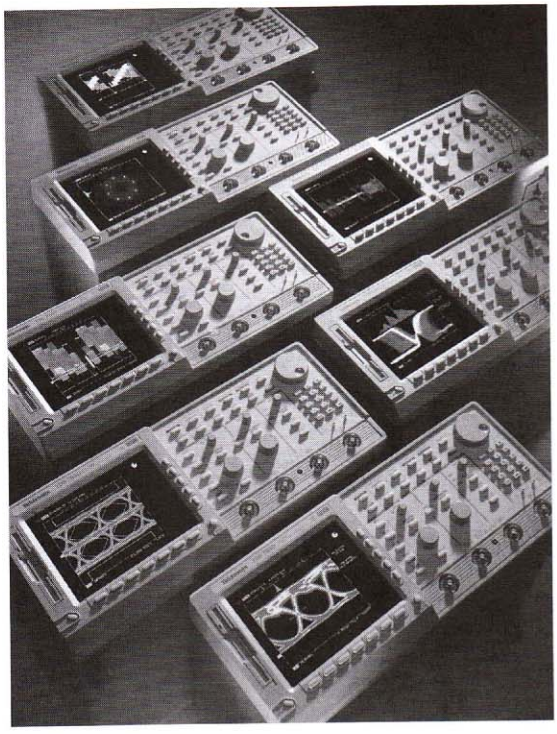
P5210.

DIFFERENTIAL SIGNAL ACQUISITION SOLUTIONS

Four products are available for acquiring differential signals. The ADA400A 1 MHz Differential Preamplifier allows single-ended oscilloscope measurements of very low signal levels (<10 μV) that are not ground referenced. The P5200, P5205, P5210 Differential Probes measure differential voltages up to 5,600 V and have bandwidths up to 100 MHz. The new P5210 Differential Probe measures differential voltages up to 5,600 V. With a bandwidth of 50 MHz, the P5210 probe easily measures those fast dV/dt transitions in switching power devices.

Oscilloscopes

TDS Series



Features – Benefits

- Digital Phosphor Oscilloscopes
- Advanced Applications Packages
- 60 MHz to 8 GHz Bandwidth
- 100 MS/s to 10 GS/s Sample Rates
- 2 and 4 Input Channels
- Advanced Logic Pattern and State Triggering
- Runt and Glitch Triggering
- HDTV Video Triggering
- High-resolution Color Display
- Record Lengths to 8 M Points
- 8– to 13-Bit Vertical Resolution
- Tektronix TriStar™ DSP for Fast Waveform Processing and Live Measurement Updates
- DSP Math Including FFT, Integration and Differentiation
- Communication Signal Analysis Including Mask Testing, Mask Autoset and SDH/SONET and Fibre Channel Optical Reference Receivers
- Automatic Measurements
- Pass/Fail Testing
- Easy Documentation with Saving of Image Files to Floppy Disk or Hardcopies Directly to Printer
- Full GPIB Programmability

Applications

- Research and Development
- Electromechanical Design
- Telecom Design and R&D
- Biophysical, Biomedical Research
- Power Supply Design
- Component Development and Characterization
- Service and Repair

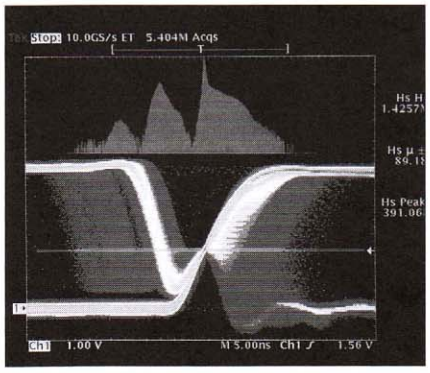
For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

TDS Oscilloscopes

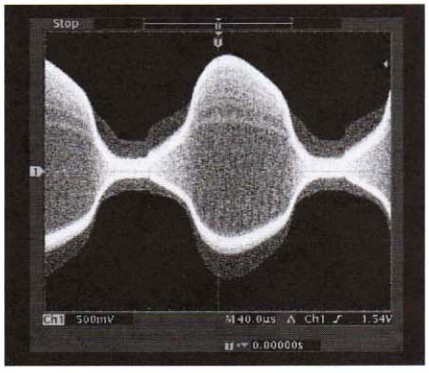
The TDS is a family of innovative oscilloscopes featuring multi-processor speed and flexibility, advanced acquisition and triggering capabilities and a unique graphical user interface for intuitive operation.

With the TDS, Tektronix introduced a new and innovative generation of digitizing oscilloscopes designed to keep pace with current and evolving needs across the electronics industry.

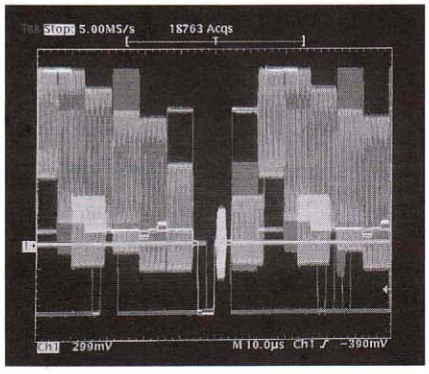
To address the complexity of the signals that the era of convergence brings, Tektronix' Digital Phosphor Oscilloscopes display, store and analyze complex signals in real-time, using three dimensions of signal information: amplitude, time and distribution of amplitude of over time. These TDS's go beyond analog real-time (ART) and digital storage oscilloscopes (DSO) by incorporating an information-rich, real-time display, that surpasses any analog or digital scope's capabilities.



The TDS 700D Digital Phosphor Oscilloscopes.



TDS 3000 Series Digital Phosphor Oscilloscopes.



Composite video signal.

TDS combines the performance needed with the ease of use demanded by customers in digital design; research and development; electromechanical design; power supply design; biophysical/biomedical high-speed component development and characterization; and telecommunications design and automated test.

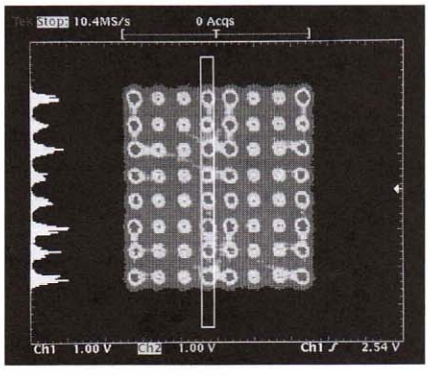
The TDS offers significant advantages over other oscilloscopes in four major areas:

HIGH-FIDELITY SIGNAL ACQUISITION

TDS offers sample rates ranging from 100 MS/s to 10 GS/s and bandwidths from 60 MHz to 8 GHz. TDS couples this performance with wide dynamic range, vertical resolution up to 13-Bits, fast overdrive recovery and 1 mV/div sensitivity. You'll find a model that precisely fits your needs.

POWERFUL AND FLEXIBLE TRIGGERING

TDS 3000, 500, 600 and 700 models feature very innovative and accessible logic triggering features that can isolate glitches, runts and timing problems quickly and reliably. Video triggering for NTSC, PAL, SECAM and custom video standards makes the TDS 3000 an excellent choice for video and display



64 QAM Modulation with histograms.

system design. Specialized HDTV triggering is available on the TDS 3000, 500, 600 and 700. 6 GHz trigger bandwidth in the TDS 800 and very low jitter make it ideal for high-speed component characterization and for telecommunications manufacturing, installation and maintenance. Four channels of 3 GHz real-time acquisition makes the TDS 694C a necessity for high-speed bus design applications.

MULTIPROCESSOR ARCHITECTURE

Our TriStar™ Digital Signal Processor complements a multi-processor design in all TDS Scopes to permit more measurement flexibility, instant response to commands and live waveform math including FFT and waveform pass/fail testing in the TDS 400, 500, 600, 700 and 800. Displays may be sent directly to a printer or plotter or exported as EPS (Encapsulated Postscript) or PCX (Microsoft Windows) files for use with common graphics and word processing software. The DPX™ waveform imaging processor makes the TDS 500D/700D the highest performance DPO's by providing the fastest waveform capture rate a deepest digital phosphor.

AFFORDABLE PERFORMANCE THAT IS EASY TO USE

A graphical user interface (GUI) makes operation intuitive. A familiar front-panel layout puts dedicated knobs for vertical, horizontal and trigger controls right where you expect to see them. This layout makes it easy for casual users to operate the basic oscilloscope features. Explanatory icons, pop-up menus, on line help and the VGA-quality display quickly guide users to even the most powerful measurement features. A color VGA display is available with the TDS 3000, 600 and 700.

SELECTION GUIDE:

	TDS 520D	TDS 540D	TDS 580D	TDS 724D	TDS 754D	TDS 784D	TDS 794D
Type	**DPO**	**DPO**	**DPO**	**DPO**	**DPO**	**DPO**	**DPO**
Signal Acquisition System							
Bandwidth	500 MHz	500 MHz	1 GHz	500 MHz	500 MHz	1 GHz	2 GHz
Channels	2+2	4	4	2+2	4	4	4
Sample Rate: 1 ch.	2 GS/s	2 GS/s	4 GS/s	2 GS/s	2 GS/s	4 GS/s	4 GS/s
2 ch.	1 GS/s	2 GS/s	2 GS/s	1 GS/s	2 GS/s	2 GS/s	2 GS/s
3, 4 ch.		1 GS/s	1 GS/s		1 GS/s	1 GS/s	1 GS/s
Record Length: Std.	50 K pts.	50 K pts.	50 K pts.	50 K pts.	50 K pts.	50 K pts.	50 K pts.
Opt.	4 M pts.*2	8 M pts.*3	8 M pts.*3	4 M pts.*2	8 M pts.*3	8 M pts.*3	8 M pts.*3
Vert. Resolution: Normal	8 Bits	8 Bits	8 Bits	8 Bits	8 Bits	8 Bits	8 Bits
w/ Averaging	11 Bits	11 Bits	11 Bits	11 Bits	11 Bits	11 Bits	11 Bits
w/ Hi Res	≥13 Bits	≥13 Bits	≥13 Bits	≥13 Bits	≥13 Bits	≥13 Bits	≥13 Bits
Vert. Sensitivity (/div)	1 mV-10 V	1 mV-10 V	1 mV – 10V	1 mV-10 V	1 mV-10 V	1 mV-10 V	10 mV-1 V (50 Ω)
Vertical Accuracy	±1%	±1%	±1%	±1%	±1%	±1%	±1%
Max Input Voltage (1 MΩ)*13	300 V Cat II	300 V Cat II	300 V Cat II	300 V Cat II	300 V Cat II	300 V Cat II	5 Vrms (50 Ω)*11
Linear Dynamic Range	±5 div	±5 div	±5 div	±5 div	±5 div	±5 div	±5 div
Channel Deskew	±25 ns	±25 ns	±25 ns	±25 ns	±25 ns	±25 ns	±25 ns
BW Limit	20, 250 MHz	20, 250 MHz	20, 250 MHz	20, 250 MHz	20, 250 MHz	20, 250 MHz	Full BW only
Time Base: Range	500 ps – 10 s/div	500 ps – 10 s/div	200 ps – 10 s/div	500 ps – 10 s/div	500 ps – 10 s/div	200 ps – 10 s/div	200 ps – 10 s/div
Accuracy	25 ppm	25 ppm	25 ppm	25 ppm	25 ppm	25 ppm	25 ppm
Delta Time Measurement Accuracy*14	±75.5 ps @ 2 GS/s	±75.5 ps @ 2 GS/s	±38 ps @ 4 GS/s	±75.5 ps @ 2 GS/s	±75.5 ps @ 2 GS/s	±38 ps @ 4 GS/s	±38 ps @ 4 GS/s
Peak Detection	1 ns	1 ns	1 ns	1 ns	1 ns	1 ns	1 ns
FastFrame™*4 Timestamp							
Std.: (372) 50-point frames	50 to	50 to	50 to	50 to	50 to	50 to	50 to
Opt. 2M: (1489) 50-point frames	50,000 points	50,000 points	50,000 points	50,000 points	50,000 points	50,000 points	50,000 points
Waveform Capture Rate (500 point waveforms/sec)	100,000	200,000	200,000	100,000	200,000	200,000	200,000
Display Sample Density (points/sec)	50 million	100 million	100 million	50 million	100 million	100 million	100 million
Triggering							
Trigger Jitter*15	8 ps	8 ps	7 ps	8 ps	8 ps	7 ps	7 ps
Trigger Conditioning	HF, LF, Noise Reject	HF, LF, Noise Reject	HF, LF, Noise Reject	HF, LF, Noise Reject	HF, LF, Noise Reject	HF, LF, Noise Reject	HF, LF, Noise Reject
Types: Edge	Std.	Std.	Std.	Std.	Std.	Std.	Std.
Pattern/State	4 inputs	4 inputs	4 inputs	4 inputs	4 inputs	4 inputs	4 inputs
Setup & Hold	Std.	Std.	Std.	Std.	Std.	Std.	Std.
Pulse Width	Std.	Std.	Std.	Std.	Std.	Std.	Std.
Glitch	1 ns	1 ns	1 ns	1 ns	1 ns	1 ns	1 ns
Runt Pulse	Std.	Std.	Std.	Std.	Std.	Std.	Std.
Slew Rate	Std.	Std.	Std.	Std.	Std.	Std.	Std.
Time Out	Std.	Std.	Std.	Std.	Std.	Std.	Std.
Comm	Opt.	Opt.	Opt.	Opt.	Opt.	Opt.	Opt.
External	Std.	Std.	Std.	Std.	Std.	Std.	Std.
Video*6	Opt.	Opt.	Opt.	Opt.	Opt.	Opt.	
Modes: Delay by Time/Event	Std.	Std.	Std.	Std.	Std.	Std.	Std.

SELECTION GUIDE:

	TDS 520D	TDS 540D	TDS 580D	TDS 724D	TDS 754D	TDS 784D	TDS 794D
Signal Processing							
Auto. Measurements	29	29	29	29	29	29	29
Math	+,-,x,÷,inv	+,-,x,÷,inv	+,-,x,÷,inv	+,-,x,÷,inv	+,-,x,÷,inv	+,-,x,÷,inv	+,-,x,÷,inv
Envelope	Std.	Std.	Std.	Std.	Std.	Std.	Std.
Average	Std.	Std.	Std.	Std.	Std.	Std.	Std.
Interpolation*7	Std.	Std.	Std.	Std.	Std.	Std.	Std.
FFT, Int., Diff.	Opt.	Opt.	Opt.	Std.	Std.	Std.	Std.
Limit Test	Std.	Std.	Std.	Std.	Std.	Std.	Std.
General							
Display Monitor	Mono	Mono	Mono	Color	Color	Color	Color
Inf. Persist, Vectors, Dots, YT, XYZ*12	Std.	Std.	Std.	Std.	Std.	Std.	Std.
Data Ports: VGA Out	Std.	Std.	Std.	Std.	Std.	Std.	Std.
GPIB	Std.	Std.	Std.	Std.	Std.	Std.	Std.
RS232	Opt.*8	Opt.*8	Opt.*8	Std.*8	Std.*8	Std.*8	Std.*8
Centronics	Opt.	Opt.	Opt.	Std.	Std.	Std.	Std.
Hardcopy/export Formats*9	Std.	Std.	Std.	Std.	Std.	Std.	Std.
Disk Drive (3.5 in.)	Std.	Std.	Std.	Std.	Std.	Std.	Std.
Online Help	Std.	Std.	Std.	Std.	Std.	Std.	
Standard Probes	2 ea. P6139A 500 MHz, 10X Passive	4 ea P6139A 500 MHz, 10X Passive	None	2 ea. P6139A 500 MHz, 10X Passive	4 ea. P6139A 500 MHz,10X Passive	None	None

TDS SELECTION GUIDE FOOTNOTES

**1 With Option 1D: Bandwidth = 8 GHz. Vertical Sensitivity = 1mV – 100mV/div. Max Input = ±3V, no pre-trigger.*

**2 Optional record length on TDS 520D/724D is: Opt. 1M: 250K pts (1-CH), 130K pts per channel (2-CH); Opt. 2M: 4M pts (1-CH), 2M pts (2-CH).*

**3 Optional record length TDS 580D/754D/784D/794D: Opt 1M: 500K pts (1-CH), 250K pts per channel (2-CH), 130K pts (3-, 4-CH). Opt 2M: 8M pts (1-CH), 4M pts (2-CH), 2M pts (3-, 4-CH).*

**4 Maximum number of 50 point frames is 372 (1489 with Opt. 2M installed). Frame lengths 50 –50,000 points.*

**5 TDS 400A triggered and untriggered roll. TDS 3000 and TDS 200 untriggered roll only.*

**6 TDS 3000: NTSC, PAL; TDS 200: Line, Field; TDS 400A: NTSC, PAL, SECAM; TDS 500D/600C/700D: NTSC, PAL, SECAM, HDTV, FlexFormat™.*

**7 Selectable sin(x)/x, linear. TDS 3000, TDS 200: sin(x)/x only.*

**8 Talk mode only, for hardcopy purposes.*

**9 Supported formats: TIFF, BMP, PCX, RLE, Interleaf (IMG), PostScript, LaserJet, Epson, ThinkJet, DeskJet, DPU411/412. TDS 3000/400A/500D/600C/700D also support Spreadsheet, MathCad™ waveform formats. TDS 200 support: Epson, ThinkJet, DeskJet, Laserjet, BMP, PCX, EPS, Interleaf.*

**10 User Interface menus in multiple languages.*

**11 Certain restrictions on range apply based on other instrument settings. Consult data sheets for details.*

**12 XYZ display mode not available on the TDS 520D and TDS 724D.*

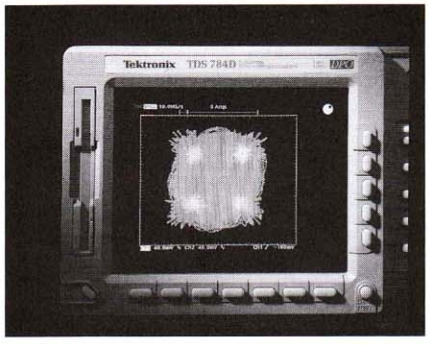
**13 Derate at 20 dB/decade above 1 MHz.*

**14 Assumes measurement of a 2 ns wide pulse. See individual product specification for complete formula.*

**15 Typical.*

**16 Option XL is mandatory for all TDS 400 Series.*

**17 TDS 2MM provides four additional automatic measurements and FFT analysis.*



SELECTION GUIDE:

		TDS 654C	TDS 680C	TDS 684C	TDS 694C	TDS 820
Type		**DSO**	**DSO**	**DSO**	**DSO**	**Sampling**
Signal Acquisition System						
Bandwidth		500 MHz	1 GHz	1 GHz	3 GHz	6-8 GHz*[1]
Channels		4	2+2	4	4	2
Sample Rate:	1 ch.	5 GS/s	5 GS/s	5 GS/s	10 GS/s	50 kS/s
	2 ch.	5 GS/s	5 GS/s	5 GS/s	10 GS/s	50 kS/s
	3, 4 ch.	5 GS/s	–	5 GS/s	10 GS/s	–
Record Length:	Std.	15K pts.	15K pts.	15K pts.	30K pts.	15K pts.
	Opt.				120K pts.	
Vert. Resolution:	Normal	8 Bits	8 Bits	8 Bits	8 Bits	14 Bits
	w/ Averaging	11 Bits	11 Bits	11 Bits	11 Bits	
Vert. Sensitivity (/div)		1 mV-10 V	1 mV-10 V	1 mV-10 V	10 mV – 1 V	2 mV-200mV
Vertical Accuracy		±1.5%	±1.5%	±1.5%	±1%	±0.7%
Max Input Voltage (1 MΩ)*[13]		300 V Cat II	300 V Cat II	300 V Cat II	5 V rms (50Ω)*[11]	±6 V
Linear Dynamic Range		±5 div	±5 div	±5 div	±5 div	±5 div
BW Limit		20, 250 MHz	20, 250 MHz	20, 250 MHz		
Time Base:	Range	200 ps – 10 s/div	200 ps – 10 s/div	200 ps – 10 s/div	100 ps – 10 s/div	20 ps – 2 ms/div
	Accuracy	100 ppm	100 ppm	100 ppm	10 ppm	0.1% + 15 ps
Delta Time Measurement Accuracy*[14]		±50 ps @ 5 GS/s	±50 ps @ 5 GS/s	±50 ps @ 5 GS/s	±15 ps @ 10 GS/s	
Peak Detection		1ns	1ns	1ns	100 ps	
Channel Deskew		±25 ns	±25 ns	±25 ns	±25 ns	
Triggering						
Trigger Jitter*[15]		8 ps	8 ps	8 ps	8 ps	
Trigger Conditioning		HF, LF, Noise Reject	HF, LF, Noise Reject	HF, LF, Noise Reject	HF, LF, Noise Reject	
Types:	Edge	Std.	Std.	Std.	Std.	Std.
	Pattern/State	4 inputs	4 inputs	4 inputs	4 inputs	
	Setup & Hold	Std.	Std.	Std.	Std.	
	Pulse Width	Std.	Std.	Std.	Std.	
	Glitch	1 ns	1 ns	1 ns	1 ns	
	Runt Pulse	Std.	Std.	Std.	Std.	
	Slew Rate	Std.	Std.	Std.	Std.	
	Time Out	Std.	Std.	Std.	Std.	
	External	Std.	Std.	Std.	Std.	Std.
	Video*[6]	Opt.	Opt.	Opt.		
Signal Processing						
Modes: Delay by Time/Event		Std.	Std.	Std.	Std.	
Auto. Measurements		29	29	29	29	27
Math		+,-,x,÷,inv	+,-,x,÷,inv	+,-,x,÷,inv	+,-,x,÷,inv	+,-,x,÷,inv
Envelope		Std.	Std.	Std.	Std.	Std.
Average		Std.	Std.	Std.	Std.	Std.
Interpolation*[7]		Std.	Std.	Std.	Std.	Std.
FFT, Int., Diff.		Std.	Std.	Std.	Std.	Opt.
Limit Test		Std.	Std.	Std.	Std.	Std.

SELECTION GUIDE:

	TDS 654C	TDS 680C	TDS 684C	TDS 694C	TDS 820
General					
Display Monitor	Color	Mono	Color	Color	Mono
Inf. Persist, Vectors, Dots, YT, XY	Std.	Std.	Std.	Std.	Std.
Data Ports: VGA Out	Std.	Std.	Std.	Std.	
GPIB	Std.	Std.	Std.	Std.	Std.
RS232	Std.*8	Std.*8	Std.*8	Std.	Opt.*8
Centronics	Std.	Std.	Std.	Std.	Opt.
Hardcopy/Export Formats*9	Std.	Std.	Std.	Std.	Std.
Disk Drive (3.5 in.)	Std.	Std.	Std.	Std.	
Online Help	Std.	Std.	Std.	Std.	Std.
Standard Probes	4 ea P6243 1 GHz, 10X FET	None	None	None	None

TDS SELECTION GUIDE FOOTNOTES

*1 *With Option 1D: Bandwidth = 8 GHz. Vertical Sensitivity = 1mV – 100mV/div. Max Input = ±3V, no pre-trigger.*

*2 *Optional record length on TDS520D/724D is: Opt. 1M: 250K pts (1-CH), 130K pts per channel (2-CH); Opt. 2M: 4M pts (1-CH), 2M pts (2-CH).*

*3 *Optional record length TDS 580D/754D/784D/794D: Opt 1M: 500K pts (1-CH), 250K pts per channel (2-CH), 130K pts (3-, 4-CH). Opt 2M: 8M pts (1-CH), 4M pts (2-CH), 2M pts (3-, 4-CH).*

*4 *Maximum number of 50 point frames is 372 (1489 with Opt. 2M installed). Frame lengths 50 –50,000 points.*

*5 *TDS 400A triggered and untriggered roll. TDS 3000 and TDS 200 untriggered roll only.*

*6 *TDS 3000: NTSC, PAL; TDS 200: Line, Field; TDS 400A: NTSC, PAL, SECAM; TDS 500D/600C/700D: NTSC, PAL, SECAM, HDTV, FlexFormat™.*

*7 *Selectable Sin (x)/x, linear. TDS 3000, TDS 200: Sin (x)/x only.*

*8 *Talk mode only, for hardcopy purposes.*

*9 *Supported formats: TIFF, BMP, PCX, RLE, Interleaf (IMG), PostScript, LaserJet, Epson, ThinkJet, DeskJet, DPU411/412. TDS 3000/400A/500D/600C/700D also support Spreadsheet, MathCad™ waveform formats. TDS 200 support: Epson, ThinkJet, DeskJet, Laserjet, BMP, PCX, EPS, Interleaf.*

*10 *User Interface menus in multiple languages.*

*11 *Certain restrictions on range apply based on other instrument settings. Consult data sheets for details.*

*12 *XYZ display mode not available on the TDS 520D and TDS 724D.*

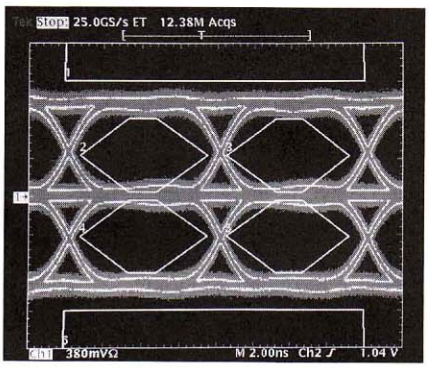
*13 *Derate at 20 dB/decade above 1 MHz.*

*14 *Assumes measurement of a 2 ns wide pulse. See individual product specification for complete formula.*

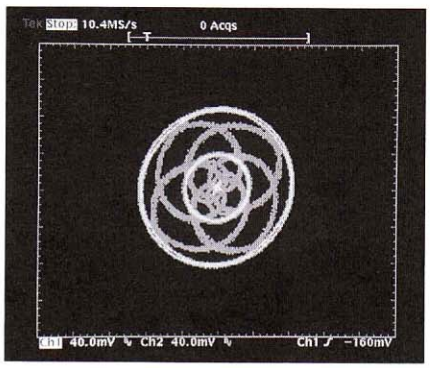
*15 *Typical.*

*16 *Option XL is mandatory for all TDS 400 Series.*

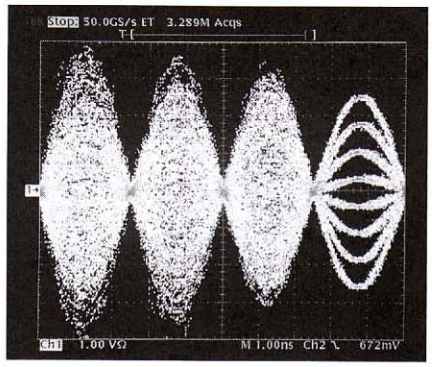
*17 *TDS 2MM provides four additional automatic measurements and FFT analysis.*



100 BaseT signal testing with standard communications mask.



GSM Signal. The second ring shows attenuated slot.



8VSB Eye Pattern.

SELECTION GUIDE:

	TDS 210*10	TDS 220*10 TDS 224*10	TDS 3012*10 TDS 3014*10	TDS 3032*10 TDS 3034*10	TDS 3052*10 TDS 3054*10	TDS 420A*16	TDS 430A*16	TDS 460A*16
Type	**DSO**	**DSO**	**DPO**	**DPO**	**DPO**	**DSO**	**DSO**	**DSO**
Signal Acquisition System								
Bandwidth	60 MHz	100 MHz	100 MHz	300 MHz	500 MHz	200 MHz	400 MHz	400 MHz
Channels	2	2 (TDS 220) 4 (TDS 224)	2 (TDS 3012), 4 (TDS 3014)	2 (TDS 3032), 4 (TDS 3034)	2 (TDS 3052), 4 (TDS 3054)	4	2	4
Sample Rate: 1 ch.	1 GS/s	1 GS/s	1.25 GS/s	2.5 GS/s	5 GS/s	100 MS/s	100 MS/s	100 MS/s
2 ch.	1 GS/s	1 GS/s	1.25 GS/s	2.5 GS/s	5 GS/s	100 MS/s	100 MS/s	100 MS/s
3, 4 ch.		1 GS/s (TDS 224)	1.25 GS/s	2.5 GS/s	5 GS/s	100 MS/s		100 MS/s
Record Length: Std.	2.5 K pts.	2.5 K pts.	10K pts.	10K pts.	10K pts.	120K pts. (XL)	120K pts. (XL)	120K pts. (XL)
Opt.								
Vert. Resolution: Normal	8 Bits	8 Bits	9 Bits	9 Bits	9 Bits	8 Bits	8 Bits	9 Bits
w/Averaging	8 Bits	8 Bits	≥13 Bits	≥13 Bits	≥13 Bits	11 bits	11 bits	11 bits
w/Hi Res	–	–	–	–	–	≥12 Bits	≥12 Bits	≥12 bits
Vert. Sensitivity (/div)	2 mV – 5 V	2 mV – 5 V	1 mV – 10 V	1 mV – 10 V	1 mV – 10 V	1 mV – 10 V	1 mV – 10 V	1 mV – 10 V
Vertical Accuracy	±3%	±3%	±2%	±2%	±2%	±1.5%	±1.5%	±1.5%
Max Input Voltage(1 MΩ)	300 Vrms	300 Vrms	150 Vrms	150 Vrms	150 Vrms	300 Vrms	300 Vrms	300 Vrms*11
Linear Dynamic Range	±5 div	±5 div	±5 div	±5 div	±5 div	±5 div	±5 div	±5 div
BW Limit	20 MHz	20 MHz	20 MHz	20, 150 MHz	20, 150 MHz	20, 100 MHz	20, 100 MHz	20, 100 MHz
Time Base: Range	5 ns – 5 s	5 ns – 5 s	4 ns – 10 s	2 ns – 10 s	1 ns – 10 s	1 ns – 20 s	1 ns – 20 s	2 ns – 20 s
Accuracy	100 ppm	100 ppm	200 ppm	200 ppm	200 ppm	50 ppm	50 ppm	50 ppm
Peak Detection	10 ns	10 ns	1 ns	1 ns	1 ns	10 ns	10 ns	10 ns
Roll Mode*5	Std.	Std.	Std.	Std.	Std.	Std.	Std.	Std.
Channel Deskew	–	–	±10 ns	±10 ns	±10 ns	–	–	–
Triggering								
Trigger Conditioning	HF, LF, Noise Reject	HF, LF, Noise Reject	HF, LF Noise Reject	HF, LF Noise Reject	HF, LF Noise Reject	HF, LF Noise Reject	HF, LF Noise Reject	HF, LF Noise Reject
Types: Edge	Std.	Std.	Std.	Std.	Std.	Std.	Std.	Std.
Pattern/State	–	–	Opt. (TDS 3012), Std. (TDS 3014)	Opt. (TDS 3032), Std. (TDS 3034)	Opt. (TDS 3052), Std. (TDS 3054)	–	–	–
Setup & Hold	–	–	–	–	–	–	–	–
Pulse Width	–	–	Opt. (TDS 3012), Std. (TDS 3014)	Opt. (TDS 3032) Std. (TDS 3034)	Opt. (TDS 3052) Std. (TDS 3054)	–	–	–
Glitch	–	–	Opt. (TDS 3012), Std. (TDS 3014)	Opt. (TDS 3032) Std. (TDS 3034)	Opt. (TDS 3052) Std. (TDS 3054)	–	–	–
Runt Pulse	–	–	Opt. (TDS 3012), Std. (TDS 3014)	Opt. (TDS 3032) Std. (TDS 3034)	Opt. (TDS 3052) Std. (TDS 3054)	–	–	–
Slew Rate	–	–	Opt. (TDS 3012), Std. (TDS 3014)	Opt. (TDS 3032) Std. (TDS 3034)	Opt. (TDS 3052) Std. (TDS 3054)	–	–	–
Time Out	–	–	–	–	–	–	–	–
Comm	–	–	Opt.	Opt.	Opt.	–	–	–
External	Std.	Std.	Std. (TDS 3012)	Std. (TDS 3032)	Std. (TDS 3052)	Std.	Std.	Std.
Video*6	Std.	Std.	Std.	Std.	Std.	Std.	Std.	Std.
Modes: Delay by Time/Event	By Time only	By Time only	Std.	Std.	Std.	Std.	Std.	Std.

SELECTION GUIDE:

	TDS 210*10	TDS 220*10 TDS 224*10	TDS 3012*10 TDS 3014*10	TDS 3032*10 TDS 3034*10	TDS 3052*10 TDS 3054*10	TDS 420A*16	TDS 430A*16	TDS 460A*16
Signal Processing								
Auto. Measurements	5*17	5*17	21	21	21	25	25	25
Math	+, –	+, –	+,-,x,inv	+,-,x,inv	+,-,x,inv	+,-,x,inv	+,-,x,inv	+,-,x,inv
Envelope	–	–	Std.	Std.	Std.	Std.	Std.	Std.
Average	Std.	Std.	Std.	Std.	Std.	Std.	Std.	Std.
Interpolation*7	Std.	Std.	Std.	Std.	Std.	Std.	Std.	Std.
FFT, Int., Diff.	Opt. (FFT)*17	Opt. (FFT)*17	FFT Opt. (TDS 3012), FFT Std. (TDS 3014)	FFT Opt. (TDS 3032), FFT Std. (TDS 3034)	FFT Opt. (TDS 3052), FFT Std. (TDS 3054)	Std. (Opt. XL)	Std. (Opt. XL)	Std. (Opt. XL)
Limit Test	–	–	–	–	–	Std.	Std.	Std.
General								
Display Monitor	Mono	Mono	Color	Color	Color	Mono	Mono	Mono
Inf. Persist, Vectors, Dots, YT, XY	Std.	Std.	Std.	Std.	Std.	Std.	Std.	Std.
Data Ports: VGA Out	–	–	Opt.	Opt.	Opt.	Std.	Std.	Std.
GPIB	Opt.	Opt.	Opt.	Opt.	Opt.	Std.	Std.	Std.
RS232	Opt.	Opt.	Opt.	Opt.	Opt.	Std. (Opt. XL)	Std. (Opt. XL)	Std. (Opt. XL)
Centronics	Opt.	Opt.	Std.	Std.	Std.	Std. (Opt. XL)	Std. (Opt. XL)	Std. (Opt. XL)
Hardcopy/Export Formats*9	Std.	Std.	Std.	Std.	Std.	Std.	Std.	Std.
Disk Drive (3.5 in.)	–	–	Std.	Std.	Std.	Std.	Std.	Std.
Online Help	–	–	–	–	–	Std.	Std.	Std.
Standard Probes	2 ea. P6112 100 MHz, 10X Passive	2 ea. (TDS 220) 4 ea. (TDS 224) P6112 100 MHz, 10X Passive	2 ea. (TDS 3012) 4 ea. (TDS 3014) P3010 100 MHz 10X Passive	2 ea. (TDS 3032) 4 ea. (TDS 3034) P6139A 500 MHz 10X Passive	2 ea. (TDS 3052) 4 ea. (TDS 3054) P6139A 500 MHz 10X Passive	4 ea. P6138A 400 MHz 10X Passive	2 ea. P6138A 400 MHz 10X Passive	4 ea. P6138A 400 MHz 10X Passive

TDS SELECTION GUIDE FOOTNOTES

*1 *With Option 1D: Bandwidth = 8 GHz. Vertical Sensitivity = 1mV – 100mV/div. Max Input = ±3V, no pre-trigger.*

*2 *Optional record length on TDS 520D/724D is: Opt. 1M: 250K pts (1-CH), 130K pts per channel (2-CH); Opt. 2M: 4M pts (1-CH), 2M pts (2-CH).*

*3 *Optional record length TDS 580D/754D/784D/794D: Opt 1M: 500K pts (1-CH), 250K pts per channel (2-CH), 130K pts (3-, 4-CH). Opt 2M: 8M pts (1-CH), 4M pts (2-CH), 2M pts (3-, 4-CH).*

*4 *Maximum number of 50 point frames is 372 (1489 with Opt. 2M installed). Frame lengths 50 –50,000 points.*

*5 *TDS 400A triggered and untriggered roll. TDS 3000 and TDS 200 untriggered roll only.*

*6 *TDS 3000: NTSC, PAL; TDS 200: Line, Field; TDS 400A: NTSC, PAL, SECAM; TDS 500D/600C/700D: NTSC, PAL, SECAM, HDTV, FlexFormat™.*

*7 *Selectable sin(x)/x, linear. TDS 3000, TDS 200: sin(x)/x only.*

*8 *Talk mode only, for hardcopy purposes.*

*9 *Supported formats: TIFF, BMP, PCX, RLE, Interleaf (IMG), PostScript, LaserJet, Epson, ThinkJet, DeskJet, DPU411/412 (not TDS 3000). TDS 3000/400A/500D/600C/700D also support Spreadsheet, MathCad™ waveform formats. TDS 200 support: Epson, ThinkJet, DeskJet, Laserjet, BMP, PCX, EPS, Interleaf.*

*10 *User Interface menus in multiple languages.*

*11 *Certain restrictions on range apply based on other instrument settings. Consult data sheets for details.*

*12 *XYZ display mode not available on the TDS 520D and TDS 724D.*

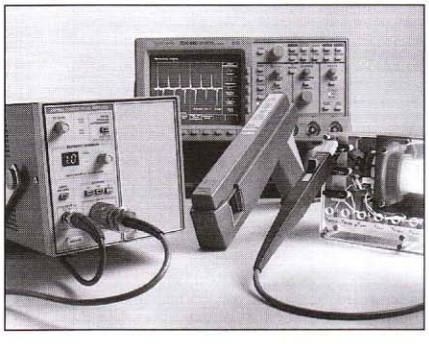
*13 *Derate at 20 dB/decade above 1 MHz.*

*14 *Assumes measurement of a 2 ns wide pulse. See individual product specification for complete formula.*

*15 *Typical.*

*16 *Option XL is mandatory for all TDS 400 Series.*

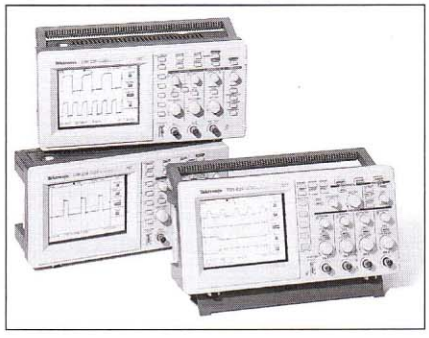
*17 *TDS 2MM provides four additional automatic measurements and FFT analysis.*



The TDS 400A Digital Storage Oscilloscopes and AM 503S Current Probe System. The AM 503S and TDS 400A combination are well-suited for measuring currents in switching supplies.



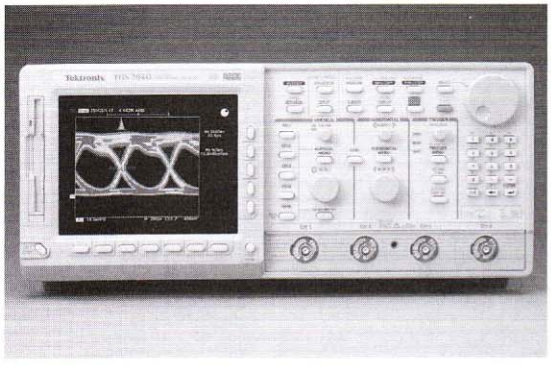
TDS 3054 Digital Phosphor Oscilloscope.



TDS 200 Series Digital Storage Oscilloscopes.

Digital Phosphor Oscilloscopes

TDS 500D • TDS 700D



For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

CE

ISO 9001

Tektronix measurement products are manufactured in ISO registered facilities.

GPIB IEEE-488

Product(s) complies with IEEE Standard 488.1-1987, RS-232-C, and with Tektronix Standard Codes and Formats.

Features – Benefits	Applications
2 GHz, 1 GHz and 500 MHz Bandwidths	Communication Compliance Testing
Sample Rates to 4 GS/s	Digital Design and Debugging
Captures and Displays up to 200,000 Waveforms per Second	Jitter Analysis
2 or 4 Channels	Fast Edge Characterization
1% Vertical Accuracy	Video Design and Debug
8-Bit Vertical Resolution, Over 11-Bits with Averaging and Over 13-Bits with Hi-res	Disk Drive Measurements
1 ns Peak Detect	Power Measurements
1 mV/div to 10 V/div Sensitivity	
Up to 1.5 GHz Differential Measurements	
Channel Deskew	
Record Lengths to 8 M Points	
Floppy Disk Storage	
Iomega Zip and Zip Plus Drive Compatible	
Advanced Triggering	
29 Automatic Measurements and Measurement Statistics	
FFT and Advanced Math	
Histograms	
Histogram Statistics	
Limit Test	
FastFrame™ Time Stamp	
Communication Signal Analysis Including Mask Testing and SONET/SDH and Fibre Channel Optical Reference Receivers	
Full GPIB Programmability	
3 Year Warranty	
CE Marking	

THE TDS 500D/TDS 700D FAMILY OF DIGITAL PHOSPHOR OSCILLOSCOPES

The TDS 500D/700D oscilloscopes are the first in the TDS family of Digital Phosphor Oscilloscopes (DPOs) designed to keep pace with current and evolving needs in advanced electronic design and debug. DPOs deliver a new level of insight that makes dealing with complex signals elementary – a new level of insight that must be seen to be believed.

DPOs capture, store, display and analyze, in real-time, three dimensions of signal information: amplitude, time and distribution of amplitude over time. The benefit of this new third dimension of information is an interpretation of the signal dynamics, including instantaneous changes and the frequency of occurrence displayed in the form of quantitative intensity information.

HIGH FIDELITY SIGNAL ACQUISITION

The high waveform capture rate of the TDS 500D/700D DPO, together with its high bandwidth and sample rate, delivers instantaneous signal feedback to show the true signals that other scopes may be missing. The DPO acquisition acquires over 1000 times more data than traditional DSOs, allowing the capture of complex signals, reducing debugging times from hours to seconds.

Channels can be transparently combined to achieve higher sample rates and longer record lengths. The record length can be optionally increased to 8 M points, providing a high-resolution representation of the signal over a long period of time.

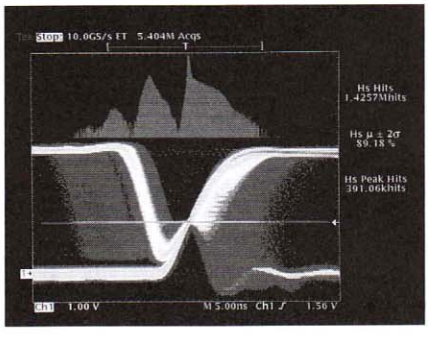
All of the TDS products provide wide dynamic range, flat response, fast overdrive recovery, calibrated DC offset, 1 mV/div sensitivity (10 mV maximum sensitivity on TDS 794D), 1 ns peak detect and internal calibration.

POWERFUL AND FLEXIBLE TRIGGERING

In addition to basic triggering such as edge and pulse-width, these Digital Phosphor Oscilloscopes have several trigger modes tailored for specific design and debug applications. Logic and pulse triggers, including setup/hold, glitch, slew rate and timeout triggers, capture hard-to-catch digital design problems. The optional video trigger provides line and field selection for NTSC, PAL and HDTV standards. The optional communications trigger capability addresses needs to acquire a wide variety of AMI, CMI, NRZ and Ethernet communication signals.

ADVANCED PERFORMANCE FEATURES

Automatic Measurements eliminate the need for manually measuring the waveform against the graticule or with cursors. Measurement gating, (gating not available for DPO operation) allows the user to select a specific part of the live waveform for measurement. Measurement statistics (min, max, mean and standard deviation), give additional information about the variations in the measurements over time (for example, worst case excursions), increasing the confidence in the quality of the measurements.



The horizontal histogram of the selected region of the waveform shows the character of a metastable flip-flop output.

Waveform Histograms allow the examination of the statistical nature of the signal. Horizontal histograms, which are useful for evaluating signal jitter, sample the waveform within a specified region, sort the values into time bins and plot the accumulated bin values versus time. Vertical histograms, which are useful for evaluating signal noise, sample the waveform within a specified region, sort the values into amplitude bins and plot the accumulated bin values versus amplitude.

For histograms of DPO acquisitions (both live and stored), the specified region can be repositioned and will update to reflect the underlying 3 dimensional data base (32 bits in shallow mode, 64 bits in deep mode).

Communication Mask Testing (available as an option) allows mask compliance testing of a wide variety of communication signals to industry standards. Specialized measurement accessories, unique trigger modes, built-in optical reference receiver filters, mask autoset and mask violation counting make these measurements easily and repeatably.

APPLICATIONS SOFTWARE PACKAGES

TDSDDM1 provides users with industry standard measurements such as Track Average Amplitude (TAA), 50% Pulse Width (PW^{50}), Non-Linear Transition Shift (NLTS) and Signal to Noise Ratio (SNR). This capability gives disk drive designers direct measurements in industry standard terminology. TDSPWR1 gives designers interested in power consumption applications the ability to automatically calculate True Power, Apparent Power, Power Factor, Instantaneous Power and Energy to eliminate manual calculations. TDSJIT1 performs a suite of jitter measurements with unprecedented accuracy on single-shot waveforms. Jitter information can be displayed as statistics, histograms or profiled. TDSPSM1 introduces a revolutionary way for making timing measurements by providing statistics on specific data and clock edges that are fully time-correlated. This application also performs automated AC timing measurements on all parameters in single-shot acquisitions. TDSCEM1 performs a suite of automated eye diagram measurements on SONET/SDH and Fibre Channel standards. These measurements include eye height, eye width and quality factor. TDSCPM1 performs automated parametric measurements of pulse amplitude, spectral power and pulse symmetry to standards requirements. Standards include ANSI T1.102 and ITU-T G.703.

COMPLEMENTARY MEASUREMENT ACCESSORIES

Tektronix provides a wide range of measurement accessories optimized for the TDS family. These accessories are designed to operate via the TEKPROBE® interface, which provides power and automatic scaling, to complete the DPO measurement solutions.

Active Probes such as the P6249 and P6245 active probes were designed specifically for the DPO products. For example, the P6249 (4 GHz probe only) is capable of achieving the full 2 GHz bandwidth on a TDS 794D, while providing low loading.

The P6339A Buffered Passive Probe is designed to provide 500 MHz bandwidth at the probe time for the TDS 794D.

Optical-to-electrical Converters (P6701B, P6703B) allow convenient analysis of optical transmission signals with the oscilloscope. Both short– and long-wavelength optical converters are compatible with the industry-standard wavelengths for SONET/SDH and Fibre Channel.

High-bandwidth Differential Probes (P6248, P6247) enable high bandwidth (up to 1.7 GHz) differential measurements while maintaining high common-mode rejection.

Current Probes such as the **TCP202** and **High-Voltage Differential Probes** such as the P5205 and P5210 allow safe, high-power measurements. Direct Probe Readouts use information from the probes to display measurements in units of Amps, Volts and Watts.

SOPHISTICATED DOCUMENTATION

Save screen displays in a number of standard desktop publishing formats to the internal 3.5 in. DOS-compatible floppy disk drive. Transfer the disk to a PC for import into word processing applications. Make hardcopies directly to monochrome or color printers and plotters connected to the computer network (LAN), GPIB, RS-232 or Centronics ports, or acquire waveforms, screen displays and scope settings using Tektronix **WaveStar™** software running on a PC interfaced to the GPIB port.

CHARACTERISTICS

TDS 500D/700D SERIES ELECTRICAL CHARACTERISTICS

	TDS 794D	TDS 784D	TDS 754D	TDS 724D	TDS 580D	TDS 540D	TDS 520D
Bandwidth	2 GHz*5	1 GHz*1	500 MHz*2	500 MHz*2	1 GHz	500 MHz*2	500 MHz*2
# Channels	4	4	4	2 + 2 aux.	4	4	2 + 2 aux.
# Samplers	4	4	4	2	4	4	2
Max Real-time Sample Rate							
1 Channel	4 GS/s	4 GS/s	2 GS/s	2 GS/s	4 GS/s	2 GS/s	2 GS/s
2 Channels	2 GS/s	2 GS/s	2 GS/s	1 GS/s	2 GS/s	2 GS/s	1 GS/s
3-4 Channels	1 GS/s	1 GS/s	1 GS/s	NA	1 GS/s	1 GS/s	NA
Equivalent-time Sample Rate	250 GS/s max.	250 GS/s max.	100 GS/s max.	100 GS/s max.	250 GS/s max.	100 GS/s max.	100 GS/s max.
Maximum Record Length							
1 Channel	50 K (Opt. 1M: 500 K, Opt. 2M: 8 M)	50 K (Opt. 1M: 500 K, Opt. 2M: 8 M)	50 K (Opt. 1M: 500 K, Opt. 2M: 8 M)	50 K (Opt. 1M: 250 K, Opt. 2M: 4 M)	50 K (Opt. 1M: 500 K, Opt. 2M: 8 M)	50 K (Opt. 1M: 500 K, Opt. 2M: 8 M)	50 K (Opt. 1M: 250 K, Opt. 2M: 4 M)
2 Channels	50 K (Opt. 1M: 250 K, Opt. 2M: 4 M)	50 K (Opt. 1M: 250 K, Opt. 2M: 4 M)	50 K (Opt. 1M: 250 K, Opt. 2M: 4 M)	50 K (Opt. 1M: 130 K, Opt. 2M: 2 M)	50 K (Opt. 1M: 250 K, Opt. 2M: 4 M)	50 K (Opt. 1M: 250 K, Opt. 2M: 4 M)	50 K (Opt. 1M: 130 K, Opt. 2M: 2 M)
3-4 Channels	50 K (Opt. 1M: 130 K, Opt. 2M: 2 M)	50 K (Opt. 1M: 130 K, Opt. 2M: 2 M)	50 K (Opt. 1M: 130K, Opt. 2M: 2 M)	NA	50 K (Opt. 1M: 130 K, Opt. 2M: 2 M)	50 K (Opt. 1M: 130 K, Opt. 2M: 2 M)	NA
Max Sample Rate Window*3	2 ms	2 ms	4 ms	4 ms	2 ms	4 ms	4 ms
Display	NuColor™ Display	NuColor™ Display	NuColor™ Display	NuColor™ Display	monochrome	monochrome	monochrome

*1 *In 50 Ω mode: 5 mV/div: 750 MHz, 2 mV/div: 600 MHz, 1 mV/div: 500 MHz. Reduce the upper bandwidth frequencies by 5 MHz for each degree C above 30°C.*

*2 *In 50 Ω mode: 1 mV/div: 450 MHz. Reduce the upper bandwidth frequencies by 2.5 MHz for each degree C above 30°C.*

*3 *Single-channel operating at full sample rate and maximum record length (Opt. 2M).*

*4 *≥ 10 mV/div in 50 Ω mode.*

*5 *Reduce the upper bandwidth frequency by 20 MHz for each degree C above 30°C.*

ACQUISITION MODES

DPO – Captures and displays complex waveforms, random events and subtle patterns in actual signal behavior. By acquiring up to 100 M points/sec TDS 794D, TDS 784D, TDS 754D, TDS 580D, TDS 540D (50M points/sec; TDS 724D and TDS 520D) DPOs are able to provide 3 dimensions of signal information, in real-time; amplitude, time, and the distribution of amplitude over time. The DPX™ Waveform Imaging Processor automatically selects record lengths between 500 and 500,000 points and sample rate up to 1 GS/s, based on horizontal time base setting, to optimize displayed sample density.

Peak Detect – High frequency and random glitch capture. Captures glitches of 1 ns using acquisition hardware at all real-time sampling rates.

Sample – Sample data only.

Envelope – Max/min values acquired over one or more acquisitions.

Average – Waveform data from 2 to 10,000 (selectable) is averaged.

Hi-res – Vertical resolution improvement and noise reduction on low-frequency signal (e.g., 12-Bits typical).

FastFrame™ Time Stamp – Acquisition memory size segmentable with trigger rate up to 80,000 per second from 50 to 5,000 points per frame (independent of the number of channels).

TDS 500D/700D SERIES VERTICAL SYSTEM

	TDS 794D	TDS 784D	TDS 754D	TDS 724D	TDS 580D	TDS 540D	TDS 520D
Sensitivity	10 mV/div to 1 V/div (50 Ω mode)	mV/div to 10 V/div 1 (1 MΩ mode), 1 mV/div to 1 V/div (50 Ω mode)	1 mV/div to 10 V/div (1 MΩ mode), 1 mV/div to 1 V/div (50 Ω mode)	1 mV/div to 10 V/div (1 MΩ mode), 1 mV/div to 1 V/div (50 Ω mode)	1 mV/div to 10 V/div (1 MΩ mode), 1 mV/div to 1 V/div (50 Ω mode)	1 mV/div to 10 V/div (1 MΩ mode), 1 mV/div to 1 V/div (50 Ω mode)	1 mV/div to 10 V/div (1 MΩ mode), 1 mV/div to 1 V/div (50 Ω mode)
DC Gain Accuracy	±1.0% (0.7% typical)	±1.0% (±0.7% typical)	±1.0% (±0.7% typical)	±1.0% (±0.7% typical)	±1.0% (±0.7% typical)	±1.0% (±0.7% typical)	±1.0% (±0.7% typical)
Effective Bits (typical)	5.0 (2 GHz @ 4 GS/s), 9.7 with Hi-res (1 MHz @ 10 MS/s)	5.5 (1 GHz @ 4 GS/s), 9.7 with Hi-res (1 MHz @ 10 MS/s)	6.8 (500 MHz @ 2 GS/s), 9.7 with Hi-res (1 MHz @ 10 MS/s)	6.8 (490 MHz @ 2 GS/s), 9.7 with Hi-res (1 MHz @ 10 MS/s)	5.5 (1 GHz @ 4 GS/s), 9.7 with Hi-res (1 MHz @ 10 MS/s)	6.8 (500 MHz @ 2 GS/s), 9.7 with Hi-res (1 MHz @ 10 MS/s)	6.8 (490 MHz @ 2 GS/s), 9.7 with Hi-res (1 MHz @ 10 MS/s)
Vertical Resolution	8-Bits (256 levels on 10.25 divisions), >11-Bits with averaging, >13-Bits typical with Hi-res (TDS 794D, TDS 784D, TDS 580D), >12-Bits typical with Hi-res (TDS 754D, TDS 724D, TDS 540D, TDS 520D)						
Position Range	±5 divisions	±5 divisions	±5 divisions	±5 divisions	±5 divisions	±5 divisions	±5 divisions
Offset Range	±1 V from 1 mV to 100 mV/div, ±10 V from 101 mV to 1 V/div, ±100 V from 1.01 V to 10 V/div (TDS 784D, TDS 754D, TDS 724D, TDS 580D, TDS 540D, TDS 520D) ±0.5 V from 10 mV to 50 mV/div						
Analog Bandwidth Selections	Full only	20 MHz, 250 MHz, full	20 MHz, 250 MHz, full	20 MHz, 250 MHz, full	20 MHz, 250 MHz, full	20 MHz, 250 MHz, full	20 MHz, 250 MHz, full
Input Coupling	DC, GND	AC, DC, GND	AC, DC, GND	AC, DC, GND	AC, DC, GND	AC, DC, GND	AC, DC, GND
Input Impedance Selections	1 MΩ in parallel with 10 pF, or 50 Ω (AC and DC coupling) (TDS 784D, TDS 754D, TDS 724D, TDS 580D, TDS 540D, TDS 520D) 50 Ω only (DC coupling only) (TDS 794D only)						
AC-coupled Low Frequency Limit	N/A	≤10 Hz when AC 1 MΩ coupled. ≤200 kHz when AC 50 Ω coupled.	≤10 Hz when AC 1 MΩ coupled. ≤200 kHz when AC 50 Ω coupled.	≤10 Hz when AC 1 MΩ coupled. ≤200 kHz when AC 50 Ω coupled.	≤10 Hz when AC 1 MΩ coupled. ≤200 kHz when AC 50 Ω coupled.	≤10 Hz when AC 1 MΩ coupled. ≤200 kHz when AC 50 Ω coupled.	≤10 Hz when AC 1 MΩ coupled. ≤200 kHz when AC 50 Ω coupled.
Channel Isolation	>100:1 at 100 MHz and >30:1 at the rated bandwidth						
Max. Input Voltage	5 V_{RMS}, with peaks ≤± 20 Volts	300 V CAT II ±400 V (peak). Derate at 20 dB/decade above 1 MHz. 1 MΩ or GND coupled.	300 V CAT II ±400 V (peak). Derate at 20 dB/decade above 1 MHz. 1 MΩ or GND coupled.	300 V CAT II ±400 V (peak). Derate at 20 dB/decade above 1 MHz, 1 MΩ or GND coupled.	300 V CAT II ±400 V (DC + peak AC). Derate at 20 dB/decade above 1 MHz. 1 MΩ or GND coupled.	300 V CAT II ±400 V (peak). Derate at 20 dB/decade above 1 MHz. 1 MΩ or GND coupled.	300 V CAT II ±400 V (peak). Derate at 20 dB/decade above 1 MHz. 1 MΩ or GND coupled.

TDS 500D/700D SERIES TIMEBASE SYSTEM

TDS 540D/TDS 520D	TDS 794D	TDS 784D/TDS 580D	TDS 754D/TDS 724D
Time Bases	Main, delayed	Main, delayed	Main, delayed
Time Base Range	200 ps to 10 s/div	200 ps to 10 s/div	500 ps to 10 s/div
Time Base Accuracy	±25 ppm (over any interval ≥1 ms)		
Delta Time Measurement Accuracy	±(0.15/sample rate) + (25 ppm x [reading])		
Trigger Jitter	7 ps (typical)	7 ps (typical)	8 ps (typical)
Pre-trigger Position	0% to 100% of any record		
Delay Between Channels	≤50 ps (any 2 channels with equal V/div and coupling)		

Single Sequence – Use RUN/STOP button to capture a single triggered acquisition at a time, which may be automatically saved to NVRAM with AutoSave.

TRIGGER SYSTEM

Triggers – Main and delayed.
Main Trigger Modes – Auto, Normal, Single.
Delayed Trigger – Delayed by time, events, or events and time.
Time Delay Range – 16 ns to 250 s.
Events Delay Range – 1 to 9,999,999 events.

External Rear Input – ≥1.5 kW; Max input voltage is ±20 V (DC + peak AC).

TRIGGER TYPES

EDGE (Main and Delayed) –
Conventional level-driven trigger. Positive or negative slope on any channel or rear panel auxiliary input. Coupling selections: DC, AC, noise reject, HF reject, LF reject.

LOGIC (Main) –
PATTERN: Specifies a logical combination (AND, OR, NAND, NOR) of the four input channels (high, low, don't care). Trigger when pattern stays true or false for a specified time.
STATE: Any logical pattern of channels 1, 2, and 3 (AUX1 on 2-CH products) plus a clock edge on channel 4 (AUX2 on 2-CH products). Triggerable on rising or falling clock edge.
SETUP/HOLD: Trigger on violations of both setup time and hold time between clock and data which are on two input channels.

PULSE (Main) –
GLITCH: Trigger on or reject glitches of positive, negative, or either polarity. Minimum glitch

width is 1.0 ns (typical) 2 ns (warranted) with 200 ps resolution.
RUNT: Trigger on a pulse that crosses one threshold but fails to cross a second threshold before crossing the first again.
WIDTH: Trigger on width of positive or negative pulse either within or out of selectable time limits (1 ns to 1 s).
SLEW RATE: Trigger on pulse edge rates that are either faster or slower than a set rate. Edges can be rising, falling or either.
TIMEOUT: Trigger on an event which remains high, low, or either, for a specified time period, selectable from 1 ns to 1 s, with 200 ps resolution.

COMM (Optional) –
AMI: Trigger on standard communications signals (including DS1, DS1A, DS1C, DS2, DS3, E1, E2, E3, STS-1 or a custom bit rate). Select between "isolated ones" (positive or negative) and eye diagrams.
CMI: Trigger on standard communications signals (including STS-3, STM1E, DS4NA, E4 or a custom bit rate). Select between positive or negative one pulses, zero pulses and eye diagrams.
NRZ: Trigger on standard communications signals (including OC1/STM0, OC3/STM1, OC12/STM4, E5, FC133, FC266, FC531, FC1063, FDDI HALT, 143 Mb/s serial digital composite video, 270 Mb/s serial digital component video or a custom bit rate). Select between an eye diagram, rising or falling edges or any of eight 3-Bit serial patterns.

VIDEO (Optional) –
Trigger on a particular line of individual, odd/even, or all fields. Trigger on a specific pixel of a line by using the video trigger with delay by events. Choose positive or negative horizontal sync polarity.
525/NTSC: Choose monochrome or color (studio-quality NTSC) sync formats.
625/PAL: Choose color or monochrome (studio-quality PAL) sync formats.
HDTV: Choose from 1125/60, 1050/60, 1250/50, and 787.5/60 HDTV formats.

MEASUREMENT SYSTEM

Automatic Waveform Measurements – Period, frequency, + width, – width, rise time, fall time, + duty cycle, – duty cycle, delay, phase, burst width, high, low, max. min, peak to peak, amplitude, + overshoot, – overshoot, mean, cycle mean, RMS, cycle RMS, area, cycle area, extinction ratio (ratio, dB, %) and mean optical power. Continuous update of up to four measurements on any combination of waveforms.

Measurement Statistics – Display minimum and maximum or mean and standard deviation on any displayed single-waveform measurements.

Thresholds – Settable in percentage or voltage.

Gating – Any region of the waveform may be isolated for measurement using vertical bars.

Snapshot – Performs all measurements on any one waveform showing results from one instant in time.

Cursor Measurements – Absolute, Delta: Volts, Time, Frequency and NTSC IRE and line number (with video trigger option).

Cursor Types – Horizontal bars (volts), vertical bars (time); operated independently or in tracking mode.

WAVEFORM PROCESSING

Waveform Functions – Sin(x)/x or linear interpolation, Average, Envelope.
Advanced Waveform Functions (optional on TDS 500D) – FFT, Integration, Differentiation.
Arithmetic Operators – Add, Subtract, Multiply, Divide, Invert.
Autoset – Single-button, automatic setup on selected input signal for vertical, horizontal and trigger systems. Also automatically normalizes signals to standard masks when used with the mask testing option.
Waveform Limit Testing – Compares incoming or math waveform to a reference waveform's upper and lower limits.
Waveform Histograms – Both vertical and horizontal histograms, with periodically updated measurements, allow statistical distributions to be analyzed over any region of the signal. For histograms on DPO acquisitions, both live and stored, the specified region can be repositioned and will update to reflect the underlying 3 dimensional data base, in both YT and XY modes (32 bits in shallow mode, 64 bits in deep mode).
Mask Testing (Optional) – In addition to the standard communication masks in the instrument, the masks can be edited on the screen. Together with automatic waveform scaling, the mask tests give rapid verification of a digital bit stream's conformance to pulse templates and eye pattern masks. For optical conformance testing, the internal Fibre Channel and SONET/SDH optical reference receiver filters provide convenient test setup which is compliant to industry standards.

ZOOM CHARACTERISTICS

The zoom feature allows waveforms to be expanded or compressed in both vertical and horizontal axes. Allows precise comparison and study of fine waveform detail without affecting ongoing acquisitions. When used with Hi-res or Average acquisition modes, Zoom provides an effective vertical dynamic range or 1000 divisions or 100 screens. Zoom features not available on DPO operations.

Dual Window Zoom – Dual graticules simultaneously show selected and zoomed waveforms. Up to two zoom boxes show areas on the selected trace that are being magnified, and the two magnified areas can be overlapped for quick comparison. Color of zoomed trace matches selected trace.

DISPLAY CHARACTERISTICS

Waveform Style – Dots, vectors, variable persistence from 32 ms to 10 s, infinite persistence, and intensified samples.
Color (TDS 794D, TDS 784D, TDS 754D, TDS 724D) – Standard palettes and user-definable color for waveforms, text, graticules and cursors. Measurement text and cursor colors matched to waveform. Waveform collision areas highlighted with different color. Statistical waveform distribution shown with color grading through variable persistence.
Color Grading (TDS 794D, TDS 784D, TDS 754D, TDS 724D) – With variable persistence selected, historical timing information is represented by temperature or spectral color scheme (or gray scale on TDS 580D, TDS 540D, TDS 520D) providing "z-axis" information about rapidly-changing waveforms.
Graticules – Full, grid, cross-hair, frame, NTSC and PAL (with video trigger option).
Format – YT and XY (and XYZ and dual XY in DPO operation).
Type – 7 in. diagonal, NuColor™ liquid crystal full color shutter display, 256 color levels (TDS 700D); 7 in. diagonal, magnetic deflection, horizontal raster-scan monitor with P4 white phosphor (TDS 500D).
Resolution – 640 horizontal by 480 vertical displayed pixels (VGA).

COMPUTER INTERFACE

GPIB (IEEE-488.2) Programmability – Full talk/listen modes. Control of all modes, settings, and measurements.

HARDCOPY

Printer – Phaser 740N/740P, HP Thinkjet, Deskjet, Laserjet, Epson, Interleaf, PostScript, TIFF, PCX, BMP, DPU411/412, RLE.
Plotter – HPGL.
Data – MathCad, spreadsheet formats.
Interface – GPIB standard.
Hardcopy Interface (optional on TDS 500D) – Centronics and RS-232 (talk only).

STORAGE

Non-volatile Waveform Storage – 4 full 50 K records (Opt. 1M or 2M: 4 full 130 K records, 2 full 250 K records, or 1 compressed 500 K record) (TDS 794D, TDS 784D, TDS 754D, TDS 580D, TDS 540D); 2 full 50 K records (Opt. 1M or 2M: 2 full 130 K records or 1 full 250 K record) (TDS 724D, TDS 520D).
Non-volatile storage for setups – 10 front panel setups.

Floppy Disk Drive – Store reference waveforms, setups, and image files on 3.5 in. 1.44 MB or 720 K DOS-format floppy disk.
Iomega Zip and Zip Plus Drive Compatible – Compatible for waveform and front panel setup file transfer to Iomega Zip and Zip Plus Drives.

POWER REQUIREMENTS

Line Voltage Range – 100 to 240 V RMS.
Line Frequency – 45 to 440 Hz.
Power Consumption – 350 W max.

ENVIRONMENTAL AND SAFETY

Temperature –
Operating: +4 to +50°C (floppy not used), +10 to +50°C (floppy in use).
Nonoperating: –22 to +60°C.

Humidity –
Operating: To 80% RH at ≤ 32°C. Derates to 30% RH at +45°C.
Nonoperating: To 90% RH at ≤ 40°C. Derates to 30% RH at +60°C.

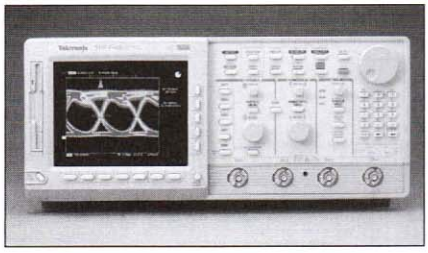
Altitude –
Operating: 15,000 ft. (hard disk not used), 10,000 ft. (hard disk in use).
Nonoperating: 40,000 ft.

Electromagnetic Compatibility – UL1244.

Safety – UL3111-1, CSA1010.1, EN61010-1, IEC61010-1.

PHYSICAL CHARACTERISTICS

Dimensions	mm	in.
Height with feet	193	7.6
Height without feet	178	7
Width with handle	445	17.5
Depth with front cover installed	434	17.1
Weight	**kg**	**lbs.**
Net approximately	14.1	31
Shipping Weight approximately	25.4	56



COMMUNICATION SIGNAL ANALYZER PACKAGE APPLICATIONS

- Advanced triggering, including triggering for AMI, CMI and NRZ communication signals
- Automatic measurements with measurement statistics including extinction ratio and average optical power
- Waveform histograms on DPO and normal waveform acquisitions
- Custom mask generation on-board
- Autoset signals to standard masks
- SONET/SDH and fibre channel optical reference receivers
- Internal standard communication signal masks provided for compliance testing for over 50 communication standards
- Debugging communications designs
- Mask testing per comm/video standards
- Optical eye pattern testing

The Tektronix TDS Communication Signal Analyzer package gives you the most comprehensive oscilloscope solutions for connecting to, capturing, and characterizing optical and electrical signals in high-speed communication designs. Based on the TDS 500D/700D family of Digital Phosphor Oscilloscopes (DPOs), the Communication Signal Analyzer options and measurement accessories tailor the oscilloscopes for engineers debugging, characterizing and verifying the compliance of communication systems to international standards. These communications options complement the Tektronix 11801C Digital Sampling Oscilloscope and the CSA 803C Communication Signal Analyzer, which provide bandwidths up to 50 GHz and measurement features tailored for optical component manufacturing and research and development applications.

CONNECTING TO THE SIGNAL

Whether the signals are electrical (differential or single-ended) or optical, connecting the design to the measurement system is no easy matter. A wide selection of complementary measurement accessories, optimized for use with the TDS oscilloscopes, are available to make probing convenient and reliable, while maintaining high accuracy.

Electrical Communication Adapters such as the AFTDS ease connection to differential communication signals, such as DS1, DS2 and E1, by terminating the signal in 100 Ω, 110 Ω or 120 Ω and adapting various connector styles (bantam, Siemens and RJ-11) to the oscilloscope's 50 Ω BNC environment.

The AMT75 75 Ω Adapter simplifies connection of video and communication signals such as DS3 and E3 to the oscilloscope. This adapter supplies a precise termination to signals up to 1 GHz.

Optical-to-electrical Converters allow convenient analysis of optical transmission signals. The P6701B can be used for Fibre Channel signals and the P6703B can be used for SONET/SDH signals. They provide high gain (1 V/mW) for signals up to 1 GHz and as large as 1 mW (0 dBm). The P6723 optical logic probe converts SONET/SDH signals into PECL digital signals suitable for use as triggers.

CAPTURING THE SIGNAL

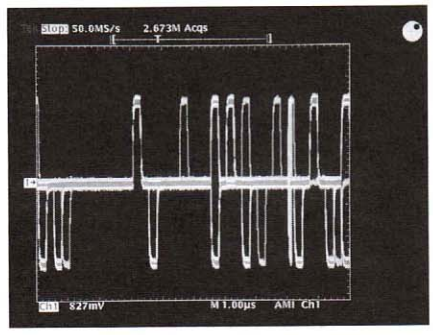
High Bandwidth and Sample Rates, up to 2 GHz and 1 GS/s per channel, enable the user to capture the signal with high fidelity. Channels can be transparently combined to achieve higher sample rates, up to 4 GS/s.

Digital Phosphor Oscilloscopes capture, store, display and analyze, in real-time, three dimensions of signal information: amplitude, time and distribution of amplitude over time. The benefit of this new third dimension of information is an interpretation of the signal dynamics, including instantaneous changes and the frequency of occurrence displayed in the form of quantitative intensity information.

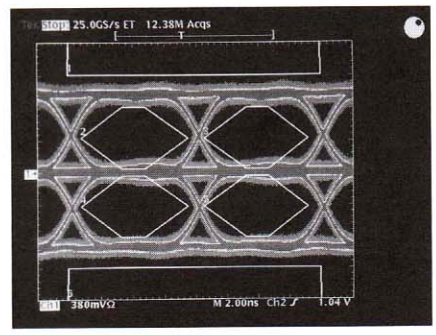
In addition to standard **Advanced Trigger** modes such as edge, pulse-width, logic and optional video trigger, these oscilloscopes have trigger modes tailored for communication design and debug. The optional Comm trigger addresses the need to acquire a wide variety of Alternate-Mark Inversion (AMI), Code-Mark Inversion (CMI) and Non-Return to Zero (NRZ) communication signals. These trigger modes may be selected manually during routine troubleshooting, but are automatically selected when mask testing is enabled.

AMI mode triggers on standard AMI signals (including DS1, DS3, E1, E2, E3 and STS-1). "Isolated ones" triggering is available on ANSI T1.102 AMI signals (including DS1 and DS3). **CMI** triggering isolates positive or negative one pulses and zero pulses in standard CMI signals (including STS-3, STM1E, DS4 and E4). **NRZ** trigger selects rising or falling edges, or any of eight 3-Bit serial patterns in NRZ signals (including SONET/SDH, Fibre Channel, FDDI, 143, 270, 360 and 1485 Mb/s serial video signals). The **serial** trigger mode allows identification of data-dependent anomalies in eye diagrams.

Long streams of serial data, up to 4 ms at full resolution, can be captured with optional long record length (up to 8 M points).



An example of the selection of isolated-one AMI trigger mode.



A DS-1 isolated-one signal is compared with the standard pulse mask, showing a compliant waveform.

CHARACTERIZING THE SIGNAL

Optional Communication Mask Testing allows mask compliance testing of a wide variety of communication signals against industry standards. The instruments are set up for mask testing by selecting the standard from the user interface. This selection sets up the trigger system and vertical and horizontal scaling and displays the appropriate mask. A specialized autoset scales and offsets the signal to the selected standard mask, making mask testing easy and repeatable. The standard communication masks in the instrument can be edited directly on the screen to create custom masks, allowing up to 8 regions with 50 vertices.

In addition to the specialized optical measurement accessories, the oscilloscopes have nominal internal 4th-order Bessel-Thompson filters for diagnostic testing of Fibre Channel and SONET/SDH signals. Optional internal SONET/SDH (Opt. 3C) and Fibre Channel (Opt. 4C) optical reference receiver filters on channel 1 of the products are also available. These reference receivers, required for optical compliance testing by ANSI FC-PH, Bellcore GR-253-Core and ITU-T G.957, can be switched in and out at the touch of a button.

Automatic Measurements eliminate the need for manually measuring waveform parameters. Measurements include average optical power (in dBm) and extinction ratio (expressed as a ratio, in % for FDDI and in dB for SONET/SDH and Fibre Channel applications).

Refer to individual product data sheets for full information.

OPTION 2C*6

Communication Signal Analyzer Package Includes:

AMI, CMI, and NRZ Comm triggers, communication mask testing, nominal Bessel-Thompson filtering, automatic pass/fail testing, mask margin testing, inverted masks and mask autoset.

Standards Supported: OC1/STM0, OC3/STM1, OC12/STM4, FC133, FC266, FC513, FC1063, DS0, DS1, DS1A, DS1C, DS2, DS3, DS4NA, E1, E2, E3, E4, E5, STM1E, STS-1, STS-3, FDDI, D1, D2, 259M-D, 292M video and Ethernet (10 Base-T, 100 Base-TX, 1000 Base-SX, 1000 Base-LX).

OPTION 3C*7

Fibre Channel Optical Reference Receiver Includes:

P6701B and reference receiver calibration.

Standards Supported: FC133, FC266, FC531*4 and FC1063*5.

OPTION 4C*7

SONET/SDH Optical Reference Receiver Includes:

P6703B and reference receiver calibration.

Standards Supported: OC1/STM0, OC3/STM1 and OC12/STM4*4.

*4 *Available on TDS 784D, TDS 754D and TDS 540D.*

*5 *Available on TDS 784D and TDS 580D only. Frequency response controlled to 1.5 * bit rate.*

*6 *TDS 794D does not provide nominal Bessel-Thompson filtering.*

*7 *Not compatible with TDS 794D.*

OPTION 1M

Record Length:

TDS 794D, TDS 784D, TDS 754D, TDS 580D, TDS 540D: 500 K maximum.

TDS 724D, TDS 520D: 250 K maximum.

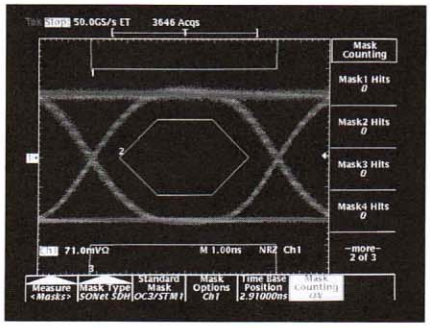
OPTION 2M

Record Length 2 M/Channel:

TDS 794D, TDS 784D, TDS 754D, TDS 580D, TDS 540D: 8 M maximum.

TDS 724D, TDS 520D: 4 M maximum.

Includes hard disk drive.



A SONET/SDH (OC-3/STM-1) signal is compared with the standard mask, showing a compliant waveform.

ACCESSORIES

High Bandwidth Differential Probes:

Probe Bandwidth:

P6248: 1.7 GHz.

P6247: 1 GHz.

P6246: 400 MHz.

AFTDS Differential Signal Adapter:

Input Impedance (selectable): 100 Ω, 110 Ω or 120 Ω, ±3%.

Available Connectors: Bantam, Siemens, RJ-11.

Electrical Standards Supported: DS1, DS1A, E1, DS1C, DS2.

AMT75 75 Ω Adapter:

Input Impedance: 75 Ω ± 1.5%.

Adapter Bandwidth: DC to 1 GHz (typical).

VSWR (Return Loss): ≤ 1.1:1 (>26 dB, up to 1 GHz typical).

Connectors: 75 Ω BNC.

Electrical Standards Supported: E2, E3, DS3, STS-1, DS4, E4, STM-1, STS-3, D1, D2 and 259M-D, 292M video.

P6701B Optical-to-electrical Converter:

Wavelength Response: 500 to 950 nm.

Optical Bandwidth: DC to 1 GHz.

Conversion Gain (at 780 nm): 1 V/mW.

Standards Supported: Fibre Channel, FDDI.

P6703B Optical-to-electrical Converter:

Wavelength Response: 1100 to 1700 nm.

Optical Bandwidth: DC to 1.2 GHz.

Conversion Gain (at 1310 nm): 1 V/mW.

Standards Supported: SONET/SDH.

P6723 Optical Logic Probe:

Wavelength Response: (1310/1550 nm).

Standards Supported: SONET/SDH ≤ 650 Mb/s.

OPTICAL ATTENUATORS

OA5002: 10 µm single-mode.

OA5012: 50 µm multimode.

OA5022: 62.5 µm multimode.

OA5032: 100 µm multimode.

ORDERING INFORMATION

For price information: Outside the U.S. contact your local Tektronix representative, inside the U.S. see the price list in the back of this catalog.

TDS 794D
Digital Phosphor Oscilloscope.

TDS 784D
Digital Phosphor Oscilloscope.

TDS 754D
Digital Phosphor Oscilloscope.

TDS 724D
Digital Phosphor Oscilloscope.

TDS 580D
Digital Phosphor Oscilloscope.

TDS 540D
Digital Phosphor Oscilloscope.

TDS 520D
Digital Phosphor Oscilloscope.

INCLUDED ACCESSORIES

Probes – 4 each P6139A passive probes (TDS 754D, TDS 540D), 2 each P6139A (TDS 724D, TDS 520D).

Documentation – Quick Reference in 9 languages (020-2235-00), User Manual (071-0130-00), Technical Reference (071-0135-00), Programmer's Manual (063-3120-00) in MS-Help format on floppy disk, and ANSI, NCSL Z 540-1-1994 (ISO Guide 25) calibration certificate.

Accessories – Front Cover (200-3696-01), US power cord (161-0230-01), and accessory pouch (016-1268-00; TDS 794D, TDS 784D, TDS 754D, TDS 724D).

INSTRUMENT OPTIONS

Opt. 05 – Add video trigger (NTSC, PAL, HDTV, FlexFormat™). (Not available on the TDS 794D)

Opt. 1M – Add 130 K/channel memory length (500 K max on TDS 794D, TDS 784D, TDS 754D, TDS 580D, TDS 540D) 250 K max (TDS 724D, TDS 520D).

Opt. 2M – Add 2 M/channel memory length (8 M max on TDS 794D, TDS 784D, TDS 754D, TDS 580D, TDS 540D; 4 M max on TDS 724D, TDS 520D). Includes internal hard disk drive.

Opt. 13 (TDS 580D, TDS 540D, TDS 520D only) – Add RS-232C and Centronics hardcopy interfaces.

Opt. 2F (TDS 580D, TDS 540D, TDS 520D only) – Extended waveform math: FFT, integration and differentiation.

COMMUNICATION SIGNAL ANALYZER OPTIONS

Opt. 2C – Communication Signal Analyzer; includes comm triggers and communication mask testing.

Opt. 3C – Short-wavelength (Fibre Channel FC133, FC266, FC513, FC1063) Optical Reference Receiver; includes P6701B and system calibration (Not Available on the TDS 794D).

Opt. 4C – Long-wavelength (SONET/SDH OC1/STM0, OC3/STM1, OC12/STM4) Optical Reference Receiver; includes P6703B and system calibration (Not Available on the TDS 794D).

INSTRUMENT PROBE OPTIONS*1

Opt. 31 (TDS 794D only) – Add 1 each P6339A buffered passive probe.

Opt. 33 (TDS 794D, TDS 784D, TDS 580D only) – Add 1 each P6158 low capacitance probe.

Opt. 34 – Add 1 each P6247 differential probe.

Opt. 35 (TDS 754D, TDS 724D, TDS 540D, TDS 520D only) – Add 1 each P6243 1 GHz active probe.

Opt. 36 (TDS 784D, TDS 754D, TDS 724D, TDS 580D, TDS 540D, TDS 520D only) – Add 1 each P6139A passive probe. (4 standard on TDS 754D, TDS 540D, 2 standard on TDS 724D, TDS 520D).

Opt. 37 (TDS 784D and TDS 580D only) – Add 1 each P6245 .5 GHz active probe.

Opt. 38 (TDS 794D only) – Add 1 each P6249 4 GHz active probe.

Opt. 39 (TDS 794D only) – Add 1 each P6248 1.7 GHz differential probe.

INSTRUMENT APPLICATIONS MEASUREMENT SOFTWARE

Requires TDS 500/600/700 Opt. HD or 2M.

TDSPRT1 – Printing Utility.
TDSDDM1 – Disk drive measurement package.
TDSPWR1 – Power measurement package.
TDSJIT1 – Jitter analysis measurement package.
TDSPSM1 – Processor specifications measurement package.
TDSCEM1 – Communications eye-diagram measurement package.
TDSPSM1 – Processor specifications measurement.
TDSCEM1 – Communications eye-diagram measurement.
WSTRO – WaveStar™ software for Oscilloscopes, Windows 95/98/NT application for waveform capture, analysis, documentation and control from your PC.
WSTROU – Upgrade from WSTR31 to WSTRO.
WSTR31 – WaveStar™ software for Windows 3.1.
LVWIN95 – LabVIEW® for Windows 95.
LVWCVI95 – LabWindows/CVI for Windows 95.
S3FT400 – WaveWriter™ AWG and waveform creation software.

INTERNATIONAL POWER PLUGS

Opt. A1 – European power cord (220 V, 50 Hz).
Opt. A2 – UK power cord (240 V, 50 Hz).
Opt. A3 – Australian power cord (240 V, 50 Hz).
Opt. A4 – North American power cord (240 V, 60 Hz).
Opt. A5 – Swiss power cord (220 V, 50 Hz).
See page 619 for description.

OPTIONAL ACCESSORIES

Opt. 1K – Add K420 scope cart.
Opt. 1R – Rackmount kit.
Opt. L1 – Substitute French user manual for English user manual.
Opt. L3 – Substitute German user manual for English user manual.
Opt. L5 – Substitute Japanese user manual for English user manual.
Opt. L9 – Substitute Korean user manual for English user manual.

RECOMMENDED PROBES

ADA400A – Differential Preamplifier.
AM503S – DC/AC Current Measurement System.
AFTDS – Electrical communication differential signal adapter.
AMT75 – 1 GHz electrical communication 75 Ω adapter.
P5100 – 2.5 kV High-voltage probe.
P5205 – 1.3 kV High-voltage 100 MHz differential probe.
P5210 – 5.6 kV High-voltage 50MHz differential probe.
P6139A – 500 MHz passive 10X voltage probe.
P6205 – 750 MHz active voltage probe.
P6243 – 1 GHz active voltage probe.
P6245 – 1.5 GHz active voltage probe.
P6249 – 4 GHz active voltage probe.
P6158 – 3 GHz low capacitance voltage probe.
P6339A – 500 MHz buffered passive voltage probe (TDS 794D only).
P6246 – 400 MHz differential probe.
P6247 – 1 GHz differential probe.
P6248 – 1.7 GHz differential probe.
P6563A – SMD passive voltage probes.
P6701B – Short-wavelength (500-950 nm) optical-to-electrical converter.
P6703B – Long-wavelength (1100-1700 nm) optical-to-electrical converter.
P6723 – Optical logic probe (1310/1550 nm).
TCP202 – DC to 50 MHz current probe.

RECOMMENDED ACCESSORIES

Also see page 56.

Service Manual – TDS 500D/600B/700D. Order 071-0136-00.
GPIB – LAN Adapter – Order AD007.
Transit Case – Order 016-1135-00.
Scope Cart – Order K420.

MEASUREMENT SERVICE OPTIONS

Opt. C3 – Three years of Calibration Services.
Opt. D1 – Cal Data Report.
Opt. D3 – Test Data (requires Opt. C3).
See page 615 for further information.

Java™ is a registered trademark of Sun Microsystems

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

CE

ISO 9001

Tektronix measurement products are manufactured in ISO registered facilities.

GPIB IEEE-488

Product(s) complies with IEEE Standard 488.1-1987, and with Tektronix Standard Codes and Formats.

Digital Storage Oscilloscopes

New TDS 694C • TDS 684C • TDS 680C • TDS 654C



For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

CE

ISO 9001

Tektronix measurement products are manufactured in ISO registered facilities.

GPIB IEEE-488

Product(s) complies with IEEE Standard 488.2-1987, and with Tektronix Standard Codes and Formats.

Features – Benefits

3 GHz, 1 GHz and 500 MHz Bandwidths to Work with the Fastest Signals in Today's Digital Designs

10 GS/s and 5 GS/s Sample Rates on all Channels Simultaneously for Full Bandwidth Single-shot Capture

Histograms and Measurement Statistics to More Fully Characterize Design Performance

Support for Java Applications Packages

Hard Disk Drive Storage (option)

Support for Iomega parallel port Zip™ drives

Waveform Math and Advanced Waveform DSP

Fully Automated Measurement System

Waveform Pass/Fail Template Testing

Color Display (TDS 654C, TDS 684C, TDS 694C)

RS-232, Centronics, and GPIB Interfaces Included Standard

Record Length to 120,000 Points/channel*

Timebase Accuracy to 10 ppm, Time Interval Measurement Accuracy to ±15 ps (TDS 694C)

Trigger Jitter 8 ps RMS (Typical)

1% Vertical Accuracy (TDS 694C)

100 ps Peak Detect (TDS 694C only)

** TDS 694C with long record length option (1 M) only. 15,000 points/channel maximum on TDS 684C/680C/654C.*

Applications

Validation and Characterization of High Speed Digital Designs
- Verify Simulation Performance with Real Measurements
- Ensure that Desired Design Margins Exist
- Jitter Measurements on High-speed Data, Phase-locked Loops and Spread-spectrum Clock Circuits
- Capture Glitches, Cross-talk, Setup/hold Violations

Telecommunications/Data Communications Design
- Characterize Rise Times, Overshoot, Channel to Channel Timing
- Verify and Test High Speed Serial Data Streams

High Energy Physics
- Transient Event Capture

Whether you are working on next generation microprocessor designs, high-speed data communications equipment, or in high-energy physics research, the TDS 694C captures your fastest signals with the best fidelity and resolution available. Its 3 GHz bandwidth preserves your waveform's fast rising edges and accurately shows signal details. With 10 GS/s digitizing rate simulta-

neously on all four channels and a high-stability timebase, the TDS 694C makes your critical timing measurements with the highest resolution and accuracy – even channel-to-channel measurements made in a single acquisition.

The TDS 600C oscilloscopes incorporate all the advanced trigger features you expect in a high performance oscilloscope: triggering on Glitches, Slew Rate violations, Setup and Hold Time violations, Time Outs, Logic Patterns and States on four channels. For applications where sophisticated multi-channel debugging is required, the TDS 694C can be configured for cross triggering with a Tektronix TLA 700 Logic Analyzer.

The TDS 600C oscilloscopes give you the total solution to your digital design characterization and debugging needs. Now you have the tool you need to verify design margins, characterize setup and hold times, and measure clock-to-data skew on the fastest digital designs.

The TDS 694C's companion probe, the P6249, offers small size to reliably contact your high-density boards with their fine-pitch, hard to reach components. The P6249 has short ground connection to give the maximum system bandwidth and preserve the details of your signals.

The TDS 600C offers 29 automatic measurements, with measurement statistics, to make your design verification and characterization job much faster and easier. Available Java-based application packages for Jitter Analysis, Disk Drive measurements and Processor Specification measurements provide customized measurements and analysis capability. The TDS 600C gives you the performance and features you need to get your job done faster and more thoroughly.

CHARACTERISTICS

	TDS 654C	TDS 680C	TDS 684C	TDS 694C
Total Channels	4	2 + 2	4	4
Sample Rate (all channels simultaneously)	5 GS/s	5 GS/s	5 GS/s	10 GS/s
Real-time Bandwidth	500 MHz	1 GHz	1 GHz	3 GHz
Maximum Record Length per Channel	15,000 pts	15,000 pts	15,000 pts	120,000 pts
Vertical Resolution	1 mV/div – 10 V/div	1 mV/div – 10 V/div	1 mV/div – 10 V/div	10 mV/div – 1 V/div
Delta Time Measurement Accuracy	<50 ps @ 5 GS/s	<50 ps @ 5 GS/s	<50 ps @ 5 GS/s	15 ps @ 10 GS/s
Advanced Waveform DSP/Math	Std.	Std.	Std.	Std.
Histograms and Measurement Statistics	Std.	Std.	Std.	Std.
Standard Probes	4 P6243	None	None	None
Display Type	7 in. NuColor™ Display	7 in. monochrome	7 in. NuColor™ Display	7 in. NuColor™ Display
Floppy Drive	Std.	Std.	Std.	Std.
GPIB, RS-232 & Centronics	Std.	Std.	Std.	Std.
VGA Output	Std. Color	Std. Mono	Std. Color	Std. Color
Hard Disk Drive	Opt.	Opt.	Opt.	Opt.

TIME BASE SYSTEM

Time Bases – Main and delayed.

Time/div Range – 200 ps/div to 10 s/div. except TDS 694C: 100 ps/div to 10 s/div.

Time Base Accuracy – Over any interval >1 ms 100 ppm. Except TDS 694C: Over any interval > 1 ms ± 10 ppm.

Time Interval Measurement Accuracy – TDS 654C/680C/684C: ±[(0.2/sample rate) + (100 ppm x |Reading|)] single shot. (≈ 50 ps @ 5 GS/s)
TDS 694C: ±[(0.15/sample rate) + (10 ppm x |Reading|)] single shot. (≈ 15 ps @ 10 GS/s)

Record Length per Channel – 500 to 15,000 pts. except TDS 694C: 500 to 30,000 pts. (optional: 120,000 pts.)

Trigger Jitter – 8 ps RMS (typical).

Pre-Trigger Position – 0% to 100% of record.

Channel to Channel Deskew Range – ±25 ns.

VERTICAL SYSTEM

Vertical Resolution – 8-Bits (>11-Bits with averaging).

Vertical Sensitivity – 1 mV/div to 10 V/div. Except TDS 694C: 10 mV/div to 1 V/div.

Maximum Input Voltage – 300 V CAT II; ±400 V peak. Derate at 20 dB/decade above 1 MHz. Except TDS 694C: 5 V RMS.

DC Gain Accuracy – ±1.5%. Except TDS 694C: ±1.0%.

Position Range – ±5 divs.

Offset – ±1 V from 1 to 99.5 mV/div, ±10 V from 100 mV to 995 mV/div, ±100 V from 1 V to 10 V/div.
Except TDS 694C: ±0.5 V from 10 to 50 mV/div, ±0.25 V from 50.5 to 100 mV/div, ±5 V from 101 mV to 500 mV/div, ±2.5 V from 505 mV to 1 V/div.

Bandwidth Selections – 20 MHz, 250 MHz, and Full. Except TDS 694C: Full only.

Input Impedance Selections – 1 MΩ in parallel with 10 pF, or 50 Ω (AC and DC coupling). Except TDS 694C: 50 Ω (DC coupled).

Input Coupling – AC, DC or GND. Except TDS 694C: DC or GND.

AC Coupled Low Frequency Limit (Except TDS 694C) – <10 Hz when AC, 1 MΩ coupled. <200 kHz when AC, 50 Ω coupled.

ACQUISITION MODES

Peak Detect – High frequency and random glitch capture. Captures glitches of 1 ns using acquisition hardware at all real-time sampling rates. TDS 694C captures glitches of 100 ps.

Sample – Sample data only.

Envelope – Max/min values acquired over one or more acquisitions.

Average – Waveform data from 2 to 10,000 waveforms (selectable) is averaged.

Single Sequence – Use RUN/STOP button to capture a single triggered acquisition at a time, which may be automatically saved to NVRAM with AutoSave.

TRIGGERING SYSTEM

TRIGGER TYPES

EDGE (Main and Delayed) – Conventional level-driven trigger. Positive or negative slope on any channel or rear panel auxiliary input. Coupling selections: DC, AC, noise reject, HF reject, LF reject.

LOGIC (Main) – PATTERN: Specifies a logical combination (AND, OR, NAND, NOR) of the four input channels (high, low, don't care). Trigger when pattern stays true or false for a specified time.
STATE: Any logical pattern of channels 1, 2, and 3 (AUX1 on TDS 680C) plus a clock edge on channel 4 (AUX2 on TDS 680C). Triggerable on rising or falling clock edge.
SETUP/HOLD: Trigger on violations of both setup time and hold time between clock and data which are on two input channels.

PULSE (Main) – GLITCH: Trigger on or reject glitches of positive, negative, or either polarity. Minimum glitch width is 1.0 ns with 200 ps resolution.
RUNT: Trigger on a pulse that crosses one threshold but fails to cross a second threshold before crossing the first again.
WIDTH: Trigger on width of positive or negative pulse either within or out of selectable time limits (1 ns to 1 s).
SLEW RATE: Trigger on pulse edge rates that are either faster or slower than a set rate. Edges can be rising, falling, or either.
TIMEOUT: Trigger on an event which remains high, low, or either, for a specified time period, selectable from 1 ns to 1 s, with 200 ps resolution.

TLA Cross Trigger (TDS 694C only) – Utilize a TLA 700 logic analyzer to detect a multichannel event, then trigger the TDS 694C. The trigger points on the TLA and TDS will be aligned in time.

VIDEO (Optional; Not Available in TDS 694C) – Trigger on a particular line of individual, odd/even, or all fields. Trigger on a specific pixel of a line by using the video trigger with delay by events. Choose positive or negative horizontal sync polarity.
525/NTSC: Choose monochrome or color (studio-quality NTSC) sync formats. 625/PAL: Choose color or monochrome (studio-quality PAL) sync formats. HDTV: Choose from 1125/60, 1050/60, 1250/50, and 787.5/60 HDTV formats.

Trigger Bandwidth (Edge Type) – 3 GHz (TDS 694C), 1 GHz (TDS 684C, TDS 680C), 500 MHz (TDS 654C).

Main Trigger Modes – Auto, Normal, Single.

Delayed Trigger – Delay by time, events, or events and time.

Delay by Time Range – 16 ns to 250 s.

Delay by Events Range – 2 to 9,999,999 events.

External Trigger Input – Input Impedance: ≥1.5 kΩ; Max. Input Voltage: ±20 V (DC + peak AC).

DISPLAY CHARACTERISTICS

Waveform Style – Dots, vectors, variable persistence from 32 ms to 10 s, infinite persistence, and intensified samples.

Color (TDS 694C, TDS 684C, TDS 654C) – Standard palettes and user-definable color for waveforms, text, graticules, and cursors. Measurement text and cursor colors matched to waveform. Waveform collision areas highlighted with different color. Statistical waveform distribution shown with color grading through variable persistence.

Color Grading (TDS 694C, TDS 684C, TDS 654C) – With variable persistence selected, historical timing information is represented by temperature or spectral color scheme (or gray scale on TDS 680C).

Graticules – Full, grid, cross-hair, frame, and NTSC and PAL (with video trigger option).

Format – YT and XY.

Resolution – 640 horizontal by 480 vertical displayed pixels (VGA).

Color CRT Monitor (TDS 654C/684C/694C) – 7 in. diagonal NuColor™ liquid crystal full-color shutter, 256 levels.

Monochrome CRT Monitor (TDS 680C) – 7 in. diagonal, magnetic deflection. Horizontal raster-scan. P4 white phosphor.

MEASUREMENT SYSTEM

Automatic Waveform Measurements – Period, frequency, + width, – width, rise time, fall time, + duty cycle, – duty cycle, delay, phase, burst width, high, low, max, min, peak to peak, amplitude, + overshoot, – overshoot, mean, cycle mean, RMS, cycle RMS, area, cycle area, extinction ratio (ratio, dB, %), and mean optical power. Continuous update of up to four measurements on any combination of waveforms.

Measurement Statistics – Display minimum and maximum or mean and standard deviation on any displayed single-waveform measurements.

Thresholds – Settable in percentage or voltage.

Gating – Any region of the waveform may be isolated for measurement using vertical bars.

Snapshot – Performs all measurements on any one waveform showing results from one instant in time.

Cursor Measurements – Absolute, Delta: Volts, Time, Frequency, and NTSC IRE and line number (with video trigger option).

Cursor Types – Horizontal bars (volts), vertical bars (time); operated independently or in tracking mode.

Histogram Measurements – Mean, median, standard deviation, hits, waveform count, peak hits, peak to peak, % mean ± 1, 2, and 3 standard deviations.

WAVEFORM PROCESSING

Waveform Functions – Interpolation (sin(x)/x or linear), Average, Envelope, Auto Setup.

Advanced Waveform Functions – FFT, Integration, Differentiation, Waveform (math or acquired) Limit Testing.

Arithmetic Operators – Add, Subtract, Multiply, Divide, Invert.

Autoset – Single-button, automatic setup on selected input signal for vertical, horizontal, and trigger systems.

Waveform Limit Testing – Compares incoming or math waveform to a reference waveform's upper and lower limits.

Waveform Histograms – Both vertical and horizontal histograms, with periodically updated measurements, allow statistical distributions to be analyzed over any region of the signal.

ZOOM CHARACTERISTICS

The zoom feature allows waveforms to be expanded or compressed in both vertical and horizontal axes. Allows precise comparison and study of fine waveform detail without affecting ongoing acquisitions. When used with Average acquisition modes, Zoom provides an effective vertical dynamic range of 1000 divisions or 100 screens.

Dual Window Zoom – Dual graticules simultaneously show selected and zoomed waveforms. Up to two zoom boxes show areas on the selected trace that are being magnified, and the two magnified areas can be overlapped for quick comparison. Color of zoomed trace matches selected trace.

HARDCOPY

Printer – HP Thinkjet, Deskjet, Laserjet, Epson, Interleaf, PostScript, TIFF, PCX, BMP, DPU411/412, RLE.

Plotter – HPGL.

Data – MathCad, spreadsheet formats.

Hardcopy Interface – Centronics and RS-232 (talk only).

DATA STORAGE

Standard – Internal MS-DOS 1.44 MB floppy, external Iomega Zip™ drive support.

Optional – Internal hard disk drive.

Non-volatile Storage for Setups – 10 front panel setups.

Floppy Disk Drive – Store reference waveforms, setups, and image files on 3.5 in. 1.44 MB or 720 K DOS-format floppy disk.

Iomega Zip™ Drive Compatible – Compatible for waveform, hardcopy, and front panel setup file transfer to Iomega Zip™, ZipPlus™, and Zip250™ Drive.

POWER REQUIREMENTS

Line Voltage Range – 90 to 250 V RMS.

Line Frequency – 45 to 440 Hz.

Power Consumption – 300 W max. (TDS 654C/680C/684C).
450 W max. (TDS 694C).

ENVIRONMENTAL AND SAFETY

Temperature –
Operating: +4°C to +45°C (floppy not used), +10°C to +45°C (floppy in use).
Nonoperating: –22°C to +60°C.
TDS 694C: Operating: +5°C to +40°C (floppy not used), +10°C to +40°C (floppy in use).
Nonoperating: –22°C to +60°C.

Humidity – Operating: 20% to 80% RH at or below +32°C.

Altitude – Operating: 15,000 ft. (hard disk not used), 10,000 ft. (hard disk in use). Non-operating: 40,000 ft.

Electromagnetic Compatibility – UL1244.

Safety – UL3111-1, CSA1010.1, EN61010-1, IEC61010-1.

PHYSICAL CHARACTERISTICS

Dimensions	mm	in.
Height with feet	193	7.6
Height without feet	178	7
Width with handle	445	17.5
Depth with front cover installed	434	17.1
Weight	**kg**	**lbs.**
Net approximately	14.1	31
Shipping Weight approximately	24.0	53

ORDERING INFORMATION

For price information: Outside the U.S. contact your local Tektronix representative, inside the U.S. see the price list in the back of this catalog.

TDS 694C
Four-channel Color 3 GHz, 10 GS/s Per Channel, Digital Storage Oscilloscope.

Includes: User Manual (071-0473-00), Quick Reference Guide (071-2313-00), Programmer's Manual in MS-Help format on floppy disk (063-3060-00), Technical Reference (Performance Verification) Manual (071-0496-00), Probe Deskew Fixture (679-4809-00), Footswitch and Adapter (260-1189-02 and 013-0312-00), Front Cover (200-3696-00), North American Power Cord (161-0230-01), Accessory Pouch (016-1268-00).

TDS 684C
Four-channel Color 1 GHz, 5 GS/s Per Channel Digital Storage Oscilloscope.

TDS 680C
Two-channel Monochrome 1 GHz, 5 GS/s Per Channel Digital Storage Oscilloscope.

TDS 654C
Four-channel Color 500 MHz, 5 GS/s Per Channel Digital Storage Oscilloscope. Includes: Four P6243 FET Probes.

TDS 654C/TDS 680C/TDS 684C Include: User Manual (070-0130-00), User Supplement (071-0273-00), Quick Reference Guide (020-2235-00), Programmer's Manual in MS-Help format on floppy disk (063-3120-00), Technical Reference Manual (071-0272-00), Front Cover (200-3696-00), North American Power Cord (161-0230-01), Accessory Pouch (016-1268-00) (Except TDS 680C).

OPTIONS

Opt. 05 – Video Trigger, NTSC, PAL, HDTV, FlexFormat™. (Except TDS 694C)

Opt. 1K – Model K420 Instrument Cart.

Opt. 1M – 120 k Record Length. (TDS 694C only)

Opt. 1R – Rackmount Kit.

Opt. 31 – Add 1 ea. P6339A Buffered Passive Probe. (TDS 694C only)

Opt. 33 – Add 1 ea. P6158 Low Capacitance Probe. (Except TDS 654C)

Opt. 34 – Add 1 ea. P6247 Differential Probe. (Except TDS 694C)

Opt. 35 – Add 1 ea. P6243 Active Probe. (TDS 654C Only)

Opt. 36 – Add 1 ea. P6139A Passive Probe. (Except TDS 694C)

Opt. 37 – Add 1 ea. P6245 Active Probe. (Except TDS 654C)

Opt. 38 – Add 1 ea. P6249 4 GHz Active Probe. (TDS 694C only)

Opt. 39 – Add 1 ea. P6248 1.7 GHz Differential Probe. (TDS 694C only)

Opt. HD – Internal Hard Disk Drive.

MEASUREMENT SERVICE OPTIONS

Opt. C3 – Three years of Calibration Services.

Opt. D1 – Calibration Data Report.

Opt. D3 – Test Data (requires Opt. C3).

INTERNATIONAL POWER PLUGS

Opt. A1, A2, A3, A5.

See page 619 for description.

SOFTWARE

TDS JAVA APPLICATIONS

TDSJIT1 – Jitter and timing analysis application.

TDSDDM1 – Hard disk drive measurement application.

TDSPSM1 – Processor specifications measurement application.

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CE

ISO 9001

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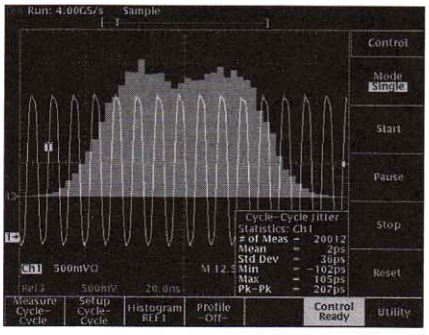
GPIB IEEE-488

Product(s) complies with IEEE Standard 488.2-1987, and with Tektronix Standard Codes and Formats.



JITTER ANALYSIS SOFTWARE

- Your TDS 500/600/700 Series oscilloscope can perform jitter analysis without external equipment
- Installs inside the TDS oscilloscope requiring no external GPIB, RS-232 or PC
- Provided on floppy disk for easy customer installation
- Uses familiar, user-friendly TDS user interface
- Characterize jitter on single inputs, differential inputs and channel to channel waveforms
- Define timing analysis features by slope, level and hysteresis
- Single-shot analysis on user-selectable record lengths
- Measure jitter timing parameters over contiguous clock cycles
- Profile all jitter timing measurements vs. cycle
- Comprehensive statistics and customized histograms on all profile parameters
- Measurements include: cycle-cycle, N-cycle, skew, period, width, and duty cycle
- Period time-stamps can be exported for external analysis
- Typical TDS 694C single-shot measurement repeatability: 3 ps RMS*[1]
- Peak TDS 694C single-shot delta time accuracy: 15.1 ps*[2]

APPLICATIONS

- Characterize the timing performance of your semiconductor systems
- Determine the timing margins in your digital designs
- Use the channel to channel measurements to characterize spread spectrum clock PLLs

*[1]*TDS 694C single-shot measurement repeatability = 0.03/(sample rate). This gives 3 ps at 10 GS/s.*

*[2]*TDS 694C single-shot delta time accuracy = 0.15/(sample rate) + 10 ppm * |measurement|. This gives 15.1 ps accuracy for a 10 ns (100 MHz) measurement at 10 GS/s.*

USER-INSTALLED, OSCILLOSCOPE RESIDENT JITTER ANALYSIS PACKAGE

Electronic design engineers in semiconductor industries develop ICs with high clock speeds and reduced timing margins. As clock frequencies in the industry continue to increase, timing margins become more critical. Sophisticated techniques are required to properly characterize the placement of these clock edges. Customers in the computer industry need to ensure that the timing margins in their designs are not violated because of excessive jitter.

The TDS 500D/600C/700D oscilloscopes have superb jitter analysis capabilities on non-contiguous clock cycles with their histogram and statistics capabilities. The Tektronix TDSJIT1 Jitter Analysis Software will extend that capability by making jitter measurements on contiguous clock cycles from single-shot acquisitions. TDSJIT1 provides many key timing parameter measurements. These are specifically designed to meet the jitter measurement needs of today's high speed digital designers. Measurements can be made on differential signals and between two separate input signals. Profile plots quickly show how various timing parameters change over time. Comprehensive statistics and histograms of timing parameters enhance the powerful analysis capabilities of TDSJIT1.

TDSJIT1 Jitter Analysis Software is a software package from Tektronix that delivers industry standard jitter and timing analysis capabilities. It comes on floppy disks, is easily installed in a TDS oscilloscope, and doesn't require any external processing or connections. After installation, the application is accessible from the oscilloscope front panel.

TEKTRONIX OSCILLOSCOPES SUPPORTED

TDS 500D, TDS 600C, TDS 700D series oscilloscopes with Option HD.

ORDERING INFORMATION

For price information: Outside the U.S. contact your local Tektronix representative, inside the U.S. see the price list in the back of this catalog.

TDS JIT1
Jitter Analysis Software for TDS 500/600/700 oscilloscopes.
Includes: Software on 3.5-in. Disk, Manual.
Note: Requires TDS 500/600/700 Opt. HD or 2M.

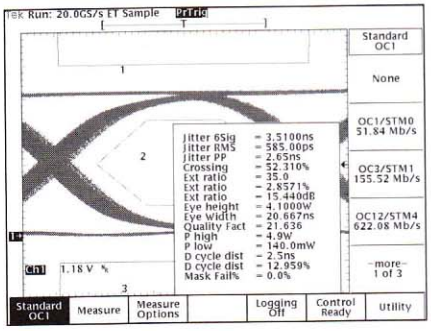
TDSJIT1 RECOMMENDED ACCESSORIES
High-bandwidth Differential Probe – P6248 1.7 GHz Differential Probe.
High-bandwidth Active Probe – P6249 4 GHz Active Probe.
Data Generator – DG2040 Data Generator.
Arbitrary Waveform Generator – AWG 610 Programmable Arbitrary Waveform Generator.

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

CE

ISO 9001

Tektronix measurement products are manufactured in ISO registered facilities.



EYE DIAGRAM MEASUREMENT SOFTWARE

- Perform automatic eye diagram measurements of: % crossing, eye height, eye width, quality factor, extinction ratio and jitter
- Provides more in-depth understanding of your communication signal beyond qualitative pass/fail mask testing
- Adds additional capability to your TDS communications analyzer package by enabling your TDS 500/700 Series oscilloscope to perform automated eye diagram measurements
- Optical standards measured include:
  - SONET/SDH: OC1/STM0, OC3/STM1, OC12/STM4
  - Fibre channel: FC133, FC266, FC531, FC1063
  - Gigabit ethernet: 1.25 Gb/s
- With the unique autoset to standard mask capability, you do not need to set up the vertical, horizontal, trigger or filter controls
- Set the population size for the statistics measurements
- Log the measurement results to a file for future analysis
- GPIB control of measurements for use in ATE applications
- Installs inside the TDS oscilloscope requiring no external GPIB, RS-232 or PC

APPLICATIONS

- Characterize the quality of your optical communications signals with accurate eye diagram analysis

USER-INSTALLED, OSCILLOSCOPE RESIDENT EYE DIAGRAM MEASUREMENT PACKAGE

Option 2C, the Tektronix TDS Communication Signal Analyzer package, gives you the most comprehensive oscilloscope solutions for connecting to, capturing, and characterizing optical and electrical signals in high-speed communication designs. Based on the TDS 500D/700D family of Digital Phosphor Oscilloscopes (DPOs), Option 2C and various measurement accessories tailor the oscilloscope for engineers debugging, characterizing, and verifying the compliance of communication systems to international standards.

TDSCEM1 adds additional capability to Option 2C by allowing communication customers to perform quantitative measurements on their eye diagrams in addition to qualitative mask testing. TDSCEM1 provides an extensive suite of additional measurements to support analysis and trouble-shooting beyond simple pass-fail testing.

Customers who will benefit from TDSCEM1 are electronic design engineers working for communication equipment manufacturers in the communications industry who develop products with standard communication interfaces. These engineers need tools to properly characterize their designs and verify compliance to industry standards. These standards include SONET/SDH, Fibre Channel and Gigabit Ethernet. Characterization of these optical and electrical signals include mask testing as well as eye diagram measurements.

TDSCEM1 comes on a single floppy disk, is easily installed in a TDS oscilloscope, and doesn't require any external processing or connections. After installation, the application is accessible from the oscilloscope front panel.

TEKTRONIX OSCILLOSCOPES SUPPORTED

TDS 500D, TDS 700D series oscilloscopes with Communication Signal Analyzer Option 2C and a hard disk drive (Option HD or Option 2M).

ORDERING INFORMATION

For price information: Outside the U.S. contact your local Tektronix representative, inside the U.S. see the price list in the back of this catalog.

TDSCEM1
Communications Eye Diagram Measurement Software for TDS 500/700 Oscilloscopes.
Includes: Software on a 3.5-in. Disk, Manual.
Note: Requires TDS 500/600/700 Opt. HD or 2M, and TDS 500/700 Communication Signal Analyzer Option 2C, FW v6.4e.

TDSCEM1 RECOMMENDED OPTIONS AND ACCESSORIES
AMT75 – 75 Ω Adapter.
TDS Option 3C – (includes P6701B) Short-wavelength Fibre Channel Optical Reference Receiver.
TDS Option 4C – (includes P6703B) Long-wavelength SONET/SDH Optical Reference Receiver.
P6701B/P6703B – Optical-to-Electrical Converters.
P6723 – Optical Logic Probe.
OA5002/OA5012/OA5022/OA5032 – Optical Attenuators.

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

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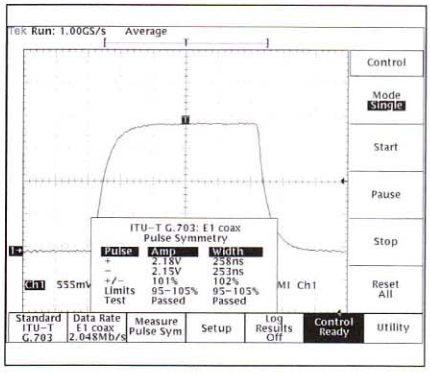

COMMUNICATIONS PULSE MEASUREMENT SOFTWARE

- Enhances the Capabilities of Your TDS Communications Analyzer Package by Enabling Your TDS 500/700 Series Oscilloscope to Perform Automated Parametric Measurements on Various Electrical Communication Pulse Waveforms
- Perform Measurements and Pass/Fail Testing of:
  - Pulse Amplitude
  - Spectral Power
  - Pulse Imbalance
  - Pulse Symmetry
  - Zero Level
- Standards Measured Include ANSI T1.102 and ITU-T G.703
- With the Unique Autoset to Standard Mask Capability, You Do Not Need to Set Up the Vertical, Horizontal, Trigger or Filter Controls
- Log the Measurement Results to a File for Future Analysis
- GPIB Control of Measurements if Desired
- Installs Inside the TDS Oscilloscope Requiring no External GPIB, RS-232 or PC
- Provided on a Single Floppy Disk for Easy Customer Installation
- Uses Familiar, User-friendly TDS User Interface

APPLICATIONS

- Characterize the Standards Compliance of Electrical Communications Signals

USER-INSTALLED, OSCILLOSCOPE RESIDENT COMMUNICATION PULSE SIGNAL MEASUREMENT PACKAGE

Electronic design engineers, working for communication equipment manufacturers in the communications industry, develop products with standard communication interfaces. These engineers need tools to properly characterize their designs and verify compliance to industry standards. These standards include ANSI T1.102-1993 and ITU-T G.703. Characterization of these electrical signals include mask testing as well as parametric testing.

Option 2C, the Tektronix TDS Communication Signal Analyzer package, gives you the most comprehensive oscilloscope solutions for connecting to, capturing, and characterizing optical and electrical signals in high-speed communication designs. Based on the TDS 500D/700D family of Digital Phosphor Oscilloscopes (DPOs), Option 2C and various measurement accessories tailor the oscilloscope for engineers debugging, characterizing, and verifying the compliance of communication systems to international standards.

This capability is further enhanced by TDSCPM1 which allows electrical communication customers to perform quantitative measurements on their pulse waveforms in addition to mask tests provided by the Option 2C capabilities and accessories.

TDSCPM1 comes on a single floppy disk, is easily installed in a TDS oscilloscope, and doesn't require any external processing or connections. After installation, the application is accessible from the oscilloscope front panel.

TEKTRONIX OSCILLOSCOPES SUPPORTED

TDS 500D, TDS 700D series oscilloscopes with Communication Signal Analyzer Option 2C and a hard disk drive (Option HD or Option 2M).

ORDERING INFORMATION

For price information: Outside the U.S. contact your local Tektronix representative, inside the U.S. see the price list in the back of this catalog.

TDSCPM1
Communications Pulse Measurement Software for TDS 500/700 Oscilloscopes.
Includes: Software on a 3.5-in. Disk, Manual.
Note: Requires TDS 500/600/700 Opt. HD or 2M.

TDSCPM1 RECOMMENDED OPTIONS AND ACCESSORIES
AFTDS – Telecom Adapter.
AMT75 – 75 Ω Adapter.

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

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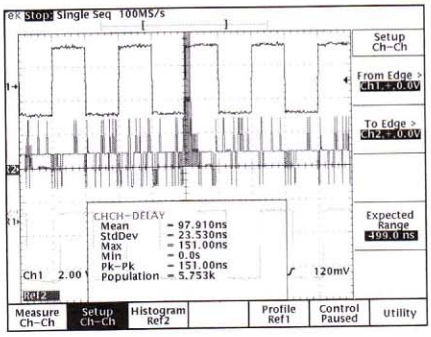


PROCESSOR SPECIFICATIONS MEASUREMENT SOFTWARE

- Your TDS 500/600/700 Series oscilloscope can perform automated measurements on processor signal specifications without external equipment
- Installs inside the TDS oscilloscope requiring no external GPIB, RS-232 or PC
- Provided on floppy disk for easy installation
- Uses familiar, user-friendly TDS user interface
- Perform automated timing measurements of Ch-Ch delay, setup margin, hold margin, and clock to output timing
- Perform automated AC specification measurements of rise, fall, high and low time
- Analysis is performed on each and every valid pulse in a single-shot acquisition
- Measurement results are returned with detailed statistics of: mean, min, max, standard deviation, and population

APPLICATIONS

- Precisely characterize the timing and AC performance of your digital designs
- Measure timing from either or both edges of clock to either or both edges of data

USER-INSTALLED, OSCILLOSCOPE RESIDENT PROCESSOR SIGNAL MEASUREMENT PACKAGE

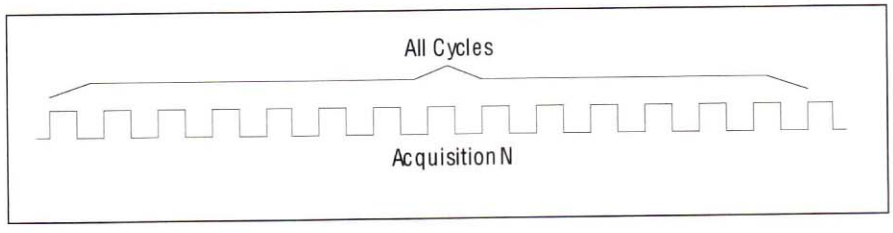
Microprocessors are used in a variety of industries and sub-systems. However, all these processors need to be integrated in a manner that will allow optimal operation. The various processor manuals detail the electrical and interface performance that is required for proper operation of these processors. As an example, the Intel Processor Developer's Manuals can be found on the WWW at http://intel.com/design/processor/. These measurements are generic to microprocessors and are useful across different processor types and across different generations of a processor family.

Many of the measurements in TDSPSM1 can be performed today using the oscilloscope automatic measurements or histograms. TDSPSM1 enhances this capability by providing direct measurements for each individual edge or pulse and showing detailed statistics. For example, the setup time measurement in TDSPSM1 is made for a specific data edge to the exact, corresponding clock edge.

TDSPSM1 comes on a single floppy disk, is easily installed in a TDS oscilloscope, and doesn't require any external processing or connections. After installation, the application is accessible from the oscilloscope front panel.

TEKTRONIX DIGITAL OSCILLOSCOPES SUPPORTED

TDS 500D, TDS 600C, TDS 700D Series oscilloscopes with Option HD.



TDSPSM1 measurements are performed on all relevant data in a single-shot acquisition.

ORDERING INFORMATION

For price information: Outside the U.S. contact your local Tektronix representative, inside the U.S. see the price list in the back of this catalog.

TDSPSM1
Processor Specifications Measurement Software for TDS 500/600/700 Oscilloscopes.
Includes: Software on a 3.5-in. Disk, Manual.
Note: Requires TDS 500/600/700 Opt. HD or 2M.

TDSPSM1 RECOMMENDED ACCESSORIES
TDSJIT1 – Jitter Analysis Software.
High-bandwidth Active Probes – P6245 1.5 GHz Active Probe.
P6249 4 GHz Active Probe.

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

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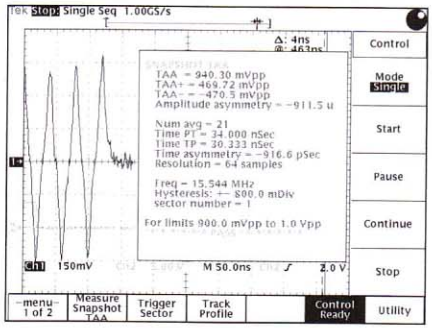

DISK DRIVE MEASUREMENT SOFTWARE

- Your TDS 500D/600C/700D Series oscilloscope can perform disk-drive measurements without external equipment
- Installs inside the TDS oscilloscope requiring no external GPIB, RS-232 or PC
- Provided on floppy disk for easy customer installation
- Uses familiar, user-friendly TDS user interface
- High-resolution measurements can be made on one channel at the highest sample rate with trigger input from multiple channels
- Comprehensive statistical measurements – mean, min, max, std dev, SNR and more for easy characterization of signals
- Snapshot display of multiple parameters for detailed waveform information
- SNR and NLTS measurements work for signal-to-noise ratios of 0 dB and below
- Auto configures trigger inputs for index, sector and read channel for easy set-up
- Thermal asperity information provided for quick problem detection
- Track profile stores and displays measurement from each sector for various parameters
- On-line help text provides information about each measurement
- Part of a complete solution for disk-drive measurements from Tektronix – high-bandwidth differential probes, SMT probes, arbitrary waveform generators, etc.
- Lower price than other custom disk-drive measurement solutions that perform limited measurements

APPLICATIONS

- IDEMA measurements including TAA, PW50, overwrite, resolution and asymmetry
- PRML measurements including autocorrelation NLTS and SNR

USER-INSTALLED, OSCILLOSCOPE-RESIDENT DISK-DRIVE MEASUREMENT PACKAGE

Design, manufacturing and failure analysis engineers at disk drive companies; silicon vendors who design read-channel components; read/write head and media manufacturers – all desire to make measurements that are specific to their industry. Performing measurements on disk-drive signals that comply with the IDEMA standards is crucial to meeting their objectives.

Tektronix now offers a solution that provides custom disk-drive measurements for the industry leading TDS oscilloscopes. Peak detect measurements include track average amplitude positive (TAA+), track average amplitude negative (TAA-), track average amplitude total (TAA), 50% pulse width positive (PW50+), 50% pulse width negative (PW50-), 50% pulse width (PW50), overwrite and resolution. Timing measurements include time – trough-to-peak, and time – peak-to-trough. PRML measurements include autocorrelation nonlinear transition shift and signal-to-noise ratio. Voltage and time asymmetry measurements are available for MR head designers. Measurement statistics are also available.

TDSDDM1 Disk-drive Measurement Software is a software package from Tektronix that delivers industry-specific disk-drive measurements. It comes on floppy disks, is easily installed into a TDS 500D/600C/700D oscilloscope and doesn't require any external processing or connections. After installation, the application is accessible from the front panel.

CHARACTERISTICS

TEKTRONIX OSCILLOSCOPES SUPPORTED

TDSDDM1 software operates on the following scopes:

Instrument*[1]	Firmware	Serial Number
TDS 724C Opt 2M	v5.2e or later	B020100 or greater
TDS 754C Opt 2M	v5.2e or later	B020100 or greater
TDS 784C Opt 2M	v5.2e or later	B020100 or greater
TDS 500D	Opt. HD	
TDS 600C	Opt. HD	
TDS 700D	Opt. HD	

*[1]*Instruments must have Option HD, Hard Disk Drive.*

ORDERING INFORMATION

For price information: Outside the U.S. contact your local Tektronix representative, inside the U.S. see the price list in the back of this catalog.

TDSDDM1
Disk-Drive Measurement Software for TDS 500D/700D.
Includes: Software on 3.5-in. Disks, Manual.
Note: Requires TDS 500/600/700 Opt. HD or 2M.

TDSDDM1 RECOMMENDED ACCESSORIES
Arbitrary Waveform Generator – AWG 520 Programmable Dual-channel Arbitrary Waveform Generator.
High-bandwidth Differential Probe – P6247 1 GHz Differential Probe.
P6248 1.7 GHz Differential Probe.

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

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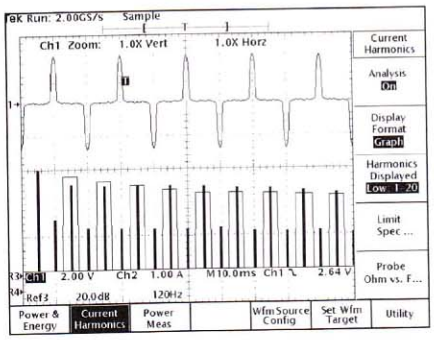

POWER MEASUREMENT SOFTWARE

- Your TDS 500D/600C/700D Series oscilloscope can perform customized power measurements without the need for a dedicated power system tester
- Installs inside the TDS oscilloscope requiring no external GPIB, RS-232 or PC
- Provided on floppy disk for easy customer installation
- Uses familiar, user-friendly TDS user interface
- Graphic and table print-out of current harmonics to easily view and document AC-line performance in either spectral or tabular form
- Direct reading of true power, apparent power and power factor measurements to eliminate manual calculations
- Part of a complete solution for power measurements from Tektronix – voltage probes, high– and low-voltage differential probes, differential amplifiers, high– and low-current probes, current-probe amplifiers, isolation systems, etc.
- Measurements include instantaneous power and energy on long records with automatic display of power and energy
- Lower price than other custom power measurement systems that perform limited measurements

APPLICATIONS

- Pre-compliance testing to CE standard per EN 61000-3-2
- Characterizing switching losses of IGBTs

USER-INSTALLED, OSCILLOSCOPE-RESIDENT POWER-MEASUREMENT PACKAGE

Engineers in the semiconductor industries who design IGBTs, power MOSFETs and electric motor drive ICs for the power supply industry need to make specialized energy curve measurements. Engineers designing switching power supplies, electric motors and ballasts for electrical lighting need to measure power on their sub-systems. Engineers designing products for the European market must ensure compliance to the EN 61000-3-2 standard.

Tektronix now offers these and others a solution that provides custom power measurements for the industry leading TDS oscilloscopes. Features include calculation of instantaneous power and energy curves from voltage and current input. Automatic measurements include true power, apparent power and power factor. In addition, this package provides pre-compliance testing to EN 61000-3-2 with a minimum of difficulty.

TDSPWR1 Power Measurement Software is a software package from Tektronix that delivers industry-specific power measurements. It comes on floppy disks, is easily installed onto a TDS 500D/600C/700D oscilloscope, and doesn't require any external processing or connections. After installation, the application is accessible from the oscilloscope front panel.

CHARACTERISTICS

TEKTRONIX OSCILLOSCOPES SUPPORTED

TDSPWR1 software operates on the following scopes:

Instrument*1	Firmware	Serial Number
TDS 724C Opt. 2M	V5.2e or later	B020100 or greater
TDS 754C Opt. 2M	V5.2e or later	B020100 or greater
TDS 784C Opt. 2M	V5.2e or later	B020100 or greater
TDS 500D, TDS 600C, TDS 700D series oscilloscopes with option HD.		

*1 *Instruments must have Option HD, Hard Disk Drive.*

ORDERING INFORMATION

For price information: Outside the U.S. contact your local Tektronix representative, inside the U.S. see the price list in the back of this catalog.

TDSPWR1
Power Measurement Software for TDS 500D/700.
Includes: Software on 3.5-in. Disks, Manual.
Note: Requires TDS 500/600/700 Opt. HD or 2M.

TDSPWR1 RECOMMENDED ACCESSORIES
High-Voltage Differential Probe – P5205 Active Differential Probe.
Current Probe – TCP202 DC Coupled Current Probe.

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

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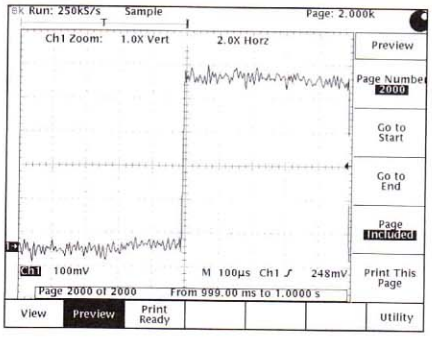

ENHANCED PRINTING UTILITY SOFTWARE

- Available for free download from the WWW
- Uses familiar, user-friendly TDS user interface
- Prints up to 2000 pages of waveform data
- Allows printing of entire record or region between cursors
- Print preview mode allows quick high resolution viewing of long records
- Print preview mode allows pages to be marked or unmarked for printing
- Help page

APPLICATIONS

- View data on multiple sectors of a disk drive
- View header information in a communications data stream

USER-INSTALLED OSCILLOSCOPE-RESIDENT ENHANCED PRINTING UTILITY

Electronic design engineers in the disk drive, communications and other related industries that use long records need to view a hardcopy of a long record. Customers in the disk drive industry want to view anomalies on certain sectors of data. Customers designing modems want hardcopies of start-up sequences that detail threshold changes with different digital modulation schemes. Bio-Medical customers want to print out long records to evaluate several minutes of activity from their pacemakers.

Tektronix now offers a solution that provides enhanced printing capabilities for the industry-leading TDS oscilloscopes. Using the familiar TDS user interface, customers can now easily navigate long records and conveniently print only screens that are of interest to them.

TDSPRT1 is a Software package from Tektronix that delivers enhanced printing capabilities. It is available for free by following the installation instructions from the following URL: www.tektronix.com/Measurements/scopes. After installation, the application will be accessible from the oscilloscope front panel.

SYSTEM REQUIREMENTS

TDSPRT1 will operate on the following Tektronix Digital Storage Oscilloscopes:

Instruments must have Option HD, Hard Disk Drive.

Instruments must also have TDSRTE1 (Run Time Environment) installed to run the application.

TEKTRONIX OSCILLOSCOPES SUPPORTED

Instrument	FW	S/N
TDS 724C Opt. 2M	V5.2e or later	B020100 or greater
TDS 754C Opt. 2M	V5.2e or later	B020100 or greater
TDS 784C Opt. 2M	V5.2e or later	B020100 or greater
TDS 500D, TDS 600C, TDS 700D, series oscilloscopes with option HD		

ORDERING INFORMATION

For price information: Outside the U.S. contact your local Tektronix representative, inside the U.S. see the price list in the back of this catalog.

Application and instructions can be downloaded for free from the www at:
www.tektronixcom/Measurement/scopes

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

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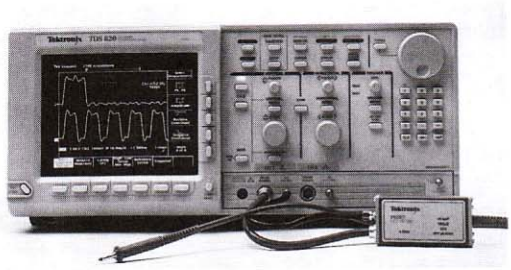
Digital Sampling Oscilloscopes

TDS 820



Features – Benefits

- 0.4 ps Timing Resolution
- 20 ps/div to 2 ms/div Sweep Speeds in 5 ps Steps
- 2 GHz External Trigger Bandwidth
- 3 ps RMS Jitter
- Infinite and Variable Persistence Displays
- 14-Bit Vertical Resolution
- 27 Automatic Measurements
- Full GPIB Programmability
- Optional Hardcopy Interface
- Optional Advanced DSP Waveform Math Including FFT, Integration and Differentiation

Applications

- Telecom Service and Manufacturing
- Semiconductor Characterization
- Digital System Design and Characterization
- Electronic Mask Drawing and Display
- Automatic Pass/Fail Limit Testing

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

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ISO 9001

Tektronix measurement products are manufactured in ISO registered facilities.

GPIB IEEE-488

Product(s) complies with IEEE Standard 488.2-1987, and with Tektronix Standard Codes and Formats.

Characteristics

SIGNAL Acquisition System	TDS 820	TDS 820 Opt. 1D
Channels	2	2
Rise time	58.3 ps	43.8 ps
Bandwidth (0.35/rise time)	6 GHz	8 GHz
Max operating input voltage	2 V_{p-p}; ±3 V DC	1 V_{p-p}; ±1.5 V DC
Sensitivity	2 m V/div to 200 mV/div	1 mV/div to 100 mV/div
Random noise	1.2 mV max, 600 µV typical	600 µV max, 300 µV typical

DC Gain Accuracy – ±0.7% after user-initiated automatic vertical calibration.

Vertical Resolution – 14-Bits (Approx. 16,384 levels over 10.24 vertical divisions).

Input Impedance – 50 Ω.

ACQUISITION MODES

Normal – One sample acquired with each trigger event.

Envelope – Max/min values acquired over one or more acquisitions.

Average – Waveform averages selectable from 2 to 10,000.

TIME BASE SYSTEM

Time Bases – Main, Delayed.

Time/Division Range – 20 ps/division to 5 ms/division in 1-2-5 steps or settable from the numeric keypad in 5 ps steps.

Delta time measurement accuracy –

Time interval	Accuracy
Ti ≥1 ns	0.1% x interval +15ps
100 ps	5 ps
10 ps	2 ps

Channel Deskew – Up to 100 ns (each channel).

Record Length – 500, 1000, 2000, and 5000, and 15,000 samples per channel.

Pre –Trigger View Time – 1.5 ns.

TRIGGERING SYSTEM

Trigger Sources – External input, internal rate generator, CH 1, CH 2.

External Trigger Sensitivity – 40 mV_{p-p} from DC to 200 MHz, increasing linearly to 200 mV_{p-p} at 2 GHz.

External Trigger Minimum Pulse Width – 0.25 ns.

Internal Trigger Sensitivity – 80 mV_{p-p} from DC to 200 MHz, increasing linearly to 400 mV_{p-p} at 1 GHz.

Trigger Delay Jitter – 3 ps RMS + 30 ppm of time base delay.

Holdoff Range – 15 µs to 2 s.

DISPLAY

Waveform Style – Dots or vectors. Infinite and variable persistence from 250 ms to 10 s.
Gray Scaling – With variable persistence selected, waveform points gradually decay through 16 levels of intensity, providing "z-axis" information about rapidly changing waveforms.
Graticules – Full, grid, cross hair, frame.
Format – YT and XY.
CRT Type – 7 in. diagonal, magnetic deflection. Horizontal raster-scan. P4 White phosphor.
CRT Resolution – 640 horizontal by 480 vertical displayed pixels.

MEASUREMENT SYSTEM

Automatic waveform measurements –

Period	Frequency
High	Low
+ Width	- Width
Maximum	Minimum
Rise	Fall
Peak to Peak	Amplitude
+ Duty Cycle	- Duty Cycle
+ Overshoot	- Overshoot
Propagation Delay	Burst Width
Mean	Cycle Mean
RMS	Cycle RMS
Phase	Cycle Area
+ Cross	- Cross
Area	

Continuous update of up to four measurements on any combination of waveforms. Snapshot mode shows all measurements on the selected waveforms.

Thresholds – Settable in percentage or voltage.
Cursor Measurements – Absolute, Delta; Volts, Time, Frequency.
Cursor Types – Horizontal bars (volts); Vertical bars (time); Paired (volts and time).

WAVEFORM PROCESSING

Waveform Functions – Interpolate-selectable sin(x)/x or linear, Average, FFT, integrate, and differentiate.
Arithmetic Operators – Add, Subtract, Multiply, Invert.
Autosetup – Single button, automatic setup on selected input signal for vertical, horizontal and trigger systems.

COMPUTER INTERFACE

GPIB (IEEE –488.2) Programmability – Full talk/listen modes. Control of all modes, settings, and measurements.

HARD COPY

Formats – HP ThinkJet, Epson, Postscript, Interleaf, DeskJet, LaserJet, EPS Monochrome, EPS Color, TIFF, PCX, BMP, HPGL.
Optional Hardcopy Interface – Centronics and RS-232C.

STORAGE

Waveforms – Up to 15 K points.
Setups – 10 front-panel setups.

POWER REQUIREMENTS

Line Voltage Range – 90 to 250 V RMS.
Line Frequency – 47 to 63 Hz.
Power Consumption – 250 W max.

ENVIRONMENT AND SAFETY

Temperature – Operating: 0 to +50°C. nonoperating: –40 to +75°C.
Humidity – Operating and nonoperating: Up to 95% relative humidity at or below +40°C; to 75% relative humidity from +41°C to 50°C.
Altitude – Operating: 15,000 ft. nonoperating: 40,000 ft.
Electromagnetic Compatibility – Meets MIL-STD-461C, CE-03, Part 4, Curve # 1, RE-02, Part 7; meets VDE 0871, Category B, FCC rules and regulations, Part 15, Subpart B, Class A.
Safety – UL3111-1, CSA1010.1, EN61010-1, IEC61010-1.

PHYSICAL CHARACTERISTICS

Dimensions	**mm**	**in.**
Height	193	7.6
with acc. pouch	236	9.3
Width	445	17.5
Depth with front cover	432	17
Weight	**kg**	**lbs.**
Net	13.2	29.1
Shipping	23.6	52

ORDERING INFORMATION

For price information: Outside the U.S. contact your local Tektronix representative, inside the U.S. see the price list in the back of this catalog.

TDS 820
2-CH, 8 GHz Digital Sampling Oscilloscope.
Includes: Reference (070-8511-01), User Manual (070-8512-01), Programmer Manual (070-8513-01), Performance Verification Manual (070-8696-00), U.S. Power Cord (161-0230-01), Two 12-inch 50 Ω Male-to-Male SMA Cables (174-1364-00), 60-inch 50 Ω Male-to-Male SMA Cable (174-1428-00), Antistatic Grounding Wrist Strap (006-3415-04), SMA "T" (015-1016-00), SMA Female-to-Female Adapter (015-1012-00), Two SMA Short Circuit Male Terminations (015-1020-00), Front Cover (200-3696-00).
Opt. 13 – RS-232/CENTRONICS Hardcopy Interface.
Opt. 1R – Rackmount.
Opt. B1 – Service Manual.
Opt. 32 – Add 1 Each P6207 Probe.

INTERNATIONAL POWER PLUGS
Opt. A1-A5 available.
See page 619 for description.

MEASUREMENT SERVICE OPTIONS
Opt. C3 – Three years of Calibration Services.
Opt. D3 – Test Data (requires Opt. C3).
See page 615 for further information.

RECOMMENDED ACCESSORIES
Also see page 495.

PROBES
Active – 3.5 GHz, 0.4 pF/100 kΩ, 1 m. Order P6207.
Differential – 1 GHz, active differential, 6 ft. Order P6247. (Requires 1103 Power Supply.)
50 Ω Divider – 9 GHz, 0.15 pF/500 Ω, Tips 1X, 10X. 1 m. Order P6150.
Carts – Order K420 Scope Cart.
Static Isolation Unit – Order SIU800.

SOFTWARE
WSTRO – WaveStar™ software for oscilloscopes, Windows 95/98/NT application for waveform capture, analysis, documentation and control from your PC.
WSTROU – Upgrade from WSTR31 to WSTRO.
WSTR31 – WaveStar™ software for Windows 3.1.
WSTR31U – Upgrade from DocuWave® software to WSTR31.
LVWIN95 – LabVIEW® for Windows 95.
LVWCVI95 – LabWindows/CVI for Windows 95.

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

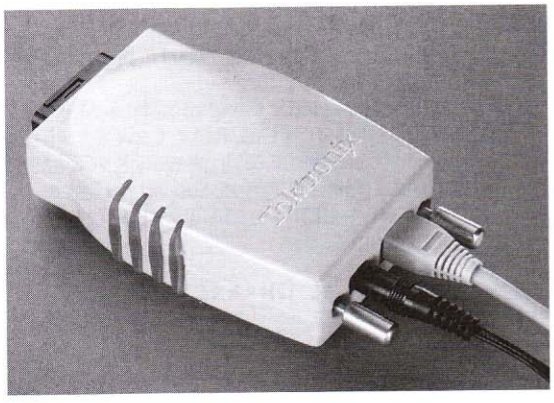
CE

ISO 9001
Tektronix measurement products are manufactured in ISO registered facilities.

GPIB IEEE-488
Product(s) complies with IEEE Standard 488.2-1987, and with Tektronix Standard Codes and Formats.

GPIB-LAN Adapter

AD007



Features – Benefits

- Control Tektronix Oscilloscopes and Other Instruments via a LAN-Based (Ethernet) TCP/IP Network PC
- Interface Up to 14 GPIB Devices to Each AD007
- Talk to Several GPIB Instruments/ Systems from Several Networked PCs
- Print to Networked Printers
- Ethernet Twisted Pair (10BaseT) Adapter
- Operates on All Windows 95/98 and NT 4.0 Operating Systems
- Compatible with WaveStar for Oscilloscopes Applications Software and Custom, Proprietary Programs (C, C++, or Microsoft Visual Basic)

Applications

- Digital Design
- Research and Development
- Manufacturing Test
- Service and Support
- Education
- Web Page-based Configuration and Statistics

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

CE

ISO 9001

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GPIB IEEE-488

Product(s) complies with IEEE Standard 488.1-1987, RS-232-C, and with Tektronix Standard Codes and Formats.

Instrument to Local Area Network (LAN) Connectivity

Control your Tektronix TDS Series oscilloscope from any networked PC. Check on its status, or capture waveforms any time you want from your office, another site, or from anywhere using WaveStar™ application software or your own software. Or command your TDS Series oscilloscope to print to a networked printer.

The Tektronix GPIB-LAN Adapter takes advantage of the fact that many of today's computers are connected together through an Ethernet 10BaseT LAN.

PRINT TO NETWORKED PRINTERS

Using any web browser, select the networked printer to which your TDS Series oscilloscope will print and route your hardcopy output to your high quality monochrome or color networked printer.

WINDOWS 95/98 OR NT 4.0 COMPATIBILITY

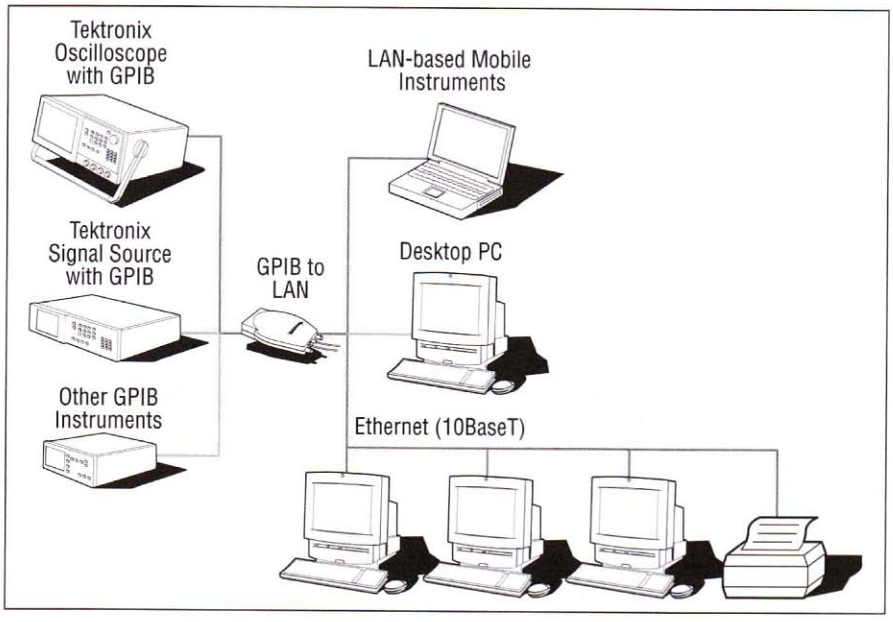
You don't need to understand or program Ethernet protocols. Both communications and Virtual Instrument Software Architecture (VISA) software for Windows 95/98 or NT 4.0 is included free with the GPIB-LAN Adapter. Now, you can also perform waveform capture from your TDS Series oscilloscopes across the LAN by using Tektronix WaveStar for Oscilloscopes application software. Or write a program using C, C++, or Microsoft Visual Basic to capture data or control your instrument. As long as the program is written using the standard VISA interface, the GPIB-LAN Adapter's software will turn your PC into a GPIB Talker, Listener, Controller.

NETWORK DETAILS

The AD007 implements a full range of adapter functions and Ethernet-based TCP/IP protocols. It operates with all of the popular network protocols such as BOOTP, DHCP, DNS, LPD, HTTP, and FTP.

CONFIGURATION AND STATISTICS

Use a web browser to configure features; examine GPIB commands, Ethernet traffic statistics, and GPIB traffic statistics; and initiate diagnostic GPIB commands.



Several GPIB-networked instruments can be connected using the AD007 Adapter to LAN (Ethernet)-based computers and printers.

EASE OF INSTALLATION

Simply connect your AD007 to your LAN with the cable provided, connect the GPIB interface to your instruments, and power up the unit. It automatically requests an IP address from the network's Boot Server, or this can be manually entered using the adapter's internal web page. Upon power-up, the unit also performs hardware diagnostics/self-test. Status indicators on the unit give evidence of successful completion of this testing, connection to the LAN, and both LAN and GPIB traffic.

Any number of AD007 Adapters may be used to connect any combination of GPIB devices to the network. (NOTE: Limit of 14 devices per GPIB cluster.)

CHARACTERISTICS

SYSTEM REQUIREMENTS

Computer Type – IBM PC-compatible with Windows 95/98 or NT 4.0 Operating System. Consult Microsoft documentation for recommended configuration.
Hard Disk – 5 Mbytes or greater.
RAM – Consult Microsoft documentation for recommended minimum configuration.
CD-ROM – Required.
NOTE: For printing only a web browser is required.

NETWORK COMPATIBILITY

Ethernet Port – 10BaseT, RJ-45 connector.
Protocols – BOOTP, DHCP, LPD, DNS, HTTP, FTP.
Networked Printer – Compatibility: Must be compatible with the GPIB instrument's hard-copy output format. Print Protocol: Must support LPD Network Print protocol.

IEEE 488 (GPIB) COMPATIBILITY

Connection – No cable required for most applications.
Compatibility – Fully IEEE488.2 compatible. NOTE: Not suitable for connection to the public telecommunications (telephone) network.

OTHER

Transmission Rate – Up to 10 Mbps on Ethernet; dependent on slowest GPIB device on the bus.
Front-Panel Indicators – Power, LAN-Link, LAN, GPIB.

ENVIRONMENTAL

Temperature – Operating: 0 to +45°C. Nonoperating: –20 to +70°C.
Humidity – 30 to 45°C, 90 to 95%, relative humidity.
Altitude – Operating: Up to 2,000 m (6,500 ft.). Nonoperating: Up to 10,000 m (33,000 ft.).
Vibration – 3 axis, 60 minutes total, 20 minutes/axis (10 minutes operating, 10 minutes non-operating).
Shock – Half sine, 500 g, 3 axis, 3 drops each axis.

EMC COMPLIANCE

Meets the intent of EMC Directive 89/336/EEC. Complies with FCC Part 15, Class A limits.

SAFETY COMPLIANCE (POWER SUPPLY)

EN60950 (CE Mark). UL1950.
CAN/CSA 22.2 No. 950.
DENTORI (T-MARK).

POWER

Source Power – Voltage Ranges: 100 to 240 VAC ±10%. Line Frequency: 50 to 60 Hz.
Power Consumption – Regulated 5 VDC at 300 mA, typical.

PHYSICAL CHARACTERISTICS

Dimensions – H (35.6 mm/1.4 In.) x W (76.2 mm/3 in.) x D (120.2 mm/4.7 in.).
Weight – Net (0.15 kg/0.34 lb.).

WARRANTY

One year parts and labor.

ORDERING INFORMATION

For price information: Outside the U.S. contact your local Tektronix representative, inside the U.S. see the price list in the back of this catalog.

AD007
GPIB-LAN Adapter.
Includes: Adapter, Regulated Power Supply, CD-ROM software, RJ-45 Cable, Manual.

AD007 INTERNATIONAL POWER PLUGS
Opt. A0 – A6 Available.
See page 619 for description.

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

CE

ISO 9001

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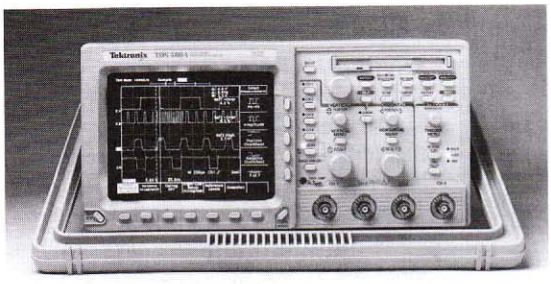
Digital Storage Oscilloscopes

TDS 430A • TDS 460A • TDS 420A



Features – Benefits

Be Confident You're Seeing Actual Signals with up to 400 MHz Bandwidth and ±1.5% Accuracy

Capture Transient Events to the Full Scope Bandwidth with Its 100 MS/s Sample Rate

2 and 4 Channels

Record Lengths to 120 K (Opt. XL)

Floppy Disk Storage

Speed Up Your Circuit Analysis with 25 Built-in Automatic Measurements and Extended Waveform Math/FFT (Opt. XL)

Roll Mode Allows You to See Acquired Data Points Without Waiting for the Acquisition of the Complete Waveform

Use the Video Trigger Mode to See NTSC, PAL, SECAM Signals or Your Own Custom Video Signals

Capture Those Glitches with the 10 ns Peak Detect Mode

DIFFERENTIAL MEASUREMENTS

ADA400A Analog Differential Amplifier (10 µV/div sensitivity)

P5200/P5205/P5210 High Voltage Differential Probes (up to 5600 V) for Floating Measurements

Applications

Biophysical/Biomedical Research

Electrophysical and Electromechanical System Design

Audio System Measurement and Analysis

Manufacturing Test and Quality Control

Power Supply and Power-related Design

Product Service and Maintenance

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

Product(s) available through your local Tektronix Distributor listed in the back of this catalog.

CE

ISO 9001

Tektronix measurement products are manufactured in ISO registered facilities.

GPIB IEEE-488

Product(s) complies with IEEE Standard 488.1-1987, and with Tektronix Standard Codes and Formats.

TDS 400A Digital Storage Oscilloscopes

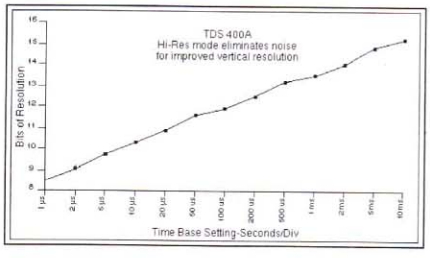
For professionals who demand high precision and fidelity from their measurements, the TDS 400A Digital Storage Scopes combine excellent performance and broad feature set, all at affordable prices. A choice of 2 and 4 channel models ranging from 200 MHz to 400 MHz with a 100 MS/s sample rate on all channels makes the TDS 400A Series a worthy fit for a variety of demanding applications.

The highly featured, portable and easy to use TDS 420A, 430A and 460A personal lab scopes are ideal for simple to complex applications, including electro-mechanical research and analysis, power electronics/power supply design, bio-physical research and analysis, digital and analog design. With its standard video trigger capability, the scopes are ideal instruments for measuring video signals including NTSC, PAL and SECAM.

The TDS 400A Series uses the renowned TDS Graphical User Interface which offers intuitive icon-based menus along with help text, making scope operation extremely simple. Knobs and buttons allow easy selection of commonly used scope functions. The standard floppy disk drive makes the saving of screen images or data to a disk simple. The disk can then be inserted into your PC for importing to desktop publishing or spreadsheet programs.

Please see page 556 and page 560 for details on ADA400A, P5200, P5205 and P5210.

CHARACTERISTICS



Theoretically achievable resolution with TDS 400A Hi-res Mode.

SIGNAL ACQUISITION SYSTEM

Bandwidth – 200 MHz (TDS 420A), 400 MHz (TDS 430A, TDS 460A).
Channels – 4 (2 on TDS 430A).
Sample Rate – 100 MS/s on all channels.
Sensitivity – 1 mV to 10 V/div (with calibrated fine adjust).
Position Range – ±5 Divisions.
Offset Range – ±1 V from 1 mV/div to 99.5 mV/div; ±10 V from 100 mV to 995 mV/div ; ±100 V from 1 V/div to 10 V/div.
DC Gain Accuracy – ±1.5%.
Vertical Resolution – 8-Bits (256 levels over 10.24 vertical divisions).
Analog Bandwidth Selections – 20 MHz, 100 MHz and full.
Input Coupling – AC, DC or GND.
Input Impedance Selections – 1 MΩ in parallel with 15 pF, or 50 Ω (AC and DC coupling).
Maximum Input Voltage – 300 V CAT II ±400 Vpeak. Derate at 20 dB/decade above 1 MHz. 1 MΩ or GND coupled.
Channel Isolation – >100:1 at 100 MHz for any two channels.
AC Coupled Low Frequency Limit – ≤10 Hz when AC 1 MΩ coupled. ≤200 kHz when AC 50 Ω coupled.

ACQUISITION MODES

Peak Detect – High frequency and random glitch capture. Captures glitches of 10 ns using acquisition hardware at all real-time sampling rates.
Sample – Sample data only.
Envelope – Max/min values acquired over one or more acquisitions, selectable from 2 to 2000, infinite.
Average – Waveform averages selectable from 2 to 10,000.
Hi-res – Vertical resolution improvement and noise reduction on low-frequency signals, e.g. 12-Bits at 10 ms/div and slower. Enhanced vertical resolution (>12-Bits) for noise reduction, on low frequency signals. Make precise low-level signal measurements (up to 5 µV) with differential amplifier (ADA400A).

TIME BASE SYSTEM

Time Bases – Main, Delayed.
Time/Division Range – 1 ns to 20 s/div.
Time Base Accuracy – 0.015% over any interval ≥1 ms.
Record Length (Real Time and Equivalent Time) – Sample points per channel: 500 to 120,000 points (with Opt. XL).
Pre-trigger Position – Selectable from 0 to 100% of record.

TRIGGERING SYSTEM

Triggers – Main, Delayed.
Main Trigger Modes – Auto, Normal, Single Sequence.
Delayed Trigger – Delayed by time or events.
Time Delay Range – 0 ns to 20 s.
Events Delay Range – 2 to 10,000,000 events.
External Rear Input – >1.5 kΩ; Max input voltage is ±6 V (DC + AC peak).
Video Trigger Types – NTSC, PAL, SECAM and custom; TV field, field 2 or both, any line within a field. Line rates –10 kHz to 64 kHz, interlaced, non-interlaced, composite.
Video Trigger Sensitivity – 0.6 divisions of composite SYNC will achieve a stable display.

DISPLAY

Waveform Style – Dots or vectors. Infinite and variable persistence from 250 ms to 10 s.
Gray Scaling – With variable persistence selected, waveform points gradually decay through 16 levels of intensity, providing "z-axis" information about rapidly changing waveforms.
Update Rate – 200 ea. 500 point waveforms per sec with infinite persistence mode selected.
Graticules – Full, grid, cross hair, frame.
Format – YT and XY.
VGA Out – Drives VGA display monitors.

ZOOM

The zoom feature allows waveforms to be expanded, compressed and positioned in both vertical and horizontal axes. Allows precise comparison and study of fine waveform detail without affecting ongoing acquisitions. When used with Hi-res or Average acquisition modes, Zoom provides an effective vertical dynamic range of 1000 divisions or 100 screens.

MEASUREMENT SYSTEM

Automatic waveform measurements –

Period	Frequency
High	Low
+ Width	- Width
Maximum	Minimum
Rise	Fall
Peak to Peak	Amplitude
+ Duty cycle	- Duty cycle
+ Overshoot	- Overshoot
Propagation delay	Burst Width
Mean	Cycle Mean
RMS	Cycle RMS
Area	Cycle Area
Phase	-

Continuous update of up to four measurements on any combination of waveforms.
Thresholds – Settable in percentage or voltage.
Gated – Any region of the record may be isolated for measurement using vertical bars.
Snapshot – Performs all measurements on any one waveform showing results from one instant in time.
Cursor Measurements – Absolute, Delta, Volts, Time, Frequency.
Cursor Types – Horizontal bars (volts); Vertical bars (time); paired; operated independently or in tracking mode.

WAVEFORM PROCESSING

Waveform Functions – Interpolate-selectable sin(x)/x or linear, Average, Envelope.
Advanced Waveform Functions – FFT, Integration, Differentiation (Opt. XL).
Arithmetic Operators – Add, Subtract, Multiply, Invert.
Autosetup – Single button, automatic setup on selected input signal for vertical, horizontal and trigger systems.
Waveform Limit Testing – Compares incoming waveform to a reference waveform's upper and lower limits.

COMPUTER INTERFACE

GPIB (IEEE 488.2) Programmability – Full talk/listen modes. Control of all modes, settings and measurements.

HARDCOPY/DESKTOP PUBLISHING

Printer – HP ThinkJet, Epson, PostScript, Interleaf, DeskJet, LaserJet, TIFF, PCX, BMP (Microsoft Windows).
Plotter – HPGL.
Interface – GPIB standard.
Hardcopy Interface – Centronics Type and RS-232 (Opt. XL).

STORAGE

Waveforms – 120,000 waveform points of non-volatile storage (with Opt. XL).
Floppy Drive – 3.5 in. 1.44 MB or 720 KB DOS compatible (store waveforms, screen data, and setups)*[1].
Setups – 10 front-panel setups.

CRT

Type – 7 in. diagonal, magnetic deflection. Horizontal raster-scan. P31 green phosphor.
Resolution – 640 horizontal by 480 vertical displayed pixels.

POWER REQUIREMENTS

Line Voltage Range – 90 to 250 V RMS.
Line Frequency – 48 to 440 Hz.
Power Consumption – 240 W max.

ENVIRONMENTAL AND SAFETY

Temperature – Operating: 0°C to +50°C. Nonoperating: –40°C to +75°C.
Humidity – Operating and nonoperating: Up to 95% relative humidity at or below +40°C; to 75% relative humidity from +41°C to +50°C.
Altitude – Operating: 15,000 ft., nonoperating: 40,000 ft.

Electromagnetic Compatibility – Meets MIL-STD-461C, CE-03, Part 4, Curve # 1, RE-02, Part 7; meets VDE 0871, Category B, FCC rules and regulations, Part 15, Subpart J, Class A.
Safety – UL3111-1, CSA1010.1, EN61010-1, IEC61010-1.

PHYSICAL CHARACTERISTICS

Dimensions	mm	in.
Height	164	6.4
w/acc. pouch	177	7.5
Width	362	14.25
Depth w/front cover installed	491	19.25
Depth w/handle extended	576	22.2
Weight	**kg**	**lbs.**
Net approximately	9.1	22.5
Shipping approximately	12.5	32

*[1] *Waveforms can be stored to file in MathCAD and Spreadsheet (Excel, Lotus 1-2-3) formats for analysis.*

ORDERING INFORMATION

For price information: Outside the U.S. contact your local Tektronix representative, inside the U.S. see the price list in the back of this catalog.

TDS 430A (order with Opt. XL) Two-Channel, 400 MHz Digitizing Oscilloscope.
TDS 420A (order with Opt. XL) Four-Channel, 200 MHz Digitizing Oscilloscope.
TDS 460A (order with Opt. XL) Four-Channel, 400 MHz Digitizing Oscilloscope.
All include: 1 Probe Per Channel (P6138A 10X Passive Probes); Video Trigger; Reference Manual (070-8035-03); User Manual (070-8034-03); Performance Verification Document (070-8721-02); U.S. Power Cord (161-0230-01).

INSTRUMENT OPTIONS

Opt. XL – (mandatory for all TDS 400 models) 120,000 Point Record Length; RS-232 and Centronics Hardcopy Interfaces; Extended Waveform Math: FFT; Integration, Differentiation; Front Cover and Accessories Pouch.
Opt. 1R – Rack Mount.
Opt. D1 – NIST, MIL-STD-45662A and ISO 9000 Calibration Data Report.

PROBES

See page 498.
Differential Probes –
400 MHz, 30 dB CMRR. Order P6246.
High Voltage Probes –
2.5 kV, 25 MHz. Order P5100.
20 kV, 75 MHz. Order P6015A.
High Voltage Differential Probes –
Up to 1300 V, 25 MHz. Order P5200.
Up to 1300 V, 100 MHz. Order P5205.
Up to 5600 V, 50 MHz. Order P5210.
Passive Probe 1x – Order P6101B.
Passive Probe 10x – Order P6138A.
FET Probe – Order P6205.
SMT Probe – Order P6562A.
TTL Logic Probe – Order P6408.
Optical Converters –
500 nm to 950 nm. Order P6701B.
1100 nm to 1700 nm. Order P6703B.
DC/AC Current Probe System – Order AM 503S, or TCP202 DC Coupled Current Probe.

RECOMMENDED ACCESSORIES–

Analog Differential Amplifier – 10 µV sensitivity. Order ADA400A.
Current Measurement Capability – Order TDS 400A and AM 503S, and appropriate probe.
Also see page 495.
Scope Cart – Order K212.
Rackmount Kit – Order 016-1166-00.
Soft-sided Carrying Case – Order 016-1158-01.
Transit Case – Order 016-1157-00.
Programmer's Manual – Order 070-9876-00.
Service Manual – Order 070-9703-04.
Video Clamp – Order 013-0278-00.

SOFTWARE

WSTRO – WaveStar™ software for Oscilloscopes, Windows 95/98/NT application for waveform capture, analysis, documentation and control from your PC.
WSTROU – Upgrade from WSTR31 to WSTRO.
WSTR31 – WaveStar™ software for Windows 3.1.
LVWIN95 – LabVIEW® for Windows 95.
LWCVI95 – LabWindows/CVI for Windows 95.

CABLES

GPIB –
1 meter. Order 012-0991-01.
2 meters. Order 012-0991-00.

INTERNATIONAL POWER PLUGS

Opt. A1 – Universal Euro 220 V, 50 Hz.
Opt. A2 – UK 240 V, 50 Hz.
Opt. A3 – Australian 240 V, 50 Hz.
Opt. A4 – North American 240 V, 60 Hz.
Opt. A5 – Switzerland 220 V, 50 Hz.
See page 619 for description.
International power options required on instruments and selected accessories for operation outside U.S. For operation outside U.S., specify A1-A5 power options. See General Customer Information pages for additional description.

MEASUREMENT SERVICE OPTIONS

Opt. C3 – Three years of Calibration Services.
Opt. D1 – NIST, MIL-STD-45662A and ISO 9000 Calibration Data Report.
Opt. D3 – Test Data (requires Opt. C3).
See page 615 for further information.

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

Product(s) available through your local Tektronix Distributor listed in the back of this catalog.

CE

ISO 9001

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GPIB IEEE-488

Product(s) complies with IEEE Standard 488.1-1987, and with Tektronix Standard Codes and Formats.

Digital Phosphor Oscilloscopes

New TDS 3012 • TDS 3014 • TDS 3032 • TDS 3034 • TDS 3052 • TDS 3054



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CE

ISO 9001

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Features – Benefits

500 MHz, 300 MHz, and 100 MHz Bandwidths

Sample Rates up to 5 GS/s

2 or 4 Channels

Full VGA Color LCD on all Models

Built-in Floppy Disk Drive For Easy Storage and Documentation

Centronics Port Standard on all Models for Quick, Convenient Hardcopies

9-Bit Vertical Resolution

Multi-Language User Interface

QuickMenu User Interface Mode for Quick, Easy Operation

Optional Modules for RS-232, GPIB, or VGA Communication Ports

Advanced Triggers, such as, Glitch, Width, and Logic Standard on 4 Channel Models

Fast Fourier Transform (FFT) for Frequency and Harmonic Analysis Standard on 4 Channel Models

Extended Video Application Module, Provides Features, such as Custom Video Trigger, Line Count Trigger and NTSC, PAL, SECAM Display Graticules

Support for Active Probes, Differential Probes, and Current Probes that Provide Automatic Scaling and Units

Optional Battery Power for Convenient Use in the Field or Away from the Bench

Applications

Telecommunications Manufacturing (Telecom Mask Test Application Module)*[1]

Digital Design and Debug

Video Design and Service (Extended Video Application Module)

Industrial Electronic Design

Power Supply Design

Connected Instrumentation (10BaseT LAN*[1], GPIB and VGA Modules with RS232)

Highly Mobile Environments (Optional Battery Pack)

*[1] *New in January 2000, refer to the Tektronix web site or your local sales rperesentative for details.*

THE TDS 3000 SERIES OF DIGITAL PHOSPHOR OSCILLOSCOPES

The TDS 3000 oscilloscopes are the lowest priced, most portable Digital Phosphor Oscilloscopes (DPOs). Now every design engineer and technician can take advantage of the tremendous benefits of DPOs. DPOs deliver a new level of insight that makes dealing with complex signals simple. DPOs display, store, and analyze, in real-time three dimensions of signal information: amplitude, time, and distribution of amplitude over time.

BENEFITS OF DPO

DPOs have an intensity graded color display that provides information about the frequency of occurrence of signal amplitudes and widths. This helps the user locate and characterize waveform anomalies that can be elusive on traditional Digital Storage Oscilloscopes. The fast update rate of DPOs also makes it easier to capture and display infrequent waveforms or waveform variations.

QUICK TO LEARN AND QUICK TO USE

The TDS 3000 Series graphical user interface offers a new operating mode called QuickMenu. This quick access user interface makes the main oscilloscope controls accessible with a push of a single button. Included with every scope is an On-Line Tour disk that runs in the oscilloscope. This disk gives an overview of the product's operation and capabilities.

FLEXIBLE FEATURES FOR EVERY APPLICATION

The portable form factor allows the instrument to go wherever it is needed. The Communication and Application Modules enable the instrument to be configured for specific applications or upgraded without returning it to the manufacturer. The TekProbe® Level II interface provides power to a range of application specific accessories.

APPLICATION MODULES

With the application module concept, the TDS 3000 Series can be easily adapted to the needs of the user. These modules can be easily installed by the user and the scope, upon power up indicates which modules are installed. Currently, there are three application modules available for the TDS 3000 Series — an FFT module, an advanced trigger module and an extended video module. In addition, there are two communication modules available — a GPIB/RS-232 module and a VGA/RS-232 module. Centronics port is standard.

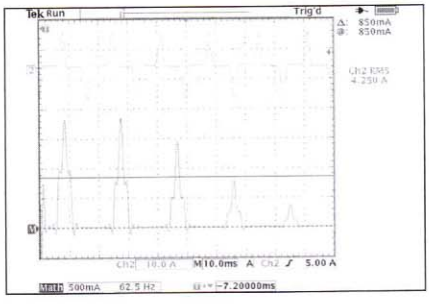
TDS3FFT – FFT MODULE

When this module is installed in the TDS 3000 Series scope, the scope becomes an excellent troubleshooting aid for:

- Testing impulse response of filters and systems.
- Measuring harmonic content and distortions in systems.
- Identifying and locating noise and interference sources
- Analyzing vibration
- Analyzing harmonics in 50 and 60 Hz power lines

The TDS 3FFT application module provides the following features

- FFT Windows; Four FFT windows (Rectangular, Hamming, Hanning and Blackman-Harris) let you match the optimum window to the signal you are analyzing
- Analyze repetive, single-shot and stored waveforms: An FFT waveform on any actively-acquired signal, last acquired signal or signal stored in the reference memory can be displayed
- The FFT vertical graticule can be set to either dB or linear rms
- The time signals and FFT waveforms can be shown on the display at the same time. This helps in the quick analysis of circuit or system problems



TDS 3000 DPO answers today's power measurement problems.

TYPICAL APPLICATION FOR THE FFT MODULE

In the design or analysis of power supplies, it is important to check the harmonics in the power supply's load current. The following figure shows the harmonic analysis of a 250 watt class D power supply. Using the scope's cursors, you can measure the frequency and magnitude of the individual frequency components.

TDS 3TRG – ADVANCED TRIGGER MODULE

When this module is installed in the TDS 3000 Series scope, an advanced trigger menu is added to the scope with the appropriate logic and pulse triggering capability.

LOGIC TRIGGER FEATURES

Logic triggering is extremely useful in the troubleshooting of digital circuits. The oscilloscope is triggered when two signals meet a Boolean trigger condition. This module provides pattern and state logic trigger modes.

Pattern Trigger.

Pattern triggering triggers the oscilloscope when two signals become logically true or false. Basically, the pattern-triggering feature triggers the oscilloscope from the output of a two-input AND, OR, NAND or NOR logic gate. You can specify time constraints and signal threshold levels as part of the triggering condition. The trigger is useful for digital logic troubleshooting.

State Trigger.

State triggering triggers the oscilloscope when a state signal is true or false at the time a clock signal transition is true. This trigger is useful for troubleshooting digital logic synchronous state machines.

PULSE TRIGGER FEATURES

Pulse triggering triggers the oscilloscope when a signal meets a timing or threshold condition. The advanced trigger module provides three pulse trigger modes: pulse width, runt pulse and slew rate.

Pulse Width (or Glitch).

Pulse-width triggering triggers the oscilloscope when a signalpulse width is les than, greater than, equal to or not equal

to a specified pulse width. this trigger is useful for digital logic troubleshooting.

Runt Pulse.

Runt-pulse triggering triggers the oscilloscope when a signal pulse is less than a specified threshold level. You can also specify runt pulse-width parameters. This trigger is useful for troubleshotting bus-contention problems.

Slew Rate.

Slew-rate triggering triggers the oscilloscope when a signal's slew rate (rise or fall time) is less than, greater than, equal to or not equal to a specified slew rate. This trigger is useful for troubleshooting digital bus transcievers, transmission lines and op-amp circuits.

TDS 3VID – EXTENDED VIDEO MODULE

All TDS 3000 Series oscilloscopes come standard with NTSC, PAL and SECAM (All Fields or All Lines) triggering capability. The TDS 3VID application module extends this basic video triggering by adding the following features.

Video QuickMenu.

This Video QuickMenu function allows you to display a bottom and side menu that contains video functions useful for displaying and measuring broadcast standard waveforms, including trigger source, when to trigger, video graticule and video autoset.

Video Autoset.

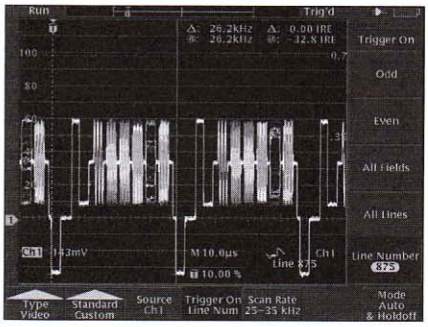
The autoset function automatically adjusts the vertical, horizontal and video trigger settings to display a video waveform triggered on all lines and fields. You can then manually adjust controls to optimize the display. This function is available in the Video QuickMenu and in the Acquire menu.

Custom Video.

Using the custom video function allows you to specify custom horizontal scan rates in order to trigger on non-broadcast video waveforms, such as those used by computer monitors and medical equipment displays. This following figure shows the TDS 3000 scope triggering on a scan rate of 26.2 kHz.

Line Count Trigger.

Sometimes it is necessary to view a single line of the video waveform. For example, the programming information in the NTSC signal is sometimes found on Line 20. Line Count triggering allows you to trigger on any particular line by scrolling through the line numbers and selecting the one you want.



Using the TDS 3000 DPO for video maintenance and service measurement.

Field Holdoff.

The field holdoff function provides the capability to specify a number of fields to wait before re-enabling triggering. This allows you to trigger on a single filed (e.g. field 1 or field 3 of NTSC) instead of both field 1 and field 3.

Video Graticules.

The video graticule function provides the capability for the user to change the standard oscilloscope graticule to either IRE or mV depending on the signal format. Video graticules make it easier to measure and analyze video waveforms.

CHARACTERISTICS

TDS 3000 SERIES ELECTRICAL CHARACTERISTICS

	TDS 3012	TDS 3032	TDS 3052	TDS 3014	TDS 3034	TDS 3054
Bandwidth	100 MHz	300 MHz	500 MHz	100 MHz	300 MHz	500 MHz
Channels	2	2	2	4	4	4
Sample Rate on Each Channel	1.25 GS/s	2.5 GS/s	5 GS/s	1.25 GS/s	2.5 GS/s	5 GS/s
Maximum Record Length	10K points on all models					
Vertical Resolution	9-bits on all models					
Vertical Sensitivity (/div)	1 mV-10 V on all models					
Vertical Accuracy	±2% on all models					
Max Input Voltage (1 MΩ)	150V RMS CAT I on all models					
Position Range	± 5 div on all models					
BW Limit	20 MHz	20, 150 MHz	20, 150 MHz	20 MHz	20, 150 MHz	20, 150 MHz
Input Coupling	AC, DC, GND on all models					
Input Impedance Selections	1 MΩ in parallel with 13 pF, or 50 Ω					
Time Base:Range (/div)	4 ns – 10 s/div	2 ns – 10 s/div	1 ns – 10 s/div	4 ns – 10 s/div	2 ns – 10 s/div	1 ns – 10 s/div
Accuracy	200 ppm	200 ppm	200 ppm	200 ppm	200 ppm	200 ppm
Display Monitor	Color LCD					

ACQUISITION MODES

Peak Detect – High frequency and random glitch capture. Captures glitches as narrow as 1 ns.
Sample – Sample data only.
Envelope – Max/Min values acquired over one or more acquisitions.
Average – Waveform data from 2 to 572 (selectable) acquisitions is averaged.
Single Sequence – Use SINGLE SEQUENCE button to capture a single triggered acquisition sequence at a time.

TRIGGER SYSTEM

Main Trigger Modes – Auto (supports Roll Mode for 40 ms/div and slower), Normal.
B Trigger – Trigger after time or events.
Trigger After Time Range – 13.2 ns to 50 s.
Trigger After Events Range – 1 to 9,999,999 events.
External Trigger Input (available on TDS 30X2 only) – >1 MΩ in parallel with 17 pF; Max input voltage is 150V RMS.

TRIGGER TYPES

Edge – Conventional level-driven trigger. Positive or negative slope on any channel. Coupling selections: DC, noise reject, HF reject, LF reject.
Video – Trigger on all lines, odd/even, or all fields. See TDS 3VID for Extended Video triggering and measurement features.
Logic – (Standard on TDS 30X4, must purchase TDS 3TRG for TDS 30X2)
PATTERN: Specifies AND, OR, NAND, NOR when true or false for a specific time.
STATE: Any logic state. Triggerable on rising or falling edge, of a clock.
Note: Logic triggers can only be used on combinations of 2 inputs.
Pulse – (Standard on TDS 30X4, must purchase TDS 3TRG for TDS 30X2)
WIDTH (or GLITCH): Trigger on pulse width less than, greater than, equal to, or not equal to a selectable time limit ranging from 39.6 ns to 50s.
RUNT: Trigger on a pulse that crosses one threshold but fails to cross a second threshold before crossing the first again.
SLEW RATE: Trigger on pulse edge rates that are either faster or slower than a set rate. Edges can be rising, falling, or either.

MEASUREMENT SYSTEM

Automatic Waveform Measurements – Period, Frequency, +Width, –Width, Rise Time, Fall Time, +Duty Cycle, –Duty Cycle, +Overshoot, –Overshoot, High, Low, Max, Min, Pk-Pk, Amplitude, Mean, Cycle Mean, RMS, Cycle RMS, Burst Width.
Display any four measurements from any combination of waveforms.
Thresholds – Settable in percentage or voltage.
Gating – Measurements can be gated using the screen or vertical cursors.

WAVEFORM PROCESSING

Deskew – Channel to channel deskew ±10 ns may be manually entered for better timing measurements and more accurate math waveforms.
Arithmetic Operators – Add, Subtract, Multiply, Divide.
Autoset – Single-button, automatic setup on selected input signal for vertical, horizontal, and trigger systems.

DISPLAY CHARACTERISTICS

Graticules – Full, grid, cross-hair, frame, NTSC, PAL and SECAM (with TDS 3VID optional application module).
Format – YT and XY.

I/O INTERFACE

Hardcopy Port (standard) – Centronics-type parallel.

TDS 3GM Communications Module – GPIB (IEEE –488.2) Programmability: Full talk/listen modes; Control of all modes, settings, and measurements.
RS-232-C Interface Programmability: Full talk/listen modes; Control of all modes, settings, and measurements. Baud Rate up to 38,400. DB-9 male connector.
Includes WaveStar™ Software for oscilloscopes 30-day, full-functioning product demo.
Programmer Manual: (071-0381-00).
Note: For Ethernet/LAN connection use this module with the AD007 GPIB to LAN adapter.

TDS 3VM Communications Module – VGA: Monitor output for direct display on large VGA-equipped monitors. DB-15 female connector, 31.6 kHz sync rate, EIA RS-343A compliant.
RS-232-C Interface Programmability: same as TDS 3GM.
Includes WaveStar™ Software for oscilloscopes 30-day, full-functioning product demo.
Programmer Manual: same as TDS 3GM.

Note: Only one Communication Module may be installed at a time.

HARD COPY CAPABILITY

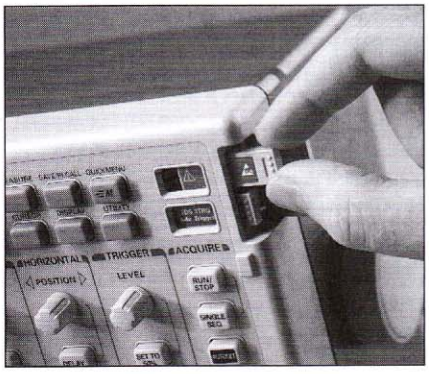
Graphics File Formats – Interleaf (.img), TIF, PCX (PC Paintbrush), BMP (Microsoft Windows), and Encapsulated Postscript (EPS).
Printer Formats – Thinkjet, Deskjet, Laserjet, Epson (9 and 24 pin).

ENVIRONMENTAL AND SAFETY

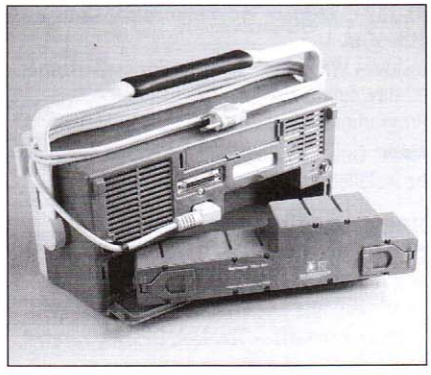
Temperature – +5 to +50°C (operating), –20 to +60°C (nonoperating).
Humidity – 20% to 80% RH below 32°C, derate to 30% RH at 45°C (operating), 5% to 90% RH below 41°C, derate to 30% RH at 60°C (nonoperating).
Altitude – to 3,000 m (operating), 15,000 m (nonoperating).
Electromagnetic Compatibility – Meets or exceeds EN55011 Class A Radiated and Conducted Emissions; EN50082-1; FCC 47 CFR, Part 15, Subpart B, Class A; Australian EMC Framework; Russian GOST EMC regulations.
Safety – UL3111-1, CSA1010.1, EN61010-1, IEC61010-1.

PHYSICAL CHARACTERISTICS

Dimensions	**mm**	**In.**
Width	375.0	14.8
Height	176.0	6.9
Depth	149.0	5.9
Weight	**kg**	**Lbs.**
Instrument Only	3.2	7.0
W/ battery	5.2	11.5



TDS 3FFT – Application Module being installed.



TDS 3BAT – Battery Pack being installed.

ORDERING INFORMATION

For price information: Outside the U.S. contact your local Tektronix representative, inside the U.S. see the price list in the back of this catalog.

TDS 3012, TDS 3014, TDS 3032, TDS 3034, TDS 3052, TDS 3054

STANDARD ACCESSORIES

Probes: 2 each P3010 10X passive probes (TDS 3012), 4 each P3010 10X passive probes (TDS 3014), 2 each P6139A 10X passive probes (TDS 3032, TDS 3052), 4 each P6139A 10X passive probes (TDS 3034, TDS 3054).

Documentation: Quick Reference Manual, User Manual, On-line Tour Disk, Front panel overlay for non-English languages.

Application Modules (TDS 3014, TDS 3034, TDS 3054 only): TDS 3FFT, TDS 3TRG.

Power Cord.

Accessory Tray.

Protective Front Cover: has holder for reference manual and/or 3.5 in. floppy disks.

NIST-Traceable Certificate of Calibration.

WARRANTY INFORMATION

Three year warranty covering all labor and parts, excluding probes.

INTERNATIONAL POWER PLUGS

Standard – US (161-0104-00).
Opt. A1 – Universal Euro 220V, 50 Hz (161-0104-06).
Opt. A2 – United Kingdom 240V, 50 Hz (161-0104-07).
Opt. A3 – Australia 240V, 50 Hz (161-0104-05).
Opt. A5 – Switzerland 220V, 50 Hz (161-0167-00).
Opt. A6 – Japan 3 to 2 wire adapter (013-0310-00).

See page 619 for description.

INTERNATIONAL USER MANUALS (TDS 3000 SERIES, TDS 3FFT, TDS 3TRG, TDS 3VID)

Standard – English.
Opt. L1 – French.
Opt. L2 – Italian.
Opt. L3 – German.
Opt. L4 – Spanish.
Opt. L5 – Japanese.
Opt. L6 – Portuguese.
Opt. L7 – Simplified Chinese.
Opt. L8 – Traditional Chinese.
Opt. L9 – Korean.
Opt. LR – Russian.

INSTRUMENT ACCESSORIES

TDS 3TMT – Telecom Mask Test Module*[1].

TDS 3FFT – FFT Application Module (standard on TDS 30X4). Adds FFT measurement capabilities in dB or linear RMS scales. A selection of four FFT windows (Rectangular, Hamming, Hanning, and Blackman-Harris) are provided.

TDS 3TRG – Advanced Trigger Application Module (standard on TDS 30X4). Adds Logic and Pulse triggering described under Trigger Types (page 2).

TDS 3VID – Extended Video Application Module. Adds line count triggering, custom video scan and field rates, readout in mV or IRE units, and includes 75 Ω terminator.

TDS 3EM – 10BaseT Ethernet (LAN) and RS-232 interfaces*[1].

TDS 3GM – GPIB and RS232 interfaces.

TDS 3VM – VGA port and RS232 interface.

TDS 3BAT – Battery pack for up to 2 hours continuous operation without line power. Note: the instrument must be grounded at all times.

013-0278-00 – Video Clamp Pod.

*[1] *New in January 2000, refer to the Tektronix web site or your local sales representative for details.*

TDS 3CHG – Fast charger for battery pack.

AC3000 – Soft case for carrying instrument.

RM3000 – Rackmount kit.

Service Manual (TDS 3000 Series) – English Only (071-0382-00).

TDS 3GM and TDS 3VM Programmers Manual – English Only (071-0381-00).

WSTRO – WaveStar™ Software for Oscilloscopes, Windows 95/98/NT Application.

PROBES

ADA400A – 100X, 10X, 1X, 0.1X High gain differential amplifier.

P6243 – 1 GHz, ≤1pF input C 10X active probe.

P6246 – 400 MHz differential probe.

P5205 – 1.3 kV, 100 MHz high voltage differential probe.

P5210 – 5.6 kV, 50 MHz high voltage differential probe.

P5100 – 2.5 kV, 100X high voltage passive probe.

TCP202 – 15 A, DC + Peak AC 50 MHz AC/DC current probe.

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

Product(s) available through your local Tektronix Distributor listed in the back of this catalog.

ISO 9001

Tektronix measurement products are manufactured in ISO registered facilities.

Digital Storage Oscilloscopes

TDS 210 • TDS 220 • New TDS 224



Features – Benefits

- 60 MHz or 100 MHz with 1 GS/s Sample Rate on all Channels
- 2 and 4 Channel Models
- Dual Timebase
- Automatic Measurements
- Multi-language User Interface
- Autoset
- Waveform and Setup Memories
- Extended Capabilities Are Provided with Optional Modules, Software and Probing

Applications

- Design/Debug
- Service and Repair
- Manufacturing Test and Quality Control
- Education/Training

Product(s) available through your local Tektronix Distributor listed in the back of this catalog.

CE

ISO 9001

Tektronix measurement products are manufactured in ISO registered facilities.

GPIB IEEE-488

Product(s) complies with IEEE Standard 488.1-1987, RS-232-C, and with Tektronix Standard Codes and Formats.

Tektronix' Most Popular DSO

The TDS 200 Oscilloscopes have quickly become the benchmark for low-cost oscilloscopes. Offering an unbeatable combination of performance, reliability and versatility, the TDS 200 Series offers breakthrough digital and real-time advantages at low-cost analog oscilloscope prices. And with the introduction of the TDS 224, Tektronix now brings the digital performance of the TDS 200 to customers that need four full-featured channels.

AFFORDABLE DIGITAL PERFORMANCE

No other digital oscilloscope offers as much bandwidth and sample rate for the price. By sampling at 10 and 16 times their bandwidths on all channels, the TDS 200 Series oscilloscopes provide accurate real-time acquisition up to their full bandwidth.

VERSATILITY AND FLEXIBILITY

The portable form factor provides increased versatility, allowing the instrument to be easily moved or safely stored away when not in use.

EASY TO USE

The user interface is similar to that of an analog oscilloscope, but with improvements that reduce learning time and increase efficiency.

THE PERSONAL OSCILLOSCOPE

The TDS 200 Series oscilloscopes are designed for people who demand the ultimate in oscilloscope value. If an inexpensive yet high performance oscilloscope is needed for the bench, production line, or training lab, a TDS 200 Series Oscilloscope is the best choice.

Characteristics

SIGNAL ACQUISITION SYSTEM

Bandwidth –
TDS 210: 60 MHz.
TDS 220: 100 MHz.
TDS 224: 100 MHz.

Sample Rate – 1 GS/s on each channel.

Channels –
TDS 210 and TDS 220: 2 identical channels plus external trigger.
TDS 224: 4 identical channels.

Sensitivity (with calibrated fine adjustment) – 2 mV to 5 V/div (bandwidth limited to 20 MHz at 2 mV/div and 5 mV/div, in all modes, and 20 MHz at 10 mV/div in Peak Detect mode).

Vertical Zoom – Vertically expand or compress a live or stopped waveform.

CALIBRATED POSITION RANGE

Volts/Div Setting	Offset Range
2 mV to 200 mV/div	±2 V
>200 mV to 5 V/div	±50 V

DC Gain Accuracy – ± 3%. (± 4% at 2 mV/div and 5 mV/div).

Vertical Resolution – 8 bits (256 levels over 10.24 vertical divisions).

AUTOMATIC MEASUREMENTS

Period, Frequency, Cycle RMS, Mean, Peak to Peak.

ACQUISITION MODES

Sample, Average, Peak Detect – High frequency and random glitch capture; captures glitches as narrow as 10 ns using acquisition hardware at all time/div settings between 5 µs/div and 5 s/div.

TIME BASE SYSTEM (MAIN AND WINDOW)

Horizontal Zoom – Horizontally expand or compress a live or stopped waveform.
Time/Division Range – 5 ns to 5 s/div.
Record Length – 2500 sample points per channel.
Horizontal Accuracy – ± 0.01%.

NON-VOLATILE STORAGE

Waveform Display – Two 2500 point reference waveforms.
Waveform Storage – Two 2500 point reference waveforms (TDS 210, TDS 220), four 2500 point reference waveforms (TDS 224).
Setups – 5 front panel setups.

TRIGGERING SYSTEM (MAIN ONLY)

Trigger Type – Edge (Rising or Falling), Video, Set to 50%.
Video Trigger Type – Triggers on Fields or Lines from composite video; triggers on broadcast standard NTSC, PAL, or SECAM video.
Trigger Modes – Auto, Normal, Single Sweep.
Trigger Source –
TDS 210 and TDS 220: CH1, CH2, Ext, Ext/5 and AC Line.
TDS 224: CH1, CH2, CH3, CH4 and AC Line.
Trigger View – Displays trigger signal while trigger view button depressed.

CURSORS

Types – Voltage, Time.
Measurements – [Δ]T, 1/[Δ]T, [Δ]V.

WAVEFORM PROCESSING

Arithmetic Operators – Add, Subtract.
Sources – CH1±CH2, CH3±CH4 (TDS 224).
Autoset – Single button automatic setup on selected input signal for vertical, horizontal, and trigger systems.

DISPLAY SYSTEM

Robust, backlit LCD with adjustable multilevel contrast.
Interpolation – Sin(x)/x.
Display Modes – Vectors, dots.
Persistence – Off, 1 sec, 2 sec, 5 sec, Infinite.
Format – YT and XY.

HARDCOPY CAPABILITY (REQUIRES MODULES)

Printer/File Formats – Thinkjet, Deskjet, Laserjet, Epson (9 or 24 pin), BMP, PCX, IMG, EPS, DPU 411, DPU 412.
Hardcopy Layout – Landscape or Portrait.

TDS 2CM COMMUNICATIONS EXTENSION MODULE

Centronics-type Parallel Port
RS-232 Programmability – Full talk/listen modes. Control of all modes, settings, and measurements. Baud Rate up to 19,200. 9-Pin, DTE.
GPIB Programmability – Full talk/listen modes. Control of all modes, settings, and measurements (IEEE Std 488-1987).
Includes WaveStar™ Software for Oscilloscopes 30 day product demo.

TDS 2MM MEASUREMENT EXTENSION MODULE

FFT – Windows: Hanning, Flat Top, Rectangular. Sample points: 2048.
Automatic Measurements – Rise/Fall Time, Positive/Negative Pulse Width.
Interface – Centronics, RS-232, GPIB.

ENVIRONMENTAL AND SAFETY

Temperature –
Operating: 0°C to +50°C.
Nonoperating: –20°C to +60°C.
Humidity –
Up to 90% RH at or below +40°C;
Up to 60% RH from 41°C to 50°C (Operating and Nonoperating).
Altitude –
Up to 3000 m (Operating).
Electromagnetic Emissions –
Meets Directive 89/336/EEC for Electromagnetic Compatibility;
FCC Code of Federal Regulations, 47 CFR, Part 15, Subpart B, Class A.
Safety – UL3111-1, CSA1010.1, IEC61010-1, EN61010-1.

PHYSICAL CHARACTERISTICS

Dimensions	mm	in.
Width	304.8	12.0
Height	151.4	5.96
Depth	120.7	4.75
Weight	**kg**	**lb.**
oscilloscope only	1.5	3.25
w/accessories	1.7	3.75

ORDERING INFORMATION

For price information: Outside the U.S. contact your local Tektronix representative, inside the U.S. see the price list in the back of this catalog.

TDS 210
Digital Storage Oscilloscopes.

TDS 220
Digital Storage Oscilloscopes.

TDS 224
Digital Storage Oscilloscopes.

EACH INCLUDE:
P6112 100 MHz 10X Passive Probes (one per channel).

WARRANTY INFORMATION
Three year warranty covering all labor and parts, excluding probes.

INTERNATIONAL POWER PLUGS
Standard – U.S. 115 V, 60 Hz (161-0230-01).
Opt. A1 – Universal Euro 220 V, 50 Hz (161-0104-06).
Opt. A2 – United Kingdom 240 V, 50 Hz (161-0104-07).
Opt. A3 – Australia 240 V, 50 Hz (161-0104-05).
Opt. A4 – North America 240 V, 60 Hz (161-0104-08).
Opt. A5 – Switzerland 220 V, 50 Hz (161-0167-00).
Opt. AC – China 240 V, 50 Hz (161-0306-00).
See page 619 for description.

INTERNATIONAL USER MANUALS (TDS 200 SERIES OSCILLOSCOPES)
Standard – English (071-0398-00).
Opt. L1 – French (071-0400-00).
Opt. L2 – Italian (071-0401-00).
Opt. L3 – German (071-0402-00).
Opt. L4 – Spanish (071-0399-00).
Opt. L5 – Japanese (071-0405-00).
Opt. L6 – Portuguese (071-0403-00).
Opt. L7 – Simplified Chinese (071-0406-00).
Opt. L8 – Traditional Chinese (071-0407-00).
Opt. L9 – Korean (071-0408-00).
Opt. LR – Russian (071-0404-00).
Translated front panel overlays included with their respective user manuals (except Russian).

INTERNATIONAL USER MANUALS (TDS 2XM EXTENSION MODULES)
Standard – English (071-0409-00).
Opt. L1 – French (071-0483-00).
Opt. L2 – Italian (071-0484-00).
Opt. L3 – German (071-0485-00).
Opt. L4 – Spanish (071-0482-00).
Opt. L5 – Japanese (071-0488-00).
Opt. L6 – Portuguese (071-0486-00).
Opt. L7 – Simplified Chinese (071-0489-00).
Opt. L8 – Traditional Chinese (071-0490-00).
Opt. L9 – Korean (071-0491-00).
Opt. LR – Russian (071-0487-00).

INSTRUMENT ACCESSORIES
TDS 2CM – Communications Extension Module. (I/O Cable not included)
TDS 2MM – Measurement Extension Module. (I/O Cable not included)
TR210 – Huntron Tracker.
AD007 – LAN/WAN GPIB Converter.
AC220 – Soft Carrying Case.
RM200 – Rackmount Kit.
Service Manual (TDS 200 Series) – English only (071-0492-00).
TDS 2CM and TDS 2MM Programmer's Manual – English only (071-0493-00).

SOFTWARE
WSTRO – WaveStar™ Software for Oscilloscopes, Windows 95/98/NT application for waveform capture, analysis, documentation and control from your PC.
WSTROU – Upgrade from WSTR31 to WSTRO.
WSTR31 – WaveStar™ software for Windows 3.1. (TDS 210, TDS 220).

PROBES
P6015A – 1000X High Voltage Probe.
P6021 – 60 MHz AC Current Probe.
P6022 – 120 MHz AC Current Probe.
A621 – 2000 A AC Current Probe/BNC.
A622 – 100 A AC/DC Current Probe/BNC.
P5100 – 100X High Voltage Passive Probe.
P5200 – High Voltage Differential Probe.
P6101B – 1X Passive Voltage Probe (15 MHz).
P6243S – Active FET Probing System (1 GHz).
P6408 – Word Recognizer/Trigger Probe.
P6561A – SMD Small Geometry Probe.
AM503S – AC/DC Current Probe System.

ACCESSORY CABLES
GPIB, 1 m (3.3 ft) – Order 012-0991-01.
GPIB, 2 m (6.6 ft) – Order 012-0991-00.
RS-232, 9-Pin female to 9-Pin male connectors, 15 ft. (4.6 m), for modems – Order 012-1241-00.
Centronics, 25-Pin male to 36-Pin Centronics, 2.4 m (8 ft), for parallel printer interfaces – Order 012-1214-00.

Product(s) available through your local Tektronix Distributor listed in the back of this catalog.

CE

ISO 9001
Tektronix measurement products are manufactured in ISO registered facilities.

GPIB IEEE-488
Product(s) complies with IEEE Standard 488.1-1987, RS-232-C, and with Tektronix Standard Codes and Formats.

Handheld Battery Operated Oscilloscope/DMM/Power Analyzers

TekScope® THS 730A • THS 720A • THS 710A • THS 720P



Features – Benefits

THS 730A/THS 720A/THS 710A/THS 720P

- 200, 100 and 60 MHz Bandwidth
- 1 GS/s, 500 MS/s, 250 MS/s Sampling Rates per Channel
- Two Channels and Dual Digitizers
- External Trigger
- 3-3/4 Digit DMM with Datalogger
- Roll Mode
- Extra Bright Backlit Display
- 8 ns Glitch Capture
- Independently Floating Isolated Scope and DMM Channels for Safety
- Advanced Trigger – Delay, Pulse and Video (Line Count and Field Select), PWM Motor Drive (THS 720P)
- NiCd Battery and AC Adapter
- 21 Automatic Measurements
- RS-232 Programmability/ Communications
- Deluxe Soft Carrying Case

THS 720P ONLY

- Measures Harmonics up to 31st (Fundamental from 30 Hz to 450 Hz)
- Automatic Power Measurement with Statistics
- Full Floating Measurement Capability up to 600 V_{RMS}
- 1 kV High-voltage Probes

Applications

- Field or Bench Electronic Troubleshooting
- Floating (Non-grounded) system Measurements
- Industrial Electronic Equipment Troubleshooting (THS 720P)
- Power Quality Surveys (THS 720P)

Product(s) available through your local Tektronix Distributor listed in the back of this catalog.

CE

ISO 9001

Tektronix measurement products are manufactured in ISO registered facilities.

THS 700 Series

The TekScope THS 700 Series Scope/DMM combines a full-featured real-time oscilloscope with a True RMS digital multimeter in rugged, battery-operated instruments. Scope and meter modes can operate simultaneously and independently on the same or separate signals. The high-resolution, backlit display and pop-up menus make it easy for users to take full advantage of the instrument's many features. These include cursors, video trigger, voltage and resistance measurements, and storage of waveforms, data and instrument setups. In addition, they offer the most comprehensive triggering capabilities – external trigger and extensive triggering including delay, pulse width and video.

The THS 700A Series is ideal for electronic applications – at the bench or at the site.

The THS 700A Series shares measurement features with the THS 720P Scope/DMM which includes features to address the needs of electric/power electronics measurements.

THE ONLY SAFE MEASUREMENT SOLUTION FOR POWER ELECTRONICS

The THS 720P TekScope IsolatedChannel™ Scope/DMM is ideal for electric/power electronics applications.

The THS 720P includes features specifically for electric/power electronics measurements which allow testing and verifying correct operation of motors, checking transformer efficiency, verifying power-supply performance, and measuring the effect of neutral current. These features include harmonic analysis, power measurements and statistics and PWM motor drive triggering. It also contains the powerful features of a modern oscilloscope that enable troubleshooting and verification of complicated electronic control circuits controlling the high-voltage power-electronics circuitry.



THS 720P

CHARACTERISTICS

OSCILLOSCOPE FUNCTIONS

	THS 730A	THS 720A	THS 710A	THS 720P
Bandwidth	200 MHz	100 MHz	60 MHz	100 MHz
Sample Rate (Each Channel)	1 GS/s	500 MS/s	250 MS/s	500 MS/s
Time/Division Range	2 ns to 50 s/div	5 ns to 50s/div	10 ns to 50s/div	5 ns to 50s/div
Power Measurements	N	N	N	Y

OSCILLOSCOPE FUNCTIONS

Channels – Two.
Sensitivity – 5 mV to 50 V/div (to 500 V/div with 10X probe).
Position Range – ±10 div.
DC Gain Accuracy – ±2%.
Vertical Resolution – 8-Bits.
Record Length – 2500 points.
Horizontal Accuracy – ±200 ppm.
Roll Mode – ≥ 0.5 s/div.
Autorange – User-selectable.
Trigger Modes – Auto, Normal.
Trigger Types – Edge, Pulse, Video, External, Motor (THS 720P).
Video Trigger Formats and Field Rates – Odd field, even field and line.
Motor Trigger (THS 720P only) – Triggers on 3– and 5-level pulse-width modulated power signal.
External Trigger Input – 5 MHz TTL compatible.
Harmonics (THS 720P only) – Up to 31st (30 Hz-450 Hz).
Waveform Processing – Add, Subtract, Multiply, Calculate Watts = V x I.
Waveform Storage – 10 waveforms.
Acquisition Modes – Sample, Envelope, Average, Peak Detect.
Cursor Measurements – Δ Volts, Δ Time, 1/ΔTime (Hz), Degree (phase).
Cursor Types – Horizontal Bars, Vertical Bars, Paired (volts @ time).
Display System – Interpolation: Sin(x)/x.
Format: YT and XY.
Mode: Vector, Dot, Vector Accumulate, Dot Accumulate.

AUTOMATIC MEASUREMENTS

Period	Frequency
+Width	-Width
Rise Time	Fall Time
+Duty Cycle	-Duty Cycle
+Overshoot	-Overshoot
High	Max
Low	Min
Peak-to-Peak	Amplitude
Mean	RMS
Cycle Mean	Cycle RMS,
Burst Width	

POWER MEASUREMENTS (THS 720P ONLY) –

W	True power
VA	Apparent power
VAR	Reactive power
V	Volts (RMS, Peak)
A	Amps (RMS, Peak)
THD-F	Total harmonic distortion as a percentage of the fundamental
THD-R	Total harmonic distortion of the RMS of the input signal
PF	Power factor
DPF	Displacement power factor
PHI	Phase difference between the voltage and current

DMM SPECIFICATIONS

DC Voltage Ranges – 400.0 mV to 880 V.
DC Volts Accuracy – ±(0.5% of reading + 5 counts).
True RMS AC Voltage Ranges – 400.0 mV to 640 V.
Maximum Float Voltage – 600 VRMS CAT II, each channel (probe dependent).
Resolution – 4000 count, 3-3/4 digits.
AC Volts Accuracy – ±(2% of reading + 5 counts).
Resistance Ranges – 400.0 Ω to 40.00 MΩ.
Resistance Accuracy – ±(0.5% of reading + 2 counts); 40 MΩ: ±(2% of reading + 5 counts).
Diode Test Range – 0 to 2 V.
Continuity Check – Audible tone when < 50 Ω.

Modes – Min, Max, delta, Max-Min, Avg, Hold.

Non-volatile Storage – 10 DMM screenshots.

External Trigger Input – 5 MHz TTL compatible.

Vertical Zoom Capability – 2X, 5X, 10X.

dB Scale – Selectable, referenced from 1 mV to 10 V.

dBm Scale – Selectable, referenced from 50 Ω to 600 Ω.

GENERAL SPECIFICATIONS

Setups – 10 front-panel setups.

Safety – UL3111-1, CSA1010.1, EN61010-1.

Power – NiCd rechargeable battery pack with AC adapter (both included).

Battery Life – Approx. 2 hours from full charge.

Display – Backlit LCD.

Display Resolution – 320 x 240.

PHYSICAL CHARACTERISTICS

Dimensions	mm	in.
Width	177	6.95
Height	217	8.53
Depth	51	2
Weight	**kg**	**lbs.**
Net	1.45	3.2

ORDERING INFORMATION

For price information: Outside the U.S. contact your local Tektronix representative, inside the U.S. see the price list in the back of this catalog.

THS 730A, THS 720A, THS 710A

Handheld Battery Operated Oscilloscopes/DMM.

Includes: Two P6117 10X Passive Probes, User Manual, Quick Reference Manual, Standard Meter Lead Set, NiCd Rechargeable Battery Pack, AC Power Adapter, Soft Carrying Case, Cable and Adapters for RS-232, NIST-traceable Certificate of Calibration.

THS 720P

Handheld Battery Operated Oscilloscope.

Includes: Two P5102 10X High-voltage Passive Probes, User Manual, Quick Reference Manual, Standard Meter Lead Set, NiCd Rechargeable Battery Pack, AC Power Adapter, Soft Carrying Case, Cable and Adapters for RS-232, NIST-traceable Certificate of Calibration.

LANGUAGE OPTIONS

Opt. L1 – French User Manual.

Opt. L2 – Italian User Manual.

Opt. L3 – German User Manual.

Opt. L4 – Spanish User Manual.

Opt. L5 – Japanese User Manual.

Opt. L6 – Portuguese User Manual.

Opt. L7 – Simplified Chinese User Manual.

Opt. L8 – Traditional Chinese User Manual.

Opt. L9 – Korean User Manual.

INTERNATIONAL POWER PLUGS

Opt. A1 – European power plug.

Opt. A2 – UK power plug.

Opt. A3 – Australian power plug.

Opt. A6 – Japanese power plug.

See page 619 for description.

RECOMMENDED ACCESSORIES

Also see page 495.

P5102 – 10X 100 MHz Passive Probe for higher voltage application: 1000V_{RMS} Tip-to-reference; 600 V_{RMS} Reference-to-earth Ground (float).

A621, A622 – Current Probes for scope operation.

P6117 (replacement) – 10X Passive Probe.

Battery Charger – Order THS 7CHG.

Rechargeable Battery (replacement) – Order THS 7BAT.

Hard Carrying Case – Order THS 7HCA.

Standard Meter Lead Set (replacement) – Order 012-1482-00.

Deluxe Meter Lead Set – Order ATLDX1.

Programming Manual – Order 070-9751-00.

Service Manual – Order 070-9752-00.

Soft Carrying Case (replacement) – Order 016-1399-01.

SOFTWARE

WSTRO – WaveStar™ software for Oscilloscopes, Windows 95/98/NT application for waveform capture, analysis, documentation and control from your PC.

WSTROU – Upgrade from WSTR31 to WSTRO.

WSTR31 – WaveStar™ software for Windows 3.1.

WARRANTY

Three years (excluding probes).

Product(s) available through your local Tektronix Distributor listed in the back of this catalog.

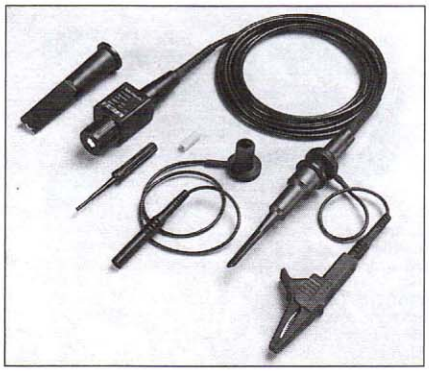
CE

ISO 9001

Tektronix measurement products are manufactured in ISO registered facilities.



P6117 Standard with the THS 710A, THS 720A, and TH730A.



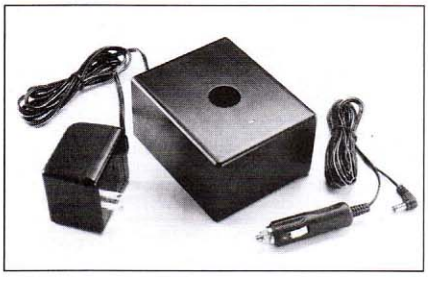
P5102 Standard with the THS 720P.

PROBES FOR THE THS 700 SERIES

Passive Voltage Probes Standard with the
THS 700 Series. Safety - UL3111-1, CSA1010.1, EN61010-1, EN61010-2-031.

Probe	Cable Length	Bandwidth	Attenuation	Comp. Range	Input C	System Input resistance	Maximum input	Scopes
P6117*[1]	2 m	200 MHz	10X	15 to 35 pF	13.3 pF	10.0 MΩ	300 V RMS	THS 710A/ 720A/730A
P5102*[1]	2 m	100 MHz	10X	24 to 28 pF	11.2 pF	5.0 MΩ	1000 V RMS	THS 720P (only)

*[1] *Both of these probes can be used with any of the THS 700 Series Scopes. This only designates that these probes come standard with the scopes.*



THS7CHG TEKSCOPE BATTERY CHARGER

- 12 to 18 volt input (DC)
- 2 hour charge time



THS7HCA TEKSCOPE HARD CARRYING CASE

- Holds TekScope oscilloscope and accessories



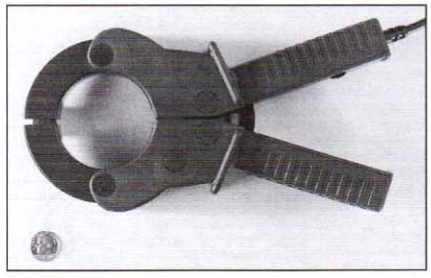
THSBAT NICAD BATTERY PACK

- 4.8 volt
- 2.8 A/hour

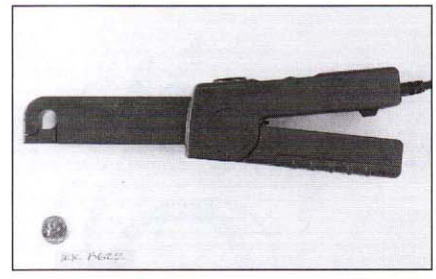
GENERAL PURPOSE CURRENT PROBES

- Clamp-on
- Excellent value
- AC and DC
- Easy to use

The A600 Series current probes are specifically designed to support measurements you make with your DMM, TekMeter® or oscilloscope.



A621.



A622.

Model Number	Frequency Range	Current Range RMS to Peak	Intrument Compatibility	Max. Conductor	Termination
A621	5 Hz to 20 kHz	100 mA to 2,000 A	Scope/DMM/TekMeter	54 mm dia.	BNC (w/banana adapter)
A622	DC to 100 kHz	50 mA to 100 A	Scope/DMM/TekMeter	11.8 mm dia.	BNC (w/banana adapter)

ORDERING INFORMATION

For price information: Outside the U.S. contact your local Tektronix representative, inside the U.S. see the price list in the back of this catalog.

P6117
10X, 200 MHz Standard Probe for THS 710A/720A/730A.

P5102
10X, High Voltage Probe for THS 700 Series.

A621
2000 A AC Current Probe/BNC.

A622
100 A AC/DC Current Probe/BNC.

THS 7BAT
Ni-Cad Battery Pack.

THS 7CHG
Battery Charger.

THS 7HCA
Hard Carrying Case.

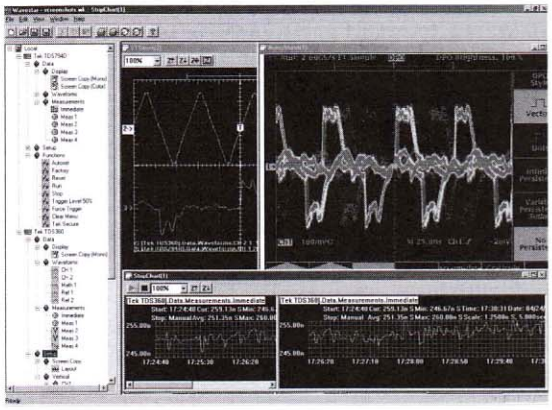
Product(s) available through your local Tektronix Distributor listed in the back of this catalog.

ISO 9001

Tektronix measurement products are manufactured in ISO registered facilities.

WaveStar™ Software Family

WSTRO • WSTRM



Features – Benefits

- Capture Measurement Waveforms and Data Easily Without the Need for Programming
- Data Log Measurements from a Single or Multiple Instruments
- Insert Information in Microsoft Office or Windows Applications
- Control Waveform or Meter Information Locally or over the Network
- Step Away from Your Desk and have WaveStar Software Automatically Capture Data Changes
- For Windows 95/98/NT Systems
- 30-Day WSTRO Product Demo Available on Web

Applications

- Digital Design
- Research and Development
- Manufacturing Test
- Service
- Education

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

Application Software Designed to Capture, Analyze, Document and Control Data

WaveStar Software introduces a family of Windows 95/98/NT applications bringing either Tektronix TDS/THS/11800/CSA803 oscilloscopes or TX-DMM™ measurement information to your PC desktop.

CAPTURE

Setup communication to instruments through the WaveStar Instrument Manager. The Explorer View displays these instruments and reveals their corresponding properties. To capture measurements, select a property, click, drag and drop into an active application sheet and begin analysis at your PC.

ANALYZE

Analyze, annotate and record information on a variety of application sheets.

Y-T Sheet – Capture and graphically view multiple waveforms on a graticule, with the same scale and position as the oscilloscope. Sheet features cursor measurements, horizontal and vertical gates, zoom function and annotation.

X-Y Sheet – Capture and display one or more pairs of waveforms plotted against each other in an X-Y fashion. Sheet features cursor measurements and annotation capabilities.

Stripchart Sheet – Automatically plots multiple waveform measurements, such as risetime or TX-DMM data, in a classic stripchart fashion. Sheet features cursor measurements, alarm control, and annotation capabilities.

Tabular Sheets – Capture, store, display and edit either waveform or data log information as a table of numbers on corresponding sheets. The Scalar Viewer Sheet displays contents of memory locations on the TX-DMM Series or measurements from the oscilloscope.

Measurement Sheet – Calculate frequency, pulse width, rise/fall time, duty cycle, overshoot, peak to peak, amplitude, min, max, mean, cycle mean and RMS measurements.

Notes Sheet – Prepare simple reports right in WaveStar software. Capture and save instrument hard copy. Save, edit and restore instrument setups.

DOCUMENT

Quickly and simply insert information into Microsoft Office applications, such as Excel, Word or PowerPoint. Transfer information into Windows applications, such as MathCad, through the Windows clipboard.

CONTROL

Easily control instrument settings and measurements such as autoset and triggers through the WaveStar Explorer View. For convenience, WSTRM also includes a unique virtual instrument control interface.

CHARACTERISTICS

SOFTWARE COMPATIBILITY

Instrument Interface Support – GPIB or RS-232 interfaces with Full Talk-Listen modes.
Windows Clipboard – Drag and Drop to compatible Microsoft Office Applications or copy/paste through Windows clipboard.
Printer Plotter Support – Uses standard Windows printer drivers.
Waveform Export Format – Microsoft Excel 6.0 compatible.

COMPUTER CONFIGURATION

Required –
Type: IBM PC-compatible.
Operating System: Windows 95/98 or Windows NT.
CD-ROM Drive: 4X or better.
Monitor: Super VGA.

Recommended
Processor: Pentium, 100 MHz.
RAM: 16 M.
Instrument Interface Card: GPIB: National Instruments IEEE-488 Interface Card.
RS-232: One free RS-232 port.
Ethernet 10BaseT Interface Card: Inquire about Tektronix AD007, GPIB-LAN Adapter.

TABLE 1. TEKTRONIX INSTRUMENT FAMILIES SUPPORTED

Product	Family*1	GPIB/RS232	Restore*2	Settings*2	Picture*2
WSTRO	TDS 200-300	Both	Yes	Yes	Yes
WSTRO	TDS 3000	Both	Yes	Yes	Yes
WSTRO	TDS 400-800	GPIB	Yes	Yes	Yes
WSTRO	THS 700	RS-232	Yes	Yes	Yes
WSTRO	CSA803/11800	Both	Yes	Yes	Yes
WSTRM	TX DMM	RS-232	Yes	Yes	Yes

*1 *Includes the newest TDS DPO oscilloscopes, as well as legacy series in each family.*

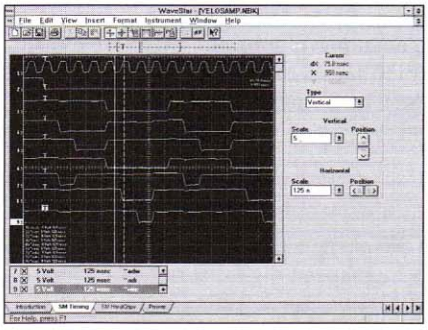
*2 *Restore waveforms, acquire/restore settings, acquire picture. WaveStar Software acquires waveforms from ALL instruments listed above.*

TABLE 2. PRODUCT FEATURES

Features	Product WSTRO	Product WSTRM
Data Sheets		
YT, XY, Waveform Tabular, and Waveform Measurement	Yes	
Data Logging Stripchart, Tabular, and Measurement	Yes	Yes
Scalar Viewer Tabular	Yes	Yes
Notes	Yes	Yes
Proxies (Drivers)		
All TDS, THS, CSA803, 11800 Series	Yes	
All TX-DMM		Yes
Online Help and Manual	Yes	Yes
Instrument Manager	Yes	Yes
Upgrade From WSTR 3.1	Yes	
PC Interface Cable		Yes
Virtual Meter Interface		Yes

ALSO AVAILABLE WAVESTAR 3.1 VERSION 1.3

ELECTRONIC LAB NOTEBOOK SOFTWARE



WaveStar (version 1.3).

APPLICATIONS

- Capture waveforms and settings from digital storage oscilloscopes
- Annotate, organize and analyze data
- Perform harmonic analysis up to 51 harmonics
- Display table of 22 measurements
- Store waveforms, pictures, settings and notes
- Read TDS floppies
- Exchange waveforms and data with other windows application software
- Restore waveforms and settings to digital storage oscilloscopes
- Windows 3.1 application

TEKTRONIX DIGITAL STORAGE OSCILLOSCOPES SUPPORTED

WaveStar 3.1 Version 1.3 Software can acquire waveforms from the following scopes:

Instrument	GPIB/RS-232	Restore*1	Settings*1	Picture*1
11401, 11402/A, 11403/A, 11801/B, 11802, CSA404, CSA803/A, DSA601/A, DSA602/A	Both	Yes	Yes	No
2212, 2216, 2430/A, 2432/A, 2440	GPIB	Yes	Yes	No
2220, 2221A, 2230, 2232	Both	Yes	No	No
TDS 200/300 Series	Both	Yes	Yes	Yes
TDS 400, TDS 500, TDS 600, TDS 700, TDS 800 Series	GPIB	Yes	Yes	Yes
THS 700 Series	RS-232	Yes	Yes	Yes

**1 Restore waveforms acquire/restore settings, acquire picture. WaveStar Software acquires waveforms from ALL scopes listed above.*

PC SOFTWARE CREATES AN ELECTRONIC LAB NOTEBOOK

WaveStar Software version 1.3 is an enhanced Windows 3.1 application program from Tektronix that allows the user to quickly create an electronic lab notebook within their personal computer to record Tektronix Digital Storage Oscilloscope (DSO) measurements. The Notebook can capture waveforms and/or screen shots, related scope settings and notes. Further, WaveStar Software provides a simple link to spreadsheet and documentation software, enabling users to analyze measurement records or incorporate them within other published materials.

Instrument Interface Support – GPIB or RS-232 interfaces with full Talk-Listen modes.

Windows Clipboard – Copy/paste through Windows Clipboard to other Windows applications as bitmaps or metafiles.

Printer/Plotter Support – Uses standard Windows printer drivers supplied by printer vendor.

Waveform Export Format – Microsoft Excel 4.0 compatible.

MINIMUM COMPUTER CONFIGURATION

Type – IBM PC-Compatible 386 (486 or greater recommended).
Operating System – Windows 3.1 or later in 386 Enhanced mode.
RAM – 4 MB or greater.
Hard Disk – 5 MB free space.
Floppy Disk – One 3.5 in. high-density disk drive.
Monitor – VGA or better.
Interface Card (DSO must have appropriate interface installed) –
GPIB: National Instruments IEEE-488 Interface Card.
RS-232: One free RS-232 port.

ORDERING INFORMATION

For price information: Outside the U.S. contact your local Tektronix representative, inside the U.S. see the price list in the back of this catalog.

WSTRO
WaveStar Software for Oscilloscopes, Windows 95/98/NT Version.
Includes: CD ROM, Manual (071-0220-00).

WSTRM
WaveStar Software for Meters, Windows 95/98/NT Version.
Includes: CD ROM, PC Interface Cable with 9– to 25-Pin adapter (118-9828-00), Boot Insert (377-0625-00), Manual (071-0220-00).

WSTROU
WaveStar 3.1 (WSTR31) Upgrade to WaveStar for Oscilloscopes, Win 95/98/NT Version.
Includes: 1 CD-ROM Disk, Manual (071-0220-00).

WSTR31
WaveStar Software version 1.3 for Windows 3.1.
Includes: 3.5 in. Disk, Manual (070-9785-01).

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

Sampling Oscilloscopes

Contents

Software (WaveStar) 109
11801C 113
Sampling Heads 116
CSA 803C 290
Probes 495
SMD Adapters 535
Probe and Instrument Accessories 540
Instrumentation Carts 582

11800 Series

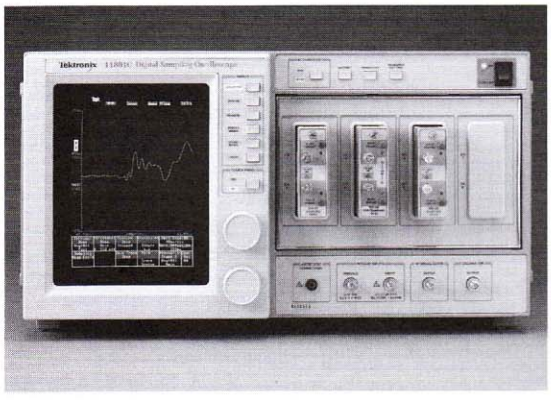
The Tektronix 11800 Series is a powerful set of analysis tools that alter your fundamental expectations of an oscilloscope. Most revolutionary is the simplification and automation of the entire measurement and analysis process. Accuracy, sensitivity, bandwidth, offset and overdrive recovery are provided by a well-planned instrument family having plug-in versatility and performance. Multiprocessor architecture allows for simultaneous display of up to eight waveforms and up to six dynamic, "live" measurement readouts. The automation needs of scientific and production environments are easily met by integrating these instruments into a measurement system through RS-232-C or GPIB interfaces.

CSA Series

The Communications Signal Analyzer (CSA) offers signal analysis and the powerful measurement capabilities required to analyze high-speed digital communication signals. Features of the CSA 803C include histograms, mask testing and a color-graded display, allowing you to perform accurate measurements such as jitter, noise and phase.

Digital Sampling Oscilloscope

11801C



Features – Benefits

- DC To 50 GHz Bandwidth
- 7 Ps Rise Time
- Eight Channels, Expandable to 136 (with SM-11 multi-channel units)
- High Resolution and Measurement Repeatability
- 10 Femtosecond Sampling Interval (0.01 ps)
- Modular Architecture
- Dual Timebase Allows Multiple Windows
- FFT
- Predefined Telecom Masks
- True Dual-Step Differential TDR
- Fully Automatic Jitter and Noise Measurements
- Automatic Statistical Measurements, Histograms and Mask Testing
- Automatic Pulse Measurements with Statistics
- Comprehensive Waveform Processing
- Complete Programmability for ATE Applications
- Color Display with Color Grading

Applications

- Semiconductor Test
- TDR Characterization
- High Speed Digital
- Data Communication

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

CE

ISO 9001

Tektronix measurement products are manufactured in ISO registered facilities.

The 11801C Digital Sampling Oscilloscope

The 11801C Digital Sampling Oscilloscope offers the widest range of on-board measurement and waveform processing capabilities of any multi-Gigahertz scope. With excellent measurement repeatability, exceptional vertical resolution and fast display update rate, the 11801C is a powerful measurement tool for semiconductor testing, TDR characterization of circuit boards, IC packages and cables, and high speed digital data communications.

MODULARITY MEETS YOUR NEEDS NOW AND IN THE FUTURE

The modular microprocessor-based architecture of the 11801C not only allows you to select the right configuration for your application, but also allows expandability to meet your future measurement needs. The 11801C accepts up to 4 dual-channel sampling heads and can be expanded through the SM-11 Multi-Channel Units to 136 channels. There are currently nine sampling heads to choose from:

- **SD-14** 3 GHz high impedance (100 kΩ/0.475 pF) dual-channel probe sampler
- **SD-20** 20 GHz single-channel loop-through head
- **SD-22** 12.5 GHz dual-channel low noise head
- **SD-24** 20 GHz dual-channel TDR/sampling head
- **SD-26** 20 GHz dual-channel sampling head
- **SD-32** 50 GHz, single-channel sampling head
- **SD-42** 6.4 GHz O/E converter (55 ps optical pulse response FWHM)
- **SD-44** 15 GHz O/E converter
- **SD-51** 20 GHz trigger head

CHARACTERISTICS

VERTICAL SYSTEMS

Rise Time/Bandwidth – Determined by the sampling head used.*1

Vertical Resolution – 8 bits full screen (78 µV LSB at 2 mV/div deflection factor).

Amplifier Gain Accuracy – ±1% of all settings.

Deflection Factors – 2 to 255 mV/div in 1 mV/div increments.

Offset Range – ±2 V.

HORIZONTAL SYSTEM

Main and Window Time Base – 1 ps/div to 5 ms/div, settable in 1-2-5 sequence or in 1 ps increments.

Time Interval Accuracy – 8 ps + 0.01% x (interval) + 0.001% x (position), guaranteed;
4 ps + 0.004% x (interval) + 0.0004% x (position), typical, where interval ≥1 ns;
2.5 ps + 0.0004% x (position), typical, where interval = 100 ps;
1 ps + 0.0004% x (position), typical, where intervals <10 ps.

Notes: 1) For intervals <100 ps, the above holds for time/div ≤20 ps/div.
2) For other intervals not listed above, linearity interpolate the cardinal points.

Record Length – 512, 1024, 2048, 4096 and 5120 samples.

Windows – Any number of window records may be placed on any number of main records, up to a maximum of 8 displayed traces. All window records have the same duration, but may be independently positioned on any main record. Windows may be set to automatically track a moving edge on the main record.

Maximum Sampling Rate – 200 ks/s.

TRIGGER SYSTEM*2

Trigger Bandwidth – Direct 4 GHz typical, Prescaled 12.5 GHz typical.

Trigger Sensitivity – Direct DC to 4 GHz: 50 mV typical.
Prescaled 2 to 10 GHz: 500 mV,
10 to 12.5 GHz: 800 mV typical.

Delay Jitter – 1.1 ps +4 ppm of a position typical. 2.0 ps +5 ppm of position maximum (rms).

Metastability: Raw <0.005 ppm at 2.488 GHz with 200mV input trigger voltage, typical. Enhanced is theoretically zero.

Internal Clock – 100 kHz (drives TDR, Internal Clock Output and Calibrator).

Trigger Level Range – ±1.0 V (±10 V with 10X trigger attenuator activated).

Trigger Input Range – ±1.5 V (±1.5 V, 5 V rms maximum with 10X).

Trigger Holdoff – 5 µs to 2.5 s.

MEASUREMENT SYSTEM

Waveform Processing Functions – Add, subtract, multiply, divide, absolute, average, differentiate, envelope, exponent, integrate, natural log, log, signum, square root, smoothing and filter.

Measurement Set – Max, min, mid, p-p, mean, rms, amplitude, extinction ratio, overshoot, undershoot, noise*3, rise, fall, spectral magnitude, spectral frequency, THD, SNR, frequency, period, prop delay, cross, width, phase, duty cycle, jitter*3, area +, area -, and energy. Measurements are constantly updated; mean and standard deviation available on all measurements.

Measurement Parameters – (Proximal, mesial, distal and start/stop levels): May be set to absolute levels.

Cursors – Paired or split dots, vertical bars, and horizontal bars.

TDR SYSTEM (SD-24 ONLY)

Combined TDR/Acquisition Reflected Risetime – 35 ps or less.

TDR Step Amplitude – Adjustable to ±250 mV (polarity of either step may be inverted).

Time Coincidence Between TDR Steps – Adjustable to less than 1 ps.

Source Resistance – 50 ±0.5 Ω.

Typical Aberrations (at ±250 mV Amplitude) –
10 ns to 20 ps before step: ±3% or less;
less than 300 ps after step: +10%, –5% or less;
300 ps to 5 ns after step: ±3% or less; elsewhere: ±1% or less.

CRT AND DISPLAY FEATURES

CRT – 9 in. diagonal, magnetic deflection, vertical raster scan orientation. Color.

Colors – Eight-color default color set included; or, colors are user-selectable from palette of 262,144 colors.

Video Resolution – 552 horizontal by 704 vertical displayed pixels.

**1 Vertical system specifications of 11801C with SD-14 non-applicable. See 11800 Series Sampling Head specifications.*

**2 11801C has external trigger only; requires 23 ns pretrigger or DL-11 Delay Lines to view trigger point (45.5 ns with Option 1M).*

**3 Available only in statistical measurement mode.*

POWER REQUIREMENTS

Line-Voltage Ranges – 90 to 132 V rms, 180 to 250 V rms.

Line Frequency – 48 to 440 Hz.

Maximum Power Consumption – 214 W.

ENVIRONMENTAL AND SAFETY

Temperature – Operating: 0°C to +50°C; nonoperating: –40°C to +75°C.

Humidity – Operating and nonoperating: up to 95% relative humidity, up to 50°C. Per Mil-T-28800E, Type III, Class 5.

Altitude, Vibration, Shock nonoperating, Bench Handling – Meets MIL-T-28800E, Type III, Class 5.

Electromagnetic Compatibility (with sampling heads or optional blank panels installed in all sampling head compartments) – Meets the requirements of: MIL-STD-461B; FCC Part 15, sub-part J, Class A; VDE 0871/6.78 Class B.

Safety – Listed UL 1244, CSA Bulletin 556B September 1973.

PHYSICAL CHARACTERISTICS

	Cabinet		Rackmount	
Dimensions	**mm**	**in.**	**mm**	**in.**
11801C				
Width	448	17.6	483	19.0
Height	238	9.4	222	8.8
Depth	599	23.6	550	21.6
SM-11				
Width	448	17.6	483	19.0
Height	238	9.4	222	8.8
Depth	558	22.0	550	21.6
Weights	**kg**	**lb.**	**kg**	**lb.**
11801C				
Net	22.3	49.0	23.2	51.0
Shipping	25.9	57.0	26.8	59.0
SM-11				
Net	20.0	44.0	20.9	46.0
Shipping	23.6	52.0	24.5	54.0

ORDERING INFORMATION

For price information: Outside the U.S. contact your local Tektronix representative, inside the U.S. see the price list in the back of this catalog.

11801C
Digital Sampling Oscilloscope.

Includes: User Manual (070-9971-00);
Programmer Manual (070-9970-00);
Service Manual (070-9972-00);
12-in. SMA-SMA cable,
2 ea. 8-1/2-in. SMA-SMA cable,
1 wrist strap.

Opt. 1M – Multi-Channel Conversion: Modifies 11801C to permit operation with up to four SM-11 Multi-Channel Units.

Opt. 1R – Rackmount.

Includes: Hardware, tooling and instructions for converting bench model to rackmount configuration. Available with 11801C.

DL-11
Delay Line.

Includes: Delay Line Instruction Sheet – Order 070-7051-01.

INTERNATIONAL POWER PLUGS

Opt. A1-A5 – Available.

See page 619 for description.

ADDITIONAL ACCESSORIES

Calibration Step Generator – USA (067– 1338-00); Europe (067-1338-01); UK (067-1338-02); Australia (067-1338-03); Switzerland (067-1338-05); Japan (067-1338-06).

Sampling Head Extender Cable, 1 meter – Order 012-1220-00.

Sampling Head Extender Cable, 2 meter – Order 012-1221-00.

DL-11 Service Manual – Order 070-7050-01.

Blank Panel for Empty Sampling Head Compartments – Order 200-3395-00.

ECL Terminator – Order 015-0558-00.

SMA Accessory Kit – Order 020-1693-00.

RECOMMENDED PROBES

P6150 – 9 GHz Passive Probe.

P6249/1103 – 4 GHz Active FET Probe and Power Source.

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

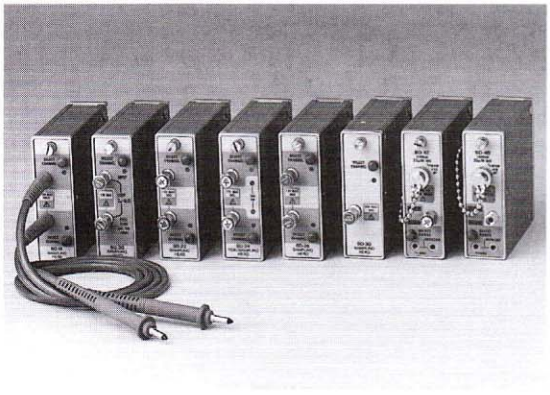
CE

ISO 9001

Tektronix measurement products are manufactured in ISO registered facilities.

Sampling Heads

SD-14 • SD-20 • SD-22/-24/-26 • SD-32 • SD-42/-44 • ORR24 • SD-51



For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

CE

ISO 9001

Tektronix measurement products are manufactured in ISO registered facilities.

Features – Benefits

SD-14

100 kΩ, 0.5 pF Typical

7 V p-p Dynamic Range

3 GHz Bandwidth

SD-20

Non-terminated

SD-22

12.5 GHz Bandwidth

Low-noise

Dual-channel

SD-24

20 GHz Bandwidth

35 ps Reflected Rise Time

SD-26

20 GHz Bandwidth

Dual-channel

SD-32

50 GHz Bandwidth

Single-channel

2.4 mm Connector

SD-42*[1]

DC to 6.4 GHz Optical Bandwidth

1000-1700 nm Wavelength Range

SD-44*[1]

DC to 15 GHz

1100 – 1650nm Wavelength range

ORR24*[1]

DC to 2.0 GHz

1310-1500 nm Wavelength Range

SD-51

1 to 20 GHz Bandwidth

Less Than 6 ps rms Jitter

ECL, CMOS and ACL GaAs Device Characterization (SD-14)

Special TDR Communications (SD-20)

Digital Data Communications (SD-22)

TDR/TDT Crosstalk (SD-24)

Device Characterization (SD-26)

High Bandwidth Communication & Microwave (SD-32)

Optical-to-electrical (SD-42/SD-44)

SONET/SDH Compliance Testing (ORR-24)

Triggering Countdown (SD-51)

SD-14 High Impedance Probe Sampler

The SD-14 is a dual-channel, 3 GHz probe sampler designed for high-impedance signal acquisition where a 50 Ω acquisition system is not the optimal solution. The SD-14 is ideal for high-speed device characterization such as ECL, CMOS, ACL and GaAs testing. The 100 kΩ input impedance and 0.5 pF capacitance results in very low loading of the device under test. The 7 V dynamic range and ±3.5 V offset range, makes the SD-14 suitable for testing all digital logic families as well as most analog circuits.

The SD-14 consists of two samplers, each attached at the end of a 1.0 meter cable for easy circuit probing. The modular architecture of the CSA 803C/11801C enables the use of extended samplers, bringing a new level of performance to sampling scopes. In conjunction with the 11801C and SM-11 multi-channel unit, it is possible to configure up to 136 channels of high-impedance, high-bandwidth acquisition with measurement accuracy approaching 140 ps.

SD-14 Option 01 adds a longer probe tip, two probe-to-ECB (etched circuit board) adapters, and two probe-to-SMB adapters. These ease probing of plated holes (as found in Outboards for IC testers) and semi-permanent connections.

SD-20 Loopthrough Sampling Head

The SD-20 is a single-channel, 20 GHz loopthrough sampling head designed for low-loss testing in applications such as microwave systems research and development, digital device characterization and high-speed digital communications circuit design. It provides an acquisition rise time of 17.5 ps with typically 750 µV rms of noise (350 µV with smoothing) to ensure clean, undistorted signals.

The SD-20 is nonterminated and keeps losses to a minimum by routing the signal of interest directly through the sampling head without the need of a power divider. The SD-20 can also be used for customized TDR measurements of transmission lines and controlled impedance devices. An external signal generator may be used, instead of the SD-24 step generator, to tailor the TDR stimulus to fit a particular situation. For instance, slower slew rates or higher amplitude may be utilized, or you may perform half-sine or impulse testing.

In digital communications, the SD-20 is useful for viewing and triggering on the clock signal without the use of a power divider.

SD-22 Low-noise Sampling Head

The SD-22 is a dual-channel, 12.5 GHz sampling head specifically designed for low-noise measurement in digital communications and device characterization applications. It provides an acquisition rise time of 28 ps, and typically 450 µV rms of displayed noise. With smoothing, noise levels are 180 µV rms.

In order to precisely capture and display the switching characteristics of high-speed communications circuits, to make accurate statistical measurements of signal noise and signal timing jitter, or to obtain stable timing measurements of fast digital ICs, the noise floor of the test equipment must be kept to a minimum. The SD-22 is the ideal instrument for these low-noise applications.

SD-24 TDR/Sampling Head

The SD-24 is a dual-channel TDR/Sampling Head. This sampling head has a rise time of 17.5 ps or less, with a typical 20 GHz equivalent bandwidth.

Each channel of the SD-24 is also capable of generating a fast rising step for use in Time Domain Reflectometry (TDR). In TDR mode, the acquisition portion of the sampling head monitors the incident step and any reflected energy. The reflected rise time of the TDR step is 35 ps or less. The polarity of each channel's TDR step can be selected independently of the other channel. This allows for differential or common-mode testing of two coupled lines, in addition to the independent testing of isolated lines. The SD-24 can be used to characterize crosstalk by using the TDR step to drive one line while monitoring a second with the other channel.

The "filter" function on the CSA 803C/11801C can be used with TDR or crosstalk measurements to characterize a system at a slower rise time.

SD-26 Sampling Head

The SD-26 is a dual-channel, 20 GHz equivalent bandwidth sampling head. This sampling head has the same acqui-

Sampling Head Characteristics

	Channels	Bandwidth	Rise Time	Impedance	Noise	Applications (Typical)
SD-14	2	3 GHz (typical)	140 ps	100 kΩ/0.5 pF 0.55 pF Opt. 01	2 mV	ECL, CMOS, ACL GaAs Dev. Characterization
SD-20	1	20 GHz	17.5 ps	50 Ω unterm.	750 µV	Special TDR, Communications
SD-22	2	12.5 GHz	28 ps	50 Ω	450 µV	Communications
SD-24	2	20 GHz	17.5 ps	50 Ω	750 µV	TDR/TDT Crosstalk
SD-26	2	20 GHz	17.5 ps	50 Ω	750 µV	Device Characterization
SD-32	1	50 GHz	7.0 ps	50 Ω	1.8 mV	High Bandwidth Communications & Microwave
SD-42	1	6.4 GHz				Optical-to-electrical
SD-44	1	15 GHz				Optical-to-electrical
ORR-24	1	2.0 GHz	205 ps	50 Ω		Optical Reference Receivers (SONET/SDH)
SD-51		20 GHz		50 Ω		Trigger Countdown Head

sition capability as the SD-24 TDR/Sampling Head but does not include the TDR step generators.

SD-32 Sampling Head

The SD-32 is a single-channel, 50 GHz bandwidth sampling head. The SD-32 performance is available for any new or existing CSA 803A/11801B mainframe. The SD-32 has measured bandwidth of greater than 50 GHz and calculated rise time less than 7.0 ps. The front-panel connector is female 2.4 mm, and an adapter is provided (011-0157-00; 2.4 mm male to 2.92 mm female) in order to maintain compatibility with SMA connector systems.

SD-42 Optical-to-Electrical Converter*[1]

The SD-42 Optical-to-electrical Converter head can be used to analyze optical signals in the 1000 nm to 1700 nm wavelength range. The pulse response of the measurement system is less than 55 ps FWHM (Full-width, Half-maximum), which is equivalent to a calculated bandwidth of DC to 6.4 GHz. The electrical output on the front panel is coupled to the adjacent sampling head via the semi-rigid coaxial link provided.

The SD-42 is also equipped with an optical power meter for average power monitoring through a pair of voltage outputs on the front panel. Power from 5 nW to 5 mW can be measured.

SD-44 Optical-to-Electrical Converter*[1]

The SD-44 is an optical-to-electrical (O/E) converter for use with the Tektronix CSA 803 and 11800 Series sampling oscilloscopes equipped with an SD-2x or SD-3x Electrical Sampling Head. The SD-44 Optical-to-electrical Converter can be plugged directly into a 11800 sampling slot, CSA 803 power slot, or attached via a sampling head extender cable for remote use. The head extenders come in either 1 meter (012-1220-00) or 2 meter (012-1221-00) options.

Optical signal input on the SD-44 is a standard FC/PC fiber optic connector. Other connector types can be accommodated by using hybrid fiber optic jumper cables (SA/SD-42) or an assortment of hybrid mating adapters (SD-44).

ORR-24 Optical Reference Receiver*[1]

The Synchronous Data Hierarchy (SDH) and the Synchronous Optical NETwork (SONET) standards are the cornerstones of today's high-speed digital telecommunications systems. The Tektronix ORR24 optical reference receiver provides an important interface for compliance testing of SDH/SONET optical transmission products or components.

The amplified design of the ORR24 converts the incoming optical light into a high gain, low noise electrical signal. This allows easy testing of optical designs as well as repeatable measurements. The ORR24 is DC coupled which is required for accurate extinction ratio measurements.

SD-51 Trigger Head

The SD-51 Trigger-countdown Head provides stable displays of signals from 1 to 20 GHz with less than 6 ps rms jitter.

The SD-51 is a free-running tunnel diode oscillator with a front-panel control to synchronize the oscillator to a subharmonic of the input signal and the output oscillator to a subharmonic of the input signal. The output from the SD-51 is coupled to the CSA 803C/11801C Series trigger input connector. The output signal is a direct countdown of the input (and the input connector) and permits triggering by the sampling time base unit.

*[1] *For more information on this product, see Telecommunications products section of this catalog.*

Characteristics

Acquisition System – SD-14, SD-22, SD-24, SD-26: dual channel; SD-20, SD-32: single channel.

Rise Time – SD-14: 140 ps; SD-20, SD-24, SD-26: 17.5 ps; SD-22: 28 ps, all from 10% to 90%.

Bandwidth – 3 GHz (typical) for the SD-14; 20 GHz for the SD-20, SD-24, and SD-26; 12.5 GHz for the SD-22; 50 GHz for the SD-32.

Dynamic Range – 1 V p-p within a ±1.6 V range for the SD-20, SD-22, SD-24, SD-32; 7 V p-p within a ±3.5 V offset range for the SD-14.

Dot Transient Response – Accuracy after calibration at operating temperature is ±5% for signals up to 0.5 V p-p. Adjustable to unity for signals up to 1.0 V p-p.

Input Impedance – SD-22, SD-24, SD-26, SD-32: 50 Ω ±0.5 Ω. SD-14 is 100 kΩ and 0.5 pF (0.55 pF for Option 01). SD-20 is not terminated and not rated.

Displayed Noise –

	Maximum	Typical
With unity dot response:		
SD-20, SD-24, SD-26	1.2 mV	750 µV
SD-22	800 µV	450 µV
SD-14	8 mV	7 mV
SD-32	2.3 mV	1.8 mV
With smoothing:		
SD-20, SD-24, SD-26	550 µV	350 µV
SD-22	400 µV	180 µV
SD-32	1 mV	700 µV

Aberrations (typical) (SD-20, SD-22, SD-24, SD-26 only) – The following are acquisition aberrations. 10 ns to 20 ps before step: ±3% or less. <300 ps after step: +10%, –5% or less. 300 ps to 5 ns after step: ±3% or less. 300 ps to 5 ns after step: ±4 or less (SD-20 only). 5 ns to 100 ns after step: ±1% or less. Elsewhere: ±0.5% or less.

Aberrations (typical) (SD-14 only) – <1.5 ns after step: +12%, –25%, 1.5 ns to 4 ns after step: +1%, –3%, 4 ns to 30 ns after step: ±2%. Elsewhere: ±1%.

Maximum Input Voltage – ±3 V. SD-14: ±15 V; SD-32: ±2 V.

Isolation Between Channels – 1% p-p voltage transmission from the channel driven by the 067-1338-00, to the quiescent channel (see page 121 in this catalog).

Time Coincidence Between Channels – 10 ps accuracy; <0.2 ps/°C stability.

TDR SYSTEM (SD-24 ONLY)

Displayed Rise Time.

Incident – 28 ps typical, 10% to 90%, at +250 mV or –250 mV output, elsewhere ±1%.

Reflected – 35 ps or less, 10% to 90%, at +250 mV or –250 mV output.

TDR Step Amplitude – Adjustable to ±250 mV (polarity of either step may be inverted).

Time Coincidence Between TDR steps – Adjustable to less than 1 ps.

Source Resistance – 50 Ω ±0.5 Ω.

Aberrations (at ±250 mV amplitude) – The following are TDR aberrations. 10 ns to 20 ps before step: ±3% or less. <300 ps after step: +10%, –5% or less. 300 ps to 5 ns after step: ±3% or less. Elsewhere: ±1% or less.

ENVIRONMENTAL AND SAFETY CHARACTERISTICS

(11801C, CSA 803C, SD-Series Heads)

Temperature – Operating: 0°C to +50°C; nonoperating: –40°C to +75°C.

Altitude, Vibration, Shock, Bench Handling – Operating and nonoperating: meets MIL-T-28800C, Type III, Class 5.

Electromagnetic Compatibility (not SD-14) – Meets the following requirements of MIL-STD-461C: CE-03 Pt 4 Curve 1, CS-01 Pt 7, CS-02 Pt 4, CS-06 Pt 5, RE-02 Pt 7, RS-01 Pt 4, RS-02 Pt 5, RS-03 Pt 7 (limited to 1 GHz). Meets FCC Part 15, subpart J, Class A. For Germany: Meets VDE 0871/6.78 Class B. (Not all for SD-14.)

Humidity – To 95% RH at up to 50°C.

CHARACTERISTICS (SD-51)

Input Signal – Frequency range is 1 to 20 GHz. Stable synchronization on signals of at least 100 mV p-p, as measured separately into 50 Ω, 5 V p-p max.

Input Characteristics – 50 Ω SMA (3 mm) connector. Open termination paralleled by 1 pF.

Trigger Output – Approximately 200 mV into 50 Ω. Jitter is 6 ps rms or less with signals from 5 to 20 GHz; 7 ps rms or less with signals from 1 to 5 GHz. Kickout at signal input is 180 mV peak; kickout occurs between successive samples.

ORDERING INFORMATION

For price information: Outside the U.S. contact your local Tektronix representative, inside the U.S. see the price list in the back of this catalog.

SD-14
High Impedance Probe Sampler.
Includes: Installation/User Manual (070-8286-01); Service Manual (070-8285-01); 4-post ECB Mount Ground Socket; Edge Tab Ground Socket; 10 ea. Wire-form Ground, .050 Spacing; 10 ea. Wire-form Ground, .040 Spacing; Plastic Accessories Case.
Opt. 01 – Longer Probe Tip, Probe to ECB Adapters, Probe to SMB Adapters.

SD-20
Loopthrough Sampling Head.
Includes: Installation/User Reference (070-7531-01), Service Reference (070-7528-01), Precision 3.5-mm Termination (011-0155-00), 2 SMA Short-circuit Terminations (015-1020-00).

SD-22
Low-noise Sampling Head.
Includes: Installation/User Reference (070-7226-02), Service Reference (070-7227-02), 2 SMA Short-circuit Terminations (015-1020-00).

SD-24
Dual TDR/Sampling Head.
Includes: Installation/User Reference (070-7052-01), Service Reference (070-7053-01), SMA Short-circuit Terminations (015-1020-00).

SD-26
Dual Sampling Head.
Includes: Installation/User Reference (070-7226-02), Service Reference (070-7227-02), 2 SMA Short-circuit Terminations (015-1020-00).

SD-32
Sampling Head.
Includes: Installation/User Reference (070-8268-01); Service Reference (070-8269-01); 1 SMA Short-circuit Termination (015-1020-00); 2.4 mm Male to 2.92 mm Female Adapter (011-0157-00).

SD-42
Optical-to-electrical Converter.
See the Telecommunication Instruments section for complete information.

SD-44
Optical-to-electrical Converter.
Includes: Hard Case, User Manual (English), Assorted Fiber Optic Hybrid Connectors (FC/FC, FC/ST, FC/SC), FC/FC Single-mode Fiber Jumper, Rigid 50 Ω U-Cable, Certificate of Traceable Calibration.

SD-44 External Power Supply with SD-4x Adapter Cable – Order 016-1609-00. Includes: IEC Compatible Power Supply, SD-44 Adapter Cable, U.S. Power Cord, Instruction Sheet.

INTERNATIONAL POWER PLUGS

Order European: 161-0066-09.
Order UK: 161-0066-10.
Order Australia: 161-0066-11.
Order Switzerland: 161-0154-00.
See page 619 for description.

DIN/FC Fiber Optic Hybrid Connector – Order 119-5118-00.

10 kHz to 21 GHz DC Block –
"N" Type: Order 015-0509-00.
"K" to "N" Type Adapter: Order 015-0369-00.

1101A
Tektronix Power Supply.
Includes: Hard Case, User Manual (English), Assorted Fiber Optic Hybrid Connectors (FC/FC, FC/ST, FC/SC), FC/FC Single-mode Fiber Jumper, 50 Ω SMA Cable, Frequency Response Graph, Certificate of Traceable Calibration.

SD-51
Trigger Head.
Includes: Installation/User Manual (070-7338-01), Service Reference (070-7339-01), 12 in. SMA Male-to-male (174-1364-00).

MEASUREMENT SERVICE OPTIONS

SD-14
Opt. R3 – Repair warranty extended to cover three years.

SD-20/–22/–24/–26/–32/–42/–44
Opt. C3 – Three years of Calibration Services.
Opt. D3 – Test Data (requires Opt. C3).
Opt. R3 – Repair warranty extended to cover three years.

SD-51
Opt. C3 – Three years of Calibration Services.
Opt. R3 – Repair warranty extended to cover three years.
ORR24 – Optical Reference Receiver.

RECOMMENDED ACCESSORIES

Also see page 495.

PROBES

P6150 – 50 Ω. Divider Probe, 2 tips: 1X, 10X. 1X: 3 GHz; 10X: 9 GHz.
P6158 – 20X, 3 GHz/KΩ.
See page 520. Requires SMA Male-to-BNC female adapter when attached to SMA-type inputs. Order 015-0554-00.

ADDITIONAL ACCESSORIES

Also see page 495.

2X Attenuator – SMA Male-to-female. Order 015-1001-00.
5X Attenuator – SMA Male-to-female. Order 015-1002-00.
75 Ω to 50 Ω Min. Loss Attenuator – BNC. Order 011-0112-00.
Blank Sampling Head – Order 200-3395-00.
SMA Accessory Kit – 2 ea. 2X and 5X Attenuators; 2 ea. SMA Terminations, Male Short Circuit, Female Short Circuit, Male 50 Ω , Female 50 Ω, 2 ea. 50 Ω Signal Cables (2 ns), 2 ea. 500 ps Semi-rigid Cable, 2 ea. Male-to-male Adapters, 2 ea. SMA Male-to-BNC Female, 2 ea. Female-to-female, 1 ea. 50 Ω Power Divider, 1 ea. Combination Wrench (.312, 6 point). Order 020-1693-00.
ECL Terminator – Provides the bias and termination for ECL device outputs. At 10 GHz bandwidth and 1% precision attenuation, accurate AC and DC measurements are ensured. Attenuation: 10X ±1.0% @ DC, 20 dB ±3 dB, DC to 10 GHz. Aberrations: ±3% max with 100 ps Rise Time. Order 015-0558-00.
DC Block (Coupling Capacitor) – BNC. Order 015-1013-00.
Slip-on Connector – Order 015-0553-00.
Connector Savers – (SMA) Order 015-0549-00.

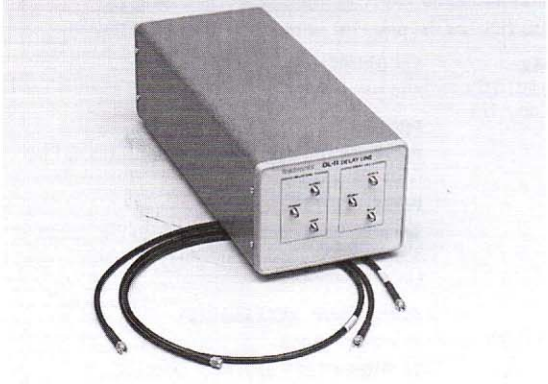
CABLES AND EXTENDERS

Sampling Head Extender Cables –
(1 m) Order 012-1220-00.
(2 m) Order 012-1221-00.
Acquisition Extender – Order 067-1324-00.
Acquisition System Extender – Order 067-1323-00.
Card Cage Extender – Order 067-1267-00.

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

Delay Line/Static Isolation Unit/Calibration Step Generator

DL-11 • SIU 800



Features – Benefits **Applications**

DL-11

47.5 ns Compensated Dual Delay Line

5 GHz Bandwidth

CALIBRATION STEP GENERATOR

250 mV

Verifies Specifications of SD-14, SD-20, SD-22, SD-24, SD-26 Sampling Heads

SIU 800

<40 PS Reflected Rise Time When Used with SD-24

<80 mp Reflection Coefficient

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

NOT AVAILABLE IN EUROPE.

ISO 9001

Tektronix measurement products are manufactured in ISO registered facilities.

DL-11 Delay Line

The DL-11 Delay Line provides approximately 47.5 ns of delay from the signal input to the signal output. The DL-11 contains two delay lines that, when connected, allow you to view the triggering event through the 11801C or CSA 803C. The DL-11 has approximately 5 GHz bandwidth and attenuates the signal by 50%.

A delay line can reduce horizontal jitter and provide more accurate measurements, because it lets you take measurements on the first rising edge of the triggering event.

The DL-11 Delay Line contains two delay lines each with 47.5 ns delay. The DL-11 is used for showing the triggering event of a signal displayed on an 11801C or a CSA 803C.

Physical Characteristics

Dimensions	**mm**	**in.**
Width	159	6.3
Height	119	4.7
Depth	356	14
Weight	**kg**	**lbs.**
Net	2.2	10
Shipping	3.08	14

Calibration Step Generator

The Calibration Step Generator is a very fast rise time, 250 mV step generator that verifies specifications of the SD-14, SD-20, SD-22, SD-24, and SD-26 sampling heads. It is supplied with a certificate and test report, stating the rise time of the step based on a measurement-controlled, internal Tektronix acquisition standard, to a tolerance of 2.5 ps typically. This reported rise time will not exceed 19.5 ps. The output connector is a precision 3.5 mm male that allows direct interface to the SD-Series head. The step generator is triggered directly from the Internal Clock Output on a CSA 803C/11801C Series mainframe.

SIU 800 Static Isolation Unit

The SIU 800 protects the sampling bridge from damage due to static discharge from circuit boards and cables. The SIU 800 is intended for use in applications such as TDR circuit board testing and cable testing where large static charges can be stored. When used with the SD-24 TDR/Sampling Head, the SIU 800 provides a reflected rise time of less than 40 ps and a reflection coefficient of less than 80 millirho.

The SIU 800 is installed between the DUT and sampling head and is controlled manually by a foot switch or under program control through a TTL-compatible input. When the foot switch is in the normal position (not pressed), the DUT is grounded through a 50 Ω termination resistor. This will discharge any static charge stored in the DUT.

Pressing the foot switch connects the DUT to the sampling head input, allowing a measurement to be made. Both channels are controlled simultaneously by the foot switch or TTL input.

PHYSICAL CHARACTERISTICS

Dimensions	**mm**	**in.**
Width	23.28	0.95
Height	71.05	2.9
Depth	91.39	3.8
Weight	**kg**	**lbs.**
Net	0.205	0.69
Shipping	0.441	2

ORDERING INFORMATION

For price information: Outside the U.S. contact your local Tektronix representative, inside the U.S. see the price list in the back of this catalog.

DL-11
Delay Line.
Includes: Installation/User Manual (070-7050-01), Instruction Sheet (070-7051-01), 20 in. Coaxial Cable, RF 50 Ω (174-1427-00), 60 in. Coaxial Cable, RF 50 Ω (174-1428-00).

MEASUREMENT SERVICE OPTIONS
Opt. C3 – Three years of Calibration Services.
Opt. R3 – Repair warranty extended to cover three years.
See page 615 for further information.

CALIBRATION STEP GENERATOR
U.S. – Order 067-1338-00.
Includes: Instruction Sheet, Test Report, SMA Female Short-circuit Termination.
Universal Euro – 220 V, 50 Hz – Order 067-1338-01.
United Kingdom – 240 V, 50 Hz – Order 067-1338-02.
Australia – 240 V, 50 Hz – Order 067-1338-03.
Switzerland – 240 V, 50 Hz – Order 067-1338-05.
Japan – 100 V, 50-60 Hz – Order 067-1338-06.

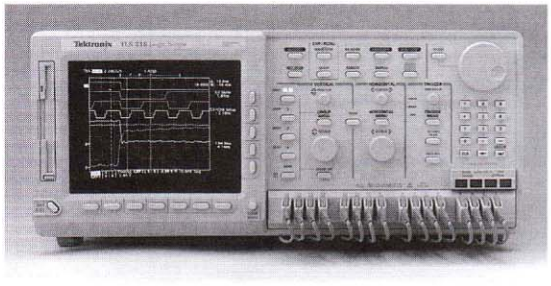
SIU 800
Static Isolation Unit.
Includes: 12 VDC Power Supply, Two SMA, Male-to-female Adapters, Foot Switch, Two 50 Ω, Terminators, and an Instruction/Performance Verification Manual.

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

NOT AVAILABLE IN EUROPE.

ISO 9001
Tektronix measurement products are manufactured in ISO registered facilities.

Logic Scope
TLS 216



For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

CE

ISO 9001

Tektronix measurement products are manufactured in ISO registered facilities.

GPIB IEEE-488

Product(s) complies with IEEE Standard 488.1-1987, RS-232-C, and with Tektronix Standard Codes and Formats.

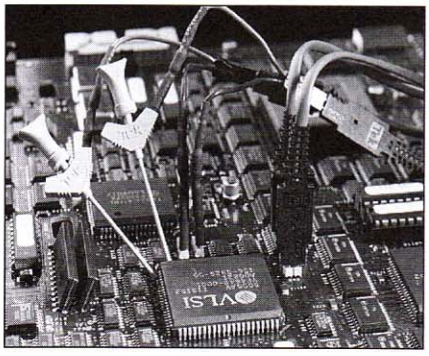
Features – Benefits	Applications
2.5 pF, 1 MΩ Podlet Style FET Probes	Hardware Performance Verification
Display Modes: Analog, Timing Diagram and BusForm™	Multi-channel Data Acquisition
<±100 ps Timing Resolution	Mixed Signal Analysis
16 Input Channels	A/D and D/A Analysis
2 GS/s Simultaneous Sampling on All Channels	Hardware Timing Analysis
500 MHz Real-time Bandwidth	
Logic Family Presets for TTL, ECL and CMOS	
Sophisticated Time Qualified Triggering with Four Word Recognizers	
3-Year Warranty	
Facilitates Hands-free Connection to SMT Devices	
Low Capacitance Probe for Non-intrusive Probing	
Powerful Triggering Reduces Time to Identify Problems	
Flexible Display Modes Simplify Recognition of Timing Faults	
High-speed Acquisitions on All Channels Facilitate Analysis of Complex System Interactions	

TLS 216 Logic Scope

The TLS 216 Logic Scope is a new class of instrument designed to simplify the task of debugging digital hardware. The Logic Scope seamlessly combines in a single instrument the analog acquisition system of a high-speed digital storage oscilloscope (DSO) with the triggering and display systems of a logic analyzer. The 500 MHz bandwidth Logic Scope samples all channels simultaneously at 2 GS/s and has sophisticated time-qualified triggering, a high resolution color display, and an integrated MS-DOS compatible 3.5 inch floppy disk drive.

Sophisticated Triggering to Identify Complex Digital Problems

In addition to edge trigger, most digital signals can be easily captured using pulse, glitch and pattern triggers. The Logic Scope provides two new trigger resources that allow the instrument to directly trigger on common digital circuit behavior. The industry's first time-interval or sequence trigger type monitors the time between two events, allowing the instrument to easily trigger on setup time violations, hold-time violations, or unexpected propagation delay. The



P6240

powerful "Time-out" trigger type can be used to capture incomplete handshake sequenc[illegible] ne instrument whe[illegible]

All o[illegible] ypes let developers identify channel-to-channel relationships, including 16-Bit patterns and time-related/time-qualified system faults. The Logic Scope's external trigger-input can be used as a "Trigger Arm" to enhance cross-triggering between two instruments, simplifying the task of using a Logic Scope with other test equipment.

2.5 pF, Low-Mass FET Probes Ensure Nonintrusive Connection

The Logic Scope includes a set of 16 specially designed probes that have extremely low probe-tip mass (1.5 grams) and input capacitance (2.5 pF). The P6240 low probe-tip mass ensures that connections made to surface mount and fine pitch ICs will be reliable. The low input capacitance, combined with the 1 MΩ input resistance, decreases the effect of the probe on the DUT's operation, allowing very accurate measurements to be made with confidence.

These characteristics are made possible by using a "podlet-style" probe-tip design instead of the "pencil-style" design of traditional oscilloscope probes. Employing the de facto industry standard of 0.1 inch spacing between the signal and ground inputs, each 0.1 inch thick podlet can directly attach to the hundreds of readily available IC adapters and clips.

Characteristics

Signal Acquisition System

Sample Rate	2 GS/s
Bandwidth	500 MHz
Channels	16
Samplers	16
Sensitivity	50 mV to 10 V/div*[1]
Position Range	±5 Div
Offset	±1 V from 1 to 99.5 mV/div

[1] Magnification used above 2 V/div range.

VERTICAL SYSTEM

DC Gain Accuracy – ±1.5% after probe calibration.
Vertical Resolution – 8-Bits (256 levels over 10.24 vertical divisions), 11-Bits with averaging.
Analog Bandwidth Selection – 20 MHz and full.
Input Coupling – DC.
Input Impedance – 50 Ω with coax adapter, 1 MΩ with probe.
Maximum Input Voltage – Max nondestructive input ±25 V (DC + Peak AC).
Dynamic Range – +15 V to –12 V with probe.

Time Base System

Time Bases	Main, Delayed
Time/Division Range	500 ps to 5 s/div
Time Base Accuracy	0.01% over any interval ≤1ms
Record Length	500 to 2,000 pts
Pre-trigger Position	20% to 80% of record

ACQUISITION MODES

Sample – Sample data only.
Envelope – Max/min values acquired over one or more acquisitions.
Average – Waveform averages selectable from 2 to 10,000.

DISPLAY

Mixed-mode Data Display – Logic Scope offers Analog, Timing and BusForm™ display formats that simplify recognition of digital timing faults and signal anomalies. BusForm display compresses many input signals into the least amount of display area. The acquired data can be displayed in any of the three display modes without re-acquiring.
Waveform Style – Dots, vectors, variable persistence selectable from 250 ms to 10 s, infinite persistence and intensified samples.
Color – Standard palettes and user definable colors for waveforms, text, graticules and cursors. Measurement text and cursor colors matched to waveform. Waveform collision areas highlighted with different color. Statistical waveform distribution shown with color grading through variable persistence.
Color Grading – With variable persistence selected, historical timing information is represented by temperature or spectral color scheme providing "z-axis" information about rapidly changing waveforms.
Graticules – Full, grid, cross hair, frame.
Format – YT.
Fit to Screen – Entire acquisition memory displayed on screen.

TRIGGERING SYSTEM

Triggers – Main, Delayed.
Main Trigger Modes – Auto, Normal, Single.
Delayed Trigger – Delayed by time and/or events.
Time Delay Range – 16 ns to 250 s (time/div ≤10 µs); 15.1 ns to 250 s (time/div ≤25 µs).
Events Delay Range – 1 to 9,999,999 events.
AUX Trigger Input – TTL compatible; Max input voltage is –1 V to +6 V.

MEASUREMENT SYSTEM

The Logic Scope provides a comprehensive suite of automatic measurements specifically designed to improve efficiency when troubleshooting digital hardware. Twenty-eight on-board measurements, including setup time, hold time and skew, speed identification of common digital problems. Whereas traditional DSOs confine waveform measurements to establishing the relationship of a single channel to a clock, the Logic Scope simultaneously samples on all channels, so you can see the relationships between multiple channels.

Automatic Waveform Measurements

Period	Frequency
High	Low
+ Width	- Width
Maximum	Minimum
Rise	Fall
Peak to Peak	Amplitude
+ Duty Cycle	- Duty Cycle
+ Overshoot	- Overshoot
Propagation Delay	Burst Width
Mean	Cycle Mean
rms	Cycle rms
Area	Cycle Area
Phase	Setup Time
Hold Time	Skew

Continuous update of up to four measurements on any combination of waveforms.

Gated – Any region of the record may be isolated for measurement using vertical bars.

Snapshot – Performs all measurements on any one waveform, showing results from one instant in time.

Cursor Measurements – Absolute, Delta; Volts, Time, Frequency, Binary Readout.

Cursor Types – Horizontal bars (volts); Vertical bars (time); operated independently or in tracking mode.

COMPUTER INTERFACE

GPIB (IEEE 488.2) Programmability – Full talk/listen modes. Control of all modes, settings, and measurements.

HARD COPY/DESKTOP PUBLISHING

Printer – HP ThinkJet, Epson, PostScript, DeskJet, LaserJet, DPU 411/412.
Export File Formats – EPS (Encapsulated PostScript), Interleaf, TIFF, PCX, BMP, RLE.
Plotter Support – HPGL.
I/O Ports – GPIB, Centronics, RS-232 (Talk only).
Floppy Disk Drive – 3.5 in., 1.44 MB DOS format.
VGA Output – 15-Pin analog output (Color).

STORAGE

Waveforms – 16 full 2,000 pt waveforms. 119,008 500 pt waveforms on 1.44 MB floppy disk.
Setups – 10 front-panel setups. 78,947 setups on 1.44 MB floppy disk.

POWER REQUIREMENTS

Line Voltage Range – 90 to 250 V rms.
Line Frequency – 47 to 63 Hz.
Power Consumption – 300 W max.

ENVIRONMENTAL AND SAFETY

Temperature – Operating: +4°C to +50°C. Nonoperating: –22°C to +60°C.
Humidity – Operating and Nonoperating: Operating to 80% at or below 29°C, to 20% from +30°C to +50°C. Nonoperating to 90% at or below 41°C, to 5% from +41°C to 50°C.

TRIGGER TYPES (MAIN AND DELAYED)

Edge	Trigger when either a rising or falling edge (positive or negative slope) is detected.
Pulse	The pulse may be positive or negative and defined by a duration.
Width (Time)	Trigger when the duration of either a positive or negative pulse is less than or greater than the user-defined input.
Range (In Range, Out of Range)	Trigger when the duration of either a positive or negative pulse is either between the upper and lower limits or outside the limits.
Time-out	Trigger at the end of a user-defined time period if the trailing edge of either a positive or negative pulse is not detected.
Pattern	Each input may be defined as a low (logic 0), high (logic 1), or don't care (X). Inputs can be ANDed or ORed. The pattern may be positive true or positive false.
Width (Time)	Trigger when the duration of a user-defined logical pattern is less than or greater than the user-defined input.
Range (In Range, Out of Range)	Trigger when the duration of a user-defined logical pattern is either between the upper and lower limits or outside the limits.
Time-out	Trigger at the end of a user-defined time period if the user-defined logical pattern of a specified duration does not occur.
Sequence	The sequence is defined by a set of start and end events. The start or end event can be either a pattern or an edge (positive or negative slope).
Width (Time)	Trigger when the duration between the user-defined start and end events is less than or greater than the user-defined input.
Range (In Range, Out of Range)	Trigger when the duration between the user-defined start and end events is either between the upper and lower limits or outside the limits.
Time-out	Trigger at the end of a user-defined time period if the user-defined end event does not occur within the specified time after the start event.
State	Trigger when a user-specified logical pattern is detected and the input defined as the clock goes true or goes false. Each input may be specified as a low (logic 0), high (logic 1), or don't care (X). Inputs can be ANDed or ORed.aa

Altitude –
Operating: 15,000 ft., Nonoperating: 40,000 ft.
Electromagnetic Compatibility – Meets 89/336/EEC.
Safety – UL1244, CSA231, EN61010-1, IEC61010-1.

PROBES

Active Probes – 2.5 pF, 1 MΩ FET.

PHYSICAL CHARACTERISTICS

Dimensions	**mm**	**in.**
Height with feet	236	9.3
without feet	193	7.6
Width with handle	445	17.5
Depth with front cover installed	432	17
Weight	**kg**	**lbs.**
Net approximately	12.3	27
Shipping approximately	20	44

ORDERING INFORMATION

For price information: Outside the U.S. contact your local Tektronix representative, inside the U.S. see the price list in the back of this catalog.

TLS 216
Logic Scope.
Includes: 16 each P6240 2.5 pF, FET Probes, 2 each Handheld Adapters (013-0281-00), 2 each 7 in. Ground Leads (196-3302-00), 2 Packages of 10 each Y-leadsets (020-2008-00), 3 Packages of 12 each KlipChip™ (020-1386-01), 2 each 2-to-1 Podlet Adapters (013-0280-00), 1 Package of 6 Probe Cable Looms (352-0139-00), 3 Cards of Channel ID Labels (334-8632-00), Instrument Front Cover (200-3696-00), U.S. Power Cord (161-0230-01), Quick Reference Guide (070-8833-00), User Manual (070-8834-00), Programmer Manual (070-8835-00).
Opt. 1B – Package of 16 50 Ω Coax Adapters.
Opt. 1K – K420 Instrument Cart Without Power Strip.
Opt. 1R – Rackmount Kit.
Opt. 1S – Substitute 16 Coax Adapters for Standard Probes.
Opt. 24 – Four Extra P6240 Probes.
Opt. D1 – Calibration Data Report.

INTERNATIONAL POWER PLUGS

Opt. A1 – Universal Euro 220 V, 50 Hz.
Opt. A2 – United Kingdom 240 V, 50 Hz.
Opt. A3 – Australian 240 V, 50 Hz.
Opt. A4 – North American 240 V, 60 Hz.
Opt. A5 – Switzerland 220 V, 50 Hz.
See page 619 for description.

MEASUREMENT SERVICE OPTIONS

Opt. IN – Product Installation Service.
Opt. C3 – Three years of Calibration Services.
Opt. S3 – Three year upgrade to "On-site" Service.

PROBES

FET Probes Only – 2.5 pF, 1 MΩ, 800 MHz, 20X, 1.5m. Order P6240.

CARTS

Instrument Cart – Order K420.

ADDITIONAL ACCESSORIES

Also see page 495.
Service Manual – Order 070-8836-00.
Soft Carrying Case – Order 016-0909-01.
Hard Transit Case – Order 016-1157-00.
U.S. Power Strip – Four Outlet, 6 ft., Noise/Surge Suppression. Order 131-5342-01.

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

Logic Analyzers

A New Family of Instruments

The TLA 700 Series is a new family of instruments developed specifically to address the fast-changing needs of today's digital design engineers. These products bring new technology to bear on the time and design pressures faced by digital system designers.

The TLA 700 Series addresses the needs of the entire digital design team. HW developers, HW/SW integrators and embedded SW developers will all find the TLA 700 provides solutions for those elusive problems that threaten their product development schedules ranging from analog signals to HLL source code.

- Source Code Support: See page 128
- Performance Analysis Support: See page 128
- Repetitive Acquisition with Memory Comparison: See page 129
- Remote Control with Support for Advanced Data Analysis: See page 129
- Processor and Bus Supports: See page 137

TLA 700 Series Logic Analyzer Modules

The TLA 700 Series includes a wide selection of logic analyzer modules with measurement capabilities not seen in logic analyzers before.

MagniVu™ Acquisition Technology: A Breakthrough for Logic Analyzers

At the heart of all the TLA 700 Series logic analyzer modules is a breakthrough called MagniVu acquisition technology. MagniVu acquisition technology is a super high-speed sampling architecture that dramatically changes the way logic analyzers work and what functionality they offer.

World-Class DSO Modules

The TLA 700 Series offers a range of DSO modules that provide the acquisition capabilities of the world's best DSOs, tightly integrated with the TLA 700 logic analyzers.

Mainframes that Establish a Platform for the Future

The TLA 700 Series mainframes offer a new paradigm for Logic Analyzers. Instead of building a proprietary compute engine into an instrument, Tektronix built-in an industry-standard computer and operating system.

Open Platform: The TLA700 Series Logic Analyzer Allows Flexibility and Interoperability of Embedded Systems Tools.

Tektronix and its Embedded Systems Tools Partners provide a wide range of development products, debug products, and services for developers. Tektronix provides logic analyzers, oscilloscopes, and other instrumentation. Partners provide processors, microprocessors, DSPs, processor development and evaluation boards, operating systems, software development tools, emulators, software debuggers, logic analyzer processor/bus supports, probe and interconnects adapters, protocol analyzers, instrument control hardware and software, and other products used in embedded systems design and debug.

Embedded Systems Tools Partners

Applied Microsystems Corp.
ARM Ltd.
CAD-UL, Inc.
CATC - Computer Access Technology Corp.
Cogent Computer Systems, Inc.
Crescent Heart Software, Inc.
EST - Embedded Support Tools Corp.
ET - Emulation Technology, Inc.
Green Hills Software, Inc.
Hitex Development Tools
Ingenieurbuero Strunck
Ironwood Electronics, Inc.
Macraigor Systems, Inc.
Mentor Graphics Corp., Microtec Division
National Instruments Corp.
New Wave PDG
Orion Instruments
TASKING, Inc.
Temic MHS
TERA Technologies, Inc.
U S Software Corp.
Wind River Systems, Inc.

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Probes 134
Carts 582

Logic Analyzers

TLA 700 Series New TLA 714 • New TLA 720



Features – Benefits

- MagniVu™ Acquisition Technology Provides 500 ps Timing Resolution on All Channels All the Time Through a Single Probe
- 200 MHz State Acquisition Supports Advanced Processors and Buses, 250 MHz Timing Acquisitions
- 400 MHz Data Rate
- Up to 16 Mbits Per Channel with Hardware – Accelerate Waveform Display and Search Functions

Applications

- Hardware Debug and Verification
- Embedded Software Integration, Debug and Verification
- Embedded Real-Time Software Optimization
- System Validation

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

CE

ISO 9001

Tektronix measurement products are manufactured in ISO registered facilities.

A New Family of Instruments

The TLA 700 Series is a new family of instruments developed specifically to address the fast-changing needs of today's digital design engineers. These products bring new technology to bear on the time and design pressures faced by digital system designers.

The TLA 700 Series addresses the needs of the entire digital design team. HW developers, HW/SW integrators and embedded SW developers will all find the TLA 700 provides solutions for those elusive problems ranging from analog signals to HLL source code that threaten their product development schedules.

The family consists of portable and benchtop mainframes, logic analyzer modules, DSO modules, and a full line of complementary support products for popular microprocessors and buses.

TLA 700 Series Logic Analyzer Modules

The TLA 700 Series includes a wide selection of logic analyzer modules with measurement capabilities not seen in logic analyzers before.

MagniVu Acquisition Technology – A Breakthrough for Logic Analyzers

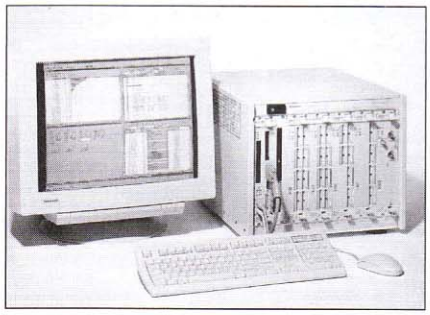
At the heart of all of the TLA 700 Series logic analyzer modules is a breakthrough called MagniVu acquisition technology. MagniVu acquisition technology is a super-high-speed sampling architecture that dramatically changes the way logic analyzers work and what functionality they offer.

All incoming data is oversampled at a 2 GHz rate, regardless of how the logic analyzer is being used. The oversampled data is then processed in real time to perform timing acquisition, state acquisition, and triggering without missing the slightest piece of crucial timing information on any channel.

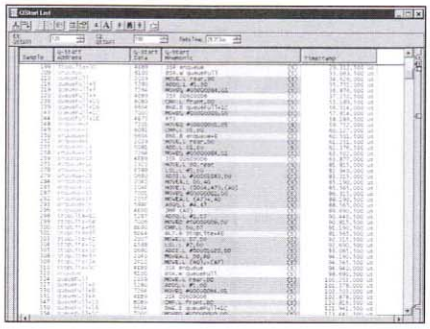
MagniVu Acquisition technology makes it possible to offer the following measurement capabilities that logic analyzer users have long needed:

500 ps Timing Resolution on All Channels. By storing timing information in MagniVu acquisition technology's high-speed memory at the full 2 GHz rate, all TLA 700 Series logic analyzers are able to offer 500 ps timing resolution on all channels, all the time.

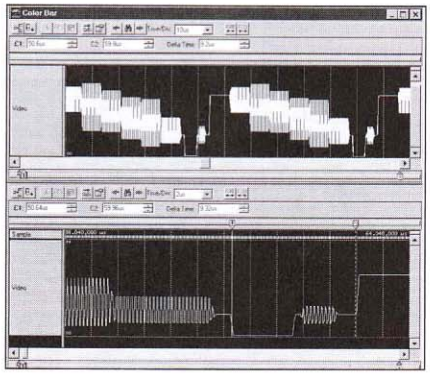
Up to 200 MHz State Acquisition. TLA 700 Series modules offer standard configurations with state acquisition up to 100 MHz for common applications and optional 200 MHz configurations for leading-edge applications.



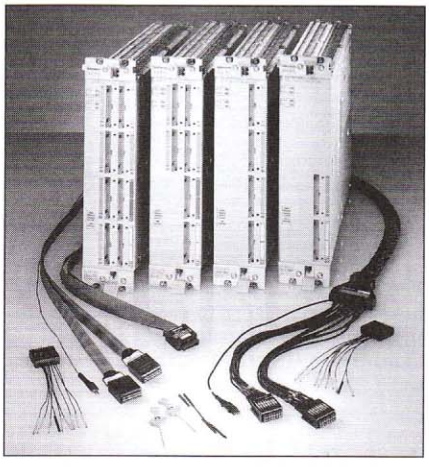
TLA 720 – Both the portable TLA 714 and the benchtop TLA 720 combine impressive performance and a modern graphical user interface to simplify debugging complex system problems and enable engineering teams to meet or exceed their development schedules.



The graphical user interface can display an almost unlimited number of data windows. In the above disassembly window, properties such as column width or text size and color can be easily changed by the user. Note the timestamp with 500 picosecond resolution.



Using the Magnitude Mode feature in the Waveform Window, you can view the value of your acquired data versus time. This is particularly useful for A/D and D/A applications, such as viewing the RGB components of a digitized video signal.



From right: The 34-CH, 68-CH, 102-CH, and 136-CH Logic Analyzer modules; available with depths up to 16 Mbits per channel with your choice of probes. A TLA 720 benchtop mainframe can hold up to five modules for a total system of 680 channels.

Since all clocks and data are oversampled at a 2 GHz rate and processed in real time to provide 200 MHz synchronous acquisition, each data sample is timestamped with 500 ps resolution.

User-selectable Setup-and-hold Window. Because TLA 700 Series logic analyzers always oversample incoming data at a 2 GHz rate, they are able to provide unmatched state acquisition capabilities as well. The combined setup-and-hold time window required across up to 136 channels is typically only 2.0 ns and can be placed anywhere from 8.5 ns before the selected clock edge to 7.0 ns after the clock edge, in 500 ps increments.

If your design involves sections of circuitry with different timing requirements or even mixed logic families, that's no problem for the TLA 700 Series; you can set different setup-and-hold time characteristics and unique threshold settings for different groups of channels.

Simultaneous State and Timing Analysis Through the Same Probes. The logic analyzer modules are able to provide both timing analysis and state acquisition simultaneously. They provide 500 ps timing AND up to 200 MHz state acquisition at the same time, through the same probes.

You no longer have to hook up a second set of probes and timing modules to a bus you're already acquiring state data from. No more running out of timing channels because you didn't have enough modules or couldn't fit them into your mainframe. No tradeoffs of channels or important features to get the results you need.

Precision Triggering on Setup-and-hold Violations and Glitches. Each logic analyzer module has the ability to trigger on very precise timing problems. Whether timing problems are suspect, or things seem to be working and you need to test for design margins, the TLA 700 Series triggering does what no other logic analyzer can.

The TLA 700 Series can trigger on setup-and-hold time violations on any or all groups of channels with 500 ps resolution. You can select different timing limits for different groups and even verify propagation delay from clock-to-output of synchronous circuits.

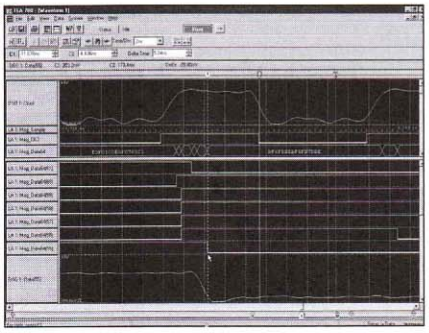
Not even glitches can escape the watchful eye of the TLA 700 Series; because the glitch detection logic is processing the same oversampled data. ANY set of two or more transitions between sample points on any channel is captured and can be used for glitch triggering.

What-You-See-Is-What-You-Triggered-On! The greatest benefit that oversampling brings to triggering is that the precise timing of whatever condition you trigger on is fully visible with MagniVu technology. This means that when you trigger on a setup-and-hold time violation on a 64-Bit data bus, you can immediately view all 64 channels to see exactly which signals caused the violation and how far those signals were beyond the limits you specified.

WORLD-CLASS DSO MODULES

The TLA 700 Series offers a range of DSO modules that provide the acquisition capabilities of the world's best DSOs, tightly integrated with the TLA 700 logic analyzers.

Tektronix wrote the book on oscilloscopes and Digital Real-Time™ (DRT) technology, which brings the bandwidth of leading analog oscilloscopes to single-shot digital applications. The 2– and 4-channel DSO modules available in the TLA 700 Series offer sample



MagniVu™ – A 64-Bit data bus and its clock signal acquired with MagniVu technology, showing that the bus takes about 3 ns to settle when the value changes. Some individual data signals are shown also, including the first and last to change. The clock signal and the slowest data signal are shown as acquired by the DSO.

rates of up to 5 GS/s and bandwidths of up to 1 GHz, with 15 K record length, on all channels at all times.

The DSO modules offer precise time correlation and flexible cross-triggering with the other installed modules. This enables you to see the quality of critical signals alongside the digital behavior they affect.

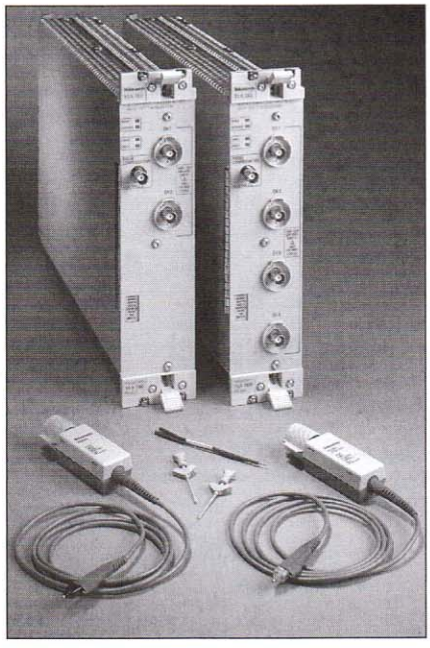
LOGIC AND TIME-DOMAIN ANALOG FAULT TRIGGERING

The DSO modules offer the kind of triggering you expect from a Tektronix DSO: Pulse Width, Runt, Glitch, Slew Rate, Logic Pattern, Setup-and-Hold Violation, Edge, and Timeout. All trigger modes can be fully time-qualified for any period from 2 ns to 1 s and are easily set up with a graphical user interface.

SOURCE CODE SUPPORT

The HLL Source Code Support post-processes real-time trace data acquired from processors and buses and automatically correlates it with your high-level language source code. It uses the information provided in the object file from your compiler to build a database of source files, line numbers and symbolic information.

Every time you acquire real-time data with your logic analyzer, you can view the acquired data disassembled in the Listing Window, which shows how your code was executed in native



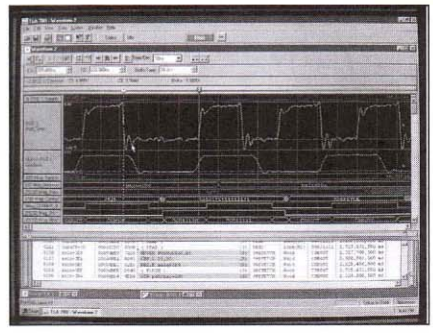
TLA7E1 and TLA7E2
From left: The 2-channel and 4-channel DSO modules, shown with P6245 FET probes, are available with either 500 MHz or 1 GHz real-time bandwidth.

assembly language, or at the source code level in the Source Window, which shows your code as written in the high level language you use. You can 'step' forward or backward through your source code and view the underlying assembly code or vice versa, using the global cursors. All lines in the Listing Window are highlighted that correspond to a particular line of source code in the Source Window, rather than using just the cursor as the indicator. Multi-processor and bus systems are supported via multiple Source and Listing Windows, all automatically time-correlated.

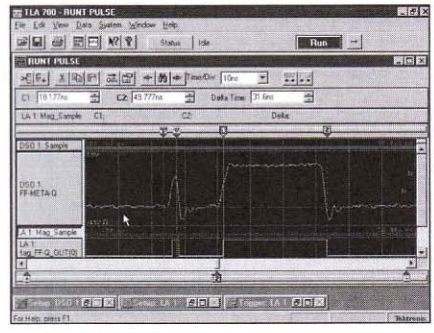
The HLL Source Code Support is a non-intrusive tool that does not require you to instrument your source code. It is a universal tool that supports any high-level language whose software tools produce supported object file formats. No modifications or recompilation of your source code is required.

PERFORMANCE ANALYSIS SUPPORT

The Performance Analysis Support generates statistical representations by postprocessing real-time data acquired



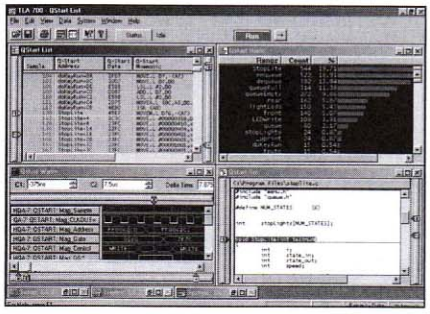
Data acquired by all instrument modules is precisely time correlated. You can now easily see when signal quality causes timing faults.



The 2-channel and 4-channel DSO modules have the performance to accurately capture signal quality and small glitches. A maximum of 20 1 GHz DSO channels is possible using the TLA 720 mainframe.

from processors and buses connected to the logic analyzer module and displaying the results in a histogram format. You can view the results acquired by three different methods:

- Group: Select a channel Group such as Address, setup your ranges either manually or automatically by loading symbols from your object module and press Run to monitor the number of hits against each range.
- Counter: Select a Counter, setup the count intervals either linearly or logarithmically and press Run to monitor the varying number of counts over multiple acquisition.
- Timer: Select a timer, setup the time intervals either linearly or logarithmically and press Run to monitor the varying time (with 4 ns resolution) over multiple acquisitions.



View processor trace data tightly time-correlated with your high-level source code using the information provided in the object file from your software development environment. Tektronix disassemblers automatically filter out unexecuted code fetches.

The Performance Analysis Support is a non-intrusive tool that does not require you to instrument your source code. No modifications or recompilation of your source code is required.

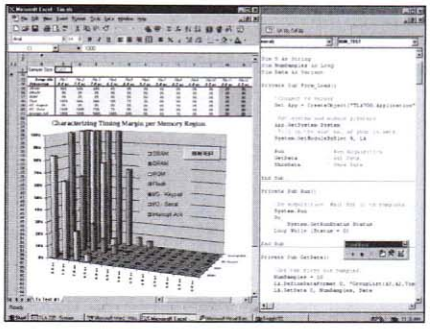
You can sort the display in either ascending or descending order. You can also export the results for further analysis.

The Performance Analysis Support utilizes the same symbols in the TLA 700's symbolic database.

REPETITIVE ACQUISITION WITH MEMORY COMPARISON

Repetitive Acquisition allows the TLA 700 to repeatedly acquire data from your target system and perform a variety of operations depending upon the comparison results. At each iteration, you can either save the results and restart or stop and send a command to the Windows 98 operating system that could send email or page you. Then, you can save the results, concatenate to a single file or specify that each new file has the filename autoincremented.

Repetitive Acquisition with Memory Comparison compares the results of two independent LA acquisitions and highlights the differences in either Listing or Waveform Windows. You can specify the range of samples over which to make the comparison or specify the offset between the two acquisition memories. You can also mask or prevent channels from being compared.



Extensive remote control command set based upon Microsoft COM/DCOM technology interfaces seamlessly with advanced Windows applications such as Excel or Visual Basic to provide advanced data analysis. Quickly develop powerful data analysis capabilities using the TLA 700 as a high-performance data acquisition device, either directly on the TLA 700 or over the network on a remote computer.

Now you can setup your TLA 700 to continuously monitor your target system, thereby freeing you up for other tasks and notifying you only when there's an anomaly.

REMOTE CONTROL WITH SUPPORT FOR ADVANCED DATA ANALYSIS

Although remote control has been a standard feature in logic analyzers, the TLA 700, being based upon an open, embedded PC running Microsoft Windows 98, provides a new capability that is a first for logic analyzers. Using the Microsoft Windows Component Object Model (COM/DCOM) technology, the TLA 700 Programmatic Interface (TPI) provides the next-generation technology for LA remote control. The TPI provides a modern 'function call' interface that is compatible with COM/DCOM programmatic interfaces of other Windows applications.

Support for non-Windows platforms (e.g., UNIX) is available via Distributed COM (DCOM) from 3rd parties.

Now with the TPI, you can spend less time trying to build advanced data analysis from scratch and instead use existing Windows applications such as Microsoft Excel or Microsoft Visual Basic or C++ to build an advanced data analysis application that seamlessly integrates with the TLA 700. You can then run your application directly on the TLA 700 or from a computer connected over a LAN connected to your TLA 700.

MAINFRAMES THAT ESTABLISH A PLATFORM FOR THE FUTURE

The TLA 700 Series mainframes offer a new paradigm for test instrumentation. Instead of building a proprietary compute engine into an instrument, Tektronix uses an industry-standard computer and operating system. You can install industry leading software debuggers and run control on the TLA 700 series to download and run code on your target.

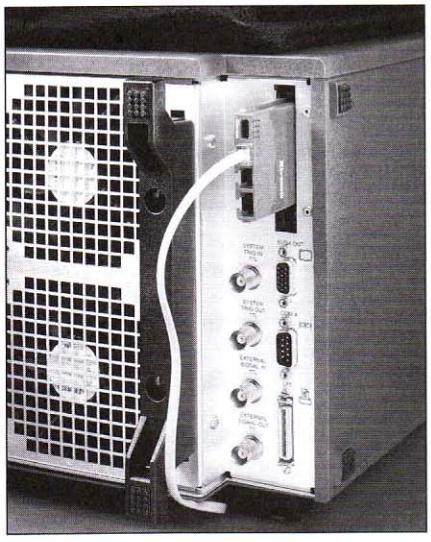
Both the portable TLA 714 and the benchtop TLA 720 use Microsoft Windows 98. That means that you don't have to spend time learning how to navigate the user-interface because it works just like other PC-based software you've used. Because Windows 98 is fully integrated and embedded when you open the box, you get the benefit of a familiar environment without having to set things up yourself. This allows you to concentrate on the problem you're solving rather than the tool you're using.

You also don't have to worry about how to integrate the TLA 700 into your test environment. Any accessories you can buy that connect a portable PC into your environment can be used directly on TLA 700 Series mainframes. Standard USB, PS2 mouse & keyboard, serial, parallel, SVGA, and PC Card, (Card Bus 32) interfaces are used for external accessories. The TLA 700 Series comes standard with a 3.5 in. floppy, CD-ROM and removeable hard drive.

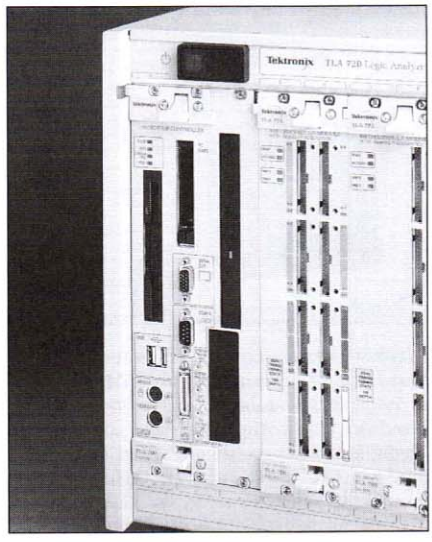
THE TPI SUPPORTS THE FOLLOWING REMOTE OPERATIONS:

System:	Configuration, Load/Save, Run Control, Status & Errors
LA Module:	Load/Save, Trigger Setup, Acquisition Data & Parameters
DSO Module:	Load/Save, Acquisition Data & Parameters

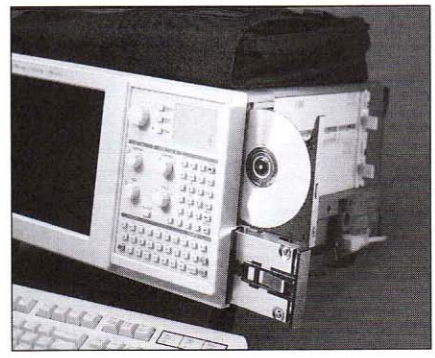
All modules, software, and accessories are fully interchangeable between portable and benchtop mainframes.



The TLA 714 includes PC card slots with Card Bus 32 support (two (2) Type II or one (1) Type III) and standard PC I/O – SVGA, parallel printer, and RS-232. Optional LAN card shown installed.



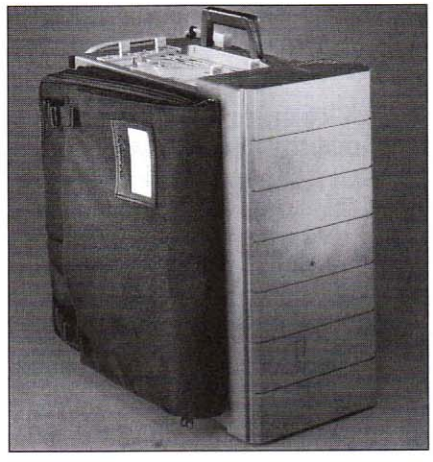
The TLA 720 includes PC card slots with Card Bus 32 support (two (2) Type II or one (1) Type III) and standard PC I/O – SVGA, parallel printer, and RS-232.



Both the TLA 714 (shown) and the TLA 720 have CD-ROM and replaceable hard drives.



TLA 714 with replaceable hard drive.



TLA 714 – The portable TLA 714 includes a standard protective hard cover, accessory pouch, and integral carrying handle.

CHARACTERISTICS

LA MODULE

GENERAL

Number of Channels per Module (all channels are acquired including clocks) –
TLA 7N1: 34 channels (2 are clock/qual channels).
TLA 7N2, TLA 7P2: 68 channels (4 are clock/qual channels).
TLA 7N3: 102 channels (4 are clock/qual and 2 are qual channels).
TLA 7N4, TLA 7P4: 136 channels (4 are clock/qual and 4 are qual channels).
Channel Grouping – No limit to number of groups or number of channels per group (all channels can be reused in multiple groups).

Module "Merging" – Three 102-CH or 136-CH modules can be "merged" to make up to a 408 CH module. Merged modules exhibit the same depth as the lesser of the three individual modules. Word/range/setup-and-hold/glitch/transition recognizers span all three modules. Only one set of clock connections is required.

Time Stamp – 50-Bits at 500 ps resolution (6.5 day range).

Clocking/Acquisition Modes- State, timing, simultaneous.

Number of Mainframe Slots Required – 2.

INPUT CHARACTERISTICS (WITH P6417, P6418 OR P6434 PROBES)

Capacitive Loading –
1.4 pf typical (P6418).
2 pf typical (P6417 & P6434).

Threshold Selection Range – From +5.0 V to –2.0 V in 50 mV increments.

Threshold Selection Channel Granularity – Separate selection for clock (1) and data (16) for each 17-CH probe connector.

Threshold Accuracy (including probe) – ±100 mV.

Input Voltage Range –
Operating: 8 V_{p-p} centered around the programmed threshold.
Non-destructive: ±15 V.

Input Signal Swing (probe overdrive) –
±250 mV or ±25% of signal swing, whichever is greater. (P6417 & P6418)
±300 mV or ± 25% of signal swing (P6434).

Input Signal Minimum Slew Rate –
200 mV/ns typical.

STATE ACQUISITION CHARACTERISTICS (WITH P6417, P6418 OR P6434 PROBES)

Maximum Synchronous Clock Rate –
100 MHz standard, 200 MHz optional.

Maximum Data Rate (Half Channels) –
400 MHz, typical. Requires 200 MHz option.

State Memory Depth – 64 K, 256 K, 1 M, 4 M or 16 M bits per channel.

Setup Time Selection Range – From 8.5 ns before to 7.0 ns after clock edge.

Setup-and-hold Window – 2.0 ns typical.

Minimum Clock Pulse Width – 2 ns.

Active Clock Edge Separation – 5 ns.

Demux Channel Selection – 32 channels can be demultiplexed to other channels by user.

TIMING ACQUISITION CHARACTERISTICS (WITH P6417, P6418 OR P6434 PROBES)

Main Timing Resolution – 4 ns to 50 ms.
Main Timing Resolution with Glitch Storage Enabled – 10 ns to 50 ms.
Main Timing Memory Depth (with or without transitional storage enabled) – 64 K, 256 K, 1 M, 4 M or 16 M per channel.
Main Timing Memory Depth with Glitch Storage Enabled – Half of default main memory depth.
MagniVu™ – 500 ps.
MagniVu Timing Memory Depth – 2 Kbits (2048) per channel.
Channel-to-channel Skew – ≤1 ns typical.
Minimum Recognizable Pulse Width (single channel) – 2 ns.
Minimum Recognizable Glitch Width (single channel) – 2 ns.
Minimum Recognizable Multi-channel Trigger Event – Sample period + 2 ns.

TRIGGER CHARACTERISTICS

Independent Trigger States – 16.
Maximum Independent If/then Clauses per State – 16.
Maximum Number of Events per If/then Clause – 8.
Maximum Number of Actions per If/then Clause – 8.
Maximum Number of Trigger Events – 18 counter/timers plus any 16 other resources.
Number of Word Recognizers – 16.
Number of Range Recognizers – 4.
Number of Counter/Timers – 2.
Trigger Event Types – Word, group, channel, transition, range, anything, counter value, timer value, signal, glitch, setup-and-hold violation.
Trigger Action Types – Trigger module, trigger all, store, don't store, start store, stop store, increment counter, reset counter, start timer, stop timer, reset timer, goto state, set/clear signal, do nothing.
Trigger Sequence Rate – DC to 250 MHz (4 ns).
Counter/Timer Range – 51-Bits each (>100 days @ 4 ns).
Counter Rate – DC to 250 MHz (4 ns).
Timer Clock Rate – 250 MHz (4ns).
Counter/Timer Latency – None (can be tested or reset immediately after starting).
Range Recognizers – Double bounded (can be as wide as any group, must be grouped according to specified order of significance).
Setup-and-hold Violation Recognizer Setup Time Range – From 8 ns before to 7 ns after clock edge in 0.5 ns increments.
Setup-and-hold Violation Recognizer Hold Time Range – From 7 ns before to 8 ns after clock edge in 0.5 ns increments.
Trigger Position – Any data sample.
MagniVu™ Trigger Position – MagniVu data is centered around the module trigger.
Storage Control (data qualification) – Global (conditional), by state (start/stop), by trigger action, or transitional.
Storage Window Granularity – Single sample or block-of-31 samples before and after.

PHYSICAL CHARACTERISTICS

Dimensions	mm	in.
Height	262	10.3
Width	61	2.4
Depth	381	15
Weight	**kg**	**lb.**
Net	3.1	6.7
Shipping	6.3	13.7

P6417 Probe Cable Length – 1.8 m (6 ft.).
P6418 Probe Cable Length – 1.8 m (6 ft.).
P6434 Probe Cable Length – 1.5 m (5 ft.).

DSO MODULES

GENERAL

Number of Channels per Module –
TLA 7D2, TLA 7E2: 4 channels.
TLA 7D1, TLA 7E1: 2 channels.
Sample Rate –
TLA 7E1, TLA 7E2: 5 GS/s on all channels.
TLA 7D1, TLA 7D2: 2.5 GS/s on all channels.
Bandwidth (at probe tips) –
TLA 7E1, TLA 7E2:
100 mV to 10 V range: 1 GHz. 50 mV to 99.8 mV range: 900 MHz. 20 mV to 49.8 mV range: 600 MHz.
All others:
500 MHz. TLA 7D1, TLA 7D2: 500 MHz on all channels in all ranges.
Memory Depth –
15,000 samples per channel in all modes.
Number of Mainframe Slots Required – 2.

VERTICAL SYSTEM

Input Sensitivity Range – 10 mV to 100 V full scale.
Vertical Resolution – 8-Bits (256 levels).
DC Gain Accuracy – ±1.5% of full scale range.
Analog Bandwidth Selections – 20 MHz, 250 MHz, and Full.
Input Coupling – AC, DC, or GND.
Input Impedance Selections – 1 MΩ in parallel with 10 pf, or 50 Ω.
AC Coupled Lower Frequency Limit – ≤10 Hz when AC 1 MΩ coupled, ≤200 kHz when AC 50 Ω coupled.
Maximum Input Voltage at Probe Connector – 300 VRMS, but no greater than ±420 V peak (1 MΩ or ground input coupling).

PROBE INPUT CHARACTERISTICS

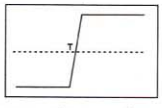
Probe Input Interface – TEKPROBE® probe interface.
Input Loading – Less than 1 pf in parallel with 1 MΩ with either P6243 or P6245.
Usable Input Voltage Range at Probe Tip -
P6243 Probe: ±8 V.
P6245 Probe: ±18 V.

ACQUISITION SYSTEM

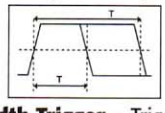
Sample Rate Range – 200 ps to 200 ms in 1, 2.5, 5 sequence.
Timebase Accuracy – ±100 ppm over any interval ≥1ms.
Record Length Range – 512 to 15,000 samples per channel in all modes.
Acquisition Modes – Single-shot, repetitive.

TRIGGER SYSTEM

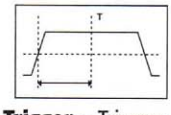
Trigger Modes – Normal, auto.
Trigger Position – Anywhere in the acquired record (pre-fill can be set anywhere from 0% to 100%).
Trigger Types – Edge, pulse width, timeout, glitch, runt, slew rate, logic pattern, setup-and-hold violation.
Trigger Actions – Trigger, trigger all, set signal, arm, immediate, wait for system trigger.



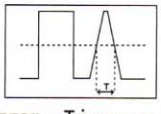
Edge Trigger – Conventional level driven trigger, positive or negative slope, on any channel or external trigger input. Coupling Selections: DC, AC, noise reject, HF reject, LF reject.



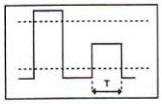
Pulse Width Trigger – Trigger on width of positive or negative pulse, either within or not within selectable time limits; settable from 2 ns to 1 s.



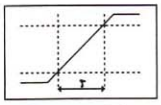
Timeout Trigger – Triggers when a pulse fails to complete when specified; settable from 2 ns to 1 s.



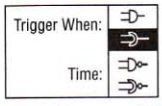
Glitch Trigger – Trigger on (or reject) glitches of positive, negative, or either polarity; settable from 2 ns to 1 s. Minimum glitch width: 2.0 ns, with 200 ps resolution (2 ns to 10 ns settings).



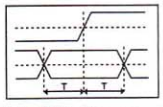
Runt Pulse Trigger – Trigger on a pulse that crosses one threshold but fails to cross a second threshold before crossing the first again; settable from 2 ns to 1 s.



Slew Rate Trigger – Trigger on pulse edge rates that are either faster or slower than a set rate, edges can be rising, falling, or either; settable from 2 ns to 1 s.



Logic Pattern Trigger – Triggers when a logical combination (AND, OR) of all the input channels (Hi, Lo, Don't Care) stays true or false for a specified period of time; settable from 2 ns to 1 s.



Setup-and-hold Trigger – Trigger on violations of both setup time and hold time between clock and data which are on separate input channels; setup time settable from –100 ns to +100 ns in 200 ps increments; hold time settable from –1 ns to +102 ns; minimum settable window of setup time + hold time is 2 ns.

PHYSICAL CHARACTERISTICS

Dimensions	mm	in.
Height	262	10.3
Width	61	2.4
Depth	381	15
Weight	**kg**	**lb.**
Net	2.7	5.8
Shipping	5.8	12.8

Safety - UL3111-1, CSA1010.1, EN61010-1, IEC61010-1.

P6243 Probe Cable Length – 1.3 m (51 in.).

P6245 Probe Cable Length – 1.3 m (51 in.).

Other Compatible Probes – P6139A, P6204, P5100, P6205, P6408, P6563A, P6701B, P6703B, AM 503S, TCP202, P6247, P6248, P6249.

MAINFRAME

PC CHARACTERISTICS (TLA 714 AND TLA 720)

Operating System – Windows 98.

Processor – 266 MHz Pentium.

DRAM –
64 MB SDRAM (128 MB with Opt.1S) [TLA 714].
128 MB SDRAM [TLA 720].

Second-Level Cache – 512 KB pipeline burst cache with writeback.

Display Memory – 2 MB.

Sound – Built-in PC speaker transducer; multimedia sound can be added via PC Card interface.

Replaceable Hard Disk Drive – 2.1 GB (6.4 GB with Opt.1S) [TLA 714]. 6.4 GB [TLA 720]. A second internal fixed hard disk available with TLA7UP Opt. 04.

CD Rom – 24x, Internal.

Floppy Disk Drive – Built-in 3.5 in. 1.44 MB drive.

Year 2000 Compliant – Yes.

INTEGRAL CONTROLS (TLA 714 ONLY)

Front-Panel Display – Size: 10.4 in. diagonal.
Type: Active-matrix color TFT LCD with backlight.
Resolution: 800 x 600.
Colors: 16.8 M (true color).

Simultaneous Display Capability – Both the front-panel and external displays can be used simultaneously at 800 x 600 resolution.

Front-panel Knobs – Special function knobs for instrument control.

Front-panel Qwerty Keypad – Mini-QWERTY keypad and Hex keypad.

Front-panel Pointing Device – Glidepoint finger pad.

EXTERNAL PERIPHERAL INTERFACES (TLA 714 AND TLA 720)

External Display Port Type – 15-Pin sub-D SVGA connector.

External Display Resolution – Up to 1600 x 1200 NI @ 256 colors.

External Display Compatibility – DDC2B (Dynamic Display Configuration 2).

External Keyboard Port Type – PS2 mini-DIN.

External Mouse Port Type – PS2 mini-DIN.

Parallel Interface Port Type – IEEE 1284-C connector (comes standard with adapter to female DB25 connector).

Parallel Interface Modes – Centronics mode, EPP (Extended Parallel Port), ECP (Microsoft high-speed mode).

Serial Interface Port Type – Male DB9.

PC Card (Card Bus 32) Slot Types – Two slots, two PC Card Type I/II or one PC Card Type III.

USB Port – Two (2).

EXTERNAL INSTRUMENTATION INTERFACES (TLA 714 AND TLA 720)

System Trigger Output – Asserted whenever a system trigger occurs (TTL-compatible output, back-terminated into 50 Ω).

System Trigger Input – Forces a system trigger (triggers all modules) when asserted (TTL-compatible, edge-sensitive, falling-edge latched).

External Signal Output – Can be used to drive external circuitry from a module's trigger mechanism (TTL-compatible output, back-terminated into 50 Ω).

External Signal Input – Can be used to provide an external signal to arm or trigger any or all modules (TTL-compatible, level-sensitive).

Instrument Slots –
TLA 714: Holds 4 single-wide or 2 double-wide modules.
TLA 720: Holds 10 single-wide or 5 double-wide modules.

SYMBOLIC SUPPORT

Number of Symbols/Ranges – Unlimited (limited only by amount of virtual memory available on TLA 700).

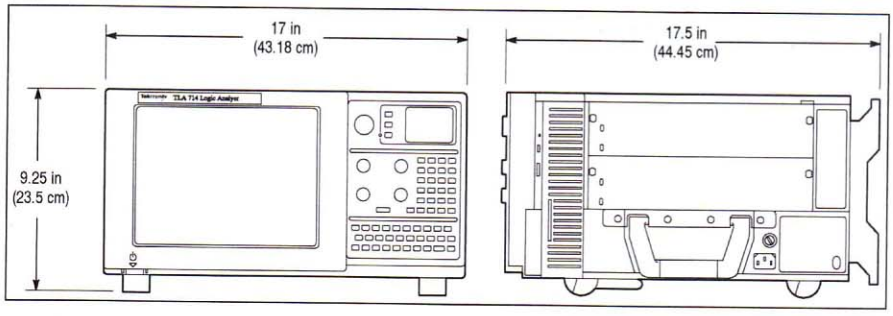
Object File Formats Supported –

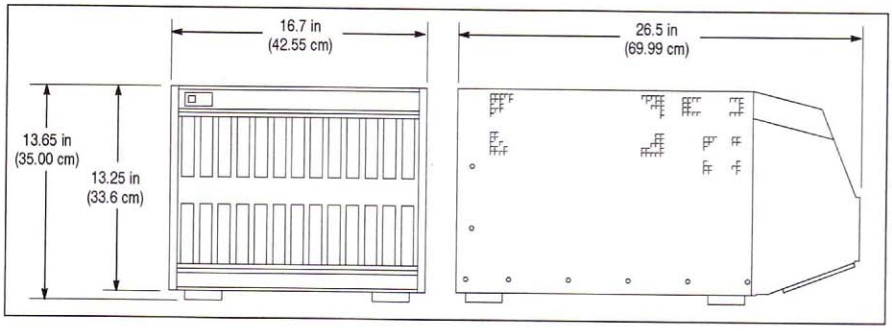
- IEEE695
- OMF 51, OMF 86, OMF 286, OMF 386
- COFF
- Elf/Dwarf
- Elf/Stabs
- TSF (if your software development tools do not generate output in one of the above formats, TSF or the Tektronix symbol file, a generic ASCII file format is supported. The generic ASCII file format is documented in the TLA 700 User Manual). If a format is not listed, please contact your local Tektronix representative.

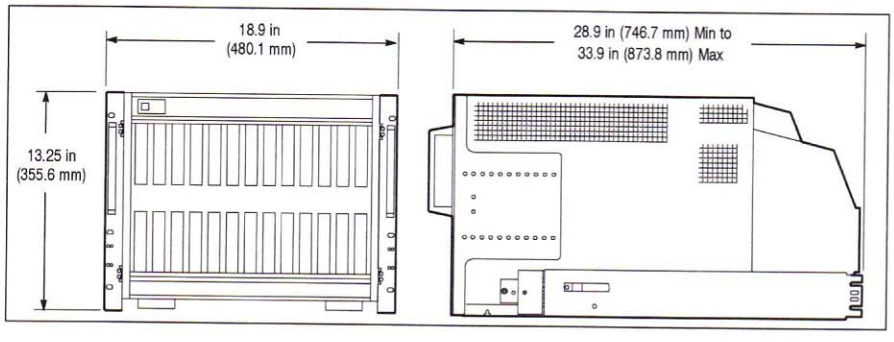
POWER

TLA 714 –
Voltage range/frequency: 90-250 VACRMS @ 45-66 Hz and 100-132 VACRMS @ 360-440 Hz.
Input current: 6 A maximum at 90 VAC (70 A surge).
Power consumption: 600 W maximum.

TLA 720 –
Input voltage: 90-250 VACRMS @ 45-66 Hz, 100-132 VACRMS @ 360-440 Hz.
Input current: 15 A maximum at 90 VAC (70 A surge).
Power consumption: 1350 W maximum.







PHYSICAL CHARACTERISTICS

TLA 714 Portable

Dimensions	mm	in.
Height	235	9.25
Width	432	17.0
Depth	455	17.5
Weight	**kg**	**lb.**
Net (w/o modules)	11.4	25
Shipping (typical)	25.5	56

TLA 720 Benchtop

Dimensions	mm	in.
Height	362	14.25
Width	426	16.75
Depth	673	26.5
Weight	**kg**	**lb.**
Net (w/o modules)	22.7	50
Shipping (typical)	51.8	114

P6041 External Signal Cable Length – 1.1 m (42 in.).

ENVIRONMENTAL

Temperature –
Operating: +5°C to +50°C.
Non-operating: –20°C to +60°C.

Humidity –
20% to 80%.
Operating: ≤30°C; 80% relative humidity (29°C maximum wet bulb temperature).
Non-operating: 8% to 80% (29°C maximum wet bulb temperature).

Altitude –
Operating: –1,000 ft to 10,000 ft.

Safety – UL3111-1, CSA1010.1, EN61010-1, IEC61010-1.

ORDERING INFORMATION

For price information: Outside the U.S. contact your local Tektronix representative, inside the U.S. see the price list in the back of this catalog.

TLA 714
Portable Color Mainframe.
Includes: Mouse, Keyboard, Front-panel Cover, Accessory Pouch, Panel Fillers for Empty Slots, Printer Adapter, Software, Manuals, Certificate of Traceable Calibration, and One-year Warranty (return to Tektronix).

TLA 720
Benchtop Color Mainframe.
Includes: Mouse, Keyboard, Panel Fillers for Empty Slots, Printer Adapter, P6041 External Signal Cables (2); Software, Manuals, max DRAM/max replaceable HD, Certificate of Traceable Calibration, and One-year Warranty (return to Tektronix). Display is not included – order Opt. 1M or Opt. 2M or use any SVGA monitor.

TLA 714/720 OPTIONS
Opt. 1S – 128 MB DRAM/max replaceable HDD (TLA 714 only).
Opt. 1A – Add LAN PC Card (119-6072-00).
Opt. 1M – Add 17-in. monitor (119-5430-00).
Opt. 2M – Add 21-in. monitor (119-5422-00).
Opt. 1K – Add LA Cart logic analyzer cart.

INTERNATIONAL POWER PLUGS
Opt. A1 – Universal Euro 220 V; 50 Hz.
Opt. A2 – UK 240 V; 50 Hz.
Opt. A3 – Australian 240 V; 50 Hz.
Opt. A4 – North American 240 V; 60 Hz.
Opt. A5 – Switzerland 220 V; 50 Hz.
See page 619 for description.

TLA 714 /TLA 720 SERVICE OPTIONS
Opt. D1 – Add calibration test data report.
Opt. IN – Product installation service (on-site configuration and user familiarization; excluding network integration).
Opt. C3 – Three years of calibration service (includes initial calibration and two annual calibrations).
Opt. D3 – Provides test data for each calibration (must be ordered with Opt. C3).
Opt. R3 – Extends depot repair warranty service period to three years.
Opt. S1 – Uplifts standard one-year warranty service of mainframe and installed modules to on-site service.
Opt. S3 – Uplifts Opt. C3 and/or R3 of mainframe and installed modules to on-site service (must be ordered with Opt. C3 and/or R3).

TLA 704/714 / TLA 711/720 OPTIONAL ACCESSORIES
Logic Analyzer Cart – LA Cart.
TLA 711 Rackmount Kit – Order 020-2197-00.
TLA 720 Rackmount Kit – Order 020-2221-00.

ORDERING INFORMATION (CONTINUED)

For price information: Outside the U.S. contact your local Tektronix representative, inside the U.S. see the price list in the back of this catalog.

TLA 704/714 Wheeled Transport Case – Order 016-1522-00.

TLA 711/720 Wheeled Transport Case – Order 016-1651-00.

17 in. Monitor Transport Case – Order 016-1653-00.

21 in. Monitor Transport Case – Order 016-1652-00.

15 in. Color TFT LCD Monitor (1024 x 768) – Order 119-5971-00.

83 Key Notebook Keyboard, PS/2 Compatible – Order 118-9402-00.

TLA 7QS – TLA 700 Series Training Package. (TLA 700 configuration required: 102 Ch LA Module plus 2 Ch DSO Module plus V 3.0 Application S/W).

Opt. A1 – Universal Euro.

Opt. A2 – United Kingdom.

Opt. A6 – Japan.

TLA 7QS Technical Reference Support Kit – Order 020-2211-02.

TLA 700 SERIES SERVICE DOCUMENTS AND TEST FIXTURES

TLA 704 Service Manual – Order 070-9777-00.

TLA 714 Service Manual – Order 070-0267-00.

TLA 711 Chassis Service Manual – Order 070-9773-00.

TLA 720 Chassis Service Manual – Order 071-0268-00.

TLA 711 Controller Service Manual – Order 070-9778-00.

TLA 720 Controller Service Manual – Order 071-0269-00.

TLA 700 Series Performance Verification and Adjustment Technical Reference Manual – Requires Logic Analyzer Module Adjustment Fixture Order 070-9776-00.

TLA 7Lx/7Mx/7Nx/7Px Logic Analyzer Module Adjustment Fixture (includes AC adapter; requires local power cord) – Order 671-3599-00.

TLA 7Lx/7Mx Logic Analyzer Modules Service Manual – Order 070-9779-00.

TLA 7Nx/7Px Logic Analyzer Modules Service Manual – Order 071-0266-00.

TLA 7Dx/7Ex DSO Modules Service Manual – Order 070-9780-00.

TLA 700 SERIES MAINFRAME FIELD UPGRADE KIT

TLA7UP – See table above for ordering information. Kit is customer installable.

Opt. 01 – TLA 704/711 Support for TLA7Nx/Px (consists of opt's 02, 04, 05, 06, 07, 08 in one package).

Opt. 02 – TLA 704/711 128 MB DRAM. (2 64 MB SIMMs)

Opt. 03 – TLA 714 128 MB DRAM. (2 64 MB SODIMMs)

Opt. 04 – TLA 704/711 TLA 714/720 MAX Hard Disk.

Opt. 05 – TLA 704 Cooling Shutter Upgrade Kit.

Opt. 06 – TLA 700 Series Applications SW.

Opt. 07 – Windows 98 OS.

Opt. 08 – TLA 704/711 External PCMCIA CD-ROM Drive.

Opt. IN – On-Site Installation Service.

Customer Wants To:	Customer's Current Mainframe Configuration	Customer Should Order
TLA704 Portable and TLA711 Benchtop Mainframe Upgrades		
Use a TLA7Nx/Px LA Module in a TLA704/711 mainframe	TLA704/711 Std. or Opt. 1S with V1.0/1.1/2.0 SW	TLA7UP Opt. 01
Upgrade the TLA704/711 mainframe to use V3.0 application SW	TLA704/711 Std. or Opt. 1S with V1.0/1.1/2.0 SW	Maximum Performance For the customer who wants the latest upgrade for maximum peformance from their TLA 700 and/or may install a TLA7Nx/Px LA module at a later date. TLA7UP Opt. 01
		Maximum Value For the customer who only wants V3.0 application SW, is satisfied with current performance of their TLA 700 and has no plans to install a TLA7Nx/Px LA module at a later date.TLA7UP Opt. 06 CD-ROM media which requires Windows 98 upgrade [TLA7UP Opt. 07] & CD-ROM drive [TLA7UP Opt. 08]
Increase DRAM to 128MB in TLA704/711 mainframe	TLA704/711 Std. or Opt. 1S	TLA7UP Opt. 02
Increase size of fixed HDD in TLA704/711 mainframe	TLA704/711 Std.	TLA7UP Opt. 04
TLA714 Portable and TLA720 Benchtop Mainframe Upgrades		
Increase DRAM to 128MB in TLA714 mainframe	TLA714 Std.	TLA7UP Opt. 03
Increase size of replaceable HDD to MAX in TLA714 mainframe	TLA714 Std.	TLA7UP Opt. 04
Add additional replaceable HDDs for TLA714/720 mainframe	TLA714 Std. or Opt. 1S TLA720 Std.	TLA7UP Opt. 04
Reconfigure replaceable HDD for data storage only (requires user to install replaceable HDD as an internal, fixed HDD) in TLA714/720 mainframe	TLA714 Std. or Opt. 1S TLA720 Std.	TLA7UP Opt. 04

LOGIC ANALYZER "N & P" MODULE PROBE OPTIONS

Quantity of probes per option

		TLA7N1	TLA7N2	TLA7N3	TLA7N4	TLA7P2	TLA7P4
1P	Add P6418 Probes	2	4	6	8	4	8
2P	Add P6434 Probes	1	2	3	4	2	4
3P	Add P6417 Probes	2	4	6	8	4	8

Opt. IF – Tektronix Installation Service.

LOGIC ANALYZER MODULES

Includes: Probe retainer bracket, probe manual, Installation Manual, Certificate of Traceable Calibration, One-year Warranty (return to Tektronix), and your choice of probes.

TLA 7N1 – 34-CH Logic Analyzer module, 2 GHz timing, 100 MHz state, 64 K depth (must select one probe option below). Can PowerFlex up to 4 M depth and/or 200 MHz state.

TLA 7N2 – 68-CH Logic Analyzer module, 2 GHz timing, 100 MHz state, 64 K depth (must select one probe option below). Can PowerFlex up to 4 M depth and/or 200 MHz state.

TLA 7N3 – 102-CH Logic Analyzer module, 2 GHz timing, 100 MHz state, 64 K depth (must select one probe option below). Can PowerFlex up to 4 M depth and/or 200 MHz state.

TLA 7N4 – 136-CH Logic Analyzer module, 2 GHz timing, 100 MHz state, 64 K depth (must select one probe option below). Can PowerFlex up to 4 M depth and/or 200 MHz state.

TLA 7P2 – 68-CH Logic Analyzer module, 2 GHz timing, 100 MHz state, 16 M depth (must select one probe option below). PowerFlex to 200 MHz state.

TLA 7P4 – 136-CH Logic Analyzer module, 2 GHz timing, 100 MHz state, 16 M depth (must select one probe option below). PowerFlex to 200 MHz state.

ORDERING INFORMATION (CONTINUED)

For price information: Outside the U.S. contact your local Tektronix representative, inside the U.S. see the price list in the back of this catalog.

Opt. 1P – Add P6418 probes (each includes two 8-CH leadsets, one 1-CH leadset, 20 SMT KlipChip™ Grabber tips).

Opt. 2P – Add P6434 probe(s).

Opt. 3P – Add P6417 probes (each includes two 8-CH leadsets, one 1-CH leadset, 20 SMT KlipChip™ Grabber tips).

LOGIC ANALYZER "N" MODULE OPTIONS

(Base configuration is 64 K @ 100 MHz)

1S – Increase memory to 256 K.

2S – Increase memory to 1 M.

3S – Increase memory to 4 M.

4S – Increase speed to 200 MHz state.

5S – Increase memory and speed to 256 K – 200 MHz state.

6S – Increase memory and speed to 1 M – 200 MHz state.

7S – Increase memory and speed to 4 M – 200 MHz state.

LOGIC ANALYZER "P" MODULE OPTIONS

(Base configuration is 100 MHz)

1S – Increase speed to 200 MHz state.

TLA 700 SERIES MODULE MEMORY/STATE SPEED FIELD UPGRADE KITS

For details and pricing on upgrading the speed or memory depth of your current TLA7Lx/7Mx/7Nx/7Px series modules please contanct your local Tektronix Account Manager.

For TLA 7Lx/7Mx LA Modules – Order TLA7F2.

For TLA 7N1 LA Module – Order TLAF11.

For TLA 7N2 LA Module – Order TLAF12.

For TLA 7N3 LA Module – Order TLAF13.

For TLA 7N4 LA Module – Order TLAF14.

For TLA 7P2 LA Module – Order TLAF16.

For TLA 7P4 LA Module – Order TLAF18.

LOGIC ANALYZER MODULE SERVICE OPTIONS

Opt. D1 – Add calibration test data report.

Opt. IN – Product installation service (on-site configuration and user familiarization, excluding network integration).

Opt. C3 – Three years of calibration service (includes initial certification and two annual calibrations).

Opt. D3 – Provide test data for each calibration (must be ordered with Opt. C3).

Opt. R3 – Extends depot repair warranty service period to three years.

LOGIC ANALYZER MODULE ACCESSORIES

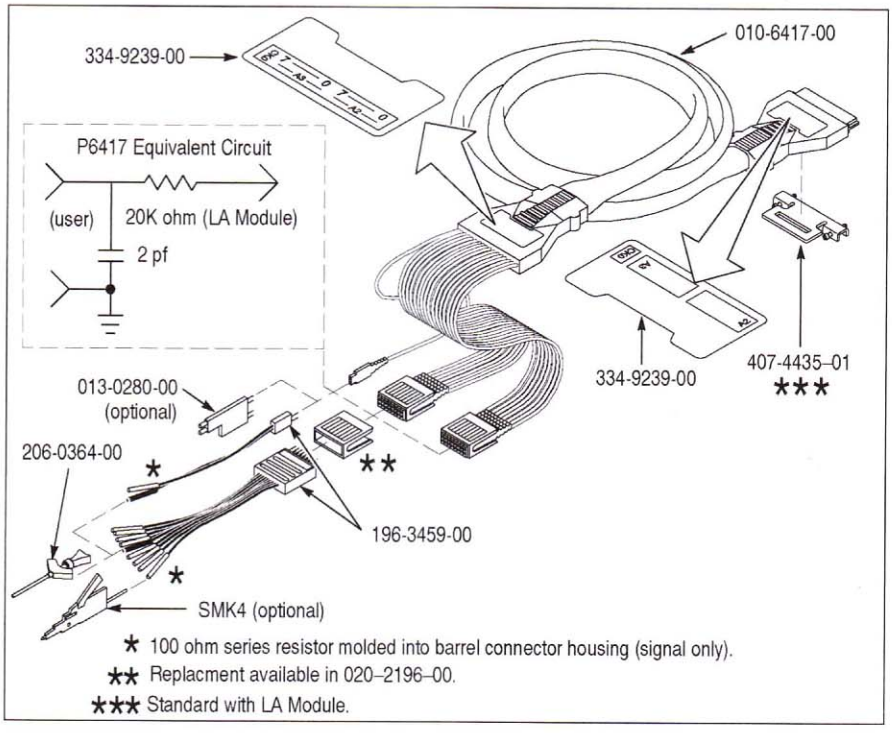
17-CH Probe and Accessories for TLA 7Lx/ TLA 7Mx, TLA 7Nx/TLA 7Px Logic Analyzer Modules – Order P6417.

17-CH Probe and Accessories for TLA 7Lx/ TLA 7Mx, TLA 7Nx/TLA 7Px Logic Analyzer Modules – Order P6418.

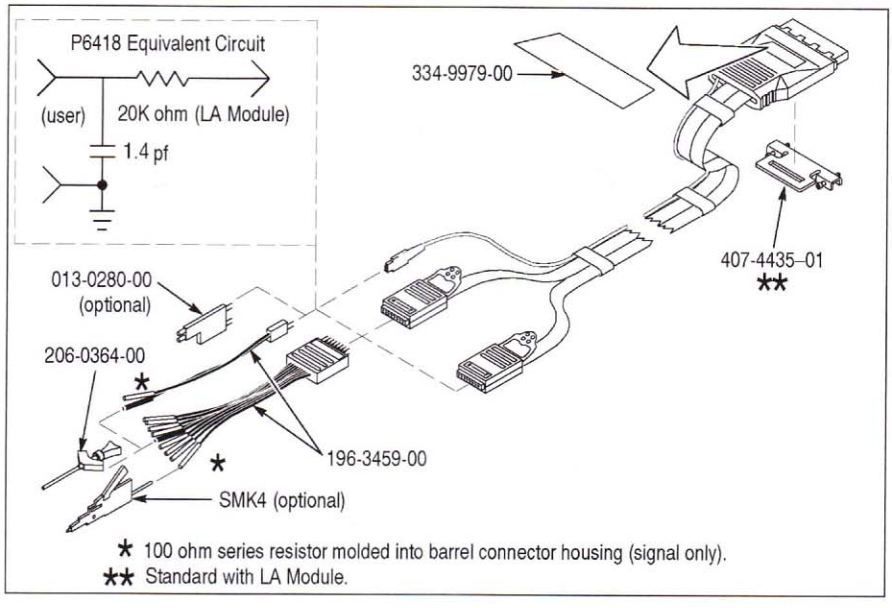
P6417 to HP/3M Type 3592, 2x10, 0.1 in. Adapter –

Order UPIK3M (5 ea.).

Order 671-2508-00 (1 ea.).



P6417



P6418

34-CH Probe Interface Kit w/ Barrel Connectors – Order 020-2199-00.

34-CH Probe Interface Kit w/ mini-PV Connectors – Order 020-3000-00.

34-CH Probe and Accessories for TLA 7Lx/TLA 7Mx, TLA 7Nx/TLA 7Px Logic Analyzer Modules – Order P6434.

34-CH Low-Profile Leadset for P6434 – Order P6434 Option 01.

Part Number	Description
010-6417-00	17-ch Probe.
N/A	2 each – 8-ch podlet holders (installed).
N/A	1 Set of 17 podlet color coding bands (installed)
334-9239-00	1 Sheet of probe labels (not installed).
196-3459-00	2 each – 8-ch leadsets (barrel connectors) and 1 each – 1-ch leadset (barrel connectors).
206-0364-00	20 each – SMT KlipChips.
013-0280-00	(optional) One to Two Adapter.
SMK4	(optional) Micro KlipChip Adapter, 4 each.
071-0567-00	P6417/P6418 Instruction Manual
010-6418-00	17-ch Probe.
334-9979-00	1 Sheet of probe labels (not installed).
196-3459-00	2 each – 8-ch leadsets (barrel connectors) and 1 each – 1-ch leadset (barrel connectors).
206-0364-00	20 each – SMT KlipChips.
013-0280-00	(optional) One to Two Adapter.
SMK4	(optional) Micro KlipChip Adapter, 4 each
071-0567-00	P6417/P6418 Instruction Manual

DSO MODULES

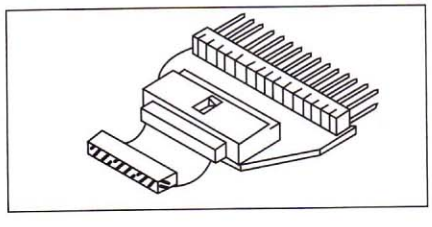
Includes: Probes, Manual, Certificate of Traceable Calibration, and One-year Warranty (return to Tektronix).

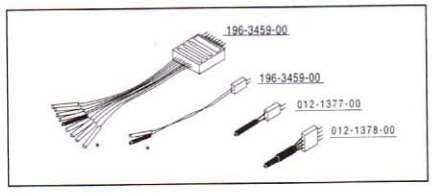
TLA 7D1 – 2-CH DSO module, 500 MHz bandwidth, 2.5 GS/s sample rate, 15 K depth (includes two P6243 1.0 GHz active FET probes, probe calibration adapter, and manual).

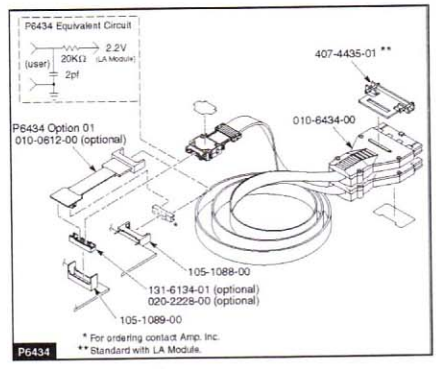
TLA 7D2 – 4-CH DSO module, 500 MHz bandwidth, 2.5 GS/s sample rate, 15 K depth (includes four P6243 1.0 GHz active FET probes, probe calibration adapter, and manual).

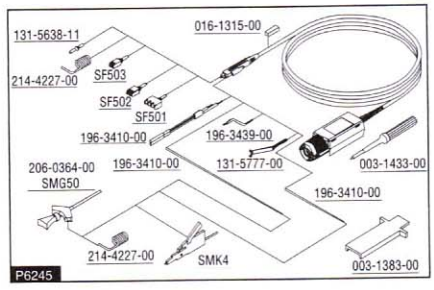
TLA 7E1 – 2-CH DSO module, 1 GHz bandwidth, 5 GS/s sample rate, 15 K depth (includes two P6245 1.5 GHz active FET probes, probe calibration adapter, and manual).

TLA 7E2 – 4-channel DSO module, 1 GHz bandwidth, 5 GS/s sample rate, 15 K depth (includes four P6245 1.5 GHz active FET probes, probe calibration adapter, and manual).









Part Number	Description
010-6434-00	34-ch probe.
N/A	1 Sheet of probe labels (not installed).
105-1088-00	1 Latch housing assembly, Edge-mount.
105-1089-00	1 Latch housing assembly, Vertical.
070-9793-02	Instruction Manual.
131-6134-01	(optional) 1 each – AMP Mictor Connector, Surface-Mount.
020-2228-00	(optional) 21 each – AMP Mictor Connector, Surface-Mount.
010-0612-00	(optional) Low-Profile Leadset for P6434

DSO MODULE SERVICE OPTIONS

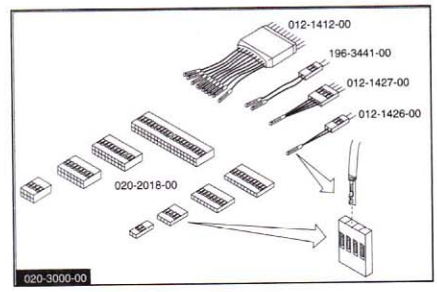
Opt. D1 – Add calibration test data report.

Opt. IN – Product installation service (on-site configuration and user familiarization, excluding network integration).

Opt. C3 – Three years of calibration service (includes initial certification and two annual calibrations).

Opt. D3 – Provide test data for each calibration (must be ordered with Opt. C3).

Opt. R3 – Extends depot repair warranty service period to three years.



Part Number	Description
003-1383-00	Compensation Box and Cover Removal Tool.
003-1433-00	Adjustment Tool.
016-1315-00	2 each – 5 colors of Cable Markers.
131-5638-10	10 each – Solderable Probe Tips.
131-5777-00	100 mil Square-Pin Ground Adapter.
196-3410-00	Ground lead set includes:
N/A	2 each – 1 in., 3 in., 6 in. Ground Leads w/ Square Pin Receptacle;
N/A	2 each – Y Lead Adapters.
196-3439-00	1 in. Ground Lead.
206-0364-00	SMT KlipChip™, 1 each
214-4227-00	Right Angle Square-Pin Adapter.
SF501	SureFoot Probe Tip Adapter, pkg. of 12, Yellow, 50 mil Pitch.
SF502	SureFoot Probe Tip Adapter, pkg. of 12, Blue, 25 mil/ 0.65 mm Pitch.
SF503	SureFoot Probe Tip Adapter, pkg. of 12, Red, 0.5 mm Pitch.
SMG50	SMT KlipChip, 20 each.
SMK4	Micro KlipChip Adapter, 4 each.
070-9408-00	P6243 Instruction Manual.
070-8995-01	P6245 Instruction Manual.

DSO MODULE ACCESSORIES

P6243 – 1.0 GHz Active FET Probe and accessories, length 1.5 m.

P6245 – 1.5 GHz Active FET Probe and accessories, length 1.5 m.

P6246 – 400 MHz, Differential Probe, 30 dB CMRR.

P6247 – 1.0 GHz, Differential Probe, 30 dB CMRR.

P6248 – 1.7 GHz, Differential Probe, 30 dB CMRR.

P6249 – 4.0 GHz, Active FET Probe and accessories, length 1.3 m.

TCP202 – Current probe, DC-15A, DC-50 MHz.

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

CE

Microprocessor and Bus Support for TLA 700 Series Logic Analyzers

Device	Package	Usage	Order These Items:	Channels Required
AMD				
Am188EA	N/A	S/W only	Contact Cust. Supt. Cntr.*9	68
Am188EB	N/A	S/W only	Contact Cust. Supt. Cntr.*9	68
Am186EA	N/A	S/W only	Contact Cust. Supt. Cntr.*9	68
Am186EB	N/A	S/W only	Contact Cust. Supt. Cntr.*9	68
Am80386DX	QFP-132	Socketed	TMS104 + Opt. 02	102
Am80486DX	PGA-168	Socketed	TMS107 + Opt. 01	102
Am80486DX2	PGA-168	Socketed	TMS107 + Opt. 01	102
Am80486SX	PGA-168	Socketed	TMS107 + Opt. 01	102
AMD K6-2 100MHz	PGA-321	Socketed	TMS109A + Opt. 01	136
Am80486SX2	PGA-168	Socketed	TMS107 + Opt. 01	102
29030	PGA-145	Socketed	TMS480 + Opt. 01	102
29035	PGA-145	Socketed	TMS480 + Opt. 01	102
29040	PGA-145	Socketed	TMS480 + Opt. 01	102
ARM				
TMS470 –TI	N/A	S/W only	Contact Cust. Supt. Cntr.*9	102
ARM7TDMi Development Board		S/W only	Contact Cust. Supt. Cntr.*9	102
AMBA-ASB	N/A	S/W only	Contact Dragonfly Software*4	102
SA-110	TQFP-144	Soldered	Contact New Wave PDG*1	102
ARM7T	N/A	S/W only	Contact Dragonfly*4	102
SA-1100	N/A	S/W only	Contact New Wave PDG*1	102
CYRIX				
6x86	PGA-296	Socketed	TMS109A + Opt. 01	136
6x86 100MHz	PGA-296	Socketed	TMS109A + Opt. 01	136
DALLAS SEMICONDUCTOR				
80C310	N/A	S/W only	Contact Cust. Supt. Cntr.*9	68
80C320	N/A	S/W only	Contact Cust. Supt. Cntr.*9	68
80C323	N/A	S/W only	Contact Cust. Supt. Cntr.*9	68
83C520	N/A	S/W only	Contact Cust. Supt. Cntr.*9	68
87C520	N/A	S/W only	Contact Cust. Supt. Cntr.*9	68
87C530	N/A	S/W only	Contact Cust. Supt. Cntr.*9	68
DIGITAL EQUIPMENT CORP.				
Alpha AXP 21064	PGA-431	Socketed	TEK-ALPHA-PGA17-HDW timing only, Contact Emulation Tech*6	
Strong ARM SA-110	TQFP-144	Soldered	Contact New Wave PDG*1	102
HITACHI				
SH-3 "7708"	QFP-144	Soldered	TMS440 + Opt. 01	102
64180	N/A	S/W only	Contact Cust. Supt. Cntr.*9	68
IBM				
PPC403GA	N/A	S/W only	TMS531	102
PPC403GC	N/A	S/W only	TMS531	102
PPC403GCX	N/A	S/W only	TMS531	102
PPC601	QFP-304	Soldered	TMS540 + Opt. 11 + Opt. 22 + Opt. 12	136
PPC601	N/A	S/W only	TMS540	136
PPC603	QFP-240	Soldered	TMS540 + Opt. 11 + Opt. 22 + Opt. 14	136
PPC603	N/A	S/W only	TMS540	136
PPC603e	N/A	S/W only	TMS540	136

Device	Package	Usage	Order These Items:	Channels Required
IBM (CONTINUED)				
PPC604	N/A	S/W only	TMS540	136
PPC604e	N/A	S/W only	TMS540	136
PPC740	N/A	S/W only	TMS541; for BGA Probe, LA-BGA-740-S-B-01, Contact Ironwood Electronics*2	136
PPC750	N/A	S/W only	TMS541; for BGA Probe, LA-BGA-750-S-B-01, Contact Ironwood Electronics*2	136
INTEL				
8051/31				
8031	DIP-40	Socketed	TMS140 + Opt. 01	68
8031	DIP-40	Soldered	TMS140 + Opt. 01 + 015-0646-00	68
8031	PLCC-44	Socketed	TMS140 + UPIK44	68
8031	PLCC-44	Soldered	TMS140 + Opt. 01 + (AC-DIP-PCC-8031/51, Contact Emulation Tech)*6	68
8032	DIP-40	Socketed	TMS140 + Opt. 01	68
8032	DIP-40	Soldered	TMS140 + Opt. 01 + 015-0646-00	68
8032	PLCC-44	Socketed	TMS140 + UPIK44	68
8032	PLCC-44	Soldered	TMS140 + Opt. 01 + (AC-DIP-PCC-8031/51, C ontact Emulation Tech)*6	68
8051	DIP-40	Socketed	TMS140 + Opt. 01	68
8051	DIP-40	Soldered	TMS140 + Opt. 01 + 015-0646-00	68
8051	PLCC-44	Socketed	TMS140 + UPIK44	68
8051	PLCC-44	Soldered	TMS140 + Opt. 01 + (AC-DIP-PCC-8031/51, Contact Emulation Tech)*6	68
8052	DIP-40	Socketed	TMS140 + Opt. 01	68
8052	DIP-40	Soldered	TMS140 + Opt. 01 + 015-0646-00	68
8052	PLCC-44	Socketed	TMS140 + UPIK44	68
8052	PLCC-44	Soldered	TMS140 + Opt. 01 + (AC-DIP-PCC-8031/51, Contact Emulation Tech)*6	68
80C152	DIP-48	Socketed	TMS140 + 013-0266-00	68
80C152	DIP-48	Soldered	TMS140 + 013-0266-00	68
80C152	PLCC-68	Socketed	TMS140 + UPIK68	68
80C152	PLCC-68	Soldered	TMS140 + 013-0250-00	68
80C251	PLCC-44	Socketed	TMS143 + Opt. 01	68
MCS251	PLCC-44	Socketed	TMS143 + Opt. 01	68
80C452	PLCC-68	Socketed	TMS140 + UPIK68	68
80C452	PLCC-68	Soldered	TMS140 + 013-0250-00	68
80515	PLCC-68	Socketed	TMS140 + UPIK68	68
80515	PLCC-68	Soldered	TMS140 + 013-0250-00	68
80532	PLCC-68	Socketed	TMS140 + UPIK68	68
80532	PLCC-68	Soldered	TMS140 + 013-0250-00	68
80535	PLCC-68	Socketed	TMS140 + UPIK68	68
80535	PLCC-68	Soldered	TMS140 + 013-0250-00	68
83C152	DIP-48	Socketed	TMS140 + 013-0266-00	68
83C152	DIP-48	Soldered	TMS140 + 013-0266-00	68
83C152	PLCC-68	Socketed	TMS140 + UPIK68	68
83C152	PLCC-68	Soldered	TMS140 + 013-0250-00	68
83C452	PLCC-68	Socketed	TMS140 + UPIK68	68
83C452	PLCC-68	Soldered	TMS140 + 013-0250-00	68

Device	Package	Usage	Order These Items:	Channels Required
INTEL (CONTINUED)				
83C537	PLCC-84	Socketed	TMS140 + UPIK84	68
83C537	PLCC-84	Soldered	TMS140 + 013-0263-00	68
8096/196/296				
8096BH	PLCC-68	Socketed	TMS141 + Opt. 02	68
8096BH	PLCC-68	Soldered	TMS141 + Opt. 01 + 013-0250-00 + 103-0311-00	68
8096BH	PGA-68	Socketed	TMS141 + Opt. 01	68
8396BH	PLCC-68	Socketed	TMS141 + Opt. 02	68
8396BH	PLCC-68	Soldered	TMS141 + Opt. 01 + 013-0250-00 + 103-0311-00	68
8396BH	PGA-68	Socketed	TMS141 + Opt. 01	68
8097BH	PLCC-68	Socketed	TMS141 + Opt. 02	68
8097BH	PLCC-68	Soldered	TMS141 + Opt. 01 + 013-0250-00 + 103-0311-00	68
8097BH	PGA-68	Socketed	TMS141 + Opt. 01	68
8097JF	PLCC-68	Socketed	TMS141 + Opt. 02	68
8097JF	PLCC-68	Soldered	TMS141 + Opt. 01 + 013-0250-00 + 103-0311-00	68
8097JF	PGA-68	Socketed	TMS141 + Opt. 01	68
8397BH	PLCC-68	Socketed	TMS141 + Opt. 02	68
8397BH	PLCC-68	Soldered	TMS141 + Opt. 01 + 013-0250-00 + 103-0311-00	68
8397BH	PGA-68	Socketed	TMS141 + Opt. 01	68
8397JF	PLCC-68	Socketed	TMS141 + Opt. 02	68
8397JF	PLCC-68	Soldered	TMS141 + Opt. 01 + 013-0250-00 + 103-0311-00	68
8397JF	PGA-68	Socketed	TMS141 + Opt. 01	68
8797BH	PLCC-68	Socketed	TMS141 + Opt. 02	68
8797BH	PLCC-68	Soldered	TMS141 + Opt. 01 + 013-0250-00 + 103-0311-00	68
8797BH	PGA-68	Socketed	TMS141 + Opt. 01	68
8797JF	PLCC-68	Socketed	TMS141 + Opt. 02	68
8797JF	PLCC-68	Soldered	TMS141 + Opt. 01 + 013-0250-00 + 103-0311-00	68
8797JF	PGA-68	Socketed	TMS141 + Opt. 01	68
80C196KB	PGA-68	Socketed	TMS141 + Opt. 01	68
80C196KB	PLCC-68	Socketed	TMS141 + Opt. 02	68
80C196KB	PLCC-68	Soldered	TMS141 + Opt. 01 + 013-0250-00 + 103-0311-00	68
80C196KB16	PGA-68	Socketed	TMS141 + Opt. 01	68
80C196KB16	PLCC-68	Socketed	TMS141 + Opt. 02	68
80C196KB16	PLCC-68	Soldered	TMS141 + Opt. 01 + 013-0250-00 + 103-0311-00	68
80C196KC	PGA-68	Socketed	TMS141 + Opt. 01	68
80C196KC	PLCC-68	Socketed	TMS141 + Opt. 02	68
80C196KC	PLCC-68	Soldered	TMS141 + Opt. 01 + 013-0250-00 + 103-0311-00	68
80C196KD	PGA-68	Socketed	TMS141 + Opt. 01	68
80C196KD	PLCC-68	Socketed	TMS141 + Opt. 02	68
80C196KD	PLCC-68	Soldered	TMS141 + Opt. 01 + 013-0250-00 + 103-0311-00	68
87C196KB16	PGA-68	Socketed	TMS141 + Opt. 01	68
87C196KB16	PLCC-68	Socketed	TMS141 + Opt. 02	68
87C196KB16	PLCC-68	Soldered	TMS141 + Opt. 01 + 013-0250-00 + 103-0311-00	68
87C196KC	PGA-68	Socketed	TMS141 + Opt. 01	68
87C196KC	PLCC-68	Socketed	TMS141 + Opt. 02	68
87C196KC	PLCC-68	Soldered	TMS141 + Opt. 01 + 013-0250-00 + 103-0311-00	68
87C196KD	PGA-68	Socketed	TMS141 + Opt. 01	68
87C196KD	PLCC-68	Socketed	TMS141 + Opt. 02	68
87C196KD	PLCC-68	Soldered	TMS141 + Opt. 01 + 013-0250-00 + 103-0311-00	68
80C196NP	QFP-100	Soldered	TMS142 + Opt. 01 + Opt. 22	102
80C196NT	PLCC-68	Socketed	TMS142 + Opt. 02 + Opt. 22	102
80C296	QFP-100	Soldered	TMS144 + Opt.11	68
MCS296	QFP-100	Soldered	TMS144 + Opt.11	68
8085	N/A	S/W only	Contact Cust. Supt. Cntr.*9	68
80C85	N/A	S/W only	Contact Cust. Supt. Cntr.*9	68
x86				
8086	DIP-40	Socketed	TMS101 + Opt. 01	102
8086	DIP-40	Soldered	TMS101 + Opt. 01 + 015-0646-00	102
8086	PLCC-44	Soldered	TMS101 + Opt. 01 + (AC-DIP-PLCC-8086/88, Contact Emulation Tech)*6	102
80C86	DIP-40	Socketed	TMS101 + Opt. 01	102
80C86	DIP-40	Soldered	TMS101 + Opt. 01 + 015-0646-00	102
80C86	PLCC-44	Soldered	TMS101 + Opt. 01 + (AC-DIP-PLCC-8086/88, Contact Emulation Tech)*6	102
8088	DIP-40	Socketed	TMS101 + Opt. 01	102
8088	DIP-40	Soldered	TMS101 + Opt. 01 + 015-0646-00	102
8088	PLCC-44	Soldered	TMS101 + Opt. 01 + (AC-DIP-PLCC-8086/88, Contact Emulation Tech)*6	102
80C88	DIP-40	Socketed	TMS101 + Opt. 01	102
80C88	DIP-40	Soldered	TMS101 + Opt. 01 + 015-0646-00	102
80C88	PLCC-44	Soldered	TMS101 + Opt. 01 + (AC-DIP-PLCC-8086/88, Contact Emulation Tech)*6	102
80186	PGA-68	Socketed	TMS102 + Opt. 01	102
80186	PLCC-68	Socketed	TMS102 + Opt. 02	102
80186	PLCC-68	Soldered	TMS102 + Opt. 01 + 013-0250-00 + 103-0311-00	102
80186	LCC-68	Socketed	TMS102 + Opt. 01 + 136-1023-00 + 136-0921-00 + 103-0294-00	102
80186	QFP-80	Soldered	TMS102 + Opt. 01 + (AC-PGA1-QF08-80186/88-NTP-A, Contact Emulation Tech)*6	102
80C186	PGA-68	Socketed	TMS102 + Opt. 01	102
80C186	PLCC-68	Socketed	TMS102 + Opt. 02	102
80C186	PLCC-68	Soldered	TMS102 + Opt. 01 + 013-0250-00 + 103-0311-00	102
80C186	LCC-68	Socketed	TMS102 + Opt. 01 + 136-1023-00 + 136-0921-00 + 103-0294-00	102
80C186	QFP-80	Soldered	TMS102 + Opt. 01 + (AC-PGA1-QF08-80186/88-NTP-A, Contact Emulation Tech)*6	102
80C186XL	PGA-68	Socketed	TMS102 + Opt. 01	102

Device	Package	Usage	Order These Items:	Channels Required
INTEL (CONTINUED)				
80C186XL	PLCC-68	Socketed	TMS102 + Opt. 02	102
80C186XL	PLCC-68	Soldered	TMS102 + Opt. 01 + 013-0250-00 + 103-0311-00	102
80C186XL	LCC-68	Socketed	TMS102 + Opt. 01 + 136-1023-00 + 136-0921-00 + 103-0294-00	102
80C186XL	QFP-80	Soldered	TMS102 + Opt. 01 + (AC-PGA1-QF08-80186/88-NTP-A, Contact Emulation Tech)*6	102
80C186EA	PGA-68	Socketed	Contact Cust. Supt. Cntr.*9	102
80C186EA	PLCC-68	Socketed	Contact Cust. Supt. Cntr.*9	102
80C186EA	PLCC-68	Soldered	Contact Cust. Supt. Cntr.*9	102
80C186EA	LCC-68	Socketed	Contact Cust. Supt. Cntr.*9	102
80C186EA	QFP-80	Soldered	Contact Cust. Supt. Cntr.*9	102
80C186EB	PLCC-84	Soldered	Contact Cust. Supt. Cntr.*9	102
80186EB	N/A	S/W only	Contact Cust. Supt. Cntr.*9	68
80186EC	N/A	S/W only	Contact Cust. Supt. Cntr.*9	68
80188	PGA-68	Socketed	TMS102 + Opt. 01	102
80188	PLCC-68	Socketed	TMS102 + Opt. 02	102
80188	PLCC-68	Soldered	TMS102 + Opt. 01 + 013-0250-00 + 103-0311-00	102
80188	LCC-68	Socketed	TMS102 + Opt. 01 + 136-1023-00 + 136-0921-00 + 103-0294-00	102
80188	QFP-80	Soldered	TMS102 + Opt. 01 + (AC-PGA1-QF08-80186/88-NTP-A, Contact Emulation Tech)*6	102
80188	PGA-68	Socketed	TMS102 + Opt. 01	102
80C188	PGA-68	Socketed	TMS102 + Opt. 01	102
80C188	PLCC-68	Socketed	TMS102 + Opt. 02	102
80C188	PLCC-68	Soldered	TMS102 + Opt. 01 + 013-0250-00 + 103-0311-00	102
80C188	LCC-68	Socketed	TMS102 + Opt. 01 + 136-1023-00 + 136-0921-00 + 103-0294-00	102
80C188	QFP-80	Soldered	TMS102 + Opt. 01 + (AC-PGA1-QF08-80186/88-NTP-A, Contact Emulation Tech)*6	102
80C188XL	PGA-68	Socketed	TMS102 + Opt. 01	102
80C188XL	PLCC-68	Socketed	TMS102 + Opt. 02	102
80C188XL	PLCC-68	Soldered	TMS102 + Opt. 01 + 013-0250-00 + 103-0311-00	102
80C188XL	LCC-68	Socketed	TMS102 + Opt. 01 + 136-1023-00 + 136-0921-00 + 103-0294-00	102
80C188XL	QFP-80	Soldered	TMS102 + Opt. 01 + (AC-PGA1-QF08-80186/88-NTP-A, Contact Emulation Tech)*6	102
80C188EA	PGA-68	Socketed	TMS102 + Opt. 01	102
80C188EA	PLCC-68	Socketed	TMS102 + Opt. 02	102
80C188EA	PLCC-68	Soldered	TMS102 + Opt. 01 + 013-0250-00 + 103-0311-00	102
80C188EA	LCC-68	Socketed	TMS102 + Opt. 01 + 136-1023-00 + 136-0921-00 + 103-0294-00	102
80C188EA	QFP-80	Soldered	TMS102 + Opt. 01 + (AC-PGA1-QF08-80186/88-NTP-A, Contact Emulation Tech)*6	102
80C188EB	PLCC-84	Soldered	TMS102 + Opt. 01 + (AC-PGA1-PCC5-80186EB, Contact Emulation Tech)*6	68

Device	Package	Usage	Order These Items:	Channels Required
INTEL (CONTINUED)				
80188EB	N/A	S/W only	Contact Cust. Supt. Cntr.*9	68
80188EC	N/A	S/W only	Contact Cust. Supt. Cntr.*9	68
80286	PGA-68	Socketed	TMS103 + Opt. 01	68
80286	PLCC-68	Socketed	TMS103 + Opt. 02	68
80286	PLCC-68	Soldered	TMS103 + Opt. 01 + 013-0250-00 + 103-0311-00	68
80286	LCC-68	Socketed	TMS103 + Opt. 01 + 136-1023-00 + 136-0921-00 + 103-0294-00	68
80376	PQFP-100	Soldered	TMS105 + Opt. 01	68
80386DX	PGA-132	Socketed	TMS104 + Opt. 01	102
80386EX	PQFP-132	Soldered	TMS106 + Opt. 01	102
80386SX	PQFP-100	Soldered	TMS105 + Opt. 01	68
80486SX	PGA-168	Socketed	TMS107 + Opt. 01	102
80486SX	QFP-196	Soldered	TMS107 + Opt. 01 + (AC-PGA10-QF15-486SX-NTP, Contact Emulation Tech)*6	102
80486SX	QFP-208	Soldered	TMS107 + (5770, Contact Pomona)*8	102
80486DX	PGA-168	Socketed	TMS107 + Opt. 01	102
80486DX	QFP-208	Soldered	TMS107 + (5770, Contact Pomona)*8	102
80486DX-50	PGA-168	Socketed	TMS107 + Opt. 01	102
(chipset mode)	PGA-168	Socketed	TMS107 + Opt. 01	102
80486DX2	PGA-168	Socketed	TMS107 + Opt. 01	102
80486DX2	QFP-208	Soldered	TMS107 + (5770, Contact Pomona)*8	102
80486DX4	PGA-168	Socketed	TMS107 + Opt. 01 + Opt. 11	102
80486DX4	QFP-208	Soldered	TMS107 + (5770, Contact Pomona)*8	102
80487SX	PGA-168	Socketed	TMS107 + Opt. 01	102
Pentium				
Pentium-75-150	PGA-296	Socketed	TMS109A + Opt. 01	136
Pentium-75-150	PGA-296	Socketed	TMS109A + Opt. 01	136
P54C	PGA-296	Socketed	TMS109A + Opt. 01	136
P54C	PGA-296	Socketed	TMS109A + Opt. 01	136
P54CM	PGA-296	Socketed	TMS109A + Opt. 01	136
P54CM	PGA-296	Socketed	TMS109A + Opt. 01	136
P54CS	PGA-296	Socketed	TMS109A + Opt. 01	136
P54CS	PGA-296	Socketed	TMS109A + Opt. 01	136
P55C	PGA-296	Socketed	TMS109A + Opt. 01	136
P55C	PGA-296	Socketed	TMS109A + Opt. 01	136
APIC Bus	N/A	GP	TMS801 + Opt. 01	102
Pentium Pro	PGA-387	Socketed	TMS110 + Opt. 01	204
P6	PGA-387	Socketed	TMS110 + Opt. 01	204
Pentium II (66 MHz)	Slot 1	Socketed	TMS111 + Opt. 01	204
Klamath	Slot 1	Socketed	TMS111 + Opt. 01	204
Pentium II (100 MHz)	Slot 1	Socketed	TMS112 + Opt. 01	204
Deschutes	Slot 1	Socketed	TMS112 + Opt. 01	204
Deschutes	Slot 2	Socketed	TMS112 + Opt. 02	204
Pentium III	SC242	Socketed	TMS113 + TMSS1A	204
Celeron	SC242	Socketed	TMS113 + TMSS1A	204
Celeron	PGA370	Socketed	TMS113 + TMSPGA	204

Device	Package	Usage	Order These Items:	Channels Required
INTEL (CONTINUED)				
i960				
i960CA	PGA-168	Socketed	TMS161 + Opt. 01	102
i960CA	QFP-196	Soldered	TMS161 + Opt. 01 + (AC-PGA10-QF15-80960CA-NTP, Contact Emulation Tech)*6	102
i960CF	PGA-168	Socketed	TMS161 + Opt. 01	102
i960CF	QFP-196	Soldered	TMS161 + Opt. 01 + (AC-PGA10-QF15-80960CA-NTP, Contact Emulation Tech)*6	102
i960Jx	PGA-132	Socketed	TMS163 + Opt. 01 + Opt. 22	102
i960Jx	QFP-132	Soldered	TMS163 + Opt. 01 + Opt. 12 + Opt. 22	102
i960HA	PGA-168	Socketed	TMS164 + Opt. 01 + Opt. 22	102
i960HD	PGA-168	Socketed	TMS164 + Opt. 01 + Opt. 22	102
i960HT	PGA-168	Socketed	TMS164 + Opt. 01 + Opt. 22	102
i960RP	BGA-352	Elastomer	TMS165 + Opt 01 or (for BGA Adapter Contact Emulation Tech)*6	102
i960RD	BGA-352	Elastomer	TMS165 + Opt 01 or (for BGA Adapter Contact Emulation Tech)*6	102
80960CA	PGA-168	Socketed	TMS161 + Opt. 01	102
80960CA	QFP-196	Soldered	TMS161 + Opt. 01 + (AC-PGA10-QF15-80960CA-NTP, Contact Emulation Tech)*6	102
80960CF	PGA-168	Socketed	TMS161 + Opt. 01	102
80960CF	QFP-196	Soldered	TMS161 + Opt. 01 + (AC-PGA10-QF15-80960CA-NTP, Contact Emulation Tech)*6	102
80960Jx	PGA-132	Socketed	TMS163 + Opt. 01 + Opt. 22	102
80960Jx	QFP-132	Soldered	TMS163 + Opt. 01 + Opt. 12 + Opt. 22	102
80960HA	PGA-168	Socketed	TMS164 + Opt. 01 + Opt. 22	102
80960HD	PGA-168	Socketed	TMS164 + Opt. 01 + Opt. 22	102
80960HT	PGA-168	Socketed	TMS164 + Opt. 01 + Opt. 22	102
80960RP	BGA-352	Elastomer	TMS165 + Opt. 01 or (for BGA Adapter Contact Emulation Tech)*6	102
80960RD	BGA-352	Elastomer	TMS165 + Opt. 01 or (for BGA Adapter Contact Emulation Tech)*6	102
MIPS				
(INCL. IDT, QED, LSI LOGIC, NEC, PERFORMANCE SEMICONDUCTOR, SIEMENS, TOSHIBA)				
R3051	PGA-88	Socketed	TMS420 + Opt. 01	102
R3051	PLCC-84	Socketed	TMS420 + Opt. 02	102
R3052	PGA-88	Socketed	TMS420 + Opt. 01	102
R3052	PLCC-84	Socketed	TMS420 + Opt. 02	102
R3081	PGA-88	Socketed	TMS420 + Opt. 01	102
R3081	PLCC-84	Socketed	TMS420 + Opt. 02	102
R4000PC	PGA-179	Socketed	CHS301SP Contact Crescent Heart Software*3	102
R4000MC/SC	PGA-447	S/W only	CHS951 Contact Crescent Heart Software*3	102
R4000MC/SC	PGA-447	S/W only	CHS953 Including Cache Bus Contact Crescent Heart Software*3	204
VR4200	PGA-179	Socketed	CHS301SP Contact Crescent Heart Software*3	102
MIPS (CONTINUED)				
VR4200	PQFP-208	Soldered	CHS310SP Contact Crescent Heart Software*3	102
VR4300	PQFP-120	Soldered	CHS312SP Contact Crescent Heart Software*3	102
VR4310	N/A	S/W only	CHS304 Contact Crescent Heart Software*3	102
R4400PC	PGA-179	Socketed	CHS301SP Contact Crescent Heart Software*3	102
R4400MC/SC	PGA-447	S/W only	CHS951 Contact Crescent Heart Software*3	102
R4400MC/SC	PGA-447	S/W only	CHS953 Including Cache Bus Contact Crescent Heart Software*3	204
R4600	PGA-179	Socketed	CHS301SP Contact Crescent Heart Software*3	102
R4600	MQUAD-208	Soldered	CHS305SP-M Contact Crescent Heart Software*3	102
R4640	PQFP-128	Soldered	CHS407SP-P Contact Crescent Heart Software*3	68
R4640	MQUAD-128	Soldered	CHS407SP-M Contact Crescent Heart Software*3	68
R4650 32-Bit Bus	MQUAD-208	Soldered	CHS413SP Contact Crescent Heart Software*3	68
R4650 64-Bit Bus	MQUAD-208	Soldered	CHS414SP Contact 64-bit Bus Crescent Heart Software*3	102
R4700	PGA-179	Socketed	CHS301SP Contact Crescent Heart Software*3	102
R4700	MQUAD-208	Soldered	CHS305SP-M Contact Crescent Heart Software*3	102
R5000 ext. cache	PGA-223	S/W only	CHS131 Contact Crescent Heart Software*3	136
R5000 no-cache	PGA-223	S/W only	CHS130 Contact Crescent Heart Software*3	102
R5000 ext. cache	BGA-272	S/W only	CHS131 Contact Crescent Heart Software*3	136
R5000 no-cache	BGA-272	S/W only	CHS130 Contact Crescent Heart Software*3	102
RM5230/1	PQUAD-128	Soldered	CHS420SP Contact Crescent Heart Software*3	68
RM5260/1	PQUAD-208	Soldered	CHS422SP Contact Crescent Heart Software*3	102
RM5270/1 no-cache	BGA-304	S/W only	CHS134 Contact Crescent Heart Software*3	102
RM5270/1 ext-cache	BGA-304	S/W only	CHS135SP Contact Crescent Heart Software*3	136
VR5432 w/o MOR's	PQFP-208	Soldered	CHS440SP Contact Crescent Heart Software*3	68
VR5432 with MOR's	PQFP-208	Soldered	CHS442SP Contact Crescent Heart Software*3	68
VR5432, R43K bus	PQFP-208	Soldered	CHS444SP Contact Crescent Heart Software*3	68
VR5464 w/o MOR's	BGA-272	S/W only	CHS146 Contact Crescent Heart Software*3	102
VR5464 with MOR's	BGA-272	S/W only	CHS148 Contact Crescent Heart Software*3	102
RM7000 w/o MOR's	BGA-304	S/W only	CHS151 Contact Crescent Heart Software*3	136
RM7000 with MOR's	BGA-304	S/W only	CHS153 Contact Crescent Heart Software*3	136

Device	Package	Usage	Order These Items:	Channels Required
MIPS (CONTINUED)				
RC32364	TQFP-144	Soldered	CHS403SP Contact Crescent Heart Software*3	68
RC64474	PQUAD-128	Soldered	CHS407SP-P Contact Crescent Heart Software*3	68
RC6475, 32-Bit bus	PQUAD-208	Soldered	CHS413SP Contact Crescent Heart Software*3	68
RC6475, 64/32-Bit bus	PQUAD-S08	Soldered	CHS414SP Contact Crescent Heart Software*3	102
MOTOROLA				
DSP				
5630X	N/A	S/W only	Contact New Wave PDG*1	102
680x				
6809e	N/A	S/W only	Contact Cust. Supt. Cntr.*9	68
68HCxx				
68HC11	ALL	S/W only	Contact Cust. Supt. Cntr.*9	68
68HC12	ALL	S/W only	TMS241	102
68HC16	ALL	S/W only	Contact Cust. Supt. Cntr.*9	68
683xx				
68302LC	N/A	S/W only	Contact Cust. Supt. Cntr.*9	68
68302SC	N/A	S/W only	Contact Cust. Supt. Cntr.*9	68
68302EN	N/A	S/W only	Contact Cust. Supt. Cntr.*9	68
68302PM	N/A	S/W only	Contact Cust. Supt. Cntr.*9	68
68302QH	N/A	S/W only	Contact Cust. Supt. Cntr.*9	68
68328	N/A	S/W only	Contact Cust. Supt. Cntr.*9	68
68331	QFP-132	Soldered	TMS260 + Opt. 01	102
68332	QFP-132	Soldered	TMS260 + Opt. 01	102
68340	PGA-145	Socketed	TMS260 + Opt. 02	102
68340	QFP-144	Soldered	TMS260 + Opt. 02 + (AC-PGA4-QF10-68340, Contact Emulation Tech)*6	102
68360	PGA-241	Socketed	TMS261 + Opt. 01 + Opt. 22	102
68360	QFP-240	Soldered	TMS261 + Opt. 01 + Opt. 22 + (#5968C, Contact Pomona)*8	102
68K				
68000	DIP-64	Socketed	TMS201 + Opt. 01	68
68000	PGA-68	Socketed	TMS201 + Opt. 02	68
68000	PLCC-68	Socketed	TMS201 + Opt. 03	68
68000	PLCC-68	Soldered	TMS201 + Opt. 02 + 013-0250-00 + 103-0312-00	68
68EC000	PLCC-68	Socketed	TMS201 + Opt. 04	68
68EC000	PLCC-68	Soldered	TMS201 + Opt. 04	68
68HC000	DIP-64	Socketed	TMS201 + Opt. 02	68
68HC000	PGA-68	Socketed	TMS201 + Opt. 02	68
68HC000	PLCC-68	Socketed	TMS201 + Opt. 03	68
68HC000	PLCC-68	Soldered	TMS201 + Opt. 02 + 013-0250-00 + 103-0312-00	68
68010	DIP-64	Socketed	TMS201 + Opt. 01	68
68010	PGA-68	Socketed	TMS201 + Opt. 02	68
68010	PLCC-68	Socketed	TMS201 + Opt. 03	68
68010	PLCC-68	Soldered	TMS201 + Opt. 02 + 013-0250-00 + 103-0312-00	68
68020	PGA-114	Socketed	TMS202 + Opt. 01	102
68020	QFP-132	Soldered	TMS202 + Opt. 03	102
68EC020	PGA-100	Socketed	TMS202 + Opt. 02	102

Device	Package	Usage	Order These Items:	Channels Required
MOTOROLA (CONTINUED)				
68030	PGA-128	Socketed	TMS203 + Opt. 01	102
68030	QFP-132	Soldered	TMS203 + Opt. 02	102
68EC030	PGA-128	Socketed	TMS203 + Opt. 01	102
68040	PGA-179	Socketed	TMS204 + Opt. 01	102
68040	TQFP	Soldered	TMS204 + Opt. 01+ (For PGA to TQFP adapter, P#8800-0051, Contact JM Engineering)*7	102
68EC040	PGA-179	Socketed	TMS204 + Opt. 01	102
68LC040	PGA-179	Socketed	TMS204 + Opt. 01	102
68060	PGA-223	Socketed	TMS205 + Opt. 01	102
68EC060	PGA-223	Socketed	TMS205 + Opt. 01	102
68LC060	PGA-223	Socketed	TMS205 + Opt. 01	102
M-CORE				
M-Core Eval Board	N/A	S/W only	Contact Cust. Supt. Cntr.*9	102
MMC2001	N/A	S/W only	Contact Cust. Supt. Cntr.*9	102
M200 Core	N/A	S/W only	Contact Cust. Supt. Cntr.*9	102
Mcore/ 56652	N/A	S/W only	Contact Cust. Supt. Cntr.*9	102
ColdFire				
MCF5202	PQFP-100	Socketed	TMS220 + Opt. 11	102
MCF5203	PQFP-100	Socketed	TMS220 + Opt. 11	102
MCF5204	TQFP-100	Socketed	TMS221 + Opt. 11	102
MCF5206	PQFP-160	Socketed	TMS222 + Opt. 01	102
MCF5206e	PQFP-160	Socketed	TMS222 + Opt. 02	102
PPC				
MPC505	N/A	S/W only	TMS550	102
MPC509	N/A	S/W only	TMS550	102
MPC601	QFP-304	Soldered	TMS540 + Opt. 11 + Opt. 22 + Opt. 12	136
MPC601	N/A	S/W only	TMS540	136
MPC603	QFP-240	soldered	TMS540 + Opt. 11 + Opt. 22 + Opt. 13	136
MPC603	N/A	S/W only	TMS540	136
MPC603e	N/A	S/W only	TMS540	136
MPC603ev	N/A	S/W only	TMS540	136
MPC604	N/A	S/W only	TMS540	136
MPC604e	N/A	S/W only	TMS540	136
MPC740	N/A	S/W only	TMS541; for BGA Probe, LA-BGA-740-S-B-01, Contact Ironwood Electronics*2	136
MPC750	N/A	S/W only	TMS541; for BGA Probe, LA-BGA-750-S-B-01, Contact Ironwood Electronics*2	136
MPC801	N/A	S/W only	TMS561	102
MPC821	N/A	S/W only	TMS560; for BGA Probe, BCP-357-2BG019Z-MPC860-1-TEK-PN, Contact Emulation Tech*6	102
MPC823	N/A	S/W only	TMS561; for BGA Probe, LA-BGA-850-Z-B-01, Contact Ironwood Electronics*2	102
MPC850	N/A	S/W only	TMS561; for BGA Probe, LA-BGA-850-Z-B-01, Contact Ironwood Electronics*2	102
MPC860	N/A	S/W only	TMS560; for BGA Probe, BCP-357-2BG019Z-MPC860-1-TEK-PN, Contact Emulation Tech*6	102

Device	Package	Usage	Order These Items:	Channels Required
MOTOROLA (CONTINUED)				
MPC8260	N/A	S/W only	TMS562; for BGA Probe, LA-BGA-8260-S-B-01, Contact Ironwood Electronics*2	136
POWERPC				
PPC403GA	N/A	S/W only	TMS531	102
PPC403GC	N/A	S/W only	TMS531	102
PPC403GCX	N/A	S/W only	TMS531	102
MPC505	N/A	S/W only	TMS550	102
MPC509	N/A	S/W only	TMS550	102
PPC601	QFP-304	Soldered	TMS540 + Opt. 11 + Opt. 22 + Opt. 12	136
PPC601	N/A	S/W only	TMS540	136
PPC603	QFP-240	Soldered	TMS540 + Opt. 11 + Opt. 22 + Opt. 14	136
PPC603	N/A	S/W only	TMS540	136
PPC603e	N/A	S/W only	TMS540	136
MPC603ev	N/A	S/W only	TMS540	136
PPC604	N/A	S/W only	TMS540	136
PPC604e	N/A	S/W only	TMS540	136
PPC740	N/A	S/W only	TMS541; for BGA Probe, LA-BGA-740-S-B-01, Contact Ironwood Electronics*2	136
PPC750	N/A	S/W only	TMS541; for BGA Probe, LA-BGA-750-S-B-01, Contact Ironwood Electronics*2	136
MPC801	N/A	S/W only	TMS561	102
MPC821	N/A	S/W only	TMS560; for BGA Probe, BCP-357-2BG019Z-MPC860-1-TEK-PN, Contact Emulation Tech*6	102
MPC823	N/A	S/W only	TMS561; for BGA Probe, LA-BGA-850-Z-B-01, Contact Ironwood Electronics*2	102
MPC850	N/A	S/W only	TMS561; for BGA Probe, LA-BGA-850-Z-B-01, Contact Ironwood Electronics*2	102
MPC860	N/A	S/W only	TMS560; for BGA Probe, BCP-357-2BG019Z-MPC860-1-TEK-PN, Contact Emulation Tech*6	102
MPC8260	N/A	S/W only	TMS562; for BGA Probe, LA-BGA-8260-S-B-01, Contact Ironwood Electronics*2	136
ROCKWELL				
6502	N/A	S/W only	Contact Cust. Supt. Cntr.*9	68
65802	N/A	S/W only	Contact Cust. Supt. Cntr.*9	68
SIEMENS				
80C161	N/A	S/W only	Contact Ingenieurbuero Strunck*3	102
80C165	N/A	S/W only	Contact Ingenieurbuero Strunck*3	102
80C166	N/A	S/W only	Contact Ingenieurbuero Strunck*3	102
80C167	N/A	S/W only	Contact Ingenieurbuero Strunck*3	102
80C167	PQFP-144	Soldered	TMS600 + Opt. 01	102
80C515	N/A	S/W only	Contact Cust. Supt. Cntr.*9	68
ST MICROELECTRONICS (THOMPSON)				
ST10-1xx	N/A	S/W only	Contact Ingenieurbuero Strunck*3	68

Device	Package	Usage	Order These Items:	Channels Required
TSQWARE				
TS701	N/A	S/W only	Contact Cust. Supt. Cntr.*9	136
TS702	N/A	S/W only	Contact Cust. Supt. Cntr.*9	136
SOCKET 7				
AMD K6-2 100 MHz	PGA-321	Socketed	TMS109A + Opt. 01	136
6x86	PGA-296	Socketed	TMS109A + Opt. 01	136
6x86 100 MHz	PGA-296	Socketed	TMS109A + Opt. 01	136
P54C	PGA-296	Socketed	TMS109A + Opt. 01	136
P55C	PGA-296	Socketed	TMS109A + Opt. 01	136
Pentium	PGA-296	Socketed	TMS109A + Opt. 01	136
Winchip	PGA-296	Socketed	TMS109A + Opt. 01	136
TEXAS INSTRUMENTS				
C2000				
TMS320C2XLP	N/A	S/W only	Contact Cust. Supt. Cntr.*9	102
TMS320C207	N/A	S/W only	Contact Cust. Supt. Cntr.*9	102
TMS320C209	N/A	S/W only	Contact Cust. Supt. Cntr.*9	102
TMS320C27xx	N/A	S/W only	Contact Cust. Supt. Cntr.*9	
C5000				
TMS320C548	N/A	S/W only	Contact Cust. Supt. Cntr.*9	
C6000				
TMS320C6201	N/A	S/W only	TMS710; for BGA Probe, BC-VI-2-26ZD/1, Contact Emulation Tech*6	102
TMS320C6701	N/A	S/W only	TMS710; for BGA Probe, BC-VI-2-26ZD/1, Contact Emulation Tech*6	102
C2x/3x/4x/5x				
TMS32020	PGA-68	Socketed	Contact Cust. Supt. Cntr.*9	68
TMS32020	PLCC-68	Socketed	Contact Cust. Supt. Cntr.*9	68
TMS320C25	PGA-68	Socketed	Contact Cust. Supt. Cntr.*9	68
TMS320C25	PLCC-68	Socketed	Contact Cust. Supt. Cntr.*9	68
TMS320C26	PLCC-68	Socketed	Contact Cust. Supt. Cntr.*9	68
TMS320C30	PGA-181	Socketed	TMS702 + Opt. 01	102
TMS320C31	QFP-132	Soldered	TMS702 + Opt. 02	102
TMS320C32	N/A	S/W only	Contact Ingenieurbuero Strunck*3	102
TMS320C40	N/A	S/W only	Contact Cust. Supt. Cntr.*9	102
TMS320C50	N/A	S/W only	Contact Cust. Supt. Cntr.*9	102
TMS320C51	N/A	S/W only	Contact Cust. Supt. Cntr.*9	102
TMS320C52	N/A	S/W only	Contact Cust. Supt. Cntr.*9	102
TMS320C53	N/A	S/W only	Contact Cust. Supt. Cntr.*9	102
TMS470	N/A	S/W only	Contact Cust. Supt. Cntr.*9 SEE ARM	102
ZILOG				
Z80	DIP-40	Socketed	TMS501 + Opt. 01	68
Z80	DIP-40	Soldered	TMS501 + Opt. 01 + 015-0646-00	68
Z180	N/A	S/W only	Contact Cust. Supt. Cntr.*9	102

Device	Package	Usage	Order These Items:	Channels Required
BUS SUPPORT				
1553A/B	N/A	N/A	Contact Cust. Supt. Cntr.*9 + PN 010-0572-00	102
AGP	N/A	Socketed	TMS806 + Opt. 01	136
AGP 4X	N/A	Socketed	Contact Cust. Supt. Cntr.*9	136
Rambus –Direct	RIMM	Socketed	TMS810+ Opt. 01	238
SCSI I/II "A" (8-bit)	Unshielded Ribbon		TMS802 + Opt. 01	102
SCSI I/II "A" (8-bit)	Shielded Ribbon		TMS802 + Opt. 01	102
SCSI I/II "A" (8-bit)	Shielded High-density		TMS802 + Opt. 01	102
SCSI II "P" (16-bit)	Shielded High-density		TMS802 + Opt. 01	102
APIC Bus (Intel)			TMS801 + Opt. 01	102
GPIB		S/W only	Contact Cust. Supt. Cntr.*9	68
PCI			NEX-PCI Contact New Wave PDG*1	102
PCI32 @ 3 V			VNEX-PCI32EXHD3 Contact New Wave PDG*1	102
PCI32 @ 5 V			VNEX-PCI32EXHD5 Contact New Wave PDG*1	102
PCI64 @ 3 V			VNEX-PCI64EXHD3 Contact New Wave PDG*1	102
PCI64 @ 5 V			VNEX-PCI64EXHD5 Contact New Wave PDG*1	102
PCI Mezzanine Cd.			NEX-PMC Contact New Wave PDG*1	102
Cardbus			NEX-CARDBUS Contact New Wave PDG*1	68
Compact PCI			NEX-CPCI Contact New Wave PDG*1	102
32&64 PCI-SW		S/W only	NEX-PCISW Contact New Wave PDG*1	102
S-DIMM	168-Pin	Socketed	NEX-SDIMM168 Contact New Wave PDG*1	136
VME			NEX-VME Contact New Wave PDG*1	102
ISA			NEX-EISA Contact New Wave PDG*1	102
EISA			NEX-ISA Contact New Wave PDG*1	102
Micro Channel			NEX-MCA Contact New Wave PDG*1	102
SIMM	72-Pin	Socketed	NEX-SIMM72 Contact New Wave PDG*1	102
PCMCIA			NEX-PCMCIA Contact New Wave PDG*1	102
USB basic suppot	N/A		CHS-USB-1LC Contact Crescent Heart Software*3	68
USB Optimized Perf.	N/A		CHS-USB-1OP Contact Crescent Heart Software*3	68
USB High Performance	N/A		CHS-USB-1XP Contact Crescent Heart Software*3	102/136
I2C	N/A	S/W only	Contact Cust. Supt. Cntr.*9	
Mil-1750A Generic	N/A	S/W only	Contact Cust. Supt. Cntr.*9	
PROBING ACCESSORIES				
Mictor Breakout			NEX-HDEXT Contact New Wave PDG*1	
Mictor to 20-pin header			NEX-HD20 Contact New Wave PDG*1	
Mictor Swizzle Board			NEX-HDSWIZ Contact New Wave PDG*1	

*1 *Order directly from:*
New Wave PDG, 59 Davis Ave., Norwood, MA 02062, USA,
(603) 595-8116 (phone), (781) 762-9445 (fax),
E-mail: busboards@aol.com, http://www.busboards.com

*2 *Order directly from:*
Ironwood Electronics, P.O. Box 21151, St. Paul, MN 55121, USA,
(651) 452-8100 (phone), (651) 452-8400 (Fax),
E-mail: info@ironwoodelectronics.com,
http://www.ironwoodelectronics.com

*3 *Order directly from:*
Crescent Heart Software, 2143 SE 55th Ave. , Portland, OR 97215-3925, USA, (503) 232-2232 (phone), (503) 232-2255 (Fax),
E-mail: sales@c-h-s.com, http://www.c-h-s.com

*4 *Order directly from:*
Dragonfly Software Development LLC, 8196 Southwest Hall Blvd. Suite 104, Beaverton, OR 97008, USA,
(503) 641-3440 (phone), (503) 641-7226 (fax),
E-mail: sales@dfsw.com, http://www.dfsw.com

*5 *Order directly from:*
Ingenieurbuero Strunck, Aplerbecker str. 443c, D-44287 Dortmund, Germany, 49-231-447126 (phone), E-mail: salimh@t-online.de

*6 *Order directly from:*
Emulation Technology, 2344 Walsh Avenue,
Bldg. F, Santa Clara, CA 95051, USA,
(408) 982-0660 (phone), (408) 982-0664 (fax), (800) ADA-PTER,
http://www.emulation.com

*7 *Order directly from:*
JM Engineering, 3502 East Boulder Street, Colorado Springs, CO 80909, USA, (719) 591-1119 (phone), (719) 637-1777 (fax),
http://www.deltaprobe.com/

*8 *Order directly from:*
ITT Pomona, 1500 East Ninth Street, Pomona, CA 91766-3835, USA,
(909) 469-2900 (phone), (909) 629-3317 (fax),
http://www.pomomaelectronics.com

*9 *Order directly from:*
Tektronix Customer Support Center,
(503) 627-2400 (phone), (800) 835-5695 (toll free in USA),
(503) 627-5695 (fax),
http://www.tek.com/Measurement/Support

RF and Wireless Test Products

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Tektronix RF and Wireless Test Capabilities Cover a Broad Spectrum

Tektronix offers a value-packed line of RF, microwave and wireless communication test products. The list includes a wide selection of spectrum analyzers, signal generators, network analyzers, communication test sets, and power meters, along with complementary ancillary equipment and software covering the following applications:

- Avionics
- Bio-Medical
- Cable TV
- Common Carrier
- Design and Development
- Education
- EMC
- EW
- Manufacturing Test
- Millimeter Test
- Millimeter Wave R & D
- Radar
- Research
- Satellite Communication
- Service
- TV/Radio Broadcasting
- Wireless Communications

SPECTRUM ANALYZERS

INTRODUCTION

Tektronix offers a broad range of spectrum analyzers. The selection ranges from high performance, high throughput models for communications test to lightweight, battery powered units suited for field use.

EXTENSIVE PRODUCTS FOR COMMUNICATIONS TEST

Testing mobile communications systems presents many unique challenges. Tektronix has products designed for meeting the specific measurement requirements of CMDA, GSM, IS-136 and AMPS along with the emerging next generation (3G) systems. In addition to spectral analysis, powerful code domain and modulation domain analysis options are available on several models.

REAL TIME SPECTRUM ANALYZERS OFFER NEW MEASUREMENT CAPABILITIES

Tektronix' new range of real time spectrum analyzers provide new data capture and analysis capabilities. The DSP/FFT based architecture acquires RF data in parallel instead of sweeping. The benefits of real time spectrum analysis include:

- Acquiring seamless blocks of RF data for immediate or post-analysis
- RF event triggering for capturing elusive events
- Modulation and code domain analysis (3066 and 3086 only)

SPECTRUM ANALYZERS FOR RADIO COMMUNICATION

FSEB20/30

FSEA20/30

FSIQ3/7/26

R3465

R3463

R3267

MICROWAVE SPECTRUM ANALYZERS

FSEM20/30

FSEK20/30

R3272

R3273

REAL TIME SPECTRUM ANALYZERS

3026

3066

3086

GENERAL PURPOSE SPECTRUM ANALYZERS

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U3641

R3132

R3132/N

R3162

2712

2711

U3661

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MICROWAVE SPECTRUM ANALYZERS

Designation	Type	Frequency	Description
Spectrum Analyzers	FSEM 20 FSEM 30 FSEK 20 FSEK 30	9 kHz to 26.5 GHz 20 Hz to 26.5 GHz 9 kHz to 40 GHz 20 Hz to 40 GHz	Highest measuring accuracy and measurement speed: general-purpose spectrum and network analysis as well as special signal analysis for digital communication systems
Spectrum Analyzers	R3273	100 Hz to 26.5 GHz	2G & 3G transmitter testing, final system development & manufacturing test; general purpose applications
Spectrum Analyzers	R3272	9 kHz to 26.5 GHz	Microwave analyzer, with external mixer up to 325 GHz

SPECTRUM ANALYZER SELECTION GUIDE

Specifications	R3267	R3272	FSEM20	R3273	FSEM30	FSEK20	FSEK30
Frequency Range	100 Hz to 8 GHz	9 kHz to 26.5 GHz	9 kHz to 26.5 GHz	100 Hz to 26.5 GHz	20 Hz to 26.5 GHz	9 kHz to 40 GHz	20 Hz to 40 GHz
Frequency Measurement Accuracy (Aging)	±80 Hz @ 1 GHz	±245 Hz @ 10 GHz CF	20.01 kHz @ CF 20 GHz CF	±211 Hz @ 10 GHz CF	30 Hz @ 20 GHz CF	40.01 kHz @ 40 GHz CF	50 Hz @ 40 GHz CF
Resolution BW Range 1, 2, 3, 5 Sequence .	10 Hz to 10 MHz	300 Hz to 3 MHz, 5 MHz	10 Hz to 10 MHz 1, 3, 10 sequence	10 Hz to 3 MHz 1, 3, 10 sequence	1 Hz to 10 MHz 1, 2, 3, 5 Sequence	10 Hz to 10 MHz 1, 2, 3, 5 Sequence	1 Hz to 10 MHz 1, 2, 3, 5 Sequence
Residual FM	< 3 Hz p-p/0.1 s	<(3 Hz x Np-p/0.1 s)		3 Hz			
Phase Noise	–113 dBc/Hz @ 500 MHz CF, 10 kHz offset	–98 dBc/Hz @ 7.5 GHz CF, 10 kHz offset	–90 dBc/Hz @ 500 MHz CF, 10 kHz offset	–102 dBc/Hz @ 10 GHz CF, 10 kHz offset	–114 dBc/Hz @ 500 MHz CF, 10 kHz offset	–90 dBc/Hz @ 500 MHz CF, 10 kHz offset	–114 dBc/Hz @ 500 MHz CF, 10 kHz offset
CRT Display Range	100 dB	100 dB	200 dB	100 dB	200 dB	200 dB	200 dB
Frequency Response	±1.5 dB	±4.0 dB 15.4 to 26.5 GHz	±1 dB total to 1 GHz total	±4.0 dB 15.4 to 26.5 GHz measurement error	±1 dB total to 1 GHz total measurement error	±1 dB total to 1 GHz total measurement error	±1 dB total to 1 GHz total measurement error
Sensitivity	–148 dBm	–130 dB @ 10 GHz CF (typical)	–108 dBm	–138 dBm @ 10 GHz CF	–123 dBm	–148 dBm	–138 dBm
Environmental		0 to 50° C ≤85% RH	+5 to +40° C	MIL-T-28800 Class 5	+5 to +40° C	+5 to +40° C	+5 to +40° C
Weight		16.5 kg (36 lb.)	23.8 kg (52.4 lb.)	22 kg (48.5 lb.)	25.2 kg (55.4 lb.)	24.4. kg (53.7 lb.)	25.8 kg (56.8 lb.)
Features/Options							
Markers	10	10	8	8	8	8	8
Tracking Generator	Yes	No	No	Yes, R3371A	Yes	Yes	Yes
Card Reader/Floppy Disk	Yes, Card, Floppy	Yes (2) PCMCIA	Yes, Floppy	Yes, Card	Yes, Floppy	Yes, Floppy	Yes, Floppy
Preamplifier	No	No	No	No	No	No	No
Quasi Peak Detector	No	No	No	Yes	No	No	No
CISPR Bandwidths	No	No	No	Yes	No	No	No
Frequency Counter	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Analog Display	Yes (Quasi)	No	Yes (Quasi)	Yes, Pseudo Analog	Yes (Quasi)	Yes (Quasi)	Yes (Quasi)
75 Ω Input	No	No	No	No	No	No	No
AM/FM Demodulator	Yes	Yes, Options	Yes	Yes	Yes	Yes	Yes
Modulation Analysis	Yes	No	Yes (Opt. B7)	Yes, R3541C	Yes (Opt. B7)	Yes (Opt. B7)	Yes (Opt. B7)
GPIB	Yes	Yes	Yes	Yes	Yes	Yes	Yes
RS-232	Yes	Yes	Yes	No	Yes	Yes	Yes
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SPECTRUM ANALYZERS FOR RADIO COMMUNICATIONS

Designation	Type	Frequency	Description
Spectrum Analyzers	FSEA 20	9 kHz to 3.5 GHz	High-performance analyzers for digital mobile radio and general-purpose applications
	FSEA 30	20 Hz to 3.5 GHz	
	FSEB 20	9 kHz to 7 GHz	
	FSEB 30	20 Hz to 7 GHz	Highest measuring accuracy and measurement speed
Signal Analyzers	FSIQ3	20 Hz to 3.5 GHz	Signal analysis in fequency, time and modulation domain; 75 dB ACPR with W-CDMA
	FSIQ7	20 Hz to 7 GHz	
	FSIQ26	20 Hz to 26 GHz	
Spectrum Analyzers	R3267	100 Hz to 8 GHz	High performance 2G & 3G transmitter testing, final system development & manufacturing test; general purpose applications
Spectrum Analyzers	R3465	9 kHz to 8 GHz	With demodulation options for CDMA with code domain IS-13 DECT, PDC, PHS, FM
	R3463	9 kHz to 3 GHz	With demodulation options for CDMA with code domain IS-13 PDC, PHS

SPECTRUM ANALYZER SELECTION GUIDE

Specifications	R3463	FSEA20	FSEA30	R3465	FSEB20	FSEB30
Frequency Range	9 Hz to 3 GHz	9 kHz to 3.5 GHz	20 kHz to 3.5 GHz	9 kHz to 8 GHz	9 kHz to 7 GHz	20 Hz to 7 GHz
Frequency Measurement Accuracy	±75 Hz @ 1 GHz CF	±1.01 kHz @ 1 GHz CF	±11 Hz @ 1 GHz CF	±75 Hz @ 1 GHz CF	±1.01 kHz @ 1 GHz CF	±11 Hz @ 1 GHz CF
Resolution BW Range	300 Hz to 3 MHz, 5 MHz 1, 3, 10 sequence	1 Hz to 10 MHz 1, 2, 3, 5 sequence	1 Hz to 10 MHz 1, 2, 3, 5 sequence	300 Hz to 3 MHz, 5 MHz 1, 3, 10 sequence	10 Hz to 10 MHz 1, 2, 3, 5 sequence	1 Hz to 10 MHz 1, 2, 3, 5 sequence
Residual FM	<3 Hz p-p/0.1 s			<3 Hz p-p/0.1 s		
Phase Noise	–100 dBc/Hz @ 10 kHz offset	–96 dBc/Hz @ 500 MHz CF, 10 kHz offset	–120 dBc/Hz @ 500 MHz CF, 10 kHz offset	–100 dBc/Hz @ 10 kHz offset	–90 dBc/Hz @ 500 MHz CF, 10 kHz offset	–114 dBc/Hz @ 500 MHz CF, 10 kHz offset
CRT Display Range	100 dB	200 dB	200 dB	100 dB	200 dB	200 dB
Frequency Response	±1.5 dB	±1 dB total to 1 GHz total power measurement error	±1 dB total to 1 GHz total power measurement error	±1.5 dB	±1 dB total to 1 GHz total power measurement error	±1 dB total to 1 GHz total power measurement error
Sensitivity	–118 dBm (typical) @ 1 GHz CF	–145 dBm	–155 dBm	–118 dBm (typical) @ 1 GHz CF	–142 dBm	–152 dBm
Environmental	0 to 50° C 85% RH	5 to 40° C	5 to 40° C	0 to 50° C 85% RH	5 to 40° C	5 to 40° C
Weight	16 kg (35.3 lb.)	21.5 kg (47.3 lb.)	22.7 kg (49.9 lb.)	16 kg (35.3 lb.)	21.8 kg (48 lb.)	23 kg (50.6 lb.)
Features/Options						
Markers	10	8	8	10	8	8
Tracking Generator	No	Yes	Yes	No	Yes	Yes
Card Reader/Floppy Disk	Yes (2) PCMCIA	Yes, Floppy	Yes, Floppy	Yes (2) PCMCIA	Yes, Floppy	Yes, Floppy
Preamplifier	No	No	No	No	No	No
Quasi Peak Detector	No	No	No	No	No	No
CISPR Bandwidths	No	No	No	No	No	No
Frequency Counter	Yes	Yes	Yes	Yes	Yes	Yes
Analog Display	No	Yes (Quasi)	Yes (Quasi)	No	Yes (Quasi)	Yes (Quasi)
75 Ω Input	No	No	No	No	No	No
AM/FM Demodulator	Yes	Yes	Yes	Yes	Yes	Yes
Modulation Analysis	Yes	Yes, Opt. 07	Yes, Opt. 07	Yes	Yes, Opt. 07	Yes, Opt. 07
GPIB	Yes	Yes	Yes	Yes	Yes	Yes
RS-232	Yes	Yes	Yes	Yes	Yes	Yes
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GENERAL SPECTRUM ANALYZERS

Designation	Type	Frequency	Description
Spectrum Analyzers	R3131	10 kHz to 3.5 GHz	General-purpose analyzer for use in development, production, testshop and service
Spectrum Analyzers	U3641 U3661	9 kHz to 3 GHz 9 kHz to 26.5 GHz	Lightweight, portable analyzers, with battery options, with synthesizer accuracy for mobil test
Spectrum Analyzers	R3132 R3132N R3162	9 kHz to 2.6 GHz 9 kHz to 3.6 GHz 9 kHz to 8 GHz	General applications in development, production, testshop and service as well as EMC precertification

SPECTRUM ANALYZER SELECTION GUIDE

Specifications	U3641/U3641N	U3661	R3131	R3132/R3132N	R3162
Frequency Range	9 kHz to 3.0 Ghz	9 kHz to 26.5 GHz	9 kHz to 3 GHz	9 kHz to 3 GHz	9 kHz to 8 GHz
Frequency Measurement Accuracy	1.2 kHz	1.2 kHz	3.6 kHz	1.2 kHz	1.2 kHz
Resolution Bandwidth Range	1 kHz to 3 MHz (Opt. 30, 300 Hz)	1kHz to 3 MHz, 100 Hz, 300Hz	1 kHz to 1 MHz (Opt. 30, 300 Hz) (with Opt. 26)	1 kHz to 3 MHz (Opt. 30, 300 Hz)	1 kHz to 3 MHz (Opt. 30, 300 Hz)
Residual FM	<60 Hz p-p	<60 Hz p-p	<100Hz p-p	< 60 Hz P-P	< 60 Hz P-P
Phase Noise	<100dBc/Hz (10 kHz offset)	<100dBc/Hz (10 kHz offset)	<100dBc/Hz (20 kHz offset)	<-100dBz/Hz (10 kHz offset)	<-100dBz/Hz (10 kHz offset)
Display Range	100dB	100 dB	80 dB	100 dB	100 dB
Frequency Reponse	≤±1 dB	≤±1 dB	≤±1 dB	≤±1 dB	≤±1 dB
Sensitivity	-117 dBm (-135 dBm preamp)	-117 dBm (-135 dBm preamp)	-113 dBm	-118dBM (preamp off) -132dBM (preamp on)	-118dBM (preamp off) -132dBM (preamp on)
Environmental	0° to +50° C	0° to +50° C	0° to +50° C	0° to +50° C	0° to +50° C
Weight	6.9 kg (15.2 lbs.)	8.5 kg (18.7 lbs.)	12 kg (26.5 lbs.)	14 kg (30.5 lbs.)	14 kg (30.5 lbs.)
Features/Options					
Markers	6	6	2	10	10
Tracking Generator	w/ Opt. 74	w/ Opt. 74	w/ Opt. 74	w/ Opt. 74	w/ Opt. 74
Card Reader/Floppy	Yes PC card (2)	Yes PC card (2)	3.5 in., MS DOS format	3.5 in., MS DOS format	3.5 in., MS DOS format
Preamplifier	Yes	Yes	No	Yes	Yes
QP Detector	No	No	Yes	Yes	Yes
CISPR Bandwidths	No	No	Yes	Yes	Yes
Frequency Counter	Yes	Yes	Yes	Yes	Yes
Analog Display	No	No	No	No	No
75ohm Input	Yes N version	No	No	Yes N version	No
AM/FM Demod	Yes	Yes	Yes	Yes	Yes
Modulation Analysis	No	No	No	No	No
GPIB	Yes	Yes	Yes	Yes	Yes
RS-232	Yes	Yes	Yes	Yes	Yes
Parallel	No	No	Yes	Yes	Yes
VGA Out	Composite video	Composite video	No	Yes	Yes
Page	188	182	192	185	185

General Spectrum Analyzers

Designation	Type	Frequency	Description
Spectrum Analyzers	2712	9 kHz to 1.8 GHz	EMC measurements for pre-certification testing and troubleshooting EMC Ancilliary devices
	2711	9 kHz to 1.8 GHz	SPA affordably priced for use in checking broadcast transmitter performance and looking for unwanted RF emissions

Spectrum Analyzer Selection Guide

Specifications	2712	2714/2715	2711
Frequency Range	9 kHz to 1.8 GHz	9 kHz to 1.8 GHz	9 kHz to 1.8 GHz
Frequency Measurement Accuracy	±510 Hz @ 1 GHz CF	±510 Hz @ 1 GHz CF	±15 kHz @ 1 GHz CF
Resolution BW Range	300 Hz, 3 kHz, 30 kHz, 300 kHz, 5 MHz	300 Hz to 5 MHz 1, 3, 10 sequence	3 kHz, 30 kHz, 300 kHz, 5 MHz
Residual FM	≤100 Hz	≤100 Hz	≤2 kHz
Phase Noise	–97 dBc @ 1 GHz CF, 10 kHz offset	–97 dBc @ 1 GHz CF, 10 kHz offset	–97 dBc @ 1 GHz CF, 10 kHz offset
CRT Display Range	80 dB	80 dB	80 dB
Frequency Response	±1.5 dB	±1.5 dB	±1.5 dB
Sensitivity	–127 dBm, –139 dBm with Preamp @ 1 GHz CF	–78 dBmV, –90 dBmV with Preamp @ 1 GHz CF	–117 dBm, –129 dBm with Preamp @ 1 GHz CF
Environmental	MIL-T-28800 Class 5	MIL-T-28800 Class 5	MIL-T-28800 Class 5
Weight	10 kg (22 lb.)	10 kg (22 lb.)	10 kg (22 lb.)
Features/Options			
Intelligent Markers	2	2	2
Tracking Generator	Yes, Opt. 04 internal, Opt. 05 external	Yes, Opt. 05 external	Yes, Opt. 04 internal, Opt. 05 external
Card Reader/Floppy Disk	No	No	No
Preamplifier	Yes	Yes	Yes
Quasi Peak Detector	Yes, Opt. 12	No	No
CISPR Bandwidths	Yes, Opt. 12	No	No
Frequency Counter	Yes	Yes	Yes, Opt. 02
Analog Display	Yes	Yes	Yes
75 Ω Input	Yes, external matching pad	Yes	Yes, external matching pad
AM/FM Demodulator	Yes	Yes	Yes
Modulation Analysis	No	No	No
GPIB	Yes	Yes, Opt. 03	Yes, Opt. 03
RS-232	Yes, Opt. 08 (N/C)	Yes, Opt. 08 (N/C)	Yes, Opt. 08 (N/C)
Page	194	384	194

Real-time Spectrum Analyzers

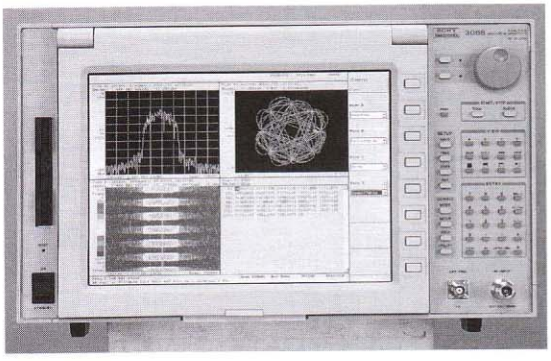
Designation	Type	Frequency	Application
Real time spectrum analyzers	3026	50 HZ to 3 GHz	Transient interference capture, PLL design, cable modem analysis
Real time spectrum analyzers	3066	DC to 3 GHz	3 G system design including modulation analysis to 5.2 Msymbols/sec, IS95 code domain option
Real time spectrum analyzers	3086	DC to 3 GHz	3 G system design including modulation to 20.48 Msymbols/sec, code domain power for IS95 and W-CDMA

Specifications

	3026	3066	3086
Instantaneous Spectral BW	2 MHz	5 MHz	30 MHz
Max. Modulation Analysis Rate	No Digital Modulation Analysis	5.3 MS/s	20.48 MS/s
I & Q Inputs	No	No	Yes
Frequency Event Trigger	Yes: 2 MHz BW	Yes: 5 MHz BW	Yes: 5 MHz BW
Zoom	No	Yes	Yes
IS-95 Code Domain power	No	Yes: Opt. 15	Yes: Opt. 16
W-CDMA Code Domain Power	No	No	Yes: Opt. 15

Real-Time Spectrum Analyzers

New 3066 • New 3086



Features – Benefits

- Seamless Acquisition for Capture of Short Duration or Intermittent Events
- Analyzes in Frequency, Time and Modulation Domain
- DC to 3 GHz Coverage
- Frequency Event Trigger for Acquisition of Burst or Infrequently Occurring Signals
- Post Capture 1000:1 Zoom Allows Analysis of Individual Signals after Wideband Capture

Applications

- 1st, 2nd, and 3rd Generation Cellular/PCS R&D – Including GSM, CDMA, IS-136, PDC, W-CDMA
- Signature Analysis
- Spectrum Monitoring
- Settling Time Measurements for Oscillators and Synthesizers
- Phase Hit Capture and Measurement
- Debugging of Hardware/Software Interface Problems

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

CE

GPIB IEEE-488

Product(s) complies with IEEE Standard 488.1-1987, RS-232-C, and with Tektronix Standard Codes and Formats.

SONY Tektronix

ISO9002 Certified JMI-0113

The 3066 and 3086 are DC to 3 GHz real-time spectrum analyzers that allow the seamless capture of frequency spectra with spans up to 30 MHz (5 MHz – 3066). This allows the spectrum of burst signals, such as those from GSM, IS-136, PDC or partial rate CDMA mobile stations, to be easily captured and examined. Real-time spectrum analyzers take a whole different approach compared to traditional sweeping spectrum analyzers. Rather than acquiring one frequency step at a time, the real-time instrument captures a block of frequencies all at once. Because the instrument samples these full frames constantly (rather than waiting for each discrete frequency step to be measured), the signal can come or go as it pleases and the real-time spectrum analyzer will detect the change instantly.

The 12.1 in. color TFT display allows easy viewing of spectrum, waterfall displays, spectrograms and digital modulation analysis screens. Constellation and vector diagrams can be displayed as well as frequency, phase, magnitude, I and Q versus time for in-depth analysis of digitally modulated signals. Users can move a marker through the time record and analyze the modulation at any point. In particular, signals with symbol rates up to 20.48 Msymbols/sec (3066 – 5.3 Msymbols/sec) may be analyzed during and after capture. This facilitates analysis of W-CDMA signals with chip rates up to 16.384 Mcps.

In addition, a frequency mask trigger allows the capture of randomly occurring or infrequent signals such as intermittent spurious emissions. If the user is not interested in the period between transmission bursts, the frequency mask trigger allows capture of the "burst-on" periods, thus maximizing the number of bursts that can be captured in memory for subsequent spectral, time or modulation analysis. The user can graphically define the frequency trigger mask; this allows the trigger condition to be generated by a particular event in the frequency domain irrespective of other activity within the displayed span. This is a major benefit when the trigger condition is used to capture signals arising from intermittent spurious or spectral re-growth events.

A 1000:1 zoom capability permits analysis to be performed on an individual signal in a multi-signal environment.

CHARACTERISTICS

INPUT/MEMORY MODE RELATED

Input Mode – RF, Baseband; Wideband, IQ (3086 only).
Input Connector – N type (RF, Baseband, Wideband), BNC type (IQ).
Input Impedance – 50 Ω.
VSWR (N type) – 1.5 (Reference Level ≥-20 dBm).
Acquisition Mode – Roll, Block.
Acquisition Memory Size – 16 Mbytes.
Acquisition Memory Management –
RF, Baseband Input
Memory Mode: Frequency, Dual, Zoom.
FFT Points: 1024, 256 (Frequency Mode).
FFT Window: Rectangular, Hamming, Blackman-Harris.
Block Size:
1 to 16,000 Frames (Frequency Mode, 256 pt).
1 to 4,000 Frames (Frequency Mode, 1024 pt).
1 to 2,000 Frames (Dual, Zoom Mode).
Minimum Frame Update Time:
20 µs (Frequency Mode, 256 pt).
80 µs (Frequency Mode, 1024 pt).
160 µs (Dual, Zoom Mode).

Wideband, IQ Input (3086 only) –
Memory Mode: Zoom.
FFT Points: 1024.
FFT Window: Rectangular, Hamming, Blackman-Harris.
Block Size: 1 to 2,000 Frames.
Minimum Frame: 25 µs.

FREQUENCY STANDARD RELATED

Characteristic	Description
Reference frequency	10 MHz
Initial frequency tolerance	± 0.1 ppm
Frequency stability Aging	± 0.0005 ppm/day
Temperature	± 0.002 ppm (5 to 40° C)

RF INPUT RELATED

Frequency –
Range: 10 MHz to 3 GHz.
Center Frequency Settability: 0.1 Hz.
Span: 100 Hz to 3 GHz.
Vector Span: 100 Hz to 6 MHz.
Real-time Span: 100 Hz to 5 MHz.
Number of Bins:
641 (100 Hz to 2 MHz span).
801 (5 MHz span).
481 (6 MHz span).
Span/6250 + 1 (span ≥ 10 MHz).
Spectrum Purity: –100 dBc/Hz (1 GHz CF, 200 kHz span, 0 dBm ref, 10 kHz offset).
Residual FM: 3 Hz p-p.

Amplitude –
Reference Level: –50 dBm to +30 dBm.
Maximum Nondestructive Input Power: +30 dBm.
Self Gain-Calibration Accuracy: ±1.0 dB at 25 MHz within 5°C temperature variation.
Flatness: ±2.0 dB (10 MHz to 3 GHz).
Input Equivalent Noise: –140 dBm/Hz.
3rd Order Distortion: –65 dBc (–10 dBfs input, at 1 GHz).
Residual Response: –70 dBfs (0 dBm ref, 5 MHz span).
Image Suppression: 70 dB.
Spurious Free Dynamic Range (1 GHz CF, 0 dBm REF, sinusoidal signal at the center, spur apart more than 10 kHz from the signal):
80 dB at 50 kHz span.
75 dB at 100 kHz span.
70 dB at 200 kHz and 500 kHz span.
65 dB at 1/2/5 MHz span.

BASEBAND INPUT RELATED

Frequency –
Range: DC to 10 MHz.
Center Frequency Settability: 0.1 Hz.
Span: 100 Hz to 10 MHz.
Vector Span: 100 Hz to 6 MHz.
Real-time Span: 100 Hz to 5 MHz.
Number of Bins:
641 (100 Hz to 2 MHz span).
801 (5 MHz and 10 MHz span).
481 (6 MHz span).
Spectrum Purity: –100 dBc/Hz (5 MHz CF, 200 kHz span, 0 dBm ref, 10 kHz offset).
Residual FM: 2 Hz p-p.

Amplitude –
Reference Level: –30 dBm to +30 dBm.
Maximum Nondestructive Input Power: +30 dBm.
Reference Level Accuracy: ±0.5 dB at 5 MHz.
Flatness: ±1.0 dB (1 MHz to 10 MHz).
Input Equivalent Noise: –150 dBm/Hz.
2nd Harmonic Distortion: –70 dBc (at 4.5 MHz).
DC Offset: –40 dBfs.
Residual Response: –70 dBfs (5 MHz CF, 5 MHz span, 0 dBm ref).
Alias Suppression: 65 dB.
Spurious Free Dynamic Range (5 MHz CF, 0 dBm ref, sinusoidal signal at the center, spur apart more than 10 kHz from the signal):
85 dB at 50 kHz span.
80 dB at 100 kHz span.
75 dB at 200 kHz span.
70 dB at 500 kHz span.
70 dB at 1/2/5 MHz span.

WIDEBAND INPUT RELATED (3086 ONLY)

Frequency – Range: 50 MHz to 3 GHz.
Center Frequency Settability: 0.1 Hz.
Span: 10 MHz, 20 MHz, 30 MHz.
Vector Span: 10 MHz, 20 MHz, 30 MHz.
Number of Bins:
501 (10 MHz and 20 MHz span).
751 (30 MHz span).

Amplitude –
Reference Level: –50 dBm to +30 dBm.
Maximum Nondestructive Input Power: +30 dBm.
Flatness within Span: ±1 dB (25° C ±5° C).
Input Equivalent Noise: –140 dBm/Hz.
3rd Order Distortion: –65 dBc (–10 dBfs input, at 1 GHz).
Residual Response: –60 dBfs (0 dBm ref, 30 MHz span).
Image Suppression: 70 dB.
Spurious Free Dynamic Range (1 GHz CF, 0 dBm ref, sinusoidal signal at the center, spur apart more than 500 kHz from the signal):
65 dB at 10 MHz span.
60 dB at 20 MHz and 30 MHz span.

IQ INPUT RELATED (3086 ONLY)

Frequency –
Range: ±15 MHz.
Span: 10 MHz, 20 MHz, 30 MHz.
Vector Span: 10 MHz, 20 MHz, 30 MHz.
Number of Bins:
501 (10 MHz and 20 MHz span).
751 (30 MHz span).

Amplitude –
Reference Level: 100 mV (amplitude of IQ signal).
Maximum Nondestructive Input Power: ±5 V.
Flatness within Span: ±0.5 dB (25° C ±5° C).
Residual Response: –60 dBfs (30 MHz span).
Alias Suppression: 55 dB.
Spurious free dynamic range (1 GHz CF, 0 dBm ref, sinusoidal signal at the center, spur apart more than 500 kHz from the signal):
65 dB at 10 MHz span.
60 dB at 20 MHz and 30 MHz span.

FRAME TIME RELATED

FRAME TIME (3086)

Span	1024 point	256 point
Baseband Mode:		
10 MHz	80 µs	20 µs
RF Mode and Baseband Mode:		
6 MHz	80 µs	20 µs
5 MHz	160 µs	40 µs
2 MHz	320 µs	80 µs
1 MHz	640 µs	160 µs
500 kHz	1280 µs	320 µs
200 kHz	3200 µs	800 µs
100 kHz	6.4 ms	1.6 ms
50 kHz	12.8 ms	3.2 ms
20 kHz	32 ms	8 ms
10 kHz	64 ms	16 ms
5 kHz	128 ms	32 ms
2 kHz	320 ms	80 ms
1 kHz	640 ms	160 ms
500 Hz	1280 ms	320 ms
200 Hz	3200 ms	800 ms
100 Hz	6400 ms	1600 ms

Span	1024 point	256 point
Wideband/IQ Input Modes: 3086 Only		
30 MHz	25 µs	25 µs
20 MHz	25 µs	25 µs
10 MHz	50 µs	50 µs

TRIGGER RELATED

Trigger Mode – Auto, Normal, Quick, Delayed, Interval, Quick-interval, Timeout, Auto, Normal [RF (span ≤ 6 MHz) and Baseband Input, Wideband and IQ Input (3086 only)].

Trigger Source – Internal/External.

Trigger Domain – Frequency, Time.

Trigger Position – 0 to 100%.

Frequency Trigger Mask –
Frequency Resolution: 1 bin.
Trigger Level Range: 0 dBfs to –70 dBfs.

Time Trigger Mask –
Time Resolution: 1 data point.
Trigger Level Range: 0 dBfs to –40 dBfs.

External Trigger Threshold Level – 1.6 V.

MARKER ZOOM RELATED

Marker –
Marker Type: Normal, Delta, Band-Power.
Search Function: Peak Right, Peak Left, Maximum.
Link between Views: On/Off.

Measurement Function – Noise Power, Power within Band, C/N, Adjacent Channel Power, Occupied Bandwidth.

Digital Zoom –
Zoom Ratio: 2 to 1000.
Maximum Span in the Zoom Mode: 5 MHz (RF, Baseband), 30 MHz (Wideband, IQ, 3086 only).

DIGITAL DEMODULATION RELATED

Characteristic	Description
Demodulator	
Carrier type	Continuous, Burst
Modulation format	BPSK, QPSK, pi/4 Shift DQPSK, 8PSK, OQPSK, 16QAM, 64QAM, GMSK
Measurement filter	Root Cosine
Reference filter	Cosine, Gauss
Filter parameter	alpha/BT: 0.0001 to 1, 0.0001 step
Maximum symbol rate	5.3 Msps (RF, Baseband); 20.48 Msps (Wideband, IQ; the 3086 only)
Standard setup	PDC, PHS, NADC, TETRA, GSM, CDPD, IS-95, T-53
Display format	
Vector diagram	Symbol/locus display, Frequency error measurement, Origin offset measurement
Constellation diagram	Symbol display, Frequency error measurement, Origin offset measurement
Eye diagram	I/Q/Trellis display (1 to 16 symbols)
Error vector diagram	EVM, Magnitude error, Phase error, Waveform quality (rho) measurement
Symbol table	Binary, Octal, Hexadecimal
Error measurement accuracy	
	10 frames averaged
PDC	EVM <1.2 %, Mag error <1.0 %, Phase error <0.8° (100 kHz span)
PHS	EVM <1.4 %, Mag error <1.2 %, Phase error <0.8° (1 MHz span)
GSM	EVM <1.8 %, Mag error <1.2 %, Phase error <1.0° (1 MHz span)
IS-95 reverse link	EVM <2.0 % (5 MHz span)
QPSK, 4.096 Msps, 2 GHz	EVM <2.5 % (20 MHz span)
QPSK, 16.384 Msps, 2 GHz	EVM <3.0 % (30 MHz span, 25° C ±5° C)

SYSTEM CONTROLLER

Pentium MMX 200 MHz, 64 Mbyte SIMM, Windows 95, PCI, ISA, TMP68301 16 MHz, 2.1 Gbyte 3.5 inch EIDE, 1.44 Mbyte floppy drive, GPIB IEEE488.1, Keyboard PC/AT (order separately), Centronics parallel port, SCSI 2.

ORDERING INFORMATION

For price information: Outside the U.S. contact your local Tektronix representative, inside the U.S. see the price list in the back of this catalog.

3086
Real-time Spectrum Analyzer.
Includes: User Manual, U.S. Power Cord, mouse.

3066
Real-time Spectrum Analyzer.
Includes: User Manual, U.S. Power Cord.

OPTIONS

Opt. 1S – Data capture software.

MEASUREMENT SERVICE OPTIONS

Opt. C3 – Three years of calibration services.
Opt. C5 – Five years of calibration services.
Opt. D1 – Test Data.
Opt. D3 – Test data (requires Opt. C3).
Opt. R3 – Three years of repair protection.

INTERNATIONAL POWER PLUGS

Opt. A1 – Universal Euro 220 V, 50 Hz.
Opt. A2 – United Kingdom 240 V, 50 Hz.
Opt. A3 – Australian 240 V, 50 Hz.
Opt. A4 – North American 240 V, 60 Hz.
Opt. A5 – Switzerland 220 V, 50 Hz.
See page 619 for description.

RECOMMENDED ACCESSORIES

PC Display Analysis Software –
3066: Order SL7PC66.
3086: Order SL7PC86.

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

CE

GPIB IEEE-488

Product(s) complies with IEEE Standard 488.1-1987, RS-232-C, and with Tektronix Standard Codes and Formats.

SONY Tektronix

ISO9002 Certified
JMI-0113

Real-time Spectrum Analyzer

New 3026



Features – Benefits	Applications
2 MHz Real-time Signal Capture	Cellular/PCS Manufacturing Test
Simultaneous Time and Frequency Domain Capture	Pager Manufacturing Test
50 Hz to 3 GHz Frequency Coverage	RF Component Manufacturing Test Including DLL and Synthesizer Settling
Frequency, Time and Phase Analysis	Network Ingress Monitoring and Analysis
25,000 Frames/Second Measurement Speed	CATV Return-path Ingress Monitoring
Display Update Rate of 40 Microseconds	Radar System Fault Location and Maintenance
	Microwave Data Link Fault Location
	Computer Manufacturing/Test for EMC
	Surveillance

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

CE

GPIB IEEE-488

Product(s) complies with IEEE Standard 488.1-1987, RS-232-C, and with Tektronix Standard Codes and Formats.

SONY Tektronix

ISO9002 Certified JMI-0113

The new 3026 real-time Spectrum Analyzer provides design engineers and manufacturing final test evaluators of communications equipment an affordable product that can be used to quickly evaluate a design or the final product for transient (Burst) phenomena that otherwise might not show up until it is in the end user's hands.

The 3026 offers a full 2 MHz of real-time bandwidth with measurement speed of 25,000 frames/second and a 1024 point update interval of 160 microseconds. The captured events can be conveniently displayed in a variety of formats selectable by the user: Spectrum, Spectrogram and Waterfall. The analyzer architecture makes it possible to capture time domain data and frequency domain data simultaneously.

To catch instantaneous phenomenon like a transmitter startup, or the beginning of a digital TDMA or CDMA transmission, the 3026 provides frequency domain and time domain real-time triggering with a mask pattern that is easily edited in the built-in editor.

Application Examples

DIGITAL CELLULAR/PCS DESIGN, TEST AND MANUFACTURE

Current spectrum analyzers do not do a very good job of analyzing burst or intermittent signals. They sweep over a band of frequencies and are therefore not able to capture simultaneously the spectrum over a band of frequencies. This makes it difficult, or sometimes impossible, for a developer to identify problems, such as phase jumps, which will adversely affect a digitally modulated system.

Transient noise burst problems that are often associated with high frequency solid state communications equipment can be captured with a measurement speed of 25,000 frames/second and a 1024 point update interval of 160 microseconds reducing intermittent problem test time.

EMC

Common Carrier and CATV Network operators have to deal with Ingress that can disrupt trans-

mission in both the forward and return paths. This interference is often impulsive in nature and very difficult to capture with a conventional spectrum analyzer. The 3026 with its real-time capture capability allows rapid detection and analysis of such interference.

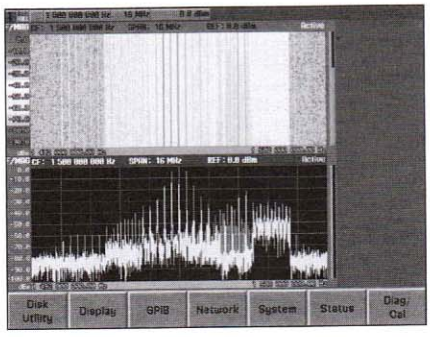
In the screen photo (1) (lower section of photo) below an interfering burst 4.8 MHz above the spectrum center is captured for analysis. In the upper spectrogram section the amplitude vs. frequency of the complete spectrum is displayed as a function of time (vertical axis). In the Spectrogram display, each line of pixels represents a frame, with the most recent frame displayed at the bottom.

TRANSITIONAL SIGNAL ANALYSIS

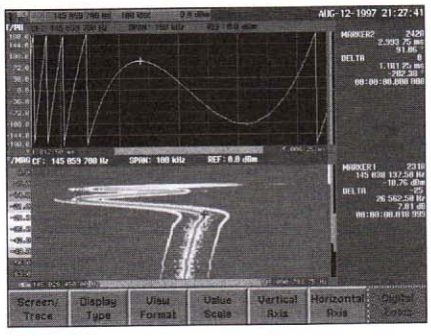
Bursting signals such as TDMA employ Phase Locked Loops (PLL) for frequency stability, a critical measurement of interest is the frequency change as the transmitter is keyed on and off.

The 3026 can capture this transition in time, frequency and phase as shown in this screen capture.

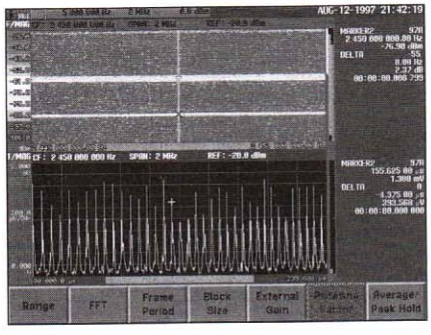
In the lower portion of the photo (2), we can see the change in Frequency vs. Time (spectrogram) and in the upper portion of the display we can see the phase change during transmitter activation. From this example, we find this transceiver makes a significant frequency, amplitude and phase shift until it stabilizes.



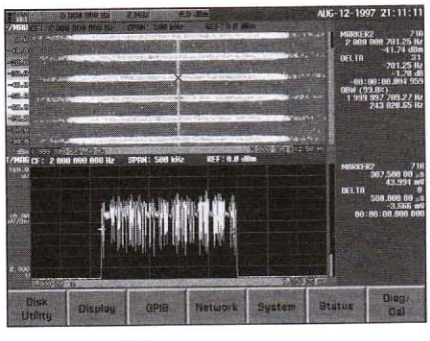
1) Signal Ingress.



2) PLL Frequency Settling.



3) Pulsed Signal.



4) CDMA Mobile Phone.

CHARACTERISTICS

FREQUENCY RELATED

Frequency Range –
RF Mode: 10 MHz to 3 GHz.
Baseband Mode: 50 Hz to 10 MHz.

Frequency Span –
RF Mode: 100 Hz to 3 GHz.
Baseband Mode: 100 Hz to 10 MHz.

Stability of Frequency Standard –
$\pm$ 5 x 10^{-9}/day.

Residual FM – 3 Hz max.

Spectrum Purity – -100 dBc/Hz (10 kHz offset).

Center Frequency Settability – 0.1 Hz.

AMPLITUDE RELATED

Reference Level Range –
RF mode: –50 to +30 dBm.
Baseband Mode: –30 to +30 dBm.

Input Impedance – 50 Ω.

Flatness –
±2.0 dB (>500 Hz).
+2.0, –5.0 dB (≤500 Hz).

Input Equivalent Noise –
-140 dBm/Hz at 1 GHz.

2nd Harmonic Distortion –
≤–70 dBc (–10 dBfs Input Level).

3rd Order Distortion –
≤–60 dBc (<20 MHz, ≤–10 dBfs Input).
≤–70 dBc (<20 MHz, ≤–10 dBfs Input).

A/D Converter – 12-Bits, 25.6 MS/s.

FFT points – 1024, 256.

FFT window – Blackman-Harris, Hamming, Rectangle.

MINIMUM FRAME UPDATE RATE

Span	1024 point	512 point
500 kHz to 5 MHz	16 µs	
500 kHz to 2 MHz		40 µ
50 kHz to 200 kHz	400 µs	400 µs
5 kHz to 20 kHz	4 ms	4 ms
500 Hz to 2 kHz	40 ms	40 ms
200 Hz	100 ms	100 ms
100 Hz	200 ms	200 ms

TRIGGER RELATED

Trigger Mode – Auto/Normal (Frequency and Time Events).

SYSTEM CONTROLLER

486DX4-100 (100 MHz Clock), 32 MB 60 ns Fast Page SIMM (non-parity), 2.5 inch 3 MB Solid State Drive, 2.5 inch 2.1 GB Hard Disk, 3.5 inch 2 HD (1.44 MB) Floppy Disk, On Board Ethernet LAN I/F, ISA Half Size GPIB.

POWER

Line Voltage Range – 90 to 250 VAC.
Line Frequency – 48 to 63 Hz.
Maximum Power – 300 W.
Maximum Current – 4 A.
Fuse Rating – 6 A, 250 V, Fast blow.
Primary Circuit Dielectric Voltage Withstand Test – 1500 V rms, 50 Hz for 15 seconds, without breakdown.

PHYSICAL CHARACTERISTICS

Dimensions	mm	in.
Height	165	6.5
Width	376	14.8
Depth	495	19.5
Weight	**kg**	**lb.**
Net	13	29

WARRANTY

One year parts and labor.

SAFETY

UL3111-1, CSA231, EN61010-1, IEC61010-1.
Self-declaration – EN61010-1 with second amendment.

For more comprehensive and environmental specifications, please see the Tektronix website.

ORDERING INFORMATION

For price information: Outside the U.S. contact your local Tektronix representative, inside the U.S. see the price list in the back of this catalog.

3026
Real Time Spectrum Analyzer.

Includes: (For U.S.) User Manual (Japanese 070-A676-02), Programmer's Manual (Japanese 070-A682-00), Application Software, Utility (VIEW3026, 3.5 in. Floppy, 062-A225-00), Power Cord (Power Cable Assy, 161-A005-00), 3-2 Adapter (103-0013-00).

Includes: (All other countries) User Manual (English 071-0418-00), Programmer's Manual (Japanese 071-0419-00), Application Software, Utility (VIEW3026, 3.5 in. Floppy, 062-A255-00), Power Cord (Power Cable Assy, 161-0230-01).

OPTIONS

Opt. 1R – Rackmount Kit.

INTERNATIONAL POWER PLUGS

Opt. A1 – Universal Euro 220 V, 50 Hz.
Opt. A2 – United Kingdom 240 V, 50 Hz.
Opt. A3 – Australian 240 V, 50 Hz.
Opt. A4 – North American 240 V, 60 Hz.
Opt. A5 – Switzerland 220 V, 50 Hz.
See page 619 for description.

MEASUREMENT SERVICE OPTIONS

Opt. C3 – Three years of calibration services.
Opt. C5 – Five years of calibration services.
Opt. D1 – Cal Data Report.
Opt. D3 – Test data (requires Opt. C3).
Opt. R3 – Repair warranty extended to cover three years.

OPTIONAL ACCESSORIES

Transit Carrying Case – Order 016-1157-00.

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

CE

GPIB IEEE-488

Product(s) complies with IEEE Standard 488.1-1987, RS-232-C, and with Tektronix Standard Codes and Formats.

SONY Tektronix

ISO9002 Certified
JMI 0113

Signal Analyzer

New FSIQ



Features – Benefits

Vector Signal Analyzer for W-CDMA

High-speed Synthesizer with 5 ms Sweep Time for FULL SPAN (FSIQ3/7)

High Display Update Rate up to 25 sweeps/s

Large Color Display with High Resolution (24 cm/9.5 in. TFT)

Analysis of Frequency, Time and Modulation Domain in One Box

82 dB ACPR (Adjacent Channel Power Ratio) in 4.096 MHz Integration Bandwidth for Alternate Channel

True RMS Detector for Precise and Repeatable Measurements of Any Signal Type

3 Models and Frequency Ranges
- FSIQ 3: 20 Hz to 3.5 GHz
- FSIQ 7: 20 Hz to 7 GHz
- FSIQ 26: 20 Hz to 26 GHz

FFT Filter with 1 Hz to 1 kHz RBW for Fast Measurements

Third-order Intercept +20 dBm with FSIQ 7/26

Total Measurement Uncertainty:
- <1 dB up to 2.2 GHz
- <1.5 dB up to 7 GHz

Fast Time Domain Analysis with 1 µs Zero Span Sweep Time

Applications

Vector Analysis of W-CDMA and Other Wireless Signals

For Universal Analysis of Digital and Analog Modulated Signals BPSK to 16QAM, (G)MSK, AM, FM, PM

For High-throughput Production Applications

Coverage for Wireless and Aerospace Applications

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

CE

ROHDE&SCHWARZ
Rohde & Schwarz' quality system complies with the DIN ISO 9001 standard and has been certified by DQS (German Association for the Certification of Quality Systems).

FSIQ – the One Box Solution in Signal Analysis

FSIQ provides in a single unit comprehensive and easy-to-use measurement functions in the

- Frequency domain
- Time domain
- Modulation domain

FREQUENCY DOMAIN

In the frequency domain, FSIQ measures intermodulation and harmonics with great accuracy. The high 3rd-order intercept point in conjunction with the extremely low noise floor yields an intermodulation-free dynamic range of >110 dB and ensures reliable performance of even sophisticated measurements.

The excellent dynamic range and the optimized phase noise values make the FSIQ an ideal tool for ACPR (Adjacent Channel Power Ratio) measurements in all mobile radio systems and in particular for W-CDMA. The maximum ACPR value for W-CDMA in 4.096 MHz bandwidth is 75 dB, attained at –12 dBm input level.

The RMS detector available for all bandwidths up to 10 MHz is the ideal tool for precise power measurements whatever the waveform. Channel power and adjacent-channel power can accurately be measured and displayed irrespective of any signal statistics. Typical measurement problems such as the high and uncertain crest factor in CDMA systems can thus be eliminated and the true RMS value displayed.

TIME DOMAIN

In the time domain, FSIQ features all modern capabilities of burst analysis in TDMA systems; gate functions, trigger delay and integrated RF trigger in conjunction with a short sweep time of 1 µs ensure precise measurement of the timing characteristics of all main mobile radio systems.

Thanks to the wide range of bandwidths available up to 10 MHz the effect of the measuring instrument becomes negligible, particularly in the case of measurements on broadband systems.

Various marker functions in conjunction with editable gated sweeps allow RMS, average and peak measurements to be carried out over any selectable time.

MODULATION DOMAIN

In the modulation domain, the integrated vector signal analyzer provides diverse measurements on signals with digital or analog modulation. The variety of settings that can be called simply at a keystroke covers 18 mobile radio standards from GSM, NADC, IS95 through to W-CDMA. These convenient presets make it superfluous for the user to spend valuable time in looking up specifications and go towards enhancing the measurement reliability.

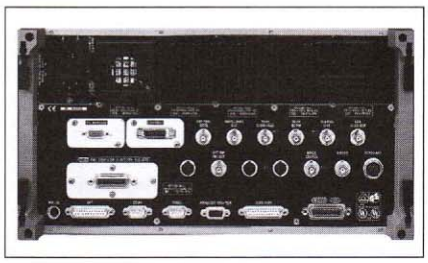
Display of the results caters to practically each and every need: in addition to vector and constellation diagrams, I/Q signal and eye/trellis diagrams, tables with modulation errors including the demodulated bit sequence are particularly useful. EVM (error vector magnitude), phase and frequency error, waveform factor and I/Q offset are output as numeric values, with RMS and peak value being shown separately.

Besides the mobile radio standards, FSIQ can also be used as a general purpose measurement demodulator for non-standard modulation methods. The list of the 14 digital demodulators available ranges from BPSK, QPSK and (G)MSK through to 16QAM. With a symbol rate selectable up to 6.4 Msymbol/s and cosine and root-cosine filters adjustable in 0.01 step width, configuration of customized systems is no problem.

The analog demodulators using digital technique throughout feature long term and temperature-independent measurements, e.g., of transmitter transients, or convenient measurement of incidental phase modulation (AM to phiM conversion) e.g., on traveling wave tubes.

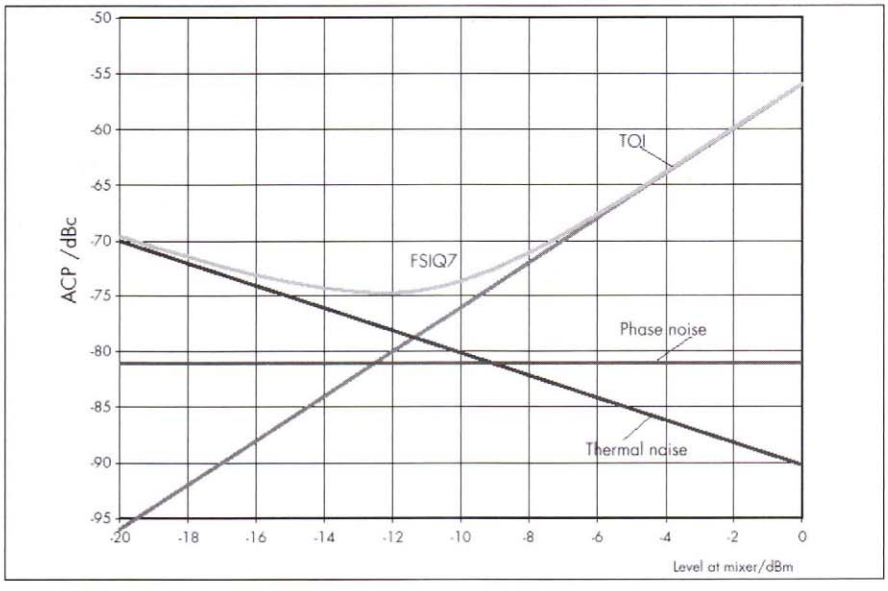
HIGH MEASUREMENT SPEED FOR USE IN DEVELOPMENT AND PRODUCTION

- The minimum sweep time for FULL SPAN is 5 ms (FSIQ3/7). The sweep is synthesizer-controlled for all frequency settings, thus providing considerably higher accuracy of the displayed spectra than comparable spectrum analyzers



Rear View of FSIQ.

- The shortest sweep time in ZERO SPAN mode is 100 ns/div and ideal for high-resolution time measurements on burst edges
- Up to 25 sweeps/s is an optimal prerequisite for applications in production or fast alignments with "analog feeling"
- High throughput on GPIB bus saves time and costs in production



ACPR with W-CDMA (4.096 MHz integration BW).

FIRMWARE AND SOFTWARE OPTIONS

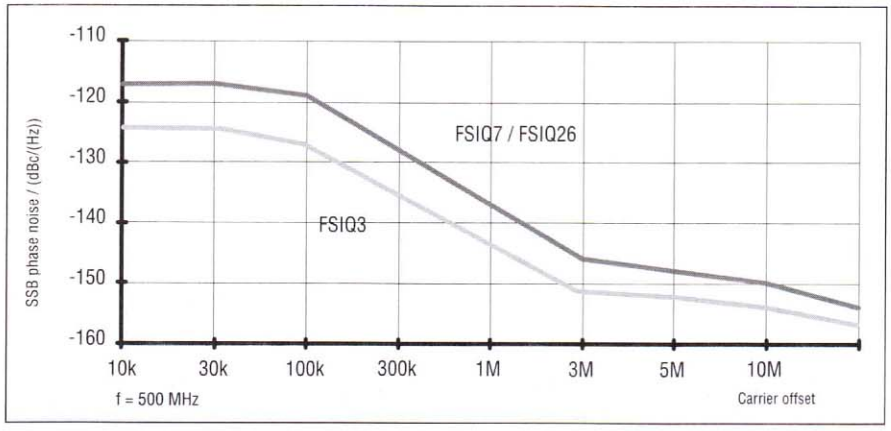
Designation	Type	Use	Functions
Noise measurement software	FS-K3	Noise figure measurements	Measurement of noise figure and temperature to Y-factor method Measurements on frequency-converting DUTs Frequency range same as basic unit, starting from 100 kHz Runs under Windows
		Editor for ENR tables	
Phase noise measurement software	FSE-K4	Phase noise measurements	Easy to use phase noise measurements Measurement of residual FM an PM Logarithmic plot over 8 decades Runs under Windows
Application firmware	FSE-K10, Mobile, FSE-K11, BTS	Mobile radio, transmitter measurements GSM standards, 11.10 and 11.20	Power ramp and power template Spectrum due to modulation/ switching Spurious emissions Mean carrier power Phase/frequency error (with Option FSE-B7)

See separately available data sheet.

CHARACTERISTICS

GENERAL DATA

	FSIQ3	FSIQ7	FSIQ26
Display		24 cm color display TFT (9.5")	
Resolution		640 x 480 pixels (VGA resolution)	
Mass memory		1.44 MB 3.5 in. floppy disk drive, hard disk	
Operating Temperature Range			
Nominal temperature range		+5° C to +40° C	
Limit temperature range		0° C to +50° C	
Storage temperature range		–40° C to +70° C	
Humidity		+40° C at 95% relative humidity (IEC 68-2-3)	
Power Supply			
AC supply		200 V to 240 V: 50 Hz to 60 Hz, 100 V to 120 V: 50 Hz to 400 Hz, protection class I to VDE 411	
Power consumption	195 VA	210 VA	245 VA
Safety		EN 61010-1, UL 3111-1, CSA1010, IEC61010-1	
Test mark		VDE, GS, UL, cUL	
Physical Characteristics			
Dimensions in mm (W x H x D)	435 x 236 x 460	435 x 236 x 570	435 x 236 x 570
Weight	24 kg	24.5 kg	26.5 kg



Phase noise for FSIQ3 (light gray) and FSIQ7/26 (dark gray).

ORDERING INFORMATION

For price information: Outside the U.S. contact your local Tektronix representative, inside the U.S. see the price list in the back of this catalog.

FSIQ3
Signal Analyzer 20 Hz to 3.5 GHz.
Order 1119.5005.03.
Includes: Keyboard, Mouse, Power Cable, Operating Manual, Spare Fuses.

FSIQ7
Signal Analyzer 20 Hz to 7 GHz.
Order 1119.5005.07.
Includes: Keyboard, Mouse, Power Cable, Operating Manual, Spare Fuses.

FSIQ26
Signal Analyzer 20 Hz to 26.5 GHz.
Order 1119.6001.26.
Includes: Keyboard, Mouse, Power Cable, Operating Manual, Spare Fuses.
Accessories Supplied –
Test-Port adapter 3.5 mm female. Order 1021.0521.00.
N female. Order 1021.0535.00.

OPTIONS

HARDWARE

FSE-B2 – 7 GHz Frequency Extension for FSIQ 3. Order 1073.5044.02.
FSE-B8 – Tracking Generator 3.5 GHz. Order 1066.4469.02.
FSE-B9 – Tracking Generator 3.5 GHz with I/Q Modulator. Order 1066.4617.02.
FSE-B10 – Tracking Generator 7 GHz. Order 1066.4769.02.
FSE-B11 – Tracking Generator 7 GHz with I/Q Modulator. Order 1066.4917.02.
FSE-B12 – Switchable Attenuator for Tracking Generator. Order 1066.5065.02.
FSE-B16 – Ethernet Interface 15-contact AUI connector. Order 1073.5973.0.
FSE-B16 – Thin-wire BNC connector. Order 1073.5973.03.
FSE-B17 – 2nd IEC/IEEE Bus Interface. Order 1066.4017.02.
FSE-B21*1 – External Mixer In/Output for FSIQ26. Order 1084.7243.02.
FSE-B22*1 – Increased Level Accuracy up to 2 GHz. Order 1106.3480.02.

SOFTWARE

FS-K3 – Noise Measurement Software. Order 1057.2996.02.
FSE-K4 – Phase Noise Measurement Software. Order 1108.0088.02.
FSE-K10 – GSM Test Software, Mobile. Order 1057.3092.02.
FSE-K11 – GSM Test Software, BTS. Order 1057.3392.02.

RECOMMENDED EXTRAS

FSE-Z1 – Service Kit. Order 1066.3862.02.
FSE-Z3 – DC Block, 5 MHz to 7 GHz, N-connector. Order 4010.3895.00.
FSE-Z4 – DC Block 10 kHz to 18 GHz, N-connector. Order 1084.7443.02.
FS-Z15 – Microwave Measurement Cable and Adapter Set for FSIQ26. Order 1046.2002.02.
Headphones – Order 0708.9010.00.

19 IN. RACK ADAPTER

ZZA-95 – With front handles. Order 0396.4911.00.
ZZA-951 – Without front handles. Order 0396.9488.00.
ZZG-95 – Set of Front Handles. Order 0396.5176.00.
ZZK-954 – Transit Case (FSIQ3/7). Order 1013.9395.00.
ZZK-955 – Transit Case (FSIQ26 only). Order 1013.9408.00.
ZZK-1 – Trolley. Order 1014.0510.00.

MATCHING PADS, 75 Ω

RAM – L section. Order 0358.5414.02.
RAZ – Series resistor, 25 Ω. Order 0358.5714.02.
ZRB2 – SWR Bridge, 5 MHz to 3000 MHz. Order 0373.9017.52.
ZRC – SWR Bridge, 40 kHz to 4 GHz. Order 1039.9492.52.

HIGH-POWER ATTENUATORS, 100 W

RBU 100 – 3/6/10/20/30 dB. Order 1073.8820.XX (XX = 03/06/10/20/30).

HIGH-POWER ATTENUATORS, 50 W

RBU 50 – 3/6/10/20/30 dB. Order 1073.8895.XX (XX = 03/06/10/20/30).
ESH3-Z3 – Preamplifier, 9 kHz to 30 MHz. Order 0827.8016.52.
ESV-Z3 – Preamplifier, 20 to 1000 MHz. Order 0397.7014.52.

FOR FSIQ26 ONLY

Test-Port Adapter, N male – Order 1021.0541.00.
Test-Port Adapter, 3.5 mm male – Order 1021.0529.00.

**1) Cannot be retrofitted.*

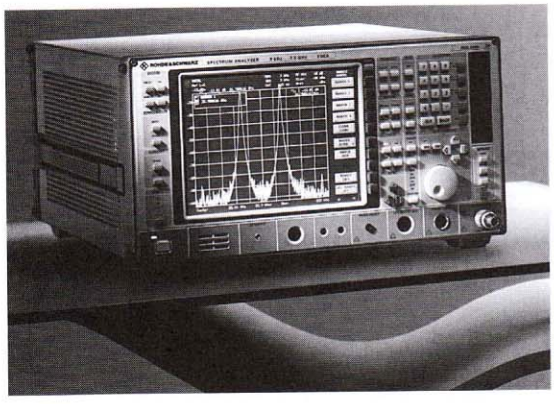
For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

CE

ROHDE&SCHWARZ
Rohde & Schwarz' quality system complies with the DIN ISO 9001 standard and has been certified by DQS (German Association for the Certification of Quality Systems).

Spectrum Analyzers

FSEA20/30 • FSEB20/30 • FSEM20/30 • FSEK20/30



Features – Benefits	Applications
Spectrum Analysis with Ultra-wide Dynamic Range	Spread Spectrum Channel Power Measurements
Universal Analysis of Digital and Analog Modulated Signals (Option) BPSK, QPSK, pi/4-DQPSK, QAM, MSK, GMSK, AM, FM, PM	High Dynamic Range Intermodulation Measurements
High-speed Synthesizer 5 ms for Full Span (FSEA, FSEB)	Modulation Quality Measurements
Refresh Rate, Quasi-analog 25 Sweeps/s	High Throughput Production Measurements
Large LC TFT Display – 24 cm/9.5 in., Active	
Future-proof Modular Design Customized Solutions through Wide Variety of Options	

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

ROHDE&SCHWARZ
Rohde & Schwarz' quality system complies with the DIN ISO 9001 standard and has been certified by DQS (German Association for the Certification of Quality Systems).

SPECTRUM ANALYZERS

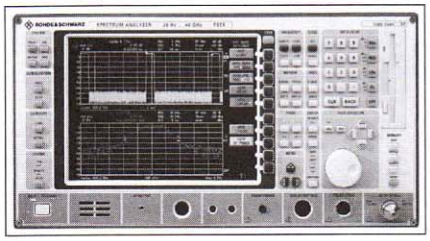
The FSE Series spectrum analyzers have been optimized for general-purpose measurements and meeting the stringent requirements of testing advanced digital communication systems. Extremely high measurement speed, future-proof modular design and excellent performance characteristics put these analyzers right at the top of today's market – at a medium-range price.

Easy upgrade of basic models into top-class models.

VECTOR ANALYSIS FOR DIGITAL COMMUNICATION

The analyzers of the FSE family combine the capabilities of high-end RF or microwave spectrum analysis with those of universal digital-signal demodulation and analysis. This becomes possible with the vector signal analyzer option. The spectrum analyzer function offers the wide dynamic range necessary for many measurements on digitally modulated signals (e.g., burst measurements), and the vector signal analyzer option adds demodulation capability to bit stream level for:

- BPSK
- pi/4DQPSK
- GMSK
- QPSK
- 16QAM
- (G)FSK



All this is backed up by a variety of display types:

- Eye diagrams
- Vector and constellation diagrams
- Frequency and phase error
- Vector error

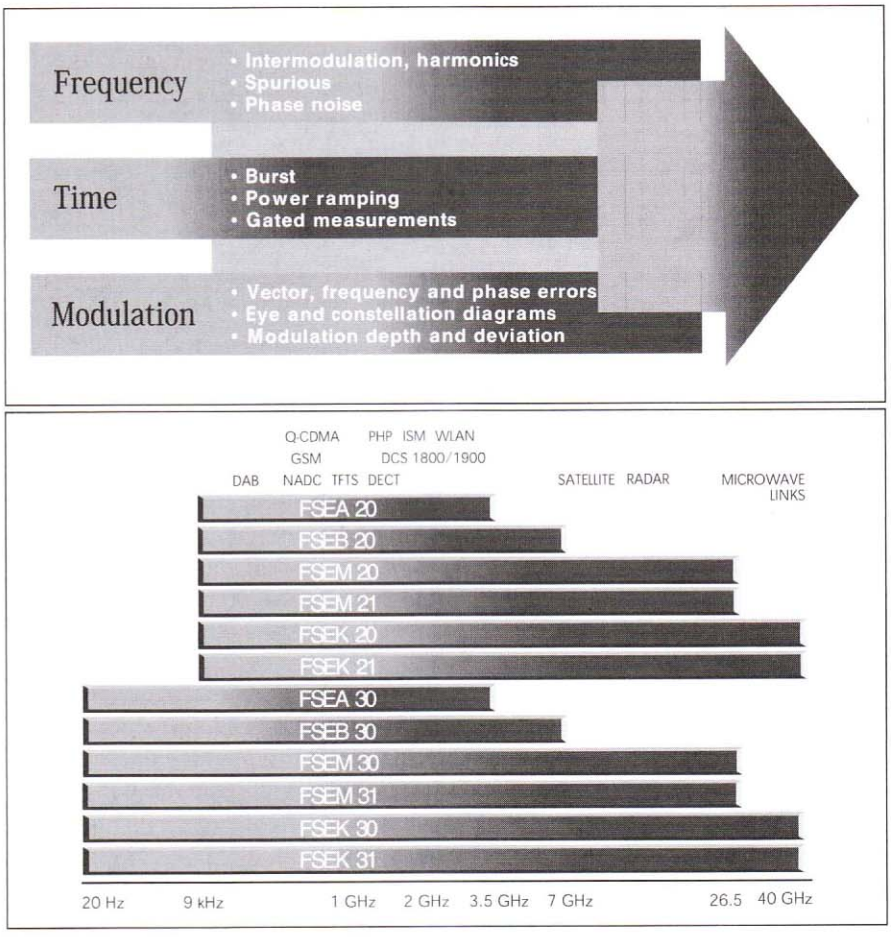
With a spectrum analyzer of the FSE family, you are perfectly equipped for the future of digital communication.

MODULARITY SAFEGUARDS INVESTMENTS

Series FSE analyzers are of modular design throughout. From the wide variety of options, you can choose exactly those needed for your particular application.

You thus get an instrument tailor-made to your requirements and pay for no more than what you actually need. At the same time, you can feel sure that FSE will grow with your tasks and requirements as most options can be retrofitted and model .20 units can easily be upgraded later to almost the same performance as provided by top-class models .30. Even extending the frequency range from 3.5 GHz to 7 GHz is no problem with Opt. FSE-B2.

Your decision for Spectrum Analyzer FSE is a decision for a safe investment.



Modular design for a safe investment.

A TRIPLE RECORD HOLDER IN SPEED

FSE breaks the speed record in three fields:

- FSE features a minimum full-span sweep time of 5 ms (for FSEA and FSEB) with a fully synchronized sweep. This means that added speed is not at the expense of frequency accuracy but even enhances it
- The shortest zero-span sweep time is 1 µs (100 ns/div) – ideal for high-resolution measurements on pulse edges
- Up to 25 sweeps per second is an optimal prerequisite for rapid and easy alignments and for applications in production

With its high measurement speed and great ease of operation, FSE will solve even highly complex measurement tasks in the shortest possible time.

TOP DYNAMIC RANGE

FSE is outstanding for its extremely low noise floor without any impairment to the dynamic range at large signal levels. This can be seen, for example, from the 1-dB compression point of +10 dBm, which yields a dynamic range of 109 dB even at a resolution bandwidth of 1 MHz, allowing GSM and DECT power ramps to be determined.

The extremely wide intermodulation-free dynamic range of typically 116 dB (FSEA30, FSEB30) and 105 dB (FSEB20, FSEB20) not only ensures reliable measurements on highly linear amplifiers, it also enables detailed analysis of complex broadband signals.

Taking as a figure of merit of an analyzer the difference between its 3rd-order intercept point and its noise figure, FSEA can offer a value of around 0 dB.

THE FSE "OPTION BUILDING BLOCKS"

Option/ Function/ Software	Designation	FSEA20	FSEA30	FSEB20	FSEB30	FSEM20	FSEM21	FSEM30	FSEK20	FSEK30
Frequency from 20 Hz	–	–	S	–	S	–	–	S	–	S
Frequency to 3.5 GHz	–	S	S	–	–	–	–	–	–	–
7–GHz Frequency Extension	FSE–B2	O	O	S	S	–	–	–	–	–
TV Demodulator	FSE–B3*	O	O	O	O	O	O	O	O	O
Low Phase Noise and OCXO	FSE–B4	O	S	O	S	O	O	S	O	S
FFT Filter	FSE–B5	O	S	O	S	O	O	S	O	S
Vector Signal Analyzer	FSE–B7	O	O	O	O	O	O	O	O	O
Tracking Generator 3.5 GHz	FSE–B8	O	O	–	–	–	–	–	–	–
Tracking Generator 3.5 GHz with I/Q Modulator	FSE–B9	O	O	–	–	–	–	–	–	–
Tracking Generator 7 GHz	FSE–B10	–	–	O	O	–	–	O	–	O
Tracking Generator 7 GHz with I/Q Modulator	FSE–B11	–	–	O	O	–	–	O	–	O
Switchable Attenuator for Tracking Generator	FSE–B12	O	O	O	O	O	O	O	O	O
Controller	FSE–B15	O	O	O	O	O	O	O	O	O
Ethernet Interface	FSE–B16	O	O	O	O	O	O	O	O	O
2nd IEC/IEEE–Bus Interface	FSE–B17	O	O	O	O	O	O	O	O	O
Removable Hard Disk	FSE–B18*	O	O	O	O	O	O	O	O	O
Second Hard Disk for FSE–B18	FSE–B19	O	O	O	O	O	O	O	O	O
External Mixing	FSE–B21	–	–	–	–	O	S	O	O	O
Increased Level Accuracy up to 2 GHz	FSE–B22*	O	O	O	O	O	O	O	O	O
Broadband Output 741.4 MHz	FSE–B23*	O	O	O	O	O	O	O	O	O
Noise Measurement Software	FS–K3	O	O	O	O	O	O	O	O	O
GSM Application Firmware	FSE–K10/–K11	O	O	O	O	O	O	O	O	O

S = Standard. O = Can be retrofitted (option). *Factory-fitted only.

FROM AF TO MICROWAVE

FSEM/K20/.30 open up the microwave range through to 26.5/40 GHz and retain the excellent characteristics of the 3.5 and 7 GHz basic models:

- Continuous full-span sweep
- Fundamental mixing, low noise floor as well as wide dynamic range up to 26.5 GHz
- Fully synchronized sweep with high frequency accuracy even for FULL SPAN (26.5/40 GHz)
- RF input adapters for N or PC 3.5 mm, or with FSEK K male/female connector

FSEM/FSEK with Opt. FSE-B21 allow frequency range extension by means of external mixers. Continuous automatic signal identification, which is used to suppress unwanted image frequency bands and mixture products, ensures fast and easy measurements. Due to the built-in diplexer, three-port as well as two-port mixers can be used.

The external mixer measurement function features great ease of operation:

- Definition of frequency range and harmonics by selection of a waveguide band
- Definition of all important parameters for each waveguide band separately
- Frequency-dependent consideration of mixer conversion loss
- Storage of parameters on hard disk

UNEQUALED MEASURING CONVENIENCE

FSE makes measuring easy for you, offering a large number of convenient test functions:

- Four markers, four delta markers
- Marker functions for direct measurement of
  - Phase noise and noise power density (/Hz)
  - NEXT MIN/PEAK, NEXT MIN/PEAK RIGHT, NEXT MIN/PEAK LEFT
  - Bandwidths and shape factor
- Measurement of channel power, adjacent channel power and occupied bandwidth
- Frequency counter with selectable resolution
- LOW NOISE, NORMAL and LOW DISTORTION modes for low-intermodulation and low-noise operation
- One-button hardcopy on printer or plotter
- Simultaneous measurement of four active traces
- Level, frequency and user-definable limit lines as evaluation help with pass/fail information
- Split screen with independent windows
- Quasi-analog display

FREQUENCY ACCURACY – TO-THE-POINT

Tuning an FSE is absolutely synchronous to the reference frequency for each span including full span. This means that every point on the frequency axis is determined with the accuracy of the internal reference frequency and the pixel resolution. Thus, when reducing the span for detailed signal analysis, readjustment of the center frequency is no longer needed.

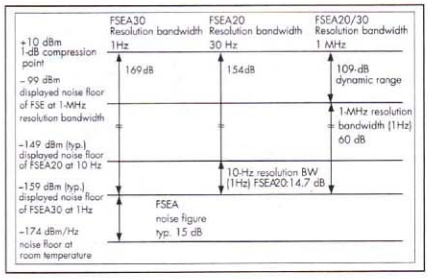
FSE in its basic configuration, includes an AM/FM demodulator. Unknown signals can easily be identified via headphones or the built-in loudspeaker. Modulation measurements are possible using the optional Vector Signal Analyzer (Opt. B7).

Limit lines facilitate checking if results are within predefined tolerances. Virtually any number of limit lines can be defined with high accuracy by means of 50 points to meet even the most exacting requirements.

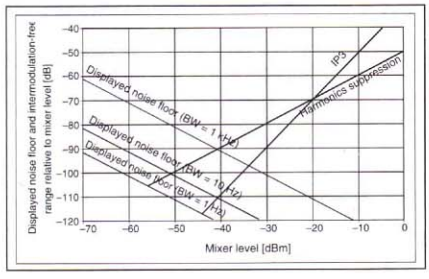
SCALAR NETWORK ANALYSIS

The optional tracking generators are an ideal tool for determining frequency response, attenuation or VSWR and feature the following characteristics:

- Wide dynamic range for attenuation measurements (up to 120 dB)
- Frequency range from 9 kHz to 3.5/7 GHz
- Frequency offset up to ±200 MHz for measurements on frequency-converting modules



Dynamic range, noise and 1 dB compression point for models of Spectrum Analyzer FSE.



Dynamic range, noise, 3rd-order intercept point.

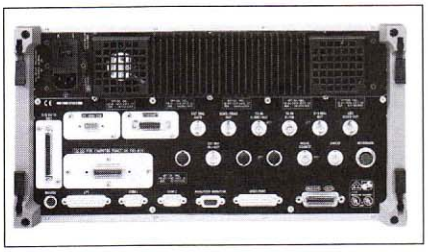
To generate digitally modulated signals the tracking generators with built-in I/Q modulator are ideal. An external two-channel Arbitrary Waveform Generator (e.g., AMIQ from Rohde&Schwarz) serves as the modulation source.

By adding the optional Vector Signal Analyzer FSE-B7, FSE can be expanded to a test assembly enabling direct measurement of the influence of amplifiers or filters on phase error for instance.

OPERATION – AS YOU LIKE IT

Despite their comprehensive functionalities the analyzers feature great ease of operation. Basic functions and frequently used help tools such as markers can be called at a keystroke. The full operating convenience based on a wide variety of evaluation routines and marker functions can be accessed via the menus.

All essential parameters and results can be seen at a glance. All test data, scale factors and setting parameters are logically arranged and thus easy to find. Setups, traces and graticules displayed in color make for error-free analysis of complex results.



Rear of Spectrum Analyzer FSE.

All models are equipped with a large 24-cm (9.5-in.) TFT color display with VGA resolution FSE6 (640 x 480 pixels).

The USER key allows operation to be tailored to your specific requirements. With this key, you can compile the functions mainly needed for your measurement tasks, doing away with frequent menu changes and speeding up measurements on the whole.

TEST RESULTS – PERFECTLY DOCUMENTED

FSE affords uncomplicated logging of results. It supports a variety of printers and plotters.

- FX-80 and compatibles
- Printers with HP-PCL
- HP-GL
- Postscript

Print files can not only be output via an interface but also be stored on diskette or the internal hard disk. With PCX, WMF and HP-GL print formats being available, there is no problem in further processing print files in standard text processing systems. Using Controller FSE-B15, it is particularly easy to generate test reports and integrate the results. Texts can then be processed under Windows on FSE itself.

FSE WORKS AS A CONTROLLER

The optional Controller FSEB15 provides an additional VGA card, 16 MB memory extension, serial mouse and a keyboard. FSEB15 is available in English and German and is supplied installed in FSE when ordered together with the unit. The option opens up the world of Windows 3.1 applications (standard mode) such as statistics programs or spreadsheet analysis. FSE can even be linked to a network using the optional Ethernet Interface FSEB16.

Complete setups, traces, limit lines and macros can be stored nonvolatile on the internal hard disk or on diskette with the built-in 1.44 Mbyte drive.

FSE IN AUTOMATIC TEST SYSTEMS

FSE is ideal for use in automatic test systems, affording not only fast processing of results and an IEC/IEEE-bus command set conforming to SCPI. Moreover, the optional controller FSEB15 and a second IEC/IEEE-bus card (Opt. FSEB17), FSE can be used as a controller for test systems, thus eliminating the need for additional units and saving space in the system cabinet.

MODULAR DESIGN – EASY RETROFITTING OF OPTIONS

The easy concept for fitting the most important options, i.e., Vector Signal Analyzer, Low Phase Noise and OCXO, 7-GHz Frequency Extension, as well as the easy, adjustment-free incorporation of the remaining options make it possible to retrofit the instrument with a minimum of downtime or installation costs being involved.

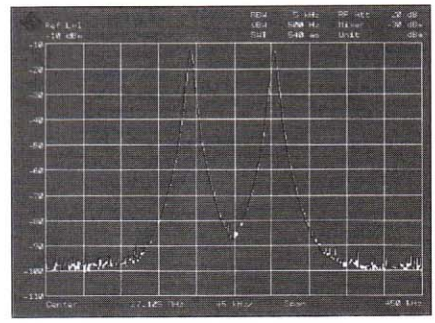
NOISE MEASUREMENT SOFTWARE FS-K3

FS-K3 turns your FSE into a noise measurement system offering the advantages of an analyzer (see also data sheet 757.2380):

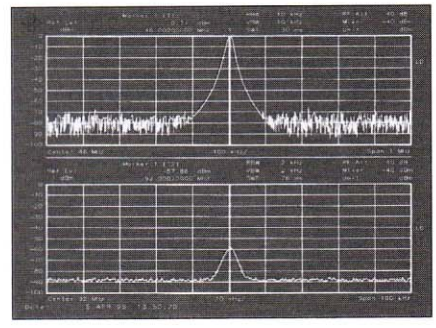
- From the large number of resolution bandwidths available, you can choose the right one for your application, even for measurements on narrowband DUTs
- With ambiguous results, you can check your test system for EM pick-up or nonharmonics
- The lower frequency limit is 100 kHz
- Measurements on frequency-converting DUTs are supported with the use of an external generator

PHASE NOISE MEASUREMENTS WITH FSE-K4

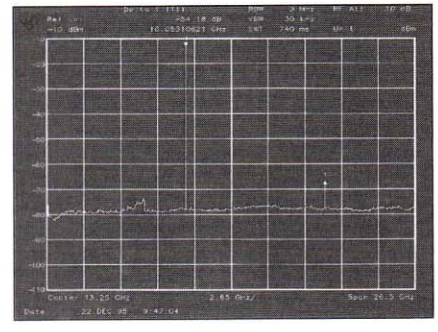
Phase Noise Measurement Software FSE-K4 extends the measurement capabilities of Rohde&Schwarz Spectrum Analyzer FSE phase noise testing. FSE is ideal for this purpose because of its low inherent phase noise and noise figure.



1) Two-tone measurements.



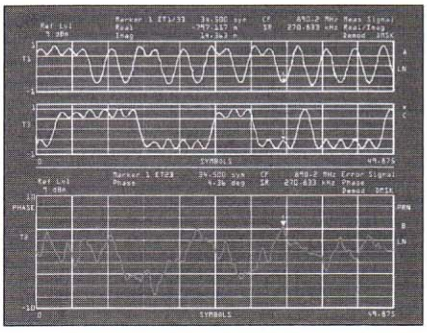
2) Harmonics with split screen.



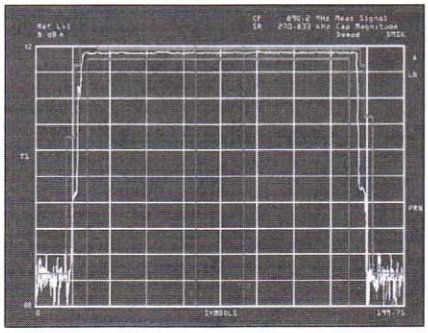
3) Fundamental mixing to 26 GHz.

High measurement speed is achieved through the high sweep rates of FSE. It is possible to trade off speed against accuracy at small resolution bandwidths (≤1 kHz) by using either FFT or digital filters. FSE-K4 allows for different settings in one phase noise graph, e.g., FFT close and analog/digital filters far off the carrier.

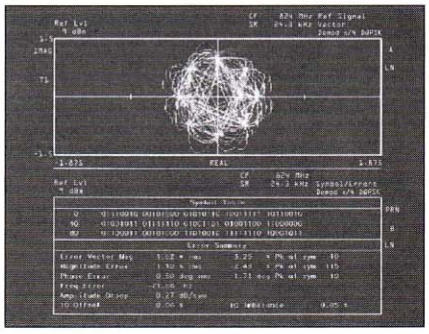
The software FSE-K4 runs under Microsoft Windows on FSE with controller function FSE-B15 fitted or on an external PC with GPIB controller.



I/Q signal and phase error measurements over 50 symbols of a GSM mobile.



Measurement of GSM power ramps to standards with high-precision time reference through synchronization to mid-amble.



Measurement of modulation error of pi/4-DQPSK signals (NADC).

TV SIGNAL IN ZERO SPAN AND TV TRIGGER

With a maximum resolution bandwidth of 10 MHz, implemented with the optional TV Demodulator FSE-B3, and the high resolution of 100 ns/div, FSE meets all requirements for the analysis of TV signals. In addition, FSE-B3 provides the following functions:

- Frame trigger
- Line trigger with selection of line
- CCVS output for connecting a monitor, adaptable to all standards

Moreover, the quasi-analog display provides luminance-signal information, enabling the detection of intermodulation products in the TV spectrum.

APPLICATIONS:

RF POWER TRIGGER REPLACES EXTERNAL TRIGGER

An internal broadband level detector (center frequency ±50 MHz) with a fixed switching threshold of approximately –20 dBm at the first mixer is used as a trigger source. With this detector it is possible, for example, to perform "Spectrum due to switching" and "Spectrum due to modulation" measurements to GSM specifications without an external trigger. Likewise, the detector replaces the external trigger needed in the gated sweep mode.

GAP SWEEP: SIMULTANEOUS MEASUREMENT OF PULSE RISE AND FALL TIMES WITH HIGH TIME RESOLUTION

The fast sweep time of 100 ns/div as well as the gap sweep and pretrigger functions of Spectrum Analyzer FSE make it possible to measure the rise and fall times of an RF pulse simultaneously and with high time resolution. The center of the pulse, which is of no interest, is blanked. Even at a resolution bandwidth of 1 MHz, FSE offers a dynamic range of over 80 dB thanks to the high 1-dB compression point of +10 dBm.

GATED SWEEP

The gated sweep function is indispensable for analyzing TDMA signals used in modern communication systems. With this function, the spectrum of burst signals can be investigated without any interference being caused by switching the signals on and off. The selected gate time determines over what interval a pulse is to be analyzed. Selection of the gate time is very easy and convenient in the time domain display (zero span) of the pulse.

UNIVERSAL ANALYSIS OF DIGITAL SIGNALS

Spectrum Analyzer FSE in conjunction with the optional Vector Signal Analyzer FSE-B7 is ideal for demodulating and measuring digitally modulated signals with frequencies up to 3.5 GHz, 7 GHz, 26.5 GHz or 40 GHz. This universal tool offers a wide variety of settings:

- Demodulation of all common mobile-radio signals
- Freely selectable symbol rates
- Type of filter
- Roll-off factor or BT product of filter
- Synchronization bit sequences
- Predefined, application-specific settings for all common standards, e.g., GSM, PCS 1900, NADC, CDMA (IS95)

VERSATILE DISPLAY OF RESULTS

- In-phase and quadrature signals
- Magnitude and phase
- Vector and constellation diagrams
- Eye and trellis diagrams
- Sum fault: amplitude, frequency, phase, vector

POWER RAMP MEASUREMENTS

To perform power ramp measurements on TDMA systems such as GSM or DECT in line with standards, reference must be made to synchronization sequences (pre- or mid-amble) in order to establish a time reference. Making such measurements to standard is not possible using conventional analyzers.

ACCURATE AM, FM AND PHIM MEASUREMENTS

Featuring high-accuracy measurement of the modulation depth and frequency deviation coupled with the display of demodulated signals in the time domain, FSE not only enables testing of analog and dual-mode radio equipment but also the determination of fast transient response in frequency and amplitude (see separate data sheet Vector Signal Analyzer FSE-B7, order number 757.2167).

Spectrum Analyzer FSE and the optional vector signal analyzer provide universal test capabilities in one unit.

CHARACTERISTICS

Specifications are guaranteed under the following conditions:
30 minutes warm-up time at ambient temperature, specified environmental conditions met, calibration cycle adhered to and total calibration performed. Data without tolerances: typical values only. Data designated "nominal" apply to design parameters and are not tested.

	FSEA20	FSEA30	FSEB20	FSEB30	FSEM20	FSEM30	FSEK20	FSEK30
Frequency-related[*1] (Models .21/.31: can be extended by ext. mixing)								
Frequency Range[*1]	9 kHz to 3.5 GHz	20 Hz to 3.5 GHz	9 kHz to 7 GHz	20 Hz to 7 GHz	9 kHz to 26.5 GHz	20 Hz to 26.5 GHz	9 kHz to 40 GHz	20 Hz to 40 GHz
Frequency Resolution	0.01 Hz	0.01 Hz	0.01 Hz	0.01 Hz	0.01 Hz	0.01 Hz	0.01 Hz	0.01 Hz
Reference Frequency Internal (Nominal)								
Aging, per year[*1]	1×10^{-6}	2×10^{-7}	1×10^{-6}	2×10^{-7}	1×10^{-6}	2×10^{-7}	1×10^{-6}	2×10^{-7}
Total error (per year)	2.5×10^{-6}	2.5×10^{-7}	2.5×10^{-6}	2.5×10^{-7}	2.5×10^{-6}	2.5×10^{-7}	2.5×10^{-6}	2.5×10^{-7}
With Opt. FSEB4								
Aging, per year[*1]	2×10^{-7}	–	2×10^{-7}	–	2×10^{-7}	–	2×10^{-7}	–
Total error (per year)	2.5×10^{-7}	–	2.5×10^{-7}	–	2.5×10^{-7}	–	2.5×10^{-7}	–
Frequency Counter	Measures marker frequency							
Resolution	0.1 Hz to 10 kHz (selectable)							
Count accuracy (S/N >25 dB)	±(frequency x reference error + 10 Hz + 1/2 (last digit))							
Spectral Purity (dBc/Hz) – SSB phase noise, f ≤500 MHz	for f >500 MHz see diagrams below							
Carrier offset 100 Hz[*2]	–	<–87	–	<–81	–	<–81	–	<–81
Carrier offset 1 kHz[*2]	<–85	<–107	<–79	<–100	<–79	–100	<–79	–100
Carrier offset 10 kHz[*2]	<–95	<–120	<–90	<–114	<–90	<–114	<–90	<–114
Carrier offset 100 kHz[*3]	<–119	<–117	<–113	<–111	<–113	<–111	<–113	<–111
Carrier offset 1 MHz[*3]	<–135	<–135	–129	–129	<–129	<–129	<–129	<–129
With Opt. FSEB4 For models .20 with Opt. FSE-B4 values of models .30 apply								
Displayed Average Noise Floor (dBm)	(0-dB RF attenuation, RBW10 Hz, VBW1 Hz, 20 averages, trace average, span 0 Hz, termination 50 Ω)							
Frequency								
20 Hz		<–80		<–74		<–74		<–74
1 kHz		<–110		<–104		<–104		<–104
10 kHz	<–90	<–125	<–84	<–119	<–84	<–119	<–84	<–119
100 kHz	<–110	<–135	<–104	<–129	<–104	<–129	<–104	<–129
1 MHz	<–130, typ. –135	<–145, typ. –150	<–125, typ. –130	<–142, typ. –145	<–124, typ. –129	<–142, typ. –145	<–124, typ. –129	<–142, typ. –145
10 MHz to 3.5/6 GHz	<–145, typ.–150	<–145, typ. –150	<–142, typ. <–147	<–142, typ. <–147	<–138, typ. –140	<–138, typ. –140	<–138, typ. –140	<–138, typ. –140
6 GHz to 7 GHz			<–139	<–139	<–135, typ. –138	<–135, typ. –138	<–135, typ. –138	<–135, typ. –138
7 GHz to 18 GHz					<–138, typ. –140	<–138, typ. –140	<–134, typ. –139	<–134, typ. –139
18 to 26.5 GHz					<–135, typ. –138	<–135, typ. –138	<–131, typ. –136	<–131, typ. –136
26.5 GHz to 30 GHz							<–120, typ. –125	<–120, typ. –125
30 GHz to 40 GHz							<–116, typ. –122	<–116, typ. –122
Max. Dynamic Range	10 Hz bandwidth	1 Hz bandwidth	10 Hz bandwidth	1 Hz bandwidth	10 Hz bandwidth	1 Hz bandwidth	10 Hz bandwidth	1 Hz bandwidth
Display noise floor to 1 dB compression	155 dB	165 dB	152 dB	162 dB	150 dB	160 dB	150 dB	160 dB
Max. Harmonics Suppres., f >50 MHz	>90 dB	>90 dB	>90 dB	>90 dB	>90 dB	>90 dB	>90 dB	>90 dB
Max. Intermodulation-free Range								
50 MHz to 3.5 GHz (nominal)	105 dB	115 dB						
150 MHz to 7/26.5 GHz (nominal)			105 dB	115 dB	103 dB	112 dB	103 dB	112 dB

*[*1] After 30 days operation.*

*[*2] Models .20/.21: valid for span <50 kHz, RBW <1 kHz.*

*[*3] Valid for span >100 kHz.*

	FSEA20	FSEA30	FSEB20	FSEB30	FSEM20	FSEM30	FSEK20	FSEK30
Intermodulation								
3rd-order intercept point (T.O.I.), Δf >5 x resolution BW or >10 kHz	≥12 dBm, typ. 15 dBm for f >50 MHz	≥12 dBm, typ. 15 dBm for f >50 MHz	≥12 dBm, typ. 15 dBm for f >150 MHz	≥12 dBm, typ. 15 dBm for f >150 MHz	≥12 dBm, typ. 15 dBm for f >150 MHz	≥12 dBm, typ. 15 dBm for f >150 MHz	≥12 dBm, typ. 15 dBm for f >150 MHz; ≥10 dBm for f >7 GHz	≥12 dBm, typ. 15 dBm for f >150 MHz; ≥10 dBm for f >7 GHz
Intermodulation-free range at –40 dBm mixer level	105 dB							
Intercept point k2 (dBm)	>25, typ. >40 for f <50 MHz, >45, typ. >50 for f >50 MHz	>25, typ. >40 for f <50 MHz, >45, typ. >50 for f >50 MHz	>25 for f <150 MHz, >35 typ. >40 for f >150 MHz, >45 typ.	>25 for f <150 MHz, >35 typ. >40 for f >150 MHz, >45 typ.	>25 for f <150 MHz, >35 typ. >40 for f >150 MHz, >45 typ.	>25 for f <150 MHz, >35 typ. >40 for f >150 MHz, >45 typ.	>25 for f <150 MHz, >40 for f >150 MHz	>25 for f <150 MHz, >40 for f >150 MHz
Immunity to Interference								
Image frequency (dB)	>75	>80, typ. >90	>80, typ. >90	>80, typ. >91	>80, typ. >92	>80, typ. >93		
Intermediate frequency (dB)	>80	>100	>75	>75	>75	>75		
Spurious response (f >1 MHz, without input signal, 0-dB attenuation)								
Span <30 MHz	<–100 dBm	<–110 dBm	<–100 dBm	<–110 dBm	<–100 dBm	<–110 dBm	<–100 dBm	<–110 dBm
Span ≥30 MHz	<–100 dBm							
f_{in} = 25.175 MHz, 5.7172 GHz	<–100 dBm							
f_{in} = 60 MHz	<–100 dBm	<–110 dBm	<–100 dBm	<–100 dBm	<–100 dBm	<–100 dBm	<–100 dBm	<–100 dBm
Other interfering signals (mixer level <–10 dBm)*1	<–80 dBm*2	<–80 dBm*2	<–75 dBm*2	<–75 dBm*2	<–75 dBm*2	<–75 dBm*2	<–75 dBm*2	<–75 dBm*2
Level Display								
Measurement display	500 x 400 pixels (with one diagram displayed); max. 2 diagrams with independent settings							
Log level range	10 dB to 200 dB (10 dB steps)							
Linear level range	10% of reference level per division (10 divisions) or logarithmic scaling							
Trace	Max. 4 traces with 1 diagram, 2 traces per diagram with 2 diagrams, simultaneous measurement with all traces							
Trace detector	Max peak, min peak, auto peak (normal), sample, rms, average							
Trace functions	Clear/write, max hold, min hold, average							
Setting range of reference level								
Log level display	–130 dBm to 30 dBm, (0.1 dB steps)							
Linear level display	7.0 nV to 7.07 V (1% steps)							
Units of level axis	dBm, dBµV, dBmV, dBµA, dBpW (log and lin level display) mV, µV, mA, µA, pW, nW (linear level display)							
Level Measurement Error	**The values are guaranteed for bandwidths from 10 Hz to 30 kHz and 100 kHz to 10 MHz**							
–40 dBm, RF attenuation 20 dB, ref. level –15 dB, RBW 5 kHz								
Absolute error at 120 MHz	<0.3 dB							
Freq. Response (10 dB RF atten.)								
<1 GHz	<0.5 dB							
1 GHz to 3.5/7 GHz	<1 dB							
7 GHz to 18 GHz					<2 dB*1	<2 dB*1	<2 dB*1	<2 dB*1
18 GHz to 26.5 GHz					<2.5 dB*1	<2.5 dB*1	<2.5 dB*1	<2.5 dB*1
26.5 GHz to 40 GHz							<3 dB*1	<3 dB*1
Attenuator error	<0.3 dB	<0.3 dB	<0.3 dB	<0.3 dB	<0.3 dB	<0.3 dB	<0.3 dB	<0.3 dB
IF gain error	<0.2 dB, 0.1 dB typical							
Linearity Error								
Log level display								
(RBW≥1kHz,analog,S/N>15dB)								
0 dB to –50 dB	<0.3 dB	<0.3 dB	<0.3 dB	<0.3 dB	<0.3 dB	<0.3 dB	<0.3 dB	<0.3 dB
-50 dB to –70 dB	<0.5 dB	<0.5 dB	<0.5 dB	<0.5 dB	<0.5 dB	<0.5 dB	<0.5 dB	<0.5 dB
-70 dB to –80 dB	<1 dB		<1 dB		<1dB		<1dB	
-70 dB to –95 dB		<1 dB		<1 dB		<1 dB		<1 dB
Linear level display	5% of ref. level							

*1 *For inputs > 7 GHz: error after calling peaking function. For sweeptimes < 10 mS/GHz, additional error 1.5 dB.*

*2 *Models .20/.21: valid for span <50 kHz, RBW <1 kHz.*

	FSEA20	FSEA30	FSEB20	FSEB30	FSEM20	FSEM30	FSEK20	FSEK30
Bandwidth Switching Error								
1 Hz to 30 kHz/100 to 300 kHz				<0.2 dB/<0.2 dB				
1 MHz to 10 MHz	<0.3 dB	<0.3 dB	<0.3 dB	<0.3 dB	<0.3 dB	<0.3 dB	<0.3 dB	<0.3 dB

DISPLAY RELATED

Standard – 24-cm (9.5 in.) LC TFT color display.
Resolution – 640 x 480 pixels (VGA resolution).
Pixel Failure Rate – $<2 \times 10^{-5}$.
Mass Memory – 1.44-Mbyte 3.5 in. diskette (built-in disk drive), hard disk.

ENVIRONMENTAL CHARACTERISTICS

Operating Temperature Range –
Nominal operating range: +5° C to +40° C.
Limit operating range: +0° C to +50° C.
Storage: –40° C to +70° C.

Humidity – +40° C at 95% relative humidity (IEC 68-2-3).

Mechanical Stress –
Sinusoidal vibration: 5 to 150 Hz, max. 2 g at 55 Hz; 0.5 g from 55 to 150 Hz; to IEC 68-2-6, IEC 68-2-3, IEC 1010-1, MIL-T-28800D, class 5.
Random vibration: 10 to 300 Hz, acceleration 1.2 g_{rms}.
Shock: 40 g shock spectrum, to MIL-STD-810C and MIL-T-28800D, classes 3 and 5.

Recommended Calibration Interval – 1 year (2 years for operation with external reference).

RFI Suppression – To EMC directive of EU (89/336/EEC) and German EMC legislation.

Safety – To EN 61010-1, UL 3111-1, CSA C22.2 No. 1010-1, IEC 1010-1.

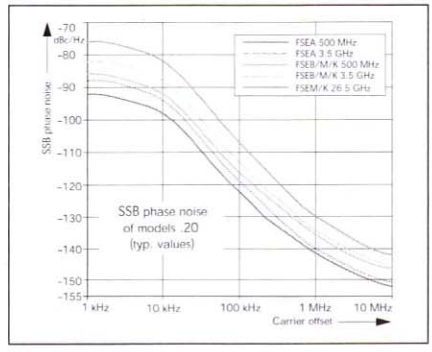
Test Mark – VDE, GS, UL, cUL.

TV DEMODULATOR FSE-B3

All specifications are nominal values.

Video Output –
Output voltage into 75 Ω: 1 V_{p-p}.
Video polarity: Positive/negative (standard switchable).
Frequency response:
0 to 4.43 MHz: –2 dB.
Video S/N ratio (rms, to CCIR, level >3 mV): 55 dB.
Nonlinearity in case of 10% to 75% modulation:
Differential gain: 10%.
Differential phase: 10&deg.
2-T-k factor: 3%.

Triggering –
TV trigger: V/H TV sync signals, any line within a 625– or 525-line system.
Standards: B/G, D/K, I, L, M.



FFT FILTER FSE-B5

- High frequency resolution due to very small shape factor of 2.5
- Extremely short measurement time, up to 150 times faster than with conventional filters

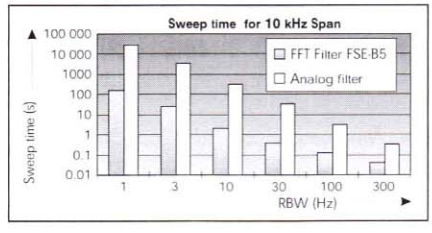
Resolution Bandwidths (RBW) –
3 dB bandwidths, in 1/2/3/5 steps: 1 Hz to 1 kHz.
Bandwidth error: 2%, nom.
Shape factor 60:3 dB: 2.5, nom.

Display Range for Frequency Axis –
Min. span: 25 x RBW.
Max. span: 100,000 x RBW, max. 2 MHz.

Level Measurement Error –
Additional total level error, referred to RBW 5 kHz: <1 dB.

Max. Display Range – 100 dB.

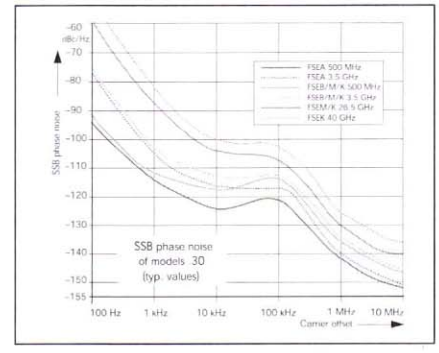
Immunity to Interference –
Spurious response: ≤100 dBm.



EXTERNAL MIXING FSE-B21

LO Output/IF Input (Front Panel) –
SMA female , 50 Ω.
LO signal: 7.5 GHz to 15.2 GHz.
Amplitude: +15.5 dBm ±3 dB.
IF signal: 741.4 MHz.
Max. reference level: –20 dBm.

IF Input (Front Panel) – SMA female , 50 Ω.
Frequency: 741.4 MHz.
Max. reference level: –20 dBm.



INCREASED LEVEL ACCURACY FSE-B22

Total Level Error –
≤0.5 dB with 10 dB RF attenuation.
≤0.6 dB with 20/30/40 dB RF attenuation.

Specifications Are Valid for –
Temperature range: 20 to 30° C.
Frequency range: 10 MHz to 2 GHz.
Resolution bandwidths:
5 to 30 kHz/300 kHz/1 MHz.
Signal level:
–10 dB to –50 dB below reference level.
Stop frequency: ≤2 GHz.
Sweep time: ≥3 x auto sweep time.

BROADBAND OUTPUT 741.4 MHZ FSE-B23

FSE-B23 reduces the suppression of other interference signals to –50 dBm and must not be combined with FSE-K10/–K11.

	FSEA	FSEB	FSEM	FSEK
Gain from RF input to IF output (dB)	6	6	4	4
3 dB BW (MHz)	60	150	150*1 40 to 80*2	150*1 40 to 120*3

*1 *f*<7 GHz.
*2 7 GHz to 26.5 GHz.
*3 7 GHz to 40 GHz.

POWER REQUIREMENTS

	FSEA20	FSEA30	FSEB20	FSEB30	FSEM20	FSEM30	FSEK20	FSEK30
Power Supply								
AC supply	200 V to 240 V: 50 Hz to 60 Hz, 100 V to 120 V: 50 Hz to 400 Hz, class of protection I to VDE 411							
Power consumption	170 VA	180 VA	185 VA	195 VA	220 VA	230 VA	220 VA	230 VA
Dimensions in mm (W x H x D)								
	435 x 236 x 460 (5 units of height)					435 x 236 x 570	435 x 236 x 460	435 x 236 x 570
Weight								
kg	21.5	22.7	21.8	23.2	23.8	25.2	24.4	25.8
lb.	47.3	49.9	48	51	52.4	55.4	53.7	56.8

ORDERING INFORMATION

For price information: Outside the U.S. contact your local Tektronix representative, inside the U.S. see the price list in the back of this catalog.

FSEA20
9 kHz to 3.5 GHz Spectrum Analyzer.
Includes: Power Cable, Operating Manual, Spare Fuses.

FSEA30
20 Hz to 3.5 GHz Spectrum Analyzer.
Includes: Power Cable, Operating Manual, Spare Fuses.

FSEB20
9 kHz to 7 GHz Spectrum Analyzer.
Includes: Power Cable, Operating Manual, Spare Fuses.

FSEB30
20 Hz to 7 GHz Spectrum Analyzer.
Includes: Power Cable, Operating Manual, Spare Fuses.

FSEM20
9 kHz to 26.5 GHz Spectrum Analyzer.
Includes: Power Cable, Operating Manual, Spare Fuses, Test Port, Adapter 3.5-mm Female and N Female.

FSEM30
20 Hz to 26.5 GHz Spectrum Analyzer.
Includes: Power Cable, Operating Manual, Spare Fuses, Test Port, Adapter 3.5-mm Female and N Female.

FSEK20
9 kHz to 40 GHz Spectrum Analyzer.
Includes: Power Cable, Operating Manual, Spare Fuses, Test-port Adapter K-Female, N-Female.

FSEK30
20 Hz to 40 GHz Spectrum Analyzer.
Includes: Power Cable, Operating Manual, Spare Fuses, Test-port Adapter K-Female, N-Female.

OPTIONS

Opt. 02/B2 – 7 GHz Frequency Extension.
Opt. B3 – TV Demodulator.
Opt. 04/B4 – (FSEA20, FSEB20, FSEK20, FSEM 20) Low phase noise and OCXO.
Opt. 07/B7 – Vector signal analyzer.
Opt. 15/B15 – Controller with mouse and keyboard (English).
Opt. 16/B16 – Ethernet interface (15 contact AUI connector).
Opt. XX – Ethernet interface, thin wire BNC connector.
Opt. 17/B17 – Second IEC/IEEE-bus interface.
Opt. 49 – Ethernet interface (BNC).
Opt. B5 – (FSEA20, FSEB20, FSEK20, FSEM20 FFT Filter) 1 Hz-1 kHz.
Opt. B8 – Tracking generator 3.5 GHz.
Opt. B9 – Tracking generator 3.5 GHz with I/Q Modulator.
Opt. B10 – FSE-B10 tracking generator 7 GHz.
Opt. B11 – FSE-B11 tracking generator 7 GHz with I/Q Modulator.
Opt. B12 – Switchable attenuator for tracking generator.
Opt. B18 – Removable hard drive.
Opt. B19 – Second hard drive (firmware included).
Opt. B21 – External mixer.
Opt. B22 – Increased level accuracy up to 2 GHz.
Opt. B23 – Broadband output 741.4 MHz.

MEASUREMENT SERVICE OPTIONS (FSEA 20/30, FSEB 20/30, FSEM 20/30, FSEK 20/30)

Opt. C3 – Three years of calibration services.
Opt. D1 – Cal Data Report.
Opt. D3 – Test data (requires Opt. C3).
Opt. R3 – Repair warranty extended to cover three years.

SOFTWARE

Noise Figure Measurement Software, Windows – Order FS-K3.
Phase Noise Measurement Software – Order FSE-K4.
GSM Application Firmware, Mobile – Order FSE-K10.
GSM Application Firmware, BTS – Order FSE-K11.
Service Kit – Extender boards and Coaxial Cables. Order FSE-Z1.
FSE-K10 – GSM Application firmware mobile (good for all models; can be ordered as Opt. K10).
FSE-K11 – GSM Application firmware BTS (good for all models can be ordered as Opt. K11).
Keyboard – American. Order PSA-Z1.
IEC/IEEE-bus –
1 m. Order 012-0991-01.
2 m. Order 012-0991-00.
19 in. Rack Adapter – With front handles, Order ZZA-95. Without front handles, Order ZZA-951.
Set of Front Handles – Order ZZG-95.
Transit Case – Order ZZK-954. (FSEM20, FSEK20). Order ZZK-955.
Trolley – Order ZZK-1.
Matching Pad – 75 Ω, L Section. Order RAM.
Matching Pad – 25 Ω, Series Resistor. Order RAZ.
Preamplifier –
9 kHz to 30 MHz. Order ESH3-Z3.
20 Hz to 1 GHz. Order ESV-Z3.
DC Block –
5 to 7000 MHz (Type N). Order FSE-Z3.
10 kHz to 18 GHz (Type N). Order FSE-Z4.
Microwave Measurement Cable and Adapter Set – For FSEM. Order FS-Z15.
PS/2 Mouse – Order FSE-Z2.
SWR Bridge –
5 MHz to 3000 MHz. Order ZRB2.
40 kHz to 4 GHz. Order ZRC.
Attenuators –
High Power 3/6/10/20/30 dB.
100 W: Order RBU100.
50 W: Order RBU50.
Test-port Adapter –
FSEM N (female), Order 1021.0535.00.
3.5 mm (female), Order 1021.0512.00.
FSEK: N (female), K (female)*[1].
Service Manual*[1]

[1] Contact your local Tektronix representative for information.

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

ROHDE&SCHWARZ
Rohde & Schwarz' quality system complies with the DIN ISO 9001 standard and has been certified by DQS (German Association for the Certification of Quality Systems).

3G Capable Spectrum Analyzers

New R3267 • New R3273



Features – Benefits

Frequency Ranges: From 100 Hz to 8 (R3267) or 26 (R3273) GHz to Cover Multiple Applications with One Unit

High Dynamic Range: 137 dB (2 GHz band) to Perform 3 G Transmitter Measurements

Excellent Signal Purity: ≤-110 dBc/Hz at 10 kHz Offset for Accurate Transmitter Characterizations

Complete Demodulation Options: For Analysis of Transmitters in Frequency, Time, Phase and Code Domains

High Measurement Throughput: 20 Trace per Second Measurement Speed for Faster Testing Times on Production Lines

Easy System Connectivity with Standard MS-DOS Floppy and GP-IB, Parallel, Serial and Color VGA Ports

Applications

1 G, 2 G and 3 G Transmitter Testing for Base Stations and Mobile Phones

Digital Radio Manufacturing and System Tests

Channel and Adjacent Channel Power Measurements of Transmitters

Transmitter Modulation Quality Measurements

Verifying Code Performance on CDMA and W-CDMA Systems

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

CE

ADVANTEST

Advantest's quality system complies with the DIN ISO 9002 standard and has been certified by TUV Product Service GMBH.

Development of the latest communication technologies, such as 3rd generation digital mobile systems (IMT-2000), requires a combination of spectrum and modulation measurement abilities. Furthermore, these new services must be introduced in less time and for more users than ever before.

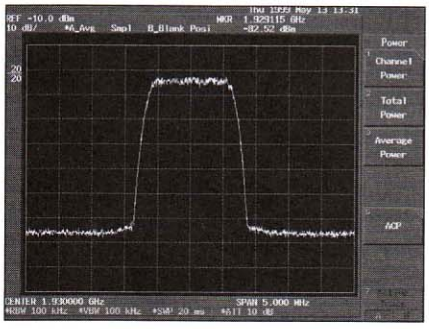
The R3267/3273 is a high-performance spectrum analyzer family designed to meet these needs for high throughput, wide bandwidth, high frequency and high quality digital modulation measurements.

These instruments feature high dynamic range ACP measurement ability in addition to automated occupied bandwidth, total power and average power measurement functions. Furthermore, the R3267 and the R3273 support optional modulation analysis for all common mobile communication standards.

HIGH PERFORMANCE SPECTRUM ANALYZERS

The R3267 and R3273 offer the necessary performance for a host of applications, from final system integration to production line or maintenance settings. This family boasts high signal purity and dynamic range (–110 dBc/Hz at 10 kHz offset and 137 dB) as well as high throughput measurements (20 per second), high speed time domain analysis (1 µs), and 70 dB (typical at 5 MHz offsets) ACP measurements for W-CDMA.

Such performance makes it ideal for next generation mobile communication, satellite communication and today's diverse group of wireless communication system applications.



OPTIONAL MODULATION ANALYSIS FOR NEXT-GENERATION DIGITAL MOBILE COMMUNICATION

The R3267 and R3273 also provide optional modulation analysis for the proposed 3 G W-CDMA communication standard. Both general modulation accuracy measurements as well as code domain power measurements, essential for W-CDMA analysis are possible.

Furthermore, base band signal analysis is made simple with built-in I/Q inputs. Finally, the R3267 and R3273 also support modulation analysis options for CDMAOne, PDC, PHS, IS-136, GSM and DECT – meaning one instrument meets today's and tomorrow's measurement needs.

These options provide measurement results such as rho, EVM, time alignment error and carrier feedthrough. Furthermore, results can be displayed numerically or in a variety of graphical formats including constellation diagrams, code domain, eye diagrams, power-time templates, demodulated data bits and plots of key modulation parameters over time.

The demodulation ability of the R3267 and R3273 is designed to give you only the capabilities that you need. Option 01 adds the basic capability; individual standards can then be ordered as required. Further, multiple standards can be loaded into the instrument simultaneously for greater flexibility.

HIGH SPEED AND HIGH THROUGHPUT

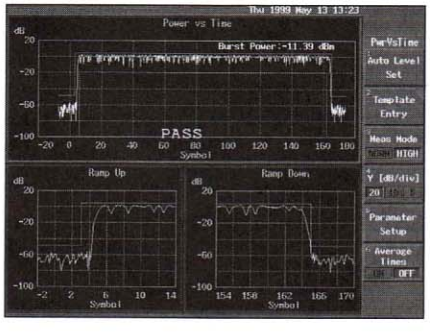
The R3267 and R3273 have been optimized for speed to enhance measurement performance on manufacturing lines. These instruments can provide as many as twenty 1000 point trace updates in one second. In addition, the GPIB speed has also been improved over previous instruments to remove testing time as a production bottleneck.

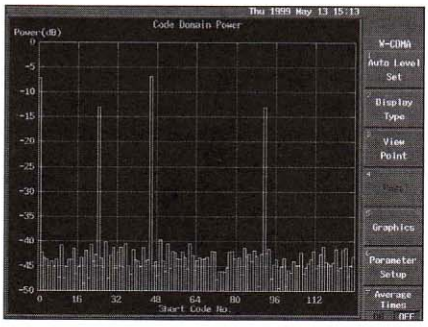
SIMPLIFIED STANDARD COMPLIANCE

The R3267 and R3273 are ideal choices for final system development, integration and manufacturing test of mobile radio transmitters. These instruments offer a host of automated measurements to make testing a transmitter's performance to a specification easy. The modulation analysis options provide standard templates with pass/fail prompts. The R3267 and R3273 also feature standard adjacent channel power, occupied bandwidth, channel power and spurious search measurements for a complete spectral evaluation of a transmitter.

EASY CONNECTIVITY

The standard GPIB, RS-232 and parallel ports ease the complexity of working with existing PC-based systems. Furthermore, the MS-DOS floppy allows you to quickly save setups, instrument traces, data results or even .BMP files of screen images. These images or ASCII data files can then be read by any of a number of standard, Windows-compatible programs. Finally, the TFT color LCD is VGA compatible and an external monitor port allows the screen image to be projected for presentations or viewed on standard computer monitors.





CHARACTERISTICS

FREQUENCY

R3267 Frequency Range – 100 Hz to 8 GHz.

Frequency	Frequency Band	Harmonic Order N
100 Hz to 3.6 GHz	0	1
1.6 GHz to 3.6 GHz	1	1
1.6 GHz to 7 GHz	2	1
6.9 GHz to 8 GHz	3	1

Built-in YIG tuning pre-selector at 1.6 GHz to 8 GHz.

R3273 Frequency Range –
100 Hz to 26.5 GHz.
18 GHz – 60 GHz (with external mixer synchronization up to 325 GHz).

Frequency	Frequency Band	Harmonic Order N
100 Hz to 3.5 GHz	0	1
3.5 GHz to 7.5 GHz	1	1
7.4 GHz to 15.4 GHz	2	2
15.2 GHz to 26.5 GHz	3	4

Built-in YIG tuning pre-selector at 3.5 GHz to 26.5 GHz.

Frequency Reading Accuracy – ±(Frequency reading x Frequency reference accuracy + Span x Span accuracy + 0.15 x Resolution bandwidth + 10 Hz).

Marker Frequency Counter – (SPAN<1 GHz).

Resolution – 1 Hz to 1 kHz.

Accuracy(S/N > 25 dB) – ±(Marker frequency x Frequency reference accuracy +5 Hz x N + 1 LSD).

Delta Counter – ±(Δ Frequency x Frequency reference accuracy + 10 Hz x N + 2 LSD).

Frequency Reference Accuracy –
±3 x 10^{-8}/day.
±1 x 10^{-7}/year.
±5 x 10^{-9}/day (Opt. 21).
±8 x 10^{-8}/year (Opt. 21).

Frequency Stability –
Residual FM: <3 Hz x N p-p/0.1 sec.
Drift: Same as reference source.

SIGNAL PURITY

	f<2.6 GHz
1 kHz	–100 dBc/Hz
10 kHz	–110 dBc/Hz
100 kHz	–118 dBc/Hz

Frequency Span –
Range:
R3267: 0, 200 Hz to 8 GHz.
R3273: 0, 200 Hz to 26.5 GHz.
Accuracy:
R3267: ± 1%.
R3273: ± 1%.

Resolution Bandwidth (3 dB) –
Range : 10 Hz to 3 MHz, 5 MHz, 10 MHz (1, 3, 10 sequences).
Accuracy:
±15% (RBW=100 Hz to 1 MHz).
±25% (RBW=30 Hz, 3 MHz, 5 MHz).

Video Bandwidth –
Range: 1 Hz to 3 MHz, 5 MHz, 10 MHz (1, 3, 10 sequences).

Frequency Sweep –
Sweep time:
Zero span: 1 µs to 1000 s.
Span ≥ 200 Hz: 20 ms to 1000 s.
Accuracy: ±3%.
Trigger: Free-run, line, single, video, external, IF.

AMPLITUDE RANGE

Measurement Range – +30 dBm to Average noise level.

Maximum Safe Input –
Average continuous power:
(Input ATT>10 dB): +30 dBm (1 W).
DC input : 0 V.

Display Range – 10 x 10 div.
Log: 10, 5, 2, 1, 0.5 dB/div.
Linear: 10% of reference level/div.

Reference Level Range –
Log: –140 dBm to +60 dBm (in 0.1 dB steps).
Linear: 22.4 nV to 223 V (steps of 1% of full scale).

Input Attenuation Range –
R3267: 0 to 75 dB (5 dB steps).
R3273: 0 to 70 dB (10 dB steps).

DYNAMIC RANGE

Average Noise Level – (100 Hz resolution bandwidth, 0 dB input attenuation, 1 Hz video bandwidth):

R3267

Frequency	Frequency Band	Average Noise Level
1 kHz	0	–90 dBm
10 kHz	0	–100 dBm
100 kHz	0	–101 dBm
1 MHz	0	–125 dBm
10 MHz to 3.6 GHz	0	–(130 – f (GHz)) dBm
1.6 GHz to 3.6 GHz	1	–125 dBm
3.5 GHz to 7.0 GHz	2	–125 dBm
6.9 GHz to 8.0 GHz	3	–125 dBm

R3273

Frequency	Frequency Band	Average Noise Level
1 kHz	0	–90 dBm
10 kHz	0	–100 dBm
100 kHz	0	–101 dBm
1 MHz	0	–125 dBm
10 MHz to 3.6 GHz	0	–(130 – f (GHz)) dBm
3.5 GHz to 7.5 GHz	1	–125 dBm
7.4 GHz to 15.4 GHz	2	–122 dBm
15.2 GHz to 26.5 GHz	3	–117 dBm

1 dB gain compression: 0 dBm.

SPURIOUS RESPONSE

2nd Order Harmonic Distortion	Frequency Range	Mixer Level
R3267		
<-70 dBc	10 MHz to 3.5 GHz	–30 dBm
<-90 dBc	>1.6 GHz	–10 dBm
R3273		
<-70 dBc	10 MHz to 3.6 GHz	–30 dBm
<-100 dBc	>3.5 GHz	–10 dBm

2 Signal 3rd Order Harmonic Distortion	Frequency Range	Mixer Level
R3267		
<-80 dBc	100 MHz to 3.5 GHz	–30 dBm
<-90 dBc	>1.6 GHz	–30 dBm
R3273		
<-80 dBc	100 MHz to 3.5 GHz	–30 dBm
<-70 dBc	>3.5 GHz	–30 dBm

Residual Response (no input, input ATT 0 dB, 50 Ω termination)	
R3267	
<-100 dBm	1 MHz to 3.5 GHz
<-90 dBm	300 kHz to 8 GHz
R3273	
<-100 dBm	1 MHz to 3.5 GHz
<-90 dBm	300 kHz to 26.5 GHz

AMPLITUDE ACCURACY

In-band Flatness	Frequency Response
R3267	
±1.5 dB	100 Hz to 3.5 GHz
±1.0 dB	50 MHz to 2.6 GHz
±1.5 dB	1.6 GHz to 3.6 GHz
±1.5 dB	3.5 GHz to 7.0 GHz
±1.5 dB	6.9 GHz to 8.0 GHz
R3273	
±1.5 dB	100 Hz to 3.5 GHz
±1.0 dB	50 MHz to 2.6 GHz
±1.5 dB	3.5 GHz to 7.5 GHz
±3.5 dB	7.4 GHz to 15.4 GHz
±4.0 dB	15.4 GHz to 26.5 GHz

Calibration Signal Accuracy (30 MHz) –
-10 dBm ±0.3 dB.

IF Gain Error ("after" automatic calibration)-
0 dBm to –50 dBm ±0.5 dB.
0 dBm to –80 dBm ±0.7 dB.

Scale Display Accuracy (after automatic calibration) –
Log:
±0.2 dB/1 dB.
±1 dB/10 dB.
±1.5 dB/90 dB.
Linear: ±5% of reference level.

Input Attenuation Switching Error (in reference to 10 dB, at 20 dB to 70 dB) –

R3267	100 Hz to 8 GHz	±1.1 dB/10 dB steps, 2.0 dB max.
R3273	100 Hz to 12.4 GHz	±1.1 dB/10 dB steps, 2.0 dB max.
	12.4 GHz to 18 GHz	±1.3 dB/10 dB steps, 2.5 dB max.
	18 GHz to 26.5 GHz	±1.8 dB/10 dB steps, 3.5 dB max.

Resolution Bandwidth Switching Error –
Resolution bandwidth in reference to 300 kHz, after automatic calibration: <±0.3 dB.

ANALOG DEMODULATION (OPTION)

Spectrum Demodulation –
Modulation type: AM, FM.
Audio output: Internal speaker, earphone jack, volume control possible.
Continuous demodulation time: 100 ms to 1000 s.

INPUT AND OUTPUT

RF Input –
Connector: N-type female (can be converted to SMA on R3273).
Impedance: 50 Ω (nominal).
VSWR (Input ATT≥10 dB):
<1.5:1 (<3.6 GHz) (nominal).
<2.1:1 (>3.6 GHz) (nominal).

Calibration Signal Output –
Connector: BNC female, front panel.
Impedance: 50 Ω (nominal).
Amplitude: –10 dBm ± 0.3 dB.

10 MHz Frequency Reference Output –
Connector: BNC female, rear panel.
Output impedance: 50 Ω (nominal).
Output amplitude range: –5 dBm to +5 dBm.

10 MHz Frequency Reference Input –
Connector: BNC female, rear panel.
Input impedance: 50 Ω (nominal).
Input amplitude range: –5 dBm to +5 dBm.

Probe Power Supply – ±12.6 V (100 mA).

Video Output –
Connector: VGA (15-Pin, female), rear panel.
640 x 480 dots (equivalent to VGA).

External Trigger/Gate Input –
Connector: BNC female, rear panel.
Impedance: 10 kΩ (nominal), DC coupled.
Trigger level: TTL.

Trigger Output –
Connector: BNC female, rear panel.
Amplitude: TTL level.

Audio Output (demodulation audio, option) –
Connector: Small-type monophonic jack, front panel.
Power output: 0.2 W max, 8 Ω (nominal).

I/O Interface –
GPIB: IEEE-488 bus connector, rear panel.
RS232: D-SUB 9-Pin, rear panel.
Printer: D-SUB 25-Pin, rear panel.
Extended I/O port: D-SUB 25-Pin, rear panel.
FDD: 3.5 in. floppy disk drive.

Safety – UL3111-1, CSA1010.1, EN61010-1, IEC61010-1.

Ordering Information

For price information: Outside the U.S. contact your local Tektronix representative, inside the U.S. see the price list in the back of this catalog.

R3267
Spectrum Analyzer.

Includes:
Power Cord, Manuals, Hard Front Cover.

R3273
Spectrum Analyzer.

Includes:
Power Cord, Manuals, Hard Front Cover.

OPTIONS

Opt. 01 – Digital Modulation Analysis.
Opt. 02 – Memory Card (replacing the Floppy Drive).
Opt. 05 – Audio Demodulation Output Option (AM, FM).
Opt. 10 – Level Tuning Option (for PDC-BS).
Opt. 16 – External Mixer Option (26.5 to 40 GHz, for R3273 only).
Opt. 17 – External Mixer Option (40 to 60 GHz, for R3273 only).
Opt. 21 – High-stability Frequency Reference Source Option (±5 x 10^{-9}/day).
Opt. 61 – cdmaOne Analysis Software*[1].
Opt. 62 – W-CDMA Analysis Software*[1].
Opt. 63 – GSM/DECT Analysis Software*[1].
Opt. 64 – PDC/PHS/IS-136 Analysis Software*[1].
Opt. 73 – FM Deviation Analysis Software*[1].
Opt. 74 – Tracking Generator Option (with attenuator).
Opt. 79 – Tracking Generator Option (without attenuator).
*[1]Requires digital modulation analysis option (Opt. 01).

ADDITIONAL ACCESSORIES

Soft Case – Order R16219.
Transit Case – Order R16074.

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

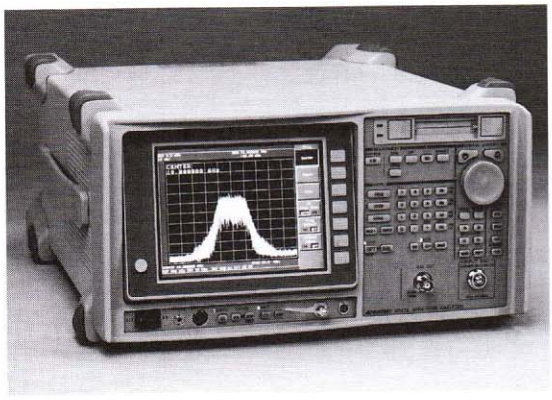
Product(s) available through your local Tektronix Distributor listed in the back of this catalog.

CE

ADVANTEST
Advantest's quality system complies with the DIN ISO 9002 standard and has been certified by TUV Product Service GMBH.

Spectrum Analyzer

R3272



Features – Benefits

Frequency Range: 9 kHz to 26.5 GHz

Compact and Lightweight – 16.5 kg (36.3 lb.)

Large TFT Color Liquid Crystal Display with VGA Output

Delayed and Gated Sweep

Highly Reliable, Narrowband Sweep Capability Based on Direct Digital Synthesizer Technology

GPIB, RS-232 and Centronics Interfaces

Two PCMCIA Memory Card Slots

Applications

Manufacturing, Installation and Maintenance of Microwave Point-to-Point Links

PCS Microwave Link Measurement

Satellite Link Manufacturing, Installation and Maintenance

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

GPIB IEEE-488

Product(s) complies with IEEE Standard 488.2-1987.

ADVANTEST

Advantest's quality system complies with the DIN ISO 9002 standard and has been certified by TUV Product Service GMBH.

LIGHTWEIGHT MICROWAVE SPECTRUM ANALYZER

Today's advanced information society is driven and supported by radio communications technology in which microwave and submillimeter wave communications are playing an increasingly important role.

The R3272 spectrum analyzer allows engineers to easily and quickly perform spectrum analysis of microwave and submillimeter wave bands. This high performance, portable spectrum analyzer covers a frequency range between 9 kHz and 26.5 GHz (up to 325 GHz using an external mixer) with an input range between +30 dBm and –120 dBm, an amplitude display dynamic range of 100 dB, and a resolution bandwidth of 300 Hz. In addition to these standard capabilities, the R3272 offers a 1 Hz resolution frequency counter.

The R3272 is optimized for radio and spurious measurements for microwave and satellite communication.

PORTABILITY ASSURES MOBILITY

The R3272 is designed to assure maximum mobility. A robust design, conforming to MIL standards that demand high tolerance to vibration and accidental drops, is impeccably housed within a compact package.

USER-FRIENDLY PANEL DESIGN

The R3272 uses a TFT color LCD to provide a clear and accurate display of an array of data and information. The panel includes independent function keys, such as Occupied Bandwidth, Adjacent Channel Power, and Harmonic, for automatically locating Harmonics of a given signal. It also includes frequently used parameter setting keys for Bandwidth, Attenuation, and Sweeptime. Results are easily stored and accessed on MS-DOS compatible PCMCIA memory cards.

Characteristics

MEASUREMENT FUNCTION

CW Mode – Spectrum measurement, power measurement, counter, spurious, OBW/ACP/HARM measurement.

FREQUENCY

Frequency Range –
Standard: 9 kHz to 26.5 GHz.
With external mixer: 18 GHz to 325 MHz.

Frequency Reference Accuracy –
$\pm 2 \times 10^{-8}$ /day, $\pm 1 \times 10^{-7}$ /year.

Resolution Bandwidth (3 dB) –
Range (1, 3, 10 sequence):
300 Hz to 3 MHz, 5 MHz.

Video Bandwidth Range – Range (1, 3, 10 sequence): 1 Hz to 3 MHz, 5 MHz.

Frequency Span –
Linear span (zero span): 2 kHz to 26.5 GHz.

DISPLAYED AVERAGE NOISE LEVEL

(Resolution Bandwidth 1 kHz, Input Attenuator 0 dB, Video Bandwidth 1 Hz) –

Frequency Range	Frequency Band (N)	Displayed Average Noise Level
10 kHz	1	-70 dBm
100 kHz	1	-80 dBm
1 MHz to 3.1 GHz	1	-(115 – 1.55 x f(GHz)) dBm
3.0 to 7.5 GHz	1	-110 dBm
7.4 to 15.4 GHz	2	-103 dBm
15.2 to 23.3 GHz	3	-96 dBm
23.0 to 26.5 GHz	4	-90 dBm

AMPLITUDE ACCURACY

Frequency Response – 10 dB input attenuation:

Frequency Range	In Band Flatness	Flatness Band (N)
9 kHz to 3.1 GHz	±1.5 dB	1
50 MHz to 3.1 GHz	±1.0 dB	1
3 to 7.5 GHz	±1.5 dB	1
7.4 to 15.4 GHz	±3.5 dB	2
15.4 to 23.3 GHz	±4.0 dB	3
23 to 26.5 GHz	±4.0 dB	4

Amplitude Range – +30 dBm to noise level.

DISPLAY RANGE

10 x 10 Divisions –
Log: 10, 5, 2, 1, 0.5 dB/div.
Linear: 10% of reference level/div.

SWEEP

Sweep Time – 50 ms to 1000 s.
Sweep Trigger – Free, run, line, single, video, external.

ANALOG DEMODULATION

Spectrum Demodulation –
Modulation type: AM, FM.
Audio output: Speaker and phone jack with volume control.
Marker pause time: 100 ms to 1000 s.

CALIBRATOR

Accuracy – -10 dBm ±0.3 dB.

INPUTS AND OUTPUTS

Front Panel –
1st LO output: Connector type: SMA female; Impedance: 50 Ω, nominal; Frequency range: 3.421 to 7.921 GHz Amplitude: >+5 dBm.
Memory card: Two IC memory card slots.

Rear Panel –
GPIB: IEEE 488 bus connector.
Centronics: D-Sub 25-Pin.
RS 232 connector, VGA connector.

ENVIRONMENTAL CHARACTERISTICS

Operating Temperature – 0 to 50° C.
Non-operating Temperature – -20 to 60° C.
Humidity – ≤85% relative humidity.

POWER REQUIREMENTS

AC Line – 90 V to 132 V or 198 V to 250 V, auto-switching.
Line Frequency – 48 to 66 Hz.
Power Consumption – ≤300 V A.

PHYSICAL CHARACTERISTICS

Dimensions (without handle, feet, and front cover)

	mm	in.
Width	350	13.8
Height	178	7
Depth	420	16.5
Weight	**kg**	**lb.**
Net	15	33

ORDERING INFORMATION

For price information: Outside the U.S. contact your local Tektronix representative, inside the U.S. see the price list in the back of this catalog.

R3272
9 kHz to 26.5 GHz Portable Spectrum Analyzer.
Includes: Power Cable, Input Cable, Connector Adapter, 6.3 A Power Fuse.

MEASUREMENT SERVICE OPTIONS

Opt. C3 – Three years of Calibration Services.
Opt. D3 – Test Data (requires Opt. C3).
Opt. R3 – Repair warranty extended to cover three years.

RECOMMENDED ACCESSORIES

Memory Card – 64 KB card. Order A09507.
Cart – Order K420.

PROBES

FET Probe – DC to 900 MHz (Requires 1101A). Order P6201.
FET Probe – DC to 500 MHz. Order P6202A.
50 Ω Divider Probe – DC to 3.5 GHz 6 ft. Order P6158.
Current Probe – 935 Hz to 120 MHz. Order P6022.

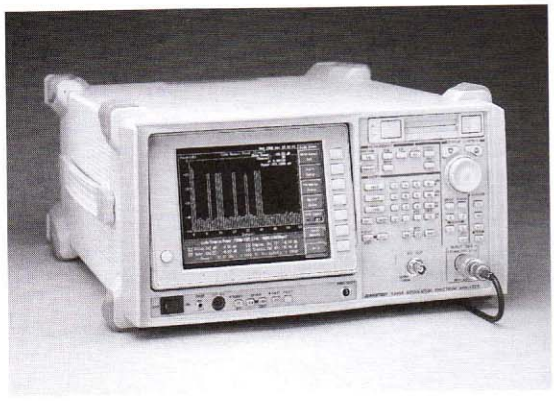
For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

GPIB IEEE-488
Product(s) complies with IEEE Standard 488.2.

ADVANTEST
Advantest's quality system complies with the DIN ISO 9002 standard and has been certified by TUV Product Service GMBH.

Spectrum Analyzers

R3465 • R3463 • R3263



Features – Benefits

R3465/R3463

9 kHz to 8 GHz Frequency Coverage for Full Range of Digital Mobile Radio Frequencies

One Button Measurements of Occupied Bandwidth, Adjacent Channel Power and Harmonics

Options for Digital Radio Measurements Including GSM, PHS, PDC, NADC and CDMA

Lightweight Portable – 16 kg (35.2 lbs.)

Automated CDMA BTS Transmitter Performance Checks with R34-AR Software

R3263

Same Features as R3463 except:
- GSM Measurement Option Available
- Designed for General-Purpose Burst Envelope/Burst Spectrum Analysis

Applications

Digital Mobile Radio Transmitter Measurements of Spectrum, Time, and Modulation Characteristics

CDMA Base Station Field and Manufacturing Test (Opt. 61) R34-AR

NADC, PDC, PHS Mobile and Base Station Measurements (R3465/R3463)

GSM Mobile and Base Station Measurements (Opt. 56 or 51)

CDMA Mobile Phone Measurements (Opt. 61)

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

GPIB IEEE-488

Product(s) complies with IEEE Standard 488.2

ADVANTEST

Advantest's quality system complies with the DIN ISO 9002 standard and has been certified by TUV Product Service GMBH.

R3465 8 GHz Modulation Spectrum Analyzer

The R3465 is a high-performance spectrum analyzer armed with capabilities sufficient to support detailed waveform analysis. The high-speed settling synthesizer significantly reduces blanking time for narrow-band sweep (span of 5 MHz or less), thus enabling truly high-speed measurement. A high-frequency sweep accuracy of 1% or less, frequency stability of 2×10^{-8} /day, and a built-in preselector starting from 1.7 GHz permit harmonic measurements with a dynamic range of 100 dBc.

In addition to these powerful spectrum analyzer functions, the R3465 also offers built-in modulation analysis for a variety of digital mobile communication standards. Available options include measurement and graphics packages for CDMA, NADC/PDC/PHS, and GSM standards. For additional flexibility, the R3465 allows any two of these modulation standards to be resident in the instrument at the same time.

R3463 3 GHz Spectrum Analyzer

The R3463 provides similar performance to the R3465 over a 9 kHz to 3 GHz range. This range is well suited for many digital radio measurements at an economical price.

R3263 3 GHz Spectrum Analyzer

The R3263 represents an economical solution for general-purpose burst signal analysis. The basic unit shares the spectrum analyzer characteristics of the R3463 along with spectrum due to modulation, spectrum due to switching, in-band spurious, and zero-span burst envelope measurements. GSM measurement capability can be added with available options.

ONE-BUTTON MEASUREMENTS

The R3465/R3463 allow one-button measurement of occupied bandwidth, adjacent channel leakage power, and harmonic signals. Assigning frequently used measurement functions to special function keys frees the user from repetitive panel operations. Measurements can be started by a simple one-key operation. The SINGLE key advances the measurement incrementally by each key stroke. The REPEAT key provides continuous measurements.

AUTOMATIC STANDARD PARAMETER SETTINGS

Standard measurements of digital radio systems including PHS, PDC, NADC, CDMA, and GSM usually involve complicated parameter settings for each standard and measurement item. The R3465/R3463 has eliminated the burden for engineers by automating setting procedures, and one-touch settings of user-defined standards.

TWO PCMCIA MEMORY CARD SLOTS

Two memory card slots are provided to enable save/recall of system conditions as well as measurement results. On-screen displays can be saved in .BMP format for use in documentation.

EASY-TO-VIEW COLOR DISPLAY

A large, high-resolution, full-color TFT 6.5 in. LCD display provides powerful support for multi-window operations. Optimum viewing is provided by a 15-degree adjustable tilt mechanism.

CDMA MODULATION ANALYSIS (WITH OPT. 61)

With addition of Opt. 61, the R3465/R3463 performs CDMA transmission measurements in accordance with IS-95. This option provides cellular and PCS base/mobile station measurements in a single test set. In addition, the unit offers waveform quality analysis (rho) and code domain power measurements.

R34-AR CDMA BASE STATION TRANSMITTER AUTORUN SOFTWARE

The Tektronix R34-AR autorun program simplifies CDMA Base Station transmitter measurements on the Advantest R3463 and R3465. The CDMA Tx Autorun program allows the user to configure the instrument for measurements in one, simplified menu screen. Another screen allows the user to define pass fail limits for all common CDMA transmitter measurements including rho, frequency error, error vector magnitude, code domain performance, and channel power. The program automatically configures the instrument correctly for each measurement.

Measurements can be run in either a single or repeat mode, with pass fail and numeric results shown on a summary screen. The repeat mode also tallies basic statistics, including maximum, minimum, and average recorded values over the length of the test. Result pages can be copied to printers, plotters, or PC compatible Flash Ram cards in .BMP format.

The R34-AR program comes pre-installed on a Flash Ram card. This card also has sufficient memory space to allow for saving multiple measurement reports.

NADC/PDC/PHS MODULATION ANALYSIS

The R3465 and R3463 come standard with the ability to perform modulation analysis of NADC, PDC, and PHS signals. Measurements such as phase error, magnitude error, error vector magnitude, and I/Q origin offset can be made at the push of a button. Additional options allow for graphical display of these measurements as well as a constellation diagram and demodulated data.

GSM MODULATION ANALYSIS

With the addition of the GSM transmission options, the R3465 and R3263 can perform frequency error, phase error, and power vs. time measurements on GSM signals. Additional display options allow these results to be shown graphically, along with the demodulated data and an FFT of the phase error.

CHARACTERISTICS

MEASUREMENT FUNCTIONS

CW Mode –
R3465/R3463: Spectrum, OBW, ACP, Harmonics.
R3263: Spectrum.

Transient Mode –
R3465/R3463: Digital modulation analysis.
R3263: Burst envelope, burst spectrum, GSM option.

FREQUENCY RELATED

R3465 – Frequency Range: 9 kHz to 8 GHz.

	Frequency Band	Harmonic Order (N)
9 kHz to 3.1 GHz	0	1
1.7 GHz to 7.0 GHz	1	1
6.9 GHz to 8.0 GHz	2	1

R3463/R3263 –
Frequency Range: 9 kHz to 3 GHz.

	Frequency Band	Harmonic Order (N)
9 kHz to 3 GHz	0	1

Frequency Readout Accuracy (Start, Stop, Center Frequency, Marker Frequency) –
±(frequency reading x frequency reference accuracy + span x span accuracy + 0.15 x Resolution BW + 10 Hz).

Frequency Reference Accuracy –
$\pm 5 \times 10^{-9}$/day with Opt. 21 (R3465).
$\pm 2 \times 10^{-8}$/day; $\pm 1 \times 10^{-7}$/year.

Frequency Stability –
Residual FM (ZERO span): <3 Hz x N p-p/0.1 s.
Drift after 1 hour warmup (Span ≤5 MHz): <20 Hz x Sweep Rate (minutes) x N.

Signal Purity –
10 kHz offset: <-100 dBc/Hz.
100 kHz offset: <-110 dBc/Hz.

Frequency Span –
Linear Span Range:
R3465: 9 kHz to 8 GHz, zero span.
R3463/R3263: 9 kHz to 3 GHz, zero span.
Accuracy:
Span >5 MHz: ±4%.
Span ≤5 MHz: ±1%.

Resolution Bandwidth (3 dB) –
Range (1, 3, 10 sequence):
300 Hz to 3 MHz, 5 MHz.

Video Bandwidth Range (1, 3, 10 sequence) – 1 Hz to 3 MHz, 5 MHz.

Frequency Sweep –
Sweep time (CW mode, Spectrum Measurement): 50 ms to 1000 s.
Accuracy; ±5%.
Sweep Trigger: Free run, Line, Single, Video, External.
Trace Speed: 10 times/second.

Gated Sweep (R3465/R3463)-
Gate Position/Resolution:
1 µs to 65 ms in 1 µs steps.
Gate Width/Resolution:
2 µs to 65 ms in 1 µs steps.
Trigger: Internal IF detection, External.

AMPLITUDE RELATED

Measurement Range – +30 dBm to average display noise level.

Maximum Safe Input Level –
Average Continuous Power
(input attenuation ≥10 dB): +30 dBm (1 W).
DC Input: 0 V.

Input Attenuator Range –
0 to 70 dB in 10 dB steps.

DYNAMIC RANGE

Average Displayed Noise Level (RBW 1 kHz, Input Atten 0 dB, Video Bandwidth 1 Hz) –

R3465

Frequency Range	Frequency Band	Displayed Average Noise Level
10 kHz	0	-70 dBm
100 kHz	0	-80 dBm
1 MHz to 3.0 GHz	0	-(115 – 1.55 x f (GHz)) dBm
1.7 GHz to 7.0 GHz	1	-115 dBm
6.9 GHz to 8.0 GHz	2	-115 dBm

R3463/R3263

Frequency Range	Frequency Band	Displayed Average Noise Level
10 kHz	0	-70 dBm
100 kHz	0	-80 dBm
1 MHz to 3.0 GHz	0	-(115 – 1.55 x f (GHz)) dBm
1.7 GHz to 3.0 GHz (R3463)	1	-115 dBm

1 dB Gain Compression – >10 MHz, –5 dBm (input mixer level).

AMPLITUDE ACCURACY

Frequency Response (Input Atten 10 dB) –

R3465

Frequency Range	Frequency Band	In Band Flatness
9 kHz to 3.0 GHz	0	±1.5 dB
50 MHz to 3.0 GHz	0	±1.0 dB
1.7 GHz to 7.0 GHz	1	±1.5 dB
6.9 GHz to 8.0 GHz	2	±1.5 dB

R3463/R3263

Frequency Range	Frequency Band	In Band Flatness
9 kHz to 3.0 GHz	0	±1.5 dB
50 MHz to 3.0 GHz	0	±1.0 dB

ANALOG DEMODULATION

Spectrum Demodulation –
Modulation Type: AM, FM.

TIME DOMAIN MEASUREMENT (R3465/R3463)

Amplitude Resolution – 12-Bits.
Sweep Time – 50 µs to 2 s.
Trigger –
Free-run, Single, Video, IF detection, external.
Delayed Trigger Time – 200 ns to 650 ns.

INPUTS AND OUTPUTS

RF Input –
Connector: Type N female.
Impedance: 50 Ω (nominal).

Calibration Signal Output –
Connector: BNC female, front panel.

10 MHz Frequency Reference Input/Output –
Connector: BNC female, rear panel.
Output Impedance: 50 Ω (nominal).

Video Output –
Connector: VGA 15-Pin female, rear panel.

X, Y and Z Axis Output –
BNC female, rear panel.

External Trigger Input –
Connector: BNC female.
Impedance: 10 kΩ (nominal), DC coupled.
Trigger Level: TTL level.

Gate Input –
Connector: BNC female, rear panel.
Impedance: 10 kΩ (nominal).

I/O –
GPIB: IEEE-488 bus connector.
Parallel: D-SUB 25-Pin connector.
RS 232: D-SUB 9-Pin connector.
Direct File Output:
Saves .BMP files to PCMCIA cards.

Other –
External Keyboard: DIN connector.
Memory Card: Two memory card slots, front panel, JEIDA-Ver 4.2/PCMCIA2.1.

CDMA BASE STATION TESTING

Refer to R3465/R3463 Opt. 61 and R3561L CDMA base station testers.

ENVIRONMENTAL

Temperature – Operating: 0 to +50° C.
Storage: –20°C to +60° C.

Humidity – 85% relative humidity or less.

POWER REQUIREMENTS

Line Voltage –
100 VAC/220 VAC, auto-switching.

Voltage Range –
100 V Operation: 100 V to 120 V.
220 V Operation: 220 V to 240 V.

Line Frequency – 50 Hz/60 Hz.

Power Consumption – 300 VA.

PHYSICAL CHARACTERISTICS

Dimensions (without handle, feet, front cover)

	mm	in.
Height	177	7
Width	350	13.8
Depth	420	16.5
Weight	**kg**	**lbs.**
Net	17	37.5

R3465/R3463/R3263 SPECTRUM ANALYZER SELECTION GUIDE BY COMMUNICATION STANDARD

Standard	R3465 – 9 kHz to 8 GHz	R3463 – 9 kHz to 3 GHz	R3263 – 9 kHz to 3 GHz
GSM	R3465 Opt. 56 (GSM Measurements only)	N/A	R3263 Opt. 55 (GSM measurements)
	R3465 Opt. 56 and 77 (GSM measurements with graphics)	N/A	R3263 Opt. 55 and 77 (GSM measurements with graphics)
CDMA	R3465 Opt. 61 (CDMA measurements/constellation analysis with graphics, NADC measurements)	R3463 Opt. 61 (CDMA measurements/constellation analysis with graphics, NADC measurements)	N/A
	R3465 Opt. R3561L Signal Generator (requires Opt. 61) for base station receiver testing	R3463 Opt. R3561L Signal Generator (requires Opt. 61) for base station receiver testing	N/A
NADC/PDC/PHS (All NADC measurements include PDC and PHS)	R3465 (standard). R3465 Opt. 76 (PDC/PHS/NADC measurements/ constellation analysis/graphics)	R3463 (standard). R3463 Opt. 76 (PDC/PHS/NADC measurements/ constellation analysis/graphics)	N/A
GSM + CDMA	R3465 Opt. 56 and 61 (GSM measurements, CDMA measurements/ constellation analysis with graphics)	N/A	N/A
	R3465 Opt. 56, 61, and 77 (GSM measurements with graphics, CDMA measurements/ constellation analysis with graphics)	N/A	N/A
GSM + NADC	R3465 Opt. 51 (GSM measurements with graphics, NADC measurements)	N/A	N/A
	R3465 Opt. 51 and 77 (GSM measurements with graphics, NADC measurements)	N/A	N/A
	R3465 Opt. 51, 76, and 77 (GSM measurements with graphics, NADC measurements/constellation analysis/graphics)	N/A	N/A
CDMA + NADC	R3465 Opt. 61 (NADC measurements, CDMA measurements/ constellation analysis with graphics)	R3463 Opt. 61 (NADC measurements, CDMA measurements/ constellation analysis with graphics)	N/A
	R3465 Opt. 61 and 76 (NADC measurements/constellation analysis with graphics, CDMA measurements/ constellation analysis with graphics)	R3463 Opt. 61 and 76 (NADC measurements/constellation analysis with graphics, CDMA measurements/ constellation analysis with graphics)	N/A

ORDERING INFORMATION

For price information: Outside the U.S. contact your local Tektronix representative, inside the U.S. see the price list in the back of this catalog.

R3465
8 GHz Modulation Spectrum Analyzer.

R3463
3 GHz Modulation Spectrum Analyzer.

R3263
3 GHz Burst Spectrum Analyzer.

All include: Power Cord (A01412), Input Cable (MC-61), Conversion Adapter (JUG-201A/U), 6.3 A Power Fuse (21806.3), Manual.

R3465/R3463/R3263 OPTIONS

Opt. 15 – Controller option for user-defined automated routines.

Opt. 21 – High stability reference (R3465).

Opt. 51 – GSM measurements (R3465 only).

Opt. 55 – GSM measurements (R3263 only).

Opt. 56 – GSM measurements only (R3465 only).

Opt. 61 – CDMA transmitter measurements (Code domain power, waveform quality, I/Q measurements), CDMA constellation analysis with graphics.

Opt. 73 – FM Deviation Measurement.

Opt. 76 – PDC/PHS/NADC Graphics (R3465/R3463).

Opt. 77 – GSM Graphics (R3465/R3263).

Opt. 1R – Rackmount.

Opt. R3561L – Reverse link signal source for CDMA base station and mobile receiver simulation (R3465/R3463). Opt. 61 and 09 required.

SOFTWARE

R34-AR – CDMA Transmitter Test Autorun Software.

MEASUREMENT SERVICE OPTIONS

Opt. C3 – 3 years of Calibration Service.

Opt. D3 – Test Data (requires Opt. C3).

Opt. R3 – Repair warranty extended to cover three years.

RECOMMENDED ACCESSORIES

64 KB PCMCIA card. Order A09507.

Memory Card – 256 KB PCMCIA card. Order A09508.

PROBES

FET Probe – DC to 900 MHz (Requires 1101A). Order P6201.

FET Probe – DC to 500 MHz. Order P6202A.

50 Ω Divider Probe – DC to 3.5 GHz, 6 ft. Order P6158.

Current Probe – 935 Hz to 120 MHz. Order P6022.

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

GPIB IEEE-488

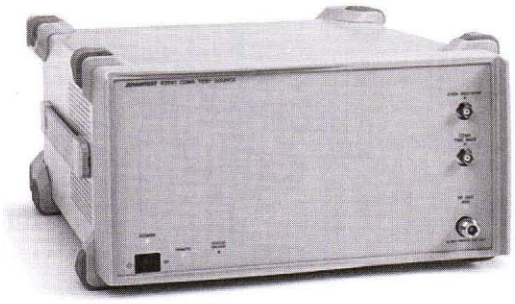
Product(s) complies with IEEE Standard 488.2.

ADVANTEST

Advantest's quality system complies with the DIN ISO 9002 standard and has been certified by TUV Product Service GMBH.

CDMA Receiver Test Sources

R3561 • New 3561L



For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

CE

ADVANTEST

Advantest's quality system complies with the DIN ISO 9002 standard and has been certified by TUV Product Service GMBH.

Features – Benefits

R3561

High Waveform Quality for Module Testing Applications

Built-in AWGN Source for Comprehensive Receiver Tests

GPIB Interface as Standard

Unit Can Be Controlled from a PC or from an R3463/65 with Opt. 61

The R3561 Generates a BTS Signal Conforming to IS-97 with a Maximum of Three Code Channels

Simulates Either Base or Mobile Station Signals

Covers Both Cellular and PCS Systems

R3561L

One Unit Covers a Wide Frequency Band (for Cellular and PCS): 50 MHz to 2 GHz (1 Hz resolution)

High Waveform Quality: 0.96 for Accurate Measurements

Detached, Portable Form Factor Means the Unit Only Has to Be Taken to a Site When Receiver Testing Is Necessary

Modulated Signal Conforming to IS-95

Delivers All Data Rates

Tracking Generator Function for Antenna and Filter Testing

Built-in AWGN Source

All Functions Can Be Controlled from the R3465/3463 (Opt. 09 Is Necessary)

Applications

R3561

Production Testing of Base Station or Mobile Phone Receivers

R3561L

Base Station Installation and Mainframe Receiver Testing

Manufacturing Test of Base Station Receivers

Note 1: Rx control option (Opt. 08) requires adding the CDMA option (Opt. 61) to the R3465/3463 series modulation spectrum analyzer.

Note 2: To add the Rx control option (Opt. 08) to your R3465/3463 series modulation spectrum analyzer after purchase and delivery, please contact your local Tektronix office.

For both the R3561 and R3561L, the system under test must provide the resulting error rate from the test source signal. For further information, consult vendor documentation or contact your local Tektronix office.

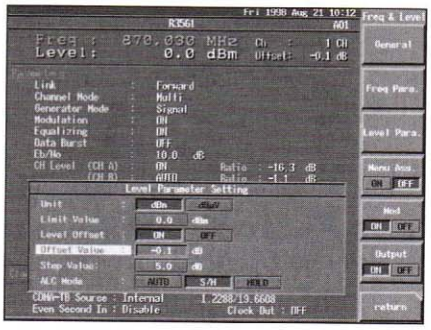
For Receiver Testing of CDMA (IS-95) Base/Mobile Stations

R3561L CDMA TEST SOURCE UNIT

The R3561L CDMA test source unit is used in combination with the R3465/3463 series modulation spectrum analyzer. CDMA test source control option (Opt. 09) is necessary for the R3465/3463. The R3561L outputs a modulated signal conforming to IS-95 to test the receiver characteristics of the base station. One unit can be used for both cellular and PCS systems.

R3561 CDMA Test Source

The stand-alone R3561 series CDMA source can be used to test base and mobile stations for both cellular and PCS CDMA systems. The R3561 generates a base station signal conforming to IS-97 with a maximum of three code channels (Pilot, Sync and Traffic). The unit can also generate a reverse traffic channel signal conforming to IS-98 for CDMA mobile stations. The R3561's wide frequency range and excellent waveform quality means the instrument is useful in a host of applications, including manufacturing test of BTS and MS receivers, as well as testing of RF modules and subsystems. The R3561 can be used with the R3463/3465, or independently through GPIB control.



R3561 Series CDMA Test Source.

Characteristics

	R3561	R3561L
Output Frequency		
Range	800 to 2300 MHz	50 to 2000 MHz
Resolution	100 Hz	1 Hz
Accuracy	Depends on the accuracy of reference source	Depends on the accuracy of the R3465/3463 reference source
Output Level		
Range	–125 dBm approximately 0 dBm	
Resolution	0.1 dB	0.1 dB

MODULATION

R3561

Output Frequency –
Range: 800 to 2300 MHz.

Modulation Mode – OQPSK / QPSK (EIA/TIA/IS-95).

Waveform Quality – >0.99 (after calibration).

Channel Type –
Forward Link:
Channel (A): Pilot/Sync/Traffic.
Channel (B): Pilot/Sync/Traffic.
Channel (C): Pilot.
Reverse Link: Pilot (ZEROS)/Traffic.

Variable Level Between Channels –
Range: –5 to –30 dB (with respect to total level).
Resolution: 0.1 dB.
Accuracy: <± 0.5 dB.

Transmission Rate –
9600 bps/4800 bps/2400 bps/1200 bps.
14400 bps/7200 bps/3600 bps/1800 bps.

Data Source –
PN 9/PN 15.
USER 600 Frames (written by user via GPIB).

PN Offset – 0 to 511 (x 64 chips).

Long Code Mask – 42 ZEROS.

External I/Q Input – DC to 2.5 MHz, Frequency characteristic < 2 dBp-p.

R3561L

Reverse Link –
Modulation mode: QPSK (EIA/TIA/IS-95).
Channel: Traffic channel.
Data rate: 9600 bps/4800 bps/2400 bps. 1200 bps,14400 bps/7200 bps. 3600 bps/1800 bps.
Data source: ZEROS/RANDOM/RAND+ERR USER 600 Frames (written by user via GPIB).

Forward Link –
Modulation mode: QPSK (EIA/TIA/IS-95).
Channel: Pilot channel.

Waveform Quality – ≥0.96.

PN Offset – 0 to 511 (x 64 chips).

Long Code Mask – 42 ZEROS.

Burst ON/OFF Ratio – ≥20 dB.

TRACKING GENERATOR FUNCTION R3561L ONLY

Output Frequency –
Range: 50 to 2000 MHz.
Resolution: 1 Hz.
Accuracy: Depends on the accuracy of R3465/3463 reference source.

Output Level –
Range: –50 to 0 dBm.
Resolution: 0.1 dB.
Accuracy (25 ±10° C): ≤±1.5 dB (center frequency 1 GHz, zero span).

Safety – UL3111-1, CSA1010.1, IEC61010-1.

Ordering Information

For price information: Outside the U.S. contact your local Tektronix representative, inside the U.S. see the price list in the back of this catalog.

R3561
CDMA Test Source.

R3561L
CDMA Test Source.

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

Product(s) available through your local Tektronix Distributor listed in the back of this catalog.

CE

ADVANTEST
Advantest's quality system complies with the DIN ISO 9002 standard and has been certified by TUV Product Service GMBH.

Spectrum Analyzer

New U3661



Features – Benefits

LIGHTEST WEIGHT 26.5 GHZ MICROWAVE SPECTRUM ANALYZER WITH 100 HZ RBW

Frequency Range: 9 kHz to 26.5 GHz

Ultra-compact and Light Weight (Main Unit: 8.5 kg or Less; with Battery: 10.8 kg or Less)

Display Dynamic Range: 100 dB

Three-way Power Supply with Battery Operation
- (100/200 VAC, external DC, and battery pack)

TFT 6-inch Color LCD and Memory Card

High-stability Measurement by Means of Synthesized Operation

50-µs High-speed Sweep Function

Diverse Options Including:
- TV Video/Audio Demodulation
- Tracking Generator
- High-stability Reference Source
- Narrow RBW
- Channel Input Setting
- CDMA Setting

Applications

Field Maintenance of Microwave Links

Installation and Maintenance of Digital Radio Facilities

TV/Broadcast Maintenance

Measurement of ACP, OBW

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

CE

ADVANTEST

Advantest's quality system complies with the DIN ISO 9002 standard and has been certified by TUV Product Service GMBH.

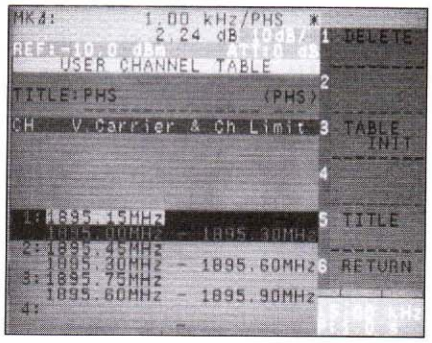
For Field Maintenance of Microwave Radio Facilities and Digital Mobile Communication

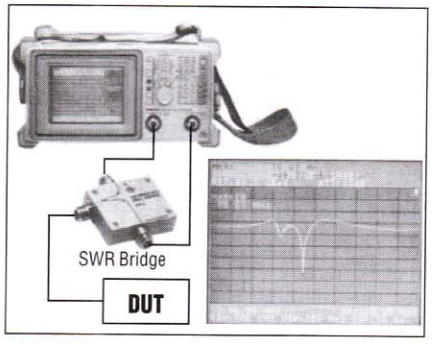
The radio communication field is undergoing fast growth on a global scale, expanding the frequency band usage across the spectrum from the microwave to the millimeter-wave bands. The U3661, at 8.5 kg, is the lightest weight microwave spectrum analyzer in the world.*1 It accommodates the diverse needs of these various communication systems. As well as enhanced basic performance as a spectrum analyzer, the U3661 is equipped with many standard functions such as power calculation and high-speed sweep.

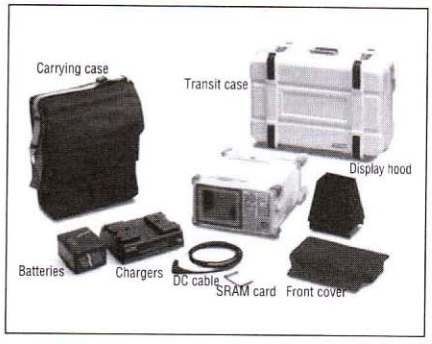
The compact, lightweight design of the U3661 utilizes a three-way power source system which includes a battery; it is an optimum analyzer for field measurement. This unit also has a built-in RS232 interface for a personal computer, facilitating flexible data management using standard memory cards.

The U3661 is rugged enough to satisfy the requirements of vibration, shock and drop tests, allowing them to be used safely under harsh field conditions.

*1 *April 1998.*







2-SLOTS MEMORY CARD DRIVE

Having two memory card drives conforming to JEIDA-Ver. 4.1/PCMCIA Rel. 2.0 as standard, measurement condition setup, and data recording can be performed while two memory cards are loaded in the drives. There are three different record formats for memory card: binary, bitmap, and text (CSV). In particular, the text (CSV) format is handy for data analysis and report creation using spreadsheet software on a personal computer.

WIDE ARRAY OF ANALYSIS FUNCTIONS

Along with basic functions such as a frequency counter with a 1 Hz resolution and a 20 dB gain preamplifier, the U3661 comes standardly equipped with analysis functions for measuring items such as dB down, third order intermodulation distortion, AM modulation, occupied bandwidth, and adjacent channel leakage power. GO-NO GO evaluations of the displayed waveform can also be easily performed using the limit line and PASS/FAIL functions which allow upper and lower limits to be set on the screen.

CHARACTERISTICS

FREQUENCY

Frequency Range: 9 kHz to 26.5 GHz.

Frequency	Frequency Band	Harmonic Order N
9 kHz to 3.2 GHz	0	1
3.0 GHz to 7.1 GHz	1	1
6.7 GHz to 14.5 GHz	2	2
13.7 GHz to 26.5 GHz	4	4

Preamplifier: 9 kHz to 3.2 GHz (Band 0).
Frequency Read Accuracy (Start, stop, center frequency, marker frequency): ± (Frequency reading x Frequency reference accuracy + 5% x Span + 15% x RBW + 60 Hz x N).

Resolution Bandwidth (3 dB) –
Range: 1 kHz to 3 MHz, 1 to 3 sequences.
100 Hz, 300 Hz (with Opt. 26).
Selectivity: <15: 1 (60 dB : 3 dB).
Video Bandwidth: 10 Hz to 3 MHz, 1 to 3 sequences.

DYNAMIC RANGE

Average Display Noise Level – RBW 1 kHz, VBW 10 Hz, input attenuator 0 dB, frequency ≥ 1 MHz.

Preamplifier OFF –

Frequency Band	Noise Level
0	–{117 – 2 f[GHz]} dBm
1	–105 dBm
2	–110 dBm
4	–105 dBm

Preamplifier ON – -132 dBm + 3 f[GHz] dBm (1 MHz to 3.2 GHz (Band 0)).

1dB Gain Compression – Input attenuator 0 dB, frequency 10 MHz or more.
Preamplifier OFF: >-10 dBm (mixer input level).
Preamplifier ON: >-30 dBm (preamplifier input level).

Spurious Response – Preamplifier OFF, input attenuator 0 dB.

AMPLITUDE ACCURACY

Frequency Response: Automatic calibration, after pre-selector peak execution.
Preamplifier OFF: 100 kHz to 2.7 GHz; ≤ ±1 dB.
9 kHz to 3.2 GHz; ≤ ±2 dB.
3 GHz to 7 GHz; ≤ ±1.5 dB.
7 GHz to 14.4 GHz; ≤ ±3.5 dB.
14.4 GHz to 26.5 GHz; ≤ ±4.0 dB.
Preamplifier ON: 100 kHz to 2.7 GHz; ≤ ±1 dB.
(Band 0) 9 kHz to 3.2 GHz; ≤ ±2 dB.

DEMODULATION

Audio Demodulation –
Modulation Type: AM, FM (FM operates at RBW ≥ 3 kHz).
Audio Output: Speaker and earphone jacks (with volume control).

INPUT/OUTPUT

RF Input –
Connector: Type N, female (or Type SMA).
Impedance: 50 Ω (nominal).
VSWR Preamplifier OFF: Input attenuator 10 dB to 50 dB.
<1.5:1 (100 kHz to 3 GHz).
<2:1 (3 GHz to 26.5 GHz).
VSWR Preamplifier ON (Band 0): <2.5:1 (9 kHz to 3.2 GHz).

GENERAL SPECIFICATIONS

Temperature –
Operating Temperature: 0° C to 50° C
Relative Humidity: 85% or less
Storage Temperature: –20° C to 60° C

Power Requirements –
External DC Input: 70 W maximum.
Connector: XLR 4 pins.
Input Range: +10 V to +16 V.
With AC Adapter: Automatic 100 V/200 VAC switching.
100 VAC Operation:
Voltage: 100 V to 120 V.
Frequency: 50 Hz/60 Hz.
220 VAC Operation:
Voltage: 220 V to 240 V.
Frequency: 50 Hz/60 Hz.

Power Consumption –
External DC Input: 70 W maximum.
With AC Adapter: 120 VA maximum.

Safety – UL3111-1, CSA1010.1, EN61010-1, IEC61010-1.

Weight –
Main Unit: 8.5 kg or less (accessories, carrying strap, and battery not included).
AC/DC Adapter (A08364): 1.1 kg.
Pro Pac 14 Battery : 2.3 kg.

Dimensions –
Approx. 148 mm (H) x Approx. 291 mm (W) x 330 mm (D). (Stand, connectors and other protrusions not included).

ORDERING INFORMATION

For price information: Outside the U.S. contact your local Tektronix representative, inside the U.S. see the price list in the back of this catalog.

U3661
Spectrum Analyzer.

OPTION GUIDE

Opt. 20 – High-stability Reference Source. High-stability reference oscillator with an aging rate of ± 2 X 10^{-8}/day.

Opt. 26 – Narrow RBW. Adds 100 Hz and 300 Hz resolution bandwidths.

Opt. 60 – CDMA Setting.* Allows channel power, ACP, OBW and spurious emission (in-band) measurement.

Opt. 72 – TV Demodulation* Frequency tuning function by channel input, TV video/audio demodulation function.

Opt. 74 – Tracking Generator. Filter evaluation function/LOSS measurement function for the frequency range from 100 kHz to 2.2 GHz.

Opt. 78 – Channel Input Setting.* VHF, UHF, CATV, BS, CS channels of various countries and user channel can be set.

ACCESSORIES

OPTIONS (SOLD SEPARATELY)

Opt. 3661 + 20 – High-stability reference option.
Opt. 3661 + 26 – Narrow RBW option.
Opt. 3661 + 60 – CDMA option.
Opt. 3661 + 72 – TV demodulation option.
Opt. 3661 + 74 – Tracking generator option.
Opt. 3661 + 78 – Channel input setting option.

ACCESSORIES (SOLD SEPARATELY)

R16072 – Transit case.
R16216A – Carrying case.
R16601 – Display hood.
A02806 – Front cover.
PROPAC14 BATT – Battery.
DUAL2401 CHARGER – Charger.
A09507 – 64 K byte SRAM memory card.
A09508 – 256 K byte SRAM memory card.
A09509 – 2 M byte SRAM memory card.
A01434 – DC cable.

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

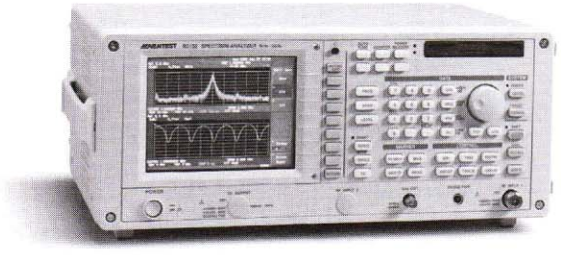
Product(s) available through your local Tektronix Distributor listed in the back of this catalog.

CE

ADVANTEST
Advantest's quality system complies with the DIN ISO 9002 standard and has been certified by TUV Product Service GMBH.

Spectrum Analyzers

New R3132 • New 3162 • New 3132N



Features – Benefits

- Frequency Range – R3132: 9 kHz to 3 GHz; R3132N: 9 kHz to 2.2 GHz; R3162: 9 kHz to 8 GHz
- Input Impedance 75 Ω model – R3132N
- High-speed GPIB, Effective for System Applications
- High Speed Measurement – 20 Traces per Second
- 6.5-inch TFT Color LCD
- Built-in Frequency Counter
- Floppy Disk for Data Saving
- Printer Port
- RS-232 Port
- VGA output
- 20 dB Preamp
- QP Detector and EMC filters

Applications

- Digital Radio Transmitter Characteristic Measurement
- Manufacturing Test
- EMC Testing (Precompliance)
- Education/Training
- Cable TV, EMC Measurements
- Digital Mobile Communications

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

CE

ADVANTEST
Advantest's quality system complies with the DIN ISO 9002 standard and has been certified by TUV Product Service GMBH.

OPTIONS

- Narrow-band Resolution Bandwidth – 30 Hz, 100 Hz, 200 Hz (EMI Bandwidth) and 300 Hz
- High-stability Frequency Reference – Aging Rate 1 x 10^{-7}/year
- High-speed Time Domain Sweep – 50 µs/10 div. (100 ns Resolution)
- Tracking Generator – 100 kHz to 3 GHz

The R3132/3162 series spectrum analyzers offer outstanding measurement capabilities and performance, at an affordable price.

For various applications, such as Cable TV, EMC measurement and Digital Mobile. Communications, the R3132/3162 can be customized by selecting from available options.

BASIC FUNCTIONS

Basic functions are reinforced so that the R3132/3162 can be used in various fields. For example, the internal automatic calibration function guarantees the total level accuracy of ±1.5 dB; level correction factor can be stored in the internal memory, DDS is employed to improve frequency reading accuracy, and frequency span error is lowered to less than 1%.

The R3132/3162 offer wider dynamic range and lower 2nd and 3rd order distortion by improving 1 dB compression point.

As a result of increasing the sweep repetition cycles by improving the synthesized local oscillator, 20 traces/second (typ.) data rewriting becomes possible, enabling far more real-time waveform measurement. Also, the high speed GPIB increases the throughput of automatic measurement.

FOR MANY APPLICATIONS

For EMI precompliance measurement, 6 dB bandwidth filters (9 kHz, 120 kHz and 1 MHz) and a QP detector are equipped as standard. An optional 200 Hz narrow RBW filter can be added for EMC measurements. A high-speed time domain measurement function which is indis

pensable for mobile communications, is available as an option.

By using the double-screen display function, you can specify the rising/falling edge of TDMA waveforms and display the magnified image.

The R3132/3162 series spectrum analyzer has ACP and OBW operation functions which are indispensible for evaluating the transmission characteristic of radio systems.

With various other functions such as AUTO TUNE, 1 Hz resolution frequency counter, dBc/Hz, %AM, and PASS/FAIL test by limit value, the R3132/3162 series can easily perform several types of measurements.

Even for signals which are lower in amplitude than the average noise level, the preamplifier ensures level calibrated, high-accuracy measurement.

For measuring the attenuation characteristics of filters or the frequency characteristics of cables, etc., a built-in tracking generator is available as an option. Because the output level can be set in a wide range, it is possible to measure amplifier gain, frequency response, etc.

EASY-OPERATION INTERFACE

The high-resolution, 6.5-inch TFT color LCD provides easy-to-see display of data. A VGA output is provided for external display.

Measured waveform data and setting condition can be saved in or recalled from the internal memory. Using the floppy disk drive which is equipped as standard, you can manage more measurement data. Text data or Bitmap data on floppy disk are also useful for making documents on a personal computer.

As the hard-copy function is provided to ESC/P. ESC/P-R and PCL, measured data can be printed out on general-purpose printers.

GPIB and RS232 are equipped as standard.

CHARACTERISTICS

FREQUENCY

Frequency Range – 9 kHz to 3 GHz (9 kHz to 2.2 GHz for R3132N).

Frequency Reading Accuracy (Start, Stop, Center Frequency, Marker Frequency) – ± (Reading of frequency x Frequency reference accuracy + Span x 1% + Resolution bandwidth x 15% + 60 Hz).

Counter –
Resolution: 1 Hz to 1 kHz.
Accuracy: ± (Marker frequency x Frequency reference accuracy + 1 LSD).

Frequency Reference Accuracy –
Stability: $\pm 2 \times 10^{-6}$/year, $\pm 1 \times 10^{-7}$/year (Opt.), $\pm 1 \times 10^{-5}$ (0° C to 50° C).

Frequency Span –
Range: 1 kHz to 3 GHz, 0 Hz.
Accuracy: ≤±1%.

Residual FM – ≤60 Hz p-p x 0.1 s.

Signal Purity –
≤-105 dBc/Hz (20 kHz offset).
≤-100 dBc/Hz (10 kHz offset).

Resolution Bandwidth (3 dB) –
Range: 1 kHz to 3 MHz, 1-3-10 sequence, 30 Hz to 300 Hz (Opt.).
6 dB bandwidth: 1 MHz, 120 kHz, 9 kHz, 200 Hz (Opt.).

Video Bandwidth – 10 Hz to 3 MHz, 1-3-10 sequence.

AMPLITUDE RANGE

Measuring Range – +30 dBm to the average of displayed noise level.

Maximum Input Level –
(Input ATT ≥5 dB)
Preamplifier OFF: +30 dBm, ±50 VDC max.
Preamplifier ON: +13 dBm, ±50 VDC max.

Input ATT Range – 0 to 50 dB (5 dB step).

DYNAMIC RANGE

Average Noise Level – RBW 1 kHz, VBW 10 Hz, input ATT 0 dB, for 1 MHz or more.
Preamplifier OFF: –118 dBm + 2f (GHz) dB.
Preamplifier ON: –132 dBm + 3f (GHz) dB.

1 dB Gain Compression – At 10 MHz or more.
Preamplifier OFF: >0 dBm (mixer input level).
Preamplifier ON: >-30 dBm (RF input level).

AMPLITUDE ACCURACY

Frequency Response – After auto calibration.
Preamplifier OFF:
≤±0.5 dB (100 kHz to 3 GHz, ATT=0 dB).
≤±1 dB (100 kHz to 2.7 GHz).
≤±2 dB (9 kHz to 3 GHz).
Preamplifier ON:
≤±1 dB (100 kHz to 2.7 GHz).
≤±2 dB (9 kHz to 3 GHz).

Calibration Signal Level Accuracy – -20 dBm ±0.3 dB.

IF Gain Error – ≤±0.5 dB after auto calibration.

Total Level Accuracy – ±1.5 dB (REF= –50 to 0 dBm, ATT=10 dB, 2 dB/div, RBW=300 kHz, f >100 kHz, after auto calibration).

SWEEP

Sweep Time – 20 ms to 1000 s, 50 µs to 1 s (Opt.).

Accuracy – <±1%.

Trigger Mode – FREE RUN, LINE, VIDEO, EXT, TV.

Sweep Mode – REPEAT, SINGLE.

I/O

RF Input –
Connector: N type female.
Impedance: 50 Ω (R3132) (nominal), 75 Ω (R3132N) (nominal).

Probe Power – ±12 V, 4-pin connector.

Calibration Output Signal – BNC female. 30 MHz, –20 dBm.

10 MHz Reference Input – BNC female, 50 Ω. 0 dBm to +16 dBm.

External Trigger Input – BNC female.

Sound Output (Demodulated Audio) – Small monophonic jack.

GPIB Interface – IEEE-488 specification BUS connector.

Serial Interface – D-sub 9-pin.

Printer Interface – D-sub 25-pin, ESC/P, ESC/P-R, PCL.

Video Out – VGA (15-pin, female).

Floppy Disk – 3.5 inch, MS-DOS format.

ENVIRONMENTAL

Operating Temperature – 0 to +50° C.
Humidity: RH 85% or less.

Storage Temperature – –20 to +60° C, RH 85% or less.

Power Supply – 100/200 VAC switchable.
100 VAC: 100 to 120 VAC, 50 to 60 Hz.
200 VAC: 200 to 240 VAC, 50 to 60 Hz.

Dimensions – 424 (W) x 177 (H) x 300 (D) mm (without feet and connectors).

R3162 SPECIFICATIONS

FREQUENCY

Frequency Range – 9 kHz to 8 GHz.

Frequency Range	Band
9 kHz to 3.4 GHz	0
3.2 GHz to 7.5 GHz	1-
6.5 GHz to 8 GHz	1+

Frequency Reading Accuracy (Start, Stop, Center Frequency, Marker Frequency) – ± (Reading of frequency x Frequency reference accuracy + Span x 1% + Resolution bandwidth x 15% + 60 Hz).

Counter –
Resolution: 1 Hz to 1 kHz.
Accuracy: ± (Marker frequency x Frequency reference accuracy + 1 LSD).

Frequency Reference Accuracy –
Stability: $\pm 2 \times 10^{-6}$/year, $\pm 1 \times 10^{-7}$/year (Opt.), $\pm 1 \times 10^{-5}$(0° C to 50° C).

Frequency Span –
Range: 1 kHz to 8 GHz, 0 Hz ≤±1%.

Residual FM – ≤60 Hz p-p x 0.1 s.

Signal Purity –
≤-105 dBc/Hz (20 kHz offset).
≤-100 dBc/Hz (10 kHz offset).

Resolution Bandwidth (3 dB) –
Range: 1 kHz to 3 MHz, 1-3-10 sequence, 30 Hz to 300 Hz (Opt.).
6 dB bandwidth: 1 MHz, 120 kHz, 9 kHz, 200 Hz (Opt.).

Video Bandwidth – 10 Hz to 3 MHz, 1-3-10 sequence.

AMPLITUDE RANGE

Measuring Range – +30 dBm to the average of displayed noise level.
Maximum Input Level – (Input ATT ≥ 5 dB).
Preamplifier OFF: +30 dBm, 0 VDC max.
Preamplifier ON: +13 dBm, 0 VDC max.

Indication Range – 10 x 10 div.
Log: 10, 5, 2, 1 dB/div.
Linear: 10% of the reference level/div.

Input ATT Range – 0 to 75 dB (5 dB step).

DYNAMIC RANGE

Average Noise Level – RBW 1 kHz, VBW 10 Hz, input ATT 0 dB, for 1 MHz or more.
Preamplifier OFF:
Band 0: –118 dBm + 2f (GHz) dB.
Band 1-: –115 dBm.
Band 1+: –115 dBm.
Preamplifier ON: –132 dBm + 3f (GHz) dB (At 1 MHz to 3.4 GHz).

1 dB Gain Compression –
At 10 MHz or more.
Preamplifier OFF: >0 dBm (mixer input level).
Preamplifier ON: >-30 dBm (RF input level).

AMPLITUDE ACCURACY

Frequency Response – After auto calibration, after pre-selector peak adjustment.
Preamplifier OFF:
≤±0.5 dB (100 kHz to 3 GHz, ATT=0 dB).
≤±1 dB (100 kHz to 2.7 GHz).
≤±2 dB (9 kHz to 3.4 GHz).
≤±2 dB (3.2 GHz to 8 GHz).
Preamplifier ON:
≤±1 dB (100 kHz to 2.7 GHz).
≤±2 dB (9 kHz to 3.4 GHz).

Calibration Signal Level Accuracy –
-20 dBm ± 0.3 dB.

IF Gain Error – ≤±0.5 dB after auto calibration.

Total Level Accuracy – ±1.5 dB (REF=-50 to 0 dBm, ATT=10 dB, 2 dB/div, RBW=300 kHz, f >100 kHz, after auto calibration).

SWEEP

Sweep Time – 20 ms to 1000 s, 50 µs to 1 s (Opt.).
Accuracy: <±1%.

Trigger Mode – FREE RUN, LINE, VIDEO, EXT, TV.

Sweep Mode – REPEAT, SINGLE.

I/O

RF Input –
Connector: N type female.
Impedance: 50 Ω (nominal).

Probe Power – ±12 V, 4-pin connector.

Calibration Output Signal –
BNC female, 50 W.
30 MHz, –20 dBm.

10 MHz Reference Input –
BNC female, 50 W.
0 dBm to +16 dBm.

External Trigger Input – BNC female.

Sound Output (Demodulated Audio) – Small monophonic jack.

GPIB Interface – IEEE-488 specification BUS connector.

Serial Interface – D-sub 9-pin.

Printer Interface – D-sub 25-pin, ESC/P, ESC/P-R, PCL.

Video Out – VGA (15-pin, female).

Floppy Disk – 3.5 inch, MS-DOS format.

ENVIRONMENTAL

Operating Temperature –
0 to +50° C.
Humidity: RH 85% or less.

Power Supply – 100/200 VAC switchable.
100 VAC: 100 to 120 VAC, 50 to 60 Hz.
200 VAC: 200 to 240 VAC, 50 to 60 Hz.

Safety – UL3111-1, CSA1010.1, IEC61010-1.

Dimensions – 424 (W) x 177 (H) x 300 (D)mm (without feet and connectors).

ORDERING INFORMATION

For price information: Outside the U.S. contact your local Tektronix representative, inside the U.S. see the price list in the back of this catalog.

R3132
Spectrum Analyzer.

R3162
Spectrum Analyzer.

OPTIONS:

Opt. 20 – High-stability frequency reference 1x10E-7/yr (aging rate).

Opt. 27 – Narrow resolution bandwidths 30 Hz, 100 Hz, 300 Hz and 200 Hz (EMI).

Opt. 29 – Fast sweep speed 50 µs/10 div. (100 ns resolution).

Opt. 74 – Tracking generator 100 kHz to 3 GHz.

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

CE

ADVANTEST
Advantest's quality system complies with the DIN ISO 9002 standard and has been certified by TUV Product Service GMBH.

Spectrum Analyzers

U3641/N



Features – Benefits

- Frequency Range: 9 kHz to 3 GHz
- Ultra-compact and Light Weight – 15 lbs.
- Three-way Power Supply – AC Line, External DC and Optional Battery Pack
- 6 in. TFT Color LCD Display
- Synthesized Local Oscillator Yields High-stability Measurements
- Two PCMCIA Memory Card Slots
- Switchable Preamp for High-sensitivity Measurements
- Optional Internal Tracking Generator
- Built-in Adjacent Channel Power, Occupied Bandwidth and Channel Power Measurements

Applications

- Digital Mobile Communications Field Measurements (TDMA or CDMA, PCS and Cellular)
- Spectrum Monitoring
- RF Component Testing with Internal Tracking Generator Option
- Fault Location in Antenna Feeds with BasePak Software

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

GPIB IEEE-488

Product(s) complies with IEEE Standard 488.2-1987.

ADVANTEST

Advantest's quality system complies with the DIN ISO 9002 standard and has been certified by TUV Product Service GMBH.

U3641/U3641N Field Portable Spectrum Analyzers

The U3641/N is a 3 GHz synthesized spectrum analyzer ideal for applications where portability is a must. With a base unit weight of 15 lbs. and the ability to run from AC, DC or optional battery power sources, the U3641/N has been designed specifically to meet the needs of field installation and maintenance applications. The synthesized local oscillator allows high-precision and high-stability measurements. Furthermore, the unit features optional resolution bandwidths down to 100 Hz. A fast zero span sweep speed of 50 µs allows characterization of TDMA signals, and its built-in measurement functions allow for easy verification of communication standard compliance.

The U3641/N can be customized for a variety of applications by selecting from a wide range of available options.

WIDE ARRAY OF ANALYSIS FUNCTIONS

Along with functions such as a frequency counter with a 1 Hz resolution and a 20 dB gain preamplifier, these analyzers come standard with measurement functions such as third order intermodulation distortion, percent AM, occupied bandwidth and adjacent channel leakage power. GO-NO GO evaluations of the displayed waveform can also be easily performed using the limit line and PASS/FAIL functions which allow upper and lower limits to be set on the screen.

Using the user-define function, commonly used measurements can be easily assigned to function keys, allowing a user-created custom, easy-to-use menu.

THE LIGHTEST FIELD ANALYZERS IN THEIR CLASS

These analyzers are light and compact – 15 lbs. base unit, under 20 lbs. with battery. The easy-to-attach strap allows the analyzer to be carried on the shoulder for transport or during measure-

ments. The rugged construction meets MIL-T-28800 and stands up to the harsh conditions of field use.

CDMA MEASUREMENTS

Addition of the CDMA Option 60 enables easy one-button measurement of CDMA transmission characteristics including in-band spurious, occupied bandwidth, channel power and adjacent channel power. Measurements are included for both base stations and mobile phones, at cellular and PCS frequencies.

THREE POWER SOURCES TO CHOOSE FROM

The U3641/U3641/N can operate not only on 100/200 V AC power, but also on +10 to +16 V DC or the optional battery pack. Choose the power source that matches your need for portable flexibility.

LARGE COLOR TFT LCD DISPLAY

The 6 in. color TFT LCD display enhances viewing of complex measurements. A built-in tilt mechanism allows adjusting the viewing angle ±15 degrees to improve visibility and efficiency.

COMPUTER AND INTERFACE FRIENDLY

These analyzers are well-suited for computer-based applications. Two PCMCIA memory card slots allow you to store and recall instrument settings and measurements. This data can also be transferred directly to a computer in CSV (comma separated variable) and BMP screen image formats. The memory card slots incorporate a dust-proof shutter and an eject mechanism for reliable operation even in difficult outdoor working conditions.

RS-232C and GPIB ports are also standard. This allows you to print hardcopies of spectrum information and to control the instruments from an external computer as well as send/retrieve data.

Composite video out jacks are standard. The output of these spectrum analyzers can be easily projected for better viewing in meetings or training sessions.

CHARACTERISTICS

FREQUENCY RELATED

Frequency Range –
9 kHz to 3 GHz.

Frequency Readout Accuracy – (Start, Stop, CF, Marker).
±(marker frequency x frequency reference error + 5% x span + 15% x RBW + 10 Hz).

Count Frequency Marker –
Resolution: 1 Hz to 1 kHz.
Count Accuracy: S/N ≥25 dB, RBW ≥3 kHz, 1 kHz ≤ SPAN ≤200 MHz): ±(marker frequency x frequency reference accuracy + 1 LSD ± 5 Hz).

Frequency Reference Accuracy –
$\pm 2 \times 10^{-6}$/year $\pm 1 \times 10^{-5}$ (at 0° C to 50° C).

Frequency Span –
Range: 1 kHz to 3.2 GHz, 0 Hz (Zero Span).
Accuracy: U3641/N: ≤±5% (SPAN).

Frequency Stability –
Residual FM: ≤60 Hz p-p/100 ms (ZERO span).
Frequency Drift: <150 Hz/min (SPAN ≤10 kHz).

Noise Sidebands –
20 kHz Offset: ≤-105 dBc.
10 kHz Offset: ≤-100 dBc.

Resolution Bandwidth (3 dB) –
Range: 1 kHz to 3 MHz, 1-3 sequence.
U3641, Opt. for 100, 300 Hz.
Selectivity:
<15:1 (60 dB to 3 dB, RBW 1 kHz to 3 MHz).
(conforming to CISPR standard).

Video Bandwidth – 10 Hz to 3 MHz (1-3 step).

AMPLITUDE RELATED

Amplitude Range –
U3641:
+20 dBm to displayed Average Noise Level.
U3641N:
+130 dBµV to displayed Average Noise Level.

Maximum Input Level (±50 V DC maximum) –
Preamplifier OFF (Input Atten ≥10 dB):
U3641: +27 dBm.
U3641N: +134 dBµV.
Preamplifier ON (input atten ≥10 dB):
U3641: +13 dBm.
U3641N: +120 dBµV.

Display Range –
Log: 10 x 10 div, 10, 5, 2, 1 dB/div.
Linear: 10% of reference level/div, RBW ≥3 kHz.

Reference Level Range (U3641/N) –
Preamplifier OFF (Input Atten 0 dB to 50 dB):
Log: U3641, –64 dBm to +40 dBm;
U3641N, +46 dBµV to +150 dBµV.
Linear: U3641, +141.1 µV to +22.36 V;
U3641N, +198.4 µV to 31.44 V.
Preamplifier ON (Input Atten 0 dB to 10 dB):
Log: U3641, –89 dBm to –25 dBm (0.1 dB step); U3641N, +21 dBµV to +85 dBµV.
Linear: U3641, +7.934 µV to +12.57 mV;
U3641N, +11.16 µV to 17.68 mV.

Input Attenuator Range –
0 to 50 dB (10 dB step).

SWEEP RELATED

Sweep Time –
50 µs to 1000 s and manual sweep.

Accuracy – ≤±5%.

Trigger Mode –
Free Run, Single, Video, Ext, TV.

DEMODULATION

Spectrum Demodulation –
Modulation Type:
AM and FM (FM at RBW ≥ 3 kHz).
Audio Output: Speaker and phone jack with volume control.

DYNAMIC RANGE

Displayed Average Noise Level (RBW 1 kHz, VBW 10 Hz) –
Preamplifier OFF:
U3641: –117 dBm + 2.7 f (GHz) dB.
U3641/N: –8 dBµV + 2.7 f (GHz) dB.
Preamplifier ON:
U3641: –135 dBm + 4.3 f (GHz) dB.
U3641/N: –26 dBµV + 4.3 f (GHz) dB.

Gain Compression (1 dB) –
Preamplifier OFF (mixer input level, f ≥10 MHz):
U3641: >-10 dBm.
U3641/N: >+100 dBµV.
Preamplifier ON (RF input level, f ≥10 MHz):
U3641 (ATT = 0): >-40 dBm.
U3641/N: >+70 dBµV.

Spurious Response (Input Atten 0 dB,f ≥10 MHz) –
Preamplifier OFF:
Second Harmonic Distortion:
U3641: ≤-70 dB (–30 dBm input).
U3641/N: ≤-70 dB (+78 dBµV input).
Third Order Intermodulation Distortion:
U3641: ≤-70 dB (–30 dBm input).
U3641/N: ≤-70 dB (+78 dBµV input).

Residual Responses (Input Atten 0 dB, f ≥10 MHz) –
Preamplifier OFF:
U3641: ≤-100 dBm, 50 Ω.
U3641/N: ≤+10 dBµV, 75 Ω.
Preamplifier ON:
U3641: ≤-105 dBm, 50 Ω.
U3641/N: ≤+5 dBµV, 75 Ω.

AMPLITUDE ACCURACY

Frequency Response (Input Atten 10 dB, 20° C to 30° C, referenced to 30 MHz, after calibration) –
Preamplifier OFF:
U3641: ≤±1 dB (100 kHz to 2.7 GHz);
≤2 dB (9 kHz to 3.0 GHz).
U3641/N: ≤±1 dB (100 kHz to 2.7 GHz).
Preamplifier ON:
U4342: ≤±1 dB (100 kHz to 2.7 GHz).
U3641: ≤±2 dB (9 kHz to 3.0 GHz).
U3641/N: ≤±1 dB (100 kHz to 2.2 GHz).

Calibration Signal Accuracy –
U3641: –20 dBm ±0.3 dB.
U3641/N: +90.5 dBµV ±0.3 dB.

IF GAIN UNCERTAINTY

(after automatic calibration) –
≤±0.5 dB.

Scale Fidelity (after automatic calibration) –
Log: ≤±1.5 dB/90 dB; ≤±1 dB/10 dB; ≤±0.2 dB/1 dB.
Linear: ≤±5% of reference level, RBW 3 kHz.

Input Attenuator Switching Accuracy (10 dB reference, 20 dB to 50 dB setting) –
U3641:
100 kHz to 2.7 GHz: ≤±1.0 dB.
9 kHz to 3.0 GHz: ≤±1.5 dB.
U3641/N:
100 kHz to 2.2 GHz: ≤±1.0 dB.

Resolution Bandwidth Switching Uncertainty (after automatic calibration) –
≤ ± 1.0 dB at RBW 3 MHz.

INPUTS AND OUTPUTS

RF Input –
Connector: N-type jack.
Impedance:
U3641 50 Ω (nominal).
U3641/N 75 Ω (nominal).
VSWR:
Preamplifier OFF:
100 kHz to 2 GHz: ≤1.5:1.
9 kHz to 3.0 GHz (2.2 GHz U3641/N): ≤2:1.
Preamplifier ON:
10 MHz to 3.0 GHz (2.2 GHz U3641/N): ≤2.5:1.
10 MHz to 2.0 GHz (U4941/N): ≤2:1.

10 MHz Reference Input –
Connector: BNC jack, rear panel.
U3641/N:
Impedance: 50 Ω (nominal).
Input Range: 0 dBm to +16 dBm.

Video Output –
Connector: BNC jack, rear panel.
Impedance: 75 Ω (nominal), AC coupled.
Amplitude: Approx. 1 V p-p, 75 Ω (composite video signal).

External Trigger Input –
Connector: BNC jack, rear panel.
Impedance 10 kΩ (nominal), DC coupled.
Trigger level: TTL level.

Gate Input –
Impedance: 10 kΩ (nominal).
Sweep step: During TTL low level.
Sweep continue: During TTL high level.

Phone Output –
Connector: Subminiature monophonic jack, front panel.

GPIB Interface –
Connector: IEEE-488 bus.
Plotter: HP-GL commands (682-XA).
Printer: PCL commands.

RS-232 –
Connector: D-SUB 9-Pin, rear panel.

Memory Card – Two memory card slots, JEIDA-Ver.4.1, PCMCIA Rel. 2.0, Type 1.

HIGH STABILITY REFERENCE SOURCE (OPT. 20 ONLY, U3641/N)

Frequency – 10 MHz.
Frequency Accuracy –
$\pm 2 \times 10^{-8}$/day.
$\pm 1 \times 10^{-7}$/year.

PHS-ID DEMODULATOR FUNCTION (OPT. 70 ONLY, U3641)

Opt. 20 and Opt. 70 cannot be installed simultaneously.

Signal Reception –
Radio access format – TDMA-TDD.
Modulation format: pi/4 DQPSK.
Transmission speed: 384 Kbits/s.
Signal channel: Logic control channel code configuration conforms to RCR STD-28.

Level Measurement Range –
Reception performance:
Preamplifier OFF (Input Atten = 10 dB):
52 dBµV to 107 dBµV.
Preamplifier ON (Input Atten = 0 dB):
16 dBµV to 67 dBµV.
Sweep Trigger Modes: Free Run, Video, ID.

Measurement Functions –
ID List displays: CI, CS-ID, PS-ID, level, time.
ID-MKR: Display of specified signal ID.
Period measurement: Measurement of specified CS-ID.

Burst Error Rate – The number of error slots/The measured (Set) number.

Level Measurement Operations –
Center value processing.
Average value processing.
Max/min. value processing.

TV DEMODULATION FUNCTION (OPT. 72 ONLY) U3641/N

TV Demodulation –
Demodulation type: NTSC, PAL, SECAM.
TV standard: M, B/G, D/K/K', I, L/L'.
Output: Video, sound.

TV Image Demodulation Output –
Connector: BNC jack, rear panel.
Impedance: 75 Ω (nominal), DC coupled.
Amplitude: Approx. 1 V_{p-p}, 75 Ω.

TV Sound Demodulation Output –
Connector: Pin jack, rear panel.
Impedance: 1 kΩ (nominal), AC coupled.

TV Image Signal Input –
Connector: BNC jack, rear panel.
Impedance: 75 Ω (nominal), AC coupled.
Input Level: About 1 V_{p-p}.

TV Sound Signal Input –
Connector: Pin jack, rear panel.
Impedance: 1 kΩ (nominal), AC coupled.

TRACKING GENERATOR FUNCTION

Opt. for U3641/N.

Frequency Range – 100 kHz to 2.2 GHz.

Output Level Range –
0 dBm to –31 dBm, 1 dB steps.
N Version: 105 dBµV to 74 dBµV, 1 dB steps.

Output Level Accuracy –
at 30 MHz, –10 dBm: ≤0.5 dB.
N Version: at 30 MHz, 95 dBµV: ≤0.5 dB.

Output Level Flatness –
(at –10 dBm, 30 MHz reference):
100 kHz to 1 GHz: ≤±0.7 dB.
100 kHz to 2.2 GHz: ≤±1.5 dB.
N Version (at 95 dBµV, 30 MHz reference):
100 kHz to 1 GHz: ≤±0.7 dB.
100 kHz to 2.2 GHz: ≤±1.5 dB.

Output Level Switching Accuracy –
(at –10 dBm reference):
100 kHz to 1 GHz: ≤±1.0 dB.
100 kHz to 2.2 GHz: ≤±2.0 dB.
N Version (at 95 dBµV reference):
100 kHz to 1 GHz: ≤±1.0 dB.
100 kHz to 2.2 GHz: ≤±2.0 dB.

Output Spurious –
Harmonic: <-20 dBc.
Non-harmonic: <-30 dBc.

Tracking Generator Leakage –
≤-95 dBm.
N Version: ≤-16 dBµV.

Tracking Generator Output –
Connector: N-type jack.
Impedance:
50 Ω (nominal).
N Version: 75 Ω (nominal).
VSWR:
(≤-10 dBm output): ≤1.5.
N Version (≤-10 dBµV output): ≤2.0.

CHANNEL INPUT SETTING (OPT. 78 ONLY, U3641/N)
(Opt. 78 is included in Opt. 72.)
Channel Setting – Channel setting for VHF, UHF, CATV, BS and CS. Two user tables are available and 99 channels can be registered for each table.

ENVIRONMENTAL
Temperature –
Operating: 0° C to 50° C.
Nonoperating: –20° C to +60° C.
Humidity – 85% or less.

POWER REQUIREMENTS
External DC Input –
Connector: XLR 4-Pin.
Voltage range: +10 V to +16 V.
Power consumption: 60 W maximum.
AC Input –
Line voltage: 100 VAC and 200 VAC, auto switching.
Voltage range:
100 V operation: 90 V to 120 V.
220 V operation: 220 V to 240 V.
Line frequency: 50 Hz/60 Hz.
Power consumption: 100 VA maximum.

PHYSICAL CHARACTERISTICS

Dimensions (without feet or connectors)

	mm	in.
Height	148	5.75
Width	291	11.375
Depth	330	13.25

Weight (without options, accessories, carrying belt, batteries)

	kg	lbs.
U3641/N	6.9	15.2

ORDERING INFORMATION

For price information: Outside the U.S. contact your local Tektronix representative, inside the U.S. see the price list in the back of this catalog.

U3641
Portable Spectrum Analyzer, 50 Ω Input.

U3641N
Portable Spectrum Analyzer, 75 Ω Input.
Includes: Power Cable (A01402), N-to-BNC Adapter (U3641 – JUG-201A/U), NC-to-BNC Adapter (U3641N – BA-A165), N-C15 Adapter (U3641N – (NCP-NFJK), AC-DC Adapter (A08364), Carrying Strap, Operation Manual, SRAM card.

OPTIONS
Opt. 15 – Program controller.
Opt. 20 – High-stability reference (cannot be installed with Opt. 70).
Opt. 26 – Narrow RBW filters (300/100 Hz).
Opt. 60 (U3641 only) – CDMA measurement IS-95/J-STD-008 TX measurement for U3641 only.
Opt. 70 (U3641 only) – PHS demodulation (cannot be installed with Opt. 20 or Opt. 72).
Opt. 72 – TV demodulation (cannot be installed with Opt. 70, includes Opt. 78).
Opt. 74 – Tracking generator.
Opt. 78 – Channel input setting (included with Opt. 72).

MEASUREMENT SERVICE OPTIONS
U3641/N
Opt. C3 – Three years of calibration services.
Opt. D3 – Test data (requires Opt. C3).
Opt. R3 – Repair warranty extended to cover three years.

RECOMMENDED ACCESSORIES
Battery – Order 146-0111-00 (requires charger).
Battery Charger – Order 119-4901-00.
External DC Power Cable – Order A01434.
Memory Card, 64K – Order A09507.
Soft Carrying Case – Order R16216.
Transit Case – Order R16072.
Front Panel Cover – Order A02806.
Carrying Handle – Order A08184.
Display Hood – Order R16601.

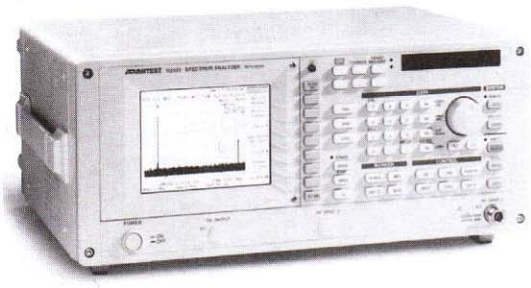
For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

GPIB IEEE-488
Product(s) complies with IEEE Standard 488.2-1987.

ADVANTEST
Advantest's quality system complies with the DIN ISO 9002 standard and has been certified by TUV Product Service GMBH.

Spectrum Analyzer

New R3131



Features – Benefits

Built-in High Accuracy OBW, ACP, and Power Measurement Functions Which Can Be Applied to Digital Radio Measurement

Improved Ease of Use Through Auto TUNE Function

Total Level Accuracy Guaranteed by Auto CAL Function

Standard Interfaces: GPIB, RS232, Centronics, and FD Drive

Large Character Display Allows Results to Be Seen

EMC Measurement Functions

Improved System Operation Speed

Operation Key Arrangement for Ease of Use

Compact and Light Weight (12 kg) with a Space-saving Design

Optional Tracking Generator for Scalar Transmission Measurements

Applications

Digital Radio Transmitter Characteristics Measurement

EMC Diagnostic Testing

Education/Training

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

CE

ADVANTEST

Advantest's quality system complies with the DIN ISO 9002 standard and has been certified by TUV Product Service GMBH.

An Affordable Personal Spectrum Analyzer with Performance to Match Many Applications

The R3131 is an easy-to-use personal spectrum analyzer which combines high accuracy necessary for digital radio measurement with excellent operability and usability. The R3131 can be used in diverse fields, for a multitude of applications.

Lots of Standard Features

The R3131 includes a number of standard features that normally are available only as options. These include an IEEE 488 interface, RS-232 interface and parallel printer (Centronics) port. A 3.5 inch floppy disk is also provided at no extra charge, as is an EMC Measurement function.

Measurement parameters and results can be recorded on a 3.5 inch floppy disk. Because the bitmap and text formats are compatible, the recorded data can easily be transferred to a PC.

INDEPENDENT OPERATION KEYS IMPROVE OPERABILITY

AUTO TUNE
Searches for the signal with the maximum level within the 3 GHz band and sets the center frequency automatically.

COUNTER
Performs frequency measurement with the built-in frequency counter simply by moving the marker to the signal.

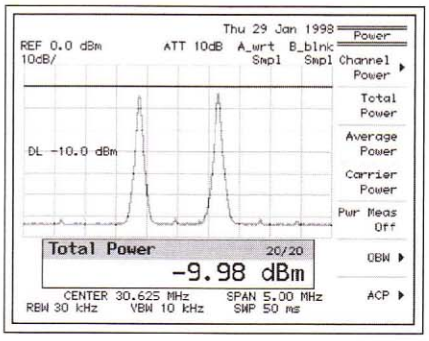
POWER MEASURE
The R3131 can measure the power within the specified band of frequency diffuse signals and the total power of multi-carrier signals. It can also be used to measure the occupied frequency bandwidth (OBW) and adjacent channel leakage power (ACP) which are essential to transmission characteristics testing for radio equipment.

CHANNEL POWER
The R3131 allows you to measure the total power within the window and display it as the channel power.

TOTAL POWER
Obtains the total power from the spectrum displayed on the screen. This function is useful for total power measurement of multi-carrier signals.

GATED SWEEP
The R3131 allows spectrum analysis of the burst signal by supplying a trigger signal synchronizing with the burst transmission.

SAVE/RECALL
The R3131 allows you to store and recall measured waveform data and measurement conditions. The R3131 unit offers up to 10 dedicated files for storage.



PASS/FAIL
Sets the limited judgment value for the level axis using a window. If the marker falls within the window, the PASS judgment results; otherwise, the FAIL judgment results.

EMC
This function measures electromagnetic interference generated by various electronic equipment. This function incorporates the 9 kHz and 120 kHz RBW and QP detector conforming to the CISPR Pub.16-1 standard. In addition, using the AM/FM demodulation signal fed from the PHONE jack on the rear panel, you can identify broadcasting radio waves which act as external noise.

CHARACTERISTICS

FREQUENCY
Range: 9 kHz to 3 GHz.
Marker counter resolution: 1 Hz to 1 kHz.
Frequency span: zero, 50 kHz to 3 GHz.
Frequency stability Residual
FM: ≤ 100 Hz_{p-p}/100 ms (zero span).
Sideband noise: ≤100 dBc/Hz (20 kHz offset).
Resolution 3 dB bandwidth: 1 kHz to 1 MHz, 1-3 step.

AMPLITUDE
Maximum input level: +20 dBm, 50 VDC.

Display range –
LOG: 10 dB/div 8 div, 1,2,5 dB/div, 10 div.

Reference level range –
LOG: –64 dBm to + 40 dBm, 1 dB steps.

SWEEP
Sweep time: 50 ms to 500 s.

DISPLAYED NOISE LEVEL
Average noise level: –113 dBm +2 f (GHz) dB (at RBW 1 kHz, VBW 10 Hz, INPUT ATT 0 dB, frequency ≥1 MHz).
Residual response: ≤ –100 dBm.
(Frequency ≥ 1 MHz, INPUT ATT = 0 dB, input 50 Ω terminated).

AMPLITUDE ACCURACY
Frequency response: ≤±0.5 dB (100 kHz to 3 GHz, ATT = 10 dB).
≤±1 dB (100 kHz to 2 GHz).
≤ ±2 dB (9 kHz to 3 GHz).
(after calibration at 30 MHz reference).

GENERAL SPECIFICATIONS
Operating Conditions – 0° C to +50° C, 85% RH max. (without condensation).
Storage Conditions – -20° C to + 60° C.
Power Supply – 100/200 VAC, auto switching.
100 VAC; 100 V to 120 V, 50 Hz/60 Hz.
220 VAC; 220 V to 240 V, 50 Hz/60 Hz.
Power Consumption –
200 VA max. (100 VAC).
Safety – UL3111-1, CSA1010.1, EN61010-1, IEC61010-1.

PHYSICAL CHARACTERISTICS

Dimensions	mm
Height	177
Width	424
Depth	300
Weight	**kg**
R3131	12

Windows is a trademark of Microsoft Corporation.

ORDERING INFORMATION

For price information: Outside the U.S. contact your local Tektronix representative, inside the U.S. see the price list in the back of this catalog.

R3131
Spectrum Analyzer.

OPTIONS
Opt. 74 – Tracking Generator.

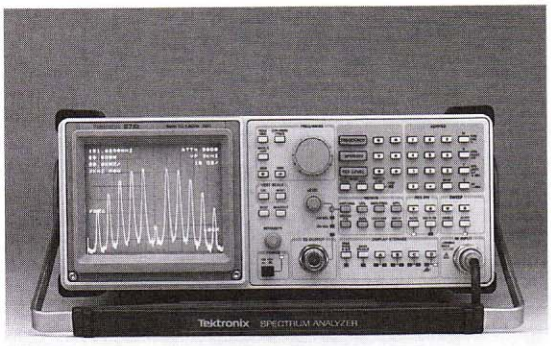
For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

CE

ADVANTEST
Advantest's quality system complies with the DIN ISO 9002 standard and has been certified by TUV Product Service GMBH.

Spectrum Analyzers

2712 • 2711



For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

CE

ISO 9001

Tektronix measurement products are manufactured in ISO registered facilities.

GPIB IEEE-488

Product(s) complies with IEEE Standard 488.1-1987, and with Tektronix Standard Codes and Formats.

Features – Benefits

2712

- High Value, Low Cost
- 5 x 10^{-7} Frequency Accuracy
- Sensitivity to –139 dBm (–92 dBmV) with Built-in Preamp
- Internal Frequency Counter
- 4 Trace Digital Plus True Analog Display
- 124 K of RAM
- Easy to Use
- Dedicated Numeric Keypad Plus Logically Grouped Menu Keys
- Powerful Built-in Measurement Routines
- EMC Measurements with Optional Quasi-peak Detector
- Swept Measurements to 1.8 GHz with Optional Internal or External Tracking Generator

2711

- Economical, Can Be Configured to Meet Most Budgets
- High Portability
- Internal or External Tracking Generator Option
- Internal Frequency Counter (Opt. 02)
- GPIB or RS-232 Interface Option
- Excellent Frequency Accuracy and Sensitivity

Applications

- Broadcast Transmitter Performance
- Communications System Operations
- EMC Prequalification Testing

2712 Spectrum Analyzer

The Tektronix 2712 Spectrum Analyzer provides excellent RF performance, a built-in frequency counter, full programmability, digital and true analog displays, high portability, enough non-volatile memory for 108 saved displays and much more.

A straightforward human interface, with conveniently grouped, dedicated front-panel keys and simple, menu-driven functions makes the 2712 easy to learn and use. You can set frequency, span and reference level directly from the front panel. A real-time clock provides an on-screen date and time display, plus date/time stamp capability for waveform printouts.

Frequency-corrected tuning and phase-lock stabilization enhance the ability to resolve close-in signals and reliably demodulate narrowband signals. Sensitivity up to –127 dBm (–80 dBmV) at 300 Hz resolution bandwidth (RBW) lets you see weak signals. The built-in preamp can improve sensitivity another 12 dB, up to –139 dBm (–92 dBmV). Up to 80 dB on-screen dynamic range ensures visibility of weak signals in the presence of strong ones.

A 300 Hz RBW filter with a shape factor ≤7:1 means you'll see many close-in sidebands and spurious or unexpected signals you might otherwise miss. At the other end of the spectrum the 5 MHz RBW filter is useful when demodulating wideband signals such as actively modulated video carriers.

The built-in signal counter, with 0.5 ppm ±10 Hz accuracy, offers added power for rapidly identifying signals. The capability to choose between digital and true analog displays lets you examine signals for characteristics that are not visible on digital-only displays.

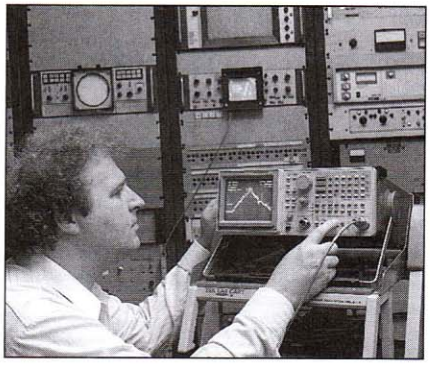
Sweep speeds of 1 µsec/div, TV Line and TV Field triggering, an internal audio amplifier and AM/FM detectors and the optional Video Monitor Mode all make video communications measurements easier.

Bandwidth, Carrier-to-Noise, Noise Power, Signal Search and FM Deviation modes provide additional measurement power and convenience. Occupied Bandwidth Mode, with percent settable from 1 to 99%, aids in broadcast and radio measurements.

The optional internal or external tracking generator provides high dynamic range swept measurements to 1.8 GHz.

EMC MEASUREMENT

To help simplify your EMC measurements, the 2712 offers an optional quasi-peak detector, EMI resolution bandwidth filters and fully corrected E-field intensity measurements to assist in pre-certification and troubleshooting. EMC ancillary devices are available to provide a complete measurement solution.



2711

2711 SPECTRUM ANALYZER

The 2711 offers a wide range of features at an extremely affordable price. This value leader is well-suited for checking broadcast transmitter performance and communications system operations, looking for unwanted RF emissions, testing two-way communications equipment, maintaining industrial security and teaching frequency domain concepts in the classroom, plus a wide variety of other applications.

The standard 2711 shares many of 2712's valuable features, such as compact size and light weight (9.5 kg, about 21 lbs.). Both instruments can also be quickly converted to rack operation with optional rackmount adapters.

Frequency accuracy is 1 x 10^{-5} and sensitivity is up to –117 dBm (–70 dBmV) at 3 kHz RBW. The built-in preamp can add another 12 dB, up to –129 dBm (–82 dBmV). Up to 80 dB on-screen dynamic range helps see weak signals, even when strong ones are present.

True analog display capability, along with fast sweep speeds and TV Line and TV Field triggering provide convenient demodulation of video carriers for making depth-of-modulation checks or looking at special baseband data, VITS and many other signals.

An internal audio amplifier and AM/FM detectors let you hear demodulated signals, using either the built-in speaker or headphone jack, for fast signal identification and trouble-shooting in communications applications.

With the Video Monitor (Opt. 10) installed, you can view broadcast (AM) TV signals or down-converted satellite (FM) signals.

The 2711 can also be used with a set of near-field probes as a handy EMC diagnostic tool.

SELECTION GUIDE

Capability	2712	2711
Frequency Range	9 kHz to 1.8 GHz	9 kHz to 1.8 GHz
±0.5 ppm Freq. Accuracy	Std.	NA
Signal Counter	Std.	Opt. 02
GPIB Interface	Std.	Opt. 03
Internal Tracking Gen.	Opt. 04	Opt. 04
External Tracking Gen.	Opt. 05	Opt. 05
RS-232C Interface (replaces GPIB) (no charge) (no charge)	 Opt. 08 Opt. 08	
Video Monitor Mode	Opt. 10	Opt. 10
EMC Pre-certification	Opt. 12	NA
Measurements		
TV Sideband	Opt. 15	Opt. 15
Adapter Interface		
Nonvolatile Memory	124 K	28 K (124 K with Opt. 03 or 08)
High Portability	Yes	Yes
Both Digital and True Analog Displays	Yes	Yes
Dedicated Numeric Keypad	Yes	Yes
Real-time Clock	Std.	With Opt. 03 or 08

CHARACTERISTICS

The following characteristics apply to both the 2712 and 2711 after a 15-minute warm-up period, unless otherwise noted.

FREQUENCY RELATED

Frequency Range – 9 kHz to 1800 MHz.

Center Frequency Accuracy –
2712: $5x10^{-7}$ of CF ±700 Hz.
2711: $1x10^{-5}$ of CF ±5 kHz.

Frequency Counter Accuracy (Std. 2712, Opt. 02 2711) –
2712: $5x10^{-7}$ of CF ±10 Hz, ±1 LSB.
2711: $1x10^{-5}$ of CF ±10 Hz, ±1 LSB.
2711: ≤2 kHz p-p/20 msec.

Resolution Bandwidth (–6 dB) –
2712: 5 MHz, 300 kHz, 30 kHz, 3 kHz, 300 Hz.
2711: 5 MHz, 300 kHz, 30 kHz, 3 kHz.
2712 with Opt. 14: Add 1 MHz, 100 kHz, 10 kHz, and 1 kHz.
2712 with Opt. 12: add 1 MHz, 120 kHz, 9 kHz, 1 kHz – 200 Hz replaces 300 Hz filter.

Resolution Bandwidth Shape Factor (60 dB/6 dB) – ≤7:1 for RBW ≤1 MHz.

Noise Sidebands – ≤70 dBc at 30 x RBW.

Video Filter –
Approx. 1/100 (Auto) of RBW.
Manual Selection: 3 Hz to 300 kHz in 1-3 sequence.

Freq. Span/Div. Range –
2712: 180 MHz to 1 kHz.
2711: 180 MHz to 10 kHz selected in 1-2-5 sequence or within two significant digits via menu.

Span Accuracy – ±3% over the center eight divisions.

AMPLITUDE RELATED

Flatness – ±1.5 dB measured with 10 dB internal RF attenuation (preamp off).

Vertical Display Modes – 10, 5, 1 dB/div, Linear.

Measurement Range –
2712: –139 (preamp on) to +20 dBm (–92 to +67 dBmV).
2711: –129 (preamp on) to +20 dBm (–82 to +67 dBmV).

Display Dynamic Range – 80 dB max (limited to 40 dB in optional 2712 Quasi-peak Detector mode).

RF Attenuation Range – 0 to 50 dB, 2 dB steps.

Sensitivity –
2712: –127 dBm (–80 dBmV) at 300 Hz RBW, –139 dBm (–92 dBmV) at 300 Hz RBW with preamp on (to 600 MHz).
2711: –117 dBm (–70 dBmV) at 3 kHz RBW, –129 dBm (–82 dBmV) at 3 kHz RBW with preamp on (to 600 MHz).

SPURIOUS RESPONSE (PREAMP OFF)

Residual Spurious Response – ≤-100 dBm referenced to input of 1st mixer.

3rd Order IM Distortion – ≤-70 dBc, from any two on-screen signals within any frequency span measured with 1st mixer input level of ≤-30 dBm (+17 dBmV).

2nd Harmonic Distortion – ≤-66 dBc measured with 1st mixer input level of ≤-40 dBm (+7 dBmV).

INPUT RELATED

LO Emission – ≤-70 dBm with 0 dB RF attenuation.

RF Input – Type N connector, 50 Ω.

VSWR with 10 dB or More RF Attenuation – 1.5:1 max.

Maximum Safe Input – +20 dBm (+67 dBmV) (0.1 W) continuous peak with 0 dB RF attenuation; 100 V DC (initially applied with full attenuation).

1 dB Compression Point – ≥-15 dBm (+32 dBmV) with 0 dB RF attenuation.

SWEEP RELATED

Sweep Times – 1 µsec to 2 sec/div in 1-2-5 seq. (7-decade range); AUTO SWEEP mode; MANUAL SWEEP select.

Trigger – Free run, internal, external, line, TV field, TV line, single sweep, manual scan.

INPUT/OUTPUT CHARACTERISTICS

External Trigger*1 –
BNC connector, 10 kΩ impedance, DC coupled 0.1 µs min. pulse width. 35 V max.

External Video Input*1 –
DC coupled. 0-50 kHz, 0-1.4 V (175 mV/div typical) signal input for vertical deflection of CRT beam.

ENVIRONMENTAL SPECIFICATIONS

Temperature –
Operating: 0° to 50° C (MIL-T-28800D).
Nonoperating: –55° to +75° C.

Electromagnetic Compatibility –
EC92 EMC Directive 89/336/EEC:
Emissions: EN50081-I.
Radiated Emissions, 30 MHz to 1 GHz, EN55022 Class B (CISPR 22 B).
Conducted Emissions, 150 kHz to 30 MHz, EN55022 Class B (CISPR 22 B).

Vibration – Meets MIL-T-28800E, Paragraph 4.5.5.3.1 (modified).

GENERAL CHARACTERISTICS

Power Requirements – 105 W max. (1.4 A) at 115 V, 60 Hz. Operates 48 Hz to 440 Hz, 90 to 132 V AC, or 48 Hz to 63 Hz to 250 V AC. Battery power (Opt. 07) available.

PHYSICAL CHARACTERISTICS

Dimensions	mm	in.
Height	137*1	5.4*1
Width	361*1	14.2*1
Depth	445*1	17.5*1
Weight	**kg**	**lbs.**
Net	9.5*2	<21*2

*1 *With feet, handle and front panel cover.*

*2 *Nominal for basic configuration.*

OTHER CAPABILITIES

Markers – Single marker/delta marker; next right, next left peaks; next lower, next higher peaks; (highest) peak find; marker to center frequency and reference level.

Nonvolatile Memory –
Lithium battery backup.
2712: 124 KB available; up to 108 displays saved; 36 front-panel setups, large user-definable key routines and antenna tables (exact number and size depends on NV RAM utilization).
2711: 28 KB available; up to 18*2 displays saved and 9*2 front-panel setups, user-definable key routines and antenna tables.

Digital Storage Display – Selectable acquisition modes of positive peak only, positive/negative peak. SAVE A, B, C and active D trace; up to four traces on screen; MAX HOLD A, B; MIN HOLD A, B, C; B, C MINUS A; WATERFALL display mode; digital storage off provides analog sweep.

Ensemble Averaging – Provides weighted continuous or discrete averaging of display resulting in reduction of random noise.

Internal Preamp – Preamp can be switched in/out of circuit (flatness degrades above 600 MHz, provides ≈ 12 dB sensitivity improvement).

Alternative Reference Level Units –
dBm, dBmV, dBV, dBµV, dBµW, dBµV/m.

User-definable Power-on Status –
Instrument powers up to user-definable state or factory default condition.

Center Measure – Signal is centered with frequency and peak amplitude automatically read out (not a marker mode). The signal is counted in the 2712 or 2711 with Option 02.

Signal Track – Drifting signal is kept at display center with correct frequency and peak amplitude displayed.

Graticule Illumination – For CRT photography in analog display mode.
Supports Epson FX and LQ Series Printers via built-in GPIB interface (Std. 2712, 2711 Opt. 03), RS-232C interface (Opt. 08, 2712 and 2711).

*1 *Typical but non-warranted performance parameters.*

*2 *Up to 108 saved displays, 36 front-panel setups available with Opt. 03 or 08.*

ORDERING INFORMATION

For price information: Outside the U.S. contact your local Tektronix representative, inside the U.S. see the price list in the back of this catalog.

2712
Spectrum Analyzer.

Includes: Power Cord (U.S. 115 V/60 Hz), User's Manual, Pocket Reference Guide, Programmer's Manual, Front Cover and N-to-BNC Adapter.

2711
Spectrum Analyzer.

Includes: Power Cord (U.S. 115 V/60 Hz), User's Manual, Pocket Reference Guide, Front Cover and N-to-BNC Adapter.

Opt. 02 – (2711 only) Add Internal Frequency Counter with selectable 1 kHz/1 Hz readout resolution.

Opt. 03 – (2711 only) GPIB Interface. Full Programmability, Direct Print, additional NV RAM and Real-time Clock. Cannot combine with Opt. 08.

Opt. 04 – Add Internal Tracking Generator, 100 kHz to 1800 MHz, 0 dBm to –48 dBm in 0.1 dB steps. (Not compatible with 2712 Opt. 12 or 14 – order External Tracking Generator Opt. 05 instead.)

Opt. 05 – External Tracking Generator with Active Probe Power Jack. Not compatible with Opt. 04.

Opt. 07 – Add 2704 Inverter/2705 Battery Pack.

Opt. 08 – (2712 only) Replace GPIB with RS-232C Interface.

Opt. 08 – (2711 only, not compatible with Opt. 03.) RS-232 Interface, Full Programmability, Direct Print, additional NV RAM and Real-time Clock.

Opt. 10 – Video Monitor Mode.

Opt. 12 – (2712 only) Add Quasi-peak Detector (built-in). Including 200 Hz, 9 kHz and 120 kHz EMC Filters; 1 kHz and 1 MHz RBW Filters. Not compatible with Opt. 04 or 14. Note: 200 Hz EMC Filter replaces standard 300 Hz RBW Filter.

Opt. 14 – (2712 only) Add 1 kHz, 10 kHz, 100 kHz and 1 MHz RBW Filters. Not compatible with Opt. 04 or 12.

Opt. 15 – 1st LO output for use with Tektronix 1405 TV Sideband Adapter Interface or 2707 Internal Tracking Generator.

Opt. 20 – EMC Antenna Set plus Tripod and Coax suitable for tests to 1 GHz (contact Tektronix sales engineer for more information).

Opt. 21 – Add 2706 Stepping RF Preselector.

Opt. 30 – Rackmount for 19 in. rack width, 5.25 in. height.

Opt. 33 – Travel Line Package. Including Accessory Pouch, Carrying Strap, Vinyl Rain Cover.

Opt. 34 – Portable-to-Rackmount Adapter for 19 in. rack width, 7 in. height.

INTERNATIONAL POWER PLUGS

Opt. A1 – Universal Euro 220 V, 50 Hz.

Opt. A2 – United Kingdom 240 V, 50 Hz.

Opt. A3 – Australian 240 V, 50 Hz.

Opt. A4 – North American 240 V, 60 Hz.

Opt. A5 – Switzerland 220 V, 50 Hz.

See page 619 for description.

MEASUREMENT SERVICE OPTIONS

Opt. C3 – Three years of Calibration Services.

Opt. D3 – Test data (requires Opt. C3).

Opt. R3 – Repair warranty extended to cover three years.

EMI Ancillary Devices – See page 255.

ADDITIONAL ACCESSORIES

Also see page 495.

PROBES

Active – All require 1103 Power Supply. 4 GHz, 0.4 pF/100 kΩ, 1 m. Order P6217. 750 MHz, 2 pF/1 MΩ, 1.5 m. Order P6205. TEKPROBE® Power Supply. Order 1103.

Power Splitter – 75 Ω/50 Ω BNC Output, 50 Ω BNC Input. Order 067-1232-00.

CABLES, PADS AND ADAPTERS

50 Ω Coaxial Cable –
BNC to BNC, 5.5 in. Order 012-0214-00.
BNC to BNC, 18 in. Order 012-0076-00.
BNC to BNC, 42 in. Order 012-0057-01.

75 Ω to 50 Ω Minimum Loss Adapter –
With DC block, 5.7 dB loss. Order 131-4199-00.

75 Ω BNC to 50 Ω Type N Minimum Loss Attenuator – Order 131-4199-00.

75 Ω to 50 Ω Matching Attenuator –
With 11.25 dB conversion factor from dBm to dBV with DC block. Order 011-0118-00.

BNC Female to "F" Male Adapter –
Order 103-0158-00.

"N" Female to BNC Male Adapter –
Order 103-0058-00.

75 Ω to 50 Ω Matching Transformer –
0.5 dB loss. 50 kHz to 300 MHz. Order 120-1883-00.
5 MHz to 1 GHz. Order 120-1884-00.

User's Manual –
2712. Order 070-8137-00.
2711. Order 070-5800-00.

Service Manual –
2712. Order 070-8130-01.
2711. Order 070-8130-01.

Front Panel Cover – Order 200-2520-00.

Transit Case – Order 016-0792-02.

Soft Side Case – Order 016-1158-01.

Rain Cover – Order 200-2500-00.

Accessory Pouch – Mounts on top. Order 016-0677-03.

Carrying Strap – Order 346-0199-00.

Viewing Hoods – Binocular. Order 016-0566-00.

CRT Filter – Smoke Grey. Order 337-2775-02.

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

CE

ISO 9001

Tektronix measurement products are manufactured in ISO registered facilities.

GPIB IEEE-488

Product(s) complies with IEEE Standard 488.1-1987.

Inverter/Battery Pack

2704 • 2705



Features – Benefits

2704/2705

Easy Connection to Tektronix 271X Family Spectrum Analyzers

115 W of AC Power

Continuous Power Using Sequential Battery Packs

Lightweight Single Package for Easy One-handed Carrying

Automatic Charging of Two Battery Packs Simultaneously

Auxiliary 18 V DC LNB Power

Low Battery Warning

Applications

Field Maintenance

Remote Operation

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

CE

ISO 9001

Tektronix measurement products are manufactured in ISO registered facilities.

2704 Inverter/2705 Battery Pack

The 2704 Inverter and 2705 Battery Pack can provide for operation of 271X spectrum analyzers in locations where AC power is not available. These units mount directly on the spectrum analyzer to form a portable package.

Several 2705s can be used to provide an uninterruptible power source for the spectrum analyzer or other equipment. The 2704 includes a battery charger, and provides an auxiliary 18 volt output. The 2704 also accepts 12 volt input from other sources, such as car batteries. These units are described in more detail in the Inverter/Battery Pack Data Sheet.

Ordering Information

For price information:
Outside the U.S. contact your local Tektronix representative, inside the U.S. see the price list in the back of this catalog.

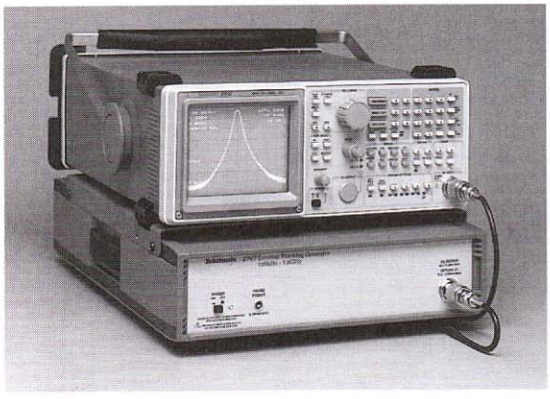
2704
Inverter.
Includes: Power Cord (U.S. 115 V, 60 Hz), Operator's Manual, Analyzer Mounting Plate.
Opt. R3 – Repair warranty extended to cover three years.
Opt. R5 – Repair warranty extended to cover five years.

2705
Battery Pack.
1.5 Meter DC Power Cord – 2704 Inverter-to-Automotive Cigarette Lighter Plug. Order 118-8549-00.
1.5 Meter DC Power Cord – 2704 Inverter-to-Alligator Clips. Order 118-8550-00.

INTERNATIONAL POWER PLUGS
Opt. A1 – Universal Euro 220 V, 50 Hz.
Opt. A2 – United Kingdom 240 V, 50 Hz.
Opt. A3 – Australian 240 V, 50 Hz.
Opt. A4 – North American 240 V, 60 Hz.
Opt. A5 – Switzerland 220 V, 50 Hz.
See page 619 for description.

Tracking Generators

2707 • 2711/2712 Opt. 04 • 2711/2712/2715 Opt. 05



Features – Benefits

2707 External Tracking Generator (271X Opt. 05) for 2711 and 2712

Internal Tracking Generator for 2711 and 2712 (Opt. 04)

Swept Measurements 100 kHz to 1.8 GHz

Output from –48 dBm to 0 dBm (–1.2 dBmV to 46.8 dBmV) in 0.1 dB Steps

Frequency Offset Capability

Applications

CATV – Check Filters, Amplifiers and Cables

EMI – Site Attenuation Tests, Filter Design, Isolation Checks and Verifying Cable Flatness

Broadcast – Check Traps and Filters

Communications Radio Maintenance – Tune Duplexers, Check Antennas

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

CE

ISO 9001

Tektronix measurement products are manufactured in ISO registered facilities.

Internal and External Tracking Generators

Characterize filters, check duplexers or cables, make frequency response, SWR measurements (with a return-loss bridge), EMI site attenuation tests – all this and much more.

The 2707, 2711/2712 Option 04 (internal) and 2711/2712/2715 Option 5 (external) tracking generator systems provide swept measurements from 100 Hz to 1.8 GHz and at least 100 dB dynamic range to see filter, ultimate rejection or circuit isolation characteristics.

Ordering Information

For price information:
Outside the U.S. contact your local Tektronix representative, inside the U.S. see the price list in the back of this catalog.

2707
External Tracking Generator.

MEASUREMENT SERVICE OPTIONS
Opt. C3 – Three years of Calibration Services.
Opt. D3 – Test Data (requires Opt. C3).
Opt. R3 – Repair warranty extended to cover three years.

2711/2712/2715 OPT. 05
External Tracking Generator.
Includes: Power Cord, 50 Ω SMA Cable, Type N Male-to-BNC Female Adapter, 15-Pin Male-to-15-Pin Male High Density D-sub Cable Assembly. Mounting Bracket with Mounting Hardware, Trim Strips, Instruction Manual.
Opt. 01 – 75 Ω output.
2711/2712 Opt. 04 Internal Tracking Generator.
See page 197 for more information.

Network Analyzers

Contents

ZVRL 201
ZVRE51 201
ZVRE52 201
ZVR61 201
ZVR62 201
ZVCE 201
ZVC 201
R3765AH 207
R3765BH 207
R3765CH 207
R3767AH 207
R3767BH 207
R3767CH 207
R3754A 211
R3754B 211

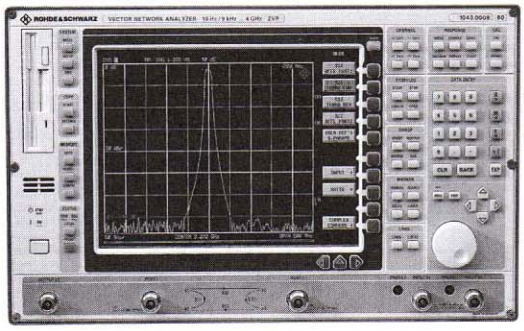
For Production Test

Network analyzers can be used to characterize a variety of devices, from components and materials to circuits, equipment, and systems. They can be used effectively even when individual components or test points cannot be accessed. Network analyzers measure the transmission and reflection characteristics of linear circuit networks by applying a sine wave to the input of the device-under-test (DUT) and measuring the resultant signals at the output. The most accurate way to analyze linear circuit networks is to measure the amplitude and phase versus frequency of circuit network transmission and reflection characteristics at various frequencies. Knowing these relationships provides the information required to characterize the behavior of linear networks quickly, accurately, and completely over a broad frequency range.

ZVR Family of Vector Network Analyzers

New Network Analyzers

SEVEN MODELS FOR ALL REQUIREMENTS: ZVRL, ZVRE51, ZVRE52, ZVR61, ZVR62, ZVCE, ZVC



Features – Benefits

Excellent Dynamic Range
- –>130 dB (IF Bandwidth 10 Hz)

Low Inherent Noise
- –< –110 dBm (IF Bandwidth 3 kHz)

Broad Frequency Range for Universal Use
- – 10 Hz to 4 GHz (ZVRL, ZVRE, ZVR)
- – 20 kHz to 8 GHz (ZVCE, ZVC)

High Measurement Speed
- –<125 µs/point (Normalized)
- –<240 µs/point (Fully Calibrated)

Fast Data Transfer via IEC/IEEE Bus
- – Transfer Time <30 ms (200 Points)

Manual Calibration Techniques
- – TOM, TRM, TRL, TNA, TOM-X

Automatic Calibration
- – AutoKal

Applications

RF and Wireless Communications
Satellite Broadcasting Equipment
Component Test
Subsystem Test
Manufacturing Test
Automated Test

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

ISO 9001

Tektronix measurement products are manufactured in ISO registered facilities.

ROHDE&SCHWARZ
Rohde & Schwarz' quality system complies with the DIN ISO 9001 standard and has been certified by DQS (German Association for the Certification of Quality Systems).

Innovation for Versatility, Speed and Accuracy

A FAMILY FOR EVERY REQUIREMENT

The vector network analyzers of the ZVR family from Rohde&Schwarz have set standards for extremely fast, highly accurate and versatile test equipment.

The family comprises the seven Vector Network Analyzers ZVRL, ZVRE51, ZVRE52, ZVR61 and ZVR62 as well as ZVCE and ZVC which extend the frequency range to 8 GHz. All models are compact instruments with integrated generator, test set and receiver, each tailored to a different field of application.

Thanks to the great variety of options and test sets, the analyzers can be tailored even to very special kinds of measurement tasks.

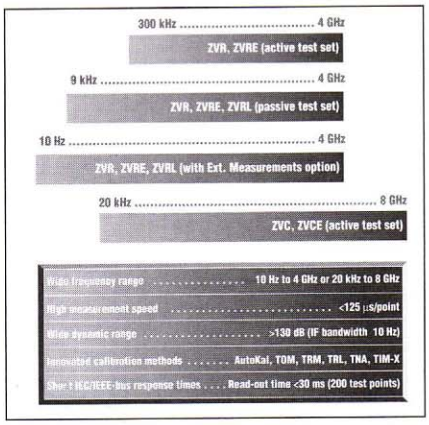
In contrast to a passive test set an active test set contains a bias network, e.g. for supplying active DUTs.

Design

With a **unidirectional** analyzer only measurements in the forward direction can be performed.

With a **bi-directional** analyzer all four S-parameters of the DUT can be determined without changing connections.

The 4-channel analyzers provide calibration methods like TOM, TRM, TRL and TNA.



The Highlights in Brief

THREE TIMES TOP SPEED

High Sweep Rate

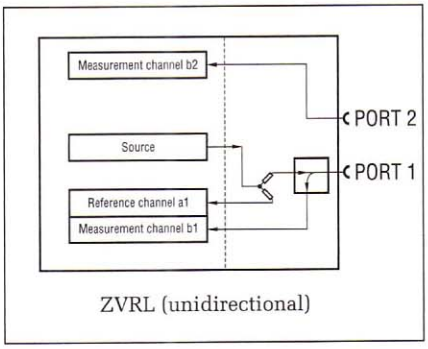
The high measurement speed allows more than 25 sweeps/s with 200 points. This gives a real analog feeling for tuning sensitive DUTs in real time. The short measurement time of <125 µs per point considerably increases the throughput in automatic test systems.

Fast IEC/IEEE Bus

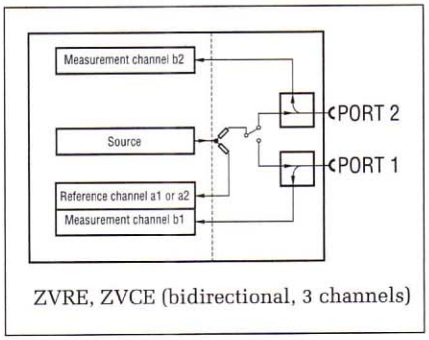
Reading out a single marker value via the IEC/IEEE bus takes only 15 ms, reading out complete trace data (200 values) less than 30 ms, which speeds up complex, computer-controlled measurements.

Short Calibration Times

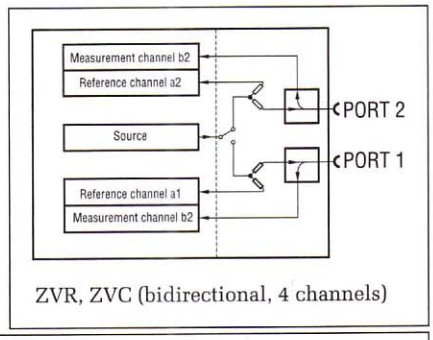
With the new R&S calibration method AutoKal a simple through-connection of the test ports is sufficient to perform automatic full two-port calibration. This calibration needs less than 20 seconds (including computation of error parameters) and cuts time and operating errors to a minimum. Short measurement time of <125 µs per point considerably increases the throughput in automatic test systems.



ZVRL (unidirectional)



ZVRE, ZVCE (bidirectional, 3 channels)



ZVR, ZVC (bidirectional, 4 channels)

ZVRL – THE LEAN MODEL

ZVRL comprises a test set with **one SWR bridge**, two measurement channels and a reference channel for measuring the magnitude and phase of the forward S-parameters S_{11} and S_{21}.

ZVRE AND ZVCE – THE ECONOMY MODELS

The test set of these models comprises **two SWR bridges (ZVRE) or directional couplers (ZVCE)**, an RF switch, two measurement channels and one reference channel. They measure the magnitude and phase of all four S-parameters of a DUT, allow a full two-port calibration (TOSM) and have an exceptionally high accuracy and wide dynamic range.

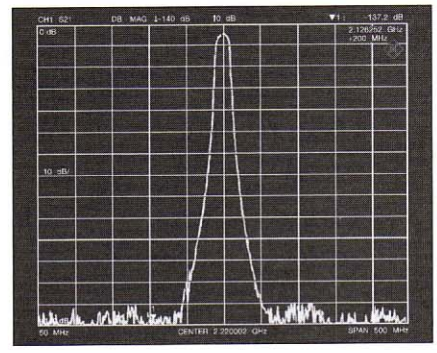
ZVR AND ZVC – THE UNIVERSAL MODELS

ZVR and ZVC comprise a test set with **two SWR bridges (ZVR) or directional couplers (ZVC)**, an RF switch, two measurement channels and – unlike ZVRE and ZVCE – **two reference channels**. With this configuration a variety of novel calibration procedures, e.g. TNA, can be performed, which considerably improve the accuracy particularly in non-coaxial applications. ZVR and ZVC are suitable for applications in R&D and production no matter how sophisticated.

Comparison of the Models

Model	ZVRL	ZVRE	ZVR	ZVCE	ZVC
Test set	unidirectional	bidirectional			
Receiver channels	3	3	4	3	4
Broad frequency range	10 Hz*1 to 4 GHz			20 kHz to 8 GHz	
Wide dynamic range*1	>125 dB	>125 dB	>130 dB	>125 dB	>130 dB
High sensitivity*1	<–125 dBm	<–125 dBm	<–130 dBm	<–125 dBm	<–130 dBm
High measurement speed	< 125 µs/point				
Fast IEC/IEEE bus*2	< 15 ms				
High frequency resolution	10 µHz				
Short calibration times*3	< 20 s				
Large display	Active 26 cm colour LCD				

*1 *With External Measurements option.*
*2 *From marker request to data output (real and imaginary values).*
*3 *Automatic two-port calibration with AutoKal.*



Bandpass filter.

Technical Details

SPEED >>25 SWEEPS/S

An efficient transputer system and the extremely fast synthesizer give high sweep rates. The result is a "quasi-analog" measurement trace with full error correction and high frequency accuracy. The dynamic range at the maximum sweep rate is 80 dB for the full measurement bandwidth of 26 kHz.

DYNAMIC RANGE >130 DB

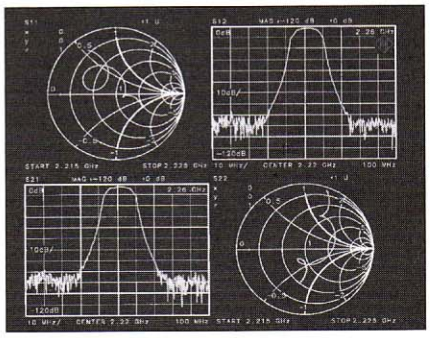
The high stopband and low passband attenuation of modern RF components are difficult for network analyzers to handle. However, thanks to fundamental mixing, the useful dynamic range of the R&S network analyzers is more than 25 dB better than that achieved by conventional sampling techniques. Because of the low-noise front end, the ZVR models attain a dynamic range of >130 dB, so transmission measurements on DUTs with extremely high stopband attenuation can be performed at high speed – even at low input levels.

POWER CALIBRATION: TESTING ACTIVE DUTS

Power calibration performed at the test ports in the factory ensures constant output power and high accuracy in the measurement of absolute input power over the full frequency range. This is particularly important for frequency-converting and nonlinear measurements on active components. Furthermore, with the aid of the Power Calibration option frequency-dependent level variations of an external test setup can be measured and compensated for.

SIMULTANEOUS DISPLAY OF FOUR TRACES ON THE 26 CM COLOR LCD

The ZVR models are the first network analyzers in this price class to simultaneously display four measurement traces with independent parameters (measured quantity, frequency range, bandwidth, etc). The high-resolution, active, color LCD with a high refresh rate allows precise alignments without operator fatigue.



Quad-channel display.

INTEGRATED CONTROLLER

When equipped with the Controller option, the network analyzer can be used as a PC. The option comprises an additional VGA card, a memory expansion, a serial mouse and a keyboard. DOS 6.22 and Windows 3.1 are included.

AUTOMATIC TEST SYSTEMS

Fast recording and processing of measured values and, in addition, an SCPI-conform IEC/IEEE-bus command set make all models of the ZVR family ideal for use in automatic measurement systems. When equipped with the Controller option and a second IEC/IEEE-bus card, the analyzers can be used as system controllers. As a result, fewer instruments are required; this saves space in the system rack. LAN connections can be set up with the Ethernet option.

EFFICIENT CALIBRATION TECHNIQUES

The classic 12-term calibration method requires four calibration standards, i.e., Through, Open, Short and Match. The abbreviation TOSM used for this method is derived from the standards names. ZVR and ZVC also provide a number of other modern calibration methods (TOM, TRM, TRL, TNA). Unlike TOSM (12-term), they require only three different standards. Additionally, Lines (L), unknown Reflects (R), matched Attenuators (A) and symmetrical two-port Networks (N) can also be used. Due to its simplicity, TOM is the recommended method and should therefore be used for general applications. To perform a calibration, the two test ports are directly connected (Through) and an open-circuit (Open) and a matched load (Match) have to be connected to each test port. For frequencies up to only a few 100 MHz, it is not necessary to connect an open circuit, the ports may simply be left open. Thus a complete two-port calibration can be performed with only two different calibration standards.

High accuracy can be obtained with a minimum of effort using the AutoKal option to which only the Through standard has to be connected.

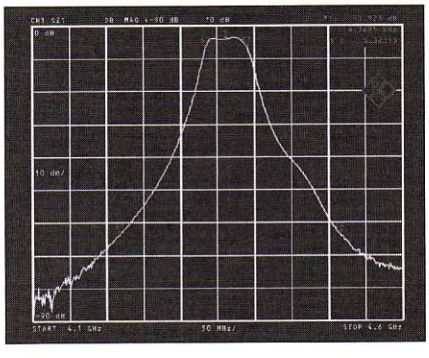


Fig. 1.

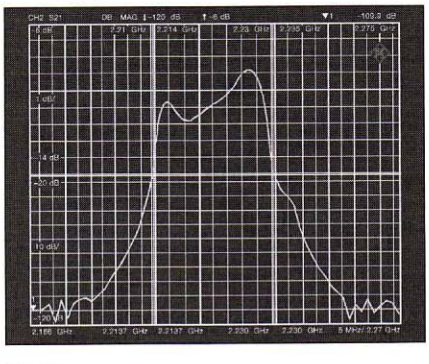


Fig. 2.

Measurement and IEC/IEEE-bus speed of network analyzers

Number of test points		51	201	401
Measurement Times (Fast Mode)				
Normalized	unidirectional incl. retrace sweep, 5 ms	10 ms	30 ms	60 ms
Two-port calibrated	bi-directional	20 ms	60 ms	100 ms
IEC/IEEE-bus Data Transfer of Real and Imaginary Values				
Time between sending the request and availability of data				
ASCII		40 ms	90 ms	160 ms
IEEE-754 floating-point format (setting data 64-Bit, measurement data 32-Bit)		20 ms	30 ms	40 ms

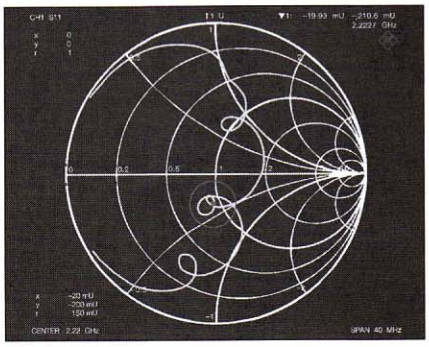


Fig. 3.

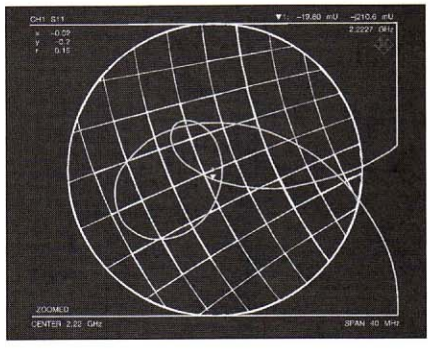


Fig. 4.

APPLICATIONS

FILTER MEASUREMENTS (1 TO 4)

For accurate transmission and reflection measurements on narrowband DUTs such as resonators and filters, a stable generator with high frequency resolution and a receiver with wide dynamic range and high measurement accuracy are required. The analyzers of the ZVR family are ideal for such measurements.

Special band-filter evaluation functions (1) minimize the time required for checking and tuning filters. Important filter data such as bandwidth, center frequency, Q and shape factor are displayed at a keystroke. Marker tracking functions provide actual information on amplitude and frequency in real time during DUT adjustment. User-defined frequency and scale segments (2) simplify and speed up evaluation of selected subranges of a sweep.

Fully arbitrary zoom even in the Smith chart allows the user to concentrate on the interesting part of the trace (3 and 4).

AMPLIFIERS AND MIXERS (5)

For measuring active components featuring high gain and high isolation, a wide dynamic range as well as high sensitivity and isolation of measurement channels are required. In addition to S-parameters and derived quantities, nonlinear parameters can also be measured:

- Magnitude of 2nd and 3rd harmonics
- n dB compression point
- IP_2 and IP_3

These parameters can also be displayed versus frequency.

Due to the use of two independent synthesizers for generator and receiver and the ability to control two external generators, a variety of measurements can be performed at full speed on frequency-converting DUTs, e.g., mixers.
Thanks to the special receiver principle used by R&S analyzers, add-ons like filters are not required for the suppression of spurious.

COMPARISON OF FULL TWO-PORT CALIBRATION PROCEDURES

By using four instead of three receiver channels, ZVR and ZVC unlike ZVRE and ZVCE can provide additional powerful calibration methods, e.g., TOM, TRM, TNA and the 15-term method TOM-X (X = crosstalk), e.g., for "on-wafer" measurements.

Full two-port calibration procedures	Number of calibration steps	Special feature
TOM	5	Implicit verification
TRM	5	Especially for test fixtures
TRL	4	High directivity
TNA	3	Especially for planar circuits
TOSM	7	Classic procedure
TOM-X	5 (9)	Eliminates crosstalk

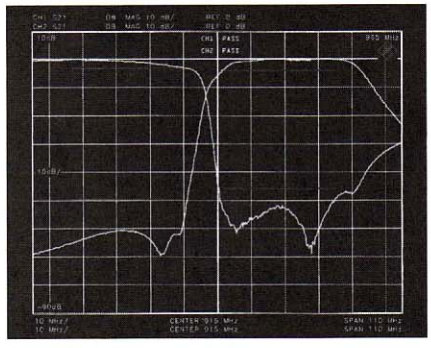


Fig. 5.

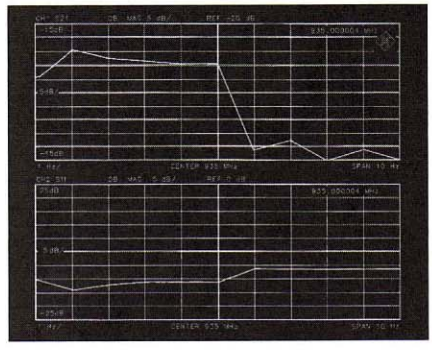


Fig. 6.

COMPATIBLE WITH CAE TOOLS

When developing circuits on the computer with the aid of CAE tools, it is essential for the S-parameters measured on a DUT to be transferred to the respective CAE program. Measured S-parameters are stored on a floppy in a CAE-tool-compatible format and ready for direct processing by simulation programs.

AF MEASUREMENTS

The External Measurements option extends the frequency range of ZVRL, ZVRE and ZVR down to 10 Hz, for instance for audio applications, and increases the sensitivity and output power of all analyzers.

MEASUREMENTS ON DUPLEX FILTERS (5)

Duplex filters, which are widely used in mobile radio, need simultaneous measurement and adjustment on several signal paths in real time. With the aid of the 3-Port and 4-Port Adapter options, several passband characteristics, e.g., those of the TX and RX path, can be displayed quasi-simultaneously. All measurement paths can be calibrated independently.

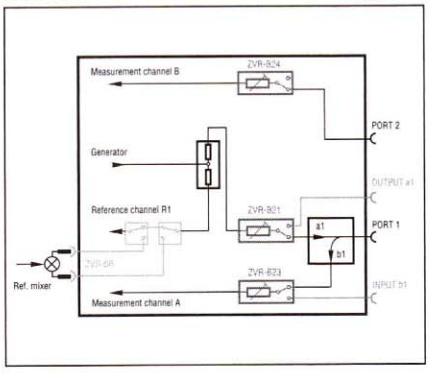
MEASUREMENTS ON PULSED SIGNALS (6)

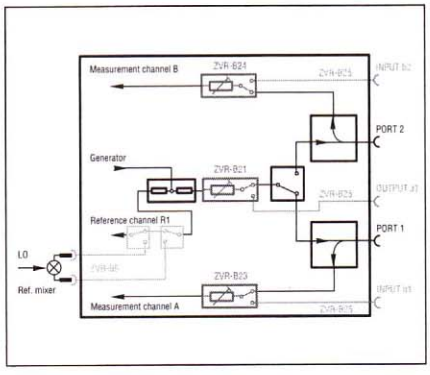
In the field of mobile radio it is important to know the transient response when an amplifier is turned on or off. Due to attractive features such as:

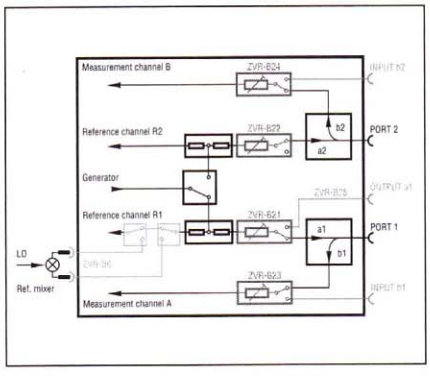
- Up to five measurements within a GSM burst
- External trigger capabilities,

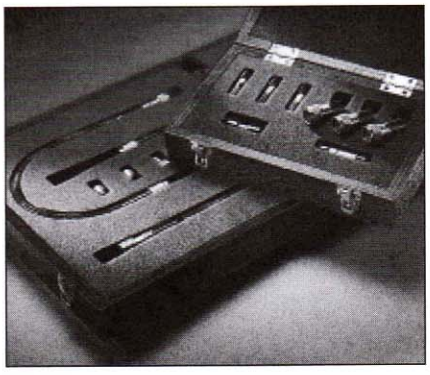
The analyzers are able to measure the magnitude and phase even of pulsed signals.

System Configuration









Test cables and calibration kit (type N).

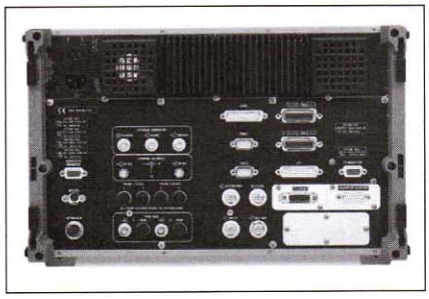
TEST SETS

The network analyzers can be provided with different test set options so that an optimally configured test setup is available to suit the applications.

For the 4 GHz analyzers "active" or "passive" test sets with a characteristic impedance of 50 Ω or 75 Ω are available. A 50 Ω passive test set is standard equipment. With active test sets, the DUT can be biased directly via the inner conductor of the test port. The 8 GHz models ZVCE and ZVC are always equipped with 50 Ω active test sets.

Depending on the model, the test sets comprise one or two power splitters, an electronic switch and one or two SWR bridges or directional couplers. Additional step attenuators (0 dB to 70 dB) can be inserted into the generator paths and the two measurement channels to extend the power range of the receivers to +27 dBm.

When the test sets are fitted with attenuators and the External Measurements option, generator and receiver can be directly switched to three additional ports on the front panel (OUTPUT a1, INPUT b1, INPUT b2). This increases output power, sensitivity and dynamic range, and measurements down to 10 Hz can be performed with the 4 GHz models. The test ports are fitted with female N connectors.



CALIBRATION AND VERIFICATION KITS

The accuracy of a calibrated network analyzer is determined by the quality of the calibration standards and the reproducibility of connections.

Rohde&Schwarz offers accessories for all common connector types for the calibration and verification of network analyzers.

The calibration kits include the required standards for TOSM (12-term) or TOM calibrations. Standards with male and female connectors are supplied. Sliding loads are also available. Supplementary calibration kits for the TRL and TOM-X methods can also be supplied.

The quality of the calibration method and so the measurement accuracy of the network analyzer system can be checked with precise verification standards.

Each verification kit includes a 20 dB attenuator, a 40 dB attenuator and two air lines, one of them with impedance steps (Beatty standard).

Ordering Information

For price information: Outside the U.S. contact your local Tektronix representative, inside the U.S. see the price list in the back of this catalog.

ZVRL – 3-channel, unidirectional, 50 Ω, passive, frequency range 9 kHz to 4 GHz.

ZVRE51 – 3-channel, bi-directional, 50 Ω, passive, frequency range 9 kHz to 4 GHz.

ZVRE52 – 3-channel, bi-directional, 50 Ω, active, frequency range 300 kHz to 4 GHz.

ZVR61 – 4-channel, bi-directional, 50 Ω, passive, frequency range 9 kHz to 4 GHz.

ZVR62 – 4-channel, bi-directional, 50 Ω, active, frequency range 300 kHz to 4 GHz.

ZVCE – 3-channel, bi-directional, 50 Ω, active, frequency range 20 kHz to 8 GHz.

ZVC – 4-channel, bi-directional, 50 Ω, active, frequency range 20 kHz to 8 GHz.

ALTERNATIVE TEST SETS*

ZVRA71 – 75 Ω passive SWR Bridge for ZVRL (instead of SWR bridge, 50 Ω passive)*[1], frequency range 9 kHz to 4 GHz.

ZVRA75 – 75 Ω passive Bridge Pairs for ZVRE and ZVR (instead of bridge pairs, 50 Ω)*[1], frequency range 9 kHz to 4 GHz.

ZVRA76 – 75 Ω active Bridge Pairs for ZVRE and ZVR (instead of bridge pairs, 50 Ω)*[1] frequency range 300 kHz to 4 GHz.

OPTIONS

Opt. B1 – AutoKal, frequency range 0 to 8 GHz.

Opt. B4 – Mixer Measurements*[2], frequency range same as analyzer.

Opt. B5 – Non-linear Measurements, frequency range same as analyzer.

Opt. B6 – Reference Channel Ports, frequency range same as analyzer.

Opt. B7 – Power Calibration*[3], frequency range same as analyzer.

Opt. B8 – 3-Port Adapter, frequency range 0 to 4 GHz.

Opt. K9 – Virtual Embedding Networks*[4].

Opt. B1402 – 4-Port Adapter (2 x SPDT), frequency range 0 to 4 GHz.

Opt. B1403 – 4-Port Adapter (SP3T), frequency range 0 to 4 GHz.

Opt. B15 – Controller (English)*[5].

Opt. B16 – Ethernet AUI for FSE-B15.

Opt. B17 – EC/IEEE-Bus Interface for ZVR-B15.

Opt. B21 – Generator Step Attenuator PORT 1, frequency range same as analyzer.

Opt. B22 – Generator Step Attenuator PORT 2*[6], frequency range same as analyzer.

Opt. B23 – Receiver Step Attenuator PORT 1, frequency range same as analyzer.

Opt. B24 – Receiver Step Attenuator PORT 2, frequency range same as analyzer.

Opt. B25 – External Measurements 50 Ω*[7], frequency range 10 Hz to 4 GHz (ZVR/E/L), frequency range 20 kHz to 8 GHz (ZVC/E).

Test Cables (Pairs) –

ZV-Z11 – N connector, 50 Ω male, frequency range 0 to 18 GHz.

Calibration Kits –

ZV-Z21 – N connector, 50 Ω, frequency range 0 to 18 GHz.

ZV-Z23 – PC 3.5, frequency range 0 to 26.5 GHz.

ZV-Z26 – TRL Suppl. Kit, N, 50 Ω, frequency range 0.4 GHz to 18 GHz.

ZV-Z27 – TRL Suppl. Kit, PC 3.5, frequency range 0.4 to 26.5 GHz.

ZV-Z28 – TOM-X Suppl. Kit, N, 50 Ω, frequency range 0 to 18 GHz.

ZV-Z29 – TOM-X Suppl. Kit, PC 3.5, frequency range 0 to 26.5 GHz.

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

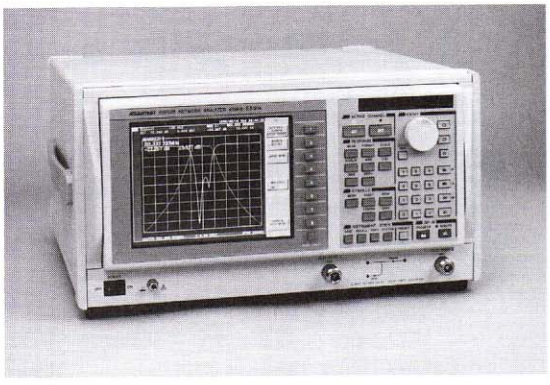
ISO 9001

Tektronix measurement products are manufactured in ISO registered facilities.

ROHDE&SCHWARZ
Rohde & Schwarz' quality system complies with the DIN ISO 9001 standard and has been certified by DQS (German Association for the Certification of Quality Systems).

Network Analyzers

R3765AH/BH/CH • R3767AH/BH/CH



Features – Benefits

40 MHz to 3.8 GHz Measurement Frequency Range (R3765)

40 MHz to 8.0 GHz Measurement Frequency Range (R3767)

Three Models Available:
- Type A Basic Model
- Type B with Built-in SWR Bridge
- Type C with Built-in S-Parameter Test Set

High Sweep Speed
- 0.10 ms/point with Normalized Calibration
- 0.20 ms/point with Two-port Full Calibration

Applications

High-speed Automated Test
RF and Wireless Communications
Satellite Broadcasting Equipment
Component Test
Manufacturing Test
Test Program Development

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

CE

GPIB IEEE-488

Product(s) complies with IEEE Standard 488.1-1987, and with Tektronix Standard Codes and Formats.

ADVANTEST

Advantest's quality system complies with the DIN ISO 9002 standard and has been certified by TUV Product Service GMBH.

The R376xxH Network Analyzers feature unprecedented measurement speed and productivity enhancements. The R3765 analyzer covers the frequency range from 40 MHz to 3.8 GHz; the R3767 extends the upper frequency limit to 8 GHz. These analyzers are designed specifically for testing components in the rapidly expanding field of RF and wireless communications (cellular phones, pagers, cordless phones, etc.).

HIGH THROUGHPUT WITH RELIABLE MEASUREMENT

The R376xxH Provide high throughput and highly reliable measurement. They achieve high-speed measurement (0.1 ms/point at 10 kHz RBW), wide dynamic range measurement (100 dB), two device simultaneous measurement with 4-channel 8-trace function and other useful functions. Besides a conventional frequency sweep function, several new concepts have been added. First, a program sweep function allows the user to freely change resolution bandwidth or output level at any point during the sweep. Second, a high-speed level sweep uses a new semiconductor switch at the output section and is ideal for drive level performance testing of quartz oscillators.

STAND ALONE MEASUREMENT FEATURES

The R376xxH are designed for stand alone benchtop use and high-speed ATE system applications. They feature a TFT (thin film transistor) color liquid crystal display for measurement results. This flat-panel display enhances visibility and operability which are important for interpreting and analyzing the results of measurements (such as data comparison and pattern recognition).

On-screen menus and soft keys provide access to a wide variety of routines for both transmission and reflection measurements. These include displays of magnitude, phase, group delay, SWR, Smith Charts or combinations of these.

BUILT-IN CONTROLLER FUNCTION

The R376xxH have a built-in BASIC controller function for configuration of a high-speed ATE system without using an external controller. A 3.5 in. MS-DOS compatible 1.44 MB floppy disk drive is also standard. This allows programs to be written on a PC-compatible controller and easily ported to the network analyzer.

POWERFUL 4-CHANNEL/8-TRACE FUNCTION WITH SIMULTANEOUS DISPLAY

The R376xxH provide 4-channel/8-trace function with simultaneous display capability. For example, when a 3-port test adapter is connected to the R376xxH, simultaneous and real-time measurement of Tx/Rx characteristics of the duplexer is possible. Channels 1 and 3 measure four S-parameters of Tx and channels 2 and 4 measure those of Rx at the same time with a throughput of approximately 250 ms (with 201 points and 2-port full calibration). In addition, limit lines and multi-marker functions can be used for each of the four screens.

HIGH THROUGHPUT AND HIGH RELIABILITY

Total throughput is one of the most important characteristics of an electronic component measurement system. Among many factors, sweep rate has the greatest influence on total throughput. The R376xxH achieve a 0.1 ms/point sweep rate (at 10 kHz RBW). The R376xxH realizes the highest throughput in its class.

100 DB DYNAMIC RANGE FOR FILTER TEST

For spurious checks in stop band, measurement with a wide dynamic range is crucial. The R376xxH realize 100 dB dynamic range with 10 Hz resolution bandwidth, making it suitable for testing of high-attenuation devices used in base stations or portable phones.

PROGRAMMED SWEEP REALIZES HIGH-SPEED AND HIGH-RESOLUTION MEASUREMENTS

The R376xxH have a programmed sweep function which makes it possible to vary output power and resolution bandwidth (RBW) during a sweep. In evaluation of filter characteristics, for example, measurement with high speed, high accuracy, and high reproducibility can be realized by varying resolution bandwidth and output power within the pass band or stop band.

LIMIT LINE FUNCTION FOR ADJUSTMENT AND TEST

The limit line function performs PASS/FAIL tests based on the judgment value set by the limit line editor. It then displays the test result. In addition, the color of the limit lines and waveform data can be specified for each judgement area, allowing the user to make PASS/FAIL decisions at a glance. In POLAR and Smith chart measurement, the ability to make limits judgements both for amplitude and phase allows amplitude/phase adjustment for specified frequency ranges with automatic test result.

CHARACTERISTICS

MEASUREMENT FUNCTIONS

Sweep Channel – 2 channels (CH 1 and CH 2).
Display Channel – 4 channels (CH 1, CH 2, CH 3, CH 4).
Display Parameters –
Type A: A/R, B/R.
Type B: Transmission, Reflection, Transmission and Reflection.
Type C: S11, S21, S22, S12, S21 and S11, S12 and S22.
Format –
Rectangular Coordinates: Log/linear amplitude, phase and group delay, or real part + imaginary part of complex parameter |Z|, R, X (at measurement with impedance conversion), |Y|, G, B (at measurement with admittance conversion).
Smith Chart:
Marker reading: Log/linear amplitude, phase, real + imaginary part, R $+_{phi}$X, G $+_{phi}$B.
Polar Coordinates:
Marker reading: Log/linear amplitude, phase, real + imaginary part.

RECEIVER CHARACTERISTICS

Resolution Bandwidth – 10 kHz to 10 Hz (in 1 or 3 steps).
Amplitude Characteristics –
Amplitude Resolution: 0.001 dB.
Frequency Characteristics (–10 dBm, 25°C ±5°C): 1.0 dBm.
Dynamic Accuracy (with respect to –20 dB below maximum input level of test port):
0 to –10 dB:
40 MHz ≤f ≤ 3.8 GHz: ±0.3 dB.
3.8 GHz ≤ f ≤ 8.0 GHz: ±0.8 dB.
-10 to –20 dB:
40 MHz ≤f ≤ 3.8 GHz: ±0.05 dB.
3.8 GHz ≤ f ≤ 8.0 GHz: ±0.2 dB.
-20 to –50 dB: ±0.05 dB.
-50 to –60 dB: ±0.15 dB.
-60 to –70 dB: ±0.15 dB.
-70 to –80 dB: ±0.40 dB.
-80 to –90 dB: ±1.00 dB.
Phase Characteristics –
Measurement Range: ±180° (display of ±180° or more is possible with display extension function).
Phase Resolution: 0.01°.
Frequency Characteristics (–10 dBm, 25°C ±5°C): ±5°.
Dynamic Accuracy (with respect to –20 dB below maximum input level of test port):
0 to –10 dB: ±5.0°.
-10 to –20 dB:
40 MHz ≤f ≤ 3.8 GHz: ±0.3°.
3.8 GHz ≤ f ≤ 8.0 GHz: ±0.8°.
-20 to –50 dB: ±0.3°.
-50 to –60 dB:
40 MHz ≤f ≤ 3.8 GHz: ±0.4°.
3.8 GHz ≤ f ≤ 8.0 GHz: ±0.8°.
-60 to –70 dB: ±1.5°.
-70 to –80 dB: ±4.0°.
-80 to –90 dB: ±8.0°.
Group Delay Time Characteristics –
Range: Calculated by the following expression: r= (phase) / (360 x aperture frequency (Hz)).
Measurement Range: 1 ps to 250 s.
Group Delay Time Resolution: 1 ps.
Aperture Frequency: Can be set to A x 2% to A x 100% for frequency span, with resolution of A x 2%:
A = (100) / (measurement points – 1).
Accuracy:
= (phase accuracy) / (360 x aperture frequency (Hz)).

SIGNAL SOURCE CHARACTERISTICS

Measurement Frequency –
Range:
R3765: 40 MHz to 3.8 GHz.
R3767: 40 MHz to 8.0 GHz.
Set Resolution: 1 Hz.
Measurement Resolution: ±0.005 ppm.
Accuracy: ±20 ppm (25°C ±5°C).

Output Level –
40 MHz to 3.8 GHz:
Range:
Type A: +17 dBM to –8 dBm.
Type B: +7 dBm to –18 dBm.
Type C: +10 dBm to –15 dBm.
Resolution: 0.01 dB.
Linearity (25°C ±5°C):
Type A (with respect to +7 dBm):
+12 dBM to –3 dBm: ±0.4 dB.
+17 dBM to –8 dBm: ±0.7 dB.
Type B (with respect to –3 dBm):
+2 dBM to –13 dBm: ±0.4 dB.
+7 dBM to –18 dBm: ±0.7 dB.
Type C (with respect to 0 dBm):
+5 dBM to –10 dBm: ±0.4 dB.
+10 dBM to –15 dBm: ±0.7 dB.
Flatness (Type C at test port, 25°C ±5°C):
20 dBp-p.
3.8 GHz to 8 GHz (R3767):
Type A: –3 dBm or more.
Type B: –16 dBm or more.
Type C: –13 dBm or more.

Output Impedance – 50 Ω.

Signal Purity (at maximum output) –
Harmonic distortion (40 MHz to 3.8 GHz):
≤20 dBc.
Non-harmonic spurious (40 MHz to 3.8 GHz):
≤25 dBc.
Phase noise (10 kHz offset, 1 Hz BW):
≤-85 dBc to 20 log (F/40 MHz).

SWEEP FUNCTION

Sweep Parameter – Frequency, signal level.

Maximum Sweep Range –
Frequency:
R3765: 40 MHz to 3.8 GHz.
R3767: 40 MHz to 8.0 GHz.
Signal Level:
Type A: +17 dBm to 8 dBm.
Type B: +7 dBm to –18 dBm.
Type C: +10 dBm to –15 dBm.

Sweep Type (minimum sweep time differs according to measurement format, type of error correction, sweep width per point, number of measurement points, and IF bandwidth) –
Normalized Calibration: 0.15 ms/point.
2-port Full Calibration: 0.25 ms/point.

Measurement Point – 3, 6, 11, 21, 51, 101, 201, 301, 401, 601, 801, 1201 points.

Sweep Trigger – Continuous, hold, single, external.

Sweep Mode –
Dual Sweep: Sweeps two channel (CH 1 and CH 2) with the same frequency range.
Alternate Sweeps two channels (CH 1 and CH 2) with different sweep types and frequency ranges.

TEST PORT CHARACTERISTICS

Test Port Load Matching (25°C ±5°C) –
0 MHz to 2.6 GHz: 18 dB.
2.6 GHz to 3.8 GHz: 16 dB.
3.8 GHz to 8.0 GHz (R3767): 14 dB.

Directivity (25°C ±5°C) –
40 MHz to 2.6 GHz: 40 dB.
2.6 GHz to 3.8 GHz: 26 dB.
3.8 GHz to 8.0 GHz (R3767): 22 dB.

Crosstalk (25°C ±5°C) –
R3765:
Types A and B: 90 dB.
Type C:
40 MHz to 2.6 GHz: 90 dB.
2.6 GHz to 3.8 GHz: 85 dB.
R3767:
Types A and B:
40 MHz to 3.8 GHz: 90 dB.
3.8 GHz to 5.0 GHz: 80 dB.
5.0 GHz to 8.0 GHz: 70 dB.
Type C:
40 MHz to 2.6 GHz: 90 dB.
2.6 GHz to 3.8 GHz: 85 dB.
3.8 GHz to 5.0 GHz: 70 dB.
5.0 GHz to 8.0 GHz: 60 dB.

Connector – Type N female, 50 Ω.

Noise Level (with respect to –20dB below maximum input level of test board) –
3 kHz bandwidth: –90 dB.
10 kHz bandwidth: –100 dB.

Maximum Input Level –
Types A and B: 0 dBm.
Type C:
40 MHz to 3.8 GHz: +15 dBm.
3.8 GHz to 8 GHz: +12 dBm.

Input Damage Level – +21 dBm ±30 V DC.

Maximum Port Bias – ±30 V DC, ±0.5 V (Type C only).

DISPLAY

Display Type – 7.8-inch TFT color LCD.
Resolution – 640 x 480 dots.
Display Mode – Log/linear Cartesian coordinate, polar coordinate, Smith chart (impedance/admittance display).
Display Format: –
Single-channel.
2 channels (overlapped display, separated display).
4 channels (separated display).

Measurement Condition Display –
Start/stop, center/span, scale/DIV, reference level, marker value, soft key functions, warning messages.

Reference Line Position – Top (100%) to bottom (0%) of vertical axis memory.

Auto Scale – Sets reference value and scale so measured trace can be displayed in optimum form.
Brightness; Back-light can be turned ON or OFF.

MARKER FUNCTION

Marker Display – Marker reading can be converted into a display value in corresponding to each measurement format.
Multi Marker – 10 markers can be set independently for each channel.
Delta Marker – Each of 10 delta markers can be specified as the reference marker and the delta value between markers can be measured.
Marker Couple – Markers of each channel can be set in coupled or independent manner.
Analysis of Specified Region – Marker search for section specified with Δ marker can be performed.
MRK Search – MAX search, MIN search and NEXT search.
Marker Tracking – Search operation for each sweep.

Target Search – Calculates bandwidth, center frequency, and Q for –X dB point. Frequency for phase 0° and frequency width of ±X°Can be searched for.
MRK –> – MRK –> reference value, MRK –> START, MRK –> STOP, MRK –> CENTER.

INPUT/OUTPUT

External Display – 15-Pin D-SUB connector (VGA).
GPIB – Conforms to IEEE 488 standard.
Parallel I/O – TTL level, 8-Bit output (2 ports), 4-Bit input and output (2 ports).
Serial I/O – Conforms to RS-232 standard.
Keyboard Jack – Compatible with IBM PC-AT.
External Reference Frequency Input –
Input Frequency Range: 1, 2, 5, and 10 MHz ±10 ppm.
Level: >0 dBm.
Impedance: 50 Ω.

PROGRAMMING FUNCTIONS

BASIC Controller Function – Built-in controller function can control internal measurement functions as well as other instruments equipped with a GPIB interface.
Built-in Functions – High-speed analysis of measurement data using built-in functions.
Floppy Disk Drive (FDD) – MS-DOS compatible, 3.5-in., 720 K (DD), 1.2 MB (HD), or 1.44 MB (HD).

ENVIRONMENTAL

Temperature –
Operating:
FDD in use: +5°C to +40°C.
FDD not in use: 0°C to +50°C.
Storage: –20°C to +60°C.
Relative Humidity (without condensation) –
FDD in use: 85% or less.
FDD not in use: 80% or less.

POWER

Line Voltage – 100 to 120 V AC, 220 to 240 V AC. Automatic switching between ranges.
Line Frequency – 48 to 66 Hz.
Power Consumption – 300 VA or less.
Safety – UL3111-1, CSA1010.1

PHYSICAL CHARACTERISTICS

Dimensions	mm	in.
Height	220	8.7
Width	424	16.7
Depth	400	15.7
Weight	**kg**	**lbs.**
	16	35.3

ORDERING INFORMATION

For price information: Outside the U.S. contact your local Tektronix representative, inside the U.S. see the price list in the back of this catalog.

R3765AH
40 MHz to 3.8 GHz Network Analyzer.

R3765BH
40 MHz to 3.8 GHz Network Analyzer with Internal VSWR Bridge.

R3765CH
40 MHz to 3.8 GHz Network Analyzer with 2-Port S-Parameter Test Set.

R3767AH
40 MHz to 8 GHz Network Analyzer.

R3767BH
40 MHz to 8 GHz Network Analyzer with Internal VSWR Bridge.

R3767CH
40 MHz to 8 GHz Network Analyzer with 2-Port S-Parameter Test Set.

Opt. 70 – Time Domain Analysis.

RECOMMENDED ACCESSORIES

50 Ω Termination – Order 26N50.
75 Ω Termination, Type N – Order 26N75.
50 Ω Calibration Open/Short Connector – Order 22N.
75 Ω Calibration Open/Short Connector, Type N – Order 22N75.
50 Ω DC to 18 GHz Calibration Kit (Type N) – Order 9617A3.
50 Ω DC to 18 GHz Calibration Kit (3.5 mm) – Order 9617F3.
Rackmount w/Handles – Order A02712(EIA).
Rackmount w/o Handles – Order A02722(EIA).

MEASUREMENT SERVICE OPTIONS

Opt. C3 – Three years of Calibration Services.
Opt. D1 – Cal Data Report.
Opt. D3 – Test Data (requires Opt. C3).
Opt. R3 – Repair warranty extended to cover three years.

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

CE

GPIB IEEE-488

Product(s) complies with IEEE Standard 488.1-1987, and with Tektronix Standard Codes and Formats.

ADVANTEST

Advantest's quality system complies with the DIN ISO 9002 standard and has been certified by TUV Product Service GMBH.

Network Analyzer

R3754A/3754B



Features – Benefits

50 µs/point Sweep Time

–122 dBm Noise Floor

127 dB Dynamic Range

10 KHz to 150 MHz Frequency Range

Self-Diagnostic Function

Single Key Analysis
- –Filter Analysis
- –Equivalent Circuit Calculations
- –RLA Drive Level Measurement

1, 2 or 3 Channel Inputs

Applications

Design and Test of Crystal and Ceramic Components

Design, Test and Tuning of MRI Coils/Antennas

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

CE

ADVANTEST
Advantest's quality system complies with the DIN ISO 9002 standard and has been certified by TUV Product Service GMBH.

The R3754 Series is a high performance network analyzer with greatly enhanced functional performance and a low price.

Optimization has been made by setting the measurement frequency range to the limited bandwidth of 10 kHz to 150 MHz. The R3754 Series can be used for adjustment and test in the production and inspection processes of crystal, ceramic, LC, and sensor parts. Two types of display units are selectable according to the application. It is recommended to use the R3754A with monochrome display for the pre-process and the R3754B with color display for shipment inspection and receiving inspection.

Doubled Maximum Sweep Speed and High Throughput

Advantest in the R3754 has doubled the sweep speed in comparison to our previous model. The newly developed measurement algorithm greatly improves the total throughput. The improved noise floor and increased maximum input level create a measurement dynamic range of 127 dB. It is possible to measure the high attenuation filter at high speed.

EXCELLENT BASIC PERFORMANCE

- Noise floor: –122 dBm (7 dB improved in comparison to previous Advantest model)
- Trace noise: typ. –0.0015 dB (2 times improved in comparison to previous Advantest model)
- Stability: typ. –0.02 dB °C (2 times improved in comparison to previous Advantest model)

Ordering Information

For price information:
Outside the U.S. contact your local Tektronix representative, inside the U.S. see the price list in the back of this catalog.

Main Unit	Display	Input Channel	Remarks
R3754A	5-inch monochrome LCD	RCH	Additional input channels are optional.
R3754B	6.5-inch color TFT LCD	RCH	Additional input channels are optional.

Opt. 01 – Parallel I/O (R3753H compatible). Plus/minus logic change.
Opt. 02 – Parallel I/O. Pin assignment is changed.
Opt. 03 – Parallel I/O. Optical Isolation.
Opt. 10 – 2-Ch input. RCH, ACH.
Opt. 11 – 3-Ch input. RCH, ACH, BCH.
Opt. 70 – TDR function. Time-axis waveform display.
Opt. 71 – Drive level measurement function. RLA method.
Opt. 72 – 3-terminal resonator measurement function. R1704 and CAL Kit are required.
Opt. 90 – Japanese manual. Operation, Programming Guide, Programming Manual.
Opt. 91 – English manual. Operation, Programming Guide, Programming Manual.

Power Meters

Contents

NRT 213
URV5/35 216
NRVD/NRVS 218
Power Sensors 222

RF Power Measurement

There are two general types of RF power meters:

- Terminating power meters absorb the test signal and indicate the resistant power
- Directional power meters separately measure the forward and reflected power in an RF line with practically no loss

Terminating power meters are often referred to simply as power meters. They typically have a resistive input impedance of 50 or 75 Ω. Depending on the principle of operation, either the heat produced is measured, or the RF power at the termination is measured with the aid of a diode rectifier. Conventional power meters with diode probes have a limited dynamic range, since departures from linearity of the diode at as low as 10 µW cause considerable measurement errors. This range can be extended by microprocessor-controlled correction of the rectifier characteristics.

Directional power meters are inserted into an RF line and measure the forward and reflected power separately based upon a directional coupler. Directional power meters can thus be used for simultaneously checking the transmitter output power and the antenna or load matching. Minimum insertion loss is required for the measurement of higher power levels. The measuring instrument can thus remain connected to the transmitter output line for continuous monitoring. Special power sensors with peak weighting are available for measuring pulsed signals (e.g., in GSM/TDMA mobile radio).

MEASUREMENT ACCURACY

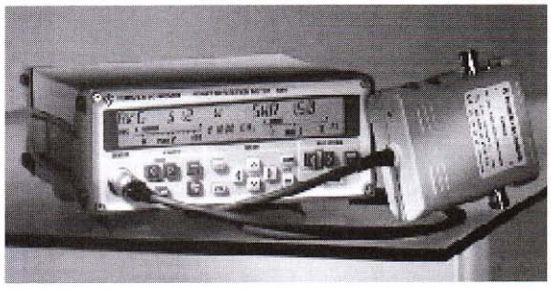
The most important characteristics of a voltmeter or power meter are high measurement accuracy and short measurement times. This requires the use of microprocessors and computed correction of factors such as frequency response, temperature effect and linearity. This relieves the user of error-prone and time-consuming tasks such as recalibration of sensors before measurement, or reading, entering and calculating correction factors.

STORED CALIBRATION DATA FOR EASE OF USE

The sensors offered for use with the URV, NRT and NRV meters are individually calibrated and their calibration data stored in memory. All relevant data required to produce accurate results are stored in calibration-data memory and are available to the meter when plugged in. Even sensor-specific data such as serial number, sensor type and calibration date are known to the meter, in addition to the permissible measurement and frequency ranges. Only the frequency of the measurement is required; the meter automatically scans the data memory for the relevant calibration factors and interpolates if necessary.

Power Meters

New NRT



Features – Benefits

Frequency Range:
200 MHz to 4 GHz

Power Range: 0.3 mW to 2 kW

For Power Measurement on Transmitters, Amplifiers, Industrial RF and Microwave Generators

For Mobile Use, Service, Development, Production and Quality Management

Simultaneous Display of Power and Reflection

Measurement of Average Power Irrespective of Modulation Mode

Measurement of Peak Power, Crest Factor and Average Burst Power

Up to 3 (4) Measurement Channels

Compatible with All Main Digital Standards, e.g. GSM, DCS1800, PCS1900, DECT, PHS, NADC, PDC, DAB, IS-95 CDMA ...

Intelligent Sensors:
Simply Plug in and Go

IEC625 (IEEE488) Bus and RS-232 Interface

Digital Interface Between Sensor and Basic Unit

Direct Connection of Sensor to a PC

Applications

Transmitter Test

VSWR Monitor

Base Station Commissioning

Base Station Maintenance

Remote BTS Monitoring

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

GPIB IEEE-488

Product(s) complies with IEEE Standard 488.1-1987, RS-232-C, and with Tektronix Standard Codes and Formats.

ROHDE&SCHWARZ
Rohde & Schwarz' quality system complies with the DIN ISO 9001 standard and has been certified by DQS (German Association for the Certification of Quality Systems).

The Next Generation in Directional Power Meters

Directional power meters are used to determine transmit power and matching parameters and therefore have a long tradition in the installation, maintenance and monitoring of transmitters and antennas. The new generation of power reflection meters not only offers self-contained sensors but also an accuracy and a wealth of functions not known before, making them suitable, even more so than their predecessors, for use in development, testing and quality management.

Directional power meters are connected between source and load and measure the power flow in both directions. The power applied to the load and the reflection can thus be measured.

Compared to low-cost instruments, power meters like the NRT provide a number of benefits: most importantly high measurement accuracy through excellent directivity and a measurement method that determines the average power like a thermal power meter. The instruments thus provide correct measurement results even in case of modulation or in the presence of several carriers.

Power Sensors NRT-Z43/–Z44 feature low insertion loss, very good matching and excellent intermodulation characteristics: the signal to be measured is virtually unaffected, the sensor is fully transparent.

Ease of Operation

With its large display and a manageable number of clearly laid out keys, operation of the NRT basic unit is extremely easy. Switchover between the main functions is made at a keystroke. Additional settings are made in three clearly arranged menus, each of which can be accessed at a keystroke.

A large variety of functions is available for daily routine measurements:

- Choice between average power, average burst power, peak envelope power (PEP) and peak-to-average power ratio (crest factor)
- Switchover between forward power and absorbed power
- Measurement of power differences in dB or %
- Choice between return loss, SWR or reflection coefficient in reflection measurements
- Acoustic SWR monitoring
- Indication of maximum and minimum values
- Quasi-analog bar graph display
- Choice between measurement at the source or at the load

Versatility Through Options

The NRT basic unit comes with an IEC-bus (IEEE488) and RS-232 interface, both to SCPI standard. Three options allow the NRT to be adapted to different applications:

- An additional test input allows the sensors of predecessor model NAP to be connected, thus covering the frequency range from 200 kHz with power up to 1 kW and above (NRT-B1)
- Two additional test inputs for sensors of type NRT-Z allow simultaneous monitoring of up to three test-points (NRT-B2)
- Battery and built-in charger allow mobile use (NRT-B3)



The Best in Sensors

DIRECTIONAL POWER SENSORS NRT-Z43/–Z44

The new Power Sensors NRT-Z43 and NRTZ44 can be used as self-contained measuring instruments with digital interface even without the basic unit. In addition to a directional coupler and analog section they comprise a processor kernel for control of the hardware and remote interface and for processing the measured data (temperature compensation, linearization, zeroing and frequency-response correction). This compact concept allows a wealth of measurement functions without the restrictions of conventional analog concepts.

AVERAGE POWER (RMS VALUE)

This measurement function returns for any type of test signal – whether modulated, unmodulated or several carriers – the average value of the power, i.e. a result as provided by a thermal power meter. It features a measurement range of 35 to 40 dB as well as high measurement accuracy.

PEAK ENVELOPE POWER (PEP) AND CREST FACTOR

These two parameters provide information on the peak power of a modulated envelope and thus describe the overdrive characteristics of transmitter output stages. The result of the crest factor measurement is referred to the average power and read out in dB. The measurements are carried out with a video bandwidth adjustable in several steps and allow determination of peak power down to a duration of 200 ns, i.e. the peak power of spread-spectrum signals with RF bandwidths of up to about 2 MHz (IS-95 CDMA, DAB) can also be measured.

AVERAGE BURST POWER

This function can be used for measuring modulated and unmodulated bursts. The measurement is based on the average power and the duty cycle, which may be defined by the user or determined automatically by the power sensor.

COMPLEMENTARY CUMULATIVE DISTRIBUTION FUNCTION (CCDF)

This function measures the probability of the peak envelope power exceeding a preset threshold and thus allows determination of the amplitude distribution of nondetermined modulation signals.

ORDERING INFORMATION

For price information: Outside the U.S. contact your local Tektronix representative, inside the U.S. see the price list in the back of this catalog.

BASIC UNIT

NRT – Power Reflection Meter. Order 1080.9506.02.

DIRECTIONAL POWER SENSORS NRT*

NRT-Z43 – 30 (75) W, 0.4 to 4 GHz. Order 1081.2905.02.

NRT-Z44 – 120 (300) W, 0.2 to 4 GHz. Order 1081.1309.02.

NRT-CAL – Calibration certification data NRT-Z43/–Z44 (CAL-1). Order 0240.8727.06.

DIRECTIONAL POWER SENSORS NAP

NAP-Z3 – 35 W, 25 to 1000 MHz. Order 0392.6610.55.

NAP-Z4 – 110 W, 25 to 1000 MHz. Order 0392.6910.55.

NAP-Z5 – 350 W, 25 to 1000 MHz. Order 0392.7116.55.

NAP-Z6 – 1100 W, 25 to 1000 MHz. Order 0392.7316.56.

NAP-Z7 – 200 W, 0.4 to 80 MHz. Order 0350.8214.02.

NAP-Z8 – 2000 W, 0.2 to 80 MHz. Order 0350.4619.02.

NAP-Z9 – 1.1 W, 100 to 1000 MHz. Order 0392.5513.55.

NAP-Z10 – 20 W, 35 to 1000 MHz. Order 0858.0000.02.

NAP-Z10 – 20 W, 890 to 960 MHz. Order 0858.0000.04.

NAP-Z11 – 200 W, 35 to 1000 MHz. Order 0852.6707.02.

NAP-Z11 – 200 W, 890 to 960 MHz. Order 0852.6707.04.

NAP-Z42 – 110 W, 0.9 to 2 GHz. Order 0852.7403.02.

NAP-CAL – Calibration at delivery NAP-Z (CAL-1). Order 0240.8727.06.

OPTIONS

NRT-B1 – Interface for NAP-Z Power Sensors. Order 1081.0902.02.

NRT-CAL – Calibration certification data NRT-B1 (CAL-1). Order 0240.8727.06.

NRT-B2 – Two rear inputs for NRT-Z Power Sensors. Order 1081.0702.02.

NRT-B3 – Battery supply with built-in charger and NiMH battery. Order 1081.0502.02.

RECOMMENDED ACCESSORIES

NRT-Z1 – NiMH Battery. Order 1081.1209.02.

NRT-Z2 – 10 m Extension Cable for NRT-Z Power Sensors. Order 1081.2505.10.

NRT-Z2 – 30 m Extension Cable for NRT-Z Power Sensors. Order 1081.2505.30.

NAP-Z2 – 25 m Extension Cable for NAP-Z Power Sensors. Order 0392.5813.02.

NRT-Z3 – RS-232 Interface Adapter for NRT-Z Power Sensors including AC Power Supply. Order 1081.2705.02.

ZZT-222 – Carrying Bag with Straps and Pocket for Accessories. Order 1001.0500.00.

ZZA-97 – 19" Rack Adapter. Order 0827.4527.00.

*Including demo software.

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

GPIB IEEE-488

Product(s) complies with IEEE Standard 488.1-1987, RS-232-C, and with Tektronix Standard Codes and Formats.

ROHDE&SCHWARZ
Rohde & Schwarz' quality system complies with the DIN ISO 9001 standard and has been certified by DQS (German Association for the Certification of Quality Systems).

Power Meters

URV 5 • URV 35



Features – Benefits

URV 5

DC, 9 kHz to 2 GHz Frequency Range (40 GHz with NRV-Z Sensors)

200 µV to 1000 V Measurement Range

Two Test Inputs

Microprocessor Error Correction for Unexcelled Accuracy

Relative Measurements

Individual, Frequency-dependent Calibration Factors Taken into Account

URV 35

DC to 26.5 GHz Frequency Range

Compact, Rugged Design

Voltmeter & Power Meter in One Unit

Combined Analog & Digital Display

Battery or AC Supply Operation

Wide Choice of Probes and Sensors

Applications

Service

Production

Precision Measurements in RF and Microwave Labs

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

GPIB IEEE-488

URV5 complies with IEEE Standard 488.1-1987, and with Tektronix Standard Codes and Formats.

ROHDE&SCHWARZ
Rohde & Schwarz' quality system complies with the DIN ISO 9001 standard and has been certified by DQS (German Association for the Certification of Quality Systems).

URV 5 RF Millivoltmeter

The URV 5 RF Millivoltmeter is a broadband voltage, level and power meter with high accuracy and sensitivity. It is suitable for both manual operation and use in systems. A great variety of probes, sensors and accessories allows the URV 5 to be used for all kinds of measurements.

URV 35 Level Meter

The URV 35 Level Meter is a precise voltage and power meter for a large variety of applications. It can be used in service and production, as well as for precision measurement in the RF and microwave lab.

The large variety of probes and sensors available opens up a wide level and frequency range. Excellent RF shielding provides precise measurements, even in the near field of antennas.

An intelligent operating concept in conjunction with an auto-range facility reduces the user's work to read the results in standard units, either as absolute or relative values. The appropriate scale is shown on the LCD display for convenient reading of the results.

Characteristics

URV 5

Probes and Sensors – Compatible with all URV 5 probes and NRV sensors except NRV-Z51, NRV-Z52, NRV-Z53, NRV-Z54 and NRV-Z31.

Test Channels – 2 (A and B).
Dynamic range: >94 dB.
Absolute measurement: A, B.
Relative measurement: A/REF_A, B/REF_B, A/B, B/A.
Absolute readout: V, W, dBm, dBV.

Relative readout: ΔV, ΔW, Δ%, ΔdB, X/REF.
Resolution: 0.01% or dB.
Error limits (18 to 28°C): ±0.15% of reading per channel.
Filter: Reduces display noise in six steps (F0 to F5).
Zero adjustment: Via keyboard or remote control.
Measurement rate (manual): Approximately 1 measurement/second with filter F0, up to 30 measurements/second with filter F5.
Measurement time (IEC/IEEE bus): Approximately 0.05 second with filter F5, up to 20 seconds with filter F0.

PEP Measurement – Pulse width: Approximately 200 µs to CW.
Minimum pulse repetition frequency:

Filter	F0	F1	F2	F3	F4	F5
f_{min}/Hz	0.05	0.25	1	5	25	100

Optional DC Output (URV 5 with Opt. 01) – Output voltage range (EMF): –1.999 to +1.999 V into Z_{out} = 1 kΩ.
Resolution: 1 mV (10 digits).
Error: ±2 mV.

Remote Control – Interface: IEC625-1 (IEEE 488) for control of all device functions.
Interface functions: SH1, AH1, T5, L4, SR1, RL1, DC1, DT1, PP1.

PHYSICAL CHARACTERISTICS

Dimensions	mm	in.
Height	110	4.3
Width	241	9.5
Depth	340	13.4
Weight	**kg**	**lbs.**
Net	4.4	9.7

URV 35

Probes and Sensors – Compatible with all URV 5-Z probes and NRV-Z sensors.

Frequency Range – DC to 26.5 GHz.

Display – Backlit LCD for display of measured value, units and meter scale; additional moving-coil meter with short response time.
Absolute readout: dBm, dBµV, V or W.
Relative readout: dB referred to stored reference value.
Resolution of digital display –
4 1/2 digits: 19,999 steps, 0.001 dB.
3 1/2 digits: 1,999 steps, 0.01 dB.
Analog display: Steps of 1/2.5/5 with readout in V, W, or dB; steps of 5 dB with readout in dBm and windows of 10 dB, manually or automatically selected; free scaling by entry of left-hand and right-hand scale limits.
Display filtering: Level-dependent digital averaging filter.
4 1/2 -digit resolution: Averaging over 16 to 256 readings.
3 1/2 -digit resolution: Averaging over 1 to 32 readings.

Error Limits (18 to 28°C) – Digital display: ±0.02 dB ±1 digit.
Moving-coil meter: 1.5% of full scale.

Zero Adjustment – Via interface or manually, ≈ 4 s.

HOLD Function – Displayed measurement result retained upon keystroke.

Measurement Rate – Five readouts per second in manual mode.

Frequency-response Correction – Specific calibration data of probe taken into account; frequency entry via keypad, interface or equivalent DC voltage at rear-panel input.

Attenuation Correction – Attenuation or gain connected to input taken into account; input of attenuation value via serial interface or keypad, range ±199.99 dB.

Reference Value Entry – Measured value on keystroke or value entered via interface or keypad.

Reference Impedance – 50 Ω/75 Ω, automatic/selectable.

Input/Output – DC frequency input: Connector: BNC female. Input impedance: 9 MΩ. Input voltage range: ±12 V, freely selectable, linear, scaling. Maximum input voltage: 50 V. DC
Voltage Output: Connector: BNC female. Source impedance: 1 kΩ. Output voltage (EMF): Proportional to pointer deflection. Left-hand scale limit: Corresponding to 0 V. Right-hand scale limit: Corresponding to 0 V. Settling time: 250 ms. Error: ≤5 mV. Ripple: 5 mV p-p typical.

Remote Control – All device functions controlled via serial interface (V.24, RS-232C).

POWER REQUIREMENTS (URV 5 AND URV 35)

Battery Operation (URV 35 Model 02) – Battery type: 5 LR20 (1.5 V). Operating time: Approximately 125 hours. Charge time (with UZ-35 charger): Approximately 24 hours.

AC Operation (URV 5 and URV 35 Model 03) –
Line voltage: 100/120/220/240 VAC ±10%.
Line frequency: 47 to 63 Hz, 400 Hz.
Power consumption: 30 VA.

ENVIRONMENTAL CHARACTERISTICS (URV 5 AND URV 35)

Temperature Range – Operating: 0 to +50°C (Class I to IEC 359, no condensation).
Storage: –40 to +70°C.

Humidity – 80% maximum (without condensation).

Mechanical Strength – To IEC 359, Class I.

RFI Suppression – VDE 0871, DBP approval number to regulations 527/1979.

EMC – To IEC 801.3, severity level 3; MIL-STD-461-B RS 03 and CS 02.

PHYSICAL CHARACTERISTICS

Dimensions	mm	in.
Height	103	4.1
Width	219	6.6
Depth	240	9.4
Weight	**kg**	**lbs.**
Model 02		
With batteries	3.1	6.8
Without batteries	2.3	5.1
Model 03	2.4	5.3

ORDERING INFORMATION

For price information: Outside the U.S. contact your local Tektronix representative, inside the U.S. see the price list in the back of this catalog.

URV 5
RF Millivoltmeter.
Includes: Power Cord, Manual.
Opt. 01 – DC Output.

URV 35 MODEL 02
RF Millivoltmeter (Battery Operated).

URV 35 MODEL 03
RF Millivoltmeter (AC Supply).
Includes: Power Cord, Manual.

RECOMMENDED ACCESSORIES
Also see page 495.
Battery Charger – Order UZ-35.
Service Kit – Order URV 35-Z1.
Transit Case – Order UZ-22.
Carrying Strap – Order ZZT-96.
Rack Adapter – Order ZZA-97.
Plastic Hood – *1.
Probes and Sensors – See page 222.
1 Contact your local Tektronix representative.

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

GPIB IEEE-488
Product(s) complies with IEEE Standard 488.1-1987, RS-232-C, and with Tektronix Standard Codes and Formats.

ROHDE&SCHWARZ
Rohde & Schwarz' quality system complies with the DIN ISO 9001 standard and has been certified by DQS (German Association for the Certification of Quality Systems).

Power Meters

NRVD



Features – Benefits

- DC to 40 GHz Frequency Range
- Two Independent Channels for Simultaneous Measurement
- Power, Level and Voltage Measurements
- Intelligent Measuring Heads – Just Plug Them in and Measure
- Autoranging
- Entry of Reference Values for Level and Attenuation
- Storage of 20 Complete Instrument Setups
- Built-in Test Generator for Checking Sensors
- Remote Control of All Functions via IEC/IEEE Bus

Applications

- Laboratory Test
- Production Test
- Research and Development

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GPIB IEEE-488

Product(s) complies with IEEE Standard 488.2-1987, and with Tektronix Standard Codes and Formats.

ROHDE&SCHWARZ
Rohde & Schwarz' quality system complies with the DIN ISO 9001 standard and has been certified by DQS (German Association for the Certification of Quality Systems).

NRVD Dual-channel Power Meter

The NRVD Dual-channel Power Meter functions like two independent measuring instruments housed in one cabinet to perform measurements simultaneously and exchange data with one another. The two channels can be separately set so that two completely different measurements can be carried out at the same time. The two measured values can also be related to each other for direct indication of reflection coefficient, SWR and return loss, for instance, when an SWR bridge is connected to the meter.

READOUT OF RESULTS

Measurement results are displayed with selectable resolution on a large 5-digit LCD display with adjustable backlighting. The values measured in the two channels, or one measured value plus an additional item of information (e.g., the correction frequency) are displayed simultaneously. All standard units of measurement or relative modes can be selected. Relative measurements are either referred to a stored reference value or to the value measured in the second channel. A high-resolution bar graph indicator with selectable scaling or autoscaling permits quasi-analog display of measured values with any unit or resolution.

POWER SENSORS

The range of probes and sensors includes thermocouple power sensors, as well as highly sensitive diode power sensors, probes, and insertion units. This allows the NRVD to cover a frequency range from DC to 26.5 GHz and a power span from 400 pW up to the kW range.

TEST GENERATOR

A test generator is included to check measuring heads and sensors for proper functioning. It generates a low-distortion, highly accurate 50 MHz signal of 1 mW power (0 dBm).

INPUT/OUTPUT WITH OPT. 01

Option 01 provides a number of inputs and outputs to extend the range of the NRVD.

CHARACTERISTICS

Measurement Functions – Unmodulated and modulated power (average power, AM, pulse power), reflection and DC voltage (depending upon measuring head).

Frequency Range – DC to 26.5 GHz (depending upon measuring head).

Level Range – 400 pW to 0.5 W (depending upon measuring head).

Measuring Heads – All NRV-Z and URV 5-Z voltage and power measuring heads.

Display – LCD with adjustable backlighting for figures, units, user prompting and analog display.

Resolution of Digital Display – 5 digits maximum, resolution adjustable in 3 modes.
HIGH: 12,000 steps or 0.001 dB.
MEDIUM: 1,200 steps or 0.01 dB.
LOW: 120 steps or 0.1 dB.

Display Noise – See measuring head specifications.

Measurement Rate – See Table 2.

Error Limits of Power Readout in W (Without Error of Measuring Head) –
18 to 28°C: 0.3% + 1 digit.
10 to 40°C: 0.8% + 1 digit.
0 to 50°C: 1.3% + 1 digit.

Zero Adjustment – Manual or via IEC/IEEE bus, duration ≈ 4 s.

Frequency Response Correction – Stored frequency response of measuring head taken into account by numerical entry of test frequency (manually or via IEC/IEEE bus) or by applying a frequency-proportional DC voltage.

Attenuation Compensation – Attenuation or gain connected to input taken into account; entry of attenuation value (±200 dB) via keyboard or IEC/IEEE bus.

Reference Value – One reference value per channel for relative measurements; numeric entry via keyboard or IEC/IEEE bus, or use stored measured value or current value of second channel.

Remote Control – Control of all instrument functions via IEC 625/IEEE 488 interface.
Interface functions: SH1, AH1, T6, L4, SR1, RL1, DC1, DT1, PP0, PPI.

Test Generator –
Output power: 1.00 mW.
Frequency: 50 MHz.
Power measurement error: ≤0.7%.
SWR: ≤1.03.
RF connector: N female.

DC Control Input for Frequency Response Correction –
Connector: BNC female.
Input level: ±12 V, linear with selectable scale.
Input impedance: 9 MΩ.
Maximum input voltage: 50 V.

I/O with Opt. 01 –
Output: Two analog outputs for simultaneous output of measurement results of both channels.
Output impedance: 1 kΩ.
Voltage range: 0 to 3 V.
Resolution: 1 mV.
Error: ≤5 mV.
Input: DC input for analog frequency response correction.
Voltage range: ±12 V.
Input impedance: 1 MΩ.
Trigger input: TTL, active low.
Ready output: TTL, active high.

POWER REQUIREMENTS

Line Voltage – 110/120 V ±10%; 220 V ±10%, 230 V –6/+15%.

Line Frequency – 47 to 63 Hz.

Power Consumption – 25 VA.

ENVIRONMENTAL CHARACTERISTICS

EMC – IEC 801-3, severity level 3; MIL-STD-461-B; RS 03 and CS 02.

PHYSICAL CHARACTERISTICS

Dimensions	mm	in.
Height	147	5.8
Width	219	8.6
Depth	350	13.8
Weight	**kg**	**lbs.**
Net	4.5	9.9

ORDERING INFORMATION

For price information: Outside the U.S. contact your local Tektronix representative, inside the U.S. see the price list in the back of this catalog.

NRVD
Dual-channel Power Meter.
Includes: Power Cable, Manual.
Opt. 01/NRVD-B2 – I/O Option.

MEASUREMENT SERVICE OPTIONS
Opt. R3 – Repair warranty extended to cover three years.

RECOMMENDED ACCESSORIES
Also see page 495.
See Probes and Sensors, Page 222.
Rack Adapter – Order ZZA-98.
Accessory Bag – Order ZZT-92.
Carrying Straps – Order ZZT-96.
Transit Case – Order ZZK-983.
Service Kit – Order NRVD-S1.

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

GPIB IEEE-488
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ROHDE&SCHWARZ
Rohde & Schwarz' quality system complies with the DIN ISO 9001 standard and has been certified by DQS (German Association for the Certification of Quality Systems).

Power Meters
NRVS



Features – Benefits

- DC to 26.5 GHz Frequency Range
- Power, Level and Voltage Measurements
- Intelligent Measuring Heads – Just Plug Them in and Measure
- DC Frequency Input for Tracking Frequency-response Correction
- Analog Output
- Menu-guided Operation with Softkeys
- Storage of 20 Complete Instrument Setups
- 13 Digital Filters for Noise Suppression, Automatic or Manual Filter Selection
- Remote Control of All Functions via IEC/IEEE Bus

Applications

- Laboratory
- Production

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

GPIB IEEE-488

Product(s) complies with IEEE Standard 488.1-1987.

ROHDE&SCHWARZ
Rohde & Schwarz' quality system complies with the DIN ISO 9001 standard and has been certified by DQS (German Association for the Certification of Quality Systems).

NRVS Power Meter

The NRVS Power Meter is the ideal instrument for any kind of power measurement in laboratory and system applications. Intelligent probes with calibration data memory and thermocouple sensors make user adjustments unnecessary. The NRVS provides high-precision measurements free of operator errors.

READOUT OF RESULTS

Measurement results, units and various items of information are displayed on a large 4 1/2-digit LCD display in three steps of resolution. All standard units of measurement or relative modes can be selected. A high resolution bargraph indicator with selectable scaling or auto-scaling permits quasi-analog display of measured values with any unit of resolution.

If pulse-modulated signals are measured, the NRVS calculates the pulse peak power from the measured average value and the entered pulse duty factor; the result is directly displayed.

MEASUREMENT RATE

The attainable measurement rate depends upon the type of measuring head used as well as the setting of the averaging filter, which must be matched to the measurement conditions. Taking into account the connected measuring head, the NRVS automatically selects the appropriate measurement rate by determining the optimum averaging time required for a steady readout as a function of level and selected resolution. This automatic selection may be disabled and an averaging time of between 4 ms and 25 s set manually to measure more quickly than in automatic operation or to further reduce the noise.

POWER SENSORS

The range of probes and sensors includes thermocouple power sensors, as well as highly sensitive diode power sensors, probes and insertion units. This allows the NRVS to cover a frequency range from DC to 26.5 GHz and a power span from 400 pW up to the kW range.

CHARACTERISTICS

Measurement Functions – Average power, pulse power, DC voltage (depending upon measuring head).

Frequency Range – DC to 26.5 GHz (depending upon measuring head).

Level Range – 400 pW to 0.5 W (depending upon measuring head).

Measuring Heads – All NRV-Z and URV 5-Z voltage and power measuring heads.

Display – LCD for figures, units, user prompting and analog display.

Readout –
Absolute: W, dBm, V, dBµV.
Relative: dB, %W or %V referred to a stored reference value, numeric readout with or without display of correction frequency.

Analog Display –
Automatic or with selectable scale.

Resolution of Digital Display – 4 1/2; digits maximum, resolution adjustable in 3 modes.
HIGH: 12,000 steps or 0.001 dB.
MEDIUM: 1,200 steps or 0.01 dB.
LOW: 120 steps or 0.1 dB.

Display Noise – See measuring head specifications.

Measurement Rate – See Table 2.

Error Limits of Power Readout in W (without error of measuring head) –
18 to 28°C: 0.4% + 1 digit.
10 to 40°C: 0.9% + 1 digit.
0 to 50°C: 1.4% + 1 digit.

Zero Adjustment – Manual or via IEC/IEEE bus, duration ≈ 4 s.

Frequency Response Correction – Stored frequency response of measuring head taken into account by numerical entry of test frequency (manually or via IEC/IEEE bus) or by applying a frequency-proportional DC voltage.

Attenuation Compensation – Attenuation or gain connected to input taken into account; entry of attenuation value (±200 dB) via keyboard or IEC/IEEE bus.

Reference Value – Numeric entry via keyboard or IEC/IEEE bus, or use stored measured value.

Reference Impedance – For conversion between voltage and power, automatic readout of reference impedance from data stored in the measuring head or numeric entry via keyboard or IEC/IEEE bus (for RF probe).

Remote Control – Control of all instrument functions via IEC 625/IEEE 488 interface.
Interface functions: SH1, AH1, T6, L4, SR1, RL1, DC1, DT1, PP0.

DC Control Input for Frequency Response Correction –
Connector: BNC female.
Input level: ±12 V, linear with selectable scale.
Input impedance: 9 MΩ.
Maximum input voltage: 50 V.

DC Output –
Connector: BNC female.
Source impedance: 1 kΩ.
Output voltage (EMF): Proportional to deflection of analog display.
Full scale value: Left 0 V, right +3 V.
Additional settling time: 250 ms.

POWER REQUIREMENTS

Line Voltage – 115 V +15/–22%; 230 V +15/–22%.
Line Frequency – 47 to 63 (440) Hz.
Power Consumption – 13 VA.

ENVIRONMENTAL CHARACTERISTICS

Temperature Range –
Operating: 0 to +50°C, for use in Class I to IEC 359.
Storage: –40 to +70°C.

Humidity – To 80% (without dewing).

Mechanical Stability – IEC 359, Class I.

RFI Suppression – DBP approval number to regulations 527/1979, VDE 0871.

EMC – IEC 801-3, severity level 3; MIL-STD-461-B; RS 03 and CS 02.

PHYSICAL CHARACTERISTICS

Dimensions	mm	in.
Height	103	4.1
Width	219	8.6
Depth	350	13.8
Weight	**kg**	**lbs.**
Net	3.2	7.1

ORDERING INFORMATION

For price information: Outside the U.S. contact your local Tektronix representative, inside the U.S. see the price list in the back of this catalog.

NRVS
Power Meter.
Includes: Power Cord, Manual.

MEASUREMENT SERVICE OPTIONS
Opt. R3 – Repair warranty extended to cover three years.

RECOMMENDED ACCESSORIES
Also see page 495.
See Probes, Sensors and Insertion Units, page 222.
Rack Adapter – Order ZZA-97.
Accessory Bag – Order ZZT-92.
Carrying Straps – Order ZZT-96.
Transit Case – Order ZZK-973.
Service Kit – Order NRVS-1.

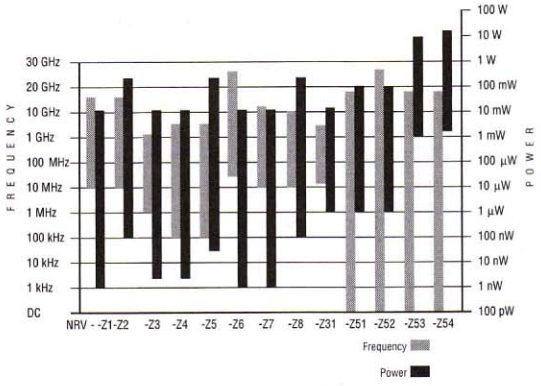
For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

GPIB IEEE-488
Product(s) complies with IEEE Standard 488.1-1987.

ROHDE&SCHWARZ
Rohde & Schwarz' quality system complies with the DIN ISO 9001 standard and has been certified by DQS (German Association for the Certification of Quality Systems).

Power Meters

Power Sensors • Probes • RF Insertion Units



Features – Benefits

Thermocouple Sensors

Diode Sensors

Diode Sensors with an Integral 20-dB Attenuator

Peak Power Sensors

RF Probes

RF Insertion Units

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

ROHDE&SCHWARZ
Rohde & Schwarz' quality system complies with the DIN ISO 9001 standard and has been certified by DQS (German Association for the Certification of Quality Systems).

A Full Range of Probes, Insertion Units and Power Sensors

These probes, insertion units and power sensors extend the measurement range and offer added measurement capability.

THE RIGHT SENSOR FOR EVERY APPLICATION

Power sensors absorb the power applied and provide an equivalent DC voltage at their output. To cover the complete power range from less than 1 nW to more than 100 mW, two different types of power sensors are required: thermocouple sensors based on the Seebeck effect and semiconductor detectors using zero-bias Schottky diodes. Both types of transducers are available for the entire frequency spectrum.

THERMOCOUPLE SENSORS

Thermocouple sensors open up a wide power range from 1 µW to 100 mW. Regardless of the waveform, they always indicate the RMS power over the full range, giving precise results, even for modulated or complex signals.

DIODE SENSORS

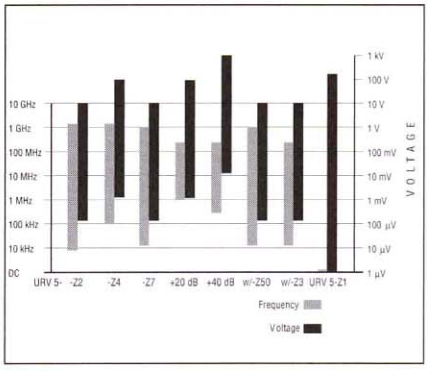
Diode sensors feature a higher sensitivity. They are able to measure power to as low as 100 pW. Since they measure true RMS power down to 10 µW, they can even be used for signals with harmonic contents, noisy or modulated signals.

DIODE SENSORS WITH AN INTEGRAL 20-DB ATTENUATOR

Diode sensors with an integral 20-dB attenuator fill the gap between pure diode sensors and thermocouples. They provide true RMS measurements in a range up to 1 mW and satisfy the most exacting requirements on measurement speed, even for levels between 10 and 100 µW, where the use of thermocouple sensors is limited.

PEAK POWER SENSORS

Peak power sensors contain rectifiers for measuring the peak modulation. They enable direct measurement of the TV sync pulse peak power, the power of TDMA signals, as well as of other pulsed signals with a pulse width from 2 µs. In the frequency range from 1 µW to 20 mW, these sensors are a value-for-money alternative to special peak power meters.



Voltage Probes for the URV/NRV family.

RF PROBES

RF probes are indispensable for measurements on non-coaxial circuits and components. Small input capacitance and low loss enable low-load measurements directly in the circuit. Dividers increase the voltage measurement range and minimize the loading of the device under test.

RF INSERTION UNITS

RF insertion units are used for voltage measurements in coaxial circuits. They incorporate a diode inserted in the inner conductor or connected via a piston attenuator and permit broadband measurements to be made up to 2 GHz with low reflection coefficient. Given matched conditions, these insertion units can also be used for practically no-loss measurements of RF power.

MEASURING HEADS

Probes

URV 5-Z1	DC Probe 0 to 400 V, 9 MΩ, 3 pF	
URV 5-Z702, 4 ft. cable URV 5-Z703, 16 ft. cable	RF Probe 200 µV to 10 V, 20 kHz to 1 GHz	RF Probe low capacitance and resistive load
URV-Z6 with 20 dB plug-on divider*[1]	2 mV to 100 V, 1 to 500 MHz	The 20 dB and 40 dB plug-on dividers increase the voltage measuring range of the RF probe
URV-Z6 with 40 dB plug-on divider*[1]	20 mV to 1000 V, 500 kHz to 500 MHz	
URV-Z50 with 50 Ω Adapter	200 µV to 10 V, 20 kHz to 1 GHz	With integrated termination for power or level measurements on test items, with a source impedance of 50 Ω in the frequency range up to 1 GHz (BNC female/male)
URV-Z3 with 75 Ω Adapter	200 µV to 10 V, 20 kHz to 500 MHz	

*[1] *Included in accessory URV-Z6.*

RF Insertion Units

(unless otherwise specified, all insertion units with N male/female; all power sensors with N male connectors)

URV 5-Z25, 4 ft. cable URV 5-Z26, 16 ft. cable	200 µV to 10 V Insertion Unit 50 Ω 9 kHz to 2 GHz	
URV 5-Z44, 4 ft. cable URV 5-Z45, 16 ft. cable	2 mV to 100 V Insertion Unit 50 Ω 100 kHz to 2 GHz	
URV 5-Z46, 4 ft. cable URV 5-Z47, 16 ft. cable	2 mV to 100 V Insertion Unit 75 Ω 100 kHz to 2 GHz	
NAS-Z1	120 W Insertion Unit, 1 to 30 MHz	
NAS-Z2	1200 W Insertion Unit, 1 to 30 MHz	
NAS-Z3	120 W Insertion Unit, 25 to 200 MHz	
NAS-Z5	120 W Insertion Unit, 70 to 1000 MHz	
NAS-Z6	120 W Insertion Unit, 890 to 960 MHz	
NAS-Z7	30 W Insertion Unit, 890 to 960 MHz, 1710 to 1880 MHz	For GSM, DCS 1800

Power Sensors		
NRV-Z1 02, 4 ft. cable NRV-Z1 03, 16 ft. cable	1 nW to 20 mW, Diode Power Sensor 50 Ω 10 MHz to 18 GHz	
NRV-Z2 02, 4 ft. cable NRV-Z2 03, 16 ft. cable	Diode Power Sensor 50 Ω 10 MHz to 18 GHz, 100 nW to 500 mW	
NRV-Z3 02, 4 ft. cable NRV-Z3 03, 16 ft. cable	Diode Power Sensor 75 Ω 1 MHz to 2.5 GHz, 400 pW to 13 mW	
NRV-Z4 02, 4 ft. cable NRV-Z4 03, 16 ft. cable	Diode Power Sensor 50 Ω 100 kHz to 6 GHz, 500 pW to 20 mW	Power measurements of highest sensitivity in the frequency range 100 kHzto 6 GHz, very large dynamic range
NRV-Z5 02, 4 ft. cable NRV-Z5 03, 16 ft. cable	Diode Power Sensor 50 Ω 100 kHz to 6 GHz, 50 nW to 500 mW	
NRV-Z6	Diode Power Sensor 50 Ω 50 MHz to 26.5 GHz, 1 nW to 20 mW	
NRV-Z7	Diode Power Sensor 50 Ω 10 MHz to 13 GHz, 1 nW to 20 mW	
NRV-Z8	Diode Power Sensor 50 Ω 10 MHz to 13 GHz, 100 nW to 500 mW	
NRV-Z15	Diode Power Sensor 50 Ω, 50 MHz to 40 GHz, 1 µW to 20 mW	
NRV-Z31	Peak Power Sensor 50 Ω 30 MHz to 6 GHz, 1 µW to 20 mW	Peak power measurements, pulse width ≥2 (200) µs, pulse repetition rate ≥10 (100) Hz, 3 models
NRV-Z51	Thermocouple Sensor 50 Ω DC to 18 GHz, 1 µW to 100 mW	High-precision power measurements also with non-sinusoidal signals
NRV-Z52	Thermocouple Sensor 50 Ω DC to 26.5 GHz, 1 µW to 100 mW	Like NRV-Z51, but with PC 3.5 connector for measurements up to 26.5 GHz
NRV-Z53	Thermocouple Sensor 50 Ω DC to 18 GHz, 100 µW to 10 W	High-power measurements up to 10 W also with non-sinusoidal signals
NRV-Z54	Thermocouple Sensor 50 Ω DC to 18 GHz 300 µW to 30 W	High-power measurements up to 30 W also with non-sinusoidal signals
NRV-Z55	Thermal Power Sensor 50 Ω, 0 -4 GHz 1µW to 100 MW	High Precision measurement of non-sinusoidal signals to 40 GHz

ORDERING INFORMATION

For price information: Outside the U.S. contact your local Tektronix representative, inside the U.S. see the price list in the back of this catalog.

PROBES

DC Probe – Order URV 5-Z1.

RF Probe – Order URV 5-Z7.

RF Probe with 20 dB and 40 dB Plug-on Divider – Order URV-Z6.

RF Probe with 50 Ω Adapter – Order URV-Z50.

RF Probe with 75 Ω Adapter – Order URV-Z3.

RF INSERTION UNITS

10 V Insertion Unit, 50 Ω – Order URV 5-Z2.

100 V Insertion Unit, 50 Ω – Order URV 5-Z44.

100 V Insertion Unit, 75 Ω – Order URV 5-Z47.

120 W Insertion Unit, 1 to 30 MHz – Order NAS-Z1.

1200 W Insertion Unit, 1 to 30 MHz – Order NAS-Z2.

120 W Insertion Unit, 25 to 200 MHz – Order NAS-Z3.

120 W Insertion Unit, 70 to 1000 MHz – Order NAS-Z5.

120 W Insertion Unit, 890 to 960 MHz – Order NAS-Z6.

30 W Insertion Unit, 890 to 960 MHz, 1710 to 1880 MHz – Order NAS-Z7.

POWER SENSORS

Diode Power Sensor, 50 Ω – Order NRV-Z1.

Diode Power Sensor, 50 Ω – Order NRV-Z2.

Diode Power Sensor, 75 Ω – Order NRV-Z3.

Diode Power Sensor, 50 Ω – Order NRV-Z4.

Diode Power Sensor, 50 Ω – Order NRV-Z5.

Diode Power Sensor, 50 Ω – Order NRV-Z6.

Diode Power Sensor, 50 Ω – Order NRV-Z7.

Diode Power Sensor, 50 Ω – Order NRV-Z8.

Diode Power Sensor, 50 Ω – Order NRV-Z15.

Peak Power Sensor, 50 Ω – Order NRV-Z31.

Thermocouple Power Sensor, 50 Ω – Order NRV-Z51.

Thermocouple Power Sensor, 50 Ω – 1 µW to 100 mW, DC to 26.5 GHz. Order NRV-Z52.

Thermocouple Power Sensor, 50 Ω – Order NRV-Z53.

Thermocouple Power Sensor, 50 Ω – Order NRV-Z54.

Diode Power Sensor, 50 Ω – Order NRV-Z15.

Thermocouple Power Sensor, 50 Ω – Order NRV-Z55.

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

ROHDE&SCHWARZ
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Signal Generators

Introduction

Signal generators are the primary stimulus tool in testing a wide range of components and systems used in wireless communication networks and RF/Microwave products. Tektronix offers a wide variety of signal generators to meet your changing needs. Generators with performance for digital modulated signals as well as analog formats, over the range of 9 kHz to 40 GHz are available.

Whether your needs are excellent phase noise, low spurious output, flexible digital modulation or high value, the signal generators from Tektronix offer you the right solution.

SIGNAL SOURCES OFFERED

SMIQ 02/03/04/06 Vector Signal Generator

300 kHz to 6.4 GHz, IQ inputs, flexible digital modulation, CDMA capability, fading simulation.

SME 02/03/03E/06 Digital Signal Generator

5 kHz to 6 GHz, digital signals for most wireless communication formats, four models cover from 5 KHz to 6 GHz.

SMHU58 Signal Generator

100 kHz to 4.32 GHz with high signal purity and frequency agility. For all types of digital and analog modulation.

IQSIM Software

Software tool for creating all types of digital modulation.

SME – K2

Software tool for generation of TDMA signals with the SME series generators.

SMT 02/03/06

5 kHz to 6 GHz multipurpose RF generators with analog modulation.

SMP 02/03/04/22

10 MHz to 40 GHz with high signal purity and output power for microwave system testing.

Contents

Signal Generators Selection Guide 226
SMIQB 227
AMIQ 233
SMR 236
SMP02/03/04/22 240
SMT06/03/02 242
SME 244

Signal Generators Selection Guide

Type	Frequency	Application/Description
Vector Signal Generators		
SMIQ02B	5 kHz to 2.2 GHz	I/Q Modulated generator with unrivalled versatility for digitally modulated signal generation. Ideal for use in development, type approval testing and production test
SMIQ03B	5 kHz to 3.3 GHz	Same as SMIQ02B with enhanced frequency range
SMIQ04B	5 kHz to 4.4 GHz	Same as SMIQ02B with enhanced frequency range
SMIQ06B	5 kHz to 6.4 GHz	Same as SMIQ02B with enhanced frequency range
RF Signal Generators		
SME02	5 kHz to 1.5 GHz	For digital radio receivers, digital radio network and analog modulation. generation of user-programable mobile data generator, PRBS generator great ease of operation
SME03	5 kHz to 3 GHz	Same as SME02 with enhanced frequency range
SME06	5 kHz to 6 GHz	Same as SME02 with enhanced frequency range
SMT02	5 kHz to 1.5 GHz	Radar applications, VOR/ILS receiver test, FM broadcast transmitter and receiver test. Customized configurations, extremely high signal quality, versatile modulation capabilities (e.g. Stereo, VOR/ILS)
SMT03	5 kHz to 3 GHz	Same as SMT02 with enhanced frequency range
SMT06	5 kHz to 6 GHz	Same as SMT02 with enhanced frequency range
SMGU	0.1 to 2160 MHz	High performance generator for all analog in-channel and out of channel measurements and LO applications, reference for noise measurements, high spectral purity and short frequency setting times
SMY01	9 kHz to 1040 MHz	Economy class instrument for all analog receiver and component measurements, high signal quality, full featured model with versatile modulation and signal generation modes
SMY02	9 kHz to 2080 MHz	Same as SMY01 with enhanced frequency range
Microwave Signal Generators		
SMR20	1 to 20 GHz	CW generators with pulse modulation capability. Excellent price performance ratio. Options for modulation and analog sweep at an affordable price
SMR27	1 to 27 GHz	Same as SMR20 with enhanced frequency range
SMR40	1 to 40 GHz	Same as SMR20 with enhanced frequency range
SMP02	0.01/2 to 20 GHz	Radar and communications receiver test, R&D and EMI Testing. High spectral purity, excellent pulse modulation characteristics, extensions for specific or universal use
SMP22	0.01/2 to 20 GHz	Same as SMP02 with output level of +22 dBm
SMP03	0.01/2 to 27 GHz	Same as SMP02 with enhanced frequency range
SMP04	0.01/2 to 40 GHz	Same as SMP02 with enhanced frequency range
Function and ARB Generators		
AMIQ	2 CH. 100 ms/sec, 14-Bit ARB	Dual channel I/Q modulation generator. 14-Bit resolution, 100 MHz sample rate, 4M Samples memory depth
Software		
WinIQSIM		Calculation of digitally modulated I/Q and IF signals, multicarrier, W-CDMA and CDMA signal, free with AMIQ
SME-K2		General data transfer software for SME series instruments

New Vector Signal Generator SMIQ

Digital Signals of Your Choice



Features – Benefits

- Frequency Range 300 kHz to 6.4 GHz
- Analog and Digital Modulation
- Versatile and Broadband Generation of Digitally Modulated Signals up to 7 Msymbol/s
- Generation of TDMA, CDMA and W-CDMA Standard Signals to all Main Mobile Radio Standards
- Broadband I/Q Modulator with Outstanding Vector Accuracy
- Optional Internal Fading Simulator to Test Specifications of Mobile Radio Standards
- Optional Internal Noise Generator and Distortion Simulator
- Low ACP Option for IS-95 CDMA and W-CDMA

Applications

- Component Development
- Component Manufacturing
- Phone Development
- BTS Development
- Receiver Test

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

ROHDE&SCHWARZ
Rohde & Schwarz' quality system complies with the DIN ISO 9001 standard and has been certified by DQS (German Association for the Certification of Quality Systems).

The new B series of Signal Generator Family SMIQ for analog and digital modulation from Rohde&Schwarz offers solutions for today and tomorrow. This series particularly takes into account future developments in the field of third generation digital mobile radio.

The SMIQ family comprises four models which differ in their upper frequency limits. These feature a hitherto unrivalled versatility regarding signal generation and signal quality and are therefore ideal for use in development and type-approval testing.

With their outstanding price/performance ratio, these signal generators are also economically attractive for applications in production.

The wide frequency range from 300 kHz to 6.4 GHz covers all main radio bands including their IF ranges.

The high-grade I/Q modulator fitted as standard ensures minimum error vector magnitude and high intermodulation suppression.

Using modern digital signal processor (DSP) technology, the versatile concept allows the generation of high-precision digital modulation signals with high bit rates without any limitations on modulation modes or standards.

In addition to digital modulation, the signal generators provide the full range of analog modulation modes as well as simultaneous modulation capability.

SMIQ – A Signal Generator Family...

RF CHARACTERISTICS

- Wide output frequency range from 300 kHz to 3.3 GHz
- High (up to 16 dBm) and precise output level (0.5 dB typ.)
- Fast setting time for frequency (<15 ms) and level (<10 ms)
- Frequency hopping (500 µs)

- High spectral purity (–126 dBc/Hz at 1 GHz and 20 kHz carrier offset)
- RF, AF and level sweep (user-programmable)

ANALOG MODULATION

- Broadband AM with up to 30 MHz modulation frequency
- I/Q modulation with 60 MHz RF bandwidth (3 dB)
- Unprecedented vector accuracy and high intermodulation suppression
- Amplitude modulation
- Pulse modulation
- Optional frequency and phase modulation (SM-B5)

DIGITAL MODULATION

ANY DIGITAL MODULATION MODES (WITH OPT. SMIQB10)

- Free choice of modulation mode from FSK through to 256QAM
- Any kind of baseband filtering with variable filter parameters
- Symbol rate adjustable up to 7 Msymbol/s
- Real-time coding of internal and external data
- Internal PRBS generators

CONVENIENT BURST GENERATION FOR TDMA STANDARDS (WITH OPT. SMIQB10/SMIQB11)

- TDMA mobile radio standards provided as standard GSM, DECT, NADC (IS-54C/IS-136), PDC, PHS
- Versatile external synchronization capabilities
- Real-time processing of external and internal data
- Generation of TDMA frame structures with versatile timeslot configuration
- Continuous PRBS sequences
- Optimization of burst shaping to reduce spectra due to switching

UP TO 20 MBIT INTERNAL DATA MEMORY (WITH OPT. SMIQB12)

OPTIONAL CDMA STANDARD TO IS-95 (OPT. SMIQB42)

OPTIONAL W-CDMA STANDARD TO ARIB (0.0 STANDARD) AND EXPERIMENTAL W-CDMA SYSTEM (OPT. SMIQB43)

...FOR ALL REQUIREMENTS

SPECIAL OPTIONS

FADING SIMULATION (OPT. SMIQB14 AND SMIQB15)

- Fading of internal or external I/Q signals conforming to mobile radio standards
- 6-path simulation can be enhanced to 12-path simulation (12-channel fading also possible with second vector signal generator)
- Selectable path attenuation and delay
- Simulation of high speeds
- Preprogrammed fading profiles for mobile radio standards GSM, NADC, IS-95 CDMA and TETRA
- Frequency range of basic unit can be fully utilized
- Calibrated RF level in range from –140 dBm to –5 dBm
- Unrivalled price/performance ratio

NOISE GENERATOR AND DISTORTION SIMULATOR (OPT. SMIQB17)

- Simulation of amplitude and phase distortion (AM/AM and AM/phi M characteristics)
- Distortion characteristics programmable from up to 30 input values
- Superimposed noise signals (AWGN)
- C/N ratio variable with high resolution over a wide range
- Broad noise bandwidth (10 kHz to 10 MHz)

LOW ACP FOR IS-95 CDMA AND W-CDMA (OPT. SMIQB47)

- Specially designed for 1.2288 Mchip/s, 4.096 Mchip/s and 8.192 Mchips/s
- Can be used with internal (Opt. SMIQB42/43) or external CDMA/W-CDMA signals
- Typical W-CDMA adjacent-channel power ratio (5 MHz off-set, 4.096 Mchip/s): –68 dBc (1 DTCH)
- Typical IS-95 CDMA adjacent-channel power ratio (885 kHz off-set): –78 dBc (9 code channels)

FAST CPU (OPT. SM-B50)

- Reduction of frequency and level setting times to one fifth (3 ms and 2 ms)
- Option required in conjunction with fading (SMIQB14/15) and distortion simulation (SMIQB17)

OUTSTANDING RF CHARACTERISTICS

FROM 300 KHZ TO 3.3 GHZ

With its wide frequency range, the SMIQ family has the right model for every application. The uppermost frequency limit of 3.3 GHz leaves sufficient margin even for WLL (wireless local loop) systems. Frequency extension options allow upgrading to higher frequency limits.

LEVEL – HIGH AND PRECISE

With an output level of maximum +13 dBm (+16 dBm in overrange) insertion losses caused by cables or switching matrices can easily be compensated. For driving components with high input level the use of an external amplifier is not necessary.

A level accuracy of typ. ±0.5 dB allows high-precision measurements even on highly sensitive analog and digital receivers.

EXCELLENT SPECTRAL PURITY

SMIQ provides output signals of excellent spectral purity. Low-noise frequency synthesis ensures modulation of highest quality for reliable test signals.

FAST SETTING TIMES

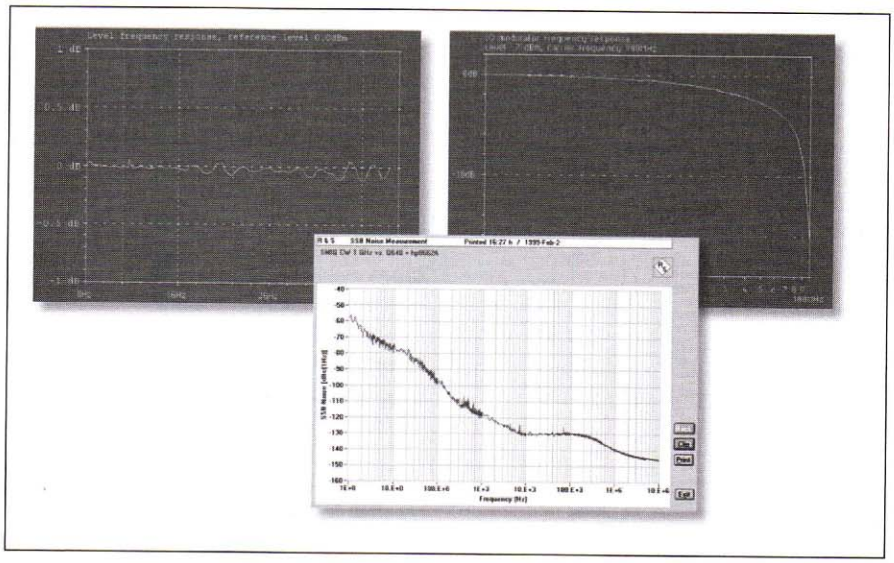
Fast setting times are among the most important criteria when it comes to choosing the right signal generator, especially in production.

The synthesizers of the SMIQ family excel in this respect: with a frequency setting time of less than 15 ms they allow extremely fast measurements. With option SM-B50 (fast CPU) the frequency setting time is reduced to 3 ms.

Besides standard sweep functions for RF, AF and level, SMIQ features an extremely versatile and fast sweep mode for frequency and level settings to be carried out with the aid of stored lists. This mode with a setting time of less than 500 µs is ideal for frequency hopping applications.

LOW COST OF OWNERSHIP

The use of high-precision reference elements with long-term stability ensures reliable operation over a long period of time. The three-year calibration intervals cut costs and increase availability.



(Left) Typical level accuracy at 0 dBm.
(Right) Typical I/Q frequency response.
(Bottom) Typical SSB phase noise at fc =1 GHz.

DESIGNED FOR THE FUTURE

The open concept of SMIQ allows the functionality of the signal generator to be adapted to future requirements in a simple and cost-effective way.

Since SMIQ uses programmable digital signal processing chips throughout, its capabilities are not limited by the hardware used.

New functions can be downloaded very simply via the serial interface of the generators.

THREE WAYS OF GENERATING DIGITAL SIGNALS

Vector Signal Generators SMIQ can generate digitally modulated signals in three different ways.

1. Vector Modulation

In this mode, externally generated I/Q signals are applied to the I/Q modulator of SMIQ. I/Q Modulation Generator AMIQ together with Simulation Software WinIQSIM are perfect tools for the generation of external I/Q signals.

2. Digital Modulation

The universal modulation coder (SMIQB10) and data generator (SMIQB11) options provide a platform for generating digitally modulated signals that are variable in a wide range. Modulation mode, filtering, data source and symbol rate can be selected by the user.

3. Digital Standards

The digital standards provide at a keystroke base-station and mobile-station signals to telecommunication standards – based on the capabilities of the optional digital modulation coder (SMIQB10). The TDMA (time division multiple access) standards GSM, DECT, NADC (IS-54C, IS-136), PDC and PHS come with the optional data generator (SMIQB11). The CDMA (code division multiple access) standard IS-95 (SMIQB42) or W-CDMA (SMIQB43) are also available as an option. The number of future digital standards that can be simultaneously accommodated in SMIQ is unlimited.

DIGITAL MODULATION

DIGITAL STANDARDS

SMIQ, fitted with the modulation coder (SMIQB10) and data generator (SMIQB11) options, provides standard-conformal signals for testing mobile and base stations of the main mobile radio networks. These test signals contain the necessary protocol information and frame structures for testing receivers.

The timeslots (bursts) and their data contents can be specified for the TDMA standards GSM, DECT, NADC, PDC and PHS via user-friendly menus. The main burst types are predefined and available at a keystroke. They can easily be modified, stored and reused for tests.

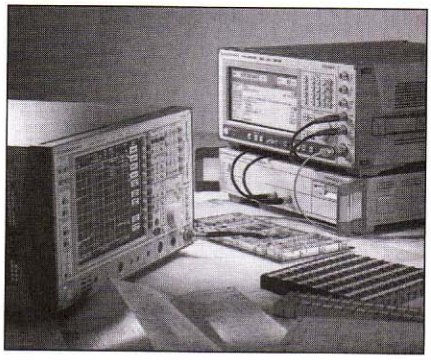
Continuous PRBS data streams and internally generated data lists as well as externally provided serial data streams can be inserted in real-time into the data fields of the frame structures.

GSM Global System for Mobile Communication

Frames and timeslot configuration conform to the GSM standard. Each time-slot (burst) has a certain data structure depending on its use, e.g., as traffic channel or channel for frequency synchronization.

DECT Digital Enhanced Cordless Telecommunication Standard

This operating mode allows signals to be generated to ETSI DECT standard.



NADC North American Digital Cellular (IS-54, IS-136)

The data protocol structure conforms to NADC specifications IS-54 and IS-136. The following predefined burst types are available: uplink burst, downlink burst, all data.

PDC Personal Digital Cellular (RCR STD-27C)

The data protocol structure conforms to PDC specification RCR-27C. This standard is largely identical with the NADC standard.

PHS Personal Handy Phone System (RCR STD-28)

The data protocol structure conforms to PHS specification RCR-28. The follow-

ing predefined burst types are provided: control physical slot, communication physical slot, sync, TCH, VOX, all data.

CDMA IS-95 Code Division Multiple Access (with Opt. SMIQB42)

For the CDMA base-station signal (forward link) up to 64 code channels can be generated with user-selected Walsh codes. The power of the code channels can be selected independently for up to four channels. The channel data consist of various internal PRBS or fixed data patterns.

The mobile-station signal (reverse link) can be configured for full-rate as well as for half-rate operation. Moreover it is possible to generate a channel-coded reverse-link signal.

W-CDMA Wideband Code Division Multiple Access (with Opt. SMIQB43)

W-CDMA – a "standard" currently still in the definition phase – is one of the favored technologies for the third mobile radio generation. Rohde&Schwarz, known as a trendsetter in the field of mobile communication test and measurement, is already able to offer signal generation capabilities for this mobile radio standard of the future.

Fitted with option W-CDMA (SMIQB43), SMIQ is able to generate W-CDMA signals to the Japanese specifications of NTT DoCoMo and ARIB*1.

Like with IS-95 CDMA, uplink (mobile station to base station) and downlink (base station to mobile station) can be simulated with up to 15 code channels. A chip rate of 4.096 Mchip/s is preset, but can be varied any time.

There is a choice of different types of physical channels, such as perch, common control or dedicated physical channels. The frame structure consisting of various data fields (traffic power control or long code mask symbol) is automatically generated for each type of channel.

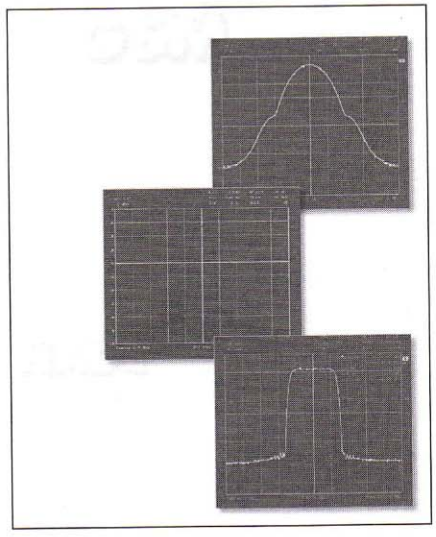
*1 *Association of Radio Industries and Businesses (ARIB), Specifications of Air Interface for a 3 G Mobile System.*

SPECIAL OPTIONS

FADING SIMULATION – OPTIONS SMIQB14/B15

With the optional fading simulator, the SMIQ models are the first signal generators allowing tests that correspond to the capabilities of conventional simulators. Fading is thus no longer a matter of highly specialized measurement technology.

Fading simulation in SMIQ is based on the WSSUS (wide sense stationary uncorrelated scattering) model and meets the test specifications of all main mobile radio standards, such as GSM Rec. 05.05. Both internal and external I/Q baseband signals are provided with defined multipath propagation factors through digital signal processing. Conversion to the RF with calibrated level setting is made with the available hardware of SMIQ.



CHARACTERISTICS

RF FEATURES

FREQUENCY

Range –
SMIQ02B: 300 kHz to 2.2 GHz.
SMIQ03B: 300 kHz to 3.3 GHz.
SMIQ04B: 300 kHz to 4.4 GHz.
SMIQ06B: 300 kHz to 6.4 GHz.

Resolution – 0.1 Hz.
Setting time to within <1x10^{-7} for f>450 MHz and <240 Hz for f<450 MHz after IEC/IEEE-bus delimiter:
Standard: <15 ms.
With Opt. SM-B50: <3 ms.

Phase offset – adjustable in steps of 0.1°.

REFERENCE FREQUENCY

Aging (After 30 Days of Operation) –
Standard: 1x10^{-6}/year.
Option: SM-B1: <1x10^{-9}/day.

Temperature Effect (0°C to 50°C) –
Standard: 2x10^{-6}.
Option: <5x10^{-8}.

LEVEL

Range – -140 dBm to +13 dBm (PEP)*1.
Overranging without guarantee of specs: up to 16 dBm.

Resolution – 0.1 dB.

Total Measurement Uncertainty –127 dBm*2, 3 –
f<2 GHz: <±1 dB.
f>2 GHz: <±1.5 dB.

Frequency Response at 0 dBm*2, 3 – typ. <0.3 dB.

SPECTRAL PURITY*2

Spurious –
Harmonics at levels ≤10 dBm: <-30 dBc.
Nonharmonics.
CW, carrier offset ≤10 kHz.
0.3 to 450 MHz: <-74 dBc.
>450 to 1500 MHz: <-80 dBc.
>1500 to 3000 MHz: <-74 dBc.
>3000 MHz: <-60 dBc.
Vector modulation:
Carrier offset 10 kHz to <300 MHz: <-70 dBc.
Carrier offset ≥300 MHz: ≤-60 dBc (typ. <-65 dBc).

Broadband Noise, CW, Carrier Offset >5MHz –
f = 20 MHz: <-135 dBc (typ. -140 dBc).
f = 3 GHz: <-130 dBc (typ. -135 dBc).

Broadband Noise, Vector Modulation, f >-135 dBc).

SSB Phase Noise, Carrier Offset 20 kHz, 1 Hz Bandwidth –
f = 20 MHz to 450 MHz – CW: <-116 dBc
Vector/dig. mod.: <-119 dBc.
f = 1 GHz – CW: <-126 dBc
Vector/dig. mod.: <-123 dBc.
f = 2 GHz – CW: <-120 dBc
Vector/dig. mod.: <-120 dBc.
f = 3 GHz – CW: <-116 dBc
Vector/dig. mod.: <-116 dBc.

Residual FM, rms (f = 1 GHz) –
0.3 to 3 kHz (ITU-T): <1 Hz.
0.03 to 20 kHz: <4 Hz.

Residual AM, rms (0.03 to 20 kHz) – <0.02%.

MODULATION WITH CODING

The table below shows the possible combinations of modulation with coding (X = combination possible).

	Coding off	Differential	Differential phase	Differential + Gray	GSM	NADC, PDC, PHS, TETRA, APCO25, PWT	TFTS/ TETRA	INMARSAT	VDL
BPSK	X	X		X					
QPSK	X	X		X				X	
QPSK (IS-95)	X	X		X				X	
INMARSAT	X	X		X				X	
QPSK ICO	X	X		X				X	
OQPSK	X	X		X				X	
OQPSK (IS-95)	X	X		X				X	
pi/4 QPSK	X								
pi/4 QPSK	X						X		
8PSK	X	X		X					X
8PSK_EDGE	X	X		X					X
2FSK	X	X		X	X				
4FSK, 4FSK, APCO	X			X					
GFSK	X	X		X	X				
GMSK	X	X		X	X				
16QAM	X	X	X	X					
32QAM	X	X	X	X					
64QAM	X	X	X	X					
256QAM	X		X						

MODULATION WITH FILTERING

The table below shows the possible combinations of modulation with filtering (X = combination possible).

	$\sqrt{\cos}$	cos	Gauss	Gauss Lin BT=0.3	Bessel BT=2.5	Bessel BT=1.26	IS-95	IS-95 Equal	APCO C4FM	TETRA	Rectangular	W-CDMA
BPSK	X	X		X			X	X		X	X	X
QPSK	X	X		X			X	X		X	X	X
QPSK (IS-95)	X	X		X			X	X		X	X	X
INMARSAT	X	X		X					X		X	X
QPSK ICO	X	X		X					X		X	X
OQPSK	X	X		X							X	X
OQPSK (IS-95)	X	X		X							X	X
pi/4 QPSK	X	X		X						X	X	X
pi/4 QPSK	X	X	X	X						X	X	X
8PSK	X	X	X	X						X	X	X
8PSK_EDGE	X	X	X	X						X	X	X
2FSK	X	X	X	X	X	X				X	X	X
4FSK, 4FSK, APCO	X	X	X	X	X	X				X	X	X
GFSK			X	X						X	X	
GMSK			X	X						X	X	
16QAM	X	X		X			X	X		X	X	X
32QAM	X	X		X			X	X		X	X	X
64QAM	X	X		X			X	X		X	X	X
256QAM	X	X		X			X	X		X	X	X

OVERVIEW OF DIGITAL STANDARDS

The table below summarizes the key data for the digital TDMA standards implemented in SMIQ. Options SMIQB10 and SMIQB11 are required for all standards.

	GSM	DECT	NADC	PDC	PHS
Error vector magnitude, rms (standard, <7 dBm PEP)	N/A	N/A	<1.2% typ. 0.4%	<1.2% typ. 0.4%	<1.2% typ. 0.4%
Phase Error (standard, <7 dBm PEP)			N/A		
rms typ. 0.3°	<1°				
	N/A	N/A	N/A	N/A	
Peak value	>3°, typ. 1°				
Deviation error, rms (standard)	N/A	<1.3%	N/A	N/A	N/A
Channel spacing/kHz	200	1728	30	25	300
Power density spectrum, typ. (standard level <7 dBm PEP, resolution BW 30 kHz					
Offset 200 kHz 400 kHz 600 kHz	–34 dB –70 dB –78 dB		N/A	N/A	N/A
Adjacent-channel power (ACP), typ. at adjacent channel At 1st alternate channel At 2nd alternate channel At 3rd alternate channel	N/A	N/A	–35 dB –75 dB –78 dB –	– –74 dBc – –78 dBc	– –74 dBc –76 dBc –
Burst types	NORMAL DUMMY ALL DATA	FULL (basic) DOUBLE (high capacity), ALL DATA	up/down TCH, ALL DATA Up SHORT	TCH, SYNC, VOX, ALL DATA	TCH (32 kbit and 16 kbit), SYNC, VOX, ALL DATA

ORDERING INFORMATION

For price information: Outside the U.S. contact your local Tektronix representative, inside the U.S. see the price list in the back of this catalog.

SMIQ02B
Vector Signal Generator 300 kHz to 2.2 GHz.
Includes – Power Cord, Operating Manual.

SMIQ03B
Vector Signal Generator 300 kHz to 3.3 GHz.

SMIQ04B
Vector Signal Generator 300 kHz to 4.4 GHz.

SMIQ06B
Vector Signal Generator 300 kHz to 6.0 GHz.
Includes – Power Cord, Operating Manual.
Opt. B1/SM-B1 – OXCO reference oscillator.
Opt. B5/SM-B5 – FM phase modulation.
Opt. B10/SMIQ-B10 – Modulation coder.
Opt. B11/SMIQ-B11 – Data Generator.
Opt. B12/SMIQ-B12 – 8 Mbit memory extension.
Opt. B14/SMIQ-B14 – Fading Simulator six paths (Requires Opt. B50).
Opt. B15/SMIQ-B15 – 2nd fading simulator 12 paths or two channels (Requires Opt. B50).
Opt. B17/SMIQB17 – Noise Generator and Distortion Simulator (Requires Opt. B50).
Opt. B19/SMIQ-B19 – RF and LF rear panel connectors.
Opt. B42/SMIQ-B42 – CDMA IS-95.
Opt. B43/SMIQ-B43 – W-CDMA.
Opt. B47/SMIQ-B47 – Low ACP for IS-95 CDMA and W-DCMA.
Opt. U47/SMIQ-U47 – Modification Kit for Low ACP.
Opt. B50/SMIQ-B50 – High speed CPU.
Opt. U50/SM-U50 – Modification Kit, High Speed CPU.
Opt. 1R – ZZA94 rack mount adapter.

MEASUREMENT SERVICE OPTIONS
Opt. C3 – Three years of Calibration Services.
Opt. D1 – Cal Data Report.
Opt. D3 – Test data (requires Opt. C5).
Opt. R3 – Repair warranty extended to cover three years.
Rackmount for 19 in. Rack – Order ZZA-94.
Service Kit – Order SM-Z3.
SMIQ-Z5 – BNC Adapter for rear panel, D type connector PAR DATA.

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

Product(s) available through your local Tektronix Distributor listed in the back of this catalog.

ROHDE&SCHWARZ
Rohde & Schwarz' quality system complies with the DIN ISO 9001 standard and has been certified by DQS (German Association for the Certification of Quality Systems).

I/Q Modulation Generator Simulation Software

New AMIQ/I/Q • WinIQSIM



Features – Benefits

AMIQ

14-Bit Resolution

4,000,000 Samples Memory Depth

100 MHz Sample Rate

Integrated Hard Disk and Floppy Disk Drive

Optional BER Measurement

WINIQSIM

Calculation of Digitally Modulated I/Q and IF Signals

Single-carrier, Multicarrier and CDMA Signals

Versatile Data Editor

Superposition/Simulation of Impairments

Graphic Display

CDMA and W-CDMA

Applications

Verification/Type-approval Testing of Digital Mobile Phones and Base Stations

- For Verification and Type Approval of Mobile Phones and Base Stations Signal

Use in ATE (Automatic Test Equipment) Systems

- AMIQ Is an Ideal Choice as a Baseband or IF Signal Source

Development of New Communication Systems

Third-generation Communication Systems, TDMA, CDMA, W-CDMA

- Signals as Used by Novel and Future Communication Systems, e.g., CDMA or W-CDMA, As Well As by Wireless Local Loop or Wireless LAN Systems Can Be Generated with Little Effort Using AMIQ and WinIQSIM

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

CE

ROHDE&SCHWARZ
Rohde & Schwarz' quality system complies with the DIN ISO 9001 standard and has been certified by DQS (German Association for the Certification of Quality Systems).

New Approaches in the Generation of Complex I/Q Signals

HIGH SAMPLING RATE

- 100 MHz clock rate
- Up to 4,000,000 samples memory capacity
- Generation of broadband digital communication signals (e.g. W-CDMA)

STORED WAVEFORMS FOR RECALL

- Built-in hard disk for storage of calculated signals
- Downloading of calculated waveforms and signals also from integrated floppy disk drive

PRECISE SIGNALS

- Anti-aliasing filters featuring excellent frequency response and constant group delay
- Autoalignment and additional user correction of amplitude and offset
- Fine adjustment of I/Q skew
- Wide dynamic range by use of 14-Bit D/A converter, ideal for multicarrier applications

AMIQ/WinIQSIM – An Ideal Pair

The number of systems based on complex digital modulation methods has dramatically increased in every field of communications. I/Q modulation is thus gaining in importance for the development of such new modulation methods. Modulation Generator AMIQ and Simulation Software WinIQSIM open up new dimensions for the generation of I/Q signals.

AMIQ is a dual-channel modulation generator that has been designed for use as an I/Q source. It is programmed with Software WinIQSIM. Alternatively, AMIQ can be operated from a Vector Signal Generator SMIQ.

Each channel can store 4,000,000 samples. Even at high symbol rates sequences of sufficient length can thus be generated. With clock frequencies of up to 100 Msample/s and a high amplitude resolution of 14 bits, AMIQ is the ideal source for any signal in the world of digital modulation.

An automatic amplitude/offset alignment as well as fine adjustment of the skew provide excellent symmetry of the two channels which previously was extremely difficult to attain with dual-channel ARB generators. The error vector can thus be minimized.

The filters have also been optimized regarding group delay, frequency response and identical configuration in the two channels for use as an I/Q modulation source.

A typical application of AMIQ and WinIQSIM is not only to drive the I/Q inputs of a vector signal generator. This combination is also ideal for direct applications in the baseband, e.g. for testing I/Q modulators/demodulators.

...the Ultimate in IQ Signals

I/Q SIMULATION SOFTWARE...

- Single-carrier signals
- Multicarrier signals (up to 512 modulated or unmodulated carriers)
- CDMA signals with user-selectable number of code channels
- Addition of impairments
- Data editor for creating any TDMA frame configuration
- Predefined files for TDMA mobile radio standards (GSM, DECT, NADC (IS54C/IS136), PDC, PHS)
- IF signal calculation
- Graphic display of calculated signals (constellation diagram, vector diagram, i(t)/q(t), magnitude and phase, eye pattern, etc)
- Remote control of AMIQ

Modulation methods like GMSK or pi/4DQPSK are used in mobile communication systems such as GSM (Global System for Mobile Communications) or NADC (North American Digital Cellular). These complex modulation modes are usually generated with the aid of an I/Q or vector modulator. The calculation and generation of the required baseband signals is of course quite complex.

WinIQSIM, successor of the well-proven IQSIM, is a Windows software, allowing calculation of I and Q baseband signals. Its capabilities range from single-carrier modulation, generation of multicarrier, CDMA and W-CDMA signals through to TDMA frame configurations with the help of a convenient data editor. All modulation parameters and impairments can be simulated for single-carrier and multicarrier as well as for CDMA signals. To put it in a nutshell: WinIQSIM is an indispensable tool for anyone engaged in modern digital modulation.

SINGLE CARRIER

Modulation parameters such as type of modulation, coding, symbol rate, filter and window functions as well as oversampling can be set for a single-carrier signal.

Impairments which may be caused by a real I/Q modulator are also taken into consideration. It is for instance easy to simulate I/Q imbalance, carrier leakage or quadrature error. The simulation of VCO noise or phase and frequency offsets of an oscillator is one of the very special features of WinIQSIM. These and many other setting possibilities enable the user to take account of real impairments as early as in the development of components and modules. But also for applications in production environments signals can be composed. Such signals allow several parameters to be tested at a time and thus testing time to be reduced dramatically.

OPTION AMIQ B2: DIFFERENTIAL OUTPUTS FOR THE AMIQ ARBITRARY WAVEFORM GENERATOR

As more components and subsystems are provided with balanced I/Q inputs, there is a need to directly provide this stimulus to devices such as mixers and modulators. In the past, customers have developed custom circuits to provide differential inputs to their DUT. AMIQ option B2 provides 4 outputs on the front panel of the AMIQ for differential stimulus. I, –I, Q and –Q can all be independently varied in DC offset for exacting differential drive matching. DC offset bias can be varied up to ± 2.5 V.

Characteristics

OUTPUT MEMORY

Waveform Length (Data and Markers) –
Clock rate mode 1 (10 Hz to 4 MHz): 24 to 4,000,000 samples in steps of one.
Clock rate mode 2 (2 to 100 MHz): 24 to 4,000,000 samples in steps of four.

Amplitude Resolution – 14 bits.

Marker Outputs – 4.

CLOCK GENERATION

Clock Rate –
Mode 1 (slow): 10 Hz to 4 MHz.
Mode 2 (fast): 2 MHz to 100 MHz.

Setting Range – 10 Hz to 105 MHz*[1].

Resolution – $1x10^{-7}$.

*[1] *Specs not guaranteed for clock >100 MHz, max. ambient temperature 35°C.*

SIGNAL OUTPUT

Number of Outputs – 2 (I and Q).
Output Impedance – 50 Ω.
Output Voltage (V_p into 50 Ωs) –
Fix mode: 0.5 V, same for both channels.
Amplitude fine variation: ±10%, separately for each channel.
Resolution: 0.01%.
Level difference between the two channels: <0.2% (at 1 kHz, after auto-alignment).
Residual DC offset: <0.5 mV, typ. 0.1 mV (after auto-alignment).
DC fine variation: typ. ±30 mV.
Resolution: 30 µV.
SFDR (sinewave 1 MHz, clock rate 10 MHz): >70 dB, typ. 80 dB.
Variable mode: 0 mV to 1 V, separately adjustable for each channel.
Resolution: 3 digits.
Residual DC offset: <5 mV, typ. 1 mV (after auto-alignment).
DC fine variation: typ. ±70 mV.
Resolution: 70 µV.
SFDR (sinewave 1 MHz, clock rate 10 MHz): >50 dB (level >0.1 V), typ. 70 dB (level >0.5 V) Skew between I and Q channel (filter off, clock rate 10 MHz, fix mode).

Skew Between I and Q Channel (Filter Off, Clock Rate 10 MHz, Fix Mode) –
Fine variation typ.: ±1 ns.
Resolution: <10 ps.

Effective Bits (Sinewave 5 MHz, Clock Frequency 50 MHz, Fix Mode) – Typ. 11.

Rise Time – Typ. 5 ns.

BER (OPTION AMIQ-B1)

Data supplied by the DUT can be compared with a nominal random bit sequence; the results are transferred to the host computer (via the currently used remote control).
Pseudo random bit sequences: 2^{9}-1, 2^{11}-1, 2^{15}-,2^{20}-1, 2^{23}-1.
Clock source: supplied by DUT, each valid bit requires a clock.
Clock rate: max. 40 MHz.
Interface: 9-pin sub-D connector.
Data: TTL.
Clock: TTL.
Setup time: 10 ns.
Hold time: 2 ns.
Polarity: normal and inverted (data, clock).
Measurement results: BER in ppm, not synchronized, no clock from DUT.

TECHNICAL SPECIFICATIONS FOR DIFFERENTIAL OUTPUTS (OPTION AMIQ-B2)[1]

Number of Outputs – 4 (I, –I, Q and –Q).
Output Configuration – Selectable between Single and Differential (50 Ω or high Z).
Bias Voltage (EMF, to Ground) – independently adjustable for both Channels I(–I) and Q(–Q).
Range: –2.5 V to +2.5 V (±10 mV).
Resolution: < 1.5 mV.
Level Difference between I and –I, Q and –Q respectively: < 0.5% + 1.5 mV.

Output Voltage – (U_{peak}, EMF, between outputs I and –I, Q and –Q respectively, if not mentioned otherwise).
Fix Mode: 2 V, identical for all outputs.
Level Difference I <–> Q: <0.5% @ 1 kHz, after auto-alignment.
I <–> –I (Q <–> –Q):<0.5% @ 1 kHz, after auto-alignment.
Residual DC offset: <1 mV (to ground, after auto-alignment).
DC fine variation: typ. ±120 mV.
Resolution: 120 µV.
Variable Mode: 0 mV to 4 V, for both Channels I and Q independently selectable.
Resolution: 3 digits.
DC fine variation: typ. ±280 mV.
Resolution: 280 µV.
Maximum Output Voltage (U_{signal} + U_{bias}): <2.5 V (to ground).

PHYSICAL CHARACTERISTICS

Dimensions	in.	mm
Width	16.8	427
Height	3.5	88
Depth	17.7	450
Weight	**lb.**	**kg**
Net	18.5	8.4

ORDERING INFORMATION

For price information: Outside the U.S. contact your local Tektronix representative, inside the U.S. see the price list in the back of this catalog.

AMIQ
I/Q Modulation Generator.
Includes: WinIQSIM version for Windows 3.x and Windows 95/NT on CD-ROM, manual, power cable, operating manual.

OPTIONS
Opt. B1 – BER Measurement.
Opt. B2 – Differential Outputs for AMIQ.
Opt. K-11- IS-95 cdma for WinIQSiM.
Opt. B19 *1 – Rear I/Q Outputs.

RECOMMENDED ACCESSORIES
19 in. Rack Adapter – Order ZZA-211.

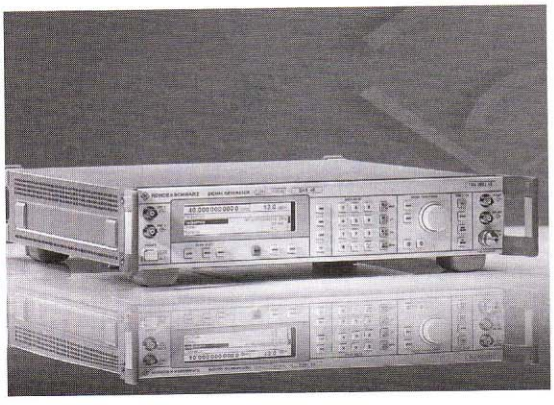
For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

CE

ROHDE&SCHWARZ
Rohde & Schwarz' quality system complies with the DIN ISO 9001 standard and has been certified by DQS (German Association for the Certification of Quality Systems).

New Microwave Signal Generator SMR

High-performance, Cost-effective and Reliable up to 40 GHz



Features – Benefits	Applications
Instrument Family with 3 Models: – SMR20 10 MHz to 20 GHz – SMR27 10 MHz to 27 GHz – SMR40 10 MHz to 40 GHz Standard Version: CW Generator With Pulse Modulation and Digital Frequency Sweep	Lab Production Service Research

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

ROHDE&SCHWARZ
Rohde & Schwarz' quality system complies with the DIN ISO 9001 standard and has been certified by DQS (German Association for the Certification of Quality Systems).

The Allrounder – Designed for Future-proofness

HIGH, LEVELED OUTPUT POWER

- SMR20 >+10 dBm (at 20 GHz)
- SMR27 >+11 dBm (at 27 GHz)
- SMR40 >+9 dBm (at 40 GHz)

THREE INSTRUMENTS IN ONE

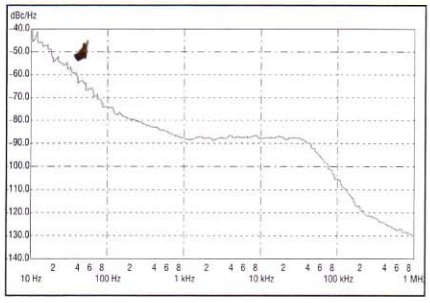
- CW generator with pulse modulation capability (standard version)
- Signal generator with AM, FM and LF generator (option SMR-B5)
- Synthesized sweeper with analog ramp sweep (option SMR-B4)

CW, Signal Generator or Synthesized Sweep Generator...

SMR AS CW GENERATOR

The SMR family comprises three basic models designed as CW generators with pulse modulation capability. The three models have a common lower frequency limit of 1 GHz and provide frequency coverage up to 20 GHz (SMR20), 27 GHz (SMR27) and 40GHz (SMR40). The lower limit can be expanded to 10 MHz by the optional Frequency Extension 0.01 to 1 GHz (SMR-B11).

Offering an excellent price/performance ratio, each of the three basic models is ideal for the user wishing to enter the field of microwave testing at an affordable price. Should measurements become more demanding – no problem with SMR: all basic models can be upgraded fast and easily by means of options to give a signal generator with AM/FM modulation capability or a synthesized sweep generator featuring fast, fully synthesized analog ramp sweep.



SSB phase noise at 10 GHz.

Excellent Spectral Purity

SMR stands out from other generators for its excellent spectral purity. Advanced frequency synthesis with fractional-N divider makes for low SSB phase noise and high spurious suppression, both of which are for example prerequisites for reliable receiver measurements. Modern microwave filters in the output path of the instrument ensure excellent harmonics suppression. This is necessary to obtain conclusive results in scalar network analysis measurements.

Stable Output Frequency

The crystal reference built in as standard ensures an accurate, low-drift output frequency. SMR can be fitted with the optional OCXO Reference Oscillator SMR-B1 to satisfy the most stringent requirements on accuracy and aging.

Application-oriented Frequency Resolution

The standard frequency resolution of 1 kHz of SMR offers a comfortable margin for most applications, for example frequency response measurements in the laboratory and in production and servicing. To satisfy more stringent requirements, e.g. for scientific applications and research, option SMR-B3 is available to improve frequency resolution to 0.1 Hz.

Pulse Modulator Included

Pulse modulation is still the most important modulation mode for microwave applications. So, each of our basic units is equipped with a high-quality pulse modulator. The on/off ratio is better than 80 dB, the rise/fall time shorter than 10 ns. Pulse widths of less than 20 ns are possible. These guaranteed values make SMR ideal for use in the development, production and maintenance of radar equipment.

Pulse Generator Option

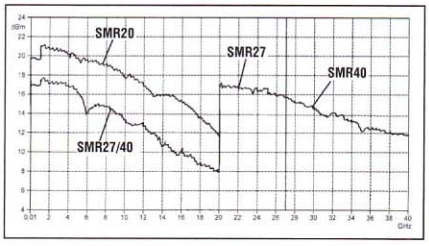
The optional Pulse Generator SMR-B14 is an ideal complement to the pulse modulator. It generates single and double pulses with pulse frequencies up to 10 MHz. The pulse generator can also be triggered externally and operated in the external gate mode. The pulse width and delay are freely selectable over a wide range.

SMR AS SIGNAL GENERATOR

The optional AM/FM/SCAN Modulator SMR-B5 added to the basic models turns them into fully-fledged signal generators with AM and FM modulation capability. The option also includes an LF generator for sinewave and squarewave signals in the range 0.1 Hz to 10 MHz.

FM and FSK

The FM modulator has a modulation bandwidth from DC to 5 MHz. Digital frequency shift keying (FSK) is possible with data rates from 0 to 2 MHz.



Typical max. output level as a function of frequency.

SMR AS SYNTHESIZED SWEEP GENERATOR

Analog Ramp Sweep Option

The analog ramp sweep mode corresponds to the analog sweep of classical sweep generators except that the sweep is fully synchronized over the complete range. In this way, the excellent frequency accuracy of digital step sweeps is achieved on the whole, and this at much higher sweep rates of up to 600 MHz/ms. In conjunction with scalar network analyzers or suitable spectrum analyzers, real-time adjustment of microwave filters can be performed.

To mark important frequency ranges such as filter bandwidths or the position of attenuation poles, SMR has 10 user-selectable frequency markers which can be output as pulse markers at the marker output (HCT/TTL level) or alternatively modulated on the RF level as level markers (level reduction of 1 dB).

The use of SMR in conjunction with a scalar network or spectrum analyzer is illustrated by the figure below.

SMR AS UPCONVERTER

IF Input Option

Vector signal generators like SMIQ generate all types of digitally modulated signals up to RF frequencies of 6.4 GHz. To generate digitally modulated signals up to 40 GHz, SMR offers upconversion capability by means of the IF input option.

CHARACTERISTICS

FREQUENCY

Range (SMR20) –
Without Opt. SMR-B11: 1 GHz to 20 GHz.
With Opt. SMR-B11: 10 MHz to 20 GHz.

Range (SMR40) –
Without Opt. SMR-B11: 1 GHz to 40 GHz.
With Opt. SMR-B11: 10 MHz to 40 GHz.

Resolution –
Without Opt. SMR-B3: 1 kHz.
With Opt. SMR-B3: 0.1 Hz.

REFERENCE FREQUENCY

Aging (After 30 Days of Operation) –
Standard: $1x10^{-6}$/year.
Opt. SMR-B1: $<1x10^{-9}$/day.

Temperature Effect (0 to 55°C) –
Standard: $2x10^{-6}$.
Opt. SMR-B1: <+>–8.

Warm-up Time – 15 min (Opt. SMR-B1).

SPECTRAL PURITY

Spurious Signals –
Harmonics (level <+6 dBm)*1:
f ≤20 GHz: <-55 dBc.
f >20 GHz: <-40 dBc.
Subharmonics:
f ≤ 20 GHz: <-65 dBc.
f >20 GHz: <-30 dBc.
Nonharmonics (50 kHz from carrier):
f < 1 GHz: <-60 dBc.
1 GHz ... 2 GHz: <-50 dBc.
>2 GHz ... 10 GHz: <-60 dBc.
>10 GHz ... 20 GHz: <-54 dBc.
f >20 GHz: <-48 dBc.

SSB Phase Noise (f = 10 GHz, 10 kHz from Carrier, 1 Hz Bandwidth, CW, FM Off) – <-83 dBc.

Residual FM, rms (f = 10 GHz, FM Off) –
0.3 kHz to 3 kHz: <-20 Hz.
0.03 kHz to 20 kHz: <-200 Hz.

1 Specifications for harmonics above 20 GHz (SMR20), 27 GHz (SMR27) and 40 GHz (SMR40) only typical. <ñ+3 dBm with Opt. SMR-B23/SMR-B24.

LINEAR AMPLITUDE MODULATION WITH OPTION SMR-B5

Operating Modes – Internal, external AC/DC.
Modulation Depth*1 – 0% to 100%.
Resolution – 0.1%.
Setting Error (AF = 1 kHz, m <80%) – <4% of reading +1%.
Modulation Frequency Range – DC to 100 kHz.
Modulation Frequency Response (20 Hz to 20 kHz, m = 60%) – <1 dB.

Maximum Level Without Opt. SMR-B23/–B24 –

Frequency Range	SMR20 without Opt. SMR-B15	SMR20 with Opt. SMR-B15	SMR27/SMR40 without Opt. SMR –B15/–B17	SMR27/SMR40 with Opt. SMR –B15/–B17
0.01 to <1 GHz	>+13 dBm	>+13 dBm	>+12 dBm	>+12 dBm
1 to <18 GHz	>+11 dBm	>+10 dBm	>+8 dBm	>+7 dBm
18 to 20 GHz	>+10 dBm	>+8 dBm	>+7 dBm	>+5 dBm
>20 to 27 GHz	>+11 dBm	>+9 dBm		
>27 to 40 GHz	>+9 dBm	>+7 dBm		

LOGARITHMIC AMPLITUDE MODULATION WITH OPTION SMR-B5 (SCAN AM)

Operating Modes – Internal, external.
Dynamic Range – >30 dB.
Sensitivity – -0.1 dB/V to –10 dB/V.
Resolution – 0.01 dB.
Rise/Fall Time (10/90%) – <10 µs.
EXT2 Modulation Input –
Input impedance: 600 Ω or 100 kΩ.
Input voltage range: –6 V to +6 V.

FREQUENCY MODULATION WITH OPTION SMR-B5

Operating Modes – Internal, external AC/DC.
1 GHz to 2 GHz (N = –1): 5 MHz.
>2 GHz to 10 GHz (N = 0): 10 MHz.
>10 GHz to 20 GHz (N = 1): 20 MHz.
f >20 GHz (N = 2): 40 MHz.

Resolution – <1%, min. 10 Hz.

Setting Error (AF = 1 kHz) – <5% of reading +20 Hz.

1 The maximum level is reduced by up to 2 dB in the temperature range 35 to 55°C.

PULSE MODULATION

Operating Modes – external, internal with option SMR-B14.
On/Off Ratio – >80 dB.
Rise/Fall Time (10/90%) –
62.5 MHz to 125 MHz: <50 ns.
>125 MHz to 450 MHz: <20 ns.
>450 MHz: <12 ns.

Pulse Repetition Frequency –
62.5 MHz to 125 MHz: <0 to 1 MHz.
>125 MHz to 450 MHz: <0 to 2 MHz.
>450 MHz: <0 to 10 MHz.

Minimum Pulse Width – 20 ns.

Pulse Delay – typ. 50 ns.

Video Feedthrough – U_{pp}<20 mV.

PULSE Modulation Input –
Input level: TTL/HCT signal.
Input impedance: 50 Ω or 10 kΩ.

SIMULTANEOUS MODULATION

FM (FSK) is independent of AM (SCAN AM, ASK) and pulse modulation.
Reduced AM bandwidth for simultaneous AM (SCAN AM, ASK) and pulse modulation.

IF INPUT OPTION SMR-B23/–B24

	SMR-B24	SMR-B23
Frequency range	DC to 700 MHz	
Level	<0 dBm	
SWR	>2	
RF-Output		
Frequency range	1 to 20GHz	2 to 27/40 GHz
Level*1	<–10dBm	
SWR	<2	

1 The RF output level can be lowered from 0 dB to 110 dB in steps of 10 dB with Opt. SMR-B15/–B17.

LF GENERATOR WITH OPTION SMR-B5

Frequency Range – 0.1 Hz to 10 MHz.
Resolution – 0.1 Hz.
Waveforms – sinewave, squarewave.
Frequency Error – $<1 \leq 10^{-4}$.
Frequency Response (Up to 500 kHz) – <0.5 dB.
Distortion (Up to 100 kHz) – <0.5% (R_{load} >200 Ω, level = 0.5 V).

PULSE GENERATOR OPTION SMR-B14

Operating Modes – automatic, external trigger, external gate mode, single pulse, double pulse, delayed pulse (externally triggered).

Active Trigger – edge positive or negative.

Pulse Repetition Period – 100 ns to 85 s.
Resolution: 5 digits, min. 20 ns.
Accuracy: same as reference frequency.

Pulse Width – 20 ns to 1 s.
Resolution: 4 digits, min. 20 ns.
Accuracy: 5% of reading ±5 ns.

Pulse Delay – 40 ns to 1 s.
Resolution: 4 digits, min. 20 ns.
Accuracy: 5% of reading –10 to +20 ns.

Double Pulse – 60 ns to 1 s.
Resolution: 4 digits, min. 20 ns.
Accuracy: 5% of reading –10 to +20 ns.

Trigger Delay Typ. – 50 ns.

PULSE Modulation Input –
Input level: TTL/HCT signal.
Input impedance: 50 Ω or 10 kΩ.

SYNC Output – TTL/HCT signal, 40 ns pulse width.

VIDEO Output – TTL/HCT signal.

RAMP SWEEP OPTION SMR-B4

RF Sweep, AF Sweep –
Operating modes:
automatic, single-shot, manual or externally triggered.
start/stop, center freq./span, markers.
Sweep range: freely selectable.
Resolution: gt 1 kHz.
Accuracy: (0.001% of deviation)/(sweep time/s) ± reference error, min. 75 kHz ± reference error.

Level Sweep –
Operating modes: automatic, single-shot, manual or externally triggered, logarithmic.
Sweep range: 0 dB to 20 dB.
Resolution: ≥0.01 dB.
Sweep time: 10 ms to 100 s (switchover time £30 ms at 1 GHz, 2 GHz, 10 GHz and 20 GHz).
Max. sweep rate: 600 MHz/ms.
Markers: 10, freely selectable.
MARKER output signal: TTL level (HCT), selectable polarity.
X output: 0 to 10 V.
BLANK output signal: TTL level (HCT), selectable polarity.

MEMORY FOR INSTRUMENT SETUPS

Storable Setups – 50.

Memory Sequence Modes – automatic, single-shot, manual or externally triggered.

Step Time – 50 ms to 60 s.

Resolution – 1 ms.

REMOTE CONTROL

System – IEC 625 (IEEE 488).

Command Set – SCPI 1995.0.

Connector – 24-contact Amphenol.

IEC/IEEE-bus Address – 0 to 30.

Interface Functions – SH1, AH1, T6, L4, SR1, RL1, PP1, DC1, DT1, C0.

PHYSICAL CHARACTERISTICS

Dimensions	mm	in.
Width	426.7	16.8
Height	87.6	3.4
Depth	450	17.7
Weight	**kg**	**lb.**
When fully equipped	<12	<26.5

ORDERING INFORMATION

For price information: Outside the U.S. contact your local Tektronix representative, inside the U.S. see the price list in the back of this catalog.

SIGNAL GENERATOR SMR20

Includes: power cable, operating manual, female adapter 3.5 mm.

Order 1104.0002.20.

SIGNAL GENERATOR SMR27

Includes: power cable, operating manual, female adapter 3.5 mm.

Order 1104.0002.27.

SIGNAL GENERATOR SMR40

Includes: power cable, operating manual, female adapter 2.9 mm.

Order: 1104.0002.40.

OPTIONS

SMR-B1 – OCXO Reference Oscillator. Order 1104.5485.02.

SMR-B3 – Frequency Resolution 0.1 Hz. Order 1104.5585.02.

SMR-B4 – Ramp Sweep. Order 1104.5685.02.

SMR-B5 – AM/FM/SCAN Modulator. Order 1104.3501.02.

SMR-B11 – Frequency Extension 0.01 GHz to 1 GHz*[1]. Order 1104.4250.02.

SMR-B14 – Pulse Generator. Order 1104.3982.02.

SMR-B15 – RF Attenuator 20 GHz (SMR20/SMR27)*[1]. Order 1104.4989.02.

SMR-B17 – RF Attenuator 40 GHz (SMR40)*[1]. Order 1104.5233.02.

SMR-B19 – Rear Connectors for RF, AF (SMR20/SMR27)*[1]. Order 1104.6281.02.

SMR-B20 – Rear Connectors for RF, AF (SMR40)*[1]. Order 1104.6381.02.

SMR-B23 – IF Input 20 GHz (SMR20)*[1]. Order 1104.5804.02.

SMR-B24 IF Input 40 GHz (SMR27/SMR40)*[1]. Order 1104.6100.02.

RECOMMENDED EXTRAS

SMR-Z1 – Service kit. Order 1103.9506.02.

ZZA-211 – 19 in. rack adapter. Order 1096.3260.00.

ADAPTER (SMR20/SMR27)

3.5 mm female – Order 1021.0512.00.

3.5 mm male – Order 1021.0529.00.

N female – Order 1021.0535.00.

N male – Order 1021.0541.00.

ADAPTER (SMR40)

2.9 mm female – Order 1036.4790.00.

2.9 mm male – Order 1036.4802.00.

N female – Order 1036.4777.00.

N male – Order 1036.4783.00.

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

Product(s) available through your local Tektronix Distributor listed in the back of this catalog.

ROHDE&SCHWARZ
Rohde & Schwarz' quality system complies with the DIN ISO 9001 standard and has been certified by DQS (German Association for the Certification of Quality Systems).

Signal Generators

SMP



Features – Benefits

Frequency Range 2 to 40 GHz (SMP04), 2 to 26.5 GHz (SMP03), 10 MHz to 20 GHz (SMP02, SMP22 Opt. 11), 2 to 20 GHz (SMP02, SMP22)

Maximum Output Level +8 dBm (SMP04), +12 dBm (SMP03), +11.5 dBm (SMP02), +20 dBm (SMP22)

Ultra-low RF Leakage

Nonvolatile Storage for up to 50 Complete Instrument Setups

Applications

Radar and Communications Receiver Testing

Research and Development

EMI Testing

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

GPIB IEEE-488

Product(s) complies with IEEE Standard 488.2-1987, with SCPI compliance.

ROHDE&SCHWARZ
Rohde & Schwarz' quality system complies with the DIN ISO 9001 standard and has been certified by DQS (German Association for the Certification of Quality Systems).

SMP Signal Generator

The SMP Signal Generator is a high-frequency microwave signal source providing high output power with accurate level setting, high spectral purity, and excellent pulse modulation.

Characteristics

FREQUENCY

Range – See chart.
Resolution – 0.1 Hz.
Accuracy @ 1 GHz – 1000 Hz based on reference aging rate per year.
Stability – $\pm 1 \times 10^{-6}$/year, $\pm 1 \times 10^{-9}$/day, with Opt. 01.
Setting Time – <11 ms +10 ms/GHz after IEEE bus delimiter.

OUTPUT LEVEL

Range – See chart.
Resolution – 0.1 dB.
Accuracy – ±0.6 to ±1.5 dB level dependent.

MODULATION

AM Rate – DC to 100 kHz.
AM Depth – 0 to 90%.
FM Rate – DC to 1 MHz.
FM Max Deviation – SMP02, SMP22: 10 MHz. SMP03, SMP04: 20 MHz (2 MHz with Opt. 5).
Phase Modulation – Yes with Opt. 02 and 05.
Phase Rate – 0.4/1/3/15 kHz internal, DC to 100 kHz external.
Phase Deviation (maximum) – 10 radians.
Pulse Modulation – Yes, optional. Pulse width: 20 ns to 1 s.
Pulse rate: 100 ns to 85 s, 0 to 10 MHz.
Pulse delay: 20 ns to 1 s.
On/Off Ratio – >80 dB.
Rise/Fall Time – <10 ns.
Simultaneous Modulation – Yes.
Internal Modulation Generator – 0.4/1/3/15 kHz.
Digital Modulation – Yes, external.
FSK Modulation – Yes, external.

SWEEP

Functions – Digital, in discrete steps, linear or log.
Modes – Automatic, manual, single-shot and external triggered.
Start/Stop – Yes.
Center Frequency/Delta Frequency – Yes.
Markers – 3.

OTHER FEATURES
IEEE-488 Interface – Yes.
POWER REQUIREMENTS
Line Voltage – 90 to 132 V, 180 to 265 V.
Line Frequency – 47 to 440 Hz.

ENVIRONMENTAL–
Operating Temperature – SMP02, SMP03, SMP04: 0 to 50°C. SMP22: 0 to 50°C.
Mechanical Stress – MIL-STD 810 D.
Electromagnetic Compatibility – MIL-STD 461 B, RE02, CE03, CS01, CS02.

PHYSICAL CHARACTERISTICS

Dimensions	mm	in.
Height	192	7.89
Width	435	17.8
Depth	570	23.42
Weight	**kg**	**lbs.**
Net	27	59.4

	SMP02	SMP03	SMP04	SMP22
FREQUENCY				
Range	2 to 20 GHz (10 MHz to 20 GHz with Opt. 11)	2 to 27 GHz (10 MHz to 27 GHz with Opt. 11)	2 to 40 GHz (10 MHz to 40 GHz with Opt. 11)	2 to 20 GHz (10 MHz to 20 GHz with Opt. 11)
OUTPUT LEVEL				
Range	-20 to +11.5 dBm to –130 dBm with Opt. 15	-20 to +12 dBm to –130 dBm with Opt. 15	-20 to +8 dBm to –130 dBm with Opt. 15	-20 to +20 dBm to –130 dBm with Opt. 15
SPECTRAL PURITY				
Harmonics	≤-30 dB, –50 dBc typical above 1.8 GHz	<-40 dBc, f>20 GHz	<-30 dBc, f>20 GHz	≤-25 dBc
Subharmonics	None f<20 GHz	<-40 dBc f>20 GHz	<-40 dBc f>20 GHz	None f>20 GHz
Nonharmonics at >10 kHz from carrier	<-60 dBc f<20 GHz	<-50 dBc f<2 GHz <-60 dBc f>2<20 GHz <-54 dBc f>20 GHz	<-50 dBc f<2 GHz <-60 dBc f>2<20 GHz <-54 dBc f<20 GHz	<-60 dBc f<20 GHz
Residual FM 10 MHz to 10 GHz 10 GHz to 20 GHz 20 GHz to 27/40 GHz	<5 Hz <10 Hz	<5 Hz <10 Hz	<5 Hz <10 Hz	f<5 Hz f<20 GHz
SSB Phase Noise 10 GHz, 10 kHz Offset	<-98 dBc	<-98 dBc	<-98 dBc	<-98 dBc

ORDERING INFORMATION

For price information: Outside the U.S. contact your local Tektronix representative, inside the U.S. see the price list in the back of this catalog.

SMP02
20 GHz Signal Generator.

SMP03
26.5 GHz Signal Generator.

SMP04
40 GHz Signal Generator.

SMP22
20 GHz Signal Generator.

Includes: Power Cable, Operating Manual, 3.5 mm Female Adapter (SMP02, SMP03, SMP22), 2.9 mm Female Adapter (SMP04).

Opt. 01/SM-B1 – OCXO Reference Oscillator.
Opt. 02/SM-B2 – LF Generator.
Opt. 05/SM-B5 – FM/phiM Modulator.
Opt. 11/SMP-B11 – Frequency Extension, 0.01 to 2 GHz.
Opt. 12/SMP-B12 – Pulse Modulator, 2 to 40 GHz.
Opt. 13/SMP-B13 – Pulse Modulator, 0.01 to 2.0 GHz.
Opt. 14/SMP-B14 – Pulse Generator.
Opt. 15/SMP-B15 – RF Attenuator, 20 GHz.
Opt.17/SMP-B17 – RF Attenuator, 40 GHz.
Opt. 18/SMP-B18 – Auxiliary Interface.

MEASUREMENT SERVICE OPTIONS
Opt. C3 – Three years of Calibration Services.
Opt. D1 – Cal Data Report.
Opt. D3 – Test Data (requires Opt. C3).
Opt. R3 – Repair warranty extended to cover three years.
Additional Accessories – Also see page 495.

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

GPIB IEEE-488
Product(s) complies with IEEE Standard 488.2-1987, with SCPI compliance.

ROHDE&SCHWARZ
Rohde & Schwarz' quality system complies with the DIN ISO 9001 standard and has been certified by DQS (German Association for the Certification of Quality Systems).

Signal Generators

SMT



Features – Benefits

Frequency Range 5 kHz to 6 GHz (SMT06), 5 kHz to 3 GHz (SMT03), 5 kHz to 1.5 GHz (SMT02)

Broadband FM Modulation from DC to 8 MHz with Deviation Up to 20 MHz

Amplitude Modulation

Phase Modulation (jM) from DC to 2 MHz

Convenient RF, LF, and Level Sweeps

Optional LF Generator (Opt. 02)

Applications

Radar Applications (with SMT06 Opt. 09, SMT03 Opt. 08, SMT02 Opt. 03)

VOR/ILS Receiver Tests (with Opt. 06)

FM Broadcast Transmitter and Receiver Test and Design (with Opt. 06)

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

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ROHDE&SCHWARZ
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SMT Signal Generator

The SMT Signal Generator covers the complete range of conventional analog receiver measurements up to 6 GHz. It provides exceptionally high signal quality, outstanding level of accuracy, a wide variety of modulation and signal generation modes, a customizable configuration and ease of operation.

THE IDEAL EMS SIGNAL SOURCE

With a specified lower frequency limit of 5 kHz (under-range down to 1 kHz), the SMT fully covers the frequency range for EMS measurements stipulated by IEC 801. The digital, step-by-step sweep function, with preselectable start and stop frequency, span, step width and step time, enables the convenient testing of wide frequency ranges. During the frequency sweeps, no level overshoots will occur. The sweep function can also be used for the RF level and AF frequency.

The frequency response of cables, amplifiers, TEM cells, etc., can be compensated in the signal generator by means of a level-correction function. Complicated external level controls or test routines are not required.

EXCELLENT RF CHARACTERISTICS AT A REASONABLE PRICE

For high-frequency measurements on AM, FM and SSB receivers, the signal source must be superior to the device-under-test. The low residual FM and SSB phase noise of the SMT make it suitable for in-channel and blocking measurements, even on high-end receivers. The small level error of <1 dB throughout the frequency range allows high-precision sensitivity measurements.

MINIMUM RF EMISSIONS FOR SENSITIVE DUTS

Measurements on highly sensitive receivers such as pagers not only require high signal quality, but also extremely high RF shielding of the signal source. Elaborate shielding measures keep RF emissions of the SMT to a minimum.

MEMORY SEQUENCE FUNCTION FOR AUTOMATIC MEASUREMENTS

For frequently repeated measurement series, the memory sequence function allows a sequence of measurements to be run without an external controller. Up to 50 instrument settings can be stored in non-volatile memory.

CHARACTERISTICS

See page 226 for characteristics.

ORDERING INFORMATION

For price information: Outside the U.S. contact your local Tektronix representative, inside the U.S. see the price list in the back of this catalog.

SMT06
Signal Generator (5 kHz to 6 GHz).
Includes: Power Cord, Operating Manual.

SMT03
Signal Generator (5 kHz to 3 GHz).
Includes: Power Cord, Operating Manual.

SMT02
Signal Generator (5 kHz to 1.5 GHz).
Includes: Power Cord, Operating Manual.
Opt. 01/SM-B1 – OCXO Reference Oscillator.
Opt. 02/SM-B2 – LF Generator.
Opt. 03/SM-B3 – (SMT02) Pulse Modulator.
Opt. 04/SM-B4 – Pulse Generator.
Opt. 06/SM-B6 – Multifunction Generator.
Opt. 08/SM-B8 – (SMT03) Pulse Modulator.
Opt. 09/SM-B9 – (SMT06) Pulse Modulator.
Opt. 20/SMT-B19 – Rear-panel Connectors for RF and AF.

MEASUREMENT SERVICE OPTIONS
Opt. C3 – Three years of Calibration Services.
Opt. D1 – Cal Data Report.
Opt. D3 – Test Data (requires Opt. C3).
Opt. R3 – Repair warranty extended to cover three years.

ADDITIONAL ACCESSORIES
Also see page 495.

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

GPIB IEEE-488
Product(s) complies with IEEE Standard 488.2-1987, with SCPI compliance.

ROHDE&SCHWARZ
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Signal Generators
SME



For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

GPIB IEEE-488

Product(s) complies with IEEE Standard 488.2-1987, with SCPI compliance.

ROHDE&SCHWARZ
Rohde & Schwarz' quality system complies with the DIN ISO 9001 standard and has been certified by DQS (German Association for the Certification of Quality Systems).

Features – Benefits

Frequency Range
- 5 kHz to 6 GHz SME06
- 5 kHz to 3 GHz SME03
- 5 kHz to 1.5 GHz SME02

All Common Digital Modulation Modes Provided in One Unit: GMSK, π/4-DQPSK, GFSK, FSK, 4FSK, FFSK, ...

No External Modulation or Data Sources Required

Internal Control of Frequency and Level Hopping Synchronous with the Data Signal

Freely Programmable Data Sequences and Trigger Conditions

Frequency Setting Time <0.5 ms for Frequency-agile Systems (Not Available in SME03E)

Extremely High Spectral Purity for Out-of-channel Measurements

Very High Level Accuracy; Resetting Error of Attenuator 0.01 dB

RF, AF and Level Sweep

Programmable Measurement Sequence for up to 50 Complete Instrument Settings

Applications

Digital Radio Receivers

Digital Radio Networks

Analog Modulations

SME SIGNAL GENERATOR

The SME Signal Generator supplies the complex signals required for the development and testing of digital mobile radio receivers. It's capable of generating all signals used in the main TDMA radio networks in line with relevant standards regarding the type of modulation, data format, TDMA structure and frequency hop patterns. The SME is also useful in the analog signal world of conventional signal generators.

The SME covers a frequency range from 5 kHz to 6 GHz. They can be tailored to your requirements by means of a wide variety of options with emphasis either on digital modulation, analog applications or expansion into a universal signal generator.

DIGITAL MODULATION

With the DM Coder (standard on SME03E, Opt. 11 all other models) the SME provides a variety of network-specific digital modulation modes:

Modulation	Network
GMSK	GSM, DCS 1800/DCS 1900 (PCN), CDPD, DSRR, MC9, MOBILTEX
pi/4-DQPSK	NADC, PDC, TFTS, TETRA, APCO25
GFSK	DECT, CT2, CT3
4FSK	ERMES, APCO25 FLEX, MODACOM
FSK, FFSK	POCSAG, FLEX, Cityraf

The SME has been designed to allow for the integration of future types of modulation and networks.

Frequency and phase changes are produced by DDS (direct digital synthesis). The frequency and phase response are therefore synthesizer-accurate. There is no drift at the carrier frequency. The DM coder is provided standard in the SME03E.

The modulation spectrum stands out for its high spectral purity. Sidebands are well below permissible levels at the frequency spacing relevant for adjacent-channel measurements. Filters other than the standard ones may be used for varying the modulation spectrum (for GMS network: filters with BxT = 0.2, 0.3, 0.5). With GFSK modulation for DECT, non-standard deviations may be set to allow in-depth receiver tests.

The data signals for modulation are applied externally or supplied by the internal data generator. Bit rates are selectable with FSK; they are network-specific for other types of modulation.

CHARACTERISTICS

See page 226 for characteristics.

ORDERING INFORMATION

For price information: Outside the U.S. contact your local Tektronix representative, inside the U.S. see the price list in the back of this catalog.

SME06
Signal Generator (5 kHz to 6 GHz).

SME03
Signal Generator (5 kHz to 3 GHz).

SME02
Signal Generator (5 kHz to 1.5 GHz).

Opt. 01/SM-B1 – Reference Oscillator OCXO.
Opt. 02/SM-B2 – LF Generator.
Opt. 03/SM-B3 (SME02) – Pulse Modulator.
Opt. 04/SM-B4 (Opt. 03, Opt. 08 or Opt. 09 required) – Pulse Generator.
Opt. 05/SM-B5 – FM/$_{phi}$M Modulator.
Opt. 06/SM-B6 – Multifunction Generator.
Opt. 08/SM-B8 (SME03) – Pulse Modulator.
Opt. 09/SM-B9 (SME06) – Pulse Modulator.
Opt. 11/SME-B11 – DM Coder.
Opt. 12/SME-B12 – DM Memory Expansion.
Opt. 19/SME-B19 – Rear Connectors for RF and AF.
Opt. 41/SM-B41 – Flex Protocol.
Opt. 42/SM-B42 – POCSAG Protocol.
Opt. B50/SME-B50 – High Speed CPU.

RECOMMENDED ACCESSORIES

Also see page 495.
19 in. Rack Adapter – Order ZZA-94.
Service Kit – Order SMZ2.

MEASUREMENT SERVICE OPTIONS

SME02/03/03E/SME06
Opt. C3 – Three years of Calibration Services.
Opt. D1 – Cal Data Report.
Opt. D3 – Test Data (requires Opt. C3).
Opt. R3 – Repair warranty extended to cover three years.

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GPIB IEEE-488

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ROHDE&SCHWARZ
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EMI/RFI Solutions

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EMI/RFI Solutions – An Introduction

Electrical and electronic devices may emit signals which interfere with other devices, or even with themselves. These signals are known as electromagnetic interference (EMI) or sometimes as radio frequency interference (RFI). Conversely, the ability of a device to withstand emissions from other devices or from itself is called immunity. The inverse of immunity is electromagnetic susceptibility (EMS).

As the number of electronic devices in use increases, so does the potential for these devices to interfere with each other. Electromagnetic compatibility (EMC) is a measure of how well they share their electromagnetic environment without adverse affects from EMI.

The goal of EMC is to construct electrical equipment with sufficiently low emissions and sufficiently high immunity to guarantee electromagnetic compatibility. The definition and enforcement of "sufficiently high" and "sufficiently low" becomes a matter of standards and regulations. In fact, when we refer to EMC compliance, we generally mean the ability of a system or device to meet standards regulating the amount of EMI that it can emit and its immunity to EMI.

EMC/EMI is a vital concern to manufacturers of electrical equipment subject to compliance. Their products must meet the applicable standards before they can be marketed. To ensure electromagnetic compatibility, the necessary measures should, therefore, be considered as early in the design phase as possible so they can be implemented in product development.

EMI

Electromagnetic interference or emissions from an electrical or electronic device may significantly impair radio and TV reception in the vicinity. While this is clearly an annoyance, an even greater concern is interference to navigation and communications equipment on board aircraft.

To prevent such a critical situation and to allow a wide variety of devices to operate next to and with each other, it's important to define interference limits ensuring a sufficient safety margin between EMI emissions and EMS limit values. Depending upon the standard being applied and the limit class required, different test conditions have to be observed in interference measurements. Test measurements are made either in shielded rooms or at an open-area test site as required. It is important that the measuring instruments themselves should not influence the result.

EMS

EMS measurements are made to test the function of a module, instrument, or system under the influence of conducted or radiated interference. These measurements must be carried out in shielded rooms or anechoic chambers. RF absorbers in the test chamber prevent erroneous results and simulate open-site conditions at high frequencies.

Field-Strength and Radio Monitoring Measurements

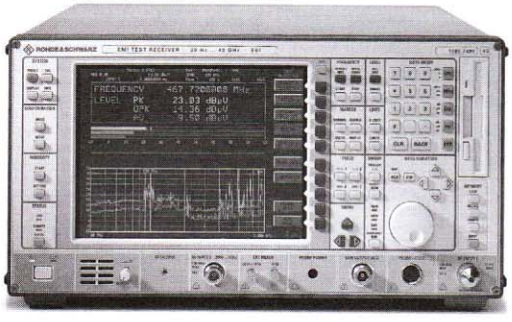
Radiocommunications services (PTT, broadcasting corporations, military, traffic and security authorities, as well as civil services) use field-strength meters for propagation measurements in the planning stage and for coverage measurements during operation of communication networks.

Field-strength measurements – in particular, propagation and coverage measurements – are usually made in mobile mode (vehicle or aircraft). Therefore, portability and DC or battery operation are important criteria in the choice of a test receiver.

Radio monitoring services use test receivers to check emissions for compliance with the specifications. Test parameters include field-strength, wave propagation, spurious responses, frequency, occupied bandwidth, frequency deviation, and amplitude modulation depth, as well as channel and band occupancy.

EMI Test Receivers

New ESI



Features – Benefits

Frequency Range
- ESI7: 20 Hz – 7 GHz
- ESI26: 20 Hz – 26.5 GHz
- ESI40: 20 Hz – 40 GHz

State-of-the-art Technology
- Low Inherent Noise
- Wide Dynamic Range
- Preselection and Preamplification
- Automatic Overload Control
- Pulse-protected 2nd RF Input
- Fast Overview Measurements

Current Standards
- Correct Weighting of Pulses to CISPR 16-1 and VDE 0876
- All Commercial and Military Standards Like CISPR, EN, ETS, FCC, VDE, ANSI, VCCI, MIL-STD, VG, DEF-STAN, and Many Others

Straightforward Operation
- Active Color LCD
- Analog Level Display for Each Detector (Parallel Operation)
- Split-screen Display for Detailed Analysis

Applications

Industrial and Military EMI Testing

Verifying Transmitter (BTS) Performance

Digital Modulation Analysis

EMC Diagnostic Work

EMC Final Certification

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

CE

ROHDE&SCHWARZ
Rohde & Schwarz' quality system complies with the DIN ISO 9001 standard and has been certified by DQS (German Association for the Certification of Quality Systems).

Final-certification EMI Measurements up to 40 GHz

The ESI family of EMI test receivers combines the flexibility and speed of spectrum analyzers with the large dynamic range required for EMI measurements in conformance with standards.

The ESI family comprises three models with different upper frequency limits:

- ESI7: 20 Hz to 7 GHz
- ESI26: 20 Hz to 26.5 GHz
- ESI40: 20 Hz to 40 GHz

All three models are characterized by:

- High sensitivity
- Excellent large-signal immunity
- Low measurement uncertainty
- High measurement speed

MEASUREMENTS TO STANDARD

ESI carries out measurements in conformance with all industrial and military EMI standards such as CISPR, EN, VDE, ANSI, FCC, BS, ETS, VCCI, MIL-STD, VG, DEF-STAN, DO160 and GAM EG13. The ESI family complies with the basic standard, i.e. CISPR16-1 or VDE0876, which places stringent requirements on receiver dynamic range.

TEST ROUTINES ORIENTED TO PRACTICAL REQUIREMENTS

During the various development phases of a product, different measurements are performed as required for each stage. The ESI family offers appropriate features and routines for the different development stages.

The ESI is outstanding for its low inherent noise, high intermodulation suppression and low SSB phase noise. Modulation analysis of analog or digital signals is possible with the optional Vector Signal Analyzer FSE-B7. Moreover, ESI provides all test routines offered by modern spectrum analyzers, such as noise measurement, phase noise measurement, channel and adjacent-channel power measurement and time-domain measurement, as known from the FSE family.

DEFINITION OF STANDARD TEST SEQUENCES

To meet the requirements of relevant standards, measurements over various frequency ranges and bandwidths have to be performed, using different step sizes and measurement times or different receiver settings characteristics. For this purpose, ESI offers a user-configurable scan table with up to 10 subranges.

EMI emissions are usually measured in two steps. An overview measurement made with the peak detector identifies critical emissions above or close to limit values. In a second measurement with the prescribed detectors (quasi-peak and average, in compliance with CISPR) and an appropriate measurement time, the critical frequencies are checked for compliance with limit values. The ESI family supports this procedure by two independent measurement windows on the screen.

SPLIT-SCREEN DISPLAY

Critical emissions can be measured with numerical display of frequency and level as with classic receivers. Bar graphs provide an analog display of measured values for the various detectors simultaneously and in different colors. By coupling the marker in the overview spectrum to the receiver frequency, emissions can be measured fast and reliably in line with standards. In the second window, the operator can zoom in on the displayed trace.

ESI can store up to 70,000 measured values per trace in background operation. This considerably reduces measurement time, since no new measurement is needed to make a detailed analysis.

LISTEN, VIEW, MEASURE

To analyze the spectrum and to exclude ambient noise, tune the receiver frequency to the marker frequency, and activate the built-in AM/FM demodulator by switching on the loudspeaker or headphones.

DOCUMENTATION OF RESULTS

Practically any type of printer can be used for the documentation of results. ESI runs under Windows NT, so all printers for which Windows drivers are available can be employed.

Results can not only be output to a printer but also stored on a floppy disk or the internal hard disk in common Windows formats like EMF, WMF or BMP. The data can be integrated into commercial word processing programs for the generation of test reports.

HIGH ACCURACY

In the frequency range up to 1 GHz, ESI performs level measurements with an accuracy of ± 1 dB, clearly better than the value of 2 dB specified by CISPR16-1.

SYSTEM INTEGRATION

The fast data processing of ESI makes it an ideal choice for use in automatic measurement systems. The IEEE 488-2-bus command set (IEC 625-2) conforms to SCPI (1994.0).

With a the IEEE 488-bus card (Opt. FSE-B17), the ESI can be used as a test system controller. This is possible because, with the operating system Windows NT, an integrated controller function is provided as standard which allows the use of a wide variety of Rohde&Schwarz software packages.

This enables the implementation of complete measurement systems without the need for an additional controller, which saves space and cost.

CHARACTERISTICS

FREQUENCY

Frequency range: Input 1 –
ESI7: 20 Hz to 7 GHz.
ESI26: 20 Hz to 26.5 GHz.
ESI40: 20 Hz to 40 GHz.
Input 2 – 20 Hz to 1 GHz.
Frequency resolution – 0.01 Hz.
Aging per year*1 – 2.5×10^{-7}.

FREQUENCY DISPLAY (RECEIVER MODE)

Display – Numerical display.
Resolution – 0.1 Hz.

FREQUENCY DISPLAY (ANALYZER MODE)

Display – With marker.
Resolution – 0.1 Hz to 10 kHz (depending on span).
Frequency counter – Measures the marker frequency.
Resolution – 0.1 Hz to 10 kHz, selectable.

FREQUENCY SCAN (RECEIVER MODE)

Scan – Scan with max. 10 subranges with different settings.
Measurement time per frequency – 100 µs to 1000 s, selectable.

SWEEP (ANALYZER MODE)

Span 0 Hz (zero span) – 1 µs to 16000 s, selectable steps of 5%.
Span – ≥10 Hz 5 ms to 1000 s, selectable in steps of ≤10%.
Picture refresh rate/s – (span ≤7 GHz): > 20 updates/s with 1 trace, > 15 updates/s with 2 traces at shortest sweep time.
Sampling rate – 50 ns (20 MHz A/D converter).
Preamplifier (9 kHz to 7 GHz) –
Selectable, between preselector and 1st mixer, gain 20 dB.

IF BANDWIDTHS (RECEIVER MODE)

6 dB bandwidths – 10 Hz, 100 Hz, 200 Hz, 1 kHz , 9 kHz, 10 kHz, 100 kHz, 120 kHz, 1 MHz, 10 MHz.
RBW ≤1 MHz: <10%.
RBW ≤1 kHz: < 5%.
RBW <1 kHz: <10%.

RESOLUTION BANDWIDTHS (ANALYZER MODE)

3 dB bandwidths – 1 Hz to 10 MHz, in steps of 1/2/3/5.
RBW ≤3 MHz: <10%.
RBW = 5 MHz: <15%.
RBW = 10 MHz: +25%, –10%.
Shape factor B_{60} dB – B_3 dB.
RBW < 1 kHz: <6.
RBW = 1 kHz to 2 MHz: <12.
RBW > 2 MHz: <7.
Video bandwidths – 1 Hz to 10 MHz, in steps of 1/2/3/5.
FFT filter –
3 dB bandwidths: 1 Hz to 1 kHz, in steps of 1/2/3/5.
Shape factor B_{60} dB: B_3 dB , nominal 2.5.

LEVEL

Display range – Displayed noise floor to 137 dBµV.

Max. input level –

Input 1 – ESI7: 20 Hz to 7 GHz.
ESI26: 20 Hz to 26.5 GHz.
ESI40: 20 Hz to 40 GHz.
RF attenuation ≥10 dB:
DC voltage: 0 V.
Sinewave AC voltage: 137 dBµV (= 1 W).
Max. pulse voltage: ESI7: 150 V, ESI26/40: 50 V, ESI7: 1 mWs, ESI26/40: 0.5 mWs.
Max. pulse energy (10 µs): ESI7: 150 V, ESI26/40: 50 V, ESI7: 1 mWs, ESI26/40: 0.5 mWs.

Input 2 (receiver mode) – 20 Hz to 1 GHz.
RF attenuation ≥10 dB:
Sinewave AC voltage: 137 dBµV (= 1 W).
Max. pulse voltage: ESI7: 1500 V, ESI26/40: 250 V.
Max. pulse energy (10 µs): ESI7: 30 mWs, ESI26/40: 15 mWs.

1 dB compression of input mixer (RF attenuation 0 dB) –
Analyzer mode: +10 dBm nominal.

Level display (receiver mode) –
Digital: numerical, 0.1 dB resolution.
Analog: bar graph display, separate for each detector.
Spectrum: level axis 10 dB to 200 dB in steps of 10 dB, frequency axis freely selectable, linear or logarithmic.
Units of level display: dBµV, dBm, dBµA, dB(rho)W, dB(rho)T, dB(µV/m), dB(µA/m).
Detectors: average (AV), RMS, peak (PK) and quasi-peak (QP), 4 detectors can be switched on simultaneously.

	ES17	ES126	ES140
Max. dynamic range	1 Hz bandwidth	1 Hz bandwidth	1 Hz bandwidth
1 dB compression point / displayed noise floor	162 dB	160 dB	160 dB
Max. intermodulation-free range			
150 MHz to 7 GHz/26.5 GHz (nominal)	115 dB	112 dB	112 dB
Intermodulation free range at –40 dBm mixer input level	105 dB		

Level display (analyzer mode) –
Result display: 500 x 400 pixels (with one diagram displayed); max. 2 diagrams with independent settings.
Trace detectors: max. peak, min. peak, auto peak (normal), sample, rms, average.
Trace functions: clear/write, max. hold, min. hold, average.

AUDIO DEMODULATION

Modulation modes – AM and FM.
Audio output: loudspeaker and phone jack.

TRIGGER FUNCTIONS

Trigger – free-run, single, line, video, gated, delayed, external, RF.
Display – 24 cm LC color display (9.5 in.).
Resolution: 640 x 480 pixels (VGA resolution).
Pixel error rate: $<2 \times 10^{-5}$.

Mass memory – 1.44 Mbyte 3.5" disk drive, hard disk.

Operating temperature range –
Nominal temperature range: +5°C to +40°C.
Limit temperature range: 0°C to +50°C.
Storage temperature range: –40°C to +70°C.
Environmental conditions: +40°C at 95% relative humidity (IEC 68-2-3).

Power supply –
AC supply: 200 V to 240 V: 50 Hz to 60 Hz, 100 V to 120 V: 50 Hz to 400 Hz, class of protection I to VDE 411.
Power consumption: 195 VA (ESI7) 230 VA (ESI26 & ESI40).

Safety – CSA1010.1, EN61010-1.

PHYSICAL CHARACTERISTICS

Dimensions	**mm**
Height	435
Width	236
Depth	570
Weight	**kg**
ESI7	25.1
ESI26	26.4
ESI40	27

[1] After 30 days of operation.

[2] Valid for span >100 kHz.

[3] For RF frequencies >7 GHz: error after calling peaking function. For sweep time <10 ms/GHz: additional error .1.5 dB.

Ordering Information

For price information: Outside the U.S. contact your local Tektronix representative, inside the U.S. see the price list in the back of this catalog.

ESI7
EMI Test Receiver (20 Hz to 7 GHz).

ESI26
EMI Test Receiver (20 Hz to 26.5 GHz).

ESI40
EMI Test Receiver (20 Hz to 40 GHz).

OPTIONS

Opt. FSE-B3 – TV Demodulator.
Opt. FSE-B7 – Vector Signal Analyzer.
Opt. FSE-B10 – Tracking Generator 7 GHz.
Opt. FSE-B11 – Tracking Generator 7 GHz with I/Q Modulator.
Opt. FSE-B12 – Switchable Attenuator for Tracking Generator.
Opt. FSE-B17 – Second IEC/IEEE-Bus Interface.
Opt. BI602 – Ethernet Interface 15-Contact AUI Connector.
Opt. BI603 – Ethernet Interface thin wire BNC Connector.

SOFTWARE

EMI Software for EMI Test Receiver (Windows) – Order ES-K1.
Script Development Kit – Order ES-K2.
Driver for ESI7/26/40 – Order ES-K16.
Driver for Mast (HCM) and Turntable (HCT12) – Order ES-K30.
Driver for EMCO Mast/Turntable – Order ES-K32.
Driver for MDS Absorbing Clamp Slideway (HCA) – Order ES-K31.

RECOMMENDED EXTRAS

Service Kit – Order FSE-Z1.
DC Block, 5 MHz to 7000 MHz (type N) – Order FSE-Z3.
DC Block, 10 kHz to 18 GHz (type N) – Order FSE-Z4.
Microwave Measurement Cable and Adapter Set – Order FS-Z15.

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

Product(s) available through your local Tektronix Distributor listed in the back of this catalog.

CE

ROHDE&SCHWARZ
Rohde & Schwarz' quality system complies with the DIN ISO 9001 standard and has been certified by DQS (German Association for the Certification of Quality Systems).

EMI Test Receiver

ESCS30



Features – Benefits	Applications
Frequency range: 9 kHz to 2.75 GHz	Commercial EMI Testing
High Measurement Accuracy: Error <1 dB; typ. <0.5 dB	
Fast Synthesizer: Any Frequency Step in <1 ms; Frequency Resolution Down to 10/100 Hz (Internal <1 Hz)	
CISPR Filters: 200 Hz, 9 kHz, 120 kHz with Constant Group Delay	
Parallel Detectors for Peak, Quasi-peak and Average Indication; All Detectors can be Switched on Simultaneously	
Tracking Generator for Attenuation and Gain Measurements; e.g., for Checking Test Cables (9 kHz to 2750 MHz; Opt. ESCS-B5)	

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

ROHDE&SCHWARZ
Rohde & Schwarz' quality system complies with the DIN ISO 9001 standard and has been certified by DQS (German Association for the Certification of Quality Systems).

Compact EMI Test Receiver Compliant to All Commercial Standards

The EMI Test Receiver ESCS30, fully complying with the CISPR 16-1 standard and having a 6.5" color LCD is an addition to the well-proven Rohde&Schwarz EMI test receiver family. It covers the entire frequency range from 9 kHz to 2.75 GHz, making it well-suited for performing in a wide variety of commercial EMI tests.

Test Receiver ESCS30 combines three types of instruments in one:

- A portable, manually tunable test receiver with built-in battery
- An automatic test receiver which as a stand-alone unit performs measurements and reports the results
- A system-compatible test receiver with IEEE 488-bus interface which supports EMI software packages running under Windows

Due to the optional built-in Ni-MH battery and an advanced power-saving circuit, the ESCS30 satisfies all requirements for portable mobile use.

POWERFUL FIRMWARE FUNCTIONS

- Macros for automatic and interactive test routines
- Frequency scan over up to 400 user-selectable channels
- Automatic level calibration
- Automatic consideration of frequency-dependent transducer factors
- Nonvolatile storage of nine complete instrument settings, 22 difference antenna factors and limit lines with up to 50 reference values

OPTIMUM RESULT DISPLAY FOR EVERY APPLICATION

- 16.5 cm (6.5") TFT color LCD for display of interference spectra, including limit lines
- Clear digital level indication with 0.1 dB resolution on separate level display
- Quasi-analog display of results in form of bar graphs to allow for quick comparison of results supplied by the detectors
- Time domain analysis (oscilloscope mode) for measurement of pulse widths and amplitudes

with a display range from 5 ms to 1 hr.

- IF spectrum analysis with 10 MHz display range for visual check of spectrum (Opt. ESCS-B4)

FULL STORAGE AND LOGGING OF RESULTS

- Built-in 3.5 in. disk drive for storing test results and instrument settings; PC compatible
- Storage of test results and test reports as HP-GL file for simple postprocessing with word processing programs
- Output of results as lists and diagrams including limit lines and user-definable labeling; the complete and conclusive test report with user comments can be output on a (pin, inkjet or laser) printer or plotter, also in color

Characteristics

Frequency Range – 9 kHz to 2750 MHz.
Frequency setting:
With tuning knob: In 10 Hz, 100 Hz, 100 kHz steps or user-defined step size (switch-selected).

RF Input – 50 Ω, N female.
RF attenuator: 0 to 60 dB, 5-dB steps.

Preamplifier –
Gain: 10 dB nominal.

Maximum Input Level –
RF attenuation 0 dB:
DC voltage: 50 V.
Sinewave AC voltage: 130 dBµV.
Pulse spectral density: 97 dBµV/MHz (100 V x 0.5 ns).
RF attenuation ≥10 dB:
DC voltage: 50 V.
Sinewave AC voltage: 137 dBµV (1 W).
Maximum pulse voltage (10 µs): 150 V.
Maximum pulse energy (20 µs): 10 mWs.

Displayed Noise Level (Average) –

Range		Preamplifier off	Preamplifier on
9 kHz to 30 MHz	BW = 200 Hz	<-25 dBµV typ. –28 dBµV	<-34 dBµV typ. –38 dBµV
50 kHz to 30 MHz	BW = 9 kHz	<-12 dBµV	<-18 dBµV
30 to 1000 MHz	BW = 120 kHz	<+1 dBµV typ. –1 dBµV	<- 4 dBµV typ. –7 dBµV
1000 to 2750 MHz	BW = 120 kHz	<+5 dBµV	<0 dBµV

Level Display –
Digital in dBµV, dBµA, dBm, dBµV/m, dBµA/m, dBpW, dBpT: 3 1/2 –digit LCD, resolution 0.1 dB.
Analog: on analog meter in operating range of IF detector with digital display of lower range limit.
Bar graph display: Horizontal bar on the screen.

Screen – 6.5 in. TFT color LCD.
Resolution: 640 x 480 pixels (VGA).

Time Domain Analysis –
Display range (sweep time): 5 ms to 10,000 s.
Minimum resolution (x axis): 100 µs.

IF Spectrum Analysis (Opt. ESCS-B4) –
Display range: 10 kHz to 10 MHz, 1/2/5 steps.
IF input attenuation: 0/20 dB (selectable).
Resolution: 1/3/10 kHz.
Sweep time: 50 ms to 10 s, 1/2/5 steps.
Level display range: 80 dB.

Demodulation Modes –
AM, FM, A0 (zero beat).
Loudspeaker: Built-in loudspeaker, headphones connection.

Date, Time of Day – Built-in clock module, continuously active, fed from internal battery.

Internal Memory –
Transducer: 22 transducer factors with up to 50 values, nonvolatile, combinable.
Limit lines: 22 limit lines with up to 50 values, nonvolatile.
Instrument settings: Nine complete setups, nonvolatile.

Documentation –
Plotter (IEC/IEEE bus) or printer (Centronics): Graphs with limit lines, settings and comments, complete test reports, lists with frequency and level.
Scaling of graphs: lin or log frequency axis.

CONNECTORS AND INTERFACES

Remote Control – Interface to IEC625.2 (IEEE488.2).
Remote-control connector: 24-Pin Amphenol.

Floppy Disk Drive – 3.5 in., 1.44 MB (formatted) for saving instrument settings, measurement results, transducer factors and limit lines.

Tracking Generator (Opt. ESCS-B5) –
Generator output: 50 Ω, N female.
Frequency range: 9 kHz to 2750 MHz.
Output level: 90 dBµV, can be electronically reduced by maximum 10 dB.
Frequency response: <2 dB.

GENERAL DATA

Power Supply –
AC supply: 100/120/230/240 V ±10%, 47 to 420 Hz (60 VA).
Battery, external: 11 to 33 V, 2.5 A at 24 V, 4.7 A at 12 V.

Safety – EN61010-1, IEC61010-1.

PHYSICAL CHARACTERISTICS

Dimensions	mm
Width	435
Height	236
Depth	350
Weight	**kg**
Net	18.4
With Opt. ESCS-B1 and 3 Battery Packs ESCS-B2	22.9

[1] ESCS-B1 and ESCS-B2.

Ordering Information

For price information: Outside the U.S. contact your local Tektronix representative, inside the U.S. see the price list in the back of this catalog.

ESCS 30 EMI TEST RECEIVER
9 kHz to 2750 MHz.

OPTIONS

Opt. ESCS-B1 – Battery Controller Ni-MH and battery support (without battery packs).
Opt. ESCS-B2 – Ni-MH Battery Pack (maximum three packs can be inserted, Opt. ESCS-B1 required).
Opt. ESCS-B4 – IF Spectrum Analysis.
Opt. ESCS-B5 – Tracking Generator 9 kHz to 2750 MHz.
Opt. ESCS-B6 – OCXO Reference Oscillator.
Opt. ESCS-B9 – RMS Detector.

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

ROHDE&SCHWARZ
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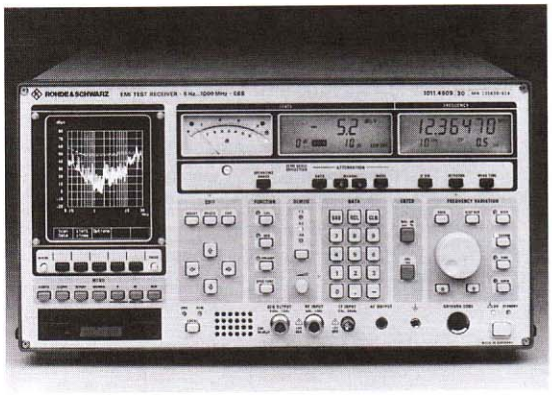
EMI Test Receivers

ESHS • ESVS • ESS



Features – Benefits

Frequency Range 9 kHz to 30 MHz (ESHS)

Frequency Range 20 MHz to 1 GHz (ESVS)

Frequency Range 5 Hz to 1 GHz (ESS)

Resolution Bandwidths from 2 Hz to 1 MHz (ESS)

Operation from AC Supply or External Battery

Applications

Measurements to Military Standards MIL-STD-461, DEF STAN 59-41, GAM-EG 13 and VG 95370 and 95673 (ESS)

Field-strength Measurements Using Test Antennas (ESVS and ESS)

Conducted Emissions Measurements (ESHS and ESS)

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

GPIB IEEE-488

Product(s) complies with IEEE Standard 488.1-1987, RS-232-C, and with Tektronix Standard Codes and Formats.

ROHDE&SCHWARZ

Rohde & Schwarz' quality system complies with the DIN ISO 9001 standard and has been certified by DQS (German Association for the Certification of Quality Systems).

The number of measurements required to ensure electromagnetic compatibility is continuously increasing. Thanks to the built-in intelligence of the ESHS/ESVS/ESS EMI Test Receivers, the time required for such measurements is reduced considerably. These test receivers are specialized for measurements to the applicable CISPR, CENELEC, ETSI, FCC, VCCI and VDE standards. In addition, the ESS provides measurements to the relevant military standards as well – MIL, VG, DEF and STAN.

The ESHS/ESVS/ESS feature high frequency resolution and accurate level indication in peak average and quasi-peak detection (ESS provides RMS also). The real strength, however, is the automatic measurement of RFI voltage, current, power and field strength. After a fast pre-scan measurement, it compares the results with prescribed limits, displays the interference spectrum with the limits on the screen, and furnishes a comprehensive test report with all the necessary information. The time-consuming quasi-peak measurement is only carried out in cases where the peak value is close to the relevant limit.

EMI TEST RECEIVER FEATURES

The ESHS 10, ESHS 30, ESVS 10, ESVS 30 and ESS share the same basic design and performance characteristics. The various models provide differing features which provide full EMI measurement performance from 5 Hz to 1 GHz. All models feature an excellent price/performance ratio, compact design, high measurement speed, and great operating convenience. Following are the primary features, shared by all instruments unless noted otherwise:

RF SECTION

- High pulse loading capacity of calibrated attenuator
- Comprehensive preselection filters
- Switchable preamplifier with wide dynamic range
- Crystal-stabilized, fast synthesizer with high resolution and sweep

DEMODULATION

- Parallel detectors for average, peak and quasi-peak indication (ESS also provides RMS indication)
- AM and A0 demodulators (ESVS and ESS also provide FM demodulation)
- Logarithmic amplifier with more than 70 dB dynamic range
- Automatic overload detection in the mixer stages and in the test channel by permanently activated peak detectors

POWERFUL PROCESSOR SYSTEM

- Macros for automatic and semi-automatic test runs
- 12-Bit A/D converter with short conversion time

- Measurement time selectable between 1 ms and 100 s
- Nonvolatile storage of 10 complete instrument setups and 22 different transducer factors and limit lines

OPTIMAL DISPLAY OF RESULTS FOR EVERY APPLICATION

- Measurement of voltage, field strength, current and pulse spectral density with full indication of units
- Indication of level on analog meter and digital readout with 0.1-dB resolution
- IF analysis for visual check of interference spectrum in manual measurement mode (ESHS 30, ESVS 30, ESS)
- Built-in tracking generator for attenuation and gain measurements (ESHS 30, ESVS 30, ESS)

STORAGE AND LISTING OF RESULTS

- Built-in 3.5 in. disk drive for storing test results and instrument settings (ESHS 30, ESVS 30, ESS)
- Output of results as lists and diagrams on printer or plotter including limit lines and user-definable labeling

SIMPLE OPERATION

A combination of hardkeys and softkeys ensures simple operation and fast access to the menu functions. All models have the classic test receiver controls on the right of the front panel for manual settings. The left section of the front panel is used to edit data for automatic test runs, tables for limit values and transducer factors (for example, for current and voltage probes and antennas), as well as special functions and the information required for test reports.

CHARACTERISTICS

	ESHS	ESVS	ESS
Frequency Related			
Frequency Range	9 kHz to 30 MHz	20 MHz to 1 GHz	5 Hz to 1 GHz, subdivided into the following ranges:
Range I			5 Hz to 50 kHz (tunable down to 1 Hz)
Range II			9 kHz to 30 MHz
Range III			20 MHz to 1 GHz (automatic range selection, depending upon IF bandwidth and RF input (balanced/unbalanced))
RF Input			
Connector	N connector, female	N connector, female	
5 Hz to 1 GHz, unbalanced			N connector, female
5 Hz to 50 kHz, balanced			Twinax connector, female
Impedance	50 Ω	50 Ω	50 Ω
Preamplifier	Switchable between input filter and 1st mixer	Switchable between input filter and 1st mixer	Switchable between input filter and 1st mixer
Gain	10 dB	10 dB	10 dB

IF Bandwidths

(Selectable in Range)	Nominal Bandwidth	-3 dB (±20%)	-6 dB	Shape Factor $BW_{6\ dB}/BW50_{\ dB}$
ESHS	200 Hz*1	140 Hz	200 Hz +20/–30 Hz	1:8 typical
	10 kHz*2	7 kHz	9.5 kHz ±0.5 kHz	1:3.5 typical
ESVS	10 kHz	7 kHz	9.5 kHz ±0.5 kHz	1:4 typical
	120 kHz	90 kHz	120 kHz ±10%	1:5.5 typical
ESS	2 Hz	1.4 Hz	2 Hz	1:2.5 (I)
	5 Hz	3.5 Hz	5 Hz	1:2.5 (I)
	10 Hz	7 Hz	10 Hz	1:2.5 (I)
	20 Hz	14 Hz	20 Hz	1:2.5 (I)
	50 Hz	35 Hz	50 Hz	1:2.5 (I+II)
	100 Hz	70 Hz	100 Hz	1:2.5 (I+II)
	200 Hz	140 Hz	200 Hz	1:2.5 n(I+II)
	500 Hz	350 Hz	500 Hz	1:2.5 (I+II+III)
	1 kHz	700 Hz	1 kHz	1:2.5 (I+II+III)
	0 kHz*3	7 kHz	9.5 kHz ±10.5 kHz	1:4 (II+III)
	100 kHz	70 kHz	100 kHz	1:5 (II+III)
	120 kHz	90 kHz	120 kHz	1:5 (II+III)
	1 MHz	700 kHz	1 MHz	1:5 (II+III)

*1 *Meets tolerances to CISPR 16.*

*2 *Meets tolerances to CISPR 16 (minimum 8 kHz, 10 kHz maximum) and complies with MIL tolerances (10 kHz ±10%).*

*3 *Complies with tolerances to CISPR and MIL tolerances of 10 kHz ±10%.*

DISPLAY RELATED

Level Display –
Digital, Digits: 3 1/2. Resolution: 0.1 dB.,Units: dBµV, dBµA, dBm, dBµV/m, dBµA/m, dBµV/MHz, dBµA/MHz, dBµV/m/MHz, dBµA/m/MHz, dBpW, dBpT. Analog: Moving-coil meter in operating range of IF detector with additional digital display of lower range limit. Operating ranges: 30, 60 dB.

Screen (ESHS 30, ESVS 30, ESS) –
(RF analysis),
Display: 5 in. CRT with digital video memory.
Resolution: 1024 x 1024 pixels.
Display range,
X axis (frequency): Freely selectable, linear or logarithmic (ESS, maximum 1 GHz).
Y axis (level): 10 to 200 dB, adjustable.
Marker Functions: Marker, delta marker, marker set to maximum, receiver frequency set to marker frequency.
Display Modes (detectors) – Average (AV), RMS (ESS only), peak (PK), spectral density measurement (PK/MHz), quasi-peak (QP).
Averaging, Hold and Measuring Times: 1 ms to 100 s (1-2-5 steps).

Demodulation Modes –
(ESHS), A0 (zero beat); A3 (for A3E emissions).
(ESVS, ESS), A0 (zero beat); A3 (for A3E emissions); F3 (for F3E).

Date, Time of Day – Internal clock, permanently operated from internal battery.

INPUT/OUTPUT

Floppy Disk Drive (ESHS 30, ESVS 30, ESS) – 3.5 in., 1.44 MB formatted.
Formatting: MS-DOS compatible. Data format HP-GL or binary.
Remote Control – IEC 625-2 (IEEE 488).
Connector: 24-contact Amphenol connector.
Front-panel Outputs –
Supply and Coding Connector for Antennas, etc.: 12-contact Tuchel connector.
AF Output, Connector: JK34 jack.

Impedance: 10 ohm.
EMF: Adjustable up to 1.5 V.
Generator output 9 kHz to 1 GHz; (ESHS 30, ESS).
Connector: N female.
Impedance: 50 Ω.
EMF: 96 dBµV ±1 dB.

POWER REQUIREMENTS

AC Operation –
Line Voltage: 100 V, 120 V, 220 V, 240 V ±10% (ESS, 230 V +6%/–10%).
Line Frequency: 47 to 440 Hz.
Power Consumption: ESHS 10, 50 VA; ESVS 10, 60 VA; ESHS 30, 80 VA; ESVS 30, 90 VA; ESS, 110 VA.

DC Operation – Internal Battery (ESHS 10, ESVS 10): 12 V, 10 AH.
Operating Time:
ESHS 10: ≈ 4 hours;
ESVS 10: ≈ 2.5 hours.

External Battery – Voltage Range: 11 to 33 V.
Current Drain 24/12 V: ESHS 10, 1.2 A/2.3A; ESVS 10, 1.9 A/3.3A; ESHS 30, 2.1 A/3.9 A; ESVS 30, 2.6 A/4.8 A; ESS, 3A/5.5A.

Noise Indication	Preamplifier off	Preamplifier on
ESHS		
Average value, BW 200 Hz		
fin 9 to 50 kHz	<-24 to <-30 dBµV	<-30 to <-36 dBµV
fin >50 kHz	<-30 dBµV, –35 dBµV typical	<-36 dBµV, –41 dBµV typical
Average value, BW 10 kHz		
fin >50 kHz	<-14 dBµV, –17 dBµV typical	<-20 dBµV, –25 dBµV typical
Peak value (typical increase against average value)	+11 dB	+11 dB
Quasi-peak		
Band A		
9 to 50 kHz	-24 to –30 dBµV typical	-30 to –36 dBµV typical
50 to 150 kHz	-32 dBµV typical	-38 dBµV typical
Band B ≥150 kHz	-13 dBµV typical	-19 dBµV typical
PK/MHz (BW 10 kHz)	34 dBµV/MHz typical	28 dBµV/MHz typical
ESVS		
Average value		
BW 10 kHz	<-12 dBµV, –15 dBµV typical	<-16 dBµV, –21 dBµV typical
BW 120 kHz	<-1 dBµV, –4 dBµV typical	<-5 dBµV, –10 dBµV typical
Peak value		
BW 10 kHz	-4 dBµV typical	-9 dBµV typical
BW 120 kHz	+7 dBµV typical	+1 dBµV typical
Quasi-peak Band C/D	+2 dBµV typical	-4 dBµV typical
PK/MHz (spectral density measurement, BW 120 kHz)	25 dBµV/MHz typical	21 dBµV/MHz typical
ESS		
Average value, Range I		
BW 2 kHz, fin = 5 to 30 Hz	<-38 to –48 dBµV typical	<-38 to –52 dBµV typical
BW 10 kHz, fin = >30 Hz	<-40 dBµV, –44 dBµV typical	<-41 dBµV, –48 dBµV typical
Average value, Range II		
BW 200 kHz, fin = 9 to 50 Hz	<-24 to –30 dBµV typical	<-30 to –36 dBµV typical
BW 200 kHz, fin = >50 Hz	<-30 dBµV, –35 dBµV typical	<-36 dBµV, –41 dBµV typical
Average value, Range III		
BW 120 kHz	<1 dBµV, –6 dBµV typical	<-5 dBµV, –10 dBµV typical
RMS value (typical increase vs. average reading)	+1 dB	+1 dB
Peak (PK) value (increase vs. average reading)	+11 dB	+11 dB

General Specifications

Physical Characteristics

Dimensions		mm	in.
Height		236	9.3
Width		435	17.1
Depth	ESHS 10	363	14.3
	ESHS 30	463	18.2
	ESS	572	22.5
Weight		**kg**	**lb.**
ESHS 10 without battery		18	39.7
ESVS 10 without battery		20.4	45
ESHS 10 with battery		21	46.3
ESVS 10 with battery		23.7	52.2
ESHS 30		28.6	63.1
ESVS 30		26.4	58.2
ESS		32.1	70.8

Ordering Information

For price information: Outside the U.S. contact your local Tektronix representative, inside the U.S. see the price list in the back of this catalog.

ESHS 10
EMI Test Receiver.
Includes: Power Cord, Manual.

ESHS 30
EMI Test Receiver.
Includes: Power Cord, Manual.

ESVS 10
EMI Test Receiver.
Includes: Power Cord, Manual.

ESVS 30
EMI Test Receiver.
Includes: Power Cord, Manual.
Opt. 01/ESVS-B1 – Pulse Power Attenuator. Maximum pulse voltage 1500 V.

ESS TEST RECEIVER
EMI Test Receiver.
Includes: Power Cable, Connector for External Battery, N-BNC Adapter, Sun Shield for Screen (ESS only), Manual.
Opt. 01/ESS-B1 – OCXO Reference Oscillator. 1 x 10^{-7} setting error, 1 x 10^{-9}/day aging error and 1 x 10^{-9}/°C temperature drift.

MEASUREMENT SERVICE OPTIONS ESHS10:
Opt. C3 – Three years of Calibration Services.
Opt. D1 – Cal Data Report.
Opt. D3 – Test Data (requires Opt. C3).
Opt. R3 – Repair warranty extended to cover three years.

ADDITIONAL ACCESSORIES
Also see page 495.

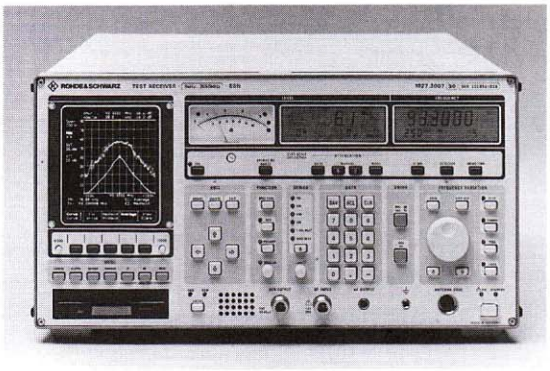
For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

GPIB IEEE-488
Product(s) complies with IEEE Standard 488.2-1987.

ROHDE&SCHWARZ
Rohde & Schwarz' quality system complies with the DIN ISO 9001 standard and has been certified by DQS (German Association for the Certification of Quality Systems).

EMI/Radio Monitoring Solutions

ESVB • ESVD • ESVN • ESN



Features – Benefits

Frequency Range 20 MHz to 1 GHz (2.05 GHz with Opt. 02) (ESVB)

Frequency Range 20 MHz to 1 GHz (2.05 GHz with Opt. 02) (ESVD)

Frequency Range 20 MHz to 1 GHz (ESVN)

Frequency Range 9 kHz to 1 GHz (2.05 GHz with Opt. 01) (ESN)

Frequency Accuracy to GSM Recommendations (ESVD)

In-phase and Quadrature Output for Evaluating Any Modulated Signal (ESVD)

Remote Control via IEEE 488 Interface

Operation from AC Supply or Internal/External Battery (ESVN)

Operation from AC Supply or External Battery (ESN)

Applications

Field-strength Measurements Using Test Antennas

Radio Monitoring to CCIR

Coverage Measurements

Selective Voltage Measurements in Labs and Test Shops

Radio Interference Measurements to EN 55011 to 55022, ETS, FCC and ANSI C63.4, VCCI, and VDE 0871 to 0879

Digital Audio Broadcasting Networks (ESVB)

Mobile Radio Networks – GSM, PCN (ESVD)

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

GPIB IEEE-488

Product(s) complies with IEEE Standard 488.1-1987, and with Tektronix Standard Codes and Formats.

ROHDE&SCHWARZ
Rohde & Schwarz' quality system complies with the DIN ISO 9001 standard and has been certified by DQS (German Association for the Certification of Quality Systems).

Introduction

The ESVB/ESVD/ESVN/ESN Test Receivers are ideal instruments for all applications in the fields of radio monitoring and radio network planning, civil RFI measurements to all relevant standards, as well as for selective voltage and two-port measurements in manual and automatic mode. ESVB/ESVD/ESVN/ESN are used to measure and demodulate both amplitude-modulated (DSB, SSB pulse) and frequency-modulated signals, as well as narrowband and broadband interference in the range from 20 MHz to 1 GHz (ESVN), 9 kHz to 2.05 GHz (ESN), and 20 MHz to 2.05 GHz (ESVB/ESVD Opt. 02).

Manual operation or automatic mode, with spectrum display on screen and reports of results on printer or plotter, make these Test Receivers extremely versatile for many applications.

TEST RECEIVER FEATURES

The ESVB/ESVD/ESVN/ESN Test Receivers combine three different types of test receivers in one:

- A compact, manually tuned and battery-operated test receiver
- A test receiver which automatically performs measurements and reports the results
- A system-compatible test receiver

Following are the primary features which are shared by all instruments unless noted otherwise:

RF UNIT

- High measurement accuracy: error <1 dB, <0.5 dB typical
- Refined preselection
- Switchable preamplifier with wide dynamic range
- Crystal-stabilized synthesizer (ESN): sweep mode for fast frequency scans, frequency resolution down to 10 and 100 Hz
- Wide dynamic range: noise figure typically 7 dB with preamplifier, 12 dB without preamplifier, third-order intercept point typically 20 dBm (without preamplifier)
- Tracking generator for attenuation and gain measurements with ESVN 30 and ESN (9 kHz to 1 GHz)
- High-level mixer ensuring high suppression of 1st LO
- IF analysis with resolution bandwidth of 1, 3 and 10 kHz; span 0.01 to 10 MHz; runs in parallel with level measurements

DEMODULATION

- High-linearity envelope detector with dynamic range of more than 70 dB
- Peak, average, RMS and quasi-peak detectors
- Automatic overload detection in mixer stages and in test channel by permanently activated peak detectors
- Logarithmic amplifier with dynamic range of more than 70 dB
- Demodulators for measuring modulation depth and frequency and phase deviation
- Demodulator circuits for FM, AM, SSB (LSB and USB), zero beat and 1-kHz beat
- Built-in loudspeakers and headphones connector; demodulation using signal processors
- Separate signal channel with 5 MHz bandwidth and demodulator for TV signals with switchover to all common TV standards

POWERFUL PROCESSOR SYSTEM

- Macros for automatic test runs
- Test runs over up to 400 freely selectable channels with programmable thresholds
- Automatic level calibration and consideration of frequency-dependent transducer factors (e.g., of antennas)
- Non-volatile storage of 10 complete instrument setups, 22 different antenna factors and limit lines
- Built-in 3.5 in. floppy disk drive
- Output of results as lists and diagrams on plotter or printer including limit lines and user-defined labeling

OPTIMAL DISPLAY OF RESULTS FOR EVERY APPLICATION

- Measurement of voltage, field-strength and current with full indication of units
- Level indication on analog meter and digital display with 0.1 dB resolution
- Display of modulation depth, deviation and frequency or frequency offset with very high resolution
- Display of frequency spectra (RF ANALYSIS) including limit values
- IF analysis with spans of up to 10 MHz
- Connector for TV monitor to identify TV programs

MANUAL MODE

These test receivers perform measurements at a fixed frequency with the desired bandwidth, attenuation, measurement time and display mode. Level measurement, modulation, and deviation measurement, as well as frequency and frequency offset measurement, are carried out simultaneously.

While measurements are being performed, the IF analysis function allows the spectrum about the receive frequency to be analyzed. Measurement of level, modulation, or frequency, as well as signal assessment using the built-in loudspeaker, are made at the center frequency of the extended spectrum with the settings selected.

AUTOMATIC MODE

The receive frequency range is scanned and the result displayed as a spectrum on the screen. The measurement parameters such as start frequency, stop frequency, IF bandwidth, measurement time, attenuation and display mode can be freely selected.

THREE OPERATING MODES FOR FREQUENCY SCANNING

Overview Mode: Frequency scanning over the desired frequency range is at maximum speed and with fixed attenuation.

Scan Mode: Frequency scanning is quasi-continuous with selectable step size and measurement time as well as automatic attenuation setting.

Channel Mode: Frequency scanning over a defined data set with up to 400 frequencies.

DOCUMENTATION OF RESULTS

The results, along with all relevant information, can be output in graphical form or as lists on a plotter or printer. In addition, data can be stored on a floppy disk along with the complete receiver setup.

USE IN COMPUTER-CONTROLLED SYSTEMS

Full use of the high measurement rate of these test receivers is possible only in the remote mode using a high-speed controller. In the determination of field-strength profiles, the receivers furnish 5,000 measured values per second after being triggered by a positioning system or a time base.

For radio monitoring, up to 10,000 frequencies can be stored in the receivers and scanned at high speed with range-related receiver settings. The results are then output to the process controller.

CHARACTERISTICS

FREQUENCY RELATED

Frequency Range –

	ESVB/ESVD/ESVN	ESN
Range I	–	9 kHz to 30 MHz
Range II	20 MHz to 1 GHz	30 MHz to 1 GHz
Range III	1 GHz to 2.050 GHz (ESVB/ESVD)	1 GHz to 2.050 GHz (with Opt. 01)

Frequency Setting –
With tuning knob: Fine, coarse or any step size selectable.
Numerical: Via keyboard entry.
Step size: Any selectable size.
Automatic scanning: For RF analysis.

Frequency Display – 8-digit LCD.

Resolution –
Range I: 10 Hz.
Range II and III: 100 Hz.

Frequency Error – ESVN: $<3 \times 10^{-6}$. ESN and ESVN with Option 01 (after 30 minutes warm-up): $<1 \times 10^{-7}$.

Temperature Drift – $<1 \times 10^{-9}$/°C.
Aging – $<1 \times 10^{-7}$/year.

RF INPUT

Connector – N connector, female.

Impedance – 50 Ω.

RF Attenuator – 0 to 120 dB, switchable in 10 dB steps.

Input Filters –
Range I: Five fixed-frequency bandpass filter.
Range II: One fixed-frequency and five tracking bandpass filters.
Range III: Four fixed-frequency bandpass filters.

Preamplifier – Can be connected between input filter and 1st mixer. Gain: 10 dB.

Maximum Input Level (with and without preamplifier) –
RF Attenuation 0 dB (AC-coupled); DC Voltage: 50 V. Sinewave AC Voltage: 130 dBµV. Spectral Pulse Density: 97 dBµV/MHz.
RF Attenuation >0 dB (DC-coupled); DC Voltage: 7 V (corresponds to 1 W). Sinewave AC Voltage: 137 dBµV. Maximum Pulse Voltage: Range 1, 700 V; Range II and III, 150 V. Maximum Pulse Energy: Range 1, 100 mWs; Range II and III, 1 mWs.

IF Bandwidths – ESVB/ESVD: See Table 1, ESVN/ESN: See Table 3.

TABLE 1

ESVB/ESVD Nominal Bandwidth	-3 dB (±10%)	-6 dB (±10%)	Shape Factor $BW_{6\ dB}/BW_{50\ dB}$
10 kHz	7 kHz	9.5 kHz	1:4 typ.
120 kHz	90 kHz	120 kHz	1:5 typ.
300 kHz	300 kHz	400 kHz	1:6 typ.
1 MHz	800 kHz	1 MHz	1:4 typ. (ESVD)
1.5 MHz	1.5 MHz	1.8 MHz	1:2.7 typ. (ESVB)

TABLE 2

ESVB/ESVD Noise Indication	Preamplifier off	Preamplifier on
20 to 1000 MHz		
Average value, BW – 10 kHz	< –12 dBµV, typ. –16 dBµV	< –16 dBµV, typ. –20 dBµV
BW – 120 kHz	typ. –5 dBµV	typ. –9 dBµV
BW – 300 kHz	typ. 0 dBµV	typ. –4 dBµV
BW – 1 MHz	typ. 4 dBµV (ESVD)	typ. 0 dBµV (ESVD)
BW – 1.5 MHz	typ. 7 dBµV (ESVB)	typ. 3 dBµV (ESVB)
1000 to 2050 MHz		
Average value, BW – 10 kHz	< –10 dBµV, typ. –15 dBµV	< –16 dBµV, typ. –20 dBµV
BW – 120 kHz	typ. –3 dBµV	typ. –9 dBµV
BW – 300 kHz	typ. 2 dBµV	typ. –4 dBµV
BW – 1 MHz	typ. 6 dBµV (ESVD)	typ. 0 dBµV (ESVD)
BW – 1.5 MHz	typ. 9 dBµV (ESVB)	typ. 3 dBµV (ESVB)

TABLE 3

ESN/ESVN Nominal Bandwidth	-3 dB (±20%)	-6 dB	Shape Factor $BW_{6\ dB}/BW_{50\ dB}$
1 kHz	1 kHz	1.2 kHz ±20%	01:02.8
3 kHz	3 kHz	3.15 kHz ±10%	01:01.8
9 kHz*[1]	7 kHz	9.5 kHz ±20%	01:02.2
15 kHz	15 kHz	17 kHz ±10%	01:01.8
120 kHz*[1]	90 kHz	120 kHz ±20%	1:05
250 kHz	250 kHz	330 kHz ±10%	01:03.7

*[1] *Meets tolerances to CISPR 16.*

TABLE 4

ESN/ESVN Noise Indication	Preamplifier off	Preamplifier on
Average value, BW 1 kHz		
Range I (fin >50 kHz)	<-22 dBµV, –27 dBµV typical	<-28 dBµV, –33 dBµV typical
Range II	<-18 dBµV, –23 dBµV typical	<-22 dBµV, –28 dBµV typical
Range III	<-16 dBµV, –22 dBµV typical	<-22 dBµV, –28 dBµV typical

Voltage Measurement Range –
Lower Limit (additional error caused by inherent noise <1 dB); Average Value (AV): 4 dB above noise indication. RMS Value (RMS): 5 dB above noise indication. Peak Value (PK): 15 dB above noise indication. Quasi-peak (QP) (100 Hz pulse frequency): 3 dB above noise indication.
Upper Limit (AV, RMS, PK, QP): 137 dBµV (RF attenuation >0 dB).
Inherent Spurious Response (equivalent input voltage); Range I: <-10 dBµV. Range II and III: <0 dBµV.

DISPLAY RELATED

Level Display –
Digital; Digits: 3. Resolution: 0.1 dB. Units: dBµV, dBµA, dBm, dBµV/m, dBµA/m, dBpW.
Analog: Moving-coil meter in operating range of IF detector with additional digital display of lower range limit.
Operating ranges: 30, 60 dB.

Screen –
Display: 5 in. CRT with digital memory.
Resolution: 1024 x 1024 pixels.
Display range; X axis (frequency): Freely selectable, linear or logarithmic. Y axis (level): 10 to 200 dB, adjustable in 10 dB steps.

Indication Modes – Average value (AV), RMS value (RMS), peak value (PK), quasi-peak value (QP, f_{in} >150 kHz). Measurement time: 1 ms to 100 s (1-2-5 steps).

Frequency Deviation (Digital in kHz) –
Resolution: 0.1/0.01 kHz. Measurement Range: Deviation + f_{mod} <0.5 IF bandwidth.
Measurement Frequency f_{mod}: 1<100 kHz.
Measurement Error (signal-to-noise >40 dB, AF = 1 kHz); IF Bandwidths 1, 3, 9, and 15 kHz: 100 Hz + 3% of measured value. IF Bandwidths 120 and 1250 kHz: 2 kHz + 3% of measured value.

Phase Deviation (Bandwidths 1, 3, 9, 15 kHz) –
Resolution: 0.1. Maximum Deviation: 8 rad.
Modulation Frequency: 300 Hz to 5 kHz.
Measurement Error (signal-to-noise >40 dB, m = 50%, AF = 1 kHz): 0.1 rad + 5% of measured value.

Modulation Depth (Digital in %) –
Resolution: 0.1%. Measurement range 1 to 99%. Modulation Frequency f_{mod}: <100 kHz.
Measurement Error (signal-to-noise >40 dB, m = 50%, AF = 1 kHz): 5% (absolute).

IF Analysis –
Frequency Display; Range I: 10 kHz to 2 MHz (1-2-5 steps). Range II and III: 10 kHz to 10 MHz (1-2-5 steps).
Level Display Range: 80 dB.
Attenuation Switchover (in IF path): 0/20 dB.
Resolution Bandwidth (–3 dB): 1, 3, 10 kHz.
Sweep Time: 50 ms to 10 s (1-2-5 steps).
Number of Test Curves: Maximum 2 traces.

AF Demodulation Modes – Zero beat, 1 kHz beat, AM (for A3E emissions), USB and LSB (for SSB emissions), FM (for F3E emissions). Squelch: Adjustable with front-panel knob.

Trigger Functions – External: TTL level, positive– or negative-going edge. Internal: Controlled by RF level, threshold adjustable.

Date, Time of Day – Internal clock, permanently operated from internal battery.

INPUT/OUTPUT

Remote Control – IEC 625-2 (IEEE 488).

Plotter – Via IEC/IEEE-bus interface. Plotter Language: HP-GL.

Printer – Connector: 15-contact Cannon connector, Parallel interface.

Keyboard – Connector: 5-contact DIN female.

Floppy Disk Drive – 3.5 in., 1.44 MB formatted, MS-DOS compatible.

Front-panel Outputs – Supply and Coding Connector for Antennas, etc.: 12-contact Tuchel connector.

AF Output –
Connector: JK34 jack. Impedance: 10 Ω. EMF: Adjustable up to 1.5 V.
Generator output (tracking generator): (ESVN 30, ESN); Connector: N female. Impedance: 50 Ω. Bandwidth: ESVN 30, 20 MHz to 1 GHz; ESN, 9 kHz to 1 GHz. EMF: 96 dBµV ±1 dB.

POWER REQUIREMENTS

AC Operation – Line voltage: 100 V, 120 V, 220 V, 240 V ±10%: 230 V +6%/–10%.

DC Operation – External Battery (switch-on voltage >12 V); Voltage Range: 11 to 33 V.

Physical Characteristics

Dimensions	mm	in.
Height	236	9.3
Width	435	17.1
Depth		
ESVN	460	18.1
ESN	572	22.5
Weight	**kg**	**lb.**
ESVN	29	63.9
ESN	32	70.5

Ordering Information

For price information: Outside the U.S. contact your local Tektronix representative, inside the U.S. see the price list in the back of this catalog.

ESVB
Test Receiver.
Includes: Power Cable, Manual.
Opt. 01/ESVD-B1 – I/Q Demodulator.
Opt. 02/ESVD-B2 – Frequency Extension to 2.05 GHz. (Opt. 01 required).

ESVD
Test Receiver.
Includes: Power Cable, Manual.
Opt. 01/ESVD-B1 – I/Q Demodulator.
Opt. 02/ESVD-B2 – Frequency Extension to 2.05 GHz. (Opt. 01 required).

ESVN 20
Test Receiver.
Includes: Power Cable, Manual.
Opt. 01/ESS-B1 – Reference Oscillator OCXO.

ESVN 30
Test Receiver with Tracking Generator.
Includes: Power Cable, Manual.
Opt. 01/ESS-B1 – Reference Oscillator OCXO.

ESN
EMI Test Receiver.
Includes: Power Cable, Connector for External Battery, N-BNC Adapter, Viewing Hood, Operating Manual.
Opt. 01/ESN-B1 – Frequency Extension. 1 GHz to 2.050 GHz operation.

MEASUREMENT SERVICE OPTIONS
Opt. C3 – Three years of Calibration Services.
Opt. D1 – Cal Data Report.
Opt. D3 – Test Data (requires Opt. C3).
Opt. R3 – Repair warranty extended to cover three years.

ADDITIONAL ACCESSORIES
Also see page 495.

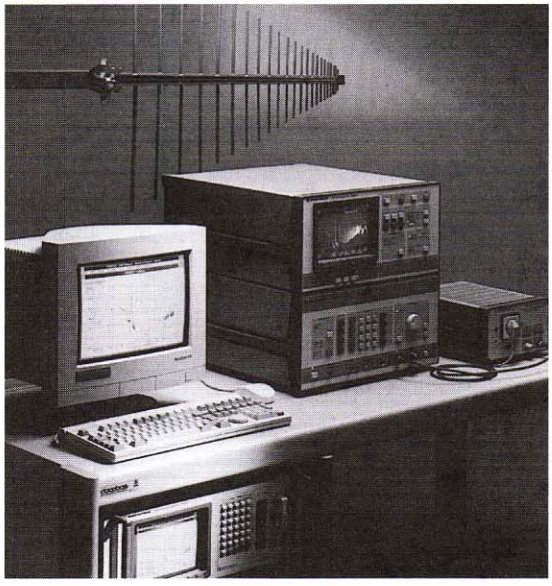
For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

GPIB IEEE-488
Product(s) complies with IEEE Standard 488.

ROHDE&SCHWARZ
Rohde & Schwarz' quality system complies with the DIN ISO 9001 standard and has been certified by DQS (German Association for the Certification of Quality Systems).

EMI Software

ES-K1



Features – Benefits

Fully Automatic and Interactive Operation for Maximum Speed, Reproducibility and User Friendliness

Automatic Compensation of Transducers (Correction Factors) and Limit Lines

Includes Powerful Scripts (Macro Routines) for Commonly Performed Measurements

Runs Under Windows 95® and Windows NT®

Applications

Conforms to the following commercial and military standards:

COMMERCIAL:
- CISPR
- EN
- ANSI
- FCC
- EACL
- VDE

MILITARY:
- MIL
- VG
- DEF-STAN
- GAM-EGI 3

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

ROHDE&SCHWARZ
Rohde & Schwarz' quality system complies with the DIN ISO 9001 standard and has been certified by DQS (German Association for the Certification of Quality Systems).

ES-K1 is an advanced, user-friendly tool which can be used for highly effective measurements for all conducted and radiated emission measurements.

When used with Rohde&Schwarz EMI test receivers and accessories, the ES-K1 EMI Test Software provides fully automatic operation. The intereactive mode allows the operation to use his/her experience to the fullest for most accurate and thorough measurements. At the same time, operation under Windows provides easy access and operation for the first-time user. The friendly graphics user interface allows the operator to concentrate on the measurement at hand. Concise documentation of results in graphic and tabular forms is possible along with the associated test setup.

Ordering Information

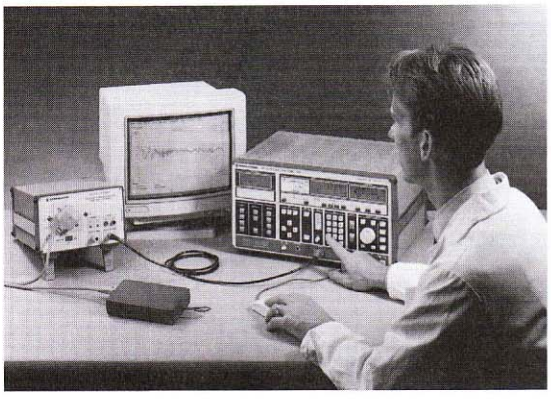
For price information:
Outside the U.S. contact your local Tektronix representative, inside the U.S. see the price list in the back of this catalog.

ES-K1
EMI Test Software.
Includes: Program Disks, Manual.

RECOMMENDED ACCESSORIES
Script Development Kit – Order ES-K2.
ESCS/ESHS/ESVS/ESVD Driver – Order ES-K10.
ESS Driver – Order ES-K11.
ESAI/ESBI/ESMI Driver – Order ES-K12.
ESVP/ESH3 Driver – Order ES-K13.
ESVP/ESH3/EZM Driver – Order ES-K14.
FSA/FSB/FSM Driver – Order ES-K15.
ESI Driver – Order ES-K16.
Slideway HCA Driver – Order ES-K31.
EMCO 1050/1060 Driver – Order ES-K32.

EMI Test Receiver ESPC

EMC-compatible Development and Production



Features – Benefits

- Correct Interference Weighting to CISPR 16-1 Down to 10 Hz Pulse Repetition Frequency
- Integrated Preselection
- For All Commercial EMI Standards (CISPR, EN, ETS, FCC, ANSI C63.4, VCCI and VDE)
- Automatic Overload Detection
- Power Sourcing From Internal or External Battery
- Easy-to-use Built-in Macro Functions
- Windows-based EMI Software is Provided as Standard Accessory

Applications

- Development and Production
- Emission Testing of Electrical Products

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

ISO 9001

Tektronix measurement products are manufactured in ISO registered facilities.

ROHDE&SCHWARZ
Rohde & Schwarz' quality system complies with the DIN ISO 9001 standard and has been certified by DQS (German Association for the Certification of Quality Systems).

Introduction

The EMI Precertification Test Receiver ESPC has been derived from various Rohde&Schwarz full-compliance receiver models and thus enables versatile applications in the field of EMI precompliance. It is a budget-priced solution for emission tests of all stages of development and production of electrical products.

Featuring built-in preselection, ESPC is able to perform accurate interference measurements with pulse repetition frequencies (PRF) to as low as 10 Hz in accordance with CISPR 16-1. An overload detection system for the complete receiver signal path, from the input through to the IF stages, warns the user of erroneous measurements.

SPECIAL FEATURES OF THE ESPC

- Frequency range from 150 kHz to 1000 MHz
- Options for frequency extension to 9 kHz and 2500 MHz
- Parallel detectors for average, peak and quasi-peak reading
- Fast synthesizer: Frequency resolution 10 and 100 Hz

POWERFUL PROCESSOR SYSTEM

- Macros for automatic and semi-automatic test routines
- Automatic level calibration
- Measurement of voltage, field strength, current and pulse spectral density with display of relevant units

COMPLETE TESTS AT A KEYSTROKE

The test receiver automatically selects the correct CISPR bandwidths for the relevant test frequency. In conjunction with firmware macros for automatic test routines, comparisons with limit lines, for instance to EN standards, can conveniently be made.

Up to 22 different:

- Limit lines
- Transducer factors

can be stored in a built-in nonvolatile memory, ensuring high accuracy for every frequency step.

Users not specialized in EMI can also easily handle and carry out these reproducible test runs. The ESPC shows its true strength by making the following measurements at the press of a button:

- RFI Voltage
- RFI Power
- RFI Field Strength

SOFTWARE-SUPPORTED EMI MEASUREMENTS

The Windows Software ESPC-K1 supplied with the ESPC supports EMI measurements in accordance with commercial standards.

Characteristics

Data with tolerances are guaranteed values (all other data are typical or approximate values).

FREQUENCY RANGE

Lower Limit – 150 kHz (optionally 9 kHz with ESPC-B2).
Upper Limit – 1000 MHz (optionally 2500 MHz with ESPC-B3).

RF INPUT

RF Attenuator – 0 to 70 dB, 10 dB steps.

IF BANDWIDTHS

Nominal Bandwidth – -3 dB, –6 dB.
200 Hz* (with Opt. ESPC-B2) – 180 Hz, 200 Hz.
10 kHz*[1] – 7 kHz, 9.5 kHz.
120 kHz* – 90 kHz, 120 kHz.
[1] Tolerances to CISPR 16-1.

NOISE INDICATION, AVERAGE

9 kHz to 3 MHz, BW = 200 Hz with Opt. ESPC-B2.
150 kHz to 3 MHz, BW = 10 kHz.

Average Indication (AV), f >3 MHz –
BW=200 Hz: typ. –28 dBµV.
BW=10 kHz: typ. –12 dµV.
BW=120 kHz: <+3 dBµV, typ. –2 dBµV.

Upper Limit AV, PK, QP – 130 dBµV (RF attenuation ≥10 dB).

LEVEL DISPLAY

Digital –
In dBµV, dBµA, dBm, dBµV/m, dBµA/m, dBpW, 3-digit LCD with backlighting (can be switched off), resolution 0.1 dB.
Analog – On moving-coil meter in operating range of IF detector with digital display of lower range limit.

MEASUREMENT ERROR

Level Calibration – Harmonics generator; calibrates the receiver for settings, correction values stored in nonvolatile memory, duration approx. 1 min.
Demodulation Modes – AM, FM, A0 (zero beat), internal loudspeaker, headphones connector.
Volume – Adjustable with rotary knob.
Day, Time of Day – Internal clock, permanently operated from internal battery.

INTERNAL MEMORY

Transducer – 22 transducer factors with up to 50 reference values, nonvolatile, can be combined.
Limit Lines – 22 limit lines with up to 50 reference values, nonvolatile.
Instrument Settings – Nine complete setups, nonvolatile.

CONNECTORS AND INTERFACES

Remote Control – Interface to IEC625-2/IEEE488.2.
Remote-control Connector – 24-contact Amphenol connector.
Plotter – Via IEC/IEEE-bus interface.
Printer – Parallel interface (15-contact Cannon connector).

FRONT-PANEL OUTPUTS

Power Supply –
AC supply: 100/120/240 V ±10%, 230 V +6/–10%, 80 VA, 47 to 420 Hz, safety class I to VDE 0411 (IEC 348).
Battery (external): 11 to 33 V.
Safety – EN61010-1, IEC61010-1.

Dimensions	mm
Height	435
Width	236
Depth	350
Weight	**kg**
Net	17

Ordering Information

For price information: Outside the U.S. contact your local Tektronix representative, inside the U.S. see the price list in the back of this catalog.

EMI TEST RECEIVER–

ESPC. Order 1082-8007-10.
Includes: Windows Software ESPC-K1, Power Cable, Connector for External Battery, Operating Manual.
PC Configuration Required for Software ESPC-K1 – IBM-AT-compatible, 386 or higher.

OPTIONS

Internal Battery with Automatic Charging – ESPC-B1. Order 1082-9503-02.
Frequency Extension 9 kHz to 150 kHz and IF bandwidth 200 Hz – ESPC-B2. Order 1082-9555-02.
Frequency Extension 1000 to 2500 MHz – ESPC-B3. Order 1082-9603-02.

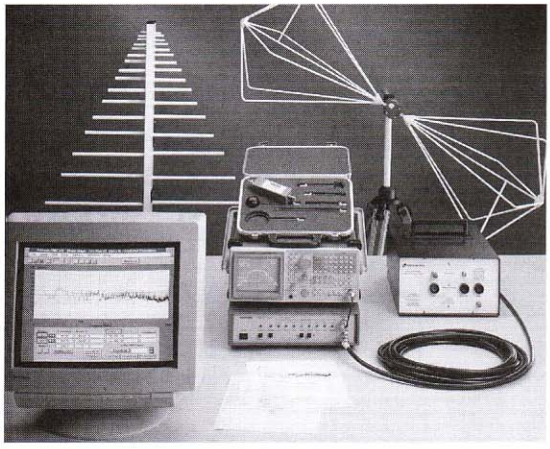
For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

ISO 9001
Tektronix measurement products are manufactured in ISO registered facilities.

ROHDE&SCHWARZ
Rohde & Schwarz' quality system complies with the DIN ISO 9001 standard and has been certified by DQS (German Association for the Certification of Quality Systems).

EMI Measurement System/Software

New 27120B EMC120



Features – Benefits

- Configurable System Designed to Meet Your EMI Testing Needs
- Powerful EMC120 Software Saves Time in Acquiring Data and Preparing Engineering Reports
- Built-in 2712 Preamp Provides Low Noise Floor for Tight Spec Limits
- Diagnose and Correct "Hot Spots" Using the 2712 and Near-Field Probes
- Option 11 Includes Antennas, Tripod and Cable for Radiated Emissions Measurements
- Option 16 Includes LISN and Transient Limiter for Conducted Emissions Measurements
- Option 17 Provides 2706 RF Preselector Which Protects Against Signal Overload

Applications

- EMC Diagnostic Work
- EMC Prequalification Testing

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

CE

ISO 9001

Tektronix measurement products are manufactured in ISO registered facilities.

The time to address compliance is before it becomes a problem. Proper attention to EMC, from the design stage through pre-certification testing, can reduce your product development cost and decrease your time to market.

Achieve these objectives and more with the Tektronix 27120B EMI Measurement System – a complete solution for EMI pre- and post-certification of your products. The heart of the system is the easy-to-use 2712 Option 12 Spectrum Analyzer. It includes many features helpful in identifying and measuring EMC signals:

- Internal preamp
- Frequency counter
- AM/FM demodulator
- True analog display
- 4-trace digital display
- Peak, Quasi-peak and Average detection
- 200 Hz, 9 kHz, 120 kHz EMC filters

Overload capability is enhanced and ambient signal interference is minimized by the 2706 Stepping RF Preselector (Opt. 17). This may be controlled manually or automatically, via IEEE 488 interface, by the EMC120 software.

For diagnostic work, the 27120B provides a set of two E-field probes, three H-field probes and an extender. These allow you to quickly locate the source and frequency of radiation.

Conducted emissions measurements are made with Option 16, which includes a 25 Amp LISN (Line Impedance Stabilization Network) and a Transient Limiter. Radiated emissions measurements are made with Option 11, which includes a biconical antenna and log-periodic antenna. A tripod and 10 m low-loss cable are also provided.

The new EMC120 Windows-based software is a feature-filled package that takes the drudgery out of EMC testing. It does everything from data acquisition, to correcting for transducer factors, to graphing and printing final test results.

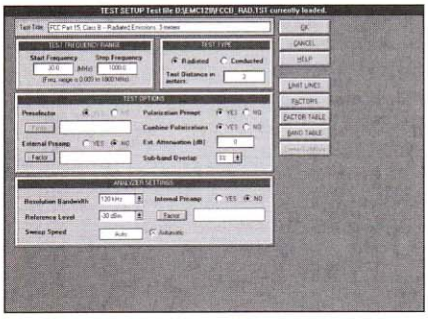


Figure 1. The EMC120 Test Setup Screen.

EMC120 – WINDOWS-BASED EMI SOFTWARE FOR THE 27120B

The EMC120 package is optimized for the Tektronix 2712 Option 12 Spectrum Analyzer, but it also runs with a standard 2712, or a 2711. The EMC120 automatically controls the Tektronix 2706 Preselector by switching to the appropriate 2706 filter setting as the test is being run.

FILE OPERATIONS

A library of typical test routines, with commonly used limit lines, is provided with the software. These support commercial testing according to standards such as CISPR 11, CISPR 22, FCC Part 15 (Class A and B) and the European Norms standards.

TEST SETUP

The Test Setup screen (see Figure 1) was designed so that commonly used spectrum analyzer test parameters are readily accessible. These include items such as the Start/Stop Frequency, Reference Level, Resolution Bandwidth and Sweep Speed. A frequency-band table allows precise control over each acquisition window on the 2712.

RUNNING THE TEST

Three detector modes are available when using a 2712 Option 12: Peak, Quasi-peak, and Average (the Average detector is simulated via the 2712 video filter). During Peak testing, data may be accumulated in Maxhold mode over a specified number of sweeps, or the data may be accumulated continuously until terminated by the user.

VIEWING THE DATA

As a test is being run, data is graphed as it is acquired. Once a test has completed, it's possible to enable one or two markers which provide absolute or relative frequency/amplitude values.

If a Quasi-peak or Average test is being run, the graph is drawn and a window with Suspect Signals pops up on screen. You can then run a test on each of these signals, or edit the list (add or delete signals) prior to executing the QP or Average test.

REPORT GENERATION

EMC120 Software has a very versatile report generator. Each of the columns in the tabular report is user definable and can include elements such as the frequency of the signal, the peak amplitude, the limit line, etc.

SYSTEM REQUIREMENTS

EMC120 Software runs on a PC-compatible computer equipped with a National Instruments GPIB (IEEE 488.2) card. A 486/33 or faster processor with at least 8 MB of RAM is recommended. A VGA monitor and hard disk with at least 10 MB of free space is required.

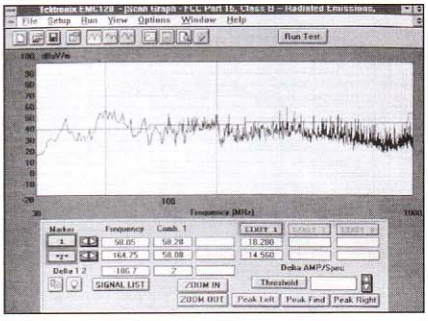


Figure 2. Graph of EMC120 data.

CHARACTERISTICS

2706 STEPPING RF PRESELECTOR (OPT. 17)

Frequency Range – 9 kHz to 1.8 GHz.
Bandpass/Highpass Filters – Eight spanning the full frequency range.
Insertion Loss – 3 dB <1 GHz.

LISN (OPT. 16)

Facilitates conducted emissions.
Frequency Range – 9 kHz to 100 MHz.

TRANSIENT LIMITER (OPT. 16)

Use with LISN to prevent inadvertent damage to spectrum analyzer.

ANTENNAS (OPT. 11)

Only two antennas required to cover the entire EC/FCC 1 GHz radiated measurement range.
Biconical – Useable from 20 MHz to 300 MHz.
Log Periodic – Useable from 200 MHz to 1 GHz.

ORDERING INFORMATION

For price information: Outside the U.S. contact your local Tektronix representative, inside the U.S. see the price list in the back of this catalog.

27120B EMI MEASUREMENT SYSTEM

Includes: 27120A System Manual and individual component instruments manuals.

27120B SYSTEM OPTIONS

Opt. 05 – Add 2707 External Tracking Generator. Useable for site attenuation, filter design and evaluation.
Frequency Range: 100 kHz to 1.8 GHz.
Output Level: –48 to 0 dBm.
Opt. 10 – Add television demodulation. Useful for signal identification. Includes broadcast (AM) and satellite (FM) demodulation.
Opt. 11 – Add antennas, tripod and cable when system used for radiated measurements.
Opt. 16 – Add LISN and Transient Limiter when system used for conducted measurements.
Opt. 17 – Add 2706 RF Preselector.

INTERNATIONAL POWER PLUGS

Opt. A1 – Universal Euro 220 V, 50 Hz.
Opt. A2 – UK 240 V, 50 Hz.
Opt. A3 – Australian 240 V, 50 Hz.
Opt. A4 – North American 240 V, 60 Hz.
Opt. A5 – Switzerland 220 V, 50 Hz.
See page 619 for description.

EMI MEASUREMENT SOFTWARE

EMC120 Software.
Includes: Instruction manual and four 3.5 in. floppy disks.

EMC120U SOFTWARE UPGRADE PACKAGE

Upgrades S26EM12 Software to EMC120 Software.

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

CE

ISO 9001

Tektronix measurement products are manufactured in ISO registered facilities.

Stepping RF Preselection

2706



Features – Benefits

Part of Automated Measurement System Using Tektronix EMC120 EMI Software

9 kHz to 1800 MHz Overall Range (Bypass Mode)

Continuous Bandpass Filtering from 9 kHz to 1800 MHz in Eight Selectable Bands

Attaches to the Tektronix 271X Spectrum Analyzers to Form Integrated Unit

Applications

EMC Precompliance Measurements

Distortion-free Measurements in High Ambient Environments

Manual or GPIB Control

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

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ISO 9001

Tektronix measurement products are manufactured in ISO registered facilities.

GPIB IEEE-488

Product(s) complies with IEEE Standard 488.2-1987, and with Tektronix Standard Codes and Formats.

2706 Preselector

The 2706 Stepping RF Preselector facilitates distortion-free measurements in the presence of large signals at the spectrum analyzer input. If total signal power at the first mixer stage of the spectrum analyzer exceeds the 1 dB compression point, inaccurate amplitude measurements and spurious intermodulation products can result. The 2706 Preselector enables the spectrum analyzer user to make accurate measurements over a wider range of signal environments by:

- Significantly attenuating undesired out-of-band signals
- Reducing energy from high amplitude, short duration pulses
- Minimizing the total number of individual signals present at the analyzer input

Use of commercial RF preselectors has been limited because of high costs. Now Tektronix offers an affordable and cost-effective solution for pre-certification testing.

Ordering Information

For price information:
Outside the U.S. contact your local Tektronix representative, inside the U.S. see the price list in the back of this catalog.

2706
Stepping RF Preselector.

Includes:
Power Cord (U.S. 115 V, 60 Hz), Operator's Manual.

271X Spectrum Analyzer Mounting Hardware and RF Interconnect Cable – Order 118-8800-00.

MEASUREMENT SERVICE OPTIONS
Opt. R3 – Repair warranty extended to cover three years.

SOFTWARE
See page 262 for complete description.

Commercial EMI Test Software –
Order EMC120.

INTERNATIONAL POWER PLUGS
Opt. A1 – Universal Euro 220 V, 50 Hz.
Opt. A2 – United Kingdom 240 V, 50 Hz.
Opt. A3 – Australian 240 V, 50 Hz.
Opt. A4 – North American 240 V, 60 Hz.
Opt. A5 – Switzerland 220 V, 50 Hz.
See page 619 for description.

EMC ANCILLARY DEVICES

- Active Loop Antenna
- Adjustable-length Dipoles
- Biconical Antenna
- Log-periodic Antenna
- RF Near-field Probe Set
- LISN
- Transient Limiter
- 10 m Low-loss Coaxial Cable
- Adjustable Tripod

Sensors or transducers are required for EMI signal reception. The sensor picks up the EMI signal and couples it to the spectrum analyzer. The spectrum analyzer then displays the EMI signal as a plot of amplitude (vertically) versus frequency (horizontally).



The type of sensor needed depends on the test standard and the nature of the test (radiated or conducted electric field, or radiated magnetic field). For radiated electric (E) field tests, a biconical, log periodic, or dipole antenna may be used. Electrostatically shielded loop antennas are used for magnetic (H) field tests.

The specific transducer type required also depends on the test standard and frequency range. Tektronix has available a line of antennas and other sensors, as shown in the figure at left.

For conducted measurement, Tektronix offers a Line Impedance Stabilization Network (LISN). It is inserted between the AC power source and the EUT. Outputs on the LISN couple the EMI emitted by the EUT to the spectrum analyzer's input.

Our complete line of ancillary devices is listed in the ordering information below.

Ordering Information

For price information: Outside the U.S. contact your local Tektronix representative, inside the U.S. see the price list in the back of this catalog.

LOOP ANTENNA

9 kHz to 30 MHz. Order No. 119-4144-00.

Application Information: Radiated H-field (magnetic) emissions.

ADJUSTABLE-LENGTH DIPOLES

28 MHz to 1 GHz. Order No. 119-4145-00.

Application Information: Radiated E-field emissions/CATV leakage. Ideal for EMI testing and site attenuation measurements. Includes four baluns.

BICONICAL ANTENNA

30 MHz to 300 MHz. Order No. 119-4148-00.

Application Information: Radiated E-field emissions. Broadband frequency capability eliminates need for band switching, element extension or external tuning.

LOG-PERIODIC ANTENNA

200 MHz to 1 GHz. Order No. 119-4142-00.

Application Information: Radiated E-field (electric) emissions. Linearly polarized design permits separate measurement of horizontal and vertical fields. Broadband frequency.

RF PROBE SET

9 kHz to 1.8 GHz. Order No. 119-4146-00.

Application Information: Locates RF "Hot Spots." Useful in diagnostic testing. Includes five probes (3 H-field, 2 E-field) plus extension.

LISN

10 kHz to 100 MHz. Order No. 119-4147-02.

Application Information: Facilitates measurement of conducted emissions on power line from equipment under test. Filters undesired signals imported on mains supply.

TRANSIENT LIMITER

9 kHz to 100 MHz. Order No. 011-0164-00.

Application Information: Use with LISN to prevent inadvertent damage to spectrum analyzer input.

10 M COAXIAL CABLE

Order No. 012-1291-00.

Application Information: Couples antenna to spectrum analyzer (male fittings).

ADJUSTABLE TRIPOD

Order No. 016-1102-00.

Application Information: Mounting for all above antennas. Wooden frame reduces field disturbance.

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

Wireless Communication Test Sets

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UPL66 286
UPL16 288

SIGNALING

Radio test sets, covering major national and international standards, including CDMA, GSM, DCS 1800, PCS 1900 and AMPS are described here.

In addition to the conventional RF and AF measuring facilities, many units also include special signaling capabilities. Testers with signaling simulate the base station and perform all signaling measurements to PTT regulations, in addition to all conventional radio measurements. For large cellular-radio networks, they also provide base-station testing, including signaling.

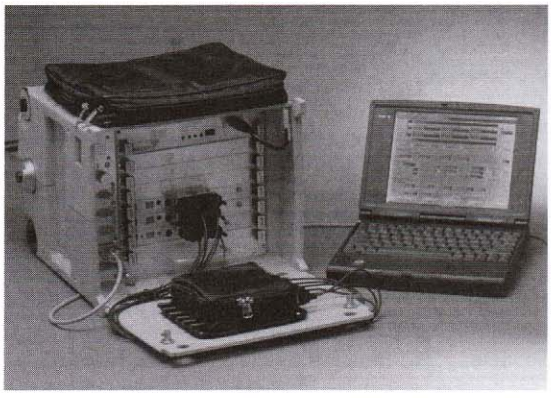
Integration of a signaling unit into the radio tester ensures fast data exchange between the control units, thus creating the prerequisites for real-time measurements under practical conditions.

If in-depth spectral analysis is required, including modulation without signaling, refer to the Spectrum Analyzers section. In particular, see information on the FSEA Series, R3465, R3463, and R3263.

- CDMA Mobile Unit Test CMD80
- CDMA Base Station Test R3465/R3463 CDMA
- GSM Mobile Unit Test CRTC02, CMD55, CMD53, CTS55
- GSM Base Station Test CMD57, CMD59

Quality of Service Analyzer for GSM Networks

New M366plus



Features – Benefits	Applications
Quality of Service, O&M and Network Optimization for GSM900, DCS1800, Dual Band and for PCS1900	Automatic Generation of Calls from a Cellular Phone to a Fixed or Cellular Phone
Voice Quality Measurements	Simultaneous Measurements on up to 4 Different Networks
Cellular Data and Fax Quality Test	Run-Time Display of Results on Digital Maps
SMS Verification	Post-processing of Data Obtained During Measurement Campaigns

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

CE

MEASURING QUALITY FROM THE SUBSCRIBER'S POINT OF VIEW

Nearly 200 cellular operators worldwide compete everyday to provide the best quality and, at the same time, increase their market penetration – as new ones are arriving. After the first battle of price rates, they have now understood that quality is the key to success: not only voice quality, but quality in all services which can be provided.

The M366plus System now provides objective measures of Quality even more accurately – not only voice quality – everywhere, all the time.

OPTIMIZING THE "MOBILE" NETWORK

A cellular network is a "mobile" network not only because of the mobility of their customers, but also because it is never stationary like a fixed one is: new BTSs are deployed, frequency plans vary, in other words the network is always being optimized.

The M366plus System is the best companion for this job.

By collecting protocol information and significant events, and by means of its powerful post-analysis tools, the M366plus identifies critical zones and highlights the reasons for the problems.

QOS: NOT ONLY VOICE, BUT ALSO DATA, FAX AND SMS

With the M366plus System it is possible to objectively measure not only the quality of voice service, but also of SMS, data and fax transmission over a cellular network.

QOS: THE ULTIMATE APPROACH

Although "Quality is not a matter of opinion," each of us has a different ear and method of judgment. This is why one feels more comfortable when he or she can personally listen on the receiving end of the communication channel and scribble down his or her own MOS. But in the M366plus System we have gone one step further: we have put together two methods in a single system, so that the accuracy, the simplicity and the unquestionable precision of our experienced technology, based on the measurement of impairment factors (clipping, impulsive noise, psophometric noise, loudness rating and echo), can be combined with the immediateness and confidence that arises from the automated measurements of real speech samples.

The M366plus System

The M366plus System has different components: each of them is flexible, configurable and powerful.

THE BASE STATION

The M366plus Base Station is the fixed node of the M366plus System. It is configurable with up to 4 interfaces and DSP measurement boards, emulating 8PSTN-interfaces, provided with a local PC controller, and it performs all the operations required from its side: originating and receiving voice, data and fax calls, measuring Quality, storing data.

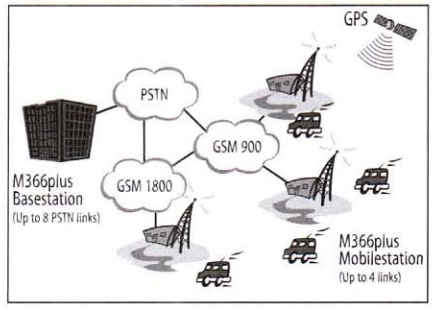
THE MOBILE STATION

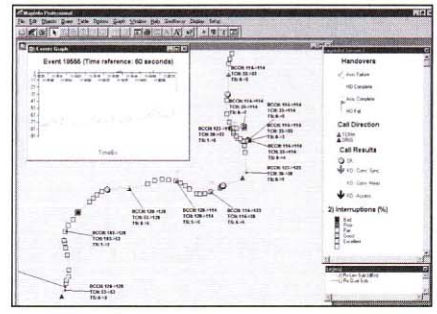
The new generation of M366plus Mobile Station boasts a remarkably increased capacity of up to 4 test phones in any combination of GSM 900, 1800, dual band and PCS 1900.

Also provided with the local PC, the Mobile Station also features all the new powerful quality measurements and protocol analysis capabilities.

THE POST PROCESSING SYSTEM

In some cases, the M366plus Measurement Units can collect huge amounts of data and information. In order to quickly and effectively focus the data of interest, Tektronix offers a powerful tool of analysis: M366 REPORT.





M366PLUS REPORT

REPORT is the software tool used for storing, organizing and analyzing the information collected by the measurement units.

REPORT can give the user all the required views on single or multiple sessions compare networks, to filter the data in any combination, and to generate all sorts of REPORTs, of course, also in graphical form.

The level of detail can be as specific as a single event occurring during one of the calls.

This information is fully exploited by M366plus REPORT, which, utilizing MAPINFO-based software, allows viewing of measurement information on digital geographic maps.

The M366plus System offers two architectures for the post-processing environment, which both support the same REPORT application.

- Standalone based on MS-ACCESS
- Client-server based on ORACLE

ORDERING INFORMATION

For price information: Outside the U.S. contact your local Tektronix representative, inside the U.S. see the price list in the back of this catalog.

BASE STATION

7KM366-BS – M366plus/GSM Basestation Platform, Includes 2 interfaces to access a PSTN network, removable notebook, DSP board, power supply and AC/DC converter.

7KM366-MT – M366plus/GSM PSTN Interface Board. Extends the Basestation with 2 interfaces to access a PSTN network.

7KM366-DSP – M366plus/GSM DSP Board.

7KM366-BS-SW-R50 – M366plus Basestation Software Release 5.0. Software license for one Basestation, media and manual.

MOBILESTATION (2 INTERFACES)

7KM366-MS-900 – M366plus/GSM Mobilestation Platform, Includes 1 interfaces to access a GSM 900 network, removable notebook, DSP board, power supply, AC/DC converter and battery backup unit. Supports Max. 2 interfaces.

7KM366-MR-900 – M366plus/GSM Radio Interface Board to extend the Mobile Station with a second interface to access a GSM 900 network (Mobile (GSM 900) included).

7KM366-MR-SAG – M366plus/GSM Radio Interface Board to extend the Mobile Station with a second interface to connect a SAGEM Mobile Phone (Mobile not included).

7KM366-DCR – Remote Control Unit for Mobilestation. For starting, pausing, stopping a test session. For using inside the testcar.

7KM366-GPS – M366plus/GSM GSP Board, including antenna.

7KM366-MS-SW-R50 – M366plus/GSM Mobilestation Softw. Rel. 5.0. Software base license for one Mobilestation, media and manual.

MOBILE STATION (4 INTERFACES)

7KM366-VMS – M366plus Mobilestation for 4 interfaces, Incl. removable notebook, one controller board with DSP processor (Mobile not included), power supply (12 VDC), battery backup unit, AC/DC converter.

7KM366-VMR – Mobile controlboard with DSP processor (only for 7KM366-VMS). Interface board for one mobile (Mobile not included).

7KM366-VGPS – M366plus/GSM GPS board, Including antenna.

7KM366-VMS-SW-R50 – M366plus Mobilestation Softw. Rel. 5.0. Software base license for one Mobilestation, media and manual.

7KM366-VOT35-D – SAGEM Mobile for GSM 1800 network. Antenna not included.

7KM366-VOT35-D-A – Antenna kit for SAGEM GSM 1800 mobile.

7KM366-VOT35-G – SAGEM Mobile for GSM 900 Network. Antenna not included.

7KM366-VOT35-G-A – Antenna Kit for SAGEM GSM 900 Mobile.

7KM366-VOT35-P – SAGEM Mobile For GSM 1900 network. Antenna not included.

7KM366-VOT35-P-A – Antenna Kit for SAGEM GSM 1900 Mobile.

7KM366-VOT75-M – SAGEM OT75 Dualband GSM900,1800 Mobile. Supports EFR. Includes 220 V battery charger, 2 rechargeable batteries, user manuals.

7KM366-VOT35-M-A – Antenna Kit for SAGEM Dualband Mobile.

POST-PROCESSING

7KM366-PC – Desktop PC, Pentium 400 MHz, 128 MB RAM, 9 GB HD, 17 in. color monitor, internal modem, Ethernet LAN communication board, CD-R unit, Windows NT4.0 in English. Optional.

7KM366-PP-CSW-R50 – Client Software of Post-processing tool for data analysis, report generation and mapping of measurements on geographical maps based on Oracle. License for one client in a client-server architecture. Incl. also 1 MAPINFO runtime license.

7KM366-PP-SSW-R50 – Server Software of Post-processing tool for data analysis, report generation and mapping of measurements on geographical maps based on Oracle. License for server in a client-server architecture.

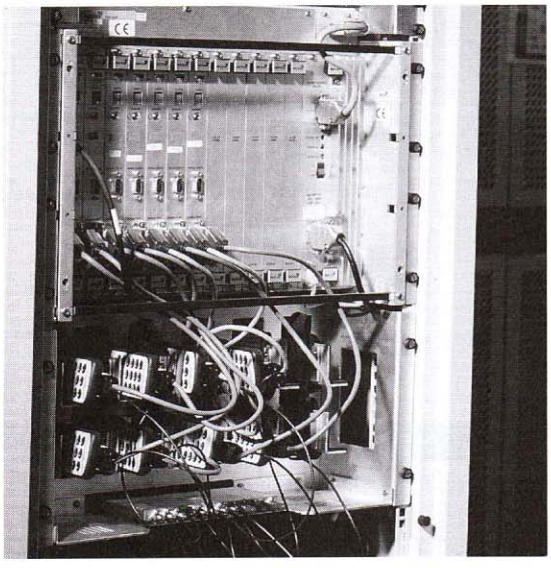
7KM366-PP-SW-R50 – Post-processing tool for data analysis, report generation and mapping of measurements on geographical maps based on MS-Access. Incl. MAPINFO runtime license. Software license for one stand alone version.

TRAINING

7KM366-Training – M366plus/GSM Training. Price is for three days/per person. Training at the customer site on request.

Mobile Call Generation System

New MCGS



Features – Benefits

Air Interface Test System for GSM900, DCS1800, PCS1900 and Dual Band Networks

Generating End-to-End Traffic

Stimulates GSM Mobile Networks and Tests All the Components (MSC, BSC, BTS)

Easy Expandable and Automatic Recognition of System Configuration

Applications

Graphical and Flexible Call and Traffic Configuration

Powerful Analysis Including Protocol Decoding

Ideal Product for Load Testing, Automatic Service Testing, Billing Verification and Roaming Tests

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

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Test of GSM Network Components

Controlled traffic is one of the most recognized ways to test the operation of telecommunication systems.

Tests are accomplished by emulating real users of the services, in all GSM variants (GSM900, DCS1800, PCS1900 and Dual Band ER/EFR).

Use of MCGS

With the MCGS, GSM network equipment (BTS, BSC, MSC) can be stimulated and tested by means of special call patterns which can be defined according to the specific testing needs.

IN THE TEST PLANT

The MCGS is particularly useful where several pieces of equipment are being integrated and tested before being put into service.

By using the MCGS, you can:

- Trace and analyze the correct execution of any single GSM procedure
- Check the performance of the network in stress conditions
- Find out the reason of the faults

IN THE OPERATION PHASE

The MCGS is very useful for discovering faults which remained inside the software even after the in-house testing or which are due to specific situations that cannot be reproduced in a Test Plant.

It is also useful to verify quickly and effectively that everything is correctly working after network re-configuration or software upgrades.

Product Description

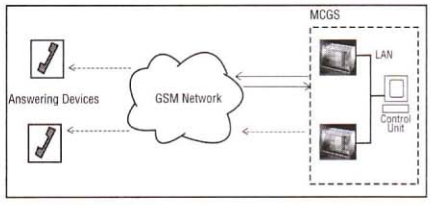
The automatic and controlled traffic generation at the GSM air interface (Um) is the main function of the MCGS.

MOC and MTC (Mobile Originated and Mobile Terminated Calls) are generated in order to emulate any kind of traffic scenario according to the schedules and patterns defined by the user.

The call progression is monitored for each test call.

Speech continuity checks and speech quality measurements (on the Traffic Channel) are made on the speech calls.

The GSM layer 2, 3 messages can be traced.



The users' mobility is emulated by forcing lock and handovers.

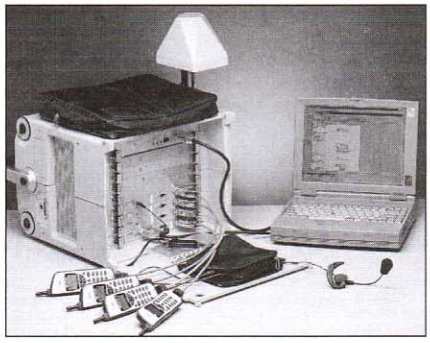
GSM SERVICE EMULATION

All the services commonly used by the GSM customers can be emulated, for example:

- Standard speech calls
- Data calls, SMS
- Phase 2 supplementary services (call forwarding, call hold, 3-party calls, etc.)

ANALYSIS OF TEST RESULTS

The ability to quickly focus on the data of interest is one of the most important features of a traffic generator and the



MCGS provides an analysis tool specifically designed to quickly focus on important data.

Powerful filtering utilities, summary and detailed reporting, fast navigation in the "ocean of data" are available.

The MCGS features strong capabilities in the area of fault analysis. More than 200 fault causes are recognized automatically and reported by the MCGS in several effective ways.

FLEXIBLE TRAFFIC SCENARIO CONFIGURATION

You can take advantage of a graphical editor to define any single step and timing of any test call. Any possible sequence of keystroke selection by a GSM customer can be reproduced.

Traffic scenarios are easily configured by grouping different kinds of user-defined test calls and by associating them to the MCGS telephone interfaces.

SYSTEM ARCHITECTURE

The MCGS is a modular, open and distributed system, based on a Windows NT Workstation connected, by means of an Ethernet LAN, to a user-definable number of Test Control Boards that can be hosted both in rack-mounted and in transportable platforms.

The Test Control Boards interface the Control Unit and the GSM test or standard mobiles that actually access the GSM network.

ORDERING INFORMATION

For price information: Outside the U.S. contact your local Tektronix representative, inside the U.S. see the price list in the back of this catalog.

RACK PLATFORM

7KM410-Base – MCGS Basic rack set. Includes 19 in. rack unit (12 slots), 1 radio interface board with Ethernet/Lan interface and a branching unit for 12 mobile phones.

7KM410-CONTRL – Radio interface board to control one test phone. Test phone not included. Occupies one slot.

7KM410-SPLITTER-2 – Splitter. Used for a wired connection of the RF output from an MCGS rack to 2 separate BTS, or for combining 2 RF outputs from 2 racks into one output to one BTS. Includes two 2 m coax cables.

7KM410-SPLITTER-4 – Splitter. Used for a wired connection of the RF output from an MCGS rack to 4 separate BTS, or for combining 4 RF outputs from 4 racks into one output to one BTS. Includes two 2 m coax cables.

7KM410-KIT – Accessories for a MCGS rack. Includes: one 20 dB attenuator, 1 antenna; 1 headset with mouthpiece. One compulsory for each rack unit.

7KM410-FP – Filler panel for the empty slots. To be ordered according to the following rule: number of FP = 12 – number of radio interface boards.

7KM410-CABINET – 19 in. Cabinet. Can house up to 2 MCGS racks with telephone trays and AC/DC converters; Includes pre-arranged cabling and fuse block.

7KM410-ACDC – AC/DC Converter 220 V-48 V, 200 W. Power supply for one MCGS cabinet.

7KM410-PC – Desktop PC, Pentium 400 MHz, 128 MB RAM, 9 GB HD, 17 in. color monitor, internal modem, Ethernet LAN communication board, CD-R unit, Windows NT 4.0 in English. Optional.

TRANSPORTABLE PLATFORM

7KM410-TRANS-6 – MCGS 19 in. transportable platform, includes, power unit, AC/DC, dualband antenna, radio interface board with Ethernet/Lan interface filler panels, cables and accessories. Provides 5 slots for additional radio interface boards (7KM410-CONTRL).

7KM410-BRAN-T – Branching unit for 6 phones and 20 dB attenuators.Optional for the MCGS transportable platform.

7KM410-LPC – PC Notebook with 160 MB RAM, Ethernet LAN communication board, Windows NT 4.0 in English. Includes 20 m LAN Cable. Optional.

TEST TELEPHONES

7KM410-OT35-G – SAGEM OT35 Test Telephone for GSM900. Includes 220 V battery charger, 2 rechargeable batteries, user manuals.

7KM410-OT35-D – SAGEM OT35 Test Telephone for DCS 1800. Includes 220 V battery charger, 2 rechargeable batteries, user manuals.

7KM410-OT35-P – SAGEM OT35 Test Telephone for PCS 1900. Includes 220 V battery charger, 2 rechargeable batteries, user manuals.

7KM410-OT75-M – SAGEM OT75 Test Telephone for GSM 900, DCS 1800. Supports EFR. Includes 220 V battery charger, 2 rechargeable batteries, user manuals.

7KM410-OTxx-x-A – Dual cable for connection of a SAGEM telephone, with 90 degr. RF Connector. One has to be ordered for each radio interface board (MCGS-Control and MCGS-CPU-Control).

7KM410-OTxx-x-UPG – Kit for upgrading the software of SAGEM mobile from a PC.

SOFTWARE

7KM410-SW-V-B-R10 – Base and user license for MCGS Application SW – Rel.1.0, in English. First user.

7KM410-SW-V-B-8-R10 – Base and user license for MCGS Application SW – Rel.1.0, in English, from 2nd-8th user.

7KM410-SW-V-B-M-R10 – Base and user license for MCGS Application SW – Rel.1.0, in English, from 9th user.

7KM410-SW-V-12-R10 – Software license for MCGS Application SW for the first to 12th interface.

7KM410-SW-V-24-R10 – Software license for MCGS Application SW for the 13th to 24th interface.

7KM410-SW-V-M-R10 – Software license for MCGS Application SW from the 25th interface.

7KM410-SW-S-B-R10 – Base license for MCGS Voice Quality Measurement SW – Rel.1.0, in English.

7KM410-SW-B-B-R10 – Base license for MCGS Billing Verification SW – Rel.1.0, in English.

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

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Communications Test Sets

CMD80 with IS-136 Support



Features – Benefits

- Fast Measurement Times
- Large LCD Display Enhances the Friendly User Interface
- Minimal Coding Required
- Dual-mode CDMA/Analog Measurements
- Cellular and PCS Frequencies in a Single Test Set
- IS-136 Support

Applications

- CDMA Mobile Phone Testing
- AMPS Mobile Phone Testing
- TDMA Mobile Phone Testing

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

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GPIB IEEE-488

Product(s) complies with IEEE Standard 488.2-1987, RS-232-C, and with Tektronix Standard Codes and Formats.

Tektronix

ROHDE&SCHWARZ
Rohde & Schwarz' quality system complies with the DIN ISO 9001 standard and has been certified by DQS (German Association for the Certification of Quality Systems).

CMD80 Digital Radio Communication Tester

The CMD80 is a multi-protocol mobile handset tester that is optimized for manufacturing test environments, attacking those areas that are most significant to a handset manufacturer; minimized capital expenditure, maximized speed/throughput and reduced test design time.

To reduce capital expenditure, the CMD80 allows the handset manufacturer to create universal test lines. The CMD80 supports all of the following network types without the use of external modules:

- CDMA
- IS-136 (NEW)
- AMPS
- NAMPS
- ETACS
- NTACS
- JTACS

By creating universal test lines, the handset manufacturer reduces the amount spent on spares, training, manufacturing space and labor.

The CMD80 provides maximum speed and throughput for the handset manufacturer. In benchmarks and in field trials, the CMD80 has been demonstrated to be as much as 20% faster than major competitors. This allows the manufacturer to produce more phones per dollar of labor and capital expense.

The CMD80 also uses the concept of test "environments" that allow the CMD80 to execute tests using 1/6th of the code required for most testers.

These environments allow the test programmer to define standard test parameter defaults that are used until they are redefined.

By using the environment technique, the test programmer is not required to repeatedly reissue a laundry list of setup commands each time a test needs to be executed. This reduces the amount of test time overhead, the time required to construct test programs, and the effort required to debug and support test programs. All of this adds up to more reliable testing for less investment.

The CMD80 Digital Radio Communication Tester is a compact tester for CDMA, AMPS, TDMA and other mobiles. The mobile RF parameters are verified under similar conditions as found in a real network; i.e., the tester simulates a base station, makes a call to the mobile, and performs the measurements without any special test modes in the device-under-test. In the CDMA mode the CMD80 measures several key IS 95 parameters using IS 98 methods:

- FER service option 2
- Frame errors
- Waveform quality ρ

- Error vector magnitude
- Phase error
- Magnitude error
- Carrier feedthrough
- Frequency accuracy
- Power measurements
- Base station signaling for mobile testing

SIMULATION OF A BASE STATION

The CDM80 simulates a base station and provides all the signaling necessary to hold up a call:

- Synchronization of mobile
- Registration of mobile
- Incoming/outgoing calls
- Handoffs

During the call, the tester verifies the RF performance and checks the correct operation of the basic signaling features.

The CMD80 does not rely on any special test modes in the mobile station and performs the measurements under conditions almost identical to those in the real network. A voice loop-back allows quick verification of mobile performance as it is perceived by the user.

EASY TO USE

The CMD80 is extremely user friendly and requires little detailed network knowledge. The large high-contrast liquid crystal display provides softkeys on both sides to allow convenient call-up of test routines under menu control.

Easily, the user can switch to a menu and change the current settings of signaling and measurement parameters. The user is guided through the menus by explanatory text and may always return to the default setting with a push of a button.

FAST MEASUREMENTS

State-of-the-art digital technology leads to quick and efficient measurements for rho and power. In remote control mode via IEEE bus, the instrument is exceptionally fast and yields high throughput in production.

TEST CAPABILITIES

All essential characteristics of a mobile station can be tested with high accuracy. The CMD80 not only verifies the RF performance of a mobile but, in addition, checks software features of the mobile which are important for the correct operation of the network. In many cases, this avoids the need for expensive custom test beds in development and QA.

HIGH FLEXIBILITY

Almost every signaling and measurement parameter can be modified by the user in the configuration menus, either dynamically during a test or in advance. Even the tolerances for pass/fail verdicts can be changed to match the requirements of the application.

DC MEASUREMENTS

The DC ammeter/voltmeter designed for pulsed signals allows correct measurement of the power consumption of the mobile station.

CHARACTERISTICS

SIGNAL GENERATOR

CDMA Frequency –
Range:
PCS U.S.: 1930 to 1990 MHz.
PCS Korea: 1805 to 1870 MHz.
U.S. Cellular: 869 to 894 MHz.
Resolution: 1 Hz.
Error: Same as timebase.

Output Level –
RF/In/Out: –20 to –132 dBm.
RF Out2: 0 to –113 dBm.
Resolution: 0.1 dB.
Error (RF In/Out): ≤1.0 dB.

Modulation –
Carrier Suppression: –30 dBc.

ANALYZER

CDMA Frequency –
Range:
PCS U.S.: 1850 to 1910 MHz.
PCS Korea: 1715 to 1780 MHz.
U.S. Cellular: 824 to 849 MHz.
Japan Cellular: 887 to 925 MHz.
Resolution: 1 Hz.
Error: Same as time base.

Power Measurement –
Reference level range:
RF In/Out (full scale): +41 to –28 dBm.
RF In2 (full scale): 0 to –69 dBm.
Measurement error:
Absolute: ≤1.5 dBm.
Relative: ≤0.3 dB (reference level to –30 dB).
Typical: ≤0.5 dB.
Dynamic Range: 50 dB below reference level.

Modulation Analyzer –
ρ error (25 ±10°C): 0.003 (for ρ 0.9 to 1).
Frequency Measurement Range: ±3 kHz.
Frequency Measurement Error: Reference ±30 Hz.
Timing Measurement Error: ±60 ns.

Timebase –
Standard:
Nominal frequency: 10 MHz.
Frequency drift (0 to 35°C): $\leq 1.5 \times 10^{-6}$.
Frequency aging: $\leq 0.5 \times 10^{-6}$ /year (at 35°C).
OCXO Reference Oscillator (Opt CMD B1):
Nominal frequency: 10 MHz.
Frequency drift (0 to 45°C): $\leq 1.1 \times 10^{-7}$.
Frequency aging: $\leq 2 \times 10^{-7}$ /yr ($\leq 0.5 \times 10^{-9}$/day after 30 days operation).
Warm up time(at 25°C): Approx. 5 minutes.

REFERENCE FREQUENCY INPUTS/OUTPUTS

Synchronization Input –
Frequency: 1, 2, 5, or 10 MHz.
Impedance: Approx. 100 Ω.
Level: 0 dBm to TTL.

Synchronization Output –
Frequency: 10 MHz or frequency at synchronization input.
TTL, R_{out} = 50 Ω.

AWGN (ADDITIVE WHITE GAUSSIAN NOISE) GENERATOR

Equivalent Noise Bandwidth – 1.8 MHz typical.
Gain Adjustment Range – -20 to +6 dB of forward channel power.

DC VOLTAGE MEASUREMENTS

Range – 0 to ±30 V.
Resolution – 10 mV.
Error – 2% + resolution.

DC CURRENT MEASUREMENT

Mode – Averaging, + peak, – peak.
Range – 0 to ±10 A.
Common-mode Rejection – ±30 V.
Shunt Resistance – 50 mΩ.
Resolution for Averaging – 1 mA/10 mA.
Resolution for Peak – 10 mA.
Residual Indices – <10 mA.
Error – <2% + resolution + residual indication.

ENVIRONMENTAL

Temperature Range –
Operating: 0 to +45° C, to DIN IEC 68-2-1/2.
Nonoperating: –40° to +60° C.

Electromagnetic Compatibility –
Corresponds to the requirements of European EMC directive (89/336/EEC).

POWER SUPPLY

Line Voltage – 110 to 120 V AC ±10%, 200 to 240 V AC ±10%.

Line Frequency – 50 to 400 Hz ±5%.
Electrical Safety – VDE 0411, class 1, IEC 1010-1, EN6101 part 1.

PHYSICAL CHARACTERISTICS

Dimensions	mm	in.
Height	192	7.6
Width	435	17.1
Depth	363	14.3
Weight	**kg**	**lb.**
Without options	≈ 15	≈33

ORDERING INFORMATION

For price information: Outside the U.S. contact your local Tektronix representative, inside the U.S. see the price list in the back of this catalog.

CMD80
Digital Radiocommunication Tester.

Includes – Power Cord, Manual.

Standard – CDMA Support, 800 MHz (U.S. Cellular), Memory Card Interface.

Opt. B1 – OCXO Reference Oscillator. Ensures high absolute accuracy, minimum temperature-dependent drift, and especially high long-term stability.

Opt. B84 – TDMA Support.

Opt. B14 – Rate set 2 (13K) Vocoder.

Opt. CMD-B17IQ – I/Q Outputs.

Opt. B3 – Reference Frequency Inputs/Outputs.

Opt. B60 – Adapter for Opt. B61 and Opt. B62 (standard).

Opt. B61 – IEC/IEEE Bus Interface.

Opt. B62 – Memory Card Interface (standard).

Opt. B81 – AWGN Generator. Allows testing mobile with additional noise (requires Opt. 04 Adapter).

Opt. K2 – Adds PCS.

Opt. K1 – Adds Cellular (standard).

Opt. B82 – AMPS Support.

Opt. MM18 – Message Monitor.

ZZA-94 – ZZA-94 – Rackmount Adapter.

MEASUREMENT SERVICE OPTIONS

Opt. C3 – Three years of Calibration Services.

Opt. D1 – Cal Data Report.

Opt. D3 – Test Data (requires Opt. C3).

Opt. R3 – Repair warranty extended to cover three years.

ADDITIONAL ACCESSORIES

MM18 – Message Monitor.

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

CE

GPIB IEEE-488

Product(s) complies with IEEE Standard 488.2-1987, RS-232-C, and with Tektronix Standard Codes and Formats.

Tektronix

ROHDE&SCHWARZ
Rohde & Schwarz' quality system complies with the DIN ISO 9001 standard and has been certified by DQS (German Association for the Certification of Quality Systems).

Communications Test Sets

CRTC02



Features – Benefits

Automatic Measurements and Logging Using Supplied Test Procedures

Built-in TTL Inputs/Outputs in the Transmit and Receive Path

Fast and Reliable Testing of Modules and Complete Mobile Stations

Automatic Test Routines

Simulate Base Station with Call Setup, Data Transfer and All Signaling Procedures Between CRTC02 and the Station-Under-Test

Log All Signaling Activities in OSI Layers 1, 2 and 3 for Protocol Analysis; Mnemonic Display of Message Content for Protocol Troubleshooting

Check Error-correction Facilities of the Mobile Station by Implanting Errors in the Data Stream

Transmitter Measurements:
- Power Ramp and Phase Trajectory
- Burst Delay
- Frequency Error

Receiver Measurements:
- Bit Error Rate in Real Time
- Receiver Sensitivity

Speech Coder and Decoder Tests

Numerical and Graphical Output of Results

IEC/IEEE Bus Interface (Opt. 04)

Applications

Measurements on GMSK-modulated RF Signals and Receiver Testing

Testing for Compliance with GSM, DCS 1800 and PCS 1900 Recommendations

Simple Generation of Customized Test Procedures

Research and Development

Quality Assurance

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

CE

GPIB IEEE-488

Product(s) complies with IEEE Standard 488.2.

ROHDE&SCHWARZ
Rohde & Schwarz' quality system complies with the DIN ISO 9001 standard and has been certified by DQS (German Association for the Certification of Quality Systems).

CRTC02 Radiocommunications Test Set

The CRTC02 provides signal generation, signal measurement and user-friendly software. They are extremely powerful test sets, providing all simulation and analysis capabilities – from measurement of GSM/DCS 1800/PCS 1900-specific signals to detailed checking for hidden errors in signaling.

SIGNALING

The CRTC02 accurately simulates the functions of an ideal base station. For troubleshooting on the unit-under-test, the signaling parameters can also be varied.

All layer 1 channel coding, as well as layer 2 signaling, is automatically performed in real time. The layer 3 signaling sequence is defined by special test programs.

PROTOCOL ANALYSIS

Every transmitted or received layer 2 or layer 3 message, or even the bits of a burst, are marked with a frame number and recorded in the log memory. Depending upon whether everything is logged or just selected logical channels, the log can cover a interval between ten seconds and 15 minutes. The logged messages are displayed in mnemonic form on the screen, using the same basic mask as the message editor.

BURST ANALYSIS

After data have been logged, power ramping as well as phase and frequency errors are calculated and displayed as a whole. Detailed analysis is supported by the zoom function.

To check the timing-advance measurement function of a mobile station, the CRTC02 measures the arrival of the burst and monitors the response of the mobile station to timing advance commands in the generator channels.

To permit synchronization of external measuring instruments, a spectrum analyzer for example, the CRTC has a trigger output for automatically starting measurement at the beginning of a burst.

TESTING RECEIVER SENSITIVITY

In the loop-back mode, bit error rates (BER) can be measured in real to test the receiver sensitivity of a mobile station.

The same test can be made on base stations by applying a signal modulated with a CCITT test pattern to the receiver input.

ACOUSTIC TESTS

These tests are supported by the built-in speech coder function and the Digital Audio Interface (DAI) of the mobile station as defined in Recommendation 11.10.III.6.4.

A serial EMMI is provided for remote control of the mobile station.

AF MEASUREMENTS (OPTION 01)

A wide range of audio measurements can be performed on the AF section of the station-under-test. The AF generator provides single or double tones. The following measurement functions are implemented:

- AF voltmeter with RMS or peak weighting
- Continuously tunable distortion and SINAD meter
- AF frequency counter
- DC ammeter/voltmeter

CHARACTERISTICS

ANALOG UNIT

SIGNAL GENERATOR

Frequency Range –
GSM band: 935 to 960 MHz.
DCS 1800 band: 1805 to 1880 MHz.
PCS 1900 band: 1930.2 to 1989.8 MHz.

Hop Size – Any frequency step within GSM, DCS 1800, or PCS 1900 bands.

Frequency Fine Tuning – 0 to 60 Hz with about 2 Hz resolution.

Frequency Setting – <500 µs (to within <4° of final phase).

Spurious Phase Modulation – <1° RMS, <4° peak.

Frequency Drift – $<2 \times 10^{-9}$/°C.

Aging (After 30 Days Operation) – $<2 \times 10^{-9}$/day.

Maximum Output Level – 13 dBm.

Static Attenuation Setting – 0 to 135 dB. Resolution: 5 dB.

Dynamic Attenuation (Electronic) – 0 to 35 dB.

Level Error (Dynamic Attenuation 0 dB) – <1.5 dB from – 122 to +13 dBm.

Modulation – GMSK, bit rate 270833 bit/s to GSM Rec. 05.04.

Burst Delay – -4.6 to +4.6 ms, variable in 0.46 steps.

ANALYZER

Frequency Range –
GSM band: 890 to 915 MHz.
DCS 1800 band: 1710 to 1785 MHz.
PCS 1900 band: 1850.2 to 1909.8 MHz.

Reference Level for Full Dynamic Range (Adjustable in 3 dB Steps) –
RF IN/OUT: 9 to 36 dBm.
RF IN 2: –21 to +6 dBm.

Level Error – <2 dB.

Sampler – Two 12-Bit A/D converters for I and Q signals, sampled at 1.083 MHz (4 samples per bit).

SYNCHRONIZATION

10 MHz output, 10 MHz input/output, 52 MHz output, slot sync output.

INPUTS/OUTPUTS

Fading Simulator – Two type N connectors, 50 Ω per channel.
Output Level – 8 to 13 dBm.
RF IN/OUT and RF IN 2 – N-type female connectors, 50 Ω.
Speech Coder Input –
Full dynamic range: 20 mV to 2 V.
R_{in}: 100 kΩ.
Speech Decoder Output –
Full dynamic range: 2 V.
R_{out}: <3 Ω.
Audio Monitor – Built-in loudspeaker, headphones connector, volume control.
Modes – Voltmeter, AF generator, speech decoder, speech coder.

DIGITAL UNIT

Processor – Pentium 233 MHz.
RAM – 8 MB.
Hard Disk – 2 GB.
Floppy Disk Drive – 3.5-in., 1.44 MB.
Graphics – VGA.
Interfaces – IEC-625/IEEE 488 bus; RS-232C; Centronics; Keyboard connector on front and rear panels; CODEC input/output; Control interface; DAI/EMMI.

AF MEASUREMENT UNIT (OPT. B1)

AF GENERATOR

Signal Source –
Single or dual tone:
Frequency range: 20 Hz to 20 kHz.
Output level (RMS): 10 µV to 5 V.
Output impedance: <3 Ω.

AF Voltmeter –
Modes: RMS, + Peak, – Peak.
Frequency range: 50 Hz to 20 kHz.
Level range (RMS): 0.1 mV to 30 V.

Weighting Filters –
CCITT filter: To CCITT 0.41.
Programmable highpass filter: 107 Hz to 10.6 kHz.
Programmable lowpass filter: 235 Hz to 21 kHz.
Programmable notch filter: 100 Hz to 5 kHz (notch frequency).

Distortion and SINAD Meter –
Fundamental frequency range: 100 Hz to 5 kHz.
Measurement range: 0 to 50%, 1 to 50 dB.

Safety – EN61010-1, IEC61010-1.

ORDERING INFORMATION

For price information: Outside the U.S. contact your local Tektronix representative, inside the U.S. see the price list in the back of this catalog.

Opt. 2T – Advanced Training.

Opt. B1/CRTP-B1- AF Measurement Unit.

Opt. B2/CRTS-B1 – AF Measurement Unit.

Opt. B4/CRT-B4 – Half rate/enhanced full rate sheet coder.

Opt. B7/CRTP-B7 – I/Q Inputs/Outputs.

Opt. B9/CRTP-B9 – 2nd internal pilot synthesizer.

MEASUREMENT SERVICE OPTIONS

Opt. C3 – Three years of Calibration Services.

Opt. D1 – Cal Data Report.

Opt. D3 – Test Data (requires Opt. C3).

Opt. R3 – Repair warranty extended to cover three years.

SOFTWARE

GSM Phase 2+ Operation Software – Required on the CRTC02 Slave and Master Unit. Order CR02P2P.

One Year Software Upgrade for CR02P2P – Required on the CRTC02 Slave and Master Unit. Order C2P2PSC.

Basic Software for Multislot – Transparent data services. REQUIRED on master Unit only. REQUIRES CRT-K8. Order CR49P2P.

Channel Coder for 14.4 Kbit – Used to permit investigation of the channel encoder software. Order CRT-K9.

Basic Operation Software for Communication Between CRTx Master and Slave (DUO) – Required on the CRTC02 Master Unit. Order CR02DUO.

One Year Software Upgrade for CR02DUO – Required on the CRTC02 Master Unit. Order C2DUOSC.

DUO – Allows the connection of two CRTC02s in order to handle multislot applications. Required on the CRTC02 Master Unit. Order CRT-U5.

GSM900/1800/1900 Audio Testcases – Section 30. Audio Analyzer UPL15 required. Order CRTKAUD.

One Year Software Upgrade for CRTKAUD – Order CRAUDSC.

Testcases for EGSM and R-GSM (Railway) – Order CRTKEGS.

One Year Software Upgrade for CRTKEGS – Order CREGSSC.

Test SIM Card – Order CRT Z2.

GSM/DCS 1800 Phase 2 Basic Software – Order CR02PH2.

SMS/TDS Phase 2 Basic Software for GSM/DCS 1800 – Order CR48 PH2.

Ciphering Software – Order CRTS-K1.

Ciphering Software (A5-2) – Order CRTS K2.

PCS1900 Phase II Test Case – Order CRTPK72.

PCS1900 Phase II Test Case – Order CRTPK73.

PCS1900 Phase II Test Case – Order CRTPK74.

PCS1900 Handover Phase II Test Case – Order CRTPK75.

PCS1900 Supplementary Service Phase II Test Case – Order CRTPK78.

PCS1900 Phase II SMS Test Case – Order CRTPK79.

GSM TDS Phase II Test Case – Order CRTPK5A.

DCS1800 TDS Phase II Test Case – Order CRTPK6A.

PCS1900 TDS Phase II Test Case – Order CRTPK7A.

GSM NTDS Phase II Test Case – Order CRTPK5B.

DCS1800 NTDS Phase II Test Case – Order CRTPK6B.

PCS1900 NTDS Phase II Test Case – Order CRTPK7B.

GSM Phase II Bundled Test Case – Order CRTBR19.

DCS1800 Phase II Bundled Test Case – Order CRTBR31.

PCS1900 Phase II Bundled Test Case – Order CRNATA.

Half Rate/Data Channel Coding – Order CRT-K3.

HSCSD/Multislot Channel Coding – Order CRT-K8.

NTDS/RLP Basic Software – Order CR28PH2.

HR/EFR Speech Coder – Order CRT-B4 Hardware and CRT-K5 and CRT-K7 Software.

Multiband Handover – Order CRT-B9 Hardware and CRTMKB1 Software.

GSM Phase 2 Test Cases – Order CRTP K52.

GSM Phase 2 Test Cases – Order CRTP K53.

GSM Phase 2 Test Cases – Order CRTP K54.

GSM Handover Test Phase 2 – Order CRTP K55.

GSM Test Cases Phase 2 – Order CRTP K56.

GSM Phase 2 Supplementary Service Test Case – Order CRTP K58.

GSM Phase 2 SMS Test Case – Order CRTP K59.

DCS 1800 Phase 2 Test Case – Order CRTP K62.

DCS 1800 Phase 2 Test Case – Order CRTP K63.

DCS 1800 Phase 2 Test Case – Order CRTP K64.

DCS 1800 Handover Test Phase 2 – Order CRTP K65.

DCS 1800 Test Cases Phase 2 – Order CRTP K66.

DCS 1800 Supplementary Service Test Case – Order CRTP K68.

DCS 1800 Phase 2 SMS Test Case – Order CRTP K69.

ADDITIONAL ACCESSORIES

One Year Software Upgrade for:

CRTPK52 – Order CPK52SC.

CRTPK53 – Order CPK53SC.

CRTPK54 – Order CPK54SC.

CRTPK55 – Order CPK55SC.

CRTPK56 – Order CPK56SC.

CRTPK58 – Order CPK58SC.

CRTPK59 – Order CPK59SC.

CRTPK5A – Order CPK5ASC.

CRTPK5B – Order CPK5BSC.

CRTPK62 – Order CPK62SC.

CRTPK63 – Order CPK63SC.

CRTPK64 – Order CPK64SC.

CRTPK65 – Order CPK65SC.

CRTPK66 – Order CPK66SC.

CRTPK68 – Order CPK68SC.

CRTPK69 – Order CPK69SC.

CRTPK6A – Order CPK6ASC.

CRTPK6B – Order CPK6BSC.

CRTPK72 – Order CPK72SC.

CRTPK73 – Order CPK73SC.

CRTPK74 – Order CPK74SC.

CRTPK75 – Order CPK75SC.

CRTPK76 – Order CPK76SC.

CRTPK78 – Order CPK78SC.

CRTPK79 – Order CPK79SC.

CRTPK7A – Order CPK7ASC.

CRTPK7B – Order CPK7BSC.

CRTKMB1 – Order CRMB1SC.

2 GB Hard Drive – Order CRTS-B2.

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

CE

GPIB IEEE-488

Product(s) complies with IEEE Standard 488.2.

ROHDE&SCHWARZ

Rohde & Schwarz' quality system complies with the DIN ISO 9001 standard and has been certified by DQS (German Association for the Certification of Quality Systems).

COMMUNICATIONS TEST SETS

CMD53 • CMD55



FEATURES – BENEFITS	APPLICATIONS
Go/Nogo Test as well as Service Mode for Exact Fault Location	Development & QA
CMD53	Production
GSM900, GSM1800 and GSM1900	Service
Testing of Handover From GSM900 and Back	
Other Features as CMD50	

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

CE

GPIB IEEE-488

Product(s) complies with IEEE Standard 488.2-1987, RS-232-C, and with Tektronix Standard Codes and Formats.

ROHDE&SCHWARZ
Rohde & Schwarz' quality system complies with the DIN ISO 9001 standard and has been certified by DQS (German Association for the Certification of Quality Systems).

MEETING THE CHALLENGES OF MODERN COMMUNICATIONS

- Go/nogo tests and comprehensive testing of mobiles
- Powerful signaling capabilities
- Short measurement time ensuring high throughput
- High measurement accuracy
- Simple interactive operation
- No specialized GSM knowledge required
- Service mode for exact fault location
- Autotest – complete mobile testing at a keystroke
- Very fast remote control operation
- Compact and lightweight
- Excellent price/performance ratio

MANUAL OPERATION PHILOSOPHY

Research and development engineers have found the CMD's large clear LC display and user interface with logically structured menus unsurpassed when measuring RF parameters. This is true both in the manual test mode and in the flexible module test with system-specific signal generator and burst analyzer. During call setup the network and system-specific signaling parameters allow the R&D engineers to control the influence of signaling parameters on the mobil's behavior in the network.

USER-DEFINABLE AUTOTEST

The user-friendly display and operation of the CMD is a main requirement when testing manually, but for automated testing, the engineer wants a quick and easy way to a ready-made autotest or he has to create his own test script for the specific task to be performed. The CMD family of testers offers different ways of creating such autotests and test scripts, depending on the CMD model and the test requirements.

FAST IEEE-BUS

In a production line there are two main factors that contribute to high throughput and product quality: IEC/IEEE-bus speed and measurement repeatability.

The CMD offers the fastest IEEE-bus operation available. With combined measurements and measurements like RF peak power which takes only milliseconds, time-consuming power level adjustments where multiple measurements are required are completed in seconds. The level of measurement repeatability offered ensures the highest possible quality of the end product leaving the factory.

COVERING ANY NEED FOR TEST MODES

Service and repair of digital mobiles and cordless phones call for a variety of tests, ranging from simple go/nogo tests to complete factory-like production tests and calibration of the phone. The CMD range offers cost-effective solutions for manual testing, stand-alone autotest, as well as remote RS232 operation solutions covering any need for testing. Every CMD comes, of course, with the same large display and user interface for manual test of phones and/or modules and RS232 interface for remote operation.

BASE STATION SURVEY MEASUREMENTS

These are often done on real base stations or by using analog signal generators with power amplifiers. The CMD is able to simulate any GSM base station BCCH, including parameters like MCC, MNC, NCC, BA list, DTX and DRX information. These and the "cell barred" feature enable close-to-life conditions without having to use a real BTS.

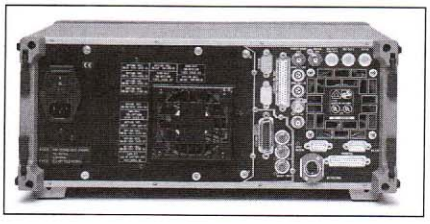
Safety – UL3111-1, CSA1010.1.

TAILORED TO YOUR APPLICATION

OPTIONS

Name	Description	Notes
Opt. B1	OCXO reference oscillator, aging ±1 x 10^{-7}. Ensures high absolute accuracy, minimum temperature-dependent drift and especially high long-term stability. Used for measurements with exacting requirements on frequency stability.	Cannot be ordered with Opt. B2
Opt. B17	I/Q signals from the CMD modulator and burst trigger signals are provided for Rohde&Schwarz Signal Generator SMIQ for GSM-conformity tests under fading conditions.	
Opt. B19	GSM1900 mobile and base station test. Provides the capability to test GSM1900 mobiles used on the North American market. Includes factory recalibration of unit.	For CMD53, 55 as of Serial No. 837176
Opt. B2	High-stability OCXO, aging 3.5 x 10^{-8}. Oven crystal with highest long-term stability. Ensures compliance with tolerances specified by GSM. Used for highly demanding requirements on frequency stability to GSM 11.20.	Cannot be ordered with Opt. B1
Opt. B20	GSM-specific voltage and current measurement. Allows readings to be taken in synchronicity with the GSM pulsed mode.	Comes as standard in all models except CMD53
Opt. B3	Multifrequency reference input/output. For synchronizing DUT and measuring instrument with internal or external frequencies. Allows synchronization of CMD to an internal or external frequency of 2.048, 10, 13, 26, 39, 52 MHz, or to the GSM bit clock.	
Opt. B30	High-level RF output/sensitive RF input. In addition to the normal RF I/O the CMD has optionally a high-sensitivity input and a high-level output which enable over-the-air tests on modules or handhelds by means of couplers like CTD-Z10.	Comes as standard in all models except CMD53
Opt. B4	Fast power ramp, phase/frequency error & BER measurement. Provides fast testing and numeric/graphic display of power bursts and phase/frequency error as well as various BER, RBER and FER test routines (necessary for Autotest).	Required for options Opt. B41, Opt. B42, Opt. B43, Opt. B44 and Opt. K43
Opt. B41	Includes audio frequency (AF) generator, voltmeter, distortion meter and frequency counter. Allows measurements on the audio interface or on modules. Enables frequency measurements up to 60 MHz which is required for LO alignment.	Requires Opt. B4
Opt. B42	High dynamic range burst analyzer. Enhances the dynamic range to more than 72 dB and allows the power ramp to be measured in the entire specified GSM, GSM1800 and GSM1900 range. Determines whether transmitter blanking in inactive time slots is correct.	Requires Opt. B4
Opt. B43	Carries out GSM measurements of spectrum due to switching and modulation according to the GSM, GSM1800 and GSM1900 recommendations faster than any spectrum analyzer.	Requires Opt. B4 and Opt. B42
Opt. B44	Audio multitone option based on DSP techniques. Makes it possible to generate and measure up to 14 tones in about a second. Useful for loudness rating, frequency response and intermodulation analysis.	Requires Opt. B4 and Opt. B41
Opt. B51	Internal GSM full rate (FR) and enhanced full rate (EFR) speech coder/decoder. This option converts digital speech signals into analog signals and vice versa, allowing for separate uplink and downlink audio measurements.	-
Opt. B6	Adapters for B6x options. Provides GSM specific signals and trigger signals for CMD52/55/65 on the multifunction connector at the front of the instrument.	Required for options Opt. B61 and Opt. B62
Opt. B61	IEC/IEEE 488-bus interface. Remote control alternative to the RS-232-C interface fitted as standard. Used for fast remote control of CMD.	Requires Opt. B6
Opt. B62	Memory card interface. Allows storage of instrument setups and fast and easy upgrade to new software features. Highly recommended.	Requires Opt. B6
Opt. K43	Narrowband spectrum analyzer. This option is used for narrowband spectrum analysis (i.e., adjustments of I/Q modulators). Analysis of constant envelope and burst signals is possible.	Requires Opt. B4
Opt. K80	Frequency extension option. For CMD5x and CMD65. Additional frequency range R-GSM.	Requires Opt. U10
Opt. U1	Upgrade to GSM multiband functionality. Allows for GSM dual-band handover with CMD53 and CMD55.	Some mobiles require Opt. U20 to ensure correct dual-band handover operation

Name	Description	Notes
Opt. U10	8 MB memory extension for CPU1 or CPU2. This update allows the use of several advanced software features such as GSM dual-band handover, fast BER measurement (burst-by-burst) and R-GSM band.	Only applicable to older versions of CMD53 and CMD55
Opt. U11	High-speed processor including 8 MB RAM. Allows for the latest software versions with the functionality as mentioned in this data sheet and ensures future updates.	For older versions of CMD55 only
Opt. U12	Modification for fast BER (burst-by-burst) capability.	For older versions of 55 only
Opt. U13	10 dB higher sensivity at RF input/output N connector. RF input level range –10 dBm to +37 dBm instead of 0 dBm to +47 dBm.	Only for GSM signals
Opt. U18	Output level of –15 dBm for RF input/output N connector. RF out 2 becomes non-functional, RF in/out 6 dB more sensitive (max. +40 dBm).	Only for GSM signals
Opt. U19	GSM1900 mobile test. Provides the capability to test GSM1900 mobiles used on the North American market. Same as CMD-B19 if installation and recalibration can be done at the local R&S service center.	For CMD53, 55 as of Serial No. 837176 and CMD65 only
Opt. U20	A special RF converter for the CMD53/55 enables handover between GSM900 and GSM1800/1900 while maintaining the BCCH in the band (lower/upper) in which the handover was initiated. Standard in current version of CMD55.	For older CMD53 in conjunction with Opt. U10 only
Opt. U5	GSM time synchronization signal and demodulated I and Q signals are copied from the multifunction connector to three BNC connectors at the rear panel.	Not compatible with instruments upgrades Opt. U56. Factory installation
Opt. U56	Upgrade to support DECT in CMD53/55 multiband testers.	See under Opt. U5. Factory installation
Opt. U61	Frequency extension upgrade covering "DECT Latin America," for CMD60 and CMD65.	For D version hardware only. Factory installation
Opt. U65	GSM multiband upgrade for CMD60. Functionality comparable to CMD6.	Factory installation



ORDERING INFORMATION

For price information: Outside the U.S. contact your local Tektronix representative, inside the U.S. see the price list in the back of this catalog.

RECOMMENDED INSTRUMENTS AND OPTIONS

	Development & QA	Production	High-end service	Service
Opt. B1	x	x	x	+*2
Opt. B2	+	x	+*2	x
Opt. B4	+	+	+	+
Opt. B51	+	+	+	x
Opt. B17	+	x	x	x
Opt. B41	+	+	+	x
Opt. B43	+	+	+	x
Opt. B61	+	+	-	-
Opt. B62	+	+	+	+
Opt. K43	+	+	+	x
Opt. U10	-	-	x	x
Opt. U11	+	+	+	+
Opt. U13	x	+	x	x
Opt. U20	+	+	+	x

+ highly recommended

x recommended

- not recommended

**1 External frequency reference may be used, if available.*

**2 One of two OCXOs should be installed to ensure high frequency accuracy.*

DIGITAL RADIOCOMMUNICATION TESTERS

CMD 53

CMD 55

Includes: Power Cord, Operating Manual, Fuses, Calibration with Certificate CMD-CAL.

RECOMMENDED ACCESSORIES

GSM Test SIM – (Essential for BER measurements). Order CRT-Z2.

Formatted Memory Card – (Opt. B62 required). Order CMD-Z1.

Shielded Chamber – With antenna coupler for mobile radio. Order CTD-Z10.

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

CE

GPIB IEEE-488

Product(s) complies with IEEE Standard 488.2-1987, RS-232-C, and with Tektronix Standard Codes and Formats.

ROHDE&SCHWARZ
Rohde & Schwarz' quality system complies with the DIN ISO 9001 standard and has been certified by DQS (German Association for the Certification of Quality Systems).

Communications Test Sets

CTS 55



Features – Benefits

- Screen, Diagnose and Facilitate Repair of GSM/PCS 1900 Mobiles
- Light Weight and Small Size for Stationary, Portable and Mobile Use
- Comprehensive Mobile Phone Testing
- High Measurement Accuracy

Applications

- Mobile Phone Testing
- Network Operator Repair Centers
- Independent Dealerships
- Central Repair Deports

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

ROHDE&SCHWARZ
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CTS 55 Digital Radio Tester

The CTS 55 Digital Radio Tester is a compact unit for testing GSM, DCS 1800 and PCS 1900 mobile phones.

THREE STEPS TO REPAIR

With an ideal combination of Quick, Auto and Manual Test, the CTS 55 caters to all steps in the process. Quick Test allows the operator to quickly check the true status of returned phones. Auto Test provides for fast diagnosis of the faulty parameter. Manual Test allows the operator to concentrate on a particular parameter during the repair phase.

ALL THE NEEDED MEASUREMENTS

The CTS provides the following measurement and test functions:

- Call setup and cleardown (incoming and outgoing)
- Free selection of channels
- Power and channel change
- Echo test
- Power measurement
- Receiver sensitivity test through bit error rate measurement as well as RxLev and RxQual
- Phase and frequency error
- Dynamic range for measuring power ramp, GSM > 55 dB

Ordering Information

For price information:
Outside the U.S. contact your local Tektronix representative, inside the U.S. see the price list in the back of this catalog.

CTS 55
Digital Radio Tester.
Includes: Power Cord, Operating Manual.

CTS 55 OPTIONS
Opt. B1 – OCXO 2 x 10^{-7}/year Reference Oscillator.
Opt. B7 – Module Test and Output RF.
Opt. K6 – Remote Control support via RS232.

MEASUREMENT SERVICE OPTIONS
Opt. C3 – Three years of Calibration Services.
Five years of Calibration Services.
Opt. D1 – Cal Data Report.
Opt. D3 – Test Data (requires Opt. C3).
Opt. R3 – Repair warranty extended to cover three years.

RECOMMENDED ACCESSORIES
GSM Test SIM – Order CRT-Z2.
Standard PC Keyboard – Order PSA-Z2.

Communications Test Sets

CMD57



Features – Benefits

- Complete Range of Transmitter and Receiver Measurements
- Large Illuminated LCD Display for Fast Reading of Parameters and Measured Values
- Menu-guided User Interface for Quick Tests as Well as for In-depth Analysis
- Softkey Control with Display of All the Important Parameters Enabling Operator to Work Error-free
- Extremely Short Setting and Measuring for Both Manual and Remote Control via IEEE Bus
- A_{bis} Control Options Available
- In-service Testing Option

Applications

- GSM 900, DCS 1800, and PCS 1900 Base Station Measurements
- Manufacturing, Installation, and Maintenance

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

GPIB IEEE-488

Product(s) complies with IEEE Standard 488.2.

ROHDE&SCHWARZ
Rohde & Schwarz' quality system complies with the DIN ISO 9001 standard and has been certified by DQS (German Association for the Certification of Quality Systems).

CMD 57 Digital Radiocommunication Tester

The CMD 57 Digital Radiocommunication Tester is a compact unit for testing GSM, DCS 1800 and PCS 1900 base stations (BTS) and BTS modules. It allows measurements on base station transmitters and receivers without affecting calls in progress. With the in-service test option, measurements can be made without taking a cell site out of service.

DETAILED KNOWLEDGE NOT REQUIRED

The CMD 57 is easy to use and is equally at home in production, installation and service environments. Ease of use goes beyond the front panel. All parameters can be individually modified in the configuration menu to allow easy adaptation to stringent user-specific tolerances. Any parameters that have modified with respect to the default standard specifications are clearly shown on the display.

Additional attenuators, cables, and amplifiers are often required for connecting to the BTS. The effect of these additions are taken into account by the CMD 57 when calculating the measurement results.

TEST YOUR TRANSMITTER

The following GSM/DCS/PCS specific measurements are available for transmitter testing:

- Mean RF carrier power
- Power ramping
- Phase/frequency error
- Spectrum due to modulation
- Spectrum due to switching

Measurements results on the transmitter's traffic channel (TCH) are obtained by simply switching to the corresponding menu. The results are graphically displayed along with applicable statistical functions.

... AND RECEIVERS TOO

You can also make the required tests on receivers.

- Bit error rate (BER)
- Adjacent time slot rejection

PLUS MANY OTHER MEASUREMENTS

You can also make may other base station measurements with the CMD 57 including:

- Echo test

- Module tests without signaling or time synchronization
- Alignment using built-in multifunction RF generator
- AF measurements with optional frequency counter

CHARACTERISTICS

ENVIRONMENTAL

Rated Temperature Range – 0 to +45°C (to DIN IEC 68-2-1/2).

Storage Temperature Range – -40 to +60°C.

Electromagnetic Compatibility – Complies with requirements of European EMC directive (89/336/EEC).

Mechanical Resistance –
Sine vibration: DIN IEC 68-2-6, 5 to 55 Hz, amplitude 0.15 mm, two cycles;
Random vibration: DIN 40046, part 24, 10 to 300 Hz, 10 ms/s2 rms, 5 min/axis;
Shock: To MIL-STD-810D, 400 m/s2, shock spectrum in six main axes.

POWER REQUIREMENTS

Line Voltage – 100 to 120 V AC ±10%; 200 to 240 V AC ±10%.
Line Frequency – 50 to 400 Hz ±5%.
Power Consumption (without options) – Approx. 85 W.
Safety – UL3111, CSA1010.1.

PHYSICAL CHARACTERISTICS

Dimensions	mm	in.
Height	192	7.6
Width	435	17.1
Depth	363	14.3
Weight	**kg**	**lb.**
Without options	Approx. 14	30.8

ORDERING INFORMATION

For price information: Outside the U.S. contact your local Tektronix representative, inside the U.S. see the price list in the back of this catalog.

CMD57
Digital Radiocommunication Tester.
Includes: Power Cord, Operating Manual, Spare Fuses.

CMD57 OPTIONS
Opt. B1 – OCXP 1.5 x 10^{-6} Reference Oscillator.
Opt. B2 – OCXO 1.5 x 10^{-7} Reference Oscillator.
Opt. B3 – Reference Frequency Inputs/Outputs.
Opt. B5 – Real Time Speech Coder/Decoder.
Opt. B6 – Adapter for Other Options.
Opt. B7 – A_{bis} interface E1 and T1 (ver 6); includes 64– and 16-KBit Signaling.
Opt. B8 – In Service Testing (Opt. B6 required).
Opt. B19 – Support for PCS1900.
Opt. B41 – AF Measurement with Frequency Counter.
Opt. B43 – Spectrum Analyzer Narrow Band.
Opt. B44 – Multitone Audio Analysis (Opt. B41 and 8 MHz RAM required).
Opt. B61 – IEEE 488 Bus Interface (Opt. B6 required).
Opt. B62 – Memory Card Interface (Opt. B6 required).
Opt. K10 – Ericsson A_{bis} Control Software (RBS2000, RBS200).
Opt. K11 – Nokia A_{bis} Control Software (DE21, DE34, DE45).
Opt. K13 – NMC A_{bis} Control Software (S2000, S4000).
Opt. K14 – Siemens A_{bis} Control Software (BS20, BS60).
Opt. K30 – Signaling Software for MOC/MTC.
Opt. K43 – Narrowband Spectrum Analyzer Software.
Opt. K51 – Ciphering Software.
Opt. U3 – 11 dBm Second RF Output (9 dBm).
Opt. U5 – I/Q Demod Outputs and Trigger Input (BNC Connectors on Rear Panel).
Opt. U6 – Extended Attenuation to 47 dB.

MEASUREMENT SERVICE OPTIONS
Opt. C3 – Three years of Calibration Services.
Opt. D1 – Cal Data Report.
Opt. D3 – Test Data (requires Opt. C3).
Opt. R3 – Repair warranty extended to cover three years.

RECOMMENDED ACCESSORIES
Soft Carrying Case – Order CMD-Z40.
Handset – Order CMD-Z50.
Memory Card (Opt. B62 required) – Order CMDZ1.
Transit Case – Order ZZK-014.
A_{bis} Cable (2 meter) – Order CMD-Z20.
A_{bis} and RF cables for Ericsson RBS2000 BTS – Order CMD-Z21.
A_{bis} and RF cables for Siemens SBS BS20 BTS – Order CMD-Z22.
A_{bis} and RF cables for Ericsson RBS2000 BTS – Order CMD-Z23.
A_{bis} and RF cables for Nokia DE21/34 BTS – Order CMD-Z24.
A_{bis} and RF cables for Nokia DE45 BTS – Order CMD-Z25.
Note: For addition of options to existing units, please consult with your Tektronix representative.

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

GPIB IEEE-488
Product(s) complies with IEEE Standard 488.2.

ROHDE&SCHWARZ
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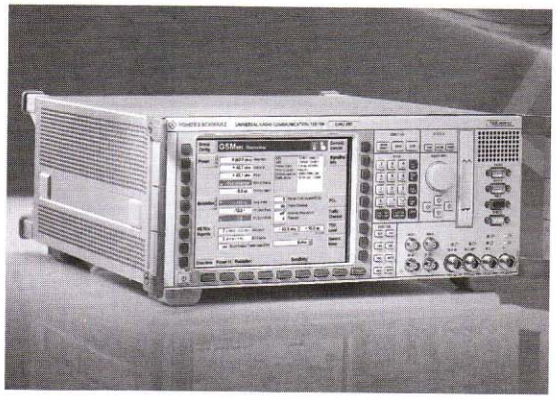
Radio Communications Tester

New CMU 200



Features – Benefits	Applications
Supports CDMA, AMPS, TDMA, GSM	CDMA Mobile Phone Testing
Executes Commands in Parallel for High Speed	TDMA Mobile Phone Testing
Temperature Corrected for High Accuracy	GSM Mobile Phone Testing
Buy What You Need Modularity Concept	AMPS Mobile Phone Testing
Designed for Growth into 3rd Generation Phones	Non-signaling Phone Testing
	3rd Generation Phone Testing

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ROHDE&SCHWARZ
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CMU 200 Radio Communications Tester

The CMU 200 Radio Communications Tester is a compact, light-weight unit designed to test existing CDMA, TDMA (IS-136), AMPS and GSM phones. Additional capability will be added to the CMU to support emerging standards such as W-CDMA, CDMA 2000 and Bluetooth.

PARALLEL PROCESSING FOR HIGH THROUGHPUT

Optimized for production environments, the CMU reaches new levels in test speed, measurement accuracy and expandability. Through the use of parallel command processing and other techniques, the CMU is able to handle throughput at levels unachievable on equivalent equipment using serial techniques.

MEASUREMENT ACCURACY

Measurement accuracy on the CMU has also been increased significantly over previous generations through the use of self-adjusting temperature correction. Airflow through the unit can be increased through software commands in order to improve cooling efficiency. These techniques not only provide accuracy over the normal operating parameters of a given network, but across the entire operational range of the system.

FUTURE PROOF

The CMU has been designed in a highly modular manner that allows for a high degree of potential growth over the life of the unit. The CPU and all DSP elements have been socketed to allow rapid replacement as faster and larger components are available. Additional unpopulated DSP space has been added to the machine to allow the user to upgrade to higher degrees of parallelism and faster performance. Unused slots are also available in the system to allow for growth in unanticipated directions. All of this combines to provide a very robust, future-proof design.

EASY TO USE

The user interface has been designed to be an extremely flat heirarchy. This allows the user to move from one area to another with a minimum of keystrokes. Programmable hot keys are also employed to allow the operator to move to frequently used locations in a single keystroke. The user interface has also been designed to use technology neutral terminology to make operator movement between standards fast and easy.

ENVIRONMENTALLY SMART

The CMU has been designed to use very little space and power. At 4 units high, the CMU requires much less rack space than many competing systems. The same compact design also

allows the system to be much lighter. Only one person is required to move the unit for installation or repair. Likewise, the CMU is designed to consume 140 W. These factors contribute to make operations in a manufacturing environment less expensive, less space consumptive, less labor intensive, and more reliable.

CHARACTERISTICS

Rated Temperature Range –
0° C to +45° C (Noncondensing, 95% Humidity).

Storage Temperature Range –
-25° C to +60° C.

Electromagnetic Compatibility –
Complies with requirements of the EMC Directive 89/336/EEC (EN50081-1 and EN50082-1).

Mechanical Resistance –
Sine Vibration: IEC68-2-6, IEC1010-1, EN61010-1, MIL-T-28800 D class 5, 5 Hz to 55 Hz max. 2 g, 55 Hz to 150 Hz 0.5 g const.
Random Vibration: DIN IEC 68-2-36, DIN 40046 T24, 10 Hz to 300 Hz, 1.2 g rms.
Shock: DIN IEC 68-2-27, 40 g shock spectrum, MIL STD 810D.

Electrical Safety –
IEC61010-1, DIN EN61010-1.

Power Supply –
88 V to 264 VAC, 47 Hz to 440 Hz, power factor correction EN61000-3-2.

Power Consumption (Base Unit) –
130 W.
With options CMU-B21 and CMU-B11: 140 W.

Electrical Safety –
ENG 1010-1, IEC 1010-1.

Dimensions –
465 mm x 193 mm x 517 mm (19 in. - 4 height units).

Weight (Base Unit) –
14 kg.
With Options CMU-B21 and CMU-B11: 15 kg.

Time Base TCXO –
Max. frequency drift in the temperature range +5°C to +45°C: $\pm 10^{-6}$
Max. aging: $\pm 10^{-6}$/year.

Time Base OCXO Opt. CMU-B11 –
Max. frequency drift in the temperature range +5°C to +45°C: $\pm 1 \times 10^{-7}$
Max. aging: $\pm 2 \times 10^{-7}$/year, $\pm 5 \times 10^{-9}$/day after 30 days of operation.
Warm up time (at +25°C): approx. 5 min.

RF GENERATOR

Frequency range: 100 kHz to 2700 MHz.
Frequency resolution: 0.1 Hz.
Frequency uncertainty:
Same as time base + resolution.
Frequency settling time: 400 µs to $\Delta f < 1$kHz.

Output level range –
RF1:
100 kHz to 2200 MHz: -130 dBm to -27 dBm.
2200 MHz to 2700 MHz: -130 dBm to -33 dBm.
RF2:
100 kHz to 2200 MHz: -130 dBm to -10 dBm.
2200 MHz to 2700 MHz: -130 dBm to -16 dBm.
RF3OUT:
100 kHz to 2200 MHz: -90 dBm to +13 dBm.
2200 MHz to 2700 MHz: -90 dBm to +5 dBm.

Reflection factor –

	Reflection	(VSWR)
RF1:		
10 MHz to 2200 MHz:	<0.83%	(<1.2).
2200 MHz to 2700 MHz:	<5.3%	(<1.5).
RF2:		
10 MHz to 2200 MHz:	<0.83%	(<1.2).
2200 MHz to 2700 MHz:	<5.3%	(<1.6).
RF3OUT:		
10 MHz to 2200 MHz:	<4%	(<1.5).
2200 MHz to 2700 MHz:	<6.7%	(<1.7).

RF ANALYZER

VSWR –
RF1:
10 MHz to 2200 MHz: <1.2.
2200 MHz to 2700 MHz: <1.6.
RF2:
10 MHz to 2200 MHz: <1.2.
2200 MHz to 2700 MHz: <1.6.
RF4IN:
10 MHz to 2200 MHz: <1.5.
2200 MHz to 2700 MHz: <1.6.

Peak power meter (wideband) for CW and pulsed operation –
Frequency range: 100 kHz to 2700 MHz
Level range –
RF1:
Continuous power*1
100 kHz to 2200 MHz: +6 dBm to +47 dBm (50 W).
2200 MHz to 2700 MHz: +12 dBm to +47 dBm (50 W).
Max peak power*2(PEP): +6 dBm to -53 dBm (200 W).
RF2:
Continuous power
100 kHz to 2200 MHz: -8 dBm to +33 dBm (2 W).
2200 MHz to 2700 MHz: -2 dBm to +33 dBm.
Max peak power*2(PEP): +39 dBm (8 W).
RF4IN (PEP):
100 kHz to 2200 MHz: -33 dBm to 0 dBm.
2200 MHz to 2700 MHz: -27 dBm to 0 dBm.

*1 *50W in the temperature range +5 ℃ to +30 ℃, linear degradation down to 25W at 45 ℃.*

*2 *Mean value of power vs. time must be equal or less than allowed continous power.*

ORDERING INFORMATION

For price information: Outside the U.S. contact your local Tektronix representative, inside the U.S. see the price list in the back of this catalog.

CMU 200
Base Unit.
Includes: Mem card reader and one Rx/Tx board.

CMU Opt. B11 – CMU-B11 Reference Oscillator OCXO.

CMU Opt. B12 – CMU-B12 High Stability OCXO.

CMU Opt. B21 – CMU-B21 Versatile Signal Board for narrowband standards.

CMU Opt. B52 – CMU-B52 Internal versatile multimode speech coder/decoder. Requires B21.

CMU Opt. K21 – CMU-K21 GSM900, R-GSM and E-GSM signaling capability. System must have B21.

CMU Opt. K22 – CMU-K22 GSM 1800 (DCS) signaling capability. System must have B21.

CMU Opt. K23 – CMU-K23 GSM 1900 (PCS) signaling capability. System must have B21.

CMU Opt. K29 – AMPS software. Must have B21.

CMU Opt. K28 – TDMA software. Must have B21.

CMU Opt. B81 – CDMA linkhandler.

CMU Opt. K81 – CDMA 800 (cellular) signaling capability. Must have B81.

CMU Opt. K82 – CDMA 1900 (PCS) signaling capability. Must have B81.

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

ROHDE&SCHWARZ
Rohde & Schwarz' quality system complies with the DIN ISO 9001 standard and has been certified by DQS (German Association for the Certification of Quality Systems).

Audio Analyzer

UPD 05



Features – Benefits

Compact Unit with Integrated PC

Two-channel Measurement for All Functions

Versatile Analysis Modes Through Built-in FFT Analyzer

All Measurements with Any Combination of Input and Output (AA, AD, DA and DD)

Flexible Application Through Almost Unlimited Range of Filters

Extremely High Dynamic Range for Measurements on High-end Equipment

High Measuring Accuracy and Speed

Applications

MEASUREMENTS ON:

High-end Audio Equipment

Entertainment Electronics

Transmission Links

Modules and Components
- ADC, DAC
- Equalizers

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

ROHDE&SCHWARZ
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Measuring the Whole Range of Audio Parameters at Analog and Digital Interfaces 2 Hz to 300 kHz

The UPD05 is the right analyzer for measurements on high-end audio equipment – whether an individual component or an audio mixer in a sound studio. It is a compact, universal measuring instrument with built-in generators for measuring the full range of audio parameters at analog and digital interfaces. The UPD05 measures fast and is equipped with all commonly used interfaces. Windowing and user prompting make the UPD05 easy to use despite the large number of measuring and signal generating possibilities.

MEASUREMENT FUNCTIONS

Thanks to the wide range of built-in analysis functions, practically any audio measurement problem can be solved:

- Level or S/N measurements, rms, peak or quasi-peak measurements can be made Selective level measurements
- SINAD or THD+N measurements

Ordering Information

For price information:
Outside the U.S. contact your local Tektronix representative, inside the U.S. see the price list in the back of this catalog.

UPD 05
Audio Analyzer.

Includes: Power Cable, Operating Manual, Back-up Disk with MS-DOS Operating System, Backup Program Disk with Operating and Measurement Software.

OPTIONS

Opt. B1 – Low Distortion Generator.
Opt. B2 – AES/EBU Interface.
Opt. B3 – High-speed Extension.
Opt. B4 – IEC-625/IEEE-488-bus Interface.
Opt. B5 – Audio Monitor.
Opt. K1 – Universal Sequence Controller.
Opt. K2 – Arbitrary Waveform Designer.
Opt. K33 – Automatic Measuring System.
Opt. 22 – Jitter and Interface Test.

RECOMMENDED ACCESSORIES

19 in. Adapter – Order ZZA-95.
Service Manual – Order 1030.7551.24.

Audio Analyzers

UPL06 • UPL66



Features – Benefits

For All Interfaces: Analog, Digital and Combined

Real Dual-channel Measurements

Maximum Dynamic Range

FFT Analysis

Jitter Analysis

Interface Tester

Freely Programmable Filters

Versatile Functions

Automatic Test Sequences

Applications

AUDIO MEASUREMENT

Sound Cards

Multimedia Cards

Development and Production of Hearing Aids

Production Test of Audio Equipment

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

ROHDE&SCHWARZ
Rohde & Schwarz' quality system complies with the DIN ISO 9001 standard and has been certified by DQS (German Association for the Certification of Quality Systems).

The Solution for the Budget Conscious

The UPL06 and UPL66 Audio Analyzers performs practically all types of analog measurement, from frequency response measurements through to externally controlled sweeps with reference traces, determination of 3rd-order difference frequency distortion, spectral display of demodulated wow and flutter signals, etc. In contrast to many other audio analyzers, UPL06 and UPL66 are capable of performing real dual-channel measurements in the audio-frequency range, i.e. there is no need for switchover between two inputs – and this facility is not limited to a few special cases.

In addition to all this, UPL features excellent technical data: analog sinewave generation with harmonics of typ. –115 dB, spectrum displays with a noise floor below –140 dB for analog and –160 dB for digital interfaces, FFT with a maximum frequency resolution of 0.05 Hz, etc.

SUPERIOR ANALYSIS CONCEPT

The UPL06 and UPL66 Audio Analyzers perform all measurements using digital signal processing. Analog signals to be tested undergo elaborate preprocessing before they are digitized and measured by means of digital routines.

- The test routines performed on analog and digital interfaces are identical
- All test functions are available both on the analog and the digital interfaces
- The filters, too, were implemented digitally, resulting in an infinite number of filters as it were, and this also for measurements on analog interfaces
- In intermodulation measurements, spurious components are measured selectively for all frequencies in accordance with the mathematical formula of the relevant test standards
- Operation is the same for the analog and the digital interfaces – a feature that should not be underestimated

VERSATILE TEST FUNCTIONS

UPL06 and UPL66 Audio Analyzers offers a wealth of measurement functions both for analog and with option B2 digital interfaces.

- Level or S/N with rms, peak or quasi-peak weighting
- Selective level The center frequency of the bandpass filter can be swept or coupled to the generator frequency, to the frequencies of a multitone signal
- SINAD or (THD+N) The sum of all harmonics and noise is measured
- Total harmonic distortion (THD) Single harmonics, all the harmonics or any combination of harmonics can be measured

- Modulation distortion to DIN/IEC 2683. 2nd and 3rd order intermodulation is measured
- Intermodulation using the difference tone method. 2nd and 3rd order intermodulation is measured
- Wow and flutter to DIN/IEC, NAB, JIS or the 2-sigma method to DIN/IEC where the demodulated-signal spectrum is also displayed
- Polarity test for checking signal paths for reversed polarity
- Crosstalk
- DC voltage
- Frequency, phase and group delay

UPL06 AND UPL66 DIFFERENCES

The UPL06 Audio Analyzer features a built-in color TFT LCD display and front-panel keypad for fully portable operation. In automated manufacturing applications where the functionality – and expense – of front-panel display and control is not needed, the UPL66 Audio Analyzer offers all the capabilities of the UPL66 without the unneeded human interface components.

TEST SIGNALS: FLEXIBLE GENERATION FOR A VARIETY OF MEASUREMENTS

The generators of UPL06 and UPL66 Audio Analyzers supply an extremely wide variety of analog, and with option B2, digital test signals:

- Sine waves for level and harmonic distortion measurements. The signal can be applied to an equalizer with user-selectable nominal frequency response, e.g., for compensating the frequency response of the test assembly
- Two-tone signal for modulation distortion analysis. Various amplitude ratios can be selected and the frequencies are continuously adjustable
- Difference tone signal for intermodulation measurements with continuous setting of the center frequency and frequency difference
- Multitone signal comprising up to 17 sine waves of any frequency and with the same or different levels
- Special multitone signal comprising up to 7400 frequencies with selectable amplitude distribution. The frequency spacing can be linked to the resolution used for the Fast Fourier Transform, thus enabling rapid and precise single-shot measurements of the frequency response of a DUT
- Sine burst signal with adjustable interval and on-time and programmable low level, e.g., for testing AGCs
- Square sine burst also with adjustable interval and on-time, e.g., for testing rms rectifier circuits
- Noise with a variety of probability distributions, e.g., for acoustic measurements
- Arbitrary waveforms for generating any voltage curve of up to 16 k points

A VARIETY OF SWEEP FUNCTIONS

For continuous variation of the test signals, UPL06 and UPL66 Audio Analyzers offer amplitude and frequency sweeps, and for sine and sine squared bursts, additional sweeps of the interval and the on-time.

SPECTRAL ANALYSIS

The UPL06 and UPL66 Audio Analyzers are also capable of spectrum analysis. The number of samples for Fast Fourier Transform can be selected between 256 and 16 k in binary steps. A special feature is zoom FFT. The signal to be measured is digitally preprocessed to increase the frequency resolution by a factor of 2 to 128 times normal over a selectable range. In this way, a maximum resolution of 0.05 Hz is attained.

PROGRAMMABLE FILTERS

The filters of UPL06 and UPL66 Audio Analyzers are software-implemented so that the user can define any number of filters. The most common weighting filters are provided as standard. Further filters can be programmed in a few seconds by entering the type (lowpass, highpass, bandpass, bandstop, notch, third octave or octave), frequency and attenuation. More complex filters can be implemented using commercial filter design programs. The filter data are transferred to instrument and the newly designed filter looped into the signal path.

HIGH MEASUREMENT SPEED

In designing the UPL06 and UPL66 Audio Analyzers, particular emphasis was placed on optimizing the measurement speed of the test system as a whole:

- All operations involving elaborate computing are carried out by digital signal processors. The PC is merely used for control of the unit and display of results
- The UPL06 and UPL66 Audio Analyzers can perform even complex test functions simultaneously on both channels. This feature alone reduces the time for stereo measurements by 50%
- The digital test routines optimize their speed based on the input frequency. This enhances measurement speed especially in the case of frequency sweeps

ORDERING INFORMATION

For price information: Outside the U.S. contact your local Tektronix representative, inside the U.S. see the price list in the back of this catalog.

UPL06
Audio Analyzer.

UPL66
Audio Analyzer.

Both Include: Power cable, operating manual, backup disks with MS-DOS operating system and user manual, backup program disk with operating and measurement software.

OPTIONS

Option B1 – Low Distortion Generator.
Option B2 – Digital Audio I/O.
Option B21 – Digital Audio Protocol.
Option B22 – Jitter and Interface Test.
Option B4 – Remote Control.
Option B5 – Audio Monitor.
Option B6 – Rub, Buzz and Coherence Functions.
Option B7 – Hearing Aid Test System.
Option B10 – Universal Sequence Controller.
Option Z1 – XLR/BNC Adapter Set.
Option U3 – 150 Ω Input Impedance.
Option B29 – Digital Audio Interface for 96 kHz.

RECOMMENDED EXTRAS

19 in. Rack Adapter – Order Option 1R.
Service Manual – Order 1078.2089.24.

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

ROHDE&SCHWARZ
Rohde & Schwarz' quality system complies with the DIN ISO 9001 standard and has been certified by DQS (German Association for the Certification of Quality Systems).

Audio Analyzer

UPL16



Features – Benefits

- Digital Audio Interface DAI Built-in
- Test Cases According to GSM 11.10 Phase 2
- All Kinds of Analog and Digital Test Signals Including Artificial Voice
- Measurements in Analog and Digital Domain
- A-Law Dodec

Applications

- Acoustical Tests of GSM Phones
- Testing for GSM Type Approval

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

CE

ROHDE&SCHWARZ
Rohde & Schwarz' quality system complies with the DIN ISO 9001 standard and has been certified by DQS (German Association for the Certification of Quality Systems).

The latest member in the family of Audio Analyzers UPL, the new model UPL16 is especially designed for acoustical tests of GSM mobiles. Therefore the instrument is equipped with the Digital Audio Interface DAI, artificial voice generator and the necessary software routines. Together with the Digital Radio communication Testers CRTx or CMD, and completed with an artificial mouth/ear combination, the UPL16 provides a complete system handling the acoustical test cases according to the GSM Phase 2 recommendation 11.10, section 30.

The Audio Analyzer UPL16 offers the same superior analysis concept as all members of the UPL family. The instrument is able to handle both analog and digital processing, it performs practically all types of measurements in the audio range from frequency response measurements through distortion measurements, FFT analysis, etc. All the details about test functions and the concept of operation can be found in the data sheet of the Audio Analyzer UPL.

UPL16 in Test System Applications

- UPL16 Is Part of Type Approval System TS8915
- UPL16 + CRTx for Type Approval Measurements and Development Labs
- UPL16 + CMD for Pre-compliance Testing

Ordering Information

For price information:
Outside the U.S. contact your local Tektronix representative, inside the U.S. see the price list in the back of this catalog.

UPL16
Audio Analyzer.
Includes:
Opt. B4 – Remote Control.
UPL B6 – Extended Analysis Functions.
UPL B10 – Universal Sequence Controller.

OPTIONS
Opt. B1 – Low Distortion Generator.
Opt. B5 – Audio Monitor.
Opt. Z1 – XLR/BNC Adapter Set.
Opt. 1R – 19 in. Rack Adapter.

RECOMMENDED ACCESSORIES

SOFTWARE OPTIONS FOR CRTX AND TS8915
Acoustical Test Cases (Mandatory) –
Order CRTKAUD 1119.2093.02.
Speech Codec for EFR (Optional), Requires CRT-B4 –
Order CRT-K5 1081.6652.02.
Speech Codec for HR (Optional), Requires CRT-K3, CRT-B4 –
Order CRT-K7 1101.4094.02.
Channel Codec for HR (Optional) – Order CRT-K3 1101.4142.02.

HARDWARE OPTIONS FOR CRTX AND TS8915
HR/EFR Speech Codec – Order CRT-B4 1101.5490.02.

Optical Networks

Optical Communication Products

With over 50 years of leadership in test and measurement, Tektronix has provided customers with unmatched technology and expertise in telecommunications and high speed components to meet your new, evolving requirements for test equipment. Tektronix offers a full line of products to help design, manufacture and test components and systems for high-speed communication transmission. As standards proliferate, Tektronix is ready to help with a continually expanding product portfolio of new and exciting instruments from characterization to compliance testing. If you are a designer, manufacturer or evaluator of high-speed communication devices we are ready to provide the test equipment required to shorten your design cycle as well improve your test efficiency. Below is a list of available products, which are recommended for the various data rate standards and communication applications.

Product Selection Guide

SONET/SDH 622 Mb/s

- TDS784D Oscilloscope
- Option 2C, 4C Optical Reference Receiver
- GB700 BERT
- GB1400 BERT
- Q8221 with Q82215 or Q82208 Power Meter
- OA5002 Optical Attenuator

Fibre Channel 1063 Mb/s & Gigabit Ethernet 1250 Mb/s

- CSA803 Communication Signal Analyzer
- SD-2x & SD-32 Electrical Sampling Heads
- SD-43 O/E Converter
- ORS20 Optical Receiver System
- GB1400 BERT
- GTS1250 GBIC Tester
- Q8221 with Q82214 or Q82215 Power Meter
- OA5002, OA5012 or OA5022 Optical Attenuator

SONET/SDH 2.488 Gb/s

- CSA 803 Communication Signal Analyzer
- SD-2x & SD-32 Electrical Sampling Heads
- SD-4x series O/E Converters
- ORR24 Optical Reference Receiver
- ORS20 Optical Receiver System
- ST2400 SONET/SDH Test Set
- Q8221 with Q82208, Q82215, Q82227 or Q82232 Power Meter
- OA5002 Optical Attenuator
- Q7606A/B Chirp Test Set

SONET/SDH 10 Gb/s

- CSA 803 Communication Signal Analyzer
- SD-2x & SD-32 Electrical Sampling Heads
- D3186/D3286 12Gb/s BERT
- SD-4x series O/E Converters
- Q8221 with Q82215, Q82227 or Q82232 Power Meter
- Q7606A/B Chirp Test Set
- OA5002 Optical Attenuator
- Q8163 Polarization Scrambler

Dense Wavelength Division Multiplexing (DWDM)

- CSA 803 Communication Signal Analyzer
- SD-2x & SD-32 Electrical Sampling Heads
- SD-4x series O/E Converters
- D3186/D3286 12Gb/s BERT
- ST2400 SONET/SDH Test Set
- Q8347 Optical Spectrum Analyzer
- Q8221 with Q82215, Q82227 or Q82232 Power Meter
- LPB1550 Tunable Laser
- LMP5000 Series Tunable Lasers
- Q7750 Optical Network Analyzer
- Q8163 Polarization Scrambler
- TQ8325 Wavelength Meter
- OA5002 Optical Attenuator

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Q7606A/6B 312
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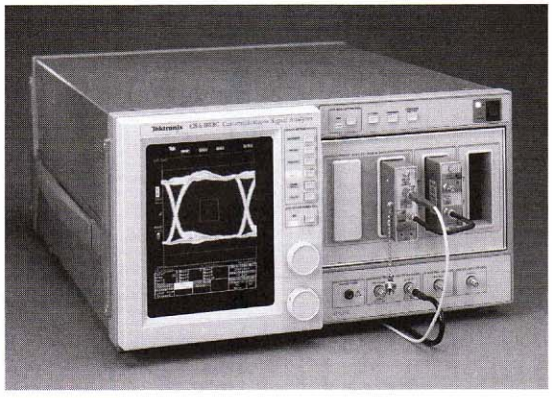
Q8163 318
QA5002/12/22/32 320
Q8221 322
TQ8210/14/15/17/18A 326
Q7750 328

Communications Signal Analyzer

CSA 803C



Features – Benefits

- DC to 50 GHz with up to 12.5 GHz Trigger Bandwidth
- Fully Automatic Jitter, Noise, and Extinction Ratio Measurements
- Normal, Infinite, Variable Persistence, and Color Graded Display Modes
- Compatible with Optional O/E Converters
- Automatic Measurements on Eye-diagrams
- Time and Voltage Histograms
- Automated ITU/ANSI Mask Testing with 47 Predefined Standard Masks

Applications

Design and Evaluation of Datacomm/Telecomm Components, Transceiver Subassemblies, and Transmission Systems.

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

CE

ISO 9001

Tektronix measurement products are manufactured in ISO registered facilities.

Digital Communications Analysis Solutions

Specifically designed for communications applications, the CSA 803C Communications Signal Analyzer is the ideal tool for design and evaluation of datacomm/telecomm components, transceiver subassemblies, and transmission systems.

The CSA 803C oscilloscope generates measurement results, not just raw data, with time and voltage histograms, mask testing, and statistical pulse parameter measurements. It provides a communications-tailored measurement set that includes jitter, noise, duty cycle, overshoot, undershoot, extinction ratio and amplitude measurements.

In addition, mask testing of SDH/SONET, Fiber Channel, and other standards simplifies compliance testing. A full color display helps you to discriminate waveform details. A color-graded display mode adds a third dimension – sample density – to your signal acquisitions and analysis. Color hardcopy capabilities allow you to accurately document your measurement results.

MODULARITY AND FLEXIBILITY

The modularity of the instrument lets you choose the right bandwidth sampling head for your application, including the 2.5 GHz high impedance (100 k Ω), low capacitance (0.475 pF) SD-14 up to 50 GHz with the SD-32.

High bandwidth probes are also available for constructing a total acquisition and measurement solution.

SUPERIOR TRIGGERING CAPABILITIES

In addition to its full-function DC-coupled 4.0 GHz trigger (typical), the CSA 803C offers a built-in, AC-coupled 12.5 GHz (typical) prescaler trigger for direct triggering on high-speed data at bit rates such as 9.953 GB/S OC192/STM64.

Customers doing pass/fail testing to communications standards benefit from the excellent metastability characteristics of these triggers. Metastability is a condition of all logic devices when they do not latch to a valid ON of OFF logic level, and can occur during trigger events with all sampling oscilloscopes and circuits under test. The raw metastability of the CSA 803C direct trigger is an impressive 5 parts per billion or less, and with Enhanced Triggering ON metastable trigger events are essentially eliminated. This is possible because Enhanced Triggering is capable of detecting possible metastable sample points and discarding them.

CHARACTERISTICS

VERTICAL SYSTEMS

Rise Time/Bandwidth – Determined by the sampling head used.*1

Vertical Resolution – 8-bits full screen (78 µV LSB at 2mV/div deflection factor).

Amplifier Gain Accuracy – ±1% of all settings.

Deflection Factors – 2 to 255 mV/div in 1 mV/div increments.

Offset Range – ±2 V.

*1 *Vertical system specifications of CSA 803C with SD-14 non-applicable.*

HORIZONTAL SYSTEM

Main and Window Time Base – 1 ps/div to 5 ms/div, settable in 1-2-5 sequence or in 1 ps increments.

Time Interval Accuracy –
8 ps + 0.01% x (interval) + 0.001% x (position), guaranteed;
4 ps + 0.004% x (interval) + 0.0004% x (position), typical, where interval ≥1 ns;
2.5 ps + 0.0004% x (position), typical, where interval = 100 ps;
1 ps + 0.0004% x (position), typical, where intervals ≤10 ps.

Notes:
1) For intervals <100 ps, the above holds for time/div ≤20 ps/div.
2) For other intervals not listed above, linearity interpolate the cardinal points.

Record Length – 512, 1024, 2048, 4096 and 5120 samples.

Windows – Any number of window records may be placed on any number of main records, up to a maximum of 8 displayed traces. All window records have the same duration, but may be independently positioned on any main record. Windows may be set to automatically track a moving edge on the main record.

Maximum Sampling Rate – 200 kHz.

TRIGGER SYSTEM*2

Trigger Bandwidth – Direct 4 GHz typical, Prescaled 12.5 GHz typical.

Trigger Sensitivity –
Direct DC to 4 GHz: 50 mV typical.
Prescaled 2 to 10 GHz: 500 mV, 10 to 12.5 GHz: 800 mV typical.

Delay Jitter – 1.1 ps +4 ppm of a position typical. 2.0 ps +5 ppm of position maximum (rms).

Metastability – Raw <0.005 ppm at 2.488 GHz with 200 mV input trigger voltage, typical. Enhanced is theoretically zero.

Internal Clock – 100 kHz (drives TDR, Internal Clock Output and Calibrator).

Trigger Level Range – ±1.0 V.

Trigger Input Range – ±1.5 V (±1.5 V, 5 V rms maximum with 10X).

Trigger Holdoff – 5 µs to 2.5 s.

*2 *CSA 803C has external trigger only; requires 21 ns pretrigger or DL-11 Delay Lines to view trigger point.*

MEASUREMENT SYSTEM

Waveform Processing Functions – Add, subtract, multiply, divide, absolute, average, differentiate, envelope, exponent, integrate, natural log, log, signum, square root, smoothing and filter.

Measurement Set – Max, min, mid, p-p, mean, rms, amplitude, extinction ratio, overshoot, undershoot, noise*3, rise, fall, spectral magnitude, spectral frequency, THD, SNR, frequency, period, prop delay, cross, width, phase, duty cycle, jitter*3, area +, area –, and energy. Measurements are constantly updated; mean and standard deviation available on all measurements.

Measurement Parameters – (Proximal, mesial, distal and start/stop levels): May be set to absolute levels.

Cursors – Paired or split dots, vertical bars, and horizontal bars.

*3 *Available only in statistical measurement mode.*

TDR SYSTEM (SD-24 ONLY)

Combined TDR/Acquisition Reflected Risetime – 35 ps or less.

TDR Step Amplitude – Adjustable to ±250 mV (polarity of either step may be inverted).

Time Coincidence Between TDR Steps – Adjustable to less than 1 ps.

Source Resistance – 50 ±0.5 Ω.

Typical Aberrations (at ±250 mV Amplitude) – 10 ns to 20 ps before step: ±3% or less; less than 300 ps after step: +10%, –5% or less; 300 ps to 5 ns after step: ±3% or less; elsewhere: ±1% or less.

CRT AND DISPLAY FEATURES

CRT – 9 in. diagonal, magnetic deflection, vertical raster scan orientation. Color.

Colors – Eight-color default color set included; or, colors are user-selectable from palette of 262,144 colors.

Video Resolution – 552 horizontal by 704 vertical displayed pixels.

PHYSICAL CHARACTERISTICS

	Cabinet	Cabinet	Rackmount	Rackmount
Dimensions	**mm**	**in.**	**mm**	**in.**
Width	448	17.6	483	19
Height	238	9.4	222	8.8
Depth	599	23.6	550	21.6
Weight	**kg**	**lb.**	**kg**	**lb.**
Net	22.3	49	23.2	51
Shipping	25.9	57	26.8	59

POWER REQUIREMENTS

Line-Voltage Ranges – 90 to 132 V rms, 180 to 250 V RMS.

Line Frequency – 48 to 440 Hz.

Maximum Power Consumption – 320 W.

ENVIRONMENTAL AND SAFETY

Temperature – Operating: 0°C to +50°C; nonoperating: –40°C to +75°C.

Humidity – Operating and nonoperating: up to 95% relative humidity, up to 50°C. Per Mil-T-28800E, Type III, Class 5.

Altitude, Vibration, Shock nonoperating, Bench Handling – Meets MIL-T-28800E, Type III, Class 5.

Electromagnetic Compatibility (with sampling heads or optional blank panels installed in all sampling head compartments) – Meets the requirements of: MIL-STD-461B; FCC Part 15, sub-part J, Class A; VDE 0871/6.78 Class B.

Safety – UL 3111-1, CSA 1010.1, EN 61010-1, IEC 61010-1.

ORDERING INFORMATION

For price information: Outside the U.S. contact your local Tektronix representative, inside the U.S. see the price list in the back of this catalog.

CSA 803C

Communications Signal Analyzer.

User Manual – (070-8782-00).

Programmer Manual – (070-8784-00).

Service Manual – (070-8780-00).

Power Cord, U.S., 120 V – (161-0066-00).

DL-11 DELAY LINE

Includes: Delay Line Instruction Sheet. Order 070-7051-01.

CSA 803C OPTIONS

Opt. 10 – Deletes the 10 GHz pre-scaler trigger capability. Does not affect the 4.0 GHz trigger capability, however.

Opt. 1R – Rackmount.

Includes: Hardware, tooling, and instructions for converting bench model to rackmount configuration. Available with CSA 803C.

INTERNATIONAL POWER PLUGS

Opt. A1-A5 – Available.

See page 619 for description.

ADDITIONAL ACCESSORIES

Calibration Step Generator – USA (067– 1338-00); Europe (067-1338-01); UK (067-1338-02); Australia (067-1338-03); Switzerland (067-1338-05); Japan (067-1338-06).

Sampling Head Extender Cable, 1 meter – Order 012-1220-00.

Sampling Head Extender Cable, 2 meter – Order 012-1221-00.

DL-11 Service Manual – Order 070-7050-01.

Blank Panel for Empty Sampling Head Compartments – Order 200-3395-00.

ECL Terminator – Order 015-0558-00.

SMA Accessory Kit – Order 020-1693-00.

RECOMMENDED PROBES

P6150 – 9 GHz Passive Probe.

P6249/1103 – 4 GHz, Active.

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

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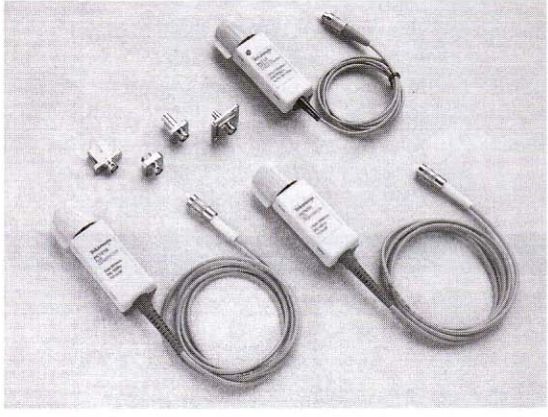
Optical-to-Electrical Converters

P6701B • P6703B • P6723 • P6711 • P6713



Features – Benefits

- Broad Wavelength Response 500 to 950 nm or 1100 to 1700 nm
- High Bandwidth DC up to 1.2 GHz
- High Gain 1 V/mW
- Low Noise <11 pW/$\sqrt{Hz}$
- Probe Connects Directly to TDS Series Scope (TEKPROBE) or Other 50 Ω Instruments with 1103 TEKPROBE Power Supply
- SONET/SDH and Fibre Channel Reference Receiver Performance: TDS 500C/700C (Opt. 3C or 4C) P6701B: Fibre Channel up to 1063 Mb/s, P6703B: SONET/SDH up to 622 Mb/s

Applications

- Eye-pattern Testing of Optical Communication Signals (SONET/SDH and Fibre Channel)

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

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P6701B, P6703B, P6723

The Tektronix P6700 Series optical-to-electrical (O/E) converters change optical signals into electrical signals for convenient analysis on Tektronix TDS Series oscilloscopes equipped with the TEKPROBE interface, or any other oscilloscope when used with the 1103 TEKPROBE power supply. The P6700 Series O/E converters are ideal for optical source characterization in the development, manufacture, or service of optical communication systems and devices.

Small, conveniently packaged P6701B and P6703B optical-to-electrical analog converters provide an accurate interface for optical pulse shape measurements. The high gain, large dynamic range and stable output offset of these O/E converters make them ideal for performing eye-pattern analysis and extinction measurements.

The P6723 optical logic probe provides a digital conversion of up to 650 Mb/s, NRZ optical signals and converts the data stream into a constant amplitude electrical 1 V pulse train. The P6723 has a sensitivity range similar to standard SONET/SDH optical receivers. It can be used as an optical interface to an electrical clock recovery circuit in support of data stream triggering or to a Bit Error Rate Tester (BERT). The LED on the P6723 indicates a valid optical input signal.

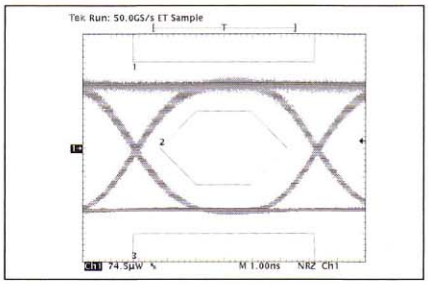
The P6701B/P6703B/P6723 optical input is a one meter, 62.5 µm multimode fiber with an FC/PC connector. Using the standard assortment of hybrid fiber optic mating sleeves, these O/Es can accommodate the various industry connector standards.

The TEKPROBE interface provides power, autoscaling, auto-termination, and correct units (microwatts) when used with Tektronix TDS Series oscilloscopes.

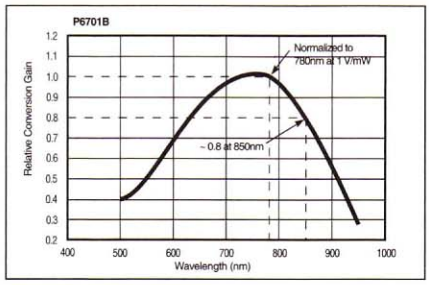
SONET/SDH AND FIBRE CHANNEL REFERENCE RECEIVER PERFORMANCE

The P6701B and P6703B can be transformed into ITU G.957 or ANSI FC-PH reference receivers when they are either ordered as an option (3C – P6701B, 4C – P6703B) to the latest Tektronix TDS 500C/700 Series digitizing oscilloscopes or as a standalone hardware solution (nominal).

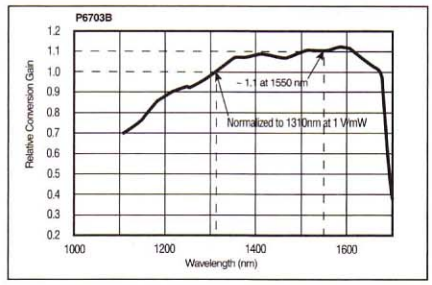
The TDS Option 3C provides a calibrated P6701B reference receiver for Fibre Channel dates rates from 133 Mb/s up to 1063 Mb/s. Option 4C provides a calibrated P6703B reference receiver for



OC-3/STM-1 SONET/SDH Transmitter Eye Pattern Test.



P6701B: Typical Wavelength Dependent Gain (@25°C).



P6703B: Typical Wavelength Dependent Gain (@25°C).

SONET/SDH dates rates from 52 Mb/s up to 622 Mb/s. The optical-to-electrical convertors are matched and calibrated to a specific scope channel which ensures complete system compliance with the fourth-order Bessel-Thompson frequency response.

The P6703B, when used in conjunction with the FS52, FS156, or FS622 SONET/SDH hardware filters, provide customers with a nominal reference receiver performance for 51.84 Mb/s, 155.52 Mb/s, and 622 Mb/s.

The standard P6701B has a nominal frequency response which follows the fourth-order Bessel-Thompson for Fibre Channel 1063 Mb/s. The 1103 TEKPROBE power supply can be used to connect these products to the 11800 Series or CSA 803 Series sampling scopes.

CHARACTERISTICS

	P6701B	P6703B	P6723	P6711	P6713
Wavelength Response	500 to 950 nm	1100 to 1700 nm	1310/1550 nm	500 to 950 nm	1100 to 1700 nm
Bandwidth*1 (Typical)	DC to 1.0 GHz (1.1 GHz)	DC to 1.2 GHz (1.4 GHz)	20 to 650 Mb/s	DC to 250 MHz	DC to 300 MHz
Rise Time (Typical)	≤500 ps	≤395 ps (≤340 ps)	≤455 ps	≤2 ns	≤1.6 ns
Conversion Gain	1 V/mW	1 V/mW	1.0 VP-P	5 V/mW	5 V/mW
Max. Input Optical Power	1 mW (0 dBm)*2 10 mW (10 dBm)*3 20 mW (13 dBm)*4	1 mW (0 dBm)*2 10 mW (10 dBm)*3 20 mW (13 dBm)*4	0.2 mW (–7 dBm)*2	0.2 mW (–7 dBm)*2 10 mW (10 dBm)*3 20 mW (13 dBm)*4	0.2 mW (–7 dBm)*2 10 mW (10 dBm)*3 20 mW (13 dBm)*4
Max. Output Modulation Depth for Reference Receiver Performance	≤200mV$_{p-p}$	≤200mV$_{p-p}$			
Noise Equivalent Power	≤0.75 µW (RMS)*5 ≤24 pW per $\sqrt{Hz}$	≤0.35 µW (RMS)*5 ≤11 pW per $\sqrt{Hz}$	N/A	≤250 nW (RMS)	≤200 nW (RMS)
Max. Input Fiber Core Diameter	62.5 µm	62.5 µm	62.5 µm	200 µm	100 µm

*1 *Optical bandwidth (–6 dB electrical).* *2 *Maximum average operating power.* *3 *Max average nondestruct.* *4 *Max peak nondestruct.* *5 *1 GHz low pass filter in series with output.*

ORDERING INFORMATION

For price information: Outside the U.S. contact your local Tektronix representative, inside the U.S. see the price list in the back of this catalog.

P6701B
Optical-to-Electrical Converter with FC/PC Connector.

P6703B
Optical-to-Electrical Converter with FC/PC Connector.

P6723
Optical Logic Probe with FC/PC Connector.

Above Include: Hard Case, User Manual (English, French, German, and Japanese), Assorted Fiber Optic Hybrid Connectors (FC/FC, FC/ST, and FC/SC), Certificate of Traceable Calibration.

P6711/P6713
Optical-to-Electrical Converter(s).

Includes: Option Specified Fiber Optic Input Connector, Hard Case (016-0156-03) and User's Manual (070-8237-00).

Opt. 01 – FC Input Connector.
Opt. 02 – ST Input Connector.
Opt. 03 – DIN 47256 Connector.
Opt. 04 – SMA 47256 Connector.

MEASUREMENT SERVICE OPTIONS
Opt. C3 – Three years of Calibration Services.
Opt. D1 – Cal Data Report.
Opt. D3 – Test Data (requires Opt. C3).
Opt. R3 – Repair warranty extended to cover three years.

ACCESSORIES
1103 TEKPROBE Power Supply – Power Cord Options:
Std. – North America/Japan.
Opt. A1 – Europe.
Opt. A2 – UK.
Opt. A3 – Australia.
Opt. A5 – Switzerland.

Single-mode Fiber Optic Cables – (9 µm)
FC/PC to FC/PC. Order 174-1387-00.
FC/PC to ST. Order 174-1386-00.
FC/PC to SC/PC. Order 174-3921-00.
FC/PC to Diamond (2.5). Order 174-1497-00.
FC/PC to Diamond (3.5). Order 174-1385-00.

Multimode Fiber Optic Cables – (62.5 µm)
FC/PC to FC/PC. Order 174-2322-00.
FC/PC to SC/PC. Order 174-4093-00.
FC/PC to SMA. Order 174-2324-00.

90/10, 3 Port Single-mode Optical Splitter FC/PC Connectors – Order 174-3737-00.

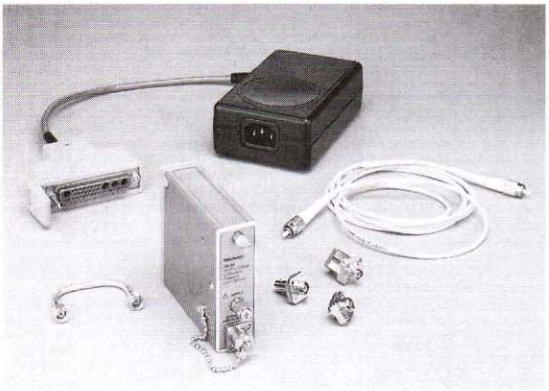
10 dB, In-Line Single-mode Optical Attenuator FC/PC Connectors – Order 119-5118-00.

DIN/FC Fiber Optic Hybrid Connector – Order 020-2209-00.

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

Optical-to-Electrical Converters

SD-42 • SD-43 • SD-44 • SD-48



Features – Benefits

- Ultra High Bandwidth for Analyzing High Frequency Signal Components
  - DC to 6 GHz (SA-42, SD-42)
  - DC to 8 GHz (SD-43)
  - DC to 15 GHz (SD-44)
  - DC to 30 GHz (SD-48)
- Plug-in Form Factor That Is Compatible with 11800/CSA 803 Series Sampling Oscilloscopes
- 10 Gb/s SONET/SDH Reference Receiver (SD-48, Opt. RR) for Communication Signal Compliance Testing
- Optional External Power Supply (016-1609-00) for Stand Alone Operation

Applications

- High Speed Optical Communication Testing (SONET/SDH)
- Optical Source and Device Characterization
- Pulse Shape Analysis
- Analyze Relaxation Oscillation

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

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SD-42, SD-43, SD-44, SD-48

The SD-42, SD-43, SD-44 and SD-48 are optical-to-electrical (O/E) converters for use with the Tektronix CSA 803 and 11800 Series sampling oscilloscopes equipped with an SD-2x or SD-3x Electrical Sampling Head. The SD-42, SD-43, SD-44 and SD-48 Optical-to-Electrical Converters can be plugged directly into a 11800 sampling slot or CSA 803 power slot.

Optical signal input on the SD-42, SD-43, SD-44 and SD-48 is a standard FC/PC fiber optic connector. Other connector types can be accommodated by using optional hybrid fiber optic jumper cables (SD-42) or an assortment of hybrid mating adapters which are standard with the SD-43, SD-44 and 48. The SD-42 has an average power meter capability when used with a Digital Multimeter (DMM) which has selectable ranges of 1 V/mW and 1 V/µW.

STAND ALONE OPERATION

The SD-42, SD-43, SD-44 and SD-48 can operate as standalone, wide-bandwidth optical-to-electrical converters with an optional power supply (016-1609-00). These optical-to-electrical converters can be used with Tektronix oscilloscopes or other instrumentation (e.g., spectrum analyzers). These easy to use O/E converters can be used in support of frequency and time domain analysis of lightwave modulation in optical fiber based products and communications systems.

CHARACTERIZATION

Opto-electronic devices such as laser diodes, light emitting diodes, optical waveguides, optical detectors and electro-optic modulators are becoming more important as applications for fiber optics in telecommunications and data communications expand. These Optical-to-Electrical Converters offer fiber optic equipment designers and researchers optical waveform measurement capability from DC to 30 GHz in the 700 nm to 1650 nm wavelength range. Measurements such as rise time, aberrations, optical power vs. drive current and voltage, modulation bandwidth and sensitivity can now be made accurately and easily at high bandwidth.

10 GB/S SONET/SDH COMPLIANCE TESTING

As optical communication signals increase in speed, the required reference receiver performance continues to be challenging. The SD-48 with option RR provides customers with reference receiver performance per ITU-T COM15-264E. The external reflectionless hardware filter mates between the 50 Ω reverse terminated SD-48 O/E Converter and a SD-22 electrical sampling head. The result is a smooth 4th order Bessel-Thompson frequency response within ±1.25 dB from DC to 7.5 GHz and ±4 dB from 7.5 GHz to 15 GHz (see below).

CHARACTERISTICS

	SD-42	SD-43	SD-44	SD-48
Wavelength	1000 to 1700 nm	700 to 1650 nm	950 to 1650 nm	950 to 1650 nm
Bandwidth (Optical)*[1]	DC to 6.0 GHz	DC to 8.0 GHz	DC to 15.0 GHz	DC to 30.0 GHz (typ)
Impulse Response (FWHM)	≤55 ps	≤48 ps	≤30 ps	15 ps (typ)
Noise Equivalent *[2]	23 pW per √Hz	15 pW per √Hz	15 pW per √Hz	15 pW per √Hz
Maximum Non-destructive Power				
Peak Power*[3]	≤25 mW	≤100 mW	≤100 mW	≤100 mW
Average Power	≤5 mW	≤5 mW	≤5 mW	≤5 mW
Aberrations*[4]	≤15% p-p	≤10% p-p	≤10% p-p	≤20% p-p
Conversion Gain*[5]	≥40 mV/mW	≥20 mV/mW @ 850 nm ≥30 mV/mW @ 1310 nm	≥35 mV/mW	≥15 mV/mW
Environmental, Physical				
Operating Temperature Range	0° C to 50° C	10° C to 40° C	10° C to 40° C	10° C to 40° C*[6]
Internal Fiber Size	9 µm	62.5 µm	9 µm	9 µm
Optical Return Loss	≤-30 dB	≤-14 dB	≤-30 dB	≤-30 dB
Output Connector Style	SMA	K (2.92 mm)	K (2.92 mm)	K (2.92 mm)

*[1] *Optical bandwidth (–6 dB electrical power).*
*[2] *Root Hertz into 50 Ω.*
*[3] *Pulse width less than 100 ps.*
*[4] *Within the first 400 ps following a pulse input.*
*[5] *DC termination into 50 Ω.*
*[6] *Reference Receiver Performance (Opt. RR) 25° ±5° C.*

ORDERING INFORMATION

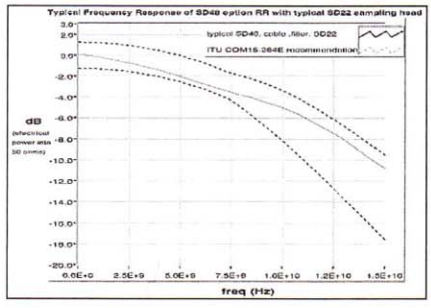
For price information: Outside the U.S. contact your local Tektronix representative, inside the U.S. see the price list in the back of this catalog.

SD-42
Optical-to-Electrical Converter.
Includes: Red 2 mm to Banana Lead 1 m length (012-1286-00), Black 2 mm to Banana Lead 1 m length (012-1287-00), 50 Ω Semi-rigid Cable Link (174-1635-00), Instruction Manual (070-8671-00).

SD-43
Optical-to-Electrical Converter.
Includes: Hard Case, User Manual (English), Assorted Fiber Optic Hybrid Connectors (FC/FC, FC/ST, FC/SC), FC/FC Single-mode Fiber Jumper, Rigid 50 Ω U-Cable, Certificate of Traceable Calibration.

SD-44
Optical-to-Electrical Converter.
Includes: Hard Case, User Manual (English), Assorted Fiber Optic Hybrid Connectors (FC/FC, FC/ST, FC/SC), FC/FC Single-mode Fiber Jumper, Rigid 50 Ω U-Cable, Certificate of Traceable Calibration.

SD-48
Optical-to-Electrical Converter.
Includes: Hard Case, User Manual (English), Assorted Fiber Optic Hybrid Connectors (FC/FC, FC/ST, FC/SC), FC/FC Single-mode Fiber Jumper, Rigid 50 Ω U-Cable, Certificate of Traceable Calibration.



SD-48 (Opt. RR) Frequency Response.

SD-48 10 GB/S SONET/SDH REFERENCE RECEIVER

Opt. RR – Add 10 Gb/s Hardware Filter (119-5916-00), SMA In-line Connector (015-1011-00), SMA 50 Ω cable (015-0560-00), and Frequency Response Graph using a Typical SD-22 Electrical Sampling Head Performance with Boundary Limits per ITU-T COM15-263E.

OTHER RELATED PRODUCTS/ACCESSORIES

SD-44/SD-48 External Power Supply with SD-4x Adapter Cable – Order 016-1609-00. Includes: IEC Compatible Power Supply, SD-44/SD-48 Adapter Cable, U.S. Power Cord, Instruction Sheet. UL1950, CAS950, EN60950.

Alternative Power Cords (IEC Compatible) –
European: Order 161-0066-09.
UK: Order 161-0066-10.
Australia: Order 161-0066-11.
Switzerland: Order 161-0154-00.

DIN/FC Fiber Optic Hybrid Connector –
Order 119-5118-00.

50 Ω Power Dividers, DC to 12 GHz (50% Splitter) –
SMA Female: Order 015-0565-00.
SMA Male: Order 015-1014-00.

SONET/SDH HARDWARE FILTERS (SMA)
155 Mb/s (117 MHz): Order 119-5936-00.
622 Mb/s (467 MHz): Order 119-5929-00.
10 Gb/s (with SD-48 and SD-22): Order 119-5916-00.

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

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Optical Reference Receivers

ORR24



Features – Benefits

- Supports SONET/SDH 2.488 Gb/s Data Rate
- Reference Receiver Performance Compliant with ITU-T G.957
- Built-in 4th Order Bessel-Thompson Frequency Response
- 2.0 GHz Bandwidth for Analyzing Communication Eye-patterns or General Purpose Optical Signals
- Amplified Design for Accurate and Repeatable Measurements
- Plug-in Form Factor That Is Compatible with 11800/CSA 803 Series Sampling Scopes
- Optional External Power Supply (016-1609-00) for Stand Alone Operation

Applications

- Standards Compliance: SONET/SDH 2.488 Gb/s
- Accurate Extinction Ratio Measurements
- Eye-pattern and Pulse Shape Measurements

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

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Verification of SONET/SDH Signals

The Synchronous Digital Hierarchy (SDH) and the Synchronous Optical NETwork (SONET) standards are the cornerstones of today's high-speed digital telecommunications systems. The Tektronix ORR24 optical reference receiver provides an important interface for compliance testing of SDH/SONET optical transmission products or components.

The amplified design of the ORR24 converts the incoming optical light into a high gain, low noise electrical signal. This allows easy testing of optical designs as well as repeatable measurements. The ORR24 is DC coupled which is required for accurate extinction ratio measurements.

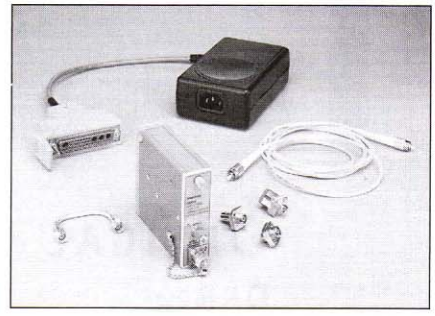
The controlled frequency design of the ORR24 optical reference receiver ensures that the measurements correctly represent the true transmitted signal for the purpose of pulse shape analysis or eye-pattern measurements. A certificate of calibration and a frequency response graph are supplied with the ORR24 for performance documentation. The compact SD-xx form factor enables the ORR24 to conveniently plug into the Tektronix 11800 or CSA 803 Series sampling oscilloscopes for complete compliance testing. An optional power supply is available for other instrument applications.

SDH/SONET recommendations define the nominal transfer function for an optical reference receiver as being a fourth-order Bessel-Thompson response. The following table lists the corresponding attenuation at various frequencies, f. In this table f_o is the transmitted data rate and f_r is the 3 dB cutoff, which is defined as $f_r = 0.75 f_o$.

Note: Allowable deviation from the nominal attenuation in the table is very tightly specified in the SDH/SONET recommendations. The actual allowable deviation values depend on f/f_r and the bit rate. These values run as low as ±0.5 dB.

NOMINAL FREQUENCY PERFORMANCE VALUES FOR AN OPTICAL REFERENCE RECEIVER

f/f_o	f/f_r	Attenuation (dB)	f/f_o	f/f_r	Attenuation (dB)
0.15	0.2	0.1	1	1.33	5.7
0.3	0.4	0.4	1.05	1.4	6.4
0.45	0.6	1	1.2	1.6	8.5
0.6	0.8	1.9	1.35	1.8	10.9
0.75	1	3	1.5	2	13.4
0.9	1.2	4.5	2	2.67	21.5



ORR24 with standard accessories and optional power supply.

CHARACTERISTICS

Wavelength Range – 1100 nm to 1650 nm.

Bandwidth*[1] – DC to 2.0 GHz.

Rise Time – 205 ps.

Conversion Gain (typical) – ≥0.7 V/mW (1310 nm/1550 nm).

Maximum Input Optical Power –
Maximum average linear response power: 100 µW (–10 dBm).
Maximum average non-destruct power: 5 mW (7 dBm).
Maximum peak non-destruct power: 10 mW (10 dBm).

Noise Equivalent Power – ≤15 pW per square root of Hz.

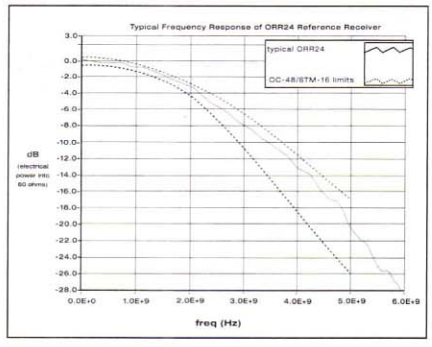
Max Output Modulation Depth for Reference Receiver Performance – ≤200mVp-p*[4].

Aberrations – ≤5% p-p.

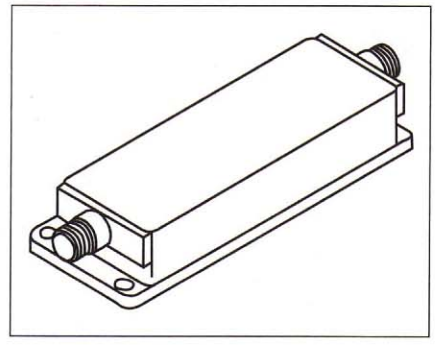
Optical Return Loss*[2] – ≥-30 dB.

Output Termination Impedance – 50 Ω ±4%.

Internal Fiber Size – 9 µm.



ORR24 frequency response (typical).



Sonet/SDH Hardware Filters.

ENVIRONMENTAL CHARACTERISTICS

Operating Temperature (Class VI)*[3] – +10°C to +40°C.

Nonoperating Temperature (Class VI) – -40°C to +70°C.

Humidity – 75% non-condensing.

*[1] *Optical bandwidth (–6 dB electrical power).*

*[2] *Single-mode fiber input.*

*[3] *Reference receiver performance over 25°C ±10°C.*

*[4] *Dependent on conversion gain of wavelength.*

ORDERING INFORMATION

For price information: Outside the U.S. contact your local Tektronix representative, inside the U.S. see the price list in the back of this catalog.

ORR24
2.488 Gb/s SDH/SONET Optical Reference Receiver.
Includes: Hard Case, User Manual (English), Assorted Fiber Optic Hybrid Connectors (FC/FC, FC/ST, FC/SC), FC/FC Single-mode Fiber Jumper, High Performance SMA Cable (015-0560-00), Frequency Response Graph, Certificate of Traceable Calibration.

MEASUREMENT SERVICE OPTIONS
Opt. C3 – Three years of Calibration Services.
Opt. D1 – Cal Data Report.
Opt. D3 – Test Data (requires Opt. C3).
Opt. R3 – Three Year Extended Warranty.

ACCESSORIES
External Power Supply – Order 016-1609-00.
Includes: IEC compatible Power Supply, ORR24 Adapter Cable, U.S. Power Cord, Instruction Sheet.
Alternative Power Cords (IEC Compatible) –
European: Order 161-0066-09.
UK: Order 161-0066-10.
Australia: Order 161-0066-11.
Switzerland: Order 161-0154-00.
2 m Single-mode Fiber Optic Cables, 8/125 µm –
FC/PC to FC/PC: Order 174-1387-00.
FC/PC to ST: Order 174-1386-00.
FC/PC to SC/PC: Order 174-3921-00.
90/10, 3-Port Single-mode Optical Splitter, FC/PC Connectors – Order 174-3737-00.
10 dB, In-line Single-mode Optical Attenuator, FC/PC Connectors – Order 119-5118-00.
50 Ω Power Dividers, DC to 12 GHz (50% Splitter) –
SMA Female: Order 015-0565-00.
SMA Male: Order 015-1014-00.
SONET/SDH Hardware Filters (SMA) –
155 Mb/s (117 MHz): Order 119-5936-00.
622 Mb/s (467 MHz): Order 119-5929-00.

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

CE

Optical Receiver System

New ORS20



Features – Benefits

Switchable Filter Design which Supports Fibre Channel 1.063 Gb/s, Ethernet 1.25 Gb/s and SONET/SDH 2.488 Gb/s Data Rates

Reference Receiver Performance Compliant with IEEE P802.3z, ANSI FC-PH and ITU-T G.957 for Standards Compliance Testing

Broad Wavelength Performance for Testing Both Short (780 nm, 850 nm) and Long (1310 nm, 1550 nm) Wavelength Optical Signals

2.3 GHz Bandwidth for Analyzing Communication Eye-patterns or General Purpose Optical Signals

High Dynamic Range

4th Order Bessel-Thompson Frequency Response

Internal Power Supply for Use with 11800/CSA 803 Series Sampling Oscilloscopes or Other Instruments

Applications

Standards Compliance Testing: Ethernet 1.25 Gb/s, Fibre Channel 1.063 Gb/s, SONET/SDH 2.488 Gb/s

Eye-pattern Measurements

Extinction Ratio Measurements

Characterize Relaxation Oscillation

Optical Signal Analysis

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

CE

ISO 9001

Tektronix measurement products are manufactured in ISO registered facilities.

VERIFICATION OF GIGABIT ETHERNET AND FIBRE CHANNEL SIGNALS

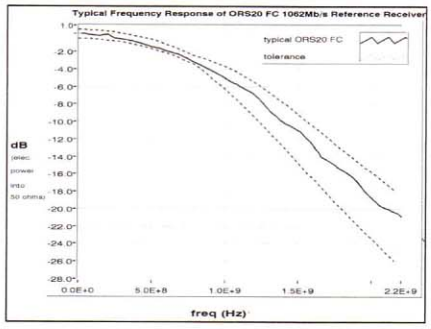
Data rates for the Local Area Networks (LANs) and Wide Area Networks (WANs) have exceeded 1 Gb/s and therefore increased the required interface performance for testing these high speeds optical signals. The Tektronix ORS20 optical receiver systems provides the latest optical-to-electrical interface for compliance testing of Gigabit Ethernet as well as Fibre Channel optical transmission signals. Whether your transmission system or component is short wavelength (850 nm) or long wavelength (1310 nm) design, the ORS20 utilizes a revolutionary broad wavelength photodetector design that allows engineers to verify standards compliance with a single optical-to-electrical converter.

The amplified design of the ORS20 converts the incoming optical light into a high gain, low noise electrical signal that can then be fed directly into the SD-22 electrical sampling head. This allows convenient testing of both low power level as well as high peak amplitude power level optical signals commonly associated with Fabry Perot lasers. The ORS20 has integrated filters which allows users to manually or automatically (TTL interface) engage 4th Order Bessel-Thompson filters required for Fibre Channel and Gigabit Ethernet eye-pattern testing. The 2.3 GHz full bandwidth setting allows designers to view the relaxation oscillation associated Vertical Cavity Side Emitting Lasers (VCSELs) or CD laser based transceivers and it also operates as a 2.5 Gb/s reference receiver as required by ITU-T G.957 for SONET/SDH 2.5 Gb/s signals. A certificate of

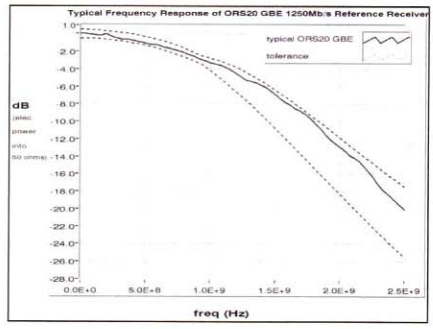
calibration and two frequency response graphs are supplied with each ORS20 for performance documentation.

FREQUENCY PERFORMANCE VALUES FOR AN OPTICAL REFERENCE RECEIVER

Gigabit Ethernet and Fibre Channel recommendations define the nominal transfer function for an optical reference receiver as being a fourth-order Bessel-Thompson response where f_o is the transmitted data rate and f_r is the 3 dB cutoff, which is defined as $f_r = 0.75f_o$.



Fibre Channel 1.063 Gb/s Frequency Response Graph (Typ).



Gigabit Ethernet 1.25 Gb/s Frequency Response Graph (Typ).

CHARACTERISTICS

Wavelength Range – 700 nm to 1650 nm.

Bandwidth*1 – DC to ≥ 2.3 GHz.

Rise Time (Typical)

	Min.	Max.
2.5 Gb/s (Full Bandwidth)	166 ps	204 ps
1.063 Gb/s	389 ps	479 ps
1.25 Gb/s	331 ps	406 ps

Conversion Gain (Typical) – ≥ =0.4 V/mW (@ 850 nm), ≥0.6 V/mW (@ 1310 nm).

Max. Input Optical Power

850 nm	1310 nm
0.16 mW (–8 dBm)*2	0.13 mW (–9 dBm)*2
5 mW (7 dbm)*3	5 mW (7 dBm)*3
10 mW (10 dBm)*4	10 mW (10 dBm)*4

Note: Allowable deviation from the nominal attenuation in the table is very tightly specified in the GIGABIT ETHERNET AND FIBRE CHANNEL recommendations. The actual allowable deviation values depend on f/f_r and the bit rate. These values run as low as ±0.5 dB.

Noise Equivalent Power – ≤15 pW per $\sqrt{Hz}$.

Max. Output Modulation Depth for Reference Receiver Performance*5: ≤200 mV_{p-p}.

Max. Output Modulation Depth (Typical)*6

RF Switch Path	2x Data Rate Frequency	≤1dB Compression
1063 Mb/s	2.12 GHz	500 mV_{p-p}
1250 Mb/s	2.5 GHz	450 mV_{p-p}
Full Bandwidth (2.5 Gb/s)	5.0 GHz	400 mV_{p-p}

Note: Compression refers to the additional frequency response loss when modulation depth exceeds 200 mVp-p.

Aberrations – ≤5% peak – peak.

Optical Return Loss – ≤-14 dB.

Output Termination Impedance – 50 Ω ±4%.

Internal Fiber Size – 62.5 µm.

ENVIRONMENTAL CHARACTERISTICS

Operating Temperature (Class VI) – +10°C to +40°C*7.

Nonoperating Temperature (Class VI) – –40°C to + 70°C.

Humidity – 80% non-condensing.

Power – Line Voltage: 100 V AC to 240 V AC ±10%.

Safety – UL3111-1, CSA1010.1, EN61010-1.

*1 *Optical bandwidth (–6 dB electrical).*

*2 *Typical max. average power for reference receiver performance.*

*3 *Max. average nondestruct power.*

*4 *Max. peak nondestruct power.*

*5 *Dependent on conversion gain of wavelength.*

*6 *Saturation of the amplifier can occur above 700 mV_{p-p}.*

*7 *Reference receiver performance over 25°C ±5°C.*

ORDERING INFORMATION

For price information: Outside the U.S. contact your local Tektronix representative, inside the U.S. see the price list in the back of this catalog.

ORS20
Optical Receiver System.
Includes: User Manual (English), SC/FC Optical Input Connectors, High Performance SMA Cable, US Power Cord, 1.25 Gb/s Frequency Response Graph, 1.063 Gb/s Frequency Response Graph, Certificate of Traceable Calibration.

OPTIONS
Opt. 01 – FC/PC Optical Input Connector.
Opt. FR – 2.5 Gb/s Frequency Response Graph.

MEASUREMENT SERVICE OPTIONS
Opt. C3 – Three years of Calibration Services.
Opt. D1 – Calibration Data.
Opt. D3 – Test Data (requires Opt. C3).
Opt. R3 – 3 Year Extended Warranty.

ACCESSORIES
TVGF11A – Single Rack Mount Kit.
TVGF13 – Dual Rack Mount Kit.
TVGF14 – Dual Half-rack Mount Kit.
TekProbe II Adapter Kit- Order 016-1726-00.
Single-mode Fiber Optic Cables, 8/125 µm, 2 Meters –
FC/PC to FC/PC, Order 174-1387-00.
FC/PC to ST, Order 174-1386-00.
FC/PC to SC/PC, Order 174-3921-00.
Multimode Fiber Optic Cables, 62.5/125 µm, 2 Meters –
FC/PC to FC/PC, Order 174-2322-00.
FC/PC to SC/PC, Order 174-4093-00.
SONET/SDH Hardware Filters (SMA) –
155 Mb/s (117 MHz): Order 119-5936-00.
622 Mb/s (467 MHz): Order 119-5929-00.

INTERNATIONAL POWER PLUGS
Opt. A1 – European.
Opt. A2 – UK.
Opt. A3 – Australia.
Opt. A5 – Switzerland.
See page 619 for description.

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

CE

ISO 9001

Tektronix measurement products are manufactured in ISO registered facilities.

Ethernet GBIC Test System

New GTS1250



Features – Benefits

- Compact Platform for Testing and Characterizing Industry-standard GBIC Modules
- Built-in Generator for Standard IEEE 802.3 Jitter Test Patterns
- Electrical Input for External Transmit Patterns
- Differential Unbuffered Output for Serial Receive Data Stream
- Serial Clock and Data Recovery (Option)

Applications

- Test and Evaluation of GBIC Modules
- Verifying Compliance to Gigabit Ethernet IEEE Standard 802.3
- Bit Error Rate Testing of Fiber Optic Links
- Supports Diagnostic Waveform Analysis of GBIC Receive Signal

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

CE

ISO 9001

Tektronix measurement products are manufactured in ISO registered facilities.

GBIC TEST PLATFORM

Gigabit Ethernet is developing into a leading communication standard for the backbones of local area networks. In support of this technology, Gigabit Interface Converters (GBICs) have become an industry standard for interfacing network hubs and processors via optical fiber links. The GTS1250 is an instrument for testing and evaluating GBICs. It accepts GBICs via a receptacle on the front-panel, and provides access to their electrical Transmit and Receive interface, and all other monitoring pins.

PROGRAMMED OR EXTERNAL TEST PATTERNS

For the transmitter side of the GBIC, the instrument can generate test patterns based on IEEE Standard 802.3, and accept externally generated patterns. The built-in patterns are selected on the instrument front-panel or remotely through TTL levels. In addition, the instrument provides an input for data cycle adjustment and jitter modulation of the transmit data.

RECEIVE SIGNALS WITH CLOCK RECOVERY (OPTION 01)

On the receiver side of the GBIC, the instrument makes available the recovered and retimed data, and the 1.25 GHz recovered clock for Bit Error Rate Testers and eye pattern triggering. For diagnostic waveform analysis, the complementary unbuffered data signal from the GBIC is also made available.

Characteristics

GBIC Port – Industry standard GBIC receptacle

Electrical Inputs and Outputs – SMA connectors, unless stated otherwise.

External Transmit Data Input –
Amplitude: >300 mV_{p-p} and <1.4 V_{p-p}.
Duty Cycle: 50% ±1%.
Data Rate: 100 Mb/s to 1.4 Gb/s.

Pattern Generator – Data Format: NRZ.
All patterns except PRBS7 as defined in IEEE Standard 802.3 Annex 36A, 1998.
Programmed Transmit Data Patterns:

D21.5: Continuously repeating 10101010 output (equivalent to 625 MHz square wave).
K28.7: Continuously repeating 1111100000 output (equivalent to 125 MHz square wave).
K28.5: Continuously repeating sequence of 0011111010 followed by logical inverse 1100000101.
LONG: Long continuous random test pattern for measuring wideband system jitter.
SHORT: Short continuous random test pattern for measuring wideband system jitter.

PRBS7: Pseudo Random Bit Sequence (equivalent to 2^7-1) for common BER and PRBS testing.
Selected pattern is sent directly to ±Tx-Data pins of GBIC receptacle.

Transmit Data Outputs –
Transmit Data: Data pattern sent to GBIC transmitter.
Transmit Data: Complement of Transmit Data.
Clock Out: 1.25 GHz clock signal synchronous to outgoing transmit pattern.
Common for Transmit Data and Clock Out:
Rise/Fall time (10 to 90%): <300 ps.
Sync Pulse:
Pulse synchronous to outgoing transmit pattern.
Random Jitter:
Transmit patterns, Clock-to-Data: <4 ps rms (typical 2 ps rms).
Common for Transmit Data, Clock, and Sync Pulse outputs:
Output amplitude: min. 300 mV_{p-p} max. 600 mV_{p-p}.
Output impedance: 50 Ω, AC coupled.

Transmit Data Jitter Modulation – Varies pulse width of transmit data stream via externally supplied voltage.
Amplitude: max. 2.5 V_{p-p}.
Frequency: DC to 4.75 MHz (typical).
Jitter variation: ±1 V changes logic pulse widths by ±110 ps.

Receive Data Output –
+ Receive Data, – Receive Data: Direct pickoff from ±Rx-Data pins of GBIC receptacle via 75 to 50 Ω min-loss conversion circuitry.
Output impedance: 50 Ω, DC coupled.

Recovered Clock (Opt. 01) –
Derived from Rx-Data of GBIC.
Lock range: 1.25 Gb/s ±10,000 ppm.
Phase lock loop bandwidth: 750 kHz ±100 kHz.
Jitter tolerance:
f_{MOD} <30 kHz: 1.5 UI (120 ps).
3 MHz <f_{MOD} <30 kHz: 0.15 UI (120 ps).
(f_{MOD} = Frequency of horizontal timing jitter of incoming optical signal)
Clock-to-recovered Data Jitter: <8 ps rms (typ. <4 ps rms).
Output amplitude: min. 300 mV_{p-p} max. 600 mV_{p-p}.
Output impedance: 50 Ω, AC coupled.
Rise/Fall time (10 to 90%): <300 ps.

Recovered Receive Data (Opt. 01) –
Derived from Rx-Data of GBIC, retimed by recovered clock.
Output amplitude: min. 300 mV_{p-p} max. 600 mV_{p-p}.
Output impedance: 50 Ω, AC coupled.
Rise/Fall time (10 to 90%): <350 ps.

Indicators –
Front-panel indicators for GBIC:
Receive Loss of Signal (Rx LOS).
GBIC Transmitter Fault (Tx Fault).
GBIC I and V overload.

GBIC Receptacle Supply –
Supply voltage: 4.85 to 5.15 V (typ. 5 V), variable by ±500 mV via auxiliary input.
Supply current: max. 400 mA steady state.
Output ripple: <50 mV_{p-p} relative to receptacle GND.
Overload protected with reset function.

Auxiliary Inputs –
Available on rear-panel 25-pin male D connector.
Remote control of Transmit Pattern: 3-Bit TTL input.
GBIC Tx Disable: TTL input.
GBIC overload reset: TTL input.
GBIC supply shutdown: TTL input.
GBIC V offset: ±500 mV from GBIC 5 V supply.

Auxiliary Outputs –
Available on rear-panel 25-pin male D connector.
GBIC Tx Fault and Rx Los: TTL output flags.
GBIC serial-ID communication lines.
GBIC I and V overload: TTL output flags.
GBIC V monitor: 1 to 1 ±3% GBIC supply voltage via 1 kΩ resistor.
GBIC I monitor: 1 mV per 1 mA ±3% of GBIC supply current.

ENVIRONMENTAL, EMC, SAFETY

Operating Temperature (Class VI) –
+10°C to +40°C.

Nonoperating Temperature (Class VI) –
–55°C to +75°C.

Random Vibration –
Operating: 0.31 g rms, from 5 to 500 Hz.
Nonoperating: 2.46 g rms, from 5 to 500 Hz. 10 minutes each axis.

EMC Compliance –
Meets intent of Directive 89/336/EEC for electromagnetic compatibility.
Australian AN/NZS 2064.1/2 and AS/NZS 3548.

Safety –
UL3111-1; CAN/CSA C22.2 No. 1010.1; EN 61010-1: 1995/A2.

PHYSICAL CHARACTERISTICS

Dimensions	mm	in.
Height	45	1.75
Width	204	8
Depth	331	13
Weight	**kg**	**lbs.**
Net	1.8	3.9

SPECIFICATIONS FOR IBM GBIC MODULES:

	IBM 850 nm multi-mode	IBM 1310 nm single-mode
	Order 119-6112-00	Order 119-6113-00
Optical data rate	1.0625 or 1.25 Gb/s	1.0625 or 1.25 Gb/s
Optical wavelength	770 to 860 nm	1270 to 1350 nm
Launch power	–9.5 to –5.0 dBm	–9.5 to –3.0 dBm
Optical connections	Female SC for Transmit and Receive Signal	

ORDERING INFORMATION

For price information: Outside the U.S. contact your local Tektronix representative, inside the U.S. see the price list in the back of this catalog.

GTS1250
Test System for Gigabit Interface Converters.
Includes: Instruction Manual, Certificate of Calibration, Power Cord.

GTS1250 OPTIONS
Opt. 01 – Clock Recovery.

INTERNATIONAL POWER PLUGS
Opt. A1 – Universal Euro 240 V, 50 Hz.
Opt. A2 – United Kingdom 240 V, 50 Hz.
Opt. A3 – Australia 240 V, 50 Hz.
Opt. A5 – Switzerland 220 V, 50 Hz.
Opt. AC – China 240 V, 50 Hz.
See page 619 for description.

MEASUREMENT SERVICE OPTIONS
Opt. D1 – Calibration Data Report.
Opt. C3 – Three years of Calibration Services.
Opt. D3 – Three years of Calibration Data (requires Opt. C3).
Opt. R3 – Three years of Extended Warranty.

RECOMMENDED ACCESSORIES
IBM 850 nm multi-mode GBIC –
Order 119-6112-00.
IBM 1310 nm single-mode GBIC –
Order 119-6113-00.

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

Tunable Laser Sources

New LPB1100 • New LPB1300 • New LPB1550



Features – Benefits

Mode-Hop Free for Smooth and Accurate Wavelength Tuning

High Power Output for Low Noise Measurements and Real-Life Signal Emulation

Wide Spectral Range to Fully Characterize Designs within the Wavelength Window of Interest

Amplitude Modulation and Mode-locked Operation for Non-Continuous Wave Test Requirements

Fine Tuning for Precise Wavelength (Frequency) Resolution

Applications

Characterization of Fiber Optic Components (Splitters, Couplers, Bragg Grating, etc.)

Characterization of Optical Amplifiers (EDFAs, etc.)

Testing of Optical Communication Transmission Systems

Emulation of DWDM Optical Signals

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

CE

GPIB IEEE-488

Product(s) complies with IEEE Standard 488.1-1987, RS-232-C, and with Tektronix Standard Codes and Formats.

LPB1100 AND LPB1550

The Tektronix LPB series tunable laser sources provide engineers with the ability to fully characterize their optical designs over a broad wavelength range at real-life power levels. There are three instruments in the series to provide customers with the performance and flexibility needed for today's optical applications:

The LPB1100 is an economically priced general-purpose bench-top optical source. This unit offers many of the features seen in the high-performance LPB1300 and LPB1550 models in a more compact package. The standard configuration features 10 pm resolution and a 1500 to 1570 nm wavelength range at 0 dBm output power. A variety of options allow users to choose a different wavelength range covering 1530 to 1600 nm, improved wavelength resolution (1 pm), and +6 dBm power output, making it a full-featured instrument for any application.

The LPB1550 is a high-performance tunable laser with features that satisfy the most stringent optical testing requirements:

- Mode-hop free operation guaranteed over a 70 nm range, which ensures smooth and accurate wavelength sweeps
- Extremely smooth scans over 100 nm, with an unsurpassed 1 pm resolution, allows for extremely fine analysis over the spectral range
- A full range of amplitude modulation capabilities and mode-locked operation which satisfies many modulation requirements
- Wavelength fine tuning down to sub-MHz resolution
- Coherence control capability

The standard configuration features a 1500 to 1600 nm wavelength range at 0 dBm output power. There are three wavelength range options and two power output options that enable users to designate an instrument that meets the exact requirements needed for their specific applications.

The LPB1300 has the same performance features as the LPB1550 but this laser source is optimized for applications where characterization is needed in the 1300 nm wavelength region. The standard configuration features a 1260 to 1330 nm wavelength window that can be modified to 1360 to 1420 by choosing Option 1W.

All of the tunable lasers have an intuitive user interface and can be completely controlled through either the IEEE Std 488.1-1987 interface

or via an RS-232 interface. Each unit also has an optional LabView driver to aid the development of software for remote control applications. There is also a polarization maintaining output option for applications that are sensitive to polarization variations.

The Tektronix Tunable Laser Diode Sources use an external cavity design that guarantees long-term top performance without any adjustments. The cavity is self aligned, a key feature for long-term stability. In most laser cavities, minute changes in the position of the optical elements, caused by mechanical drifts over time, can rapidly degrade both the power and the spectral purity. In contrast, the patented cavity design uses a dihedral rear reflector made with a 180° folding prism that acts as a "2D corner cube," which enables the resonator to remain perfectly in tune, irrespective of small misalignments. As a result, these instruments have no fine adjustments that might require periodic "tweaking", and can maintain top performance over time.

These instruments also incorporate optical heads that are constructed entirely of Invar, a zero-thermal-expansion metal. No temperature control of any kind is required for the instrument to perform to full specifications. Instant start-up and low power dissipation are also benefits of this design.

Mode hops plague most tunable laser designs and are quite bothersome in many user applications. Their most conspicuous manifestation is in the power-vs-wavelength characteristic at a constant diode current, which exhibits significant stair-like glitches that can create measurement discrepancies. Less obvious, but potentially more troublesome, are the sudden unpredictable, and non-reproducible 40 pm wavelength jumps, which make the sweep discontinuous, preclude accurate calibration, and make testing of very narrow-band components impossible. The scanning mechanism in the Tektronix bench instruments, with only one moving part, is configured such that the cavity length is a fixed multiple of the wavelength at all times. This guarantees a large range of smooth spectral sweep, free of any mode hop.

CHARACTERISTICS

TUNING

	LPB1100	LPB1300	LPB1550
Wavelength Range (standard)			
P = 0 dBm	1500 to 1570 nm	1260 to 1330 nm	1500 to 1600 nm
P = 6 dBm (Option P6)	1520 to 1560 nm		1530 to 1590 nm
P = 10 dBm (Option PX)			1535 to 1585 nm
Modified Wavelength Range (Option 1W)			
P = 0 dBm	1530 to 1600 nm	1360 to 1420 nm	1520 to 1620 nm
P = 6 dBm (Option P6)	1550 to 1590 nm		1540 to 1600 nm
Modified Wavelength Range (Option 2W)			
P = 0 dBm			1540 to 1640 nm
P = 6 dBm (Option P6)			1580 to 1620 nm
Modified Wavelength Range (Option 3W)			
P = 0 dBm			1480 to 1580 nm
P = 6 dBm (Option P6)			1510 to 1570 nm
Mode Hop Spacing	>30 nm	>40 nm	>70 nm
Absolute Wavelength Accuracy	±0.2 nm	±0.2 nm	±0.2 nm
Tuning Repeatability (typical)	±0.01 nm	±0.005 nm	±0.005 nm
Wavelength Setting Resolution	0.01 nm	0.001 nm	0.001 nm
Optical Frequency Fine Tuning (typical)	±2 GHz (Option 1C)	±2 GHz	±2 GHz
Tuning Speed (typical)	10 s (70 nm)	0.5 s (40 nm)	1 s (100 nm)

LASER OUTPUT

	LPB1100	LPB1300	LPB1550
Power Stability (P = 0 dBm, 1 hour)	±0.01 dBm	±0.01 dBm	±0.01 dBm
Line Width (typical)			
Coherence Control OFF	150 kHz	150 kHz	150 kHz
Coherence Control ON (typical)	>100 MHz (Option 1C)	>100 MHz	>100 MHz
Side Mode Suppression Ratio	>45 dB	>45 dB	>45 dB
RIN (typical)	< –145 dB/Hz	< –145 dB/Hz	< –145 dB/Hz
Low-frequency Modulation	10 kHz to 8 MHz	DC to 8 MHz	DC to 8 MHz
High-frequency Modulation		30 kHz to 1 GHz	30 kHz to 1 GHz
Mode-lock Frequency (typical)		5 GHz	5 GHz

INTERFACES

	LPB1100	LPB1300	LPB1550
Optical Connector	FC/APC	FC/APC	FC/APC
Output Fiber*	SMF-28™ (yellow)	SMF-28™ (yellow)	SMF-28™ (yellow)
Return Loss (typical)	-60 dB	-60 dB	-60 dB
Programmability			
IEEE Std 488.1-1987	yes	yes	yes
RS-232C	yes	yes	yes

** With Option 1M a polarization maintaining fiber (blue) is used.*

GENERAL CHARACTERISTICS

ENVIRONMENTAL

Temperature Range –
Operating: +15 to +30°C (+60 to +85°F).
Nonoperating: –20°C to +70°C (0 to +160°F).

Altitude –
Operating: Up to 2,000 m (6,500 ft.).
Nonoperating: Up to 5,000 m (16,400 ft.).

EMC COMPLIANCE
EN 55011 Class A.
EN 50082-1.

SAFETY COMPLIANCE

Electrical –
EN 61010-1/A2.
ANSI/ISA Std S82.01. (UL 3111-1).
CAN/CSA-C22.2 No. 1010.1-92.

Laser –
LPB1550 & 1300: EC60825-1. (Class 3A), 21CFR, part 1000 (Class IIIb).
LPB1100: EC60825-1. 21CFR, part 1000 (Class I).

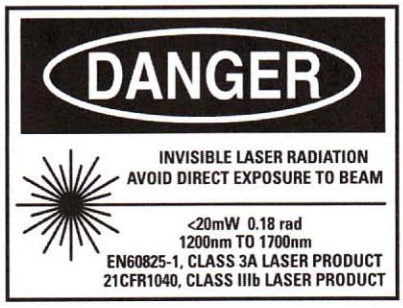
POWER
Line Voltage – 100 V AC or 240 V AC ±10%.
Line Frequency – 50 to 60 Hz ±5%.

PHYSICAL CHARACTERISTICS

LPB1300 and LPB1550

Dimensions	mm	in.
Height	133	5.2
Width	448	17.6
Depth	370	14.6
Weight	**kg**	**lb.**
Net	12.2	26.9

WARRANTY
One year parts and labor.



ORDERING INFORMATION

For price information: Outside the U.S. contact your local Tektronix representative, inside the U.S. see the price list in the back of this catalog.

LPB1100 TUNABLE DIODE LASER SOURCE.
Includes: User Manual, FC/APC to FC/PC Single-mode Fiber Optic Cable, US Power Cord, Calibration Data, Certificate of Traceable Calibration.

LPB1100 OPTIONS
Option 1C – Coherence control and fine tuning.
Option 1L – LabView driver.
Option 1M – Polarization maintaining output.
Option 1S – 1 pm resolution.
Option 1W – 1530 to 1600 modified wavelength range.
Option P6 – +6 dBm output power.

LPB1300 TUNABLE DIODE LASER SOURCE.
Includes: User Manual, FC/APC to FC/PC Single-mode Fiber Optic Cable, US Power Cord, Calibration Data, Certificate of Traceable Calibration.

LPB1300 OPTIONS
Option 1L – LabView driver.
Option 1M – Polarization maintaining output.
Option 1W – 1360 to 1420 modified wavelength range.

LPB1550 TUNABLE DIODE LASER SOURCE.
Includes: User Manual, FC/APC to FC/PC Single-mode Fiber Optic Cable, US Power Cord, Calibration Data, Certificate of Traceable Calibration.

LPB1550 OPTIONS
Option 1L – LabView driver.
Option 1M – Polarization maintaining output.
Option 1W – 1520 to 1620 modified wavelength range.
Option 2W – 1540 to 1640 modified wavelength range.
Option 3W – 1480 to 1580 modified wavelength range.
Option P6 – +6 dBm output power.
Option PX – +10 dBm output power.

MEASUREMENT SERVICE OPTIONS
Option C3 – Three years of calibration services.
Option R3 – Three years of repair protection.
Option D3 – Three year test report (with Opt. C3).

INTERNATIONAL POWER PLUGS
Option A1 – Universal Euro 220 V, 50 Hz.
Option A2 – United Kingdom 240 V, 50 Hz.
Option A3 – Australian 240 V, 50 Hz.
See page 619 for description.

RECOMMENDED ACCESSORIES
Laser Output Safety Lock Keys – Order 105-1125-00.
Cable, Fiber Opt.; Singlemode Polarization Maintaining (Blue Jacket) – Order 012-1566-00.
Cable, Fiber Opt.; Singlemode FC/APC to FC/PC (Yellow Jacket) – Order 012-1564-00.

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

CE

GPIB IEEE-488

Product(s) complies with IEEE Standard 488.1-1987, RS-232-C, and with Tektronix Standard Codes and Formats.

Modular Laser-Source Mainframe

New LPM5000



Features – Benefits

Modular Form Factor Provides Flexibility for Multi-wavelength Applications

Large Display and Easy Controls for Adjusting the Parameters of Up to Eight Modules

Mainframe Form Factor Allows Convenient Rack Mounting (19 in. rack)

IEEE std-488.2 and RS-232-C Compliant for Automated Test Environments

Internal and External Amplitude Modulation Operation for Noncontinuous Wave Test Requirements

Applications

Characterization of Fiber Optic Components (Splitters, Couplers, Bragg Grating, etc.)

Characterization of Optical Amplifiers (EDFAs, etc.)

Testing of Optical Communication Transmission Systems

Emulation of Multi-wavelength DWDM Optical Signals

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

CE

GPIB IEEE-488

Product(s) complies with IEEE Standard 488.1-1987, RS-232-C, and with Tektronix Standard Codes and Formats.

The Tektronix LPM5000 mainframe features eight (8) plug-in slots for various modules in a compact form factor that can be used in bench or rackmount (19 in.) applications. A complete line of laser sources plug directly into the LPM5000 and provide a flexible solution for engineers characterizing multi-wavelength optical designs. The LPM5000 features a large display and easy-to-use button controls for quick access to module functions. Modules can be accessed individually to control power and wavelength parameters or as a group so that an entire rack can be disabled with one command sequence. Each module can also be controlled through the IEEE std-488.2 or RS-232-C interfaces. The mainframe features an internal modulator and can receive input from external modulation sources as well.

AVAILABLE LASER MODULES

LPM5200 Tunable Laser Source
LPM5500 DFB Laser Source
LPM5700 Broadband Source

Ordering Information

For price information:
Outside the U.S. contact your local Tektronix representative, inside the U.S. see the price list in the back of this catalog.

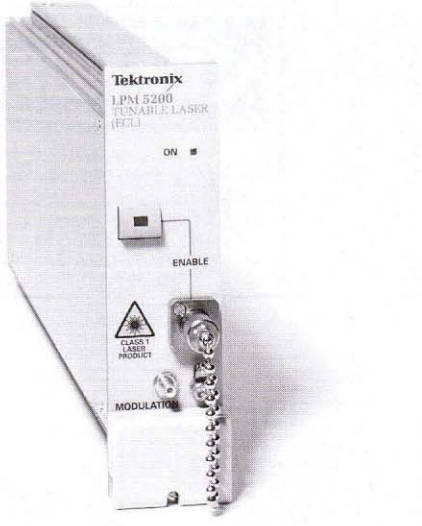
LPM5000
Modular Laser Source Mainframe.
Includes: User Manual, US Power Cord, Certificate of Traceable Calibration.

MEASUREMENT SERVICE OPTIONS
Opt. C3 – Three years of calibration services.
Opt. R3 – Three years of repair protection.

INTERNATIONAL POWER PLUGS
Opt. A1 – Universal Euro 220 V, 50 Hz.
Opt. A2 – United Kingdom 240 V, 50 Hz.
Opt. A3 – Australian 240 V, 50 Hz.
See page 619 for description.

Modular Tunable Laser Source

New LPM5200



Features – Benefits

- Wide Wavelength Tuning Range for Complete Spectral Characterization
- Provides Flexibility for Multi-wavelength Applications
- Wavelength Range Options for Complete DWDM Spectral Coverage
- High-power Output for Low-noise Measurements and Real-life Signal Emulation
- Internal and External Amplitude Modulation Operation for Noncontinuous Wave Test Requirements

Applications

- Characterization of Fiber Optic Components (Splitters, Couplers, Bragg Grating, etc.)
- Characterization of Optical Amplifiers (EDFAs, etc.)
- Testing of Optical Communication Transmission Systems
- Emulation of Multi-wavelength DWDM Optical Signals

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

CE

GPIB IEEE-488

Product(s) complies with IEEE Standard 488.1-1987, RS-232-C, and with Tektronix Standard Codes and Formats.

The Tektronix LPM5200 is a modular, external cavity laser that provides maximum flexibility for optical design characterization applications. A high-precision FP laser diode used in conjunction with a precisely controlled stepper motor assembly allows the wavelength to be tuned over an 80 nm range. The LPM5200 external cavity design also provides stable output power over the entire tuning range. To cover the complete spectrum of requirements for DWDM testing, the LPM5200 has several options available. There are three wavelength range options that provide overlapping coverage of the wavelengths between 1480 nm and 1640 nm. The standard peak power output is >+3 dBm, but for applications where optical signals are attenuated, such as long haul or multiple device testing, there are +6 dBm and +10 dBm power options available.

With specifications that are comparable to some bench-top units, the LPM5200 is ideal for testing fiber optic components such as multiplexers, filters, Bragg gratings and splitters. The small form factor makes it perfect for setting up multiple wavelengths for testing optical communication systems.

Up to eight LPM5200s can be inserted in an LPM5000 mainframe. The instrument is controlled via an easy-to-use user interface accessed on the mainframe. Power and wavelength parameters can be quickly accessed and changed using the front-panel buttons. The unit can also be controlled through an IEEE-488.2 or an RS232-C interface. For applications that require a varying light source, the LPM5200 output can be modulated from the mainframe interface or by an external input through an SMA connector on the front panel of the LMP5200.

High wavelength resolution (0.001 nm) and polarization maintaining output fiber options are also available which give the LPM5200 added capabilities for DWDM test applications.

Characteristics

Wavelength Accuracy – ±0.2 nm.
Wavelength Stability – 0.1 nm.
Wavelength Setting Resolution – 0.01 nm.
Tuning Repeatability (typical) – ±0.01 nm.
Tuning Speed (typical) – 10 nm/s.

Wavelength Range	LPM5200 Opt. 2W	LPM5200	LPM5200 Opt. 1W
P = 0 dBm	1480 to 1560 nm	1520 to 1600 nm	1560 to 1640 nm
P = 6 dBm (Opt. P6)	1510 to 1550 nm	1530 to 1580 nm	1580 to 1620 nm
P = 10 dBm (Opt. PX)		1540 to 1580 nm	

Peak Power – >+3 dBm.

Power Stability (P = 0 dBm, 1 hour) – ±0.01 dB.

Spectral Width –
Coherence control off: 100 kHz.
Coherence control on: >100 MHz.

Side Mode Suppression Ratio – >45 dB.

RIN (typical @ 1 mW) – <-145 dB/Hz.

Return Loss (typical) – -60 dB.

Output Isolation – 35 dB.

Analog Modulation – 1 kHz to 1 GHz (external modulation).

Digital Modulation – 100 Hz to 500 kHz (internal or external).

Optical Interface – FC/APC connector on Corguide™ SMF-28 fiber.

ENVIRONMENTAL

Temperature Range –
Operating: +15 to +30°C (+60 to +85°F).
Nonoperating: –20 to +70°C (0 to +160°F).

EMC COMPLIANCE

EN 50082-1.
EN 55011 Class A.

SAFETY COMPLIANCE

Electrical –
EN61010-1/A2.
ANSI/ISA Std. S82.01 (UL3111-1).
CAN/CSA-C22.2 No. 1010.1-92.

Laser –
EN60825-1 (Class 3A).
21CFR, part 1000 (Class IIIb).

PHYSICAL CHARACTERISTICS

Single-width module compatible with LPM5000 Mainframe.

Dimensions	mm	in.
Height	130	5.1
Width	40	1.6
Depth	330	13.0
Weight	**kg**	**lb.**
Net	1.0	2.2

WARRANTY

One year parts and labor.



ORDERING INFORMATION

For price information: Outside the U.S. contact your local Tektronix representative, inside the U.S. see the price list in the back of this catalog.

LPM5200
Tunable Laser Source.
Includes: User Manual, FC/APC to FC/PC Single-mode Fiber Optic Cable, Calibration Data and Certificate of Traceable Calibration.

LPM5200 OPTIONS

Opt. 1M – Polarization Maintaining Output.
Opt. 1S – 1 pm Resolution.
Opt. 1W – Modified Wavelength Range (1560 to 1640 nm).
Opt. 2W – Modified Wavelength Range (1480 to 1560 nm).
Opt. P6 – +6 dBm Output Power.
Opt. PX – +10 dBm Output Power.

MEASUREMENT SERVICE OPTIONS

Opt. C3 – Three years of calibration services.
Opt. R3 – Three years of repair protection.
Opt. D3 – Three year test report (with Opt. C3).

RECOMMENDED ACCESSORIES

Fiber Optic Cable; Single-mode FC/APC to FC/PC (Yellow Jacket) – Order 012-1564-00.
Fiber Optic Cable; Single-mode FC/APC, Polarization Maintaining (Blue Jacket) – Order 012-1566-00.

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

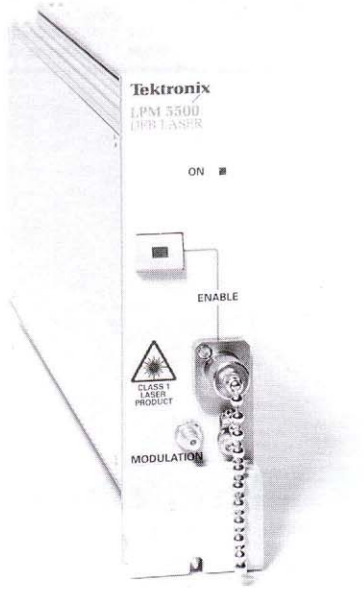
CE

GPIB IEEE-488

Product(s) complies with IEEE Standard 488.1-1987, RS-232-C, and with Tektronix Standard Codes and Formats.

Modular DFB Laser Source

New LPM5500



Features – Benefits

- Selectable Wavelength Options for ITU DWDM Grid Matching
- Provides Flexibility for Multi-wavelength Applications
- Internal Calibration for High Wavelength Accuracy
- Internal Polarization Maintaining Fiber for High Wavelength Stability
- High-power Output for Low-noise Measurements and Real-life Signal Emulation
- Internal and External Amplitude Modulation Operation for Noncontinuous Wave Test Requirements

Applications

- Characterization of Fiber Optic Components (Splitters, Couplers, Bragg Grating, etc.)
- Characterization of Optical Amplifiers (EDFAs, etc.)
- Testing of Optical Communication Transmission Systems
- Emulation of Multi-wavelength DWDM Optical Signals

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

CE

GPIB IEEE-488

Product(s) complies with IEEE Standard 488.1-1987, RS-232-C, and with Tektronix Standard Codes and Formats.

The Tektronix LPM5500 is a modular Distributed Feedback Bragg (DFB) Laser that provides an excellent solution for multi-wavelength test requirements. Internal wavelength calibration enables the instrument to maintain ±0.03 nm accuracy, which is important for Dense Wavelength Division Multiplexing (DWDM) applications. The DFB Laser offers excellent wavelength stability while also providing more than +10 dBm of optical power. The standard configuration comes with an internal polarization-maintaining fiber, which is instrumental in keeping the output stable. Output stability is especially important for component or system tests that run for long periods of time. Output drifts could invalidate hours or even days of testing.

Wavelength options are available that correspond to the optical channels between 1530 nm and 1564 nm defined by the ITU. Even greater wavelength flexibility is obtained with the ±1 nm tuning range.

Up to eight LPM5500s can be inserted in an LPM5000 mainframe. The instrument is controlled via an easy-to-use user interface accessed on the mainframe. Power and wavelength parameters can be quickly accessed and changed using the front-panel buttons. The unit can also be controlled through an IEEE-488.2 or an RS232-C interface. For applications that require a varying light source, the LPM5500 output can be modulated from the mainframe interface or by an external input through an SMA connector on the front panel of the LMP5500.

Characteristics

Center Wavelength Selection – 1530 to 1564 nm. User selected on the ITU grid.
Wavelength Tuning Range – ±1.0 nm.
Wavelength Accuracy – ±0.03 nm.
Wavelength Stability (1 hour) – 0.005 nm.
Peak Power – +10 dBm.
Power Stability (1 hour) – ±0.01 dB.

Attenuation Accuracy – ±0.1 db (10 dB range).

Spectral Width – <30 MHz.

Side Mode Suppression Ratio – >30 dB.

RIN (typical @ 1 mW) – <-145 dB/Hz.

Output Interface – FP/APC connector on polarization maintaining fiber.

Analog Modulation – 1 kHz to 1 GHz (external modulation).

Digital Modulation – 100 Hz to 500 kHz (internal or external).

ENVIRONMENTAL

Temperature Range –
Operating: +15 to +30°C (+60 to +85°F).
Nonoperating: –20 to +70°C (0 to +160°F).

EMC Compliance –
EN 55011, Class A.
EN 50082-1.

SAFETY COMPLIANCE

Electrical –
EN61010-1/A2.
ANSI/ISA Std. S82.01.
CAN/CSA-C22.2 No. 1010.1-92.

Laser –
EN60825-1 (Class 3A).
21CFR, part 1000 (Class IIIb).

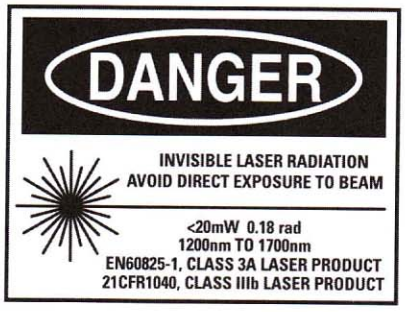
PHYSICAL CHARACTERISTICS

Single-width module compatible with LPM5000 Mainframe.

Dimensions	mm	in.
Height	130	5.1
Width	40	1.6
Depth	330	13.0
Weight	**kg**	**lb.**
Net	0.7	1.5

WARRANTY

One year parts and labor.



ORDERING INFORMATION

For price information: Outside the U.S. contact your local Tektronix representative, inside the U.S. see the price list in the back of this catalog.

LPM5500
Modular DFB Laser Source.
Includes: User Manual, FC/APC to FC/PC Single-mode Fiber Optic Cable, Calibration Data and Certificate of Traceable Calibration.

MEASUREMENT SERVICE OPTIONS

Opt. C3 – Three years of calibration services.
Opt. R3 – Three years of repair protection.
Opt. D3 – Three year test report (with Opt. C3).

RECOMMENDED ACCESSORIES

Fiber Optic Cable, Single-mode (FC/APC), Polarization Maintaining (Blue Jacket) –
Order 174-1566-00.

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

CE

GPIB IEEE-488

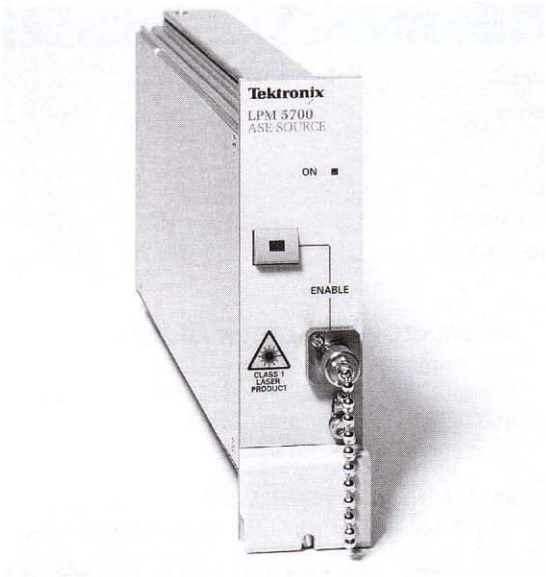
Product(s) complies with IEEE Standard 488.1-1987, RS-232-C, and with Tektronix Standard Codes and Formats.

Option	Nominal Wavelength (nm)	Optical Frequency (THz)
1	1530.3	195.9
2	1531.1	195.8
3	1531.9	195.7
4	1532.7	195.6
5	1533.5	195.5
6	1534.3	195.4
7	1535.0	195.3
8	1535.8	195.2
9	1536.6	195.1
10	1537.4	195.0
11	1538.2	194.9
12	1539.0	194.8
13	1539.8	194.7
14	1540.6	194.6
15	1541.3	194.5
16	1542.1	194.4
17	1542.9	194.3
18	1543.7	194.2
19	1544.5	194.1
20	1545.3	194.0
21	1546.1	193.9
22	1546.9	193.8

Option	Nominal Wavelength (nm)	Optical Frequency (THz)
23	1547.7	193.7
24	1548.5	193.6
25	1549.3	193.5
26	1550.1	193.4
27	1550.9	193.3
28	1551.7	193.2
29	1552.5	193.1
30	1553.3	193.0
31	1554.1	192.9
32	1554.9	192.8
33	1555.7	192.7
34	1556.6	192.6
35	1557.4	192.5
36	1558.2	192.4
37	1559.0	192.3
38	1559.8	192.2
39	1560.6	192.1
40	1561.4	192.0
41	1562.2	191.9
42	1563.0	191.8
43	1563.9	191.7

Modular Broadband Source

New LPM5700



Features – Benefits

Broad Wavelength Stimulus for DWDM Component Characterization

Flexibility for Multi-source Applications

High-power Output for Low-noise Measurements and Real-life Signal Emulation

Applications

Characterization of Fiber Optic Components (Splitters, Couplers, Bragg Grating, etc.)

Testing of Optical Communication Transmission Systems

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

CE

GPIB IEEE-488

Product(s) complies with IEEE Standard 488.1-1987, RS-232-C, and with Tektronix Standard Codes and Formats.

The LPM5700 is a 1550 nm broadband source based on Amplified Spontaneous Emission (ASE) in an erbium-doped fiber, which is pumped by a high power 980 nm laser diode. Proprietary module designs for spectral shaping provide a near-gaussian output spectrum centered on 1555 nm. The stable power output (greater than +13 dBm) is suitable for characterizing components such as filters and Bragg gratings. The module is particularly useful in detailed tests of passive WDM components when combined with a high performance optical spectrum analyzer.

Up to eight LPM5700s can be inserted in an LPM5000 mainframe. The instrument is controlled via an easy-to-use user interface accessed on the mainframe. Optical power parameters can be accessed quickly and changed using the front-panel buttons. The unit can also be controlled through an IEEE-488.2 or an RS232-C interface.

Characteristics

Center Wavelength – 1555 nm ±10 nm.
Spectral Width @ –10 dB – 25 nm ±5 nm.
Peak Power – +13 dBm.
Output Polarization – Depolarized.
Power Stability (1 hour) – <0.1 dB.
Optical Interface – FC/APC connector on Corguide™ SMF-28 fiber.

Ordering Information

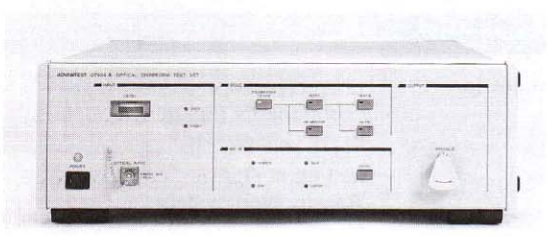
For price information:
Outside the U.S. contact your local Tektronix representative, inside the U.S. see the price list in the back of this catalog.

LPM5700
Broadband Laser Source.
Includes: User Manual, FC/APC to FC/PC Single-mode Fiber Optic Cable, Calibration Data and Certificate of Traceable Calibration.

MEASUREMENT SERVICE OPTIONS
Service Options R3, C3 and D3 are also available with this unit.

Dynamic Chirp Measurement System

New Q7606A • New Q7606B



Features – Benefits	Applications
Quick Measurement Time	Chirp Testing for Optical Components and Optical Systems
High Resolution Evaluation	
Excellent Repeatability	
Wide-frequency Measurements	
Automatic Polarization Adjuster	
Built-in Optical Amplifier (Q7606A)	

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

CE

ADVANTEST
Advantest's quality system complies with the DIN ISO 9002 standard and has been certified by TUV Product Service GmbH.

Overview

The landscape for information carrying networks is rapidly changing due to enabling technologies that increase transmission rates for optical communication systems, especially for optical long-distance and wavelength division multiplexing (WDM) transmission systems. This means optical engineers who design/integrate high-speed optical components and transmission systems require new instruments to meet their test needs. One such test need is the ability to measure chirp.

Tektronix now offers a complete chrip measurement solution with the Q7606, D3186 Pulse Pattern Generator and Tektronix' high-end sampling oscilloscope. Hence, this solution is ideal for optical modulators and laser diodes.

Features/Benefits

QUICK TIME-DOMAIN CHIRP MEASUREMENTS: 30 SECONDS OR LESS*1

The Q7606 makes dynamic chirp measurements a simple and easy process by automatically separating the frequency-modulation (FM) and intensity-modulation (IM) components. In contrast, conventional methods using spectral diffraction take 20 minutes or more for chirp measurement.

HIGH-RESOLUTION*2

The Q7606 measures chirp in approximately 20 MHz or less.

AUTOMATIC POLARIZATION ADJUSTER

The Automatic Polarization Adjuster determines the optimum polarization level for chirp measurements. This feature yields faster and more accurate chirp measurements.

EXCELLENT REPEATABILITY*3

The Q7606's measurement repeatability is +5%.

WIDE-MEASUREMENT FREQUENCY BANDWIDTH

The measurement frequency bandwidth is approximately 50 GHz or more. This allows the Q7606 to measure transmission signals greater than 10 Gbps.

SIMPLE OPERATION

The user can measure chirp on any personal computer. The measurement data can also download to a spreadsheet, transmission waveform simulator, etc.

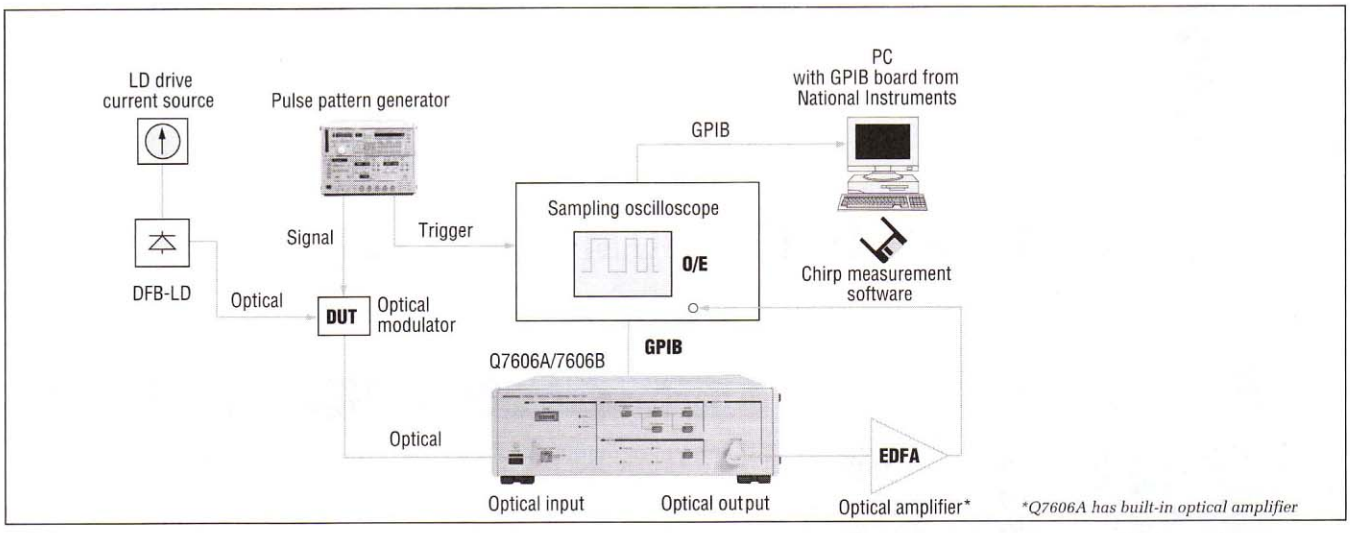
Q7606A WITH BUILT-IN OPTICAL AMPLIFIER

The Q7606A's built-in Optical Fiber Amplifier is ideal for non-amplified, high-bandwidth O/E converters. This allows the Q7606A to connect directly with the oscilloscope's O/E converter.

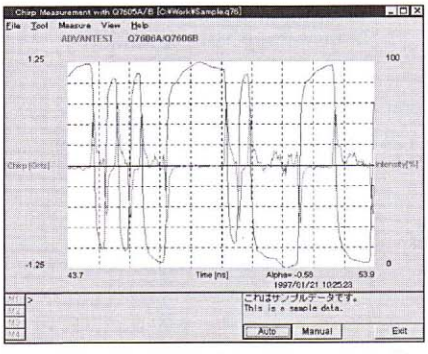
*1 *Chirp measuring time depends on oscilloscope's trigger setting and other factors.*

*2 *The measurement resolution depends on the sampling oscilloscope's setting and intensity of the incidental light.*

*3 *The measurement repeatability depends on intensity fluctuation of the sampling oscilloscope and the incident light.*



System Configuration Diagram.



Dynamic Chirp Measurement Software.

CHARACTERISTICS

Input Characteristics*1	**Q7606A**	**Q7606B**
Wavelength Measurement Range	1530 to 1580 nm	1510 to 1590 nm
Input Optical Power Range	-10 to +10 dBm	-20 to +10 dBm
FSR	150 GHz ±15 GHz	150 GHz ±15 GHz
Demodulation Bandwidth *2	100 Hz to 50 GHz	100 Hz to 50 GHz
Deviation of Demodulation Frequency	65 GHz p-p or less*3	65 GHz p-p or less*3
Insertion Loss	-	10 dB or less
Optical Output Power*5	0 dBm or higher*4	Input optical power (dBm) −10 dB or higher*5
Resolution of Demodulation Frequency	20 MHz p-p or less*3	20 MHz p-p or less*3
Output Stage Optical Amplifier	Built-in optical amplifier with automatic gain adjustment	*6 –
Input Light Polarization Compensation	Built-in automatic polarization compensator	Built-in automatic polarization compensator

**1 23 ±5°C.*

**2 1 dB down with 130 MHz as standard.*

**3 Depends on the resolution of external sampling oscilloscope.*

**4 Average power of output light.*

**5 Depends on the input optical power.*

**6 Generally, when Q7606B is used for chirp measurement, an external optical amplifier capable of gain adjustment is required to obtain optical power conforming with the range of input optical power of an external O/E converter.*

ORDERING INFORMATION

For price information: Outside the U.S. contact your local Tektronix representative, inside the U.S. see the price list in the back of this catalog.

Q7606A, Q7606B
Optical Chirpform Test Set.
Includes: Manual, GPIB Cable, Chirp Measurement Software.

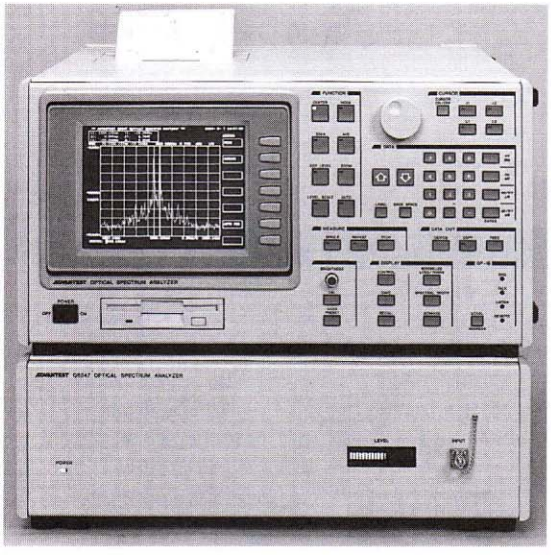
For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

CE

ADVANTEST
Advantest's quality system complies with the DIN ISO 9002 standard and has been certified by TUV Product Service GmbH.

Optical Spectrum Analyzer

Q8347



Features – Benefits

- Michelson Interferometer Type Optical Unit
- Wavelength Range 350 to 1750 mm
- High Wavelength Resolution
  - –0.01 nm at 1550 nm
  - –0.001 nm at 550 nm
- Low Wavelength Error of ±0.01 nm
- Measurement Speed of 1 to 3.5 Seconds
- Direct Coherence Length Analysis
- High Accuracy Wavelength Setting Resolution
- Color LCD Display
- Built-in High Speed Thermal Printer

Applications

- WDM Transmission Analysis
- Analysis of Source Coherence Length
- Characterization of Narrow-band Optical Filters, Fiber Gratings and Arrayed Waveguide Gratings
- Communications Laser and LED Transmitter Characterization
- Manufacturing Test of Optical Sources and Components
- Optical Transmission Standards Compliance
- Short Wavelength Laser Characterization

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

CE

GPIB IEEE-488

Product(s) complies with IEEE Standard 488.1-1987, and with Tektronix Standard Codes and Formats.

ADVANTEST

Advantest's quality system complies with the DIN ISO 9002 standard and has been certified by TUV Product Service GMBH.

Advantest Q8347

The Q8347 makes use of a Fourier spectrum analysis approach based on a Michelson interferometer. The instrument achieves a wavelength resolution that is ten times that of conventional optical spectrum analyzers. It is especially suitable for evaluating characteristics of optical narrow-band-pass filters used for WDM like AWG and Fiber gratings. Also the Q8347 is powerful for analyzing chirps from LDs and Soliton transmission.

TREND MONITORING FUNCTION

Incoming power and wavelength can be displayed in digital read-out, as well as a time domain trend chart.

OPTICAL FREQUENCY CAN BE DISPLAYED

In addition to general wavelength display mode, a measured spectrum can be displayed as optical frequencies. As light can be directly read in units of THz, it is useful for measuring optical WDM and chirps from LDs and for analyzing Soliton transmission system.

COHERENCE ANALYSIS OF ±165 MM

As the Q8347 uses a Michelson interferometer, the system is capable of performing coherence analysis in a range of ±165 mm. This makes the instrument exceptionally well-suited for the measurement of coherence length of laser diodes and LED optical sources. This function also allows easy evaluation of noise suppression performance of LDs for optical discs.

A standard rackmount set is available for both the Display Unit and Optical Unit making up the Q8347.

CHARACTERISTICS

	Normal Mode	High Resolution Mode
Wavelength		
Measurement Range	350 to 1750 nm	
Max. Resolution	Approx. 0.1 nm/1550 nm Approx. 0.05 nm/850 nm	Approx. 0.01 nm/1550 nm Approx. 0.003 nm/850 nm
Error	±0.1 nm or less	±0.01 nm or less
Repeatability (typical)	±7 pm/1550 nm (for all time)	
Span	0.01 nm/DIV to 140 nm/DIV	
Processing Functions		
Measurement Time*4	1 sec. or less	2.5 sec. or less (at long wavelength band: 950 to approximately 1750 nm) *5 3.5 sec. or less (at short wavelength band: 350 to approximately 1050 nm)
Memory Function	16 Screens (Measured Data) with Battery Back-up 10 Screens (Measured Conditions) with Battery Back-up Floppy Disk (MS-DOS format 720 KB/1.2 MB)	
Display	Frequency, Super Impose, 3-D, Trend Monitoring (Power, Wavelength) Division into 2 parts, Cursor Function, Color Display Customization, Listing	
Computing/Analysis	Spectrum Analysis, Coherence Analysis (Analysis Range: Max. ±165 mm), Spectral-width Calculation, Automatic Peak Search, Normalization (LOSS/TRANS), Averaging, Automatic Setting of the Optimum Measurement Conditions, Curve fitting (sech^2, Gauss), Smoothing, MAX/MIN Hold	

POWER LEVEL

Measurement Range (Input Sensitivity) –
−72 to +10 dBm (1200 to 1600 nm)
−65 to +10 dBm (700 to 1600 nm)
−52 to +10 dBm (450 to 1700 nm)
−42 to +10 dBm (350 to 1750 nm).
The minimum level is measured over a 50 nm span and averaging 16 times.
Error – ±1.0 dB (780 nm), ±0.7 dB (1310 nm, 1550 nm) input level −10 dBm
Linearity*1 –
±0.1 db/−20 dB or less
±0.5 db/−30 dB or less.

Dynamic Range*2 –
35 dB or more (Value between peak and average display noise level)/
40 dB (Between peak and ±0.5 nm).
Repeatability Including Polarization Dependence*3 – ±0.1 dB or less (23 ±5°C).
Scale – 0.2, 0.5, 1.0, 2.0, 5.0, 10.0 dB/DIV and LINEAR.

PHYSICAL CHARACTERISTICS

Dimensions	mm (Main Unit)	in. (Main Unit)	mm (Optical Unit)	in. (Optical Unit)
Height	221	8.6	132	5.1
Width	424	16.5	424	16.5
Depth	500	19.5	500	19.5
Weight	**kg**	**lbs.**	**kg**	**lbs.**
Net	16	35.3	20	44.1

INPUT/OUTPUT

Input Connector – FC Connector (Internal Fiber: PC Rubbed, GI 50/125).
Data Output – GPIB Equipped as Standard, Direct Plotter Output, Built-in Printer (Printing Speed: 8 sec. or less).

*1 *With input at 0 dBm or less.*
*2 *At 1550 nm band, SPAN: 20 nm or less, advance averaging 16 times, Smoothing at 11 point, spectral width calculation at less than 1 nm.*
*3 *At wavelength 1550 to 1570 nm. In the case of coherent light input, wavelength shift cause the level change of ±0.4 dB or less.*
*4 *Measurement Condition: On SINGLE measurement, one averaging performed. Measuring time is from triggering to SRQ output. At long wavelength band.*
*5 *Approx. 5 sec/measurement with advance averaging mode.*

ENVIRONMENTAL AND SAFETY

TEMPERATURE/HUMIDITY

Operating – +10° to +40°C, RH 85% or less (Noncondensing).
Nonoperating – -10° to +50°C, RH 90% or less (Noncondensing).

POWER REQUIREMENTS

Line Voltage – Main/Optical Units: AC100 to 120 V/220-240 V.
Line Frequency – 48 to 66Hz.

POWER CONSUMPTION.

Main Unit – 180 VA or less.
Optical Unit – 80 VA or less.

ORDERING INFORMATION

For price information: Outside the U.S. contact your local Tektronix representative, inside the U.S. see the price list in the back of this catalog.

Q8347
Advantest High Resolution Optical Spectrum Analyzer.
Includes: Instruction Manual, Power Cable (AO1402), Fuse (2 ea.); Interconnection Cable; Printer Paper; 3.5 in. Floppy Disk.

RECOMMENDED ACCESSORIES

Rackmount Set –
(EIA) Main Unit: Order A02732.
(EIA) Optical Unit: Order A02728.
(JIS) Main Unit: Order A02733.
(JIS) Optical Unit: Order A02729.
Slide Rail Set: Order A02615.
Thermal Printer Paper for Built-in Advantest Printer (5-roll Box): Order A09075.

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

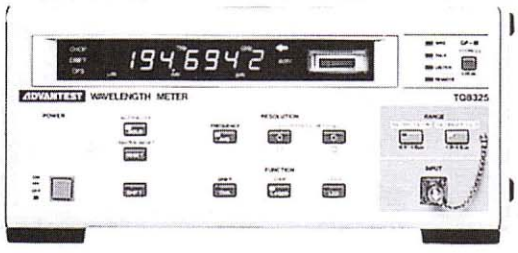
CE

GPIB IEEE-488

ADVANTEST
Advantest's quality system complies with the DIN ISO 9002 standard and has been certified by TUV Product Service GMBH.

Optical Wavelength Meter

TQ8325



Features – Benefits

- Michelson Interferometer Design
- High Accuracy
- High Resolution
- High Speed
- Measurement Display Switchable From Wavelength to Frequency
- Built-in He-Ne Laser Standard
- Input Level Meter
- Analog Output
- GPIB Controllable

Applications

- Calibration of Optical Spectrum Analyzers
- Tune Dye Lasers and Monitor the Wavelength Output of Tunable Laser Sources
- Characterization of Communications Laser and LED Transmitter
- Automated Measurement of the Wavelength-temperature or Wavelength-drive Current Characteristics of Laser Diodes
- Measure Wavelength Fluctuation of Laser and LEDs While Devices Under Modulation
- Screen Laser Diodes and LEDs in the Manufacturing Environment

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

CE

GPIB IEEE-488

Product(s) complies with IEEE Standard 488.1-1987, and with Tektronix Standard Codes and Formats.

ADVANTEST

Advantest's quality system complies with the DIN ISO 9002 standard and has been certified by TUV Product Service GMBH.

ADVANTEST TQ8325

The Advantest TQ8325 is a digital optical wavelength meter capable of making high accuracy, high resolution measurements of the central emitted wavelength of optical sources such as lasers and LEDs. Measurements are made based on an interference method using a single-pass Michelson interferometer working with an internal He-Ne laser wavelength standard.

This basic design allows a very high level of 5ppm wavelength accuracy and 0.001 nm resolution to be achieved and maintained over long periods of time without calibration. Also the TQ8325 takes measurements at a rate of five per second thereby enabling the reliable measurement of changes in wavelength with changing temperature.

A switch selection enables measurements over the 480 to 1000 nm or 1000 to 1650 nm wavelength bands. The TQ8325 can also measure the wavelength of modulated light sources for modulation rates of 3 MHz and above. An auto-resolution function automatically optimizes the resolution depending upon the spectral half-width of the source being measured.

The TQ8325 can also display the changing frequency deviation of a measured source from a reference frequency determined by pressing the deviation display key. This feature enables the continual wavelength changes (from temperature fluctuations) of a light source to be measured and displayed with high accuracy and resolution.

CHARACTERISTICS

WAVELENGTH

Measurement Range –
480 to 1000 nm (short wavelength band).
1000 to 1650 nm (long wavelength band).

Display Resolution –
1, 0.1, 0.01, 0.001 nm (10 digits).
100 GHz, 10 GHz, 100 MHz.

Accuracy –
±Full width (nm) at half maximum x 0.05 ±5 ppm ±1 count (at 25°C ±10°C).

Stability –
±1 count (in AVG mode).

LEVEL

Measurement Range (Input Sensitivity) –
-27 to +3 dBm (1200 to 1600 nm).
-23 to +3 dBm (600 to 1650 nm).
-15 to +3 dBm (480 to 600 nm).

SAMPLING

Sample Period – 200 ms (5 samples/sec rate).

NON CW INPUTS

CHOP Mode – Chopping frequency must be 1 to 500 Hz.
Modulated Input – Modulation must be ≥3 MHz.

PROCESSING

Averaging – Moving average of 10 measurements is displayed (AVG mode).
Deviation Display – Deviation is displayed in reference to the standard determined by pressing the deviation display key.

INPUT/OUTPUT

Optical Input – FC type connector.
Data Output – GPIB and Analog output.

GENERAL

Operating Environment –
–10 to +40°C, ≤85% RH (noncondensing).
Power Supply – 90 to 132 VAC (standard), 180 to 250 VAC (optional). 50/60 Hz, ≤ 52 VA.

PHYSICAL CHARACTERISTICS

Dimensions	mm	in.
Width	300	11.8
Height	132	5.2
Depth	450	17.7
Weight	**kg**	**lb.**
Net	12	26.5

ORDERING INFORMATION

For price information: Outside the U.S. contact your local Tektronix representative, inside the U.S. see the price list in the back of this catalog.

TQ8325
Advantest Optical Wavelength Meter.
Includes: Instruction Manual, Power Cable (A01402).
Opt. 4D – 180 to 250 VAC power.

MEASUREMENT SERVICE OPTIONS

Opt. R3 – Repair warranty extended to cover three years.

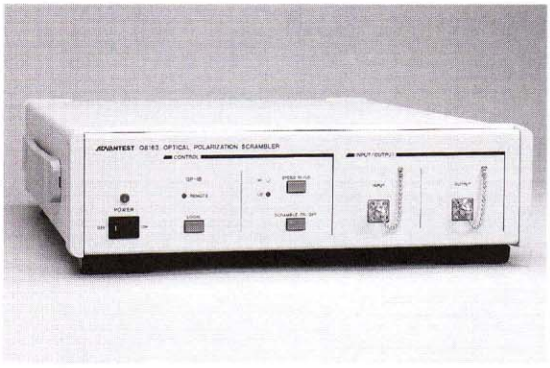
For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

GPIB IEEE-488
Product(s) complies with IEEE Standard 488.1-1987, and with Tektronix Standard Codes and Formats.

ADVANTEST
Advantest's quality system complies with the DIN ISO 9002 standard and has been certified by TUV Product Service GMBH.

Optical Polarization Scrambler

New Q8163



Features – Benefits	Applications
High-speed Polarization Variance: ≥500 Poincaré Sphere Rotations per Second Low Insertion Loss Fluctuations: ±0.005 dB or Less Low Insertion Loss: 3 dB or Less	Polarization Dependent Loss (PDL) Measurements

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

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ADVANTEST
Advantest's quality system complies with the DIN ISO 9002 standard and has been certified by TUV Product Service GMBH.

A NEW POLARIZATION-VARIANCE METHOD

The Q8163 implements a new technology that allows the instrument to quickly and accurately generate every polarization state on the Poincaré sphere.

The Q8163 also produces every polarization state within a short time by drawing traces of numerous points on the Poincaré sphere. Other conventional methods use a polarization control paddle or a wavelength plate that is rotated manually or by a motor. In comparison with the Q8163, the conventional methods are very slow.

QUICK POLARIZATION-DEPENDENT LOSS (PDL) MEASUREMENTS

With the Q8221 Optical Power Meter, Q82232 Optical Sensor, and Q82203 Interface Plug-In, the Q8163 yields quick and precise PDL measurements (1 second at PDL = 0.2 db). In addition, high-speed wavelength-dependent PDL measurements are possible with a tunable laser.

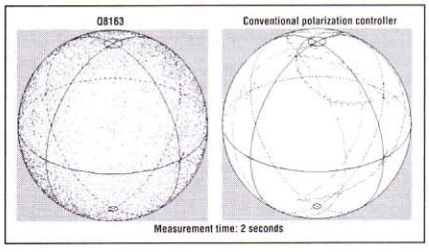
EASY POLARIZATION DEPENDENT LOSS (PDL) ADJUSTMENTS

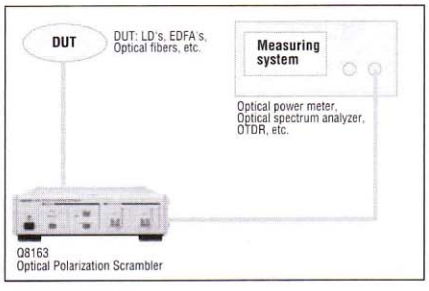
PDL fluctuations are monitored in real time by sending the analog output to an oscilloscope. Thus, adjustments on manufacturing lines are easily made.

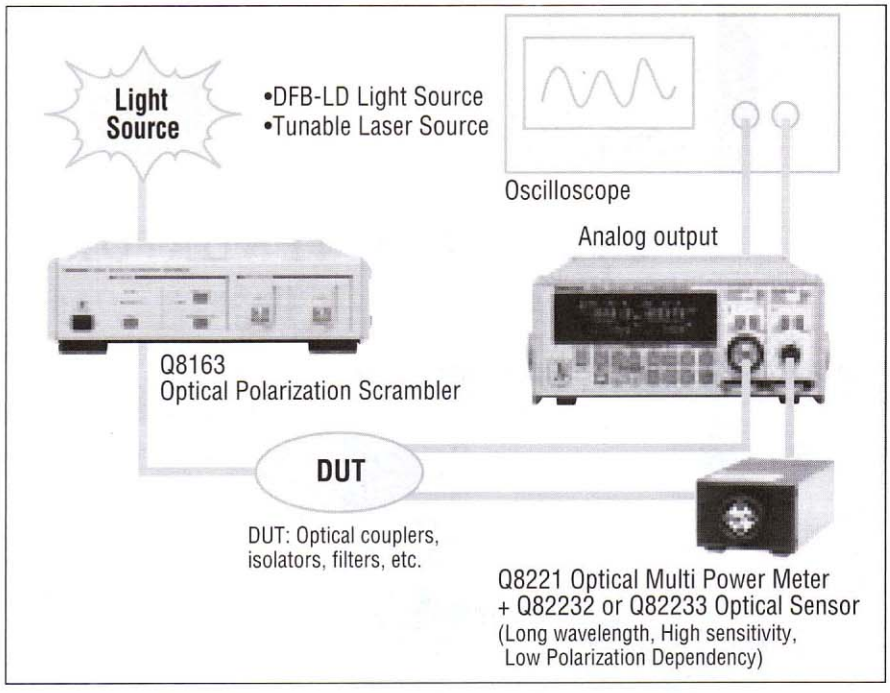
Optical Polarization Scrambler
NEW Q8163

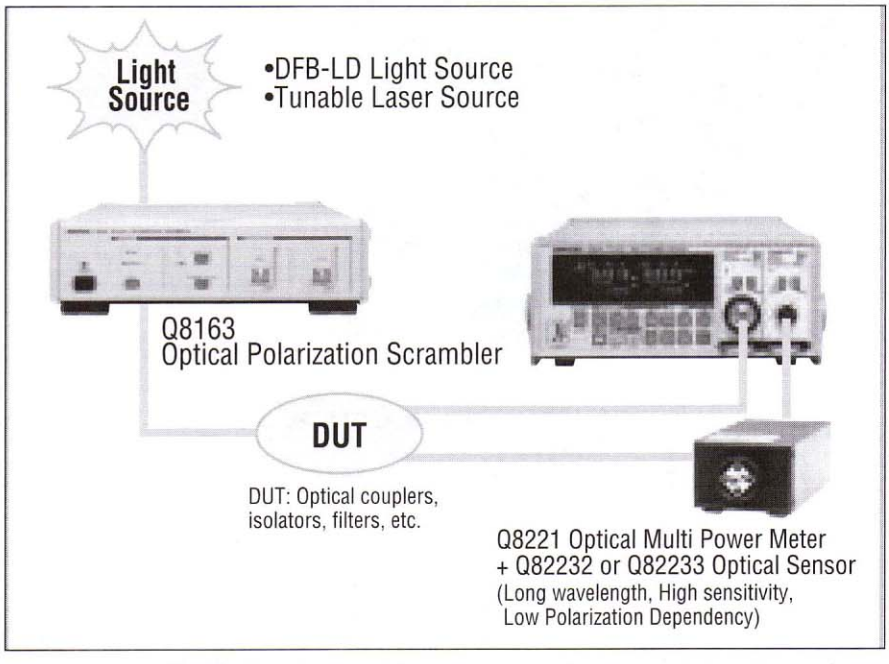
Characteristics

Wavelength Range – 1290 to 1580 nm.
Insertion Loss – ≤3 dB.
Insertion Loss Fluctuation – ± 0.005 dB or less.
Return Loss – ≥43 dB (47 dB typical).
Polarization-variance Speed (Two Modes Available) –
≥500 Poincaré sphere rotations per second (high speed).
≥10 Poincaré sphere rotations per second (low speed).
Input/output Connector – FC-SPC.
External Control – GPIB equipped as standard.









Ordering Information

For price information: Outside the U.S. contact your local Tektronix representative, inside the U.S. see the price list in the back of this catalog.

Q8163
Optical Polarization Scrambler

ACCESSORIES
A08162 – SC-type input/output connector-adapter.
A08163 – ST-type input/output connector-adapter.
A02245 – Rack Mount Set EIA.
Opt. 13* – 2 meter fiber pigtail with an FC-SPC connector.

** Please order this option at the same time as the purchase of Q8163 main unit.*

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

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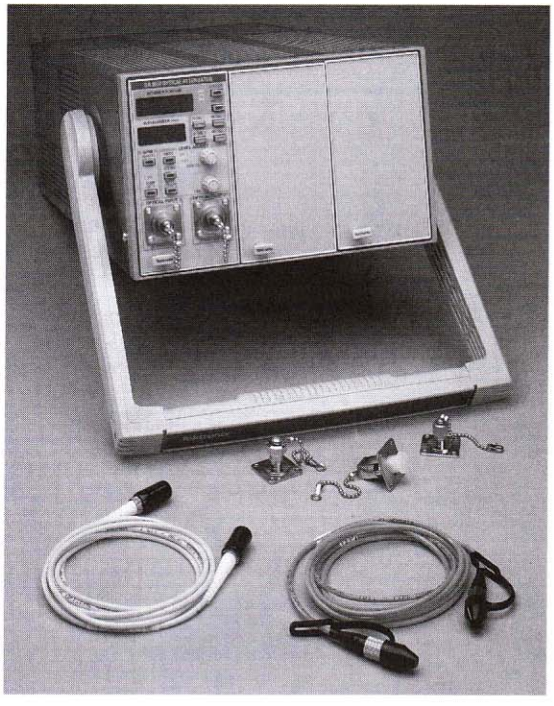
ADVANTEST
Advantest's quality system complies with the DIN ISO 9002 standard and has been certified by TUV Product Service GMBH.

Optical Attenuators

OA5002 • OA5012 • OA5022 • OA5032



Features – Benefits

- Broad Wavelength Range
  - 750 to 1600 nm
- Supports Multiple Fiber Sizes
  - OA5002 10 µm (Single-mode)
  - OA5012 50 µm (Multimode)
  - OA5022 62.5 µm (Multimode)
  - OA5032 100 µm (Multimode)
- Support Multiple Connector Styles
  - (FC, ST, SC and DIN)
- GPIB, IEEE-488.2 Controllable

Applications

- Evaluate Receiver Sensitivity as a Function of Optical Power
- General Development of Fiber Optic Equipment
- SDH/SONET, Fibre Channel and Ethernet Standards Testing
- OTDR Attenuation Measurement Calibration
- Optical Power Meter Linearity Calibration
- Manufacturing Test of Fiber Optic Equipment

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CE

ISO 9001

Tektronix measurement products are manufactured in ISO registered facilities.

GPIB IEEE-488

Product(s) complies with IEEE Standard 488.2-1987, and with Tektronix Standard Codes and Formats.

A Vital Link in Optical Systems Analysis

Tektronix Programmable Optical Attenuators provide a convenient, accurate and cost-effective means of controlling optical power levels in fiber optic media.

The OA5000 Series instruments provide variable attenuation of single and multimode fiber optic signals commonly used in communications equipment. Attenuation levels can be varied manually, using the front-panel controls or automatically via programmable, IEEE-488.2 interface.

The single filter design eliminates measurement dark spots caused by "range changes" and an internal mechanical motion algorithm provides outstanding repeatability.

TYPICAL APPLICATIONS

Communication standards using optical components typically require that the receiver operate over a given optical power range. This specification is tested by monitoring the bit error rate (BER) as a function of optical power.

TRANSMISSION SYSTEM DESIGN

Using the OA5000 Series Optical Attenuators with either the CSA803, 11800 or TDS700C/500C oscilloscopes, network equipment designers can characterize, with repeatable results, the system performance over the specified optical power range.

SDH/SONET COMPLIANCE TESTING

SDH/SONET compliant signal levels may be as high as +2 dBm to as low as –34 dBm. To verify the performance of SONET equipment over these signal levels, it is necessary to have calibrated attenuators with at least this much range. The OA5002 is the attenuator of choice for SDH/SONET testing.

MANUFACTURING AND OTHER AUTOMATED TEST APPLICATIONS

Because the OA5000 Series Optical Attenuators are GPIB Programmable, these units can be operated in a completely automated environment. With the step size of 0.01 dB and a calibrated attenuation range of 0 to 60 dB (continuous), measuring parameters, such as receiver linearity, is quickly and reliably accomplished. Also, with their storable attenuation levels, the OA5000 Series Optical Attenuators are very useful for repeat measurements in manufacturing environments.

CHARACTERISTICS

Wavelength Range	750 to 1600 nm
Fiber Size	
OA5002	9 µm Single Mode fiber
OA5012	50 µm Multimode fiber
OA5022	62.5 µm Multimode fiber
OA5032	100 µm Multimode fiber
Insertion Loss	≤2.0 dB*1, ≤4.0 dB*2
Return Loss	≤-45 dB*1 ≤-25 dB*2
Attenuation Range	≥60 dB*3 ≥50 dB*4
Disable	≥100 dB ≥90 dB*5
Accuracy	±0.15 dB (±0.05 dB typ.)
Repeatability	±0.05 dB (±0.02 dB typ.)
Linearity	±0.05 dB
Max. Input Power	+3 dBm (2 mW)
Max. Non-destruct Power	+10 dBm (100 mW) Ave +20 dBm (200 mW) Peak

*1 *OA5002 (1100-1600 nm).*

*2 *OA5012/OA5022/OA5032 (700-1350 nm).*

*3 *750-1350 nm.*

*4 *1350-1600 nm.*

*5 *OA5032 only.*

Note: (a)For further technical information request Product Data Sheet #3TW-8032-1. (b)For information on OA5000 Series compatibility with other fiber sizes, contact your local Tektronix sales office.

ORDERING INFORMATION

For price information: Outside the U.S. contact your local Tektronix representative, inside the U.S. see the price list in the back of this catalog.

OA5002
Optical Attenuator.
Includes: Single Mode Input and Output.

OA5012
Optical Attenuator.
Includes: 50 Micron Multimode Input and Output.

OA5022
Optical Attenuator.
Includes: 62.5 Micron Multimode Input and Output.

OA5032
Optical Attenuator.
Includes: 100 Micron Multimode Input and Output.
All include: OCP5502 Mainframe (PN 620-0057-00) Two Blank Plug-in Panels (PN 016-0195-05); Universal Optical Input and Output Connector Kit (020-1885-00); Instruction Manual (070-7612-0).

MEASUREMENT SERVICE OPTIONS

OA5022 ONLY
Opt. R3 – Repair warranty extended to cover three years.
Opt. R5 – Repair warranty extended to cover five years.
See page 615 for further information.

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

CE

ISO 9001

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Optical Power Multimeter

Q8221



Features – Benefits	Applications
Two Independent Plug-in Channels	General-purpose and Manufacturing
Optical Sensor and Source Plug-ins	Short Wavelength (LAN/WAN)
Simultaneous Channel Measurements	Long Wavelength (TELECOM/CATV)
Dual Channel Displays	High Power Devices and Components
High Power Input	
High Sensitivity and High Accuracy	
High Speed Measurements	
Low Polarization Dependence	
On-board Recorded Data Memory	
GPIB Controllable	

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CE

GPIB IEEE-488

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ADVANTEST

Advantest's quality system complies with the DIN ISO 9002 standard and has been certified by TUV Product Service GMBH.

The Q8221 is a compact lab instrument providing both precision optical power measurement and stable light source capabilities. It is a small bench-top unit weighing less than 3.9 kg (with plug-ins). The Q8221 mainframe accepts two small plug-ins that can be either power sensors (detectors) or optical sources.

KEY PRODUCT FEATURES AND BENEFITS

The Q8221 mainframe allows measurement of optical power on two channels simultaneously. These measurements can be ratioed, multiplied by a constant or offset, thus allowing a wide variety of applications. The mainframe's on-board processor also provides automatic wavelength compensation for the power sensor being used. This processor also allows measurement averaging, identification of maximum values, storage of up to 400 data points and five front-panel set-ups for each of the two channels. Also the mainframe provides direct output of digital stored data to an external plotter, real-time analog voltage output proportional to measured optical power and full instrument operation via a GPIB controller.

Both single and multimode LED and laser sources are available and can be used in either or both plug-in slots. These stable sources operate at 850 nm, 1310 nm and 1550 nm wavelengths. Source output power levels cover a wide range from 0 dBm to –53 dBm depending upon the source's wavelength, type (laser or LED) and spectral width.

Applications

This bench-top instrument and its related family of plug-ins are intended for use by engineers and skilled technicians in the design, evaluation, manufacture or service of fiber optic equipment and systems. This class of product is one of the most widely applicable fiber optic test and measurement instruments used in engineering, manufacturing and service organizations.

Typical applications include:

- General-purpose and Manufacturing
- Short Wavelength (780 to 850 nm) for High Speed LAN/WAN
- Long Wavelength (1310 to 1650 nm) TELECOM/CATV
- High Power Devices and Components

GENERAL-PURPOSE AND MANUFACTURING

For general-purpose and manufacturing applications, Tektronix recommends the Q8221

Mainframe and the Q82208 Power Meter Sensor (a direct plug-in). With its InGaAs sensor element, the Q82208 provides high-sensitivity measurements and works over a wide optical power range (–80 dBm to +17 dBm). The Q82208 also operates within a broad transmission window (800 nm to 1700 nm). Regarding general purpose light-sources, Tektronix recommends either the Q81206 Edge-Emitting Light Source (for 1300 nm applications) or the Q81207 Edge-Emitting Light Source (for 1550 applications).

SHORT WAVELENGTH (LAN/WAN)

The Q8221 Mainframe, Q82203 Plug-In, Q82214 Power Meter Sensor and Q81201 LED Light Source provides a robust system for short distance LAN applications. With its Q82214 Power Meter Sensor, the system provides excellent measurement accuracy for short wavelength applications (400 nm to 1100 nm). For applications needing a light source in the 850 nm transmission window, the user can employ the Q81201 LED Light Source.

LONG WAVELENGTH (TELECOM/CATV)

For TELECOM and Cable TV (CATV) applications, the user can employ the Q8221 Mainframe, Q82203 Plug-In and Q82215 Power Meter Sensor. The Q82215 is a long wavelength sensor that works in conjunction with the Q81211 Fabry-Perot Laser Diode (1310 nm), the Q81212 Fabry-Perot Laser Diode (1550 nm) or the user's own light source.

HIGH POWER DEVICES AND COMPONENTS

The suggested setup for High Power Devices and Components applications is the Q8221 Mainframe, Q82203 Plug-In, Q82227 Power Meter Sensor or Q82232 Power Meter Sensor. With its high sensitivity, low polarization dependency optical sensor, the Q82232 is ideal for active and passive components. The Q82227 is designed to provide accurate measurements up to +27dBm of input power.

Application	General Purpose/ Manufacturing	Short Wavelength (LAN/WAN)	Long Wavelength (Telecom/CATV)	High Power Devices and Components
Mainframe	Q8221	Q8221	Q8221	Q8221
Optical Plug-in	Not Needed	Q82203	Q82203	Q82203
Power Meter Sensor	Q82208	Q82214 or Q82215	Q82215	Q82232 or Q82227
Light Source	Q81206/07	Q81201/11	Q81211/12 Tunable Laser	Tunable Laser or Broadband ASE Source

CHARACTERISTICS

BASIC CAPABILITIES

Wavelength and Power Ranges – Depends upon plug-in.

Sensor Plug-in Channels – Two independent measurement channels (A and B).

Resolution – 0.001 dB (dBm readout), 0.0001 dB (GPIB).

Display – Five and one half digits (7 segment FL device) with brightness adjustment, 11 segment measurement level bar-type meter.

Sensor Wavelength – If wavelength is entered, an internal wavelength compensation constant for the sensor is automatically applied.

Units Display – Watts (mW, µW, nW, pW), dBm, dB.

Range Switching – Automatic, manual or remote.

Measurement Rate – Approx. 50 meas./sec (with integrate time of 7 msec), approx. 9 meas./sec (with integrate time of 100 msec), 1 channel operation.

PROCESSING

Averaging – Can be set to any value from 2 to 256 (moving average).

Calculations – A/B, B/A, CF (in Watts mode; multiplication of measurement and constant value, in dBm mode offset can be added).

Other Measurement Functions – Maximum value hold, settable measurement integration time (100 msec, 20 msec or 7 msec), relative value measurement (dBr, with 0.001 dB max. resolution), modes for CW or chopped light inputs.

Record Function – Memory storage of 400 data points for each of A and B channels (external data retrieval possible via GPIB interface).

Memory Function – Up to five instrument settings storable and readable for each of A and B channels.

INPUT/OUTPUT

Optical Input – Connector type determined by sensor head or plug-in.

Data Output – GPIB IEEE 488 control, 0 to 2 V analog output (each range) proportional to input optical power, direct output to external plotter.

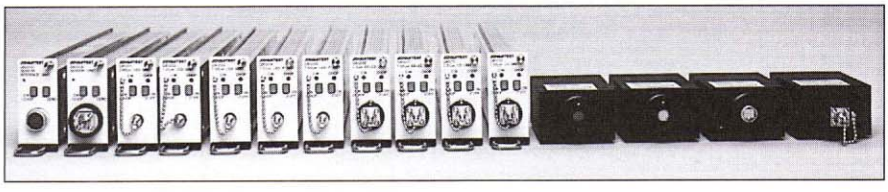
GENERAL

Operating Environment – 0°C to +40°C, ≤85% RH (noncondensing).

Power Supply – 100 to 230 VAC, 48 to 66 Hz.

Physical Characteristics –

Dimensions	mm
Height	88
Width	212
Depth	360
Weight	**kg**
Net (Including Plug)	3.9



Q8221 Source and Sensor Plug-ins.

OPTICAL POWER SENSOR PLUG-IN SPECIFICATIONS

Characteristic	Q82214	Q82215	Q82216	Q82208	Q82227	Q82232
Application type	Short wavelength, general purpose	Long wavelength, general purpose	Long wavelength, wide area, medium sensitivity	Long wavelength, high sensitivity	Long wavelength, high sensitivity, high power	Long wavelength, high sensitivity, low polarization
Wavelength range (nm)	400 to 1100	800 to 1750	800 to 1750	800 to 1700	900 to 1650	900 to 1650
Power range (dBm)	–80 to +17	–60 to +10	–77 to +10	–94 to +10	–80 to +27	–94 to +10
Photosensor type	Silicon	Germanium	Germanium (cooled)	In GaAs (cooled)	In GaAs (cooled)	In GaAs (cooled)
Measurement Accuracy						
Optical input form*1 at calibration wavelength	Beam or fiber ±3.0%, 780 nm 1 mW, 0 to 40°C	Beam or fiber ±3.0%, 1300 nm 1 mW, 0 to 40°C	Beam or fiber ±2.5%, 1300 nm 1 mW, 0 to 40°C	Fiber only ±2.5%, 1300 nm 1 mW, 0 to 40°C	Fiber only ±2.5%, 1550 nm 1 mW, 0 to 40°C	Fiber only ±2.5%, 1550 nm 2 mW, 0 to 40°C
Over wide wavelength range	±5.0%, 480 –900 nm 1 mW, 23 ±3°C	±5.0%, 950 –1600 nm 1 mW, 23 ±3°C	±4.5%, 950 –1600 nm 1 mW, 0 to 40°C	±4.5%, 1000 –1650 nm 1 mW, 0 to 40°C	±4.5%, 950 –1600 nm 1 mW, 0 to 40°C	±4.5%, 950 –1600 nm 2 mW, 0 to 40°C
Linearity						
Over range 1	±0.5% ±10 pW, –54 to +17 dBm, 23 ±3°C	±0.5% ±1 nW, –37 to +10 dBm, 23 ±3°C	±0.5% ±20 pW, –47 to +10 dBm, 23 ±3°C	±0.5% ±0.4 pW, –72 to +10 dBm, 0 to 40°C	±0.5% ±10 pW, –58 to +27 dBm, 0 to 40°C	±0.5% ±0.4 pW, –72 to +10 dBm, 0 to 40°C
Over range 2	±1.0% ±10 pW, –57 to +17 dBm, 23 ±3°C	±1.0% ±1 nW, –40 to +10 dBm, 23 ±3°C	±1.0% ±20 pW, –50 to +10 dBm, 23 ±3°C	±1.0% ±0.4 pW, –75 to +10 dBm, 0 to 40°C	±1.0% ±10 pW, –61 to +27 dBm, 0 to 40°C	±1.0% ±0.4 pW, –75 to +10 dBm, 0 to 40°C
Noise level (one second average)	–80 dBm	–60 dBm	–77 dBm	–91 dBm	–80 dBm	–94 dBm
Polarization dependence		0.03 dB p-p (typ)	0.03 dB p-p (typ)	≤0.02 dB p-p	≤0.05 dB p-p	≤0.003 dB p-p
Return loss	≥45 dB (with angled polished connectors), ≥30 dB (with A08186 adapter, depending upon specifications of fiber used), ≥14 dB (with flat polished connectors)					
Connection to Q8221 Mainframe	Q82203 interface plug-in required			No plug-in required	Q82203 Interface Plug-in required	Q82203 Interface Plug-in required
Dimensions and mass	Approx. 60 mm (W) x 43 mm (H) x 110 mm (L), ≤270 g			Approx. 60 mm (W) x 43 mm (H) x 135 mm (D), 600 g or less	Approx. 60 mm (W) x 43 mm (H) x 135 mm (D), 600 g or less	Approx. 60 mm (W) x 43 mm (H) x 135 mm (D), 600 g or less

**1 Refer to connector-to-adapter correspondence table following.*

CONNECTOR-TO-ADAPTER CORRESPONDENCE

Connector Type	Q82214	Q82215	Q82216	Q82208	Q82227	Q82232
FC A08012	A08012	A08012	A08012	A08161*1	A08340	A08340
SC A08090	A08090	A08090	A08090	A08162	A08338	A08338
ST A08096	A08096	A08096	A08096	A08163	A08339	A08339
D4 A08013	A08013	A08013	A08013			
SMA	A08028	A08028	A08028			
MT adapter	A08187	A08187	A08187			
Bare Fiber	A08020/A08021	A08020/A08021	A08020/A08021			

**1 Standard Accessory with Q82208.*

SOURCE PLUG-IN CHARACTERISTICS*5

	Q81201	Q81202	Q81203	Q81204	Q81205	Q81206	Q81207	Q81211*4	Q81212*4
Photo emitting element type	LED	LED	LED	LED	LED LED	Edge Emitting LED	Edge Emitting (FP)	Laser diode (FP)	Laser diode
Wave-length (nm)	850 ±25	1310 ±40	1550 ±30	1310 ±10	1550 ±10	1300 ±30	1550 ±30	1310 ± 10	1550 ± 20
Spectral width (at half max. power)	≤55 nm	≤160 nm	≤210 nm	20 ±5 nm	20 ±5 nm	≤100 nm	≤140 nm	0 ±1 dBm*2	1 ±1 dBm*2
Output power	-15 ±1 dBm*1	-20 ±1 dBm*1	-43 ±1 dBm*2	-35 ±1 dBm*1	≤-53 ±1 dBm*2	-14 ±1 dBm*2	-17 ±1 dBm*2	0 to –6 dB	1 to –6 dB
Output power attenuation (variable)						3	3	3 (0.1 db steps)	4 (0.1 db steps)
Temperature stability 23±2°C/1 hrs.	≤ ±0.02 dB	≤ ±0.02 dB	≤ ±0.04 dB	≤ ±0.02 dB	≤ ±0.04 dB	≤ ±0.02 dB*3	≤ ±0.04 dB*3	≤ ±0.01 dB*3	≤ ±0.01 dB*3
Temperature stability 0 to 40°C/8 hrs.	≤ ±0.2 dB	≤ ±0.2 dB	≤ ±0.2 dB	≤ ±0.2 dB	≤ ±0.2 dB	≤ ±0.4 dB	≤ ±0.4 dB	≤ ±1 dB	≤ ±1 dB

*1 *At the emitting end of 2 m fiber (Graded index, 50/125 fiber type).*

*2 *At the emitting end of 2 m fiber (Single mode, 10/125 fiber type).*

*3 *Stability between 0 to 40°C ±2°C/1 hrs.*

*4 *Stability ≤ ±0.05 dB, within 0 to 40°C ±2°C/1 hrs.*

*5 *Output waveform: CW or chopped light (270 Hz, 2 kHz, 4 kHz); FC type output connector; Preheating time of 60 minutes after power on.*

ORDERING INFORMATION

For price information: Outside the U.S. contact your local Tektronix representative, inside the U.S. see the price list in the back of this catalog.

Q8221
Mainframe, Optical Power Multimeter.
Includes: AC Power Cable and Instruction Manual.
Q82203 – Interface Plug-in.
Q82208 – Power Sensor, High Sensitivity.
Q82214 – Power Sensor, Short Wavelength, General Purpose.
Q82215 – Power Sensor, Long Wavelength, General Purpose.
Q82216 – Power Sensor, Large Area and High Sensitivity.
Q82227 – Power Sensor, Long Wavelength, High Sensitivity.
Q82232 – Power Sensor, Long Wavelength, Low Polarization.
Q81201 – LED Source, 850 nm.
Q81202 – LED Source, 1310 nm.
Q81203 – LED Source, 1550 nm.
Q81204 – LED Source, 1310 nm.
Q81205 – LED Source, 1550 nm.
Q81206 – EELED Source, 1300 nm.
Q81207 – EELED Source, 1550 nm.
Q81211 – Laser Source, 1310 nm.
Q81212 – Laser Source, 1550 nm.

MEASUREMENT SERVICE OPTIONS (EXCLUDING Q81206/207)
Opt. R3 – Repair warranty extended to cover three years.

Depending upon the application and plug-in modules selected, one or more of the following fiber interconnection adapters may be needed:
A08012 – Connector Adapter, FC.
A08013 – Connector Adapter, D4.
A08020 – Bare Fiber Adapter (Requires A08021).
A08021 – Adapter Cap (Required by A08020).
A08028 – Connector Adapter, SMA.
A08090 – Connector Adapter, SC.
A08096 – Connector Adapter, ST.
A08161 – Connector Adapter, FC (Used with Q82208).
A08162 – Connector Adapter, SC (Used with Q82208).
A08163 – Connector Adapter, ST (Used with Q82208).
A08187 – Connector Adapter, FC (Used with Q82215 and Q82216).

RACKMOUNT KITS
A02463 – Rackmount Set (EIA, single).
A02464 – Rackmount Set (EIA, twin).
A02263 – Rackmount Set (JIS, single).
A02264 – Rackmount Set (JIS, twin).

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

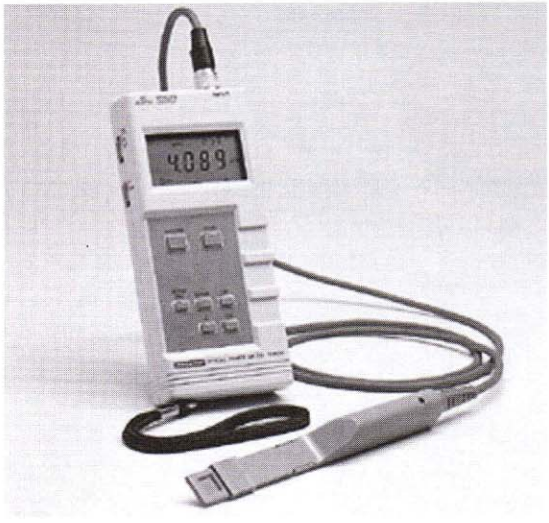
CE

GPIB IEEE-488
Product(s) complies with IEEE Standard 488.1-1987, and with Tektronix Standard Codes and Formats.

ADVANTEST
Advantest's quality system complies with the DIN ISO 9002 standard and has been certified by TUV Product Service GMBH.

Handheld Optical Power Meter

TQ8210



Features – Benefits

- Automatic Wavelength Sensitivity Compensation
- Multiple Sensors Available
- Battery and AC Line Powered
- High Sensitivity
- Wide Dynamic Range
- Measurement Smoothing
- Max-hold Function
- Backlit Liquid Crystal Display
- Analog Output
- Easy to Use

Applications

- General Optical Power Measurements
- Fiber Optic Manufacturing Test
- Optical Communications Equipment R&D
- Optical Data Storage Testing
- Optical Equipment Calibration and Repair

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

CE

ADVANTEST
Advantest's quality system complies with the DIN ISO 9002 standard and has been certified by TUV Product Service GMBH.

The Advantest TQ8210 is a general purpose battery or AC powered portable optical power meter. It is a compact and easy to use handheld unit weighing less than 400 g. The TQ8210 can be operated continuously on its internal battery supply for up to 13 hours before recharge. Optical power measurements can be made over –60 dBm to +17 dBm levels and in the 400 nm to 1650 nm wavelength range using one of the available power sensors specified below.

KEY FEATURES

Depending upon the measurement requirements and the physical configuration needed, one of several power sensor units can be selected to work with the TQ8210 mainframe. Optical power sensors using silicon photo diodes are available for use at shorter wavelengths. At longer wavelengths, sensors based on germanium (Ge) or indium-gallium-arsenide (InGaAs) are available and recommended. The TQ8210 automatically applies a wavelength sensitivity compensation factor to the optical power measurement for any of the available power sensors attached.

To allow maximum flexibility in making measurements in tight spaces or awkward positions, the power sensors are connected to the mainframe using a flexible electrical cable which is detachable from the handheld unit. The mechanical design of some power sensors also allow them to be used with both free-space optical beams as well as bare or connectorized optical fibers. A wide range of fiber connector types are accommodated by selecting the appropriate connector adapter for the sensor being used.

The TQ8210 has several built-in functions that contribute to its measurement capability and ease of use. Automatic measurement range selection and max-value hold is available with a button push. Also, measurement smoothing using a variable length moving average can be invoked using one button.

Power measurements can be conveniently displayed on a linear power scale (milliwatts, microwatts, nanowatts) or on a logarithmic absolute (dBm) or relative (dBr) scale. Sensor measurement offset is automatically detected and compensated.

CHARACTERISTICS

MAINFRAME

BASIC CAPABILITIES

Wavelength & Power Ranges – Depends upon sensor selected.

Sensor Plug-in Channels – One.

Resolution – 0.005% to 0.1% (Watt readout), 0.01 dB (dBm readout).

Display – Backlit liquid crystal, 4 digits (wavelength), 4 1/2 digits (power).

Sensor Wavelength Compensation – Automatic for sensor sensitivity at set wavelengths.

Units Display – Watts (mW, µW, nW), dBm, dBr, Wavelength (nm).

Range Switching – Automatic or manual.

Measurement Rate – ≥2 measurements/sec.

PROCESSING

Averaging – Digital smoothing by 2 to 20 sample moving average.

Measurement Functions – Maximum value hold (Watt meas.), Relative value measurement (dBr).

Offset & Zero – Automatic sensor offset zero compensation.

INPUT/OUTPUT

Optical Input – Input style & connector type determined by sensor & adapter, sensor attached with electrical cable to mainframe.

Data Output – Analog output voltage (0 to 2 V) proportional to input optical power, output impedance ≤10 ohm.

TQ8210 OPTICAL POWER SENSORS

Characteristic	TQ82014/TQ82017	TQ82015	Q82018A
Wavelength range	400 to 1100 nm	800 to 1600 nm	800 to 1650 nm
Power range*1	-60 to +17 dBm (1 nW to 50 mW)	-40 to +10 dBm (100 nW to 10 mW)	-60 to 0 dBm (1 nW to 1 mW)
Photo sensor type	Silicon photo diode	Germanium photo diode	InGaAs PIN photo diode
Optical input form*2	Beam or fiber	Beam or fiber	Fiber only
Size of photo sensor's active area	TQ82014: 8 mm dia.*3 TQ82017: 10 mm x 10 mm*4	5 mm dia.	
Measurement ranges	8 ranges in 10 dB steps	5 ranges in 10 dB steps	6 ranges in 10 dB steps
Measurement accuracy	±5.0% (at 850 nm)	±5.0% (at 1300 nm)	±5.0% (at 1300 nm)
Connection to TQ8210 Mainframe	sensor attached cable	sensor attached cable	A01905 sensor cable

*1 *At reference wavelength shown under Measurement Accuracy.*

*2 *Refer to connector-to-adapter correspondence table on next page for required adapters.*

*3 *The TQ82014 has a 38 mm (dia.) x 40 mm (length) cylindrical sensor housing with attached cord.*

*4 *The TQ82017 has a wand-shaped sensor housing (3.2 mm thick x 18 mm wide tip) with attached cord.*

CONNECTOR-TO-ADAPTER CORRESPONDENCE

Connector Type	TQ82014/TQ82015	Q82018A
FC/PC	A08012	A08081 (Standard accessory)
SC	A08090	A08082
ST	A08096	A08083
Biconical	A08025	
D4	A08013	
DIN	A08029	A08084
SMA 2.5	A08095	
SMA 3.175	A08028	
Bare Fiber	A08020/A08021	A08024

GENERAL

Operating Environment – 0°C to +40°C, ≤85% RH (noncondensing).

Power Supply – Internal NiCd battery (operating life >10 hrs. with LCD backlight on, >13 hrs. with backlight off), 100 VAC (using AC adapter, which also charges the NiCd battery).

PHYSICAL CHARACTERISTICS

Dimensions (approximate)	mm
Width	80
Length	180
Height	35
Weight	**g**
Net	≤400

ORDERING INFORMATION

For price information: Outside the U.S. contact your local Tektronix representative, inside the U.S. see the price list in the back of this catalog.

TQ8210
Handheld Optical Power Meter Mainframe.
Includes: Instruction Manual, AC Power Adapter.
TQ82014 – Power Sensor, 0.4 µm to 1.1 µm.
TQ82015 – Power Sensor, 0.8 µm to 1.6 µm (Ge).
TQ82017 – Power Sensor, 0.4 µm to 1.1 µm, Thin Wand.
Q82018A – Power Sensor, 0.8 µm to 1.65 µm (InGaAs).

MEASUREMENT SERVICE OPTIONS

(TQ82015/17/18A)
Opt. R3 – Repair warranty extended to cover three years.

Optional Accessory	Used With Q8221	Used With TQ8210	Description
A01905		X	Sensor cable
A08014		X	Connector adapter, OF2
A08017		X	AC Power adapter (90 to 110 V AC)
A08019		X	AC Power adapter (200 to 245 V AC)
A08026		X	Connector adapter, Diamond 2.5
A08027		X	Connector adapter, Diamond 3.5
A08030		X	Connector adapter, Sumitomo Mini-BNC
A08031		X	Connector adapter, MBO
A08032		X	Connector adapter, HFBR-4000

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

ADVANTEST
Advantest's quality system complies with the DIN ISO 9002 standard and has been certified by TUV Product Service GMBH.

CE

OPTSCOPE OPTICAL NETWORK ANALYZER

NEW Q7750



FEATURES – BENEFITS	APPLICATIONS
Maximum Optical Frequency Resolution (50 MHz)	Comprehensive Optical Carrier-Frequency Domain Measurements
High-speed Measurements	
Wide Wavelength Range (1530 to 1600 nm)	
Wide Dynamic Range (40 dB)	
Extensive Group Delay Measurement Range	
Excellent Wavelength Accuracy	

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

CE

ADVANTEST
Advantest's quality system complies with the DIN ISO 9002 standard and has been certified by TUV Product Service GMBH.

- **Performs Quick and Accurate Chromatic Dispersion Measurements for High-speed Optical Devices**
- **Yields Excellent and Fast Transmission Characteristics in the Optical Carrier-Frequency Domain**

Research and development advancements for ultra-high-speed optical transmission and high-density wavelength division multiplexing transmission systems (Dense WDM) have changed the Optical Communications landscape. As a result, engineers require new measurement tools for measuring amplitude characteristics, chromatic dispersion, and group delay of optical devices. For example, optical components (like AWGs, Fiber Bragg Grating filters, and Dispersion Compensators) require detailed optical carrier frequency measurements.

The Q7750 quickly characterizes optical carrier-frequency measurements for optical devices. For instance, the Q7750 measures amplitude, chromatic dispersion, group delay, phase-of-transmission and reflection characteristics. The Q7750 also performs these measurements by employing the phase-shift method, which provides a narrow optical frequency resolution over a wide dynamic range.

The Q7750 uses a tunable light source to sweep over the wavelength range (optical frequency). As a result, transmission and reflection characteristics (S_{21} and S_{11} in the S parameters) are measured simultaneously in the optical carrier-frequency band with a single sweep. See Table 1.

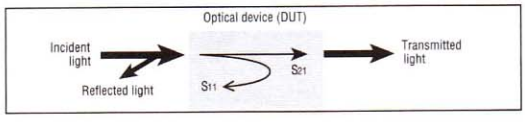


TABLE 1 – MEASUREMENT ITEMS

Measurement item	Reflection characteristics (S_{11})	Transmission characteristics (S_{21})
Amplitude	Yes	Yes
Chromatic Dispersion	Yes	Yes
Group delay-time	Yes	Yes
(Phase)	Yes	Yes

HIGH OPTICAL FREQUENCY RESOLUTION

Maximum optical frequency resolution: 50 MHz (Wavelength of 0.4 pm)

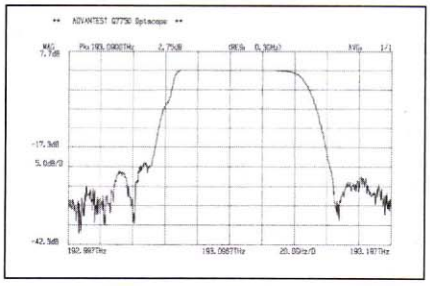


Figure 1.1 – Amplitude characteristics (optical intensity bandpass characteristics).

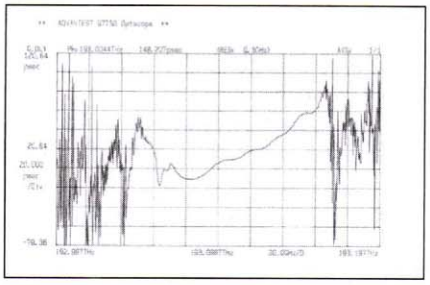


Figure 1.2 – Group delay characteristics.

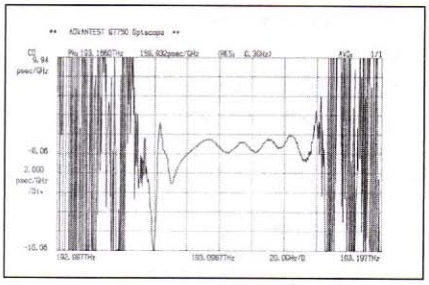


Figure 1.3 – Chromatic dispersion characteristics.

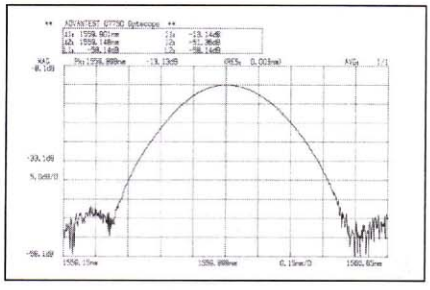


Figure 2.1 – Amplitude characteristics (optical intensity bandpass characteristics).

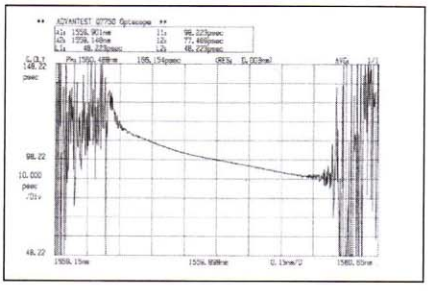


Figure 2.2 – Group delay characteristics.

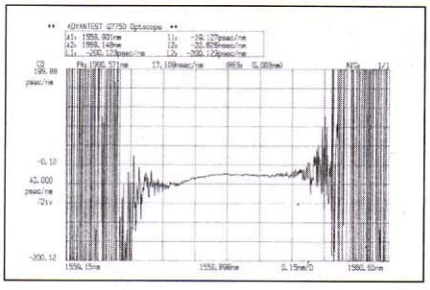


Figure 2.3 – Chromatic dispersion characteristics.

This capability facilitates amplitude and chromatic dispersion measurements for optical devices in Dense Wavelength Division Multiplexing (DWDM) sytems, which use narrow channel spacing (such as 25, 50, and 100 GHz).

HIGH-SPEED MEASUREMENT

The measurement time for a single sweep is approximately four seconds when sweep span is set to 60 GHz.

EXTENSIVE MEASUREMENT WAVELENGTH RANGE

The Q7750 operates in the C-band and L-band range.

WIDE DYNAMIC RANGE

The Q7750's dynamic range is 40 dB (Typical). This enables the Q7750 to measure optical transmission amplitude and chromatic dispersion characteristics for optical filters and other optical devices (like a traditional optical spectrum analyzer).

EXTENSIVE GROUP DELAY MEASUREMENT RANGE

Maximum resolution: 0.1 ps

Maximum measurement range: 25 ns

The Q7750 achieves a maximum group delay resolution of 0.1 ps and a maximum measurement range of 25 nm, which yields clearer chromatic dispersion measurements. Hence, the Q7750 can be used to measure a wide range of devices. This includes both low-dispersion and high-dispersion optical devices.

MEASUREMENT SAMPLES

FBG optical filter (100 GHz spacing)

The measurement examples shown in Figures 1.1, 1.2 and 1.3 show reflected light measured in an FBG optical filter (band-pass characteristics). The figures show that the characteristics of group delay time and chromatic dispersion are measured with high resolution.

In particular, Figure 1.3 clearly shows that there are ripples in the chromatic dispersion characteristics.

AWG Multi/Demultiplexer

The measurement examples shown in Figures 2.1, 2.2 and 2.3 illustrate the transmission characteristics (S_{21}) measured in an AWG Multi/Demultiplexer. Notice the mild changes in the group delay time within the transmission band are measured.

** Developed in cooperation with KDD.*

CHARACTERISTICS

MEASUREMENT FUNCTIONS

Sweep Channels – 2 channels (input-end reflection characteristics, forward transfer characteristics).

Input-end Reflection Characteristics (S_{11}) –
Amplitude.
Group delay time.
Chromatic dispersion.

Forward Transfer Characteristics (S_{21}) –
Amplitude.
Group delay time.
Chromatic dispersion.

OPTICAL SIGNAL SOURCE CHARACTERISTICS

Measurement Range – 1530 to 1600 nm.
Absolute Wavelength Accuracy *1 – ±0.025 nm.
Wavelength Setting Resolution – 0.001 nm.
Sweep Wavelength Range – Settable within 0.1 to 70 nm range. (Settable within the optical frequency range of 12.5 GHz to 8.75 THz.)
Sweep Frequency Linearity*2 – Set span X (±2.5%).
Sweep Repeatability*2 – Set span X (±0.3%) ±30 MHz or less.
Sweep Time (Measurement Time)*3 – Approx. 4 sec. (at setting wavelength span is less than 60 GHz).

Optical Output Power Level*4 – -14 dBm or more.

AMPLITUDE CHARACTERISTICS

Scale – Logarithmic table (0.2, 0.5, 1.0, 2.0, 5.0, 10.0 dB/div) and also linear.
Modulation Frequency Range – 40 MHz to 3 GHz.
Dynamic Range*5 –
Forward transfer characteristics: 35 dB (Typ. 40 dB).
Input-end reflection characteristics: 33 dB (Typ. 38 dB).
Linearity*6 –
±0.10 dB (Relative level 0 to –25 dB).
±0.25 dB (Relative level –25 to –30 dB).
Polarization Dependency –
Forward transfer characteristics (test port 2): ±0.05 dB.
Input-end reflection characteristics (test port 1): ±0.10 dB.
Repeatability at Connector Insertion*7
±0.1 dB.

GROUP DELAY TIME CHARACTERISTICS

Frequency Modulation Range (fm) – 40 MHz to 3 GHz.
Max. Measurement Range –
At fm = 40 MHz: 25 ns.
At fm = 3 GHz: 333 ps.
Group Delay Time Resolution – 0.1 psec.
Relative Group Delay Time Accuracy*6 –

Relative level (dB)	Accuracy
0 to –15 dB	±0.2%/fm
-15 to –20 dB	±0.4%/fm
-20 to –25 dB	±1.0%/fm

CHROMATIC DISPERSION

Measurement Unit –
Wavelength range (ps/nm), optical frequency range (ps/GHz).
Displays in ps/nm•km, ps/GHz•km are also possible by inputting the length of optical fiber under test.
Measurement Range – 0.1 psec/nm to 1 µsec/nm.
Measurement Resolution – 0.01 ps/nm.

PROCESSING FUNCTIONS

Memory Function – Save measurement date to back-up memory and/or to a floppy disk.
Display – Optical frequency display, overlay, dividing into two parts, cursor function.
Computing/Analysis – Averaging, Normalization, Smoothing.

OPTICAL INPUT/OUTPUT

Optical Connector Type*8 –
FC type connector (Standard).
Adapts to SC and ST type by using adapters sold separately.

INPUT/OUTPUT INTERFACE

GPIB – IEEE488-1978.
Floppy Disk Drive- 3.5 inch, MS-DOS format.
Printer – D-SUB 25 pin ESC/P, ESC/P-R, PCL.
Keyboard – Conforms to IBM PC-AT.
Display – 15 pin, D-SUB connector (VGA).


A08161 FC adapter — SC adapter — A08163 ST adapter

GENERAL SPECIFICATION

Operating Environment –
Ambient temperature: 15 to 35°C.
Relative humidity: 85% or less (no condensation).
Storage Environment –
Ambient temperature: –10 to 45°C.
Relative humidity: 90% or less (no condensation).
Power –
Display unit: AC 100 to 120 V, AC 220 to 240 V, 50/60 Hz, 300 VA or less.
Optical network analyzer unit: AC 100 to 120 V, AC 220 to 240 V, 50/60 Hz, 310 VA or less.
Dimensions –
Display unit: Approx. 424 (W) x 220 (H) x 400 (D) mm.
Optical network analyzer unit: approx. 424 (W) x 220 (H) x 500 (D) mm.
Mass – Display unit: 16 kg or less.
Optical network analyzer unit: 25 kg or less.

ACCESSORIES (SOLD SEPARATELY)

Optical Connector Adapters –

**1 At initial sweep wavelength and at 25±5°C.*
**2 At 25±5°C.*
**3 Excluding internal setting time.*
**4 At average power.*
**5 Amplitude level at through measurement as reference. At fm = 3 GHz, RBW = 10 Hz and averaging 4 times.*
**6 Relative level with amplitude level at through measurement as standard.*
**7 Value taken by 10 times connector insertion using SMF fiber with FC connector.*
**8 Exchangeable by user-side.*

Please be sure to read the manual of product thoroughly before using the products.
Specifications may change without notification.

ORDERING INFORMATION

For price information: Outside the U.S. contact your local Tektronix representative, inside the U.S. see the price list in the back of this catalog.

Q7750
Optical Network Analyzer.
Includes: Instruction Manual (English), US Power Cord, One I/O Connector Cable, One GPIB Cable, Four RF Connector Cables.

OPTIONS
Option 10 – Optical Output Port for TQ8325 Wavelength Meter.

OPTIONAL ACCESSORIES
A08161 FC Adapter.
A08163 ST Adapter.

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

CE

ADVANTEST
Advantest's quality system complies with the DIN ISO 9002 standard and has been certified by TUV Product Service GMBH.

Broadband Transmission

With the burgeoning growth of photonic networks, measurement issues are becoming more critical, complex, and lengthy. Tektronix solves measurement needs with solutions ranging from tests for waveshapes and eye patterns to multi-channel SONET/SDH test capabilities that have been enhanced for DWDM.

Contents

D3186/3286 332
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ST112 341
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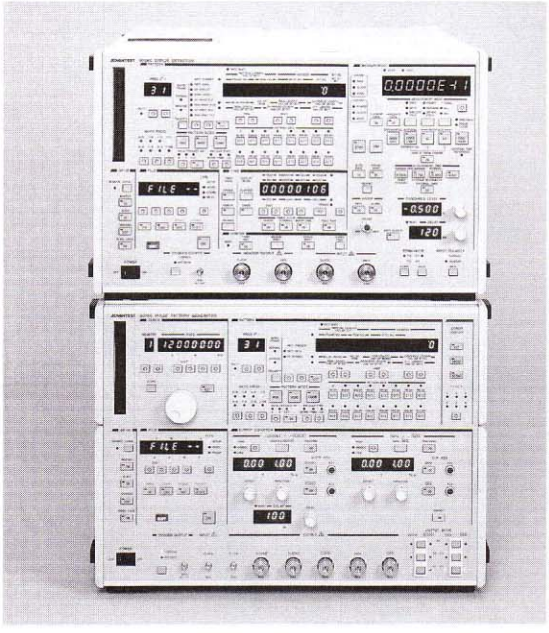
SJ300E 346
GB700 348
GB1400 348
PB200 350

Pulse Pattern Generator/Error Detector

New D3186 • New D3286



Features – Benefits

D3186 PULSE PATTERN GENERATOR

Excellent Waveform Quality

Generation of SDH/SONET Frame Patterns (Mixed Patterns)

Large Memory

Multi-channel Output: 2 Data Channels, 3 Clock Channels, and Sub-rate Channels

Cross Point Variable for Output Waveform

Burst Signal Output

D3286 ERROR DETECTOR

SDH/SONET Frame Synchronization Suitable for System Evaluation

Error Detection with Area Specification Effective for SDH Frame and ATM Cell Measurement

Auto Search Function

Monitor Output of Data and Clock Signals

Applications

COMPONENT TEST AND DEVELOPMENT

Laser Diodes

Photo Detectors

Mach-Zehndev Modulator

Clock Recovery

Limiting Amplifiers

Optical Fiber

Optical Amplifier

SYMPTOM COMPLIANCE AND INTEGRATION

Ultra-long Haul Undersea

Line Terminals

Repeaters

Mux/Demux

Optical LAN

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

CE

ADVANTEST

Advantest's quality system complies with the DIN ISO 9002 standard and has been certified by TUV Product Service GMBH.

FOR PERFORMANCE EVALUATION FOR OPTICAL COMPONENTS

High waveform quality is essential to evaluate the performance of laser diodes and optical components in optical telecommunication systems. To meet this demand, the D3186 Pulse Pattern Generator provides excellent waveforms. In addition, the D3186 expands the cross point variable range for the output waveform which makes it easier to evaluate the output waveform correction mark ratio.

USE AS A MODULATION SIGNAL SOURCE FOR OPTICAL MODULATORS

The D3186 makes an excellent signal source for optical modulators, especially when analyzing chirp with Tektronix's high-speed sampling Oscilloscope and Advantest's Q7606 Chirp Instrument.

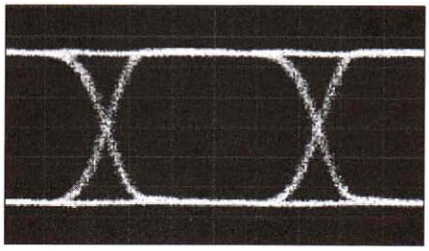
Favorable Matching with 50 Ω Output Impedance

With its 50 Ω output impedance matching, the D3186 yields high quality waveforms.

Generation of SDH/SONET Frame Patterns Close to Actual Data

FOR EVALUATION OF OPTICAL TRANSMISSION EQUIPMENT AND E/O AND O/E MODULES

In O/E and E/O tests used for the SDH/SONET system, testing at the frame level is required. In addition to the large WORD memory with 8 M-Bit length, the D3186 Pulse Pattern Generator comes with an optional function (Option 70) to insert WORD patterns in the header section of the STM frame and arbitrary PRBS in the payload section, realizing test patterns which are very close to actual data. Of course, the D3286



error detector can also measure errors at the header and payload sections separately. In addition, the D3286 pinpoints the cause of errors with the frame synchronization function and specific area error measurement function.

APPLICABLE TO FIBER LOOP TESTING

In long-distance transmission testing, fiber loop-based transmission evaluation is performed. In this test, bit error measurements for irregular burst condition data is essential. The D3186 pulse pattern generator can also send a burst signal based on an external gate signal. Similarly the D3286 enables bit error measurements for burst condition data. This allows the fiber loop transmission test to be performed efficiently.

Remote Control – The standard GPIB interface is mounted. The MASTER/SLAVE function allows pattern editing in conjunction with the D3286 error detector.

Disk Operation Section – The standard FD drive allows operating conditions and pattern setup conditions to be stored in floppy disks.

CHARACTERISTICS

D3186 PULSE PATTERN GENERATOR

OPERATING CLOCK

Operating clock source: Internal clock (optional), external clock.

Internal Clock (Optional) –
Frequency range: 150 MHz to 12 GHz (Opt. 10).
2 GHz to 12 GHz (Opt. 11).
Frequency setting resolution: 1 kHz.
Frequency stability: ±10 ppm/year.
Output waveform: Sine wave, approx. 1 V_{p-p}.
Spurious: –50 dBc (non-harmonic wave).
SSB phase noise: –70 dBc/Hz (10 kHz offset, 12 GHz carrier).
Frequency memory: 16 items.
Load impedance: 50 Ω.
Connector: SMA (Jack).
Reference frequency output: 10 MHz, 1.5 V_{p-p} min., AC coupled, BNC.
Reference frequency input: 10 MHz, 1.5 V_{p-p} min., AC coupled, BNC, automatically switched.

External Clock –
Frequency range: 150 MHz to 12 GHz.
Input level: 0.7 V_{p-p} to 1.5 V_{p-p}.
Input waveform: Sinewave.

Patterns –
Pattern Modes: Can be selected from the 3 choices below.
Pseudo-random pattern (PRBS).
Fully programmable pattern (WORD).
Frame pattern (FRAME) (Optional).

PRBS –
Pattern length: 2^N-1, where N can be selected from among 7 choices: N=7, 9, 10, 11, 15, 27 or 71.

NUMBER OF STAGES (N) AND GENERATING FUNCTION:

Number of stages	Generating function	Applied Standard
7	X^7+X^6+1	ITU-T recommended V.29
9	X^9+X^5+1	ITU-T recommended V.52
10	$X^{10}+X^7$	
11	$X^{11}+X^9+1$	ITU-T recommended 0.152
15	$X^{15}+X^{14}+1$	ITU-T recommended 0.151
23	$X^{23}+X^{18}+1$	ITU-T recommended 0.151
31	$X^{31}+X^{28}+1$	

Mark ratio: Can be selected from among 1/2, 1/4, 1/8, 0/8, 1/2B, 3/4, 7/8 or 8/8.
The patterns 1/2B, 3/4, 7/8 and 8/8 are the logical inversions of the patterns 1/2, 1/4, 1/8 and 0/8 respectively.
AND bit Shift count: 1-Bit.

Word –
Pattern length: 1 to 8,388,608 (2^{23}) bits (with ALTERNATE OFF).
1 to 4,194,304 (2^{22}) bits (with ALTERNATE ON).
Logical inversion: Possible.
ALTERNATE mode: Can be turned ON/OFF; When ON, can be switched to either of 2 patterns, A or B.
Switching control: Internal, external switching possible.
Internal switching: Done by front panel keys or GPIB.
External switching: Done by external alternate input signal.

FRAME (Opt. 70) –
Payload format: 3 types below can be selected.
Fully programmable (WORD).
Pseudo-random (PRBS).
0/1 continuous pattern + PRBS (CID).
Frame structure:
When payload format is WORD or PRBS:
Number of frames: 1 to 8,192 (with ALTERNATE OFF).
1 to 4,096 (with ALTERNATE ON).
1 frame steps.
Number of lines in 1 frame: 1 to 16 (1 line steps).
Number of bytes in 1 line: 44 to 32,768.
Number of overhead bytes in 1 line: 4 to (number of bytes in 1 line – 40 bytes), 4 byte steps.
When payload format is CID:
Number of bites in 1 line: 40 to 32,768, 4 byte steps.
Number of overhead bytes in 1 line: 36 to (number of bytes in 1 line ÷ integer quotient of 36) x 36, 36 byte steps.
Number of 0/1 continuous pattern bits: 0 to (number of bytes in 1 line – number of overhead bytes in 1 line) x 8 bits, 1 bit steps.
Stage Number of PRBS: 7, discontinuous parts may exist.
Logical inversion: Possible.
ALTERNATE mode: Can be turned ON/OFF (only when payload type is WORD or PRBS); When ON, can be switched to either of 2 patterns, A or B.
Switching control: Internal, external switching possible.
Internal switching: Done by front panel keys or GPIB.
External switching: Done by external alternate input signal.

Error Addition –
Error addition mode: Repeat, single, external.
Repeat: Error ratio $1x10^{-N}$, N=4 to 9, bit error is added at a set interval.
Single: 1-Bit error is added with every error addition command.
External: 1-Bit error is added with every falling edge of an external error addition pulse input.

MAIN OUTPUTS

Number of outputs: Data, 2 patterns (DATA, DATA).
Clock, 3 patterns (CLOCK1, CLOCK1, CLOCK2).

SUB RATE OUTPUTS

1/2 CLOCK, 1/4 CLOCK, 1/32 CLOCK, CLOCK (DC), CLOCK (AC).
DATA, DATA, 4-1/4 DATA

Data Outputs (DATA, DATA) –
Number of outputs: 2 patterns (DATA, DATA, complementary).
Format: NRZ.
Coupling: DC.
Amplitude range: 0.5 V_{p-p} to 2 V_{p-p}, 10 mV steps (TO 0 V, AC).
0.6 V_{p-p} to 1 V_{p-p}, 10 mV steps (TO –2 V).

Offset range: –2 V to +2 V, 10 mV steps (TO 0 V).
–1 V to –0.6 V, 10 mV steps (TO –2 V).
(HIGH level reference).
Rise/fall time: 30 ps max.
Load terminal conditions:
Can be selected as either DC coupled TO 0 V, TO –2 V or AC coupled.
Offset setting level: Can be selected as either HIGH, MIDDLE or LOW.
Cross point variable: ON/OFF selectable.
Load impedance: 50 Ω.
Connector: SMA (plug).

Clock Outputs (CLOCK1, CLOCK1) –
Number of outputs: 2 patterns (CLOCK1, CLOCK1, complementary).
Format: RZ.
Coupling: DC.
Amplitude range: 0.5 V_{p-p} to 2 V_{p-p}, 10 mV steps (TO 0 V, AC).
0.6 V_{p-p} to 1 V_{p-p}, 10 mV steps (TO –2 V).
Offset range: –2 V to +2 V, 10 mV steps (TO 0 V).
–1 V to –0.6 V, 10 mV steps (TO –2 V).
(HIGH level reference).
Rise/fall tame: 30 ps max or less.
Load terminal conditions:
Can be selected as either DC coupled TO 0 V, TO –2 V or AC coupled.
Offset setting level: Can be selected as either HIGH, MIDDLE or LOW.
Duty ratio variable: ON/OFF selectable.
Variable delay range: ±400 ps, 1 ps steps (CLOCK2 output reference).
Load impedance: 50 Ω.
Connector: SMA (plug).

Clock Output (CLOCK2) –
Number of outputs: 3 pattern.
Format: RZ.
Coupling: AC (Built-in DC blocking condenser).
Amplitude: Approx. 1 V_{p-p} fixed.
Offset: 0 V ± 0.1 V fixed (MIDDLE level reference).
Waveform: Rectangular wave.
Rise/fall time: 30 ps max.
Load impedance: 50 Ω.
Connector: SMA (plug).

Trigger Signal Output –
Output Signal: Can be selected as either clock synchronization or pattern synchronization.
Clock synchronization (1/32 CLK): Clock frequency 1/32 divided output.
Pattern synchronization (PATTERN): Varies output position to any position in 16 bit units.
Output level: HIGH level 0 V ±0.2 V, LOW level –1 V ±0.2 V.
Load impedance: 50 Ω to 0 V.
Connector: SMA.

AUXILIARY OUTPUT

1/2 Clock Output –
Format: RZ.
Coupling: DC.
Output level: HIGH level, 0 V±0.2 V, LOW level –1 V ±0.2 V.
Load impedance: 50 Ω to 0 V.
Connector: SMA.

1/4 Rate Output –
Output bit rate: 1/4 operating clock frequency.
Number of pattern outputs: Four patterns.
Number of clock outputs: 3 pattern.
Output skew: ±150 ps max.
Output level: HIGH level 0 V ±0.25 V, LOW level –1 V ±0.25 V.
Load impedance: 50 Ω to 0 V.
Connector: SMA.

CONTROL INPUT

External Gate Input –
Function: Inhibits data output, inhibits at LOW level.
Input level: 0 V/–1 V.
Input pulse width: At least 20 ns, or at least 64x operating clock cycle, whichever is longer.
Input impedance: Approx. 50 Ω to 0 V.
Connector: BNC.

External Alternate Input –
Function: In ALTERNATE mode, switches between patterns A and B; Pattern A at HIGH level, Pattern B at LOW level.
Input level: 0 V/–1 V.
Input impedance: Approx. 50 Ω to 0 V.
Connector: BNC.

External Error Addition –
Function: When pattern error addition is (EXT), 1-Bit error is added for every fall edge of the input pulse.
Input level: 0 V/–1 V.
Input impedance: Approx. 50 Ω to 0 V.
Connector: BNC.

SYSTEM FUNCTIONS

Master/Slave Function –
Function: When used together with the D3286 Error Detector, allows the pattern settings of the D3186 and D3286 to be interlocked.

Panel Lock – Possible.

External Clock Generator Control Function –
Function: When external clock generator (SG) is used, the frequency and output level are controlled from the D3186.
Connection method: Dedicated GPIB connector.

Remote Control –
Interface: GPIB (IEEE 488-1978).

Calendar/Clock Function –
Display: Can be selected as either year/month/day/hour or day/hour/minute/second.

File Function –
Built-in floppy disk drive.
Functions: Save, re-save, read in, erase and initialize.
Saved data: Operating conditions, pattern settings.
Read in data: Operating conditions, pattern settings.
Disks used: 3.5 inch floppy disks, 720 KB (2DD), 1.2 MB (2HD), 1.4 MB (2HD).
Disk format: MS-DOS® Rev. 4.0.
File format: Proprietary binary format.

MS-DOS is a registered trademark of Microsoft Corporation.

GENERAL SPECIFICATIONS

Numerical value display: Green 7 segment LED display.
Set conditions memory: After power has been ON for 12 hours, retained at least two weeks (backed up by secondary battery).
Operating temperature range: 0°C to + 40°C.
Operating humidity range: 40% to 85% RH.
Storage temperature range: –20°C to +60°C.
Storage humidity range: 30% to 85% RH (without condensation).
Power: AC 100 V to 120 V, AC 220 V to 240 V (switches automatically). 48 to 63 Hz, sine wave.
Power consumption: 550 VA max.
Mass: 42 kg max.

D3286 ERROR DETECTOR

DATA

This input connector allows logic inversion.
Input amplitude: 0.1 to 2 Vp-p.
Threshold level setup range : –2.040 to +2.040 V.
Input sensitivity: 40 mV (typ.).

CLOCK

Clock input connector
Input amplitude: 0.5 to 2 Vp-p.
Variable amount of delay: Variable range ±400 ps with respect to data.

Monitor Output – Monitor output for input data and clock. Waveform monitoring is possible during bit error measurement.

Auto Search Function – Used to automatically adjust the amount of delay for clock input and the threshold level of data input with a touch of key, simplifying complicated operations.

Measurement Time Mode Selection Section – The measurement time mode can be set to one of three modes: frame time, frame interval and burst. Applicable to burst measurement time in SDH frame measurement and fiber loop test.

Measurement Results Display Function Setup – ERROR RATE, ERROR COUNT, EI, EFI or FREQ/FRAME can be selected.

Error Measurement Results Display – Displays error measurement results with a display format dependent on the measurement function.

Pattern Setup Section – Used to edit data comparison pattern in error measurement. The panel layout is the same as that of the D3186.

Number-of-Stages (N) Selection Key for PRBS – Applicable to 7 PRBS patterns with N of 7, 9, 10, 11, 15, 23 and 31.
Pattern Mode Selection Section – Used to select data comparison pattern from PRBS, WORD and FRAME (option).
Remote Control – The standard GPIB interface is mounted. The MASTER/SLAVE function allows pattern editing in conjunction with the D3186 Pulse Pattern Generator.
Disk Operation Section – The standard FD drive allows operating conditions and pattern setup conditions to be stored on floppy disks. The built-in printer allows measurement results to be printed easily.

Internal Clock (Optional) –
Frequency range: 150 MHz to 12 GHz (Opt. 10).
2 GHz to 12 GHz (Opt. 11).

MAIN OUTPUTS
Number of outputs: Data, 2 patterns (DATA, DATA).
Clock, 3 patterns (CLOCK1, CLOCK1, CLOCK2).

SUB RATE OUTPUTS
1/2 CLOCK, 1/4 CLOCK, 1/32 CLOCK, CLOCK (DC), CLOCK (AC).
DATA, DATA, 4-1/4 DATA.

Data Outputs (DATA, DATA) –
Number of outputs: 2 patterns (DATA, DATA, complementary).
Format: NRZ.
Coupling: DC.
Amplitude range: 0.5 V_{p-p} to 2 V_{p-p}, 10 mV steps (TO 0 V, AC).
0.6 V_{p-p} to 1 V_{p-p}, 10 mV steps (TO –2 V).
Offset range: –2 V to +2 V, 10 mV steps (TO 0 V).
–1 V to –0.6 V, 10 mV steps (TO –2 V).
(HIGH level reference).
Load impedance: 50 Ω.
Rise/fall time – 30 ps max.

AUXILIARY OUTPUT
1/2 Clock Output –
Format: RZ.
Coupling: DC.
Output level: HIGH level, 0 V±0.2 V, LOW level –1 V ±0.2 V.
Load impedance: 50 Ω to 0 V.
Connector: SMA.

1/4 Rate Output –
Output bit rate: 1/4 operating clock frequency.
Number of pattern outputs: Four patterns.
Number of clock outputs: 3 pattern.
Output skew: ±150 ps max.
Output level: HIGH level 0 V ±0.25 V, LOW level –1 V ±0.25 V.

OPERATING FREQUENCY
Operating Frequency Range – 150 MHz to 12 GHz.

MEASUREMENT INPUT
Data Input –
Input amplitude: 0.1 V_{p-p} to 2 V_{p-p}.
Clock Input –
Input amplitude: 0.5 V_{p-p} to 2 V_{p-p}.

PHYSICAL CHARACTERISTICS

Dimensions (Approx.)	mm
Height	266
Width	424
Depth	550

Please be sure to read the product manual thoroughly before using the products.
Specifications may change without notification.

ORDERING INFORMATION

For price information: Outside the U.S. contact your local Tektronix representative, inside the U.S. see the price list in the back of this catalog.

D3186
Pulse Pattern Generator.
Includes: Power Cable, Type A01402 (Order DCB-DD2428X01), 7 SMA-SMA Cables, Type DGM224-00700A (Order DCB-FF1211X01), GPIB Cable, Type 408JE-101 (Order DCB-SS1076X02), 3-Pin – 2-Pin Converter Adapter For Power Plug, Type A09034 (Order JCD-AL003EX03), 5 K Adapters, Type 30-672-0000-890 (Order JCF-BJ001EX02), User's Manual, Japanese (Order JD3186), User's Manual, English (ED3186).

OPTIONS
Opt. 10 – 150 MHz – 12 GHz internal clock source.
Opt. 11 – 2.2 GHz – 12 GHz internal clock source.
Opt. 70 – Mixed pattern PRBS with user word.

D3286
Error Detector.
Includes: Power Cable, Type A01402 (Order DCB-DD2428X01), 3 SMA-SMA Cables, Type DGM224-00700A (Order DCB-FF1211X01), GPIB Cable, Type 408JE –101 (Order DCB-SS1076X02), 3-Pin – 2-Pin Converter Adapter For Power Plug, Type A09034 (Order JCD –AL003EX03), 2 K Adapters, Type 30-672-0000-890 (Order JCF –BJ001EX02), 3 Quantities Printer Paper, Type FTP-020PG021 (Order EPA-000409), User's Manual, Japanese (Order JD3286), User's Manual, English (Order ED3286).

OPTIONS
Opt. 70 – Mixed pattern PRBS with user word.

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

CE

ADVANTEST
Advantest's quality system complies with the DIN ISO 9002 standard and has been certified by TUV Product Service GMBH.

SONET Test Sets

CTS 710



Features – Benefits

- 52 Mb/s, 155 Mb/s and 622 Mb/s Transmit and Receive
- DS1 and DS3 Testing (Optional)
- Bit Error Rate Testing Including BIP Error Monitoring and Analysis
- Payload Mapping and Demapping
- Tributary Add, Drop and Test
- Pointer Generation and Analysis
- Alarms Generation and Analysis
- DCC and User Channel Access
- Simple User Interface
- Automatic Setup
- Rugged Modular Design, Customer Configurable
- Disk Drive
- IEEE 488.2 and RS-232C

Applications

- Network Integrity Testing
- In-service Performance Monitoring
- Overhead Testing
- Tributary Mapping and Demapping
- Tributary Testing
- Stimulus and Response Testing
- Stress Testing
- APS Testing
- Pass/Fail Testing

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

CE

ISO 9001

Tektronix measurement products are manufactured in ISO registered facilities.

GPIB IEEE-488

Product(s) complies with IEEE Standard 488.2-1987, RS-232-C, and with Tektronix Standard Codes and Formats.

The ANSI standards for SONET specify requirements for the network element (ADM, multiplexers, terminals, etc.) interfaces. Installation, commissioning, maintenance and repair of the SONET network involves the challenge of testing to ANSI standards. The CTS 710 is ready for the challenge to assist with these and other testing needs. In one configurable, expandable and upgradable instrument you will find everything required to do your testing.

CONFIGURABLE

The CTS 710 is a rugged portable test set designed not only for your current tasks; through its unique architecture, it will grow with you as SONET grows. When you require additional capabilities such as optical interfaces, jitter analysis, ATM testing, etc., you can add such functionality to your CTS 710. This upgradability is important due to evolving nature of the standards, test requirements and equipment capabilities.

The CTS 710 is part of a new generation of test sets combining various different functions in one instrument with the power to go beyond basic testing. The modular nature of the test set allows you to configure the instrument to your needs, without the cost of unwanted built-in capabilities. Starting with a low cost platform which addresses your basic SONET testing needs, you can expand its capabilities as desired with a growing number of options.The CTS 710 incorporates a number of new productivity features:

- AutoScan – Graphically presents the incoming signal structure and allows easy instrument setup
- Pass/Fail Testing – Automates following a written test procedure
- TroubleScan – Highlights error, alarms and defects
- Graphical Displays – For historical trend analysis

- Online Help – For quick assistance with operation
- Floppy Disk Drive – For easy storage of instrument setups, Pass/Fail Test and results

This instrument employs innovative hardware technology which reprograms itself, depending on the operational mode. Future demands regarding access and control of particular bytes are easily reprogrammed. Upgrades are distributed on disks.

Characteristics

Transmit and Receive rates –
STS-1, STS-3 (electrical).
STS-3c and OC-3c.
OC-1, OC-3, OC-12 (optical).
DS1, DS3 (Opt. 22).
Compliance to ANSI T1-105.

Generation and Analysis –
Testing of Bit Error Rates including B1, B2, B3, VT BIP, Line FEBE, Path FEBE and Payload.
Complete alarm monitoring and generation.
Measurements: 1 sec to 99 days.
Histograms: 72 hours with 1 minute resolution. 45 days with 15 minute resolution.
Measurements with ANSI T1M1.3 analysis.

Overhead Management –
Transport Overhead, Path Overhead and VT Overhead.
Set and View Byte Value: All.
Set and View Byte Trace Message: J1.
Add/Drop: DCCs, F1, F2.

Other –
APS Control.
Pointer movement control.
Complete Pointer Sequence selection in accordance with ANSI T1X1.6.
Timing offset: up to ±100 ppm.
DS1 and DS3 T-carrier testing (Opt. 22).
Disk storage: 200 instrument setups, 400 hours of results including histories or 200 Pass/Fail tests on each disk (DOS compatible).

Safety – UL3111-1, CSA1010.1, EN61010-1, IEC61010-1.

Laser – EN60825-1 (Class 1), 21CFR1000 (Class I).

Physical Characteristics

Dimensions	mm	in.
Height	164	6.4
Width	491	14.25
Depth	1362	19.25
Weight	**kg**	**lbs.**
Net	10	22.5

Ordering Information

For price information: Outside the U.S. contact your local Tektronix representative, inside the U.S. see the price list in the back of this catalog.

CTS 710
SONET DS3/DS1 Test Set.
Includes: User Manual, Reference Manual, Performance Verification, Front Cover, Accessory Pouch, 75 Ω Cable, Power Cord.

OPTIONS
Opt. 03 – Optical/Electrical Interface, 52 Mb/s, 155 Mb/s, 1310 nm.
Includes: Two Optical Connector Kits 020-1885-00 for FC-PC, ST, DIN, SC.
Opt. 04 – Optical/Electrical Interface,52 Mb/s, 155 Mb/s, 622 Mb/s, 1310 nm.
Includes: Two Optical Connector Kits 020-1885-00 for FC-PC, ST, DIN, SC.
Opt. 05 – Optical/Electrical Interface, 52 Mb/s, 155 Mb/s, 622 Mb/s, 1550 nm, 0 dBm Power.
Includes: Two Optical Connector Kits 020-1885-00 for FC-PC, ST, DIN, SC.
Opt. 06 – Optical/Electrical Interface, 52 Mb/s, 155 Mb/s, 622 Mb/s, 1310/1550 nm.
Includes: Two Optical Connector Kits 020-1885-00 for FC-PC, ST, DIN, SC.
Opt. 22 – DS1 and DS3 Testing
Includes: Standalone, Map/Demap and Add/Drop.

MEASUREMENT SERVICE OPTIONS
Opt. R5 – Repair warranty extended to cover five years. See page 615 for further information.

FIELD UPGRADE KITS
CTS7F01 – Electrical Interface 52 Mb/s, 155 Mb/s, 75 Ω BNC.
CTS7F03 – Optical/Electrical Interface, 52 Mb/s, 155 Mb/s, 1310 nm.
CTS7F04 – Optical/Electrical Interface, 52 Mb/s, 155 Mb/s, 622 Mb/s, 1310 nm.
CTS7F05 – Optical/Electrical Interface, 52 Mb/s, 155 Mb/s, 622 Mb/s, 1550 nm.
CTS7F22 – DS1 and DS3 Testing. Includes: Standalone, Map/Demap and Add/Drop.

INTERNATIONAL POWER PLUGS
Opt. A1 – Universal Euro (220 V, 50 Hz).
Opt. A2 – U.K. (240 V, 50 Hz).
Opt. A3 – Australian (240 V, 50 Hz).
Opt. A4 – North American (240 V, 60 Hz).
Opt. A5 – Switzerland (220 V, 50 Hz).
See page 619 for description.

ACCESSORIES
Rackmount – Order 016-0819-1x.
Optical Connector Kit – Order 020-1885-00.
Includes: FC-PC, ST, DIN, SC.
Hard Transit Case – Order 016-1157-00.
Soft Carrying Bag – Order 016-1158-01.
Cart – Order K212.

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

CE

ISO 9001
Tektronix measurement products are manufactured in ISO registered facilities.

GPIB IEEE-488
Product(s) complies with IEEE Standard 488.2-1987, RS-232-C, and with Tektronix Standard Codes and Formats.

SDH/PDH & Jitter/Wander Test Set

CTS 850



For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

CE

ISO 9001

Tektronix measurement products are manufactured in ISO registered facilities.

Features – Benefits

- STM-0, STM-1 and STM-4 Transmit and Receive
- STM-16 Transmit and Receive (with ST2400A)
- VC4-4c Concatenated Payload Testing
- PDH Mux/Demux with N/Mx64 kb/s Testing
- Complete Jitter and Wander Tests at all Equipped Line Rates from 2 MB/s to 622 MB/s in One Option Plus 45 MB/s
- Real-time Wander Analyst Application Software for MTIE, TDEV, Frequency Offset and Drift-rate Measurements
- Full-band Jitter Measurements to 0.1 Hz with Variable High-pass Cutoff Frequencies
- SDH/PDH Defect Generation and Analysis
- Manipulation of K1/K2 Bytes for MSP/APS Testing
- Field-interchangeable 1310 nm and 1550 nm Optical Interfaces
- AutoScan with Graphical Display of Signal Format and Payload
- Histogram Results, Correlated Alarms, Defects, Errors and Events to 1-Second Resolution
- Exclusive New Measurements for Digital Video Network Characterization
- Conformance to Latest ITU-T Standards

Applications

- Network Integrity Testing
- Mapping/Demapping (Including 45 MB/s)
- MSP/APS Testing

Supports New ITU-T O.172 Conformance Test Set

The CTS 850 is a versatile Analyzer for Broadband Network Testing. It has a powerful, yet uncomplicated, menu structure which allows both the novice and expert user to accurately configure measurements on SDH and PDH networks very quickly. All measurement connections are conveniently located directly on the front panel close to the signal status LEDs and easy-to-read display.

A field-interchangeable optical module and a floppy disk drive for retrieval of stored setups and results complete the front panel layout to create a "field-friendly" instrument.

SDH/PDH/JITTER AND WANDER TESTING

The CTS 850 creatively addresses growing concerns surrounding hybrid SDH/PDH networks in the area of timing and synchronization. Its industry-leading, DSP-based, Jitter and Wander measurement capability provides a high 300 UI jitter measurement range, handles all line rates from 2 MB/s to 622 MB/s via existing front panel connectors and introduces exclusive new measurements for digital video services.

The CTS 850 unlocks the power of the SDH frame structure by combining bit error testing with overhead analysis and payload mapping and demapping. It provides read/write access to overhead bytes, DCC add/drop and complete G.783 pointer test sequences.

The CTS 850 is optimized for installation and maintenance of both current and future SDH networks. Additional functionality, reflecting evolving standards such as new O.172, can be downloaded via the built-in disk drive.

One of the CTS 850's many powerful functions is error analysis and display. In addition to simple error counts and rate determination, the CTS 850 makes measurements according to G.821, G.826, G.827 and new M.2101.1 performance analysis and M.2100 error analysis so that network quality of service can be fully verified in or out of service.

Histograms boost the power of error analysis by enabling an easy correlation of time-critical events. Thus, time-consuming searches through long strips of error printouts are eliminated, freeing you to spend time fixing problems, not finding the cause.

PDH TESTING

Many networks have evolved from PDH to include SDH rings and long-distance, high-capacity trunks. The PDH network segments are commonly retained for access, service delivery and economic reasons. The CTS 850 Opt. 38, PDH Tributary card provides features for testing and accessing PDH sub-rates from 140 MB/s, 34 MB/s, 8 MB/s, 2 MB/s down to N/Mx64 kb/s. Additional PDH test features also include simultaneous multi-layer G.826, M.2100 results, Round Trip Delay, Voice Channel Monitor and Burst FAS Errors.

This option also empowers the CTS 850 with mapping and demapping of 2, 34 and 140 MB/s payloads in virtual containers and testing of TU-12, TU-3 and AU-4 overheads, making it ideal for testing hybrid networks.

JITTER AND WANDER TESTING

To support current and emerging ITU-T and ETSI standards, CTS 850 Opt. 14 for Jitter and Wander provides the most comprehensive, easy-to-use measurements for both SDH and PDH equipment and networks.

The CTS 850 is the first test set to fully conform to the requirements of the new ITU-T O.172 (Jitter/wander test for SDH networks). So for the first time, measurements of pointer jitter can be made reliably and accurately. Widely variable results are a thing of the past.

With its wide-ranging and comprehensive generation, analysis, pointer movement, automated jitter output, transfer and tolerance testing, the CTS 850 is the complete solution for your current and future test requirements.

Also included in Opt. 14 is Real-time Wander Analyst application software for MTIE and TDEV parameter analysis. Now you can fully test and qualify the timing and synchronization of your new SDH/PDH equipment and networks. Jitter history histograms can be correlated with simultaneously-acquired Wander TIE data so troublesome conditions can be quickly diagnosed.

VIDEO SERVICE PERFORMANCE AND 45 MB/S MAPPING AND DEMAPPING

Digital video services demand a more stringent level of SDH/PDH timing and synchronization performance than many other services. The CTS 850 Opt. 14 provides exclusive new measurements at the network interface to assess video service performance. Also, CTS 850 Opt. 55, provides the ability to test 45 MB/s Mapping and Demapping, including Jitter and Wander testing, to bring the CTS 850's advanced benefits to Video Service Measurement.

FLEXIBLE AND EASY-TO-USE

Graphical display of AU/TU payload and alarms (AutoScan). Provides the fastest signal identification. Allows quick identification of incorrect provisioning and easy location of the customer's signal path

Pass/fail tests can be created, stored and executed in the field. Ensures a uniform test methodology in an increasingly diverse network. Allows faster installation and responsive maintenance

3.5" Floppy Disk Drive. Distribute firmware updates in the field. Archive Pass/Fail tests and test results. Document operating- and result-screen bitmaps

Measurement Histograms with up to 1-second resolution Allows visual presentation of measurement results to customers. Correlate alarms, errors, pointer movements, etc.

Cleanly structured menu system. Enables all users (technicians, experts and occasional users) to be immediately productive

Large, bright CRT user interface. Easy-to-see in low lighting conditions. Histogram resolution is clearly visible

SDH TESTING

STM-0, STM-1 and STM-4 Transmit and Receive. STM-0 (51 MB/s) is becoming more prevalent in radio links/subsystems and SDH access systems

STM-16 Transmit and Receive (with ST2400A). Test STM-1/4 payloads in STM-16 ring

Performance analysis to G.821, G.826 and new M.2101.1, M.2100 error analysis on all SDH/PDH layers simultaneously. Simplified testing for correct error performance compliance on both in-service and out-of-service systems

Pointer test sequences exceed requirements of G.783. Thoroughly stress the margins of equipment performance

SDH/PDH Defect generation and analysis. Verify correct network response at all layers

Set and detect K1/K2 bytes. Generate Linear and Ring messages to G.841 and G.783. Send standard network messages and monitor network response. Verify protection switching system

Interchangeable 1310 nm and 1550 nm optical interfaces. Swap between Long Haul/Short Haul trunk testing

VC4-4c testing for concatenated payloads. Efficiently qualify transport of concatenated 622 MB/s data for IP and ATM applications

45 MB/s (DS3) Mapping/Demapping and Jitter/Wander Testing. Focus on new 45 MB/s services and Video quality testing. Complete set of jitter and wander conformance tests with specification limits

PDH Testing

Test 2, 8, 34, 140 MB/s directly at each line rate. Make traditional PDH measurements when necessary

Map unique test patterns into TU-12, TU-3 and AU-4 containers. Verify correct provisioning and payload integrity

Test PDH signals dropped from SDH rates. Monitor PDH services to verify tariffed performance

Add/Drop external 2, 34 and 140 MB/s signals to/from SDH containers and induce timing impairments. Generate SDH test signals using customer-generated PDH traffic. Add pointer sequences, test pointer hit tolerance of terminals and desynchronizers

Mux/Demux N/Mx64 kb/s and sub-rate PDH signals into/out of higher-speed PDH signals. Verify correct PDH multiplexer/demultiplexer service configuration for data and video conferencing

Round trip delay testing. Measure round-trip delay for data and voice services

2 MB/s Channel Associated Signaling. Verify channel-busy occupancy and utilization

Jitter/ Wander Testing

Exceeds new ITU-T O.172. Fully conforms with requirements of new ITU-T O.172 (jitter/wander test sets for SDH networks). DSP engine provides precise measurement filter characteristics – unlike previous O.171 test sets, pointer jitter is reliably and accurately measured

SDH/PDH Jitter and Wander testing from 2 to 622 MB/s. Most complete solution in one option supports installed interfaces for both generation and analysis (including 45 MB/s)

Automatic built-in conformance tests for output jitter, jitter tolerance, jitter transfer, pointer jitter. Perform all standard ITU-T SDH/PDH equipment and network jitter/wander tests with quick, simple Pass/Fail tests. Supports G.783, G.823, G.824, G.825, G.958, G.735 and G.751 specifications

New Video Timing Quality measurements: Frequency drift-rate (ppm/sec). Allows characterization of SDH networks for video applications. Correlate SDH pointer activity with video sub-carrier and Hsync drift

DSP Jitter and Wander measurement technology. Standards requirements can easily be updated in firmware and distributed on a floppy disk. Measurements are more repeatable and reliable between two test sets. Allows existing customers' test sets to be firmware-upgraded to support new O.172

Combined mapping and pointer jitter testing function. Allows testing of tributary jitter caused by G.783 SDH pointer test sequences together with PDH mapping frequency offset

Up to 100,000 UI wander and 300 UI jitter generation ranges exceed requirements of G.823, G.824, G.825 and new O.172. Enables full margin testing of low frequency jitter/wander and full input tolerance testing

300 UI jitter measurement range allows measurement of Pointer Hits. Test set stays in lock, identifies/logs Pointer Hits on PDH service when dropped from SDH network

SDH/PDH line/clock wander and frequency measurement on all installed interface rates. Allows diagnosis of network synchronization problems in the field

Full set of standard measurement filters in conformance with new O.172 plus measurements to 0.1 Hz. Ensures reliable and accurate measurements of pointer jitter, improves accuracy of line jitter measurements. Full-band jitter measurement (down to 0.1 Hz) allows characterization of phase transients that affect video, ATM and PDH service quality

MTIE and TDEV wander parameter analysis. Real-time Wander Analyst software provides pass/fail testing to the most recent ITU-T, ETSI, ANSI and Bellcore standards. Also provides frequency offset and drift-rate analysis

Physical Characteristics

Dimensions	mm	in.
Height:	165	6.5
(with accessory pouch):	191	7.5
Width:	362	14.25
Depth (with front cover):	490	19.25
(with handle extended):	564	22.2
Weight	**kg**	**lb.**
Net (Approx.):	8.7	19.3
Shipping (Approx.):	14.1	31

Power Requirements

Line Voltage	Line Frequency
100 V to 132 V	50 /60 Hz
180 V to 250 V	40 Hz to 60 Hz
100 V to 132 V	400 Hz

Maximum current is 6 A_{RMS}

Safety – UL3111-1, CSA1010.1, EN61010-1, IEC61010-1.

Laser – EN60825 (class 1), 21 CFR 1000 (class I).

Ordering Information

For price information: Outside the U.S. contact your local Tektronix representative, inside the U.S. see the price list in the back of this catalog.

CTS 850 SDH/PDH/JITTER/WANDER TEST SET

INSTRUMENT OPTIONS

Opt. 01 – STM-0/1E 51/155 MB/s Electrical, Interface.

Opt. 03 – 1310 nm Interface.

Opt. 04 – 1310 nm Interface.

Opt. 05 – 1550 nm Interface.

Opt. 06 – 1310/1550 nm Interface. (combines Opt. 04 and Opt. 05).

Opt. 08 – VC4-4c concatenated 622 MB/s mapping.

Opt. 12 – 1.6/5.6 connectors for all 75 Ω BNC front panel connectors.

Opt. 14 – SDH/PDH Jitter/Wander Test, including real-time Wander Analyst application software for a Microsoft Windows®; compatible PC.

Opt. 31 – FC Connectors.

Opt. 32 – ST Connectors.

Opt. 33 – SC Connectors.

Opt. 34 – DIN Connectors.

Opt. 38 – N/Mx64 kb/s, 2 MB/s, 8 MB/s, 34 MB/s, 140 MB/s, TU-12, TU3 Capabilities.

Opt. 55 – 45 MB/s Mapping/Demapping.

Opt. C3 – 3-years calibration service.

Opt. D1 – Calibration Data Report.

INTERNATIONAL POWER PLUGS

Opt. A1 – Universal Euro (220 V, 50 Hz).

Opt. A2 – U.K. (240 V, 50 Hz).

Opt. A3 – Australian (240 V, 50 Hz).

Opt. A4 – North American (240 V, 60 Hz).

Opt. A5 – Switzerland (220 V, 50 Hz).

See page 619 for description.

ACCESSORIES

Hard Case – 016-1157-00.

Soft Case – 016-1158-00.

10 dB Attentuator (FC-PC to FC-PC) – 119-1387-00.

Connector Kit (FC-PC, ST, DIN, & SC) – 020-1885-00.

Rack Mount Kit (19") – 016-1406-00.

SINGLE-MODE OPTICAL CABLES

FC-PC to FC-PC, 2 m – 174-1387-00.

FC-PC to ST, 2 m – 174-1386-00.

FC-PC to Biconic, 2 m – 174-1388-00.

FC-PC to Diamond 3.5, 2 m – 174-1385-00.

ELECTRICAL CABLES

2 MB/s Siemens-Siemens, 120 Ω, 2 m – 012-1469-00.

PDH/STM-1E BNC-BNC, 75 Ω, 2 m – 012-1338-00.

Adapter BNC-1.6/5.6 – 013-0300-00.

RELATED BROADBAND TEST PRODUCTS

ST2400A 2.4 Gb/s SDH/SONET Analyzer.

SJ300E SDH/SONET Jitter/Wander Generator/Analyzer.

MTS200 Series MPEG Test Systems.

CTS 710 SONET/DS3/DS1 Test Set.

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

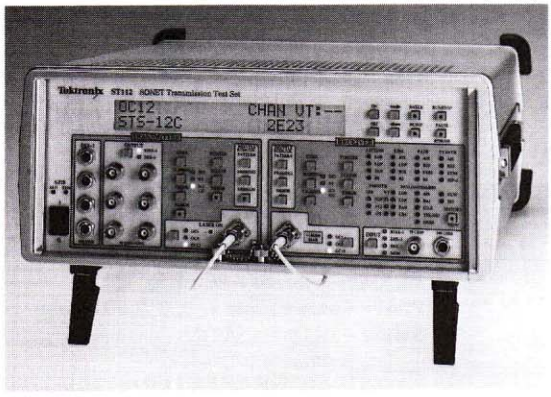
CE

ISO 9001

Tektronix measurement products are manufactured in ISO registered facilities.

SONET Test Sets

ST112



Features – Benefits

- OC-1/3/3c/12/12c Framing and Payload per Bellcore and ANSI Specifications
- Complete Overhead and Bit Error Rate Testing (BERT)
- STS-3c/12c, DS3 and VT1.5 Payload Mappings
- Unique VT1.5 Channel Scan and SONET Trouble Scan
- Standalone DS1/3 Test Capability
- Six DSX-3 or Six STSX-1 and Four DSX-1 Electrical Outputs
- Quick Setup for Automatic Configuration of Standard Test Modes
- AutoSeek (Automatic Detection of Receive Signal) and AutoLink (Receiver Follows Transmitter)
- Full SPE and VT Pointer Control
- Multiple Electrical Outputs for Four DS1, Six DS3/STSX-1
- Access to All SONET Overhead Bytes
- Data Communications Channel (DCC) Add/Drop

Applications

- SONET Network Element Testing
- Loopback Testing
- End-to-End Testing and Monitoring
- Path Provisioning and Performance Monitoring
- Software Regression Testing

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

NOT AVAILABLE IN EUROPE.

ISO 9001

Tektronix measurement products are manufactured in ISO registered facilities.

ST112 Portable Transceiver

The portable ST112 transmission analyzer is on the leading edge of today's growing need for SONET testing. It's designed not only to support today's needs, but tomorrow's emerging technologies as well. The powerful ST112 is a compact single-unit solution for providing extensive SONET STSX-1, OC-1/3/3c/12/12c signal generation and analysis for tributary and network testing. Optimized for lab-based conformance and field-based installation testing, the ST112 extends SONET testing technology to ATM by delivering a clear channel STS-3c concatenated mapping in addition to the standard DS3 and VT1.5 mappings. The ST112 combines easy-to-use, powerful test solutions with user-upgradeable software to meet evolving SONET standards.

EXTENSIVE SONET TEST CAPABILITIES

The ST112's SONET capabilities include not only optical carrier generation, but also STS-3c/12c, DS3 and VT1.5 payload generation. Additional features include:

- VT Channel Scan for testing VT mappings
- Event sync (Opt. 07) provides output signals for deriving switch timing or propagation delay from alarm conditions
- Byte synchronous payload mapping for next generation DLC testing
- Full error and alarm generation

The ST112 Receiver analyzes the incoming optical signal and displays performance-monitoring information for the optical signal and payloads.

TROUBLESCAN SYSTEMATICALLY SEARCHES FOR ERRORS

The ST112 has been carefully engineered to enable the user to work smarter, not harder. For example, the ST112 Receiver has a unique, time-saving feature called STS TroubleScan, which systematically scans the entire input signal and displays any detected errors and alarms on all payload envelopes.

Characteristics

PAYLOADS

DS3 Payload –
General: A single internally or externally generated asynchronous DS3 signal is mapped into an STS-1 payload.
Frame Patterns: M13, C-Bit, unframed.
Payload Patterns: $2^{23} - 1$, $2^{15} - 1$, AIS, Idle, All Ones.

STS-3c/12c Payloads – An internally generated $2^{23} - 1$ PRBS sequence with valid path overhead.

ALARM AND ERROR GENERATION

Section – Loss of Signal (LOS), Loss of Frame (LOF), BER, Single error inject.
Line – Alarm Indication Signal (AIS), Far End Receive Failure (FERF), Bit Error Rate (BER), Single error inject.
Path – Loss of Pointer (LOP), STS Path Yellow, STS Path AIS, BER, Single error inject, Far End Block Error (FEBE).
VT – VT LOP, VT Path Yellow, VT Path AIS, BER.
Alarm Type – Burst or continuous, external TTL event trigger when alarm is activated.
Random Bit Error Injection – 1.5×10^{-3} to 10^{-9} Rate or single.
Bipolar Pulse Violation – 1.5×10^{-3} to 10^{-9} Rate or single.

EDITING

Transport and Path Overhead Byte Modification – All of the overhead bytes except B1-B3 and H1-H3.
Pointer Control – Single positive and negative pointer justifications and NDF pointer changes to any valid value for both SPE and VT.

GENERAL

Frame Detection –
STS-1: Detection based on A1, A2.
STS-3/12: Detection based on A1, A2, A2.
Indicator Lamps – LEDs provide current and history status for Section, Line, Path, SPE, VT, DS1 and DS3 status.
NOTE: CLASS 1 LASER PRODUCT. This product conforms to the applicable requirements of 21 CFR 1040 at the date of manufacture.

MEASUREMENTS

SONET Alarms –
Section: B1 Code Errors OOF (Out-of-frame), LOF, Frame pattern errors, LOS.
Line: B2 Code Errors, LOP, FEBE, AIS.
Path: B3 Code Errors, AIS, Yellow, FEBE, RDI.
VT: BIP-2, AIS, RDI, FEBE.
Payload Parameters –
VTI.5 Payload to DS1 payload: Parity and frame errors, bit errors, AIS, Idle and All Ones, X-Bit.
VT1.5 payload: Bit Errors (PRBS or fixed word), AIS, Yellow, CRC-6, Frame errors, LOF.
STS-3c payload: Bit Errors.
T-carrier Parameters –
DS3: BPV, Parity, Bit and Status parameters.
DS1: BPV, CRC, Bit and Status parameters.

PERFORMANCE STATISTICS

Parameters –
Section (B1): Total, Rate, ES, SES Total.
Line (B2): Total, Rate, ES, SES Total.
STS Path (B3): Total Rate, ES, SES.
VT Path (BIP-2): Total, Rate, ES, SES Total.
Payload/DS3 (Bit and Parity): Rate, Total, ES, SES.
Payload/DS1 (Bit Error): Rate, Total, ES.
Payload/3c (Bit Error): Rate, Total, ES.

DATA COMMUNICATIONS CHANNEL

Section – D1-D3, 192 KB/s.
Line – D4-D12, 576 KB/s.

ORDERWIRE

Local and Express handset interface.
Ports – RS-232C, GPIB, parallel printer.
Drivers – VT100 terminal.

POWER

AC Line – 115/220 V AC ±10%.
Power Consumption – -250 W maximum.
Safety – UL1244, CSA231.

Physical Characteristics

Dimensions	mm	in.
Height	152	6
Width	366	14.4
Depth	419	16.5
Weight	**kg**	**lbs.**
Net	10	22

Ordering Information

For price information: Outside the U.S. contact your local Tektronix representative, inside the U.S. see the price list in the back of this catalog.

ST112
SONET Test Set DS1/3, STS-1.
Includes: Power Cord, Manual.
Opt. 03 – OC-1/3/3c 1310 nm FC Connector.
Opt. 04 – OC-1/3/3c/12 1310 nm FC Connector
Opt. 06 – LabVIEW*[1] Drivers Remote Test.
Opt. 07 – Event Sync Output.
Opt. 08 – Payload Mappings; OC-12c/STS-12-c.
Opt. 1C – Replace BNC Connectors with WECO 560.
Opt. 2C – Replace 310 Connectors with Bantam.
Opt. 3C – Replace FC Connectors with SC.
Opt. 4C – Replace FC Connectors with ST.
Opt. 1M – Rackmount.

MEASUREMENT SERVICE OPTIONS

Opt. C3 – Three years of Calibration Services.
Opt. R3 – Repair warranty extended to cover three years.

RECOMMENDED ACCESSORIES

Soft Carrying Case for ST112 – Order 016-1442-00.
Hard Carrying Case for ST112 – Order 016-1443-00.
10 ft. 25-Pin Male-to-male RS-232 Cable – Order 012-1384-00.
10 ft. 25-Pin Male to 9-Pin Female RS-232 Cable – Order 012-1298-00.

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

NOT AVAILABLE IN EUROPE.

ISO 9001
Tektronix measurement products are manufactured in ISO registered facilities.

DWDM Test Set

New ST2400A



Features – Benefits

- Available in Transceiver, Receiver and Transmitter Only Versions
- Tributary Testing of STM-64/OC-192 Systems
- Easily Switchable to/from SDH/SONET
- Optical Tributary Payload Add/Drop with Payload Independence
- External Sync Reference for Timing Coordination
- Compact and Light Weight for Production and Installation Test
- Conforms to Latest ITU-T, ANSI, ETSI and Bellcore Standards
- ±1 nm Wavelength Tuning (1550 nm Laser Only)

Applications

- Optimized for Dense Wavelength Division Multiplexing (DWDM) Transmission Quality Testing
- Active Through Mode to Simulate Fault Conditions on Installed Networks
- Emulates Network Elements Transmitting Live Traffic

The ST2400A meets the needs of development, manufacturing, installation and service engineers by providing the capabilities for:

- System interrogation and conformance testing
- Manufacturing Production Testing
- Network Integrity testing
- Network Performance monitoring
- Network Troubleshooting

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

CE

ISO 9001

Tektronix measurement products are manufactured in ISO registered facilities.

GPIB IEEE-488

Product(s) complies with IEEE Standard 488.1-1987 and 488.2-1987, RS-232-C, and with Tektronix Standard Codes and Formats.

The ST2400A is optimized for testing 2.488 Gbit/s Dense Wavelength Division Multiplexed (DWDM) client systems. Its compact size, flexibility of configuration, choice of operating modes, unique I/O features, extensive software driver support, and range of error and defect inject capabilities make it particularly effective for DWDM system test during production and installation.

The ST2400A is payload-independent; external SDH/SONET 155 Mbit/s optical and electrical and 622 Mbit/s optical signals are supported in add/drop mode. The ST2400A can be ordered as an ST2400A Transceiver, as an ST2400R Receiver, or as an ST2400T Transmitter to meet a wide range of application needs economically.

Three Operating Modes

The ST2400A Transceiver features three operating modes to provide the flexibility you need to test today's advanced systems. Analysis is done at the SDH/SONET Regenerator Section (Section), Multiplexer Section (Line) and Path levels independent of the payload.

STANDALONE (INTERNAL) MODE

Where payload testing is not required, or an external 155 or 622 Mbit/s tributary signal is not available, the ST2400A can operate independently. An internally-generated 2.488 Gbit/s test signal provides full error performance analysis and reporting of the 2.488 Gbit/s signal. 1.5 Mbit/s, 2 Mbit/s, and 2 MHz external reference clock signals or an internal clock signal can be used to time the transmitted signal in internal mode. Internal mode is ideal for DWDM SDH/SONET client system testing, where transmission quality test time and cost can be lowered through the use of a high-speed signal.

ACTIVE THROUGH MODE

Through Mode allows overhead bytes to be passed or edited while regenerating the received 2.488 Gbit/s signal. Alarms and errors can also

be added to the received signal prior to retransmission. This mode is especially valuable for testing framing synchronization and protection switching, and for diagnosing system interoperability problems. 155 or 622 Mbit/s signals can be dropped from the receiver for path level analysis on another tester.

ADD/DROP (EXTERNAL) MODE

In this mode, the ST2400A transmitter creates the 2.488 Gbit/s signal from an externally added 155 or 622 Mbit/s SDH or SONET signal. The external signal can be copied into one or all available payload envelopes in the 2.488 Gbit/s signal. The ST2400A receiver performs 2.488 Gbit/s level testing and, as required, drops a tributary signal for path level analysis by a Tektronix CTS 850, CTS 710, ST112, or any other 155 or 622 Mbit/s SDH or SONET test set. Previous investment in lower speed test equipment is preserved.

Emulation of Real SDH/SONET Systems

The ST2400A provides two features that let the tester emulate real network conditions. First, a 2^{23}-1 or 2^{31}-1 PRBS pattern can be generated to produce a synchronous signal that behaves like live traffic. Second, the optical receiver's decision threshold can be offset to emulate older SDH/SONET network elements that are deployed in the field and which can create interoperability issues when connected to optically amplified systems such as DWDM. By controlling what the ST2400A considers a "one" or a "zero," true system transmission quality can be determined; installed behavior predicted; and, optimized in the factory.

DWDM Parallel Channel Test

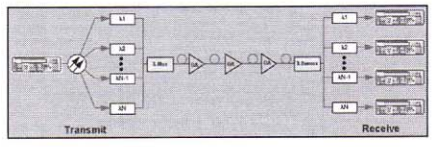
Because DWDM systems carrying SDH/SONET clients are expected to operate at a transmission quality level of 10^{-12} BER or better per ITU-T G.692 and Bellcore GR-2918, per channel transmission quality test cycles can easily exceed twelve hours. By testing all channels in parallel, system test time can remain constant as channel counts increase from eight to sixteen to thirty two and beyond. The ST2400R Receiver provides the means for highly cost-effective simultaneous multi-channel analysis. A Receiver can measure the transmission performance of each channel of the multi-wavelength system, while a ST2400T Transmitter is used to generate the 2.488 Gbit/s signal, which can be split to multiple inputs of the DWDM system. The Parallel Channel Test is illustrated in the figure below.

Help in Lowering per Channel Test Time

In addition to using the ST2400A for effective parallel channel test, the product can also help lower per-channel test time.

ACCELERATING LOW BER MEASUREMENT THROUGH EXTRAPOLATION

Measuring the low error rates that DWDM systems promise can take a minimum of 11 hours at 2.488 Gbit/s. The ST2400A provides a way in some applications to save test time by extrapolating to low BERs through offset of the optical receiver's decision threshold.



IMPROVED TEST CONVENIENCE

If the system has been characterized in design, then many of these tests need not be repeated further down the value chain. The power of the ST2400A is focused on system transmission quality verification during production and installation. For production test, a full remote command set plus LabView and LabWindows CVI, HP-VEE drivers help manufacturing engineers create automated test suites quickly and efficiently. A "pause" feature enables tests to be suspended while rearrangements are made, which allow long-term testing to proceed. Tests can also be automatically resumed after lost power is restored, again saving retest time. Finally, by using the ST2400A in constant wavelength (unmodulated) mode, optical tests such as OSNR and spectral width can be done without the need for an additional laser source.

STM-64/OC-192 TRIBUTARY TESTING

Testing 10 Gbit/s systems at the line rate requires very expensive test equipment. These systems can be tested more economically at the 2.488 Gbit/s tributary rate using the ST2400A.

CAPABILITIES

- STM-16 SDH RS, MS Testing/OC-48 SONET Section Line and Path Testing
  - B1, B2, B3 Error Generation
  - B1, B2, B3 Error Measurement
  - Path REI, Path Alarms, Pattern Bit Error
  - J0, J1 Capture and J0 Edit
  - RS and MS Alarm Generation
  - RS and MS Alarm Detection
  - RS and MS Layer Alarm and Error Generation
- VC4 PRBS Mappings/STS1, STS3c PRBS Mappings
- Ability to receive, generate and modify an STM-4c/STM-16c (OC-12c/OC-48c) Payload (Opt. 41)
- External Clock Input (2 Mbps/2 MHz) or 1.5 Mbps
- User-selectable power failure recovery mode
- Electrical Offset of Receiver Decision Threshold
- Automatic Optical Receiver shut-off if power exceeds maximum rating
- Tributary Access at 155 Mb/s or 622 Mb/s
- Easily software switched between SDH and SONET
- Through Mode with Overhead Editing, Error, and Alarm Injection
- Complete Remote Control
  - RS-232 and GPIB ports, and standard printer interfaces
  - LabView, LabWindows CVI, and HP Vee
- Standard tributary interfaces
  - STM-1e 155 electrical/STS-3 155 electrical
  - STM-1 155 optical/OC-3 155 optical
  - STM-4 622 optical/OC-12 622 optical

- Interface to Regenerator Section Terminating Element and Multiplexer Section Terminating Element and other test equipment

With (Opt. 42), the ST2400A has the following new features:

- Payload bit error injection/B3 Injection on the TX side (TSE)▶ B3, Path-REI, Payload bit error count measurement on the RX side (TSE ES, SES (SDH only))
- Alarm signal status (RX) – Path RDI, Loss of Pointer, Path AIS, Path REI
- Path Overhead Monitor (RX) – Displays value of bytes: J1, B3, C2, G1, F2, H4, Z3/F3, Z4, N1
- For the path overhead, C2 byte added at TX (Path Signal Label C2)
  - Identifies High Order Path Label Unequipped and High Order Path Label Mismatch. C2 byte can be set to any value from 0x00 to 0xFF
- B3 Path Analysis/J1 Path Trace (displayed as ASCII text)
- TX Patterns. PRBS 2^{31}-1 and 2^{31}-1 Inverted; Fixed (00 to FF)
- Pointers. Pointer Value displayed (0 to 782). Pointer Measurement Counts for Positive Pointer Justifications, Negative Pointer Justifications, New Data Flag (NDF)

Characteristics

POWER

Source Power – Voltage Requirements (auto-ranging): 110 (90 to 135) VAC or 220 (180 to 270) VAC.
Line Frequency – 47 to 63 Hz.
Power Consumption – 250 Watts maximum.

Physical Characteristics

Dimensions	cm	in.
Height	11.6	4.5
Width	37.2	14.5
Depth	44.9	17.5
Weight	**kg**	**lb.**
Net	11.4	25

Ordering Information

For price information: Outside the U.S. contact your local Tektronix representative, inside the U.S. see the price list in the back of this catalog.

ST2400A STM-16/OC-48 SDH/SONET TRANSCEIVER

Opt. 13 – Add wideband receive optics and 1310 nm intermediate-reach 2.488 Gbit/s laser.
Opt. 15 – Add wideband receive optics and 1550 nm long-reach 2.488 Gbit/s laser.
Opt. 17 – Add wideband receive optics and switchable 1310 nm intermediate-reach and 1550 nm long-reach 2.488 Gbit/s lasers.
Opt. 35 – Add wideband receive optics and 1550 nm G.692 specific frequency long-reach 2.488 Gbit/s laser.
Opt. 41 – Add STM-16C/OC-48C payloads.
Opt. 42 – Add B3 path analysis.

ST2400R STM-16/OC-48 SDH/SONET RECEIVER

Includes: 2.488 Gbit/s Receiver with electrical clock and data, tributary drop, power cord, user manual.
Opt. 11 – Add wideband receive optics.
Opt. 42 – Add B3 path analysis.

ST2400T STM-16/OC-48 SDH/SONET TRANSMITTER

Includes: 2.488 Gbit/s Transmitter with electrical clock and data, tributary add, power cord, user manual.
Opt. 13 – Add 1310 nm intermediate-reach 2.488 Gbit/s laser.
Opt. 15 – Add 1550 nm long-reach 2.488 Gbit/s laser.
Opt. 17 – Add switchable 1310 nm intermediate-reach and 1550 nm long-reach 2.488 Gbit/s lasers.
Opt. 35 – Add 1550 nm G.692 specific frequency long-reach 2.488 Gbit/s laser.
Opt. 41 – Add STM-16C/OC-48C payloads.
Opt. 42 – Add B3 path analysis.

ST2400A, ST2400R, AND ST2400T COMMON OPTIONS

Opt. 01 – FC/PC optical connectors (Opt. 01, 02, or 03 must be chosen).
Opt. 02 – SC/PC optical connectors (Opt. 01, 02, or 03 must be chosen).
Opt. 03 – ST/PC optical connectors (Opt. 01, 02, or 03 must be chosen).
Opt. 05 – Rack mount.
Opt. 06 – FC/PC 15 dB attenuator for 2.488 Gbit/s receiver.
Opt. 07 – SC/PC 15 dB attentuator.
Opt. 08 – ST/PC 15 dB attentuator.
Opt. C3 – Three year calibration service.
Opt. C5 – Five year calibration service.
Opt. D3 – Three year calibration data report.
Opt. D5 – Five year calibration data report.
Opt. R5 – Extended warranty to five years.

RECOMMENDED ACCESSORIES

1 m BNC-to-BNC 75 Ω Coaxial Cable – Order 012-1338-00.
Adaptor Plug, BNC-1.6/5.6 – Order 013-0300-00.
2 m FC-PC to FC-PC Optical Patchcord – Order 174-1387-00.
9 ft. 25-pin DB25 Male to 9-pin DB9 Female RS-232 Cable – Order 012-1298-00.
AMP 06-0033 FC Style Build Out Attenuator, 15 dB Fixed Value – Order 119-5610-00.
Rackmount Kit – Order 016-1407-00.
Hardside Transit Case – Order 016-1494-00.

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

CE

ISO 9001

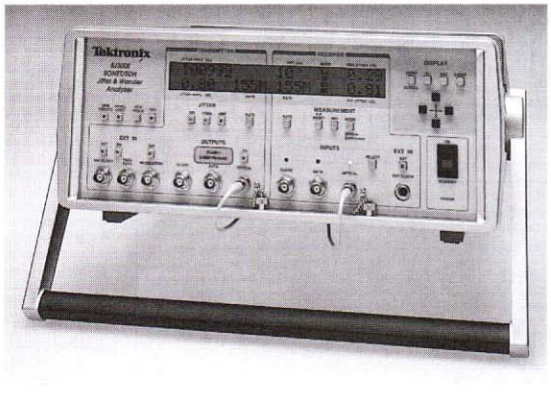
Tektronix measurement products are manufactured in ISO registered facilities.

GPIB IEEE-488

Product(s) complies with IEEE Standard 488.1-1987 and 488.2-1987, RS-232-C, and with Tektronix Standard Codes and Formats.

SDH/SONET Analyzers

SJ300E



Features – Benefits

- Generates and Measures Jitter up to 622 Mb/s
- Measures Jitter Generation, Transfer and Tolerance
- Generates and Measures Wander on 1.544 Mb/s and 2.048 MHz Synchronization Signals
- Conformance to ANSI, Bellcore and ITU-T Timing Standards
- Real Time Wander Analysis and Display

Applications

- Measure Jitter and Wander Generated and Tolerated by SDH/SONET Equipment and Clock-recovery ICs
- Measure Jitter and Wander Transfer of SDH/SONET Equipment
- Measure or Monitor Jitter and Wander at Line or Synchronization Interfaces
- Generate and Analyze Line and Synchronization Phase Transients

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-462-2200.

CE

ISO 9001

Tektronix measurement products are manufactured in ISO registered facilities.

GPIB IEEE-488

Product(s) complies with IEEE Standard 488.2-1987, RS-232-C, and with Tektronix Standard Codes and Formats.

SJ300E SDH/SONET JITTER AND WANDER ANALYZER

Jitter and wander are causing increased concern in the industry. The SJ300E provides the assurance that your systems are operating properly. It enables manufacturers and service providers to verify proper operation and standards compliance of their products and networks. With its comprehensive measurements and associated analysis tools, the SJ300E is a complete solution.

Jitter and wander can cause severe problems in SDH and SONET systems. In addition, it generates and analyzes line and synchronization signal wander in SDH/SONET systems.

NETWORK TEST CAPABILITIES

The SJ300E can also perform network wander tests. This includes sync transient generation, a choice of monitor or terminate levels for measuring sync signals and a wide choice of sync signal framing patterns. The wander analysis option (Opt. 06) includes software for fast analysis and graphical display of Time Deviation/Maximum Time Interval Error (TDEV/MTIE). This PC-based software drastically reduces the time and effort required to do wander analysis.

Characteristics

STS-1/STS-3/STM-1e
OC-1/OC-3/STM-1/OC-12/STM-4

Generator – Internal 27 PRBS or external "through data."

Receiver – A PRBS signal of pattern length 27 or a SDH/SONET formatted signal with the payload portion consisting of all zeros or all ones.

Generator – Jitter frequency: 1 Hz to 1/125 of baud rate.
Frequency accuracy: ±20 ppm.
Jitter amplitude: Up to 22 UI_{p-p} depending on jitter frequency. Resolution: 0.01 UI. Resolution accuracy: ±1%, ±0.01 UI.

Clock Out – Frequency: 51.84, 155.52 or 622.08 MHz ±20 ppm.
Level: ECL nominal levels.
Impedance: 50 Ω to –2 V terminated.
Connector: BNC (internal) with external CLOCK OUT.
Same frequency as external clock.

Data Out –
Baud rate: Equals frequency of CLOCK OUT, NRZ.
Impedance: 50 Ω to 2 V terminated.
Connector: BNC.

Optical Out –
Baud rate: Equals frequency of CLOCK OUT.
Standard Connector: FC/PC.
Mean output power (EOL): –9 dBm ±3 dBm.
Center wavelength: 1305 nm ±35 nm.
Spectral width (at –3 dB): 5 nm maximum.

Ref Clock Out –
Output: Same as CLOCK out without added jitter.
Amplitude: 0.4 to 1.2 V_{p-p} into 50 Ω.
Impedance: 50 Ω AC-coupled, to ground.
Connector: BNC.

TRANSMITTER INPUTS

Clock In – Frequency: 51.84, 155.52 or 622.08 MHz ±100 ppm.
Level: ECL nominal levels.
Impedance: 50 Ω or AC-coupled.
Connector: BNC.

Thru Data In – Level: ECL nominal levels.
Impedance: 50 Ω to –2 V terminated, NRZ.
Connector: BNC.

External Modulation In –
Impedance: 50 Ω terminated to ground.
Connector: BNC connector.
Sensitivity: 0.1 V/UI.
Accuracy: ±5%.
Amplitude limits: ±0.8 V maximum.
Rate-of-change limits:
52 MHz: ±0.135 V/µs.
155 MHz: ±0.405 V/µs.
622 MHz: ± 1.62 V/µs.

RECEIVER PEAK-TO-PEAK JITTER

Wide Mode –
Jitter amplitude: Up to 16 UI_{p-p} depending on the jitter frequency and receiver baud rate.
Resolution: 0.01 UI.
Amplitude accuracy:
52 MHz: ±1%, ±0.01 UI.
155 MHz: ±1%, ±0.02 UI.
622 MHz: ±1%, ±0.03 UI.

Fine Mode –
Frequency response: First-order high-pass filter with cutoff frequencies that depend on receiver baud rate as follows:
52 Mb/s: 14 Hz + 3 Hz.
155 Mb/s: 30 Hz + 10 Hz.
622 Mb/s: 120 Hz + 35 Hz.
Jitter amplitude: Up to 0.6 UI_{p-p} depending on the jitter frequency and receiver baud rate.
Resolution: 0.001 UI.
Amplitude Accuracy:
52 MHz: ±3%, ±0.002 UI.
155 MHz: ±3%, ±0.003 UI.
622 MHz: ±5%, ±0.009 UI.

Range – +3 to –50 dB.

Resolution – 0.01 dB.
Note: The maximum jitter amplitude received cannot exceed the maximum receiver input range.

Wide Mode –
Frequency response: First-order high-pass filter at the greater of 12 kHz and the selected high-pass filter. Third-order, maximally flat, low-pass filter at 1/125 of the receiver baud rate.
Jitter range: Measures RMS value of jitter that meets the wide mode peak-to-peak jitter tolerance.
Resolution: 0.01 UI.
Amplitude accuracy:
52 MHz: ±3%, ±0.01 UI_{rms}.
155 MHz: ±3%, ±0.01 UI_{rms}.
622 MHz: ±3%, ±0.02 UI_{rms}.

Fine Mode –
Jitter range: Measures RMS value of jitter that meets the peak-to-peak requirements.
Resolution: 0.001 UI_{rms}.
Amplitude accuracy:
52 MHz: ±3%, ±0.001 UI_{rms}.
155 MHz: ±3%, ±0.002 UI_{rms}.
622 MHz: ±5%, ±0.003 UI_{rms}.
Window range: 1 to 99 seconds or infinity.
Resolution: 1 second.
Selectable high-pass filters:
52 Mb/s: 10 Hz, 100 Hz or 20 kHz.
155 Mb/s: 10 Hz, 500 Hz or 65 kHz.
622 Mb/s: 10 Hz, 1000 Hz or 250 kHz.
Threshold range: 0.000 to 16 UI_{p-p}.
Resolution: 0.001 UI_{p-p}.

Clock In –
Rate: 51.84, 155.52 or 622.08 Mb/s ±20 ppm.
Level: ECL nominal levels.
Impedance: 50 Ω terminated to –2 V or AC-coupled.
Connector: BNC.

Data In –
Rate: 51.84, 155.52 or 622.08 Mb/s ±20 ppm.
Level: ECL nominal levels.
Impedance: 50 Ω terminated to –2 V, NRZ.
Connector: BNC.

Optical In –
Rate: 51.84, 155.52 or 622.08 Mb/s ±20 ppm.
Connector: FC/PC.
Power: –22 to –5 dBm.
Wavelength: 1200 to 1600 nm.

Laser Safety – Class 1 laser product.

Ref Clock In –
DS1: 1.544 Mb/s AMI, framed all 1s.
Framing: ESF/SF.
E1: 2.048 Mb/s HDB3, framed all 1s.
2 MHz: 2.048 MHz square wave.
Connector: WECO 310 (100 Ω balanced), BNC (75 Ω unbalanced).

RECEIVER OUTPUTS

Ref Clock Out –
Level: 0.4 to 1.2 V_{p-p}, AC-coupled.
Impedance: 50 Ω to ground.
Connector: BNC.

AC Line – 115 V/230 VAC ±10%
Safety – UL1244, CSA231, EN61010-1.
Power Consumption – 100 W maximum.

PHYSICAL CHARACTERISTICS

Dimensions	mm	in.
Height	152	6
Width	366	14.4
Depth	419	16.5
Weight	**kg**	**lb.**
Net	10	22

Ordering Information

For price information: Outside the U.S. contact your local Tektronix representative, inside the U.S. see the price list in the back of this catalog.

SJ300E
SONET/SDH Jitter/Wander Analyzer.
Opt. 04 – OC-1/3/12, STM-1/4 Optical
Opt. 06 – DS1, E1, 51-622 MB Wander Test.
Opt. 09 – SC100A Line Code Converter.
Opt. 1M – Rackmount.
Opt. 3C – Replace FC Connectors with SC.
Opt. 4C – Replace FC Connectors with ST.
Opt. 4S – FFT SW Application Diskette.
Opt. 7C – Replace DS1 Connectors with E1 BNC.

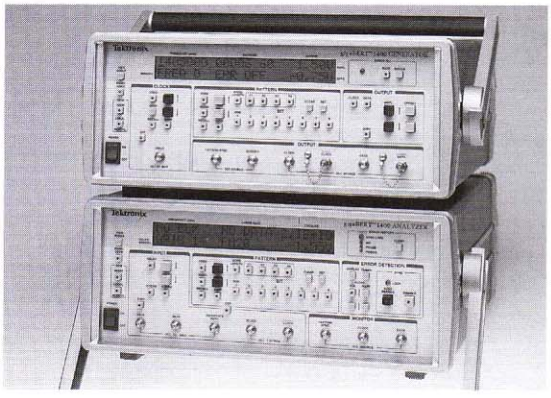
MEASUREMENT SERVICE OPTIONS
Opt. C3 – Three years of Calibration Services.
Opt. R3 – Repair warranty extended to cover three years.
See page 615 for further information.

INTERNATIONAL POWER PLUGS
Opt. A1 – Opt. A5.
See page 619 for description.

RECOMMENDED ACCESSORIES
Soft Carrying Case for SJ300E –
Order 016-1442-00.
Hard Carrying Case for SJ300E –
Order 016-1443-00.
Rackmount – Order 016-1462-00.
10 ft. 25-Pin Male-to-male RS-232 Cable –
Order 012-1384-00.

Bit Error Rate Tester

GigaBERT® GB1400 • GigaBERT GB700



Features – Benefits

- Internal PLL Synthesized Clock Source
- PRBS 2^n-1 n: 7, 15, 17, 20, 23
- Programmable Pattern Memory (128 Kbit GB700, 1 Mbit Optional GB1400)
- Auto-synchronization
- Clock/Data Delay 4 ns, 5 ps (GB1400), 20 ps (GB700) Resolution
- Automatic Eye-width Measurements (GB1400)
- Reference Data Input for Proprietary Framed Data
- Phase Synchronous Clock and Data Edge Tracking
- TTL, ECL and PECL I/O Compatible

Applications

GB1400

- Gigabit LAN Testing
- Satellite System Testing
- High-speed Circuits and System Design
- Full Rate HDDV Simulation/Testing
- Manufacturing Test in TE Environment
- GaAs, ECL and Optical Component Testing
- Test Clock Recovery Circuit

GB700

- LAN/SONET/SDH Component Development
- Satellite System Testing
- Digital Transmission System Testing
- Fibre Channel Testing
- Uncompressed Digital Video
- High-speed ATM Margin Testing

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

GPIB IEEE-488

GB1400 complies with IEEE Standard 488.2-1987.

ISO 9001

Tektronix measurement products are manufactured in ISO registered facilities.

CE (GB700 only)

GigaBERT GB1400 and GB700

The GB1400 operates at bit rates up to 1400 Mb/s. The GB700 operates at bit rates up to 700 Mb/s. These instruments are cost-effective for lower-speed applications today and will accommodate your future high-speed requirements as well.

SYMMETRICAL, LOW-JITTER OUTPUT WAVEFORMS

The GB1400 generates low-jitter, symmetrical waveforms over its entire operating frequency range. The clock and data ports provide both true and inverted output signals. The instrument can drive single-ended or differential ECL inputs. The GB700 also drives PECL inputs and also provides levels suitable for TTL inputs.

PRBS OR USER-DEFINED TEST PATTERNS

The GB1400 can generate pseudo-random bit sequences (PRBS) up to 2^{23}-1 bits and others optional in length, user-programmable patterns. Patterns can be created locally using setup menus or externally by using a workstation or PC. Externally created patterns can be downloaded via the GPIB or RS-232 port.

The GB700 can generate pseudo-random bit sequences (PRBS) up to 2^{23}-1 bits in length or user-programmable patterns containing up to 128 Kbits so the user can effectively simulate live traffic or "worst case" patterns. Patterns can be created locally using setup menus or externally by using a workstation or PC.

AUTO SEARCH FOR EASY SETUP

Auto search greatly simplifies the Error Detector setup. The GB1400 Error Detector automatically synchronizes to the incoming signal by 1) Setting the input data decision voltage to its optimum value; 2) Adjusting input data delay for an optimum clock/data phase relationship; 3) Selecting

the correct PRBS test pattern; and 4) selecting the correct pattern polarity (normal or inverted).

It synchronizes with any pattern sourced by a gigaBERT Pattern Generator. It can perform a bit-by-bit comparison of an arbitrary signal with an external Reference input. Thus the GB1400 can perform bit error analysis on any data pattern with a known good reference pattern.

POWERFUL ANALYSIS AND REPORTING FUNCTIONS

Not only will the GB1400 and GB700 Error Detectors synchronize with any pattern sourced by a gigaBERT Pattern Generator, they can perform a bit-by-bit comparison and bit error analysis on an arbitrary signal if provided with a known good external Reference data stream.

Moreover, the GB1400 calculates errored seconds (ES), percentage error-free seconds (%EFS), severely-errored seconds (SES), degraded minutes (DM), unavailable seconds (US) and loss of signal (LOS) seconds. All bit error results – including the three BER measures – are calculated simultaneously and may be displayed during a test or after a test has been completed. Reports may be printed when an error is detected, at the end of test intervals or both.

The GB700 performs a full-rate, bit-by-bit analysis of the received signal. Bit error results are then used to calculate three bit error rate (BER) measures. Total BER is calculated from the last power-on or reset. Window BER is calculated over a sliding window specified in terms of time (1 second to 24 hours) or bits (1^8– to 1^{16}-Bit).

BURST MODE (GB1400 ONLY)

BURST mode allows for operation with non-continuous external clocks. Use of BURST mode requires ECL-level signals with a minimum rate during the burst of 150 kHz.

CHARACTERISTICS

PATTERN GENERATOR (GB1400)

Frequency Range –
Internal Clock Source: 1 Mb/s to 1400 Mb/s.
External Clock with BURST Mode: 150 Kb/s to 1400 Mb/s.

Freq. Resolution (Internal Clock) – 10 kHz.

Clock Output Amplitude –
500 mV to 2.0 Vp-p in 50 mV steps.
500 mV to 2.8 V with PECL opt.

Clock Output Offset –
2.0 V to 1.0 V in 50 mV steps.
2.0 V to 1.8 V with PECL opt.

Data Output Amplitude –
500 mV to 2.0 V in 50 mV steps.
500 mV to 2.8 V with PECL opt.

Data Output Offset –
2.0 V to 1.0 V in 50 mV steps.
2.0 V to 1.8 V with PECL opt.

Data Delay Range – ±4 ns.

Data Delay Increments – 5 ps.

Clock Delay – ±4 ns.

Clock Delay Increments – 5 ps.

Std. Programmable Memory – 16-Bit.

PRBS Patterns (2^n –1) – 7,15,17,20,23.

ERROR DETECTOR (GB1400)

Frequency Range –
1 Mb/s to 1400 Mb/s.
150 Kb/s to 1400 Mb/s (with BURST Mode).

Clock Input Levels (Max.) – 500 mV to 1.5 Vp-p.

Clock Input Terminations – GND, AC, –2 Vp-p.

Clock Input Threshold – Fixed threshold levels.

Data Input Level (Max.) – 500 mV to 1.5 Vp-p (does not support PECL).

Data Input Threshold – 1.5 V to 1.0 V in 50 mV steps.

Data Input Terminations –
GND, AC, –2 V.
Single-ended or differential operation for clock and data inputs.

Safety – EN61010-1.

PHYSICAL CHARACTERISTICS

Dimensions	mm	in.	mm	in.
Height	152	6	152	6
Width	366	14.4	366	14.4
Depth	340	1304	419	16.5
Weight	**kg.**	**lbs.**	**kg**	**lbs.**
Net	10	22	10	22

ORDERING INFORMATION

For price information: Outside the U.S. contact your local Tektronix representative, inside the U.S. see the price list in the back of this catalog.

GIGABERT GB1400

1400 Mb/s BERT Generator and Detector. Not available in Europe.

OPTIONS (GB1400)

Opt. 02 – 75 Ω Both Sets.
Opt. 05 – BURST Mode Both Sets.
Opt. 07 – Positive ECL Pattern Generator Only.
Opt. 08 – 1 MB RAM WORD Both Sets & PC Pattern Editor Software.
Opt. 2M – Rack Mounts – 2.

GB1400T ONLY

1400 Mb/s BERT Pattern Generator.
Opt. 02 – 75 Ω Pattern Generator Only.
Opt. 05 – BURST Mode Pattern Generator Only.
Opt. 07 – Positive ECL Pattern Generator Only
Opt. 08 – 1 MB RAM WORD, Generator Only with PC Pattern Editor Software.
Opt. 1M – Rack Mount.

GB1400R ONLY

1400 Mb/s BERT Error Detector.
Opt. 02 – 75 Ω Error Detector Only.
Opt. 05 – BURST Mode Error Detector Only.
Opt. 08 – 1 MB RAM WORD, Detector Only with PC Pattern Editor Software.
Opt. 1M – Rack Mount.

GIGABERT GB700

700 Mb/s BERT Generator and Detector.

GB700T ONLY

700 Mb/s BERT Pattern Generator.

GB700R ONLY

700 Mb/s BERT Error Detector.
Opt. 02 – 75 Ω Term Error Detector Only.
Opt. 1M – Rack Mount.

INTERNATIONAL POWER PLUGS

Opt. A1 – Opt. A5.
See page 619 for description.

RECOMMENDED ACCESSORIES

Soft Carrying Case – Order 016-1442-00.
Hard Carrying Case – Order 016-1443-00.
Rack Mount – Order 016-1462-00.
10 ft. 25-Pin Male-to-male RS-232 Cable – Order 012-1384-00.

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

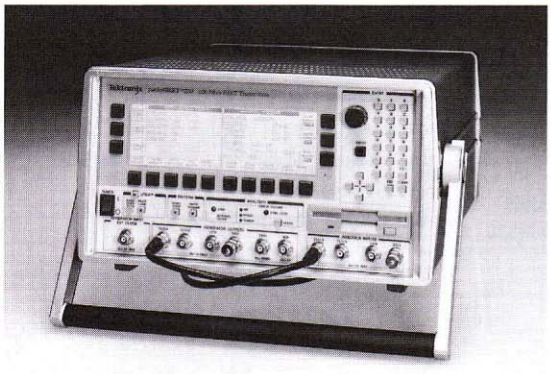
GPIB IEEE-488
GB1400 complies with IEEE Standard 488.2-198.

ISO 9001
Tektronix measurement products are manufactured in ISO registered facilities.

CE (GB700 only)

Bit Error Rate Test Set

PacketBERT™ PB200



Features – Benefits

- Packet or Cell BER Testing
- DC to 200 Mbits/s Data Rate, NRZ-1
- 256 Kbits Programmable WORD, PRBS, 1's Density and Selectable Mixed Mode
- Auto Search and Auto Sync Capability
- Controllable Gapped Tx Clock
- Automatic Eye-width Measurement and Extrapolation
- Clock/Data Delay up to 32 ns in 20 ps Increments
- Variable Data/Clock Amplitude and Offset Including ECL, PECL and High-Z TTL
- Mixed-mode Testing
- Pattern Editor Software for Custom Word Patterns (PC Windows-based)

Applications

- Wireless and Satellite Communications
- B-ISDN, Ethernet, TDMA and CDMA System Design
- Modem Development
- MPEG Frame Generation
- UTP, Fiber Optic Module Development
- Video-on-demand System Development

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

CE

ISO 9001

Tektronix measurement products are manufactured in ISO registered facilities.

GPIB IEEE-488

Product(s) complies with IEEE Standard 488.2-1987.

PacketBERT PB200 Packet Generator and Error Detector

The PB200 is particularly suited to packet-based systems. It's ideal for component or sub-system development testing of TDMA, B-ISDN, FITL, ATM, Satellite modems and similar communications protocols.

The ability to generate a "Mixed Mode" data pattern allows flexibility in constructing many forms of test signals. Two separate programmable word memories of 16 to 256 Kbits in length allow the construction of a packet or cell that can consist of user-definable preamble, overhead and data. The PB200 data generator has one word memory that is used to define the overhead and preamble and a second word memory to define the data. Each memory can consist of a user-defined pattern or PRBS. The PB200 can also function as a fully featured non-packetized BERT.

SIGNAL ANALYSIS

For complete flexibility in signal analysis, the PB200 allows BER analysis on all, or only part, of the received digital information. Analysis can be performed on only the overhead, only the data or both overhead and data at the user's selection.

UNIQUE PACKETBERT PB200 FEATURES

The PB200 provides several unique features and capabilities that are not found on other BERT products in this class. The receiver has a clock/data deskew range of 32 ns and the ability to measure propagation delay. Along with the Auto Search setup capability, the receiver can automatically measure "eye-width" at user-selectable BERs and extrapolate BER from data accumulated over much shorter elapsed times than normally required. The transmitter can also generate a gapped clock.

CHARACTERISTICS

GENERATOR

Clock –
External clock input:
Frequency: DC to 200 MHz.
Amplitude: 0.5 to 5.0 V p-p.
Connector: BNC.
Termination select: 50 Ω to –2 V, +3 V, AC or GND.
Input range: ECL, TTL, PECL compatible.
Threshold resolution: 10 mV step.
External clock reference input:
Frequency: 10 MHz, ±100 ppm maximum.
Amplitude: 0.5 to 2.0 V p-p, AC coupled.
Termination: 50 Ω.
Connector: BNC.
Internal synthesized clock source:
Frequency: 1 Hz to 200 MHz.
Resolution: 1 Hz.
Accuracy: 10 ppm.
BURST clock:
Programmable gap: 16 Kbits maximum, 8-Bit resolution.

Pattern Generator –
PRBS: $2^N - 1$, N = 31, 23, 15, 11, 10, 9, 7.
Programmable word: 256 Kbits maximum, 8-Bit resolution.
Mark density: PRBS 2^{10} 1 (1/8, 1/4, 1/2, 3/4, 7/8).
Mixed mode frame: 256 Kbits maximum, 8-Bit resolution.
Error injection:
Error: Single, Rate, External (TTL).
Field select: Overhead, payload or both.
Error rates: Error rate of 10^{-n}, n = 3, 4, 5, 6, 7.

Outputs –
Data and clock outputs:
Format: NRZ.
Configurations: Differential (True/Complement).
Source impedance: 50 Ω.
Connector: BNC.
Amplitude: 0.5 V to 2.0 V, 10 mV step.
Offset, 50 Ω to GND: –2.0 V to +1.8, 10 mV step (termination to 50 Ω will increase the range for PECL).
Data delay range: ±1.0 ns, 20 ps resolution.
Rise/fall time: 300 ps typical, 500 ps maximum (20 to 80%).
Pattern sync output:
Signal level: 250 mV_{p-p} into 50 Ω load.

Auxiliary –
Data inhibit input: ECL, 50 Ω to –2 V, BNC.
Clock disable input: ECL, 50 Ω to –2 V, BNC.

ANALYZER

Data and Clock –
Data and clock inputs:
Clock input: External or internal from generator.
Data polarity: True/invert selectable.
Input mode select: Single-ended or differential.
Termination select: 50 Ω to –2 V, +3 V, AC or GND.
Input range: ECL, TTL, PECL compatible.
Threshold resolution: 10 mV step.
Threshold resolution: 10 mV step.

Synchronization –
Auto search: Clock and data threshold, clock and data timing skew, data pattern and polarity.

Measurements –
Frequency: 1 Hz to 200 MHz.
Bit errors: Window, Totalize, Timed Test, Simultaneous 1's, 0's and All Errors.
BER test field: Overhead, payload or both.
Propagation delay: Up to 128 Kbits.
Eye-width: Up to 32 ns.

Reference Data Patterns –
Identical to Pattern Generator but independent.
Startup delay: 0 to 64 Kbits programmable.

Auxiliary Signals (BNC Connectors) –
Error count inhibit input: ECL, 50 Ω to –2 V.
Error detect output: RZ, TTL, 50 Ω source.
Analyzer clock disable: ECL, 50 Ω to –2 V.
Data delay output: ECL, 50 Ω source.

COMMON CHARACTERISTICS

Pattern –
Controls: Start/Stop, Pause/Resume or Single Step.
Save/Load:
Floppy disk: 3.5 in.
Internal storage: 2 Mbits.
Pattern Editor Software requires PC running Windows 3.1 or above.

Remote Interface –
GPIB: IEEE 488.2 compatible.
RS-232C: DB9 connector.
Parallel printer: DB25 connector.
Monitor: DB15, VGA Analog Output.

Environmental –
Operating temperature: 5 to 40°C.
Storage temperature: –10 to 60°C.
EMC – Meets European Community EMC Directive 89/336/EEC for electromagnetic compatibility.

Safety –
UL1244, CSA231, EN61010-1, IEC61010-1.

Power –
AC line: 100 to 120 V AC, 200 to 240 V AC.
Power consumption: 300 W maximum.

PHYSICAL CHARACTERISTICS

Dimensions	mm	in.
Height	203.2	8
Width	355.6	14
Depth	508	20
Weight	**kg**	**lbs.**
Net	13.6	30

ORDERING INFORMATION

For price information: Outside the U.S. contact your local Tektronix representative, inside the U.S. see the price list in the back of this catalog.

PACKETBERT PB200
Bit Error Rate Test Set.
Includes: Power Cord, Manual (Including Pattern Editor Software Diskette).
Opt. 1M – Rack Mount.

INTERNATIONAL POWER PLUGS
Opt. A1 – Universal Euro 220 V, 50 Hz.
Opt. A2 – United Kingdom 240 V, 50 Hz.
Opt. A3 – Australian 240 V, 50 Hz.
Opt. A4 – North American 240 V, 60 Hz.
Opt. A5 – Switzerland 220 V, 50 Hz.
See page 619 for description.

RECOMMENDED ACCESSORIES
Transit Case for Transmitter or Receiver – Order 016-1447-00.
10 ft. 25-Pin Male-to-male RS-232 Cable – Order 012-1384-00.
Rack Mount Kit – Order 016-1464-00.
Additional Manual – Contact your local Tektronix representative for information.

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

CE

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Access Network Products

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Tektronix offers a full line of optical and metallic test products for access networks. The primary focus of our new access network products is on enabling mass deployment of digital services. Our objective is to provide products to assist customers in improving quality and reducing costs for these rapidly growing and highly competitive services. Significant new additions are the TS200 access network analyzer and the DMA120 and DMA121 digital modulation analyzers.

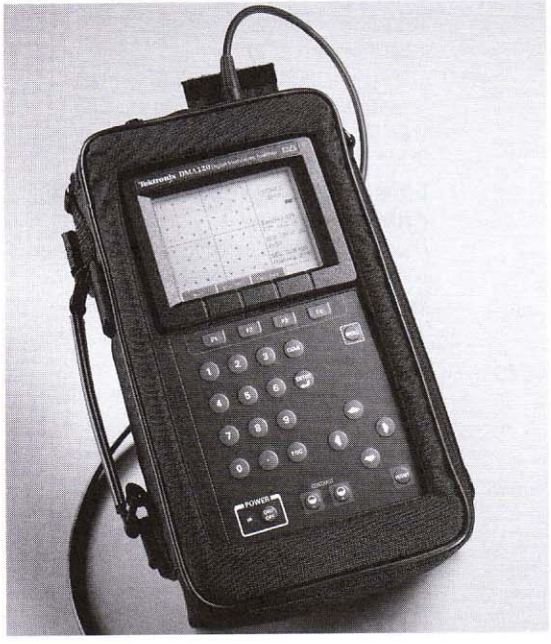
The TelScout TS200 is designed for use in clearing and testing outside plant for xDSL and ISDN services, and also offers plain old telephone system (POTS) and time domain reflectometer (TDR) measurement capabilities. The versatile, configurable and upgradeable product meets communications network operators' need to deliver analog and digital services supporting applications such as high-speed Internet access and video-on-demand.

Network operators activating digital transmission of video or downstream high-speed digital services on a RF broadband system need the DMA 120 and DMA 121. The line provides comprehensive in-service performance verification measurements for both 64- and 256-QAM transmissions.

A helpful xDSL poster explaining and mapping the various services and a comprehensive telephone access network measurements book are available on the web at Tek.com. To read or print these documents, go to the website and follow the instructions provided-or contact your local account manager for paper copies.

Digital Modulation Analyzers

New DMA120 • New DMA121



Features – Benefits

- 64 and 256QAM Analysis
- Measurements Compliant with DVB (ETSI) Standard ETR290
- Troubleshooting Aided by Constellation, Spectrum, and Equalization Display Modes
- Most Measurements Require Only Two Keystrokes
- Pass/fail Indication Reduces Training Requirements for Technicians New to Digital Signal Measurements
- PC Card (PCMCIA) Slot for Easy Memory Expansion
- Small and Light Weight
- Easy-change Battery

Applications

- In-service Digital Channel Performance Verification Measurements at an Affordable Price
- Digital Channel Diagnostic Testing and Troubleshooting

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: TVC Technology Group, Phone: 1-800-233-7600, FAX: 1-717-263-1547.

CE

Affordable, Portable, Ready for Cable System Technicians: Digital Channel 64 and 256QAM Transmission Performance Verification Measurements

The DMA120 Series Digital Modulation Analyzers provide answers to nagging questions about how to test and verify performance of your digital plant. Quantification of digital transmission performance – at any point in your system – will greatly enhance technical management and decision making. The DMA120 provides analysis of ITU-T-J.83, Annex B 64 and 256QAM and the DMA121 verifies 64 and 256QAM formatted per DVB-C.

The DMA120 Series field tools are housed in a rugged, weather resistant package and are powered by an easy-to-change NiMh battery. Standard accessories include a protective soft case, mains power supply, and user's manual.

QUALIFY SYSTEM PERFORMANCE

The built-in digital demodulator makes possible in-service measurements of:

- Modulation Error Ratio (MER)
- Error Vector Magnitude (EVM)
- Estimated Noise Margin
- BER before Reed-Solomon (R-S) decoder
- Estimated BER after R-S decoder

System availability statistics are also reported by the DMA120 Series, including:

- Errored seconds (number of seconds that include an errored block)
- Severely errored seconds (one-second periods with greater than specified number of errored blocks)
- Severely disturbed periods (duration of sync loss)
- System unavailability time (time period containing at least 10 consecutive severely errored seconds)

System availability statistics are very useful for tracking intermittent impairments that may not be observable based on MER or average BER measurements.

MAINTAIN AND TROUBLESHOOT YOUR DIGITAL PLANT

When performance quality measurements indicate transmission problems, the DMA120 Series can provide assistance to find out what's wrong. Additional measurements and display modes that can help the technician include:

- Channel Average Power (Signal Level)
- Adjacent Channel Levels
- Spectrum Display Mode
- Constellation Display Mode with zoom capability
- Adaptive Equalizer Display Mode

NEW MEASUREMENT TECHNOLOGY THAT'S EASY-TO-USE

Using the DMA120 Series is easy. Two keystrokes execute most measurement functions. There's a MENU key on the front panel that instantly gets the user to the instrument's Main Menu screen.

The system engineer or chief technician can determine measurement-result threshold values. This enables the technician to continue working if measurements are passing or follow an Engineering directive if failures are encountered.

OPERATING CONVENIENCE

The DMA120 Series includes many capabilities designed to simplify the job of digital plant installation and maintenance:

- Front panel print screen button
- PC Card (PCMCIA) input for 2 and 20 Megabyte memory cards to store additional measurement results and/or system channel tables
- User-changeable input adapter (type F or BNC – optional accessory)
- User-changeable, NiMH battery to extend the operating day

CHARACTERISTICS

RECEIVER

Frequency Range (channel center frequency) – DMA120: 54 to 860 MHz.
DMA121: 50 to 866 MHz.

Distortion-free Dynamic Range – >40 dB.

Sensitivity – <20 dBµV (–40 dBmV).

DISPLAY MODES

Spectrum – Span Settings: 2 to 824 MHz (fixed to 135 kHz RBW). Flatness: ±1 dB.

Constellation – Evaluation: Full constellation, quadrant, single point (box).

Adaptive Equalizer – Scale: +10 to –40 dBc. Mask: DVB.

MEASUREMENT MODES

Signal Level – Accuracy:
64QAM: ±1.5 dB, referenced to 25°C.
256QAM: ±1.8 dB, referenced to 25°C.

Channel Power-to-Noise –
Accuracy: ±2.1 dB.

Adjacent Channel Level –
Difference Amplitude Range:
DMA120: +10 to –25 dB.
DMA121: +15 to –25 dB.
Accuracy: ±2.1 dB referenced to 25°C.

Modulation Error Ratio (MER) –
Range:
64QAM: 22 to 35 dB.
256QAM, DMA120: 28 to 35 dB.
256QAM, DMA121: 30 to 35 dB.
Accuracy: ±1.5 dB at 65 dBµV/5 dBmV, referenced to 25°C.

Error Vector Magnitude (EVM) – Range:
64QAM: 1.2 to 4.1%.
256QAM: 1.1 to 1.9%.
Accuracy: ±0.4% over 1.2 to 2.0% range; ±0.8% over 2.1 to 4.1% range at 65 dBµV/5 dBmV.

Average Bit Error Rate (BER), Before R-S Decoding – Range:
64QAM: 10^{-4} to 10^{-9}.
256QAM, DMA120: 10^{-4} to 10^{-8}.
256QAM, DMA121: 10^{-4} to 10^{-6}.
User-selectable Time Period: 1 to 60 minutes.
Number of Periods Comparable: 24.

Estimated Average Bit Error Rate (BER), After R-S decoding –
User-selectable Time Period: 1 to 60 minutes.
Number Periods Comparable: 24.

Estimated Noise Margin – Range:
DMA120: 64QAM – 1 to 12 dB, 256QAM – 2 to 7 dB.
DMA121: 64QAM – 1 to 10 dB, 256QAM – 3 to 5 dB.
Accuracy: ±1.5 dB at 65 dBµV/5 dBmV.

Symbol Rate – Range:
DMA120: 5.057 to 5.360 Msymb/s.
DMA121: 5.000 to 6.956 Msymb/s.

ENVIRONMENTAL

Temperature – Operating: –5 to +40°C.

POWER

DC Input Range – 12 V, 2 A.
Battery Run Time – >2.5 hours, typical.
Battery Charge Time (instrument off) – 4 hours, typical.

ORDERING INFORMATION

For price information: Outside the U.S. contact your local Tektronix representative, inside the U.S. see the price list in the back of this catalog.

DMA120
Digital Modulation Analyzer for ITU-T-J83, Annex B 64QAM.

DMA121
Digital Modulation Analyzer for DVB-C 64QAM.

Includes: User's Manual, Reference Card, Padded Carrying Case, 120 VAC North American Power Pack with DMA120, 220 VAC Euro Universal Power Pack with DMA121, Precision Female-Female Type F Adapter,Vehicle Power Adapter, Channel Table Loader Software with Manual, RJ45 to 9-pin Adapter, RJ45 Cable.

OPTIONS
Opt. C3 – Three years calibration services.
Opt. R3 – Three years post-warranty repair protection.

AC ADAPTER OPTIONS
Opt. A0 – North American 115 V, 60 Hz (standard with DMA120).
Opt. A1 – Euro Universal 220 V, 50 Hz (standard with DMA121).
Opt. A2 – U.K. 240 VAC, 50 Hz.
Opt. A3 – Australian 240 V, 50 Hz.

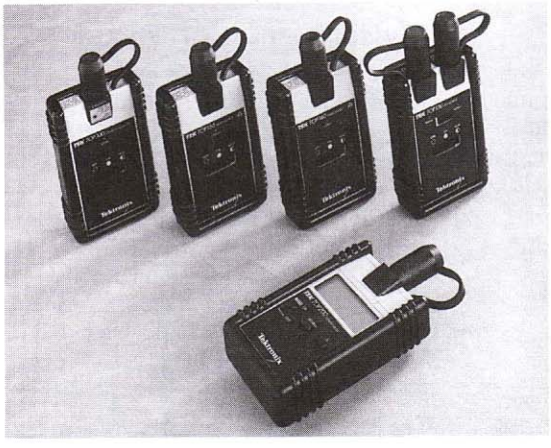
RECOMMENDED ACCESSORIES
Type F-to-BNC Input Adapter – 103-0310-00.
Additional Battery – DMABAT.
External Battery Charger for DMABAT – DMACHG (specify power cord Option as applicable).
Thermal Printer – DMAPRN.
Includes: Five Rolls Paper, Battery, AC Adapter. Select one of following AC Adapter options:
Option A0 – North American 115 V, 60 Hz.
Option A1 – Euro Universal 220 V, 50 Hz.

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: TVC Technology Group, Phone: 1-800-233-7600, FAX: 1-717-263-1547.

CE

Optical Sources/Power Meter/ Attenuator

TOP130 • TOP140 • TOP160 • TOP200 • TOP220 • TOP300 • TOP400



For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-462-2200.

CE

Products are manufactured in ISO 9001 registered facilities.

Features – Benefits

TOP130

Dual Wavelength (850 nm and 1300 nm)

Excellent Long-term Stability

TOP140/TOP160

Stabilized Calibrated Output

Hermetically Sealed Laser Diode for Longevity

Selectable Modulation Frequencies (270 Hz, 1 kHz, 2 kHz)

TOP200

Relative dB Mode for Direct Attenuation and Insertion Loss Measurements

0.01 dB Resolution

TOP220

Measures Outputs as High as +27 dBm

980 to 1550 nm

>100 Hours Battery Life

TOP300

High Brightness

Universal (UCI) Connector Interface

Fiber Tracing

TOP400

Ideal for Testing System Headroom

Passive Device – No Power Required

Adjustable Attenuation

Applications

System Loss Measurements

Optical Troubleshooting

Fault Location

Installation

Maintenance

Optical Links

Research

TOP130 OPTICAL LED SOURCE

- Selectable output – CW or modulate
- Three modulation frequencies – 270 Hz, 1 kHz, 2 kHz
- >20 hours battery life
- Universal (SOC) interface

The Tektronix TOP130 Optical LED Source is a small, rugged LED source designed for use in installing, maintaining and researching LAN, FDDI and other fiber optic links.

This multimode instrument provides two calibrated outputs – at 850 nm and 1300 nm. Providing both CW and modulated outputs, the user can set the modulation frequency to match the frequency signatures required by fiber identifiers and signal tracers (270 Hz, 1 kHz, 2 kHz). The TOP130 comes with a choice of adapters; two selected adapters will be provided. (Laser class 1)

TOP140/TOP160 OPTICAL LASER SOURCES

- Universal Connector Interface (UCI)
- >80 hours battery life (>50 hours TOP160)

The TOP140 and TOP160 Optical Laser Sources answer the need for small, rugged and truly versatile laser sources for use in installation, maintenance and testing of fiber optic systems. These laser sources cover the most used singlemode transmission windows – 1310 nm and 1550 nm. The TOP140 and TOP160 provide both CW and modulated output modes. In CW mode these instruments feature extremely stable output power. In the modulated mode the frequency may be set to 270 Hz, 1 kHz or 2 kHz.

All laser sources feature the Universal Connector Interface which adapts to all standard fiber optic connectors via a complete line of simple, screw-on/screw-off UCI adapters. (Laser class 1)

TOP200 OPTICAL POWER METER

- Set reference for different wavelengths
- Save references for each wavelength
- Universal (SOC) interface
- >100 hours battery life

The TOP200 handheld optical power meter covers the full range of optical fiber applications. This instrument is quality engineered for field and lab personnel requiring a high performance, cost effective, compact and rugged optical power meter.

The TOP200 uses the Snap-On Connector (SOC) interface. Most industry standard fiber optic connectors can be accommodated, including FC, ST and SC.

The extraordinary design combines a state-of-the-art signal processor and microcomputer electronics to provide superb performance as well as simple and elegant operation with just three controls: ON/OFF, dBm/dB and lambda. A reference value can be set and also saved for each wavelength.

TOP220 HIGH-POWER OPTICAL POWER METER

- Universal (SOC) interface
- Auto shutoff

The Tektronix TOP220 is a handheld, high-power optical power meter. It can measure optical signals as high as +27 dBm. It also can make measurements on the low end down to –30 dBm. This instrument is quality engineered for field and lab applications requiring a high performance, cost effective, compact and rugged optical power meter.

The TOP220 uses the Snap-On Connector (SOC) interface. Most industry standard fiber-optic connectors can be accommodated, including FC, ST and SC.

TOP300 VISUAL FAULT FINDER

- Fault location to millimeter accuracy
- Long battery life

The TOP300 Visual Fault Finder is specifically designed for field personnel who need an efficient and economical tool to visually check continuity and integrity of fiber installations, during and after installation. Unlike many other visual fault finders, the high-efficiency laser diode operates at short wavelengths which makes the emitted light particularly visible.

Difficult-to-locate fiber breaks are easily detected when using the TOP300 visual fault finder. Whenever the fiber is interrupted, the light escapes the fiber and becomes visible to the operator. Precise pinpointing of problems is immediate and intuitive to the user.

The optical connection is via the precision Universal Connector Interface (UCI) which offers superior repeatability, longevity and ease of maintenance. (Laser class 1)

TOP400 OPTICAL ATTENUATOR

- Universal Connector Interface (UCI)
- Less than 2 dB insertion loss

The Tektronix TOP400 is a handheld optical attenuator. Its superior design allows it to have less than 2 dB of insertion loss. The TOP400, when used with an optical power meter and source, allows the user to manually dial in attenuation to determine system headroom. It's a passive device and does not require any batteries or power for operation.

The TOP400 uses a proprietary scheme for the attenuating mechanism. The small size and large dial indicator make this instrument an indispensable tool for fiber optic line commissioning, bit error rate (BER) measurements, system margin analysis and receiver sensitivity testing. All optical connections are via the precision Universal Connector Interface (UCI) which offers low insertion loss, low return loss and excellent stability.

CHARACTERISTICS

TOP130

OPTICAL

Functions –
MOD: Modulated output mode.
CW: Continuous wave DC output mode.
FREQ: User selectable frequency – 270 Hz, 1 kHz or 2 kHz.
Center Wavelength – 850 nm: 830-880 nm, 1300 nm: 1270-1345 nm.
Spectral Width (FWHM) – 850 nm: <55 nm; 1300 nm: <140 nm.
Stability (1 Hour) – ±0.05 dB.

Power Output (Into 62.5/125 GI Fiber) –
850 nm: –13 dBm (50 µW).
1300 nm: –20 dBm (10 µW).
Connector Interface – Universal (SOC) Interface. Choice of standard adapters.

POWER
Source – Two AA batteries.
Battery Life – >20 hours.

ENVIRONMENTAL
Temperature –
Operating: –15°C to +55°C, 0 to 95% RH (non-condensing).
Storage: –35°C to +70°C, 0 to 95% RH (non-condensing).

PHYSICAL CHARACTERISTICS

Dimensions	mm	in.
Width	72	2.8
Height	142	5.6
Depth	36	1.4
Weight	**g**	**oz.**
Net	240	8.4

TOP140 AND TOP160

OPTICAL
Center Wavelength – TOP140: 1310 nm (1280-1340 nm).
TOP160: 1310/1550 nm (1280 to 1340 nm and 1520 to 1580 nm).
Spectral Width RMS – 5 nm.
Stability – 1 hour maximum deviation: ±0.05 dB.
24 hours maximum deviation: ±0.15 dB.
Power Output*1*3 (into SM –28/9 µm Core) – TOP140 and TOP160: –7 dBm (200 µW).
Power Output Uncertainty*2 – ±0.5 dB (calibrated launch level into SM-28/9 µm core fiber).
Connector Interface – Universal (SOC) Interface. Choice of standard adapters.

POWER
Source – Two AA alkaline batteries.
Battery Life – TOP 140: >80 hours.
TOP 160: >50 hours.

ENVIRONMENTAL
Temperature –
Operating: –15°C to +55°C, 0-95% RH (non-condensing).
Storage:-35°C to +70°C, 0-95% RH (noncondensing).

PHYSICAL CHARACTERISTICS

Dimensions	mm	in.
Width	72	2.8
Height	142	5.6
Depth	36	1.4
Weight	**g**	**oz.**
Net	230	8

*1 *Within specified ambient temperature of +20°C to +25°C.*

*2 *Specified with properly terminated FC-PC, ST, SC, DIN, HMS-10/HP (2.5 mm) connectors. Uncertainty for other connectors may be higher.*

*3 *In modulated mode, power is 3 dB lower.*

TOP200

OPTICAL
Sensor Type – InGaAs (1 mm).
Power Range – +3 to –60 dBm.
Cal Wavelengths – 850, 1300 and 1550 nm.
Absolute Accuracy – ±0.25 dB at calibration conditions.
Display – Custom triplexed liquid crystal display with 4-digit data field (0.01 dB resolution) and simultaneous display of cal wavelength. Display incorporates the following distinct annunciators: 850, 1310, 1550, dB, dBm, B (Low Bat) and C (CAL).
Calibration Data – Data stored in nonvolatile memory.
Connector Interface – Universal (SOC) Interface.

POWER
Source – Two AA alkaline batteries.
Battery Life – >100 hours.

ENVIRONMENTAL
Temperature –
Operating: –15°C to +55°C, 0-95% RH (non-condensing).
Storage: –35°C to +70°C, 0-95% RH (noncondensing).

PHYSICAL CHARACTERISTICS

Dimensions	mm	in.
Width	72	2.8
Height	142	5.6
Depth	36	1.4
Weight	**g**	**oz.**
Net	250	8.9

TOP220

OPTICAL
Sensor Type – InGaAs (2 mm).
Power Range – +27 to –30 dBm.
Cal Wavelengths – 980, 1310 and 1550 nm.
Absolute Accuracy – ±0.25 dB at calibration conditions.
Display – Custom triplexed liquid crystal display with 4-digit data field (0.01 dB resolution) and simultaneous display of cal wavelength.
Calibration Data – Data stored in nonvolatile memory.
Connector Interface – Universal (SOC) Interface.

POWER
Source – Two AA alkaline batteries.
Battery Life – >100 hours.

ENVIRONMENTAL
Temperature –
Operating: –15°C to +50°C, 0-95% RH (non-condensing).
Storage: –35°C to +70°C, 0-95% RH (noncondensing).

PHYSICAL CHARACTERISTICS

Dimensions	mm	in.
Width	72	2.8
Height	142	5.6
Depth	36	1.4
Weight	**g**	**oz.**
Net	250	8.9

TOP300

OPTICAL
Center Wavelength – 635 nm (630-640 nm).
Spectral Width (FWHM) – <2 nm rms.
Stability – 1 hour maximum deviation: ±0.15 dB.
10 hours maximum deviation ±0.25 dB.
Power Output (Into SMF –28 Fiber) – -5 dBm.
Connector Interface – Universal (UCI) Connector Interface, UCI Adapters.

POWER
Source – Two AA alkaline batteries.
Battery Life – >20 hours.

ENVIRONMENTAL
Temperature –
Operating: –15°C to +40°C, 0-95% RH (non-condensing).
Storage: –35°C to +70°C, 0-95% RH (noncondensing).

PHYSICAL CHARACTERISTICS

Dimensions	mm	in.
Width	72	2.8
Height	142	5.6
Depth	36	1.4
Weight	**g**	**oz.**
Net	230	8.1

TOP400

OPTICAL

Insertion Loss – <2 dB (1.25 dB typical).
Attenuation Range – 0 to 35 dB.
Return Loss – <-40 dB (with FC, ST, SC and DIN connectors).
Connector Interface – Universal Connector Interface (UCI) .

ENVIRONMENTAL

Temperature –
Operating: –15°C to +60°C, 0-95% RH (non-condensing).
Storage: –35°C to +70°C, 0-95% RH (noncondensing).

PHYSICAL CHARACTERISTICS

Dimensions	**mm**	**in.**
Width	72	2.8
Height	142	5.6
Depth	36	1.4
Weight	**g**	**oz.**
Net	230	8.1

ORDERING INFORMATION

For price information: Outside the U.S. contact your local Tektronix representative, inside the U.S. see the price list in the back of this catalog.

TOP130 – LED Optical Source (850/1300 nm).
TOP200 – Optical Power Meter (850/1310/1550 nm).
TOP220 – High Power Optical Power Meter.
TOP140 – Laser Optical Source (1310 nm).
TOP160 – Laser Optical Source (1310/1550 nm).
TOP300 – Visual Fault Finder (635 nm).
TOP400 – Optical Attenuator.
All include – User Manual (070-9392-01); Protective Rubber Jacket with Stand (348-1480-00); One Connector Adapter Options*[1] (user selected from the following Optional Adapters list).

CONNECTORS FOR TOP130

Opt. 30 – Biconic. Order 119-5168-00.
Opt. 31 – FC. Order 119-5146-00.
Opt. 32 – D4. 119-5167-00.
Opt. 33 – SMA 905/906. Order 119-5169-00.
Opt. 34 – ST. Order 119-5144-00.
Opt. 35 – DIN. Order 119-5166-00.
Opt. 36 – Diamond 3.5. Order 119-5172-00.
Opt. 37*[2] – Diamond 2.5. Order 119-5171-00.
Opt. 38 – SC. Order 119-5145-00.
Opt. 39 – SMA 25. Order 119-5170-00.

CONNECTORS FOR TOP140/160

Opt. 30*[2] – Biconic. Order 119-4515-00.
Opt. 31 – FC. Order 119-4516-00.
Opt. 32*[2] – D4. 119-4514-00.
Opt. 33 – SMA 905/906. Order 119-4557-00.
Opt. 34 – ST. Order 119-4513-00.
Opt. 35 – DIN. Order 119-4546-00.
Opt. 36 – Diamond 3.5. Order 119-4558-00.
Opt. 37*[2] – Diamond 2.5. Order 119-4556-00.
Opt. 38 – SC. Order 119-4518-00.
Opt. 39 – SMA 2.5. Order 119-4517-00.

CONNECTORS FOR TOP200/220

Opt. 30 – Biconic. Order 119-5168-00.
Opt. 31 – FC. Order 119-5146-00.
Opt. 32 – D4. 119-5167-00.
Opt. 33 – SMA 905/906.*[3]
Opt. 34 – ST. Order 119-5144-00.
Opt. 35 – DIN. Order 119-5166-00.
Opt. 36 – Diamond 3.5. Order 119-5172-00.
Opt. 37 – Diamond 2.5. Order 119-5171-00.
Opt. 38 – SC. Order 119-5145-00.
Opt. 39 – SMA 2.5. Order 119-5170-00.

CONNECTORS FOR TOP300/400

Opt. 30*[2] – Biconic. Order 119-4515-00.
Opt. 31 – FC. Order 119-4516-00.
Opt. 32*[2] – D4. 119-4514-00.
Opt. 33 – SMA 905/906. Order 119-4557-00.
Opt. 34 – ST. Order 119-4513-00.
Opt. 35 – DIN. Order 119-4546-00.
Opt. 36 – Diamond 3.5. Order 119-4558-00.
Opt. 37*[2] – Diamond 2.5. Order 119-4556-00.
Opt. 38 – SC. Order 119-4518-00.
Opt. 39 – SMA 2.5. Order 119-4517-00.

*[1] *One adapter option per instrument. Order additional connector using the 119- part number.*

*[2] *Optional at additional cost.*

*[3] *Contact your local Tektronix representative.*

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-462-2200.

CE

Products are manufactured in ISO 9001 registered facilities.

Optical Time Domain Reflectometer

TFP2A FiberMaster®



Features – Benefits

- Floppy Disk Drive
- High-speed Processing
- High-resolution Color Display
- Dual Optical Plug-in Capacity
- Dual Wavelengths in each Plug-in
- Language Options
- Dual Trace Capability
- Internal Printer Option
- DC Power Input Option

Applications

- Installation and Acceptance Testing of Fiber Optic Networks
- Fiber Optic System Maintenance Testing
- Locating Optical Cable Faults During Restoration
- Optical System Documentation

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-462-2200.

CE

ISO 9001

Tektronix measurement products are manufactured in ISO registered facilities.

GPIB IEEE-488

Product(s) complies with IEEE Standard 488.1-1987, and with Tektronix Standard Codes and Formats.

FiberMaster® OTDR

Unlike any other OTDR on the market, the FiberMaster® TFP2A sets a high level of performance and flexibility, providing faster, easier, more efficient solutions to fiber optic network testing requirements.

FiberMaster is equipped to accommodate two dual-wavelength optical plug-in modules at the same time. Fully utilized, this allows testing of virtually any communications network (Telephone, LAN, WAN, CATV) without exchanging modules.

The FiberMaster TFP2A is driven by a high-speed 32-Bit processor that delivers clear, concise, accurate waveforms in a fraction of the averaging time taken by other OTDR systems.

Off-line waveform analysis and documentation is made easy with the FMTAP™ Trace Analysis Software.

Characteristics

CRT Display – Color 16.5 cm (6.5 in.) diagonal.

Plug-in Module Capacity – Up to two plug-ins/four wavelengths.

Hardcopy Output – Optional Internal Printer: High speed, high res., dot matrix, 150 dots/in.
External Interfaces: Keyboard, RS-232C and GPIB.

Power Requirements – AC Operation: 90 to 130 VAC, 47 to 440 Hz, 180 to 253 VAC, 47 to 73 Hz. DC Operation (optional): 10 to 16 VDC.

Measurements – Event loss, distance, two-point distance, two-point loss, fiber attenuation, event return loss (reflectance) link return loss (ORL).

MASS STORAGE

Internal Floppy Disk Drive – Size: 3.5 in., 1.44 Mbyte, 720 Kbyte MS-DOS Compatible.
Internal RAM (optional) – 1 Mbyte, non-volatile RAM for waveform storage.
Data Points Per Waveform – 16,000 maximum (normal density). 32,000 maximum.
Display Range – Vertical: 1.0 dB to 100 dB full screen.
Loss Readout Resolution: 0.001 dB.
Horizontal System: 1 m to 320 km.

Distance Measurements
Units: cm, m, km, kfeet, feet.
Accuracy: ±0.001% + minimum cursor resolution, ± uncertainty in IR. IR Range: 1.4000 to 1.6000.

ENVIRONMENTAL

May be reduced with disk drive and printer operating.

Temperature – Operating: –10° C to +55° C. Nonoperating: –40° C to +60° C.

Humidity – Operating: 5% to 90%, non-condensing.
Nonoperating: 5% to 90%.

OTHER PERIPHERAL CAPABILITIES

FMTAP – Off-line trace analysis and documentation software for Windows.

Remote Control – via RS-232C or GPIB interface.

Data Transfer – via RS-232C or GPIB interface.

PHYSICAL CHARACTERISTICS

Dimensions	cm	in.
Length	60.7	23.9
Width	45.2	17.8
Height	19.8	7.8
Weight	**kg**	**lb.**
Net (Typical)	15.0	33.0

ORDERING INFORMATION

For price information: Outside the U.S. contact your local Tektronix representative, inside the U.S. see the price list in the back of this catalog.

PLUG-IN OPTICS MODULE CHARACTERISTICS

FM8513 –MULTIMODE
Wavelengths – 850 / 1300 nm.
Fiber size – 62.5 µm.
Dynamic range – 26.5 dB / 26 dB.
Event dead zone – 0.2 / 3 m.
Loss dead zone – 2.5 / 14 m.

FS1315 –HIGH RESOLUTION SM
Wavelengths – 1310 / 1550nm.
Fiber size – Singlemode.
Dynamic range – 29.5 / 26.5 dB.
Event dead zone – 3 / 3 m.
Loss dead zone – 15 / 18 m.

FG1315 –GENERAL PURPOSE SM
Wavelengths – 1310 / 1550nm.
Fiber size – Singlemode.
Dynamic range – 31 / 29 dB.
Event dead zone – 4 / 4 m.
Loss dead zone – 25 / 30 m.

FL1315 LONG RANGE SM
Wavelengths – 1310 / 1550nm.
Fiber size – Singlemode.
Dynamic range – 37.5 / 37 dB.
Event dead zone – 25 / 25 m.
Loss dead zone – 125 / 170 m.

TFP2A – FiberMaster Mainframe (includes 3.5 in. floppy disk drive).

STANDARD ACCESSORIES

Operators Manual – Order 070-9189-02.
Reference Card – Order 063-2292-01.
Soft Carrying Case – Order 016-1037-01.
Front Panel Cover – Order 200-3566-00.
Power Cord – Order 161-0104-00.

INTERNATIONAL POWER PLUGS

Opt. A1 – Opt. A5.
See page 619 for description.

FACTORY MAINFRAME OPTIONS

Opt. 14 – 1 Mb Internal RAM.
Opt. 16 – Internal High Speed, High Resolution Internal Printer.
Opt. 17 – DC Power (10-32VDC).

LANGUAGE OPTIONS

Opt. L1 – French.
Opt. L3 – German.
Opt. L4 – Spanish.
Opt. L5 – Japanese.
Opt. L6 – Portuguese.
Opt. L7 – Chinese.

OPTICAL MODULES

When ordering Modules for an existing mainframe use the nomenclature after the option (e.g, FM8513 for Opt. 03).

OPTICAL MODULES – MULTIMODE.

Opt. 03 (FM8513) – 850/1300 nm.
62.5µm fiber. Call for other core sizes.
Each Multimode Optical Module comes with one connector option from those listed below. Additional connectors can be ordered by the 9-digit part number:
Opt. 20 – Biconic (119-4515-00).
Opt. 21 – FC-PC (119-4516-00).
Opt. 22 – D4-PC (119-4514-00).
Opt. 23 – SMA905/906 (119-4557-00).
Opt. 24 – ST-PC* (119-4513-00).
Opt. 25 – DIN-PC (119-4546-00).
Opt. 26 – Diamond 3.5 (119-4558-00).
Opt. 27 – Diamond 2.5 (119-4556-00).
Opt. 28 – SC-PC (119-4518-00).
Opt. 29 – SMA2.5 (119-4517-00).

OPTICAL MODULES – SINGLEMODE

HIGH RESOLUTION
Opt. 06 (FS1315) – 1310/1550nm.

GENERAL PURPOSE
Opt. 11 (FG1315) – 1310/1550nm.

LONG RANGE
Opt. 08 (FL1315) – 1310/1550nm.

OFF-WAVELENGTH
Opt. WV (FS1500) – 1625 nm.
Each Singlemode Optical Module comes with one connector option from those listed below. Additional connectors can be ordered by the 9-digit part number:
Opt. 30 – Biconic (119-4515-00).
Opt. 31 – FC-PC (119-4516-00).
Opt. 32 – D4-PC (119-4514-00).
Opt. 33 – SMA905/906 (119-4557-00).
Opt. 34 – ST-PC* (119-4513-00).
Opt. 35 – DIN-PC (119-4546-00).
Opt. 36 – Diamond 3.5 (119-4558-00).
Opt. 37 – Diamond 2.5 (119-4556-00).
Opt. 38 – SC-PC (119-4518-00).
Opt. 39 – SMA2.5 (119-4517-00).
Opt. 41 – FC-APC (119-5115-00).
Opt. 42 – SC-APC (119-5116-00).

OTHER OPTIONS/ACCESSORIES

Opt. 1S – FMTAP, FiberMaster Trace Analysis Software Package.
Opt. 19 – AT Keyboard.
Opt. 1R – 19" Rackmount.
Opt. 2T – 850/1300 LED Source.
Opt. 3T – 1310nm Laser Source.
Opt. 5T – Optical Power Meter.
Opt. 6T – Visual Fault Finder.
Opt. 7T – 1310/1550nm Laser Source.
Opt. 8T – High Power Meter.
Opt. 9T – Optical attenuator.
Keyboard Adapter – Order 174-2356-00.
Printer Paper (One Roll) – Order 006-7682-00.
Printer Paper (50 Rolls) – Order 006-7682-20.
Service Manual – Order 070-9188-03.

TYPICAL CONFIGURATIONS

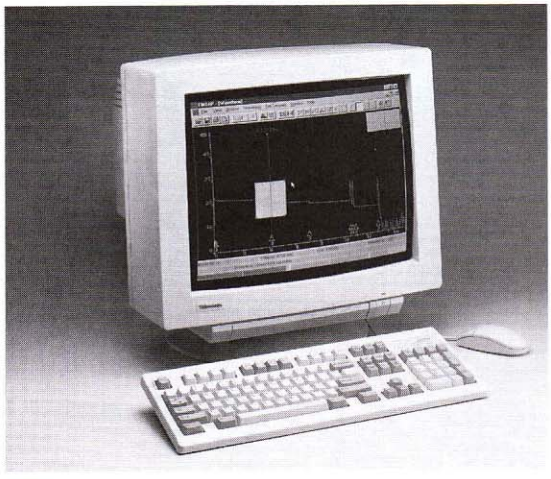
INSTALLER CONFIGURATION
(MM and SM in one unit)
TFP2A – FiberMaster Mainframe.
Opt. 03 – Dual λ multimode.
Opt. 24 – ST connector.
Opt. 06 – Dual λ singlemode.
Opt. 31 – FC connector.
Opt. 16 – Built in printer.
Opt. 1S – PC software.

LONG-HAUL TELCO CONFIGURATION
(for long distance fiber lines).
TFP2A – FiberMaster Mainframe.
Opt. 08 – Dual λ singlemode.
Opt. 31 – FC connector.
Opt. 16 – Built in printer.
Opt. 1S – PC software.

LAN INSTALL/MAINTAIN CONFIGURATION
TFP2A – FiberMaster Mainframe.
Opt. 03 – Dual λ multimode.
Opt. 24 – ST connector.
Opt. 11 – Dual λ singlemode.
Opt. 38 – SC connector.
Opt. 16 – Built in printer.
Opt. 1S – PC software.

Trace Analysis Software

FMTAP™



Features – Benefits

- Windows 3.1, 95, 98 and NT Compatible
- Bi-directional Event Averaging
- Batch File Comparison Against a Template Allows Faster Analysis of OTDR Data
- Batch File Printing and Data Export Functions Provides Easy Documentation of OTDR Data
- Extensive HELP Menus (Feature HELP and Application HELP) Make FMTAP Software Easy to Learn
- Easy to Install and Use

Applications

- System Documentation Generation
- Off-line Analysis of TDR Data
- Analyzing and Exporting Data for Spreadsheet or Other External Report Tools
- Batch Print of Installation Tests
- Adding Analysis and Notes to Batches of Tests

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-462-2200.

ISO 9001

Tektronix measurement products are manufactured in ISO registered facilities.

FMTAP Version 3.1 OTDR trace analysis software allows you to access, analyze and document OTDR test data from a PC Windows platform. You can easily analyze and document the quality of fiber links in your network using FMTAP software and your saved OTDR data files from Tektronix mainframe and mini-OTDRs including the TFP2, TFP2A, TFS3030 and TFS3031.

FMTAP version 3.1 software can perform the following functions on OTDR datafiles on a PC Windows platform:

- View a Saved OTDR Trace Datafile
- View the Trace Event Table and Event Notes
- View the Acquisition Parameters of the Datafile
- View the Filename and File Notes of the Datafile
- Edit Filename, File Notes and Event Notes
- Measure Splice Loss, Link Loss, Reflectance, Link Return Loss and Fiber Slope
- Adjust Refractive Index, Backscatter Factor, Event Threshold and Distance Units
- Zoom In/Out on Any Section of the Trace
- Manually Mark Events
- Automatically Mark Events
- View Two OTDR Traces Simultaneously
- Perform Bi-directional Measurements on OTDR Traces
- Read .cff, .wfm and .sor OTDR Datafile Formats
- Write .cff, .wfm and .sor OTDR Datafile Formats
- Extensive HELP Menus (Features and Applications)

In addition, FMTAP software provides the following documentation functions:

- Batch File Printing of Trace and Table Data
- Batch File Comparison Against a User-defined Template
- Export OTDR Data to Other Windows Software (Word Processing, Desktop Publishing, Spreadsheets)

CHARACTERISTICS

SYSTEM REQUIREMENTS:

Processor – 80486 or higher-based PC, math coprocessor recommended.

Operating System – Windows 3.1, '95 (Windows '95 or above recommended).

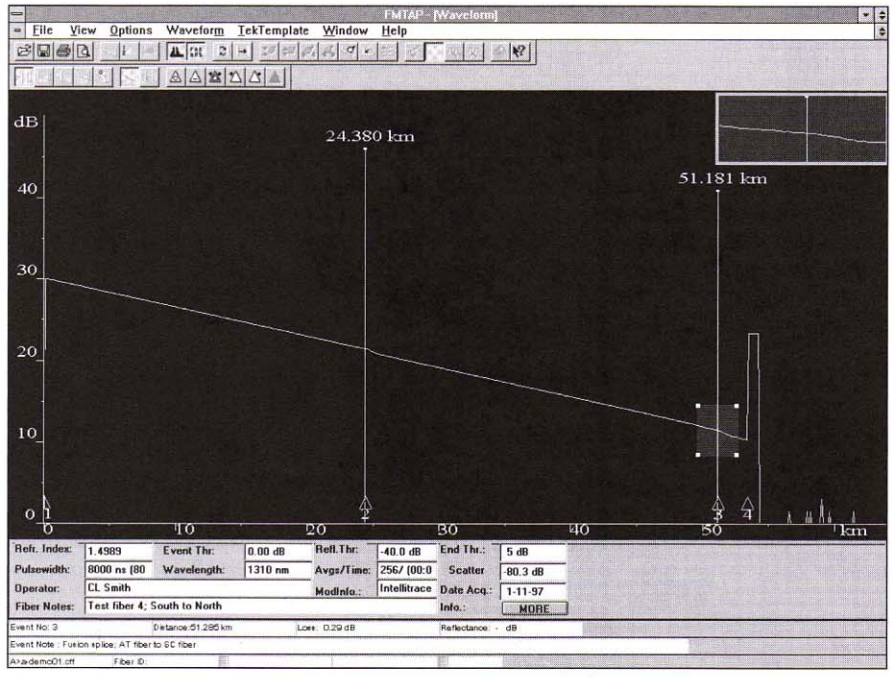
Base Memory – 640 K RAM minimum.

Extended or Expanded Memory – 4 MB minimum required.

Graphics Adapter and Monitor – Windows-compatible color display.

Hard Drive – Minimum 5 MB available space.

Floppy Disk Drive – 3.5 inch, 1.44 MB IBM-compatible.



FMTAP Version 3.1 screen showing data trace and fiber parameters.

ORDERING INFORMATION

For price information: Outside the U.S. contact your local Tektronix representative, inside the U.S. see the price list in the back of this catalog.

FMTAP OTDR

TRACE ANALYSIS SOFTWAREVERSION 3.1

Includes: Disk Pack (five 3.5 inch floppy disks).

User Manual – (070-9844-00).

Quick Reference Card – (063-2750-00).

Utilities Disk Pack – (119-5433-00).

FMTAP

FMTAP Software only. FMTAP may also be ordered as Opt. 1S to TFS3031 or TFP2A.

FMTAP-SL – FMTAP-Software Company Site License.

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-462-2200.

ISO 9001

Tektronix measurement products are manufactured in ISO registered facilities.

Mini Optical Time Domain Reflectometer

TekRanger®2 TFS3031



Features – Benefits

- One-button Fully Automatic IntelliTrace Fiber Analysis
- Singlemode Distance and Loss Measurements Traceable to NIST
- Large, Backlit, High-resolution Display
- Multimode/Singlemode in One Unit (Optional)
- Keyboard Port and Optional Mini-keyboard
- RS232 and Parallel Ports for Printing and PC Access
- Shock, Water and Dust Resistant
- Auto Echo Detection
- Selectable Splice Loss and Reflectance Thresholds
- Files are Compatible with, FiberMaster™ OTDR, FMTAP, PC Spreadsheets
- Export to Bellcore SOR
- Context Sensitive Help

Applications

- Installation and Acceptance Testing of Fiber Optic Networks
- Fiber Optic System Maintenance Testing
- Locating Optical Cable Faults During Restoration
- Optical System Documentation

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-462-2200.

CE

ISO 9001

Tektronix measurement products are manufactured in ISO registered facilities.

TEKRANGER 2 TFS3031

If your job is to install, maintain or restore optical fiber, the TekRanger 2 TFS3031 mini-OTDR with IntelliTrace Automated Fiber Analysis System is a rugged, easy-to-use, mini-optical time domain reflectometer (OTDR) that's built for you. It's designed to stand the rigors of field work, while providing precise measurements on singlemode or multimode optical fiber systems.

THE INTELLITRACE ADVANTAGE

IntelliTrace technology automatically adjusts and optimizes test parameters so you don't have to. Just press the Start/Stop button and it will provide the best possible resolution, while maximizing dynamic range to give you the most accurate measurements available in a mini-OTDR today. Unlike competitive units, one IntelliTrace acquisition provides consistent, repeatable and accurate results. The location, reflectance and loss of every splice appears quickly and clearly on the large, high-contrast display.

The TFS3031 is the only mini-OTDR that can locate an event at 10 meters while also finding an end at 175 km away (on singlemode fiber) with the push of a single button. No need for multiple acquisitions to get a complete picture of your fiber, either with a displayed trace or an event table. You get greater productivity in labor with less training.

TRACEABLE MEASUREMENTS

The TekRanger 2 TFS3031 offers traceability on singlemode distance and loss measurements. This means that both the hardware and the software are included in our accuracy specifications. What

this means to you is that you can count on the TFS3031 mini-OTDR to provide the most reliable and repeatable measurements of any OTDR in the world.

SUPERIOR PERFORMANCE

The TFS3031 sets a new performance standard for the combination of dynamic range, measurement range and dead zone performance in a mini-OTDR. We've made it easier to see events up close as well as to see events as far as 175 km.

CONVENIENT DATA STORAGE

Test results can be stored in the TekRanger 2's ample internal memory or collected on the optional floppy disk drive. Windows based FMTAP software package gives you virtually unlimited flexibility when analyzing and documenting your spliced fibers. The data can also be used in the Tektronix FiberMaster OTDR.

EASY SYSTEM SOFTWARE UPDATES

The TFS3031's optional disk drive and RS-232 port permit updating of the unit's firmware in the field so you can easily keep up with the latest technology.

CHARACTERISTICS

WAVELENGTHS

850 nm ±30 nm, multimode.
1300 nm ±30 nm, multimode.
1310 nm ±20 nm, singlemode.
1550 nm ±20 nm, singlemode.
1625 nm ±20 nm, singlemode.

DYNAMIC RANGE*1

	Dynamic Range
850 nm (Opt. 01)	31 dB
850/1300 nm (Opt. 03)	31/28 dB
1310 nm (Opt. 04)	30 dB
1310/1550 nm (Opt. 06)	30/28 dB
1310/1550 nm (Opt. 10)	35/35 dB
1625 nm (Opt. 12)	30 dB

Readout Resolution –
25 cm minimum.
Loss threshold: 0.02 dB.
Loss resolution: 0.001 dB.

Distance Measurements – Meters, Feet, Miles.

OTDR Distance Range Settings –
Singlemode: 1 to 240 km.
Multimode: 1 to 40 km.

Distance Resolution (IntelliTrace) – 25 cm to 40 m.

Hardware Scale Accuracy*3 –
Horizontal Time Base: ±1.25 m ±1.25 m ± 10^{-5} x Distance
Vertical Linearity: 0.02 dB/dB.

System Measurement Accuracy*4 –
Distance: ±4 m.
Loss: ±0.01 dB.

Reflectance Accuracy – Exceeds Bellcore GR-196-CORE*2.

Measurement Time (Auto) – Less than 3 minutes (20 dB loss).

DEAD ZONE*2 (OPT. 01, 03, 04, 06, 10, 12)

	Event	Loss Measurement
Singlemode	5 m	15 m
Multimode	3.5 m	8 m

Display – High resolution 640 x 480; 7.2 in., high contrast; Operator switchable backlight.

Selectable Pulse Widths – (dependent on option).
Multimode:
850 nm: 1 m, 5 m, 10 m.
1300 nm: 1 m, 5 m, 10 m, 20 m, 50 m, 100 m.
Singlemode: 1 m, 5 m, 10 m, 20 m, 50 m, 100 m, 200 m, 500 m, 1000 m, 2000 m, 3200 m (with Opt. 10 and 12 only).

Memory Capacity –
100 traces in internal memory (typical).
3.5 in. floppy disk drive (optional).

Output Ports – RS-232 Serial; Centronics parallel printer, mini-DIN (keyboard).

Power Options – AC (100 to 240 V, 50 to 60 Hz). DC Operation: 9 to 16 VDC. Internal NiCad rechargeable battery (4 hours of operation depending on operating mode).

Laser Safety –
Class 1 per 21 CFR 1040.
Class 1 per CEI/IEC 825-1: 1993.
Options 3T, 4T and 7T are Class 1.
Option 6T is Class 2.

ENVIRONMENTAL (WITHOUT INTERNAL DISK DRIVE)

Temperature Range –
Operating: –10°C to +40°C.
Nonoperating: –20°C to +60°C.

Storage Temperature – –20°C to +60°C.

Relative Humidity – 5% to 95% (noncondensing).

Field Usage*2 –
Shock, water and dust resistant.

Shock*2 – 30 in. drop.

Safety – UL 3111-1, CSA 1010.1.

PHYSICAL CHARACTERISTICS

Dimensions	cm	in.
Width	29.2	11.5
Height	11.4	4.5
Depth	24.1	9.5
Weight	**kg**	**lb.**
Net	4.2	9.2

*1 *Typical performance @ 25°C.*

*2 *Per Bellcore GR-196-CORE.*

*3 *Excludes uncertainty in fiber IR and cabling factor.*

*4 *Verified on NIST traceable calibration system, singlemode options only.*

ORDERING INFORMATION

For price information: Outside the U.S. contact your local Tektronix representative, inside the U.S. see the price list in the back of this catalog.

TFS3031
TekRanger 2 Base Unit.

Includes: Operator Manual (070-9027-06); Quick Reference Card (063-2096-02); NiCad Battery Pack (146-0112-00); Power/Charger Adapter (119-4545-01); Power Cord (161-0228-00); Soft Carrying Case (016-1215-02).

OUTPUT PORT OPTIONS*1

Multimode Options (62.5 µm GI Fiber) –

Opt. 01: Single wavelength 850 nm.

Opt. 03: Dual wavelength 850/1300 nm.

Singlemode Options (ITU-T G.652) –

Opt. 04: Single wavelength 1310 nm.

Opt. 06: Dual wavelength 1310/1550 nm.

Opt. 10: Dual wavelength 1310/1550 nm extended range.

Opt. 12: Single wavelength 1625 nm.

INTERNATIONAL POWER PLUGS

Opt. A1 – Universal Euro 220 V. Order 161-0066-09.
Opt. A2 – United Kingdom 240 V. Order 161-0066-10.
Opt. A3 – Australia 240 V. Order 161-0066-11.
Opt. A4 – N. American 240V, 60 Hz.
Opt. A5 – Switzerland 220 V. Order 161-0154-00.
Opt. A6 – Japan 110 V. Order 161-0288-00.

See page 619 for description.

LANGUAGE OPTIONS

Includes: Alternate language instrument interface and User Manual. All language options can also be run in English.

Opt. L1 – French.
Opt. L2 – Italian.
Opt. L3 – German.
Opt. L4 – Spanish.
Opt. L5 – Japanese.
Opt. L6 – Portuguese.
Opt. L7 – Simple Chinese.
Opt. L8 – Standard Chinese.
Opt. LF – Finnish.
Opt. LD – Dutch.

MEASUREMENT SERVICE OPTIONS

Opt. R3 – Repair warranty extended to cover three years.

CONNECTOR OPTIONS*2

Multimode Options	Singlemode Option	Connector Type	Part Number
20	30	Biconic	119-4515-00
21	31	FC/PC	119-4516-00
22	32	D4/PC	119-4514-00
24	34	ST/PC	119-4513-00
25	35	DIN/PC 47256	119-4546-00
26	36	DIAMOND 3.5	119-4558-00
28	38	SC/PC	119-4518-00
	41	FC/APC*3	119-5115-00
	42	SC/APC*3	119-5154-00
	44	ST/APC*3	119-5888-00
	45	DIN/APC*3	119-5887-00

OPTIONAL ACCESSORIES

Opt. 11 – 3.5 in. Disk Drive.
Opt. 19 – Mini-keyboard (118-9402-00).
Opt. 1D – Test Data Sheet.
Opt. 1S – FMTAP™ Software.
Opt. 1T – Hard Transit Case (016-1210-00).
Opt. 2T*4 – Optical LED Source, multimode 850/1300 nm reference source (TOP130).
Opt. 3T*5 – Optical Laser Source, singlemode 1310 nm reference source (TOP140).
Opt. 5T*4 – Optical Power Meter 850/1310/1550 nm (TOP200).
Opt. 6T*4 – Visual Fault Finder 635 nm (TOP300).
Opt. 7T*5 – Optical Laser Source, singlemode 1310/1550 nm reference source (TOP160).
Opt. 8T*5 – High Power Optical Power Meter 980/1310/1550 nm (TOP220).
Opt. 9T*5 – Adjustable Optical Attenuator, single-mode 0-35 dB (TOP400).
Hard Travel Case – Order 016-1210-00.
RS-232 PC Interface Cable – Order 012-1379-00.
FMTAP Trace Analysis Package – Order FMTAP.
Cigarette Lighter Power Adapter – Order 198-5810-00
Centronics Parallel Printer Cable – Order 012-1214-00.
Module Level Service Manual – Order 070-9026-04.
E2000/PC Connector – Order 119-5164-00.
Portable Printer – Order DMAPRN.

CONFIGURATION KITS

TFS3031 Opt. AN – LAN Configuration.

Includes: 850/1300 nm multimode OTDR port, 3.5 in. disk drive, ST connector, FMTAP software, Hard travel case.

TFS3031 Opt. AX – Installer Configuration.

Includes: 850/1300 nm multimode port, 1310/1550 nm singlemode OTDR Port, 3.5 in. disk drive, ST connector on multimode, FC connector on singlemode, FMTAP Software, Hard travel case.

**1 An OTDR must have at least one OTDR Port; it can contain two OTDR Ports (e.g., 03 and 06).*

**2 One connector option at no charge per OTDR port option. Order additional connectors using the 119- part number.*

**3 Eight degree angled-PC connector. Cannot mix APC and PC connectors on the same optical port.*

**4 Will have same connector as multimode port.*

**5 Will have same connector as singlemode port.*

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-462-2200.

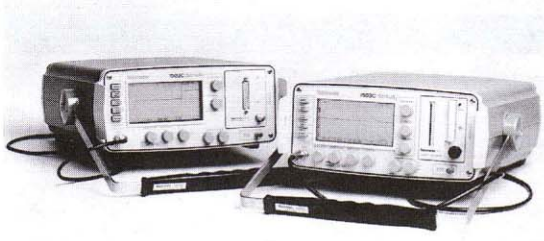
CE

ISO 9001

Tektronix measurement products are manufactured in ISO registered facilities.

Metallic Cable Testers

1503C • 1502C



Features – Benefits

- Menu-Driven Operation for Easy Test Set-Up
- Help Screens Provide Information on Instrument Operation and Measurements
- Vertical and Horizontal Delta Modes Allow Easy Delta Measurements
- Waveform Storage Allows Comparison of the Current and Previously Recorded Waveform
- Ω at Cursor Allows Direct Readout of Characteristic Impedance

Applications

- Telephony
- Computer/LAN
- CATV
- Power Companies
- Agriculture
- PCB Manufacturers
- Cable Manufacturers
- Airlines

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-462-2200.

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The 1500C Series is designed to quickly and easily locate opens, shorts, crimps, and other defects in metallic cables. The 1503C can measure cables up to 50,000 feet (15,000 meters) in length; 2,000 feet (625 meters) for the 1502C.

Using a process similar to radar, the 1500C Series transmits electrical pulses down the cable under test. Impedance changes in the cable reflect some of the pulse energy back to the MTDR. The reflections are displayed on a backlit, HyperTwist, high-contrast nematic LCD display. The characteristics of the displayed trace allow the user to determine the nature of the cable fault.

When testing 50 Ω cable with a Vp of 0.66, the 1502C allows the determination of 0.5 Ω cable faults. Multiple faults can be measured as close as 10 inches with the 1503C or 0.8 inch with the 1502C. The 1503C can measure cables with impedances of 50, 75, 93, and 125 Ω; the 1502C measures 50 Ω impedance only.

CHARACTERISTICS

ELECTRICAL

Test Signal –
1503C: 1/2 sine.
1502C: Step rise.

Amplitude –
1503C:
Terminated: –2.5 V.
Unterminated: –5.0 V.
1502C: 300 mV nominal into 50 Ω load.

Pulse Widths (1503C) – 2 ns, 10 ns, 100 ns, 1000 ns.

System Risetime (1502C) – 10% to 90%, 200 ps (1.15 in./2.92 cm).

Output Impedance –
1503C: 50 Ω, 75 Ω, 93 Ω, 125 Ω.
1502C: 50 Ω.

Input Protection (1503C) – ±400 V (DC + peak AC) to a maximum of 440 Hz.

Electrostatic Discharge Protection (1502C) – 1 kV/500 pF/1 kΩ.

Maximum Range –
1503C: 50,000 ft. (15,000 m).
1502C: 2,000 ft. (625 m).

Distance Readout Resolution –
1503C: 0.04 ft. (0.01 m).
1502C: 0.05 in. (0.12 cm).

Noise Filtering – 1 to 128 averages.

Vertical Scale –
1503C: 0 dB to 63.75 dB.
1502C: 0.5 mp/div to 500 mp/div.

Vertical Accuracy – ±3% full scale.

Distance/Division –
1503C: 1 ft./div to 5000 ft./div (0.25 m/div to 1000 m/div).
1502C: 0.1 ft./div to 200 ft./div (0.025 m/div to 50 m/div).

Horizontal Accuracy – 1.6 inches (0.041 m) or ±1% of measured distance plus uncertainty in Vp, whichever is greater (for Vp = 0.66 and Dist/Div = 1 ft.).

ENVIRONMENTAL

Meets capabilities of Type III, Class 3, Style C instruments (except EMI where it meets FCC; Part 15,3,A, and VDE 0871, Class B) as prescribed by MIL-T-28800C.

POWER

Source Power –
AC Line: 115/230 V.
Battery: Internal 12 V.

Safety – UL1244, CSA231, EN61010-1.

PHYSICAL CHARACTERISTICS

Dimensions	cm	in.
Height	17	6.5
Width	30	12
Depth	48	19
Weight	**kg**	**lb.**
Net	10	23

WARRANTY

One year parts and labor.

ORDERING INFORMATION

For price information: Outside the U.S. contact your local Tektronix representative, inside the U.S. see the price list in the back of this catalog.

1502C
Metallic TDR.

Includes: Operatoris Manual (070-7169-01), 50 Ω BNC Terminator (011-0123-00), Precision 50 Ω Cable (012-1350-00), BNC Female-to-Female Adapter (103-0028-00), Accessory Pouch (016-0814-00), Option Port Cover (200-3737-00), Calculator Slide Rule (003-0700-00), AC Power Cord, Spare Fuse, Internal Battery (040-1276-01).

1503C
Metallic TDR.

Includes: Operator's Manual (070-7323-02), 50 Ω BNC Terminator (011-0123-00), Precision 93 Ω Cable (012-1351-00), BNC Female-to-Female Adapter (103-0028-00), BNC Female-to-Clip Leads Adapter (013-0261-00), Accessory Pouch (016-0814-00), Option Port Cover (200-3737-00), Calculator Slide Rule (003-1419-00), AC Power Cord, Spare Fuse, Internal Battery (040-1276-01).

OPTIONS

Opt. 04 – YT1 chart recorder.
Opt. 05 – Metric default.
Opt. 06 (1503C) – Live Ethernet testing.
Opt. 08 (1503C) – Token ring adapter.
Opt. 09 (1503C) – USOC/EIA568/Token ring (RJ45) adapter.
Opt. 10 (1503C) – Token ring interface.

INTERNATIONAL POWER PLUGS

Opt. A1 – Universal Euro 220 V, 50 Hz.
Opt. A2 – UK 240 V, 50 Hz.
Opt. A3 – Australian 240 V, 50 Hz.
Opt. A4 – North American 240 V, 60 Hz.
Opt. A5 – Switzerland 220 V, 50 Hz.
See page 619 for description.

RECOMMENDED ACCESSORIES

Additional Internal Battery – 040-1276-01.
YT1 Chart Recorder – YT1S.
SP232 RS-232 Interface Module – SP232.
Chart Paper, 1 Roll – Order 006-7647-00.
Chart Paper, 25 Rolls – Order 006-7677-00.
Chart Paper, 100 Rolls – Order 006-7681-00.
1502C Service Manual – Order 070-7168-02.
1503C Service Manual – Order 070-7170-03.
BNC Female-to-Twisted Pair Clip Leads Adapter (1503C) – Order 012-0671-02.
BNC Female-to-Dual Banana Plug Adapter – Order 103-0090-00.
BNC Male-to-Dual Binding Post Adapter – Order 103-0035-00.
BNC Female-to-N Male Adapter – Order 103-0045-00.
BNC Female-to-F Male Adapter – Order 103-0158-00.
BNC Male-to-N Female Adapter – Order 103-0058-00.
BNC Male-to-UHF Female Adapter – Order 103-0032-00.
BNC Female-to-UHF Male Adapter (1503C) – Order 103-0015-00.
BNC Male-to-GR Adapter (1502C) – Order 017-0064-00.
BNC Female-to-GR Adapter (1502C) – Order 017-0063-00.
BNC Male-to-BNC Male Adapter (1503C) – Order 103-0029-00.
BNC Termination, 75 Ω – Order 011-0102-01.
BNC 50 Ω/75 Ω Adapter (1502C) – Order 017-0091-00.
BNC 50 Ω/93 Ω Adapter (1502C) – Order 017-0092-00.
BNC 50 Ω/125 Ω Adapter (1502C) – Order 017-0090-00.
Token Ring Adapter (1503C) – Order 015-0500-00.
USOC/EIA568/Token Ring (RJ45) Adapter (1503C) – Order 015-0579-00.
Token Ring Interface (1503C) – Order 015-0600-00.
10 Base T/Starlan Adapter (1503C) – Order 015-0578-00.

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-462-2200.

Cable Tester for Telephone Applications

TelScout® TS100



Features – Benefits

- Twisted Pair and Coax Testing in a Single Unit (Optional)
- One-Step Setup
- 15 km Fault Location Capability
- Rugged – Survives 2 m Drop
- Single-button Zoom Function
- Pair Comparison Mode
- Splits/Crosstalk Mode
- Internal Storage for 20 Waveforms and Notes
- Serial Printer Output for Stored or Displayed Waveforms
- Online Tutorials
- Large Backlit Display

Applications

- Twisted Pair Telephony Maintenance and Repair
- Intermittent Fault Location
- Wet Cable Identification
- Measure Distance to Load Coil
- Identify Opens, Shorts and Splits on POTS Plant

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-462-2200.

CE

ISO 9001

Tektronix measurement products are manufactured in ISO registered facilities.

If your job is to find faults on telephone twisted pair cable, the Tektronix TelScout TS100 is built for you. Designed specifically for telephone local loop applications, the TS100 applies the newest technology to provide both ease of use and telephony performance that cannot be found in any other TDR.

The TS100 is designed for ease-of-use you'll spend less time operating the TDR, and more time repairing faults. Simply select the cable type to be tested and the TS100 does the rest. Impedance, Vp, gain, pulse width, and vertical position are automatically selected and adjusted as you scan the cable. Just move the cursor to the fault to pinpoint its location.

On the performance side, the TS100 employs optimized pulsing and sampling, coupled with advanced filtering and signal processing techniques, to insure the maximum measurement range. That way, you'll always have a clean waveform for easier fault interpretation.

Short Pulse and Coax Option

The short pulse Option 01 provides a 5 ns pulse width for close-in resolution. Faults as near as 3 ft. from the pedestal can be located with ease.

Option 01 also includes a coaxial cable setup menu and an adapter cable. This enables you to locate faults in coaxial cables used in today's emerging broadband systems.

Best of all, you get all this performance in the industry's most rugged TDR package. Come snow, rain, heat and humidity, the TS100 keeps working, because you have to.

CHARACTERISTICS

Test Signal Output –
Standard: 1/2 Sine, balanced.
Opt. 01: 1/2 Sine.

Amplitude –
Standard: 20 ns: 8 V into 105 Ω.
All Other Pulse Widths: 20 V into 105 Ω.
Opt. 01: 5 ns: 2.5 V into 105 Ω.
20 ns: 1 V into 105 Ω.
All Other Pulse Widths: 4 V into 105 Ω.

Output Impedance –
Standard: 105 Ω.
Opt. 01: 105 Ω.

Pulse Widths –
Standard: 20 to 3,000 ns.
Opt. 01: 5 to 3,000 ns.

Input Protection –
±400 V, DC + peak AC, to a maximum of 440 Hz.

Maximum Range –
Standard: 15,000 m (45,000 ft.), depending on cable type and condition.
Opt. 01: 10,000 m (30,000 ft.) depending on cable type and condition.

Display Resolution –
0.33% of selected range, 4.5 cm (0.15 ft.) minimum, on 640 x 200 high-resolution backlit LCD.

Display Ranges – Eleven display ranges plus single-button expand window. Ranges are user definable in manual mode.

Filter – High pass, cutoff frequency 150 kHz, user selectable.

Amplifier- 5 mV reflection produces a full-screen vertical deflection.

Gain – 0 to 63 dB.

Waveform Storage – Up to 20 waveforms with notes.

Horizontal Accuracy –
0 to 5,000 m: ±1 m ± uncertainty in Vp.
5,000 to 15,000 m: ±2 m ± uncertainty in Vp.
0 to 2,000 ft.: ±2 ft. ± uncertainty in Vp.
2,000 to 10,000 ft.: ±3 ft ± uncertainty in Vp.
10,000 to 20,000 ft.: ±4 ft. ± uncertainty in Vp.

Serial Interface – 9-Pin D-type serial connector.

GENERAL CHARACTERISTICS

ENVIRONMENTAL

Temperature –
Operating: –15°C to +60°C.
Nonoperating: –20°C to +65°C.
Humidity: 95% RH, non-condensing.
Shock: (test specification) Survives drop of 2 m to concrete in standard soft case.
EMI Emissions: FCC part 15, subpart J, class A; VFG243 and EN55022.

POWER

Mains Operation –
Voltage Ranges: 110 V, 220 V, 240 V with appropriate AC to DC adapter.

Battery Operation –
Operating Time: 8 hrs. continuous.
Battery Saver: Selectable for 5 to 30 minutes or disabled.

Safety – UL1244, CSA231.

PHYSICAL CHARACTERISTICS

Dimensions	cm	in.
Height	30.0	12.0
Width	25.0	10.0
Depth	9.0	3.5
Weight	**kg**	**lb.**
Net	3.0	6.4

ORDERING INFORMATION

For price information: Outside the U.S. contact your local Tektronix representative, inside the U.S. see the price list in the back of this catalog.

TELSCOUT TS100
Includes: Test Leads (174-3066-01) (two sets), Soft Carrying Case with Shoulder Strap (016-1215-02), U.S. AC Adapter/Charger (119-4242-00) (120 VAC, 60 Hz, 9 V @ 1 A), Cigarette Lighter-DC Adapter, User Manual (070-8778-05), Quick Reference Card (063-2542-00), Rechargeable Internal Battery (146-0098-00), TANM Application Primer (071-0546-00).

Opt. 01 – Adds 5 ns Pulse Width, Coax Setup Menu, and Adapter Cable.

Opt. 1C – Changes U.S. AC Adapter/Charger to 119-4240-00 Universal Euro Adapter/Charger (220 VAC, 1 A).

Opt. 2C – Changes U.S. AC Adapter/Charger to 119-4239-00 United Kingdom Adapter/Charger (240 VAC, 1A).

Opt. 3C – Changes U.S. AC Adapter/Charger to 119-4238-00 Australian Adapter/Charger (240 VAC, 1A).

Opt. 6C – Changes U.S. AC Adapter/Charger to 119-4241-00 Japanese Adapter/Charger (110 VAC, 60 Hz, 1 A).

INTERNATIONAL LANGUAGE OPTIONS
Standard – English.
Opt. L1 – French.
Opt. L4 – Spanish/Portuguese (Spanish default).
Opt. L6 – Portuguese/Spanish (Portuguese default).

MEASUREMENT SERVICE OPTIONS
Opt. C3 – Three years of Calibration Services.
Opt. D1 – Cal Data Report.
Opt. D3 – Test Data (requires Opt. C3).
Opt. R3 – Repair warranty extended to cover three years.

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-462-2200.

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Cable Tester Software

MCTAP

Features – Benefits	Applications
Uploading/Downloading to and/or from the TS100, TS200, TV220	Telephony
Cursor Movement	CATV
Help Screens	
Windows 95/98/NT	
Screen-dumps for Printing or Importing into Word Processor Documents	
Screen-dumps in BMP, JPEG, GIF or TIFF Format	
Export of Waveform Data for Use with Spreadsheet or Word Processor	

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-462-2200.

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MCTAP Trace Analysis Software

MCTAP, Trace Analysis Software for the TS100, TS200, TV220 and TV110 TDRs, allows you to use an IBM PC or compatible to display and analyze waveforms created by the TDR software.

THE MEASUREMENT SCREEN

Once loaded into your PC, the measurement screen appears, displaying a menu bar, a status bar and the waveform display area, which includes a horizontal distance scale. The distance and marker are positioned where they were located at the time the waveform was written into mass storage in the TDR software.

The waveform area of the measurement screen is color coded for easier interpretation of the data.

The control panel allows you to select the waveform to display, the measurement mode and cursor functions. You can also choose various waveform settings:

- Single– or dual-trace, or difference
- Units (Meters or Feet)
- Change and add notes
- V.p.
- Set marker

Ordering Information

For price information:
Outside the U.S. contact your local Tektronix representative, inside the U.S. see the price list in the back of this catalog.

MCTAP
Metallic Cable Trace Analysis Package.
Includes: Disk Pack: Contains one 3.5 in. Floppy Disk; MCTAP User Manual (070-9306-00); RS-232C Cable (012-1379-00).

Telephone TDR Cable Tester

TelScout® TS90



Features – Benefits

- Two Pair Test Capability
- One-step Setup
- Automatic Instrument Control Mode
- 10 km (30,000 ft.) Fault Location Capability
- Splash and Drip Proof
- Single-button Zoom Function
- Pair Comparison Mode
- Splits/Crosstalk Mode
- Measures Distance to Fault in Feet, Meters or Time
- Configurable for Any Cable Type and Vp (0.300 to 1.000)
- Accurate (±3 ft. at 10,000 ft.)
- Online Tutorials
- Large Backlit Display

Applications

- Twisted Pair Telephony Maintenance and Repair
- Intermittent Fault Location
- Wet Cable Identification
- Measure Distance to Load Coil
- Identify Opens, Shorts and Splits on POTS Plant

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-462-2200.

CE

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Tektronix measurement products are manufactured in ISO registered facilities.

If your job is to find faults on telephone twisted pair cable, the Tektronix TelScout TS90 is built for you. Designed specifically for telephone local loop applications, the TS90 applies the newest technology to provide both ease of use and telephony performance that cannot be found in any other TDR.

The TS90 is designed for ease-of-use – you'll spend less time operating the TDR and more time repairing faults. Simply select the cable type to be tested and the TS90 does the rest. Impedance, Vp, gain, pulse width and vertical position are automatically selected and adjusted as you scan the cable. Just move the cursor to the fault to pinpoint its location.

On the performance side, the TS90 employs optimized pulsing and sampling, coupled with advanced filtering and signal processing techniques, to insure the maximum measurement range. That way, you'll always have a clean waveform for easier fault interpretation.

SHORT PULSE WIDTH

The TS90 provides a 5 ns pulse width for close-in resolution. Faults as near as 3 ft. from the pedestal can be located with ease.

RUGGED PACKAGE

Best of all, you get all this performance in a rugged handheld TDR package. Come snow, rain, heat and humidity, the TS90 keeps working, because you have to.

Characteristics

Test Signal Output – 1/2 Sine, balanced.
Amplitude – ≤6 V into 105 Ω.
Output Impedance – 105 Ω nominal.
Pulse Widths – 5 ns to 2,500 ns (automatic).
Input Protection – ±200 V, DC + peak AC, to a maximum of 440 Hz.

Maximum Range – 10,000 m (30,000 ft.) depending on cable type and condition.

Cursor Resolution – 0.4% of selected range.

Display – 5.25-in. high-contrast, high-resolution, backlit LCD, 520 x 200 pixels.

Display Ranges – Eleven automatic display ranges plus single-button expand window.

Filter – High pass, cutoff frequency 150 kHz, user selectable.

Amplifier – 5 mV reflection produces a full-screen vertical deflection.

Gain – 0 to 63 dB.

Horizontal Design Accuracy – 0.01% ± 300 ps ± Vp uncertainty ± cursor resolution.

ENVIRONMENTAL

Temperature –
Operating: 0°C to +45°C.
Nonoperating: –20°C to +60°C.

Humidity – 95% RH, non-condensing.

EMI Emissions –
EN55011 class A.
EN60555-2.

POWER

Battery Operation –
Battery Type: Six AA Alkaline.
Operating Time: >4.5 hrs. with backlight off.
Battery Saver: Selectable for 5 to 30 minutes or disabled.

PHYSICAL CHARACTERISTICS

Dimensions	cm	in.
Height	14.1	5.6
Width	21.1	8.3
Depth	4.3	1.8
Weight	**kg**	**lb.**
Net	1	2.2

ORDERING INFORMATION

For price information: Outside the U.S. contact your local Tektronix representative, inside the U.S. see the price list in the back of this catalog.

TELSCOUT TS90

Includes: Test Leads (two pair) (012-1545-00), Carrying Case (016-1643-00), Alkaline Batteries (six) (146-0115-00), User Manual (071-0062-00), TANM Application Primer (071-0546-00).

OPTIONAL ACCESSORIES

Rechargeable NiCad Battery Pack – THM5BAT.

External Charger for NiCad Battery Pack – THM5CHG.

Includes: DC Adapter, Charger Pedestal and one of following wall transformers (specify when ordering):

Standard – 110 V US.
Opt. A1 – 220 V Universal Euro.
Opt. A2 – 240 V UK.
Opt. A3 – 240 V Australia.
Opt. A6 – 110 V Japan.
D-Ring Hook – Order 354-0745-00.
Service Manual – Order 071-0095-00.

LANGUAGE OPTIONS

Standard – English.
Opt. L1 – French.
Opt. L4 – Spanish/Portuguese (Spanish default).
Opt. L6 – Portuguese/Spanish (Portuguese default).
Opt. LC – Czechoslovakian.
Opt. LD – Dutch/French (Dutch default).
Opt. LF – Finnish.
Opt. LS – Swedish.

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-462-2200.

Product(s) available through your local Tektronix Distributor listed in the back of this catalog.

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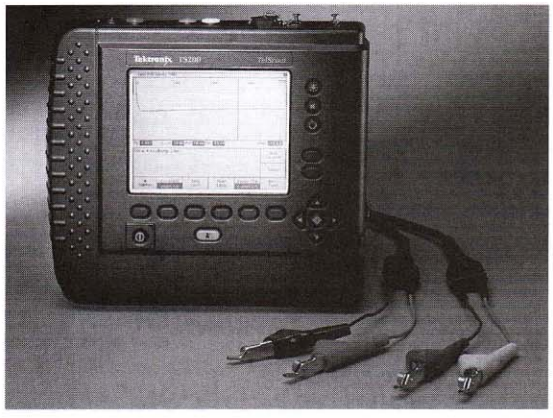
Access Network Analyzer For Telephone Applications

New TelScout® TS200



Features – Benefits

- TestWizard™ – True One-button Testing
- VOM
- Transmission Tests for xDSL, ISDN, and POTS Capability
- Load Coil Counter
- Longitudinal Balance
- Open (Capacitance) Meter
- Resistance Fault Locator
- Full Function TDR with Automatic Multiple Event Marking
- Flexible, Upgradeable Platform
- Complete Online Help and Tutorials
- Rugged Design – Survives 2 m drop
- Extra Large, High-contrast, Backlit Display

Applications

- POTS Maintenance and Repair
- Digital Services Deployment
- Physical Layer Qualification
- Identify Missing Load Coils
- Verify Length of Bridged Taps
- Wet Cable Identification
- Identify Opens, Shorts and Splits

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-462-2200.

CE

ISO 9001

Tektronix measurement products are manufactured in ISO registered facilities.

If your job is to analyze and troubleshoot the access network for analog or digital services, the Tektronix TelScout TS200 is built for you. Designed specifically for telephone access network applications, including xDSL, ISDN, and POTS, the TelScout TS200 applies the newest technology to provide both ease-of-use and telephony performance that cannot be found in any other access network analyzer.

TESTWIZARD ANALYSIS

With the TelScout TS200, you'll spend less time operating the instrument, and more time analyzing and repairing faults. The TelScout TS200 can be configured to perform a variety of tests to meet your specific needs. The strength of the TelScout TS200 is its ability to perform logical test sequences that lead the operator toward potential troubleshooting solutions. With TestWizard analysis, this innovative solution is just a single button press away.

TELSCOUT TS200 – DESIGNED FOR YOUR NEEDS

With true multi-function test capability, the TelScout TS200 is designed for easy upgradeability to meet your future needs. You get all this flexibility and performance in one of the industry's most rugged access network packages. Come snow, rain, heat, and humidity, the TelScout TS200 keeps working, because you have to.

CHARACTERISTICS

XDSL/ISDN/POTS

AC Voltage –
Range: 0 to 300 V.
Resolution: 0.1 V.
Accuracy: ±(1% + 0.5 V).

DC Voltage –
Range: 0 to ±400 V.
Resolution: 0.1 V.
Accuracy: ±(1% + 0.5 V).

Loop Current –
Range: 0 to 300 mA.
Resolution: 0.1 mA.
Accuracy: ±1% @ 60 mA.

Resistance –
Range: 0 to 1 kΩ:
Resolution: 0.1 Ω.
Accuracy: ±(0.9% + 1.0 Ω + 1 count).
Range: 1 kΩ to 100 kΩ.
Resolution: 10 Ω.
Accuracy: ±0.9% + 1 count.
Range: 100 kΩ to 1 MΩ.
Resolution: 100 Ω.
Accuracy: ±1% + 1 count.
Range: 1 MΩ to 100 MΩ.
Resolution: 100 kΩ.
Accuracy: ±6% + 1 count.

Load Coil Counter – Range: 0 to 7 Load Coils.

Ringers –
Range: 0 to 5 REN.
Resolution: 0.1 REN.
Accuracy: ±0.5 REN (C4 type ringers).

Ωs/Distance Calculator –
Resistance Range: 0 to 9999 Ω.
Distance Range: 0 to 60 km (2000 ft.).

Loss –
Frequency Range: 20 Hz to 200 kHz.
Frequency Resolution: 1 Hz.
Frequency Accuracy: ±2 Hz @ 0 dBm.
Level Range: –40 to +10 dBm.
Level Resolution: 0.1 dB.
Level Accuracy:
300 Hz to 4.5 kHz: ±0.5 dB.
40 kHz: ±2.0 dB.
196 kHz: ±4.0 dB.
Z_{in}: 600 Ω (Z_{ref} = 135 Ω above 20 kHz).

Noise –
Range: 0 to 50 dBrnC (dBrnp).
Resolution: 0.1 dB.
Accuracy: ±2.0 dB + Filter Accuracy.
Z_{in}: 600 Ω.

Power Influence –
Range: 40 to 100 dBrnC (dBrnp).
Resolution: 0.1 dB.
Accuracy: ±2.0 dB + Filter Accuracy.

Slope –
Frequency Range: 20 Hz to 200 kHz.
Frequency Resolution: 1 Hz.
Frequency Accuracy: ±2 Hz at 0 dBm.
Level Range: –40 to +10 dBm.
Level Resolution: 0.1 dB.
Level Accuracy:
300 Hz to 4.5 kHz: ±0.5 dB.
40 kHz: ±2.0 dB.
196 kHz: ±4.0 dB.

Preset Tones –
Frequency Range: 404 Hz, 577.5 Hz, 820 Hz, 1004 Hz, 1020 Hz, 2713 Hz, 2804 Hz, 5000 Hz, 28 kHz, 32 kHz, 40 kHz; plus 3-, 6-, and 10-step tone sequences.
Frequency Resolution: 1 Hz.
Frequency Accuracy: ± 2 Hz (20 Hz to 20 kHz).
Level Range: –40 to +10 dBm.
Level Resolution: 1 dB.
Level Accuracy: ±0.5 dB above –25 dBm.

User Defined Tones –
Frequency Range: 20 Hz to 65 kHz.
Frequency Resolution: 1 Hz.
Frequency Accuracy: ±2 Hz (20 Hz to 20 kHz).
Level Range: –40 to +10 dBm.
Level Resolution: 1 dB.
Level Accuracy: ±0.5 dB above –25 dBm.

Longitudinal Balance –
Range: 40 to 62 dB.
Resolution: 0.1 dB.
Accuracy: ±2 dB.

Open Meter –
Range: 0 to 300 m (1,000 ft.).
Resolution: 0.5 m (1 ft.).
Range: 300 m to 60 km (1,000 ft. to 2,000 ft.).
Resolution: 3 m (10 ft.).
Accuracy: ±1% @ 3 km (1,000 ft.).

Capacitance –
Range: 10 pF to 10 nF.
Resolution: 10 pF.
Range: 10 nF to 10 µF.
Resolution: 10 nF.
Accuracy: ±(1% + 50 pF + 1 count) up to 3.5 µF.

Resistance Fault Locator –
Fault Resistance Range: 0 to 40 MΩ.
Distance Range: 0 to 60 km (2,000 ft.).
RTF Range: 0 to 400 Ω.
RTF Resolution: 0.01 Ω.
RTF Accuracy: ±(0.9% ±1.0 Ω + 1 count).
RTF Range: 400 Ω to 4 kΩ.
RTF Resolution: 0.1 Ω.
RTF Accuracy: ± 0.9% + 1 count.
RTF Range: 4 kΩ to 40 kΩ.
RTF Resolution: 1 Ω.
RTF Accuracy: ±0.9% + 1 count.

TDR

Test Signal Output – 1/2 sine, 1.55 to 31 V_{p-p}.
Pulse Widths – 2, 10, 75, 340, 3400 ns.
Output Impedance – 105 Ω typical.
Maximum Range – 15,000 m (45,000 ft.), depending on cable type and condition.
Gain – 0 to 72 dB.
Input Protection – ±400 VDC + peak AC at power line frequencies, maximum duration up to 30 sec.
Waveform Storage – Up to 20 waveforms with notes.
Horizontal Design Accuracy – 0.1% ± 300 ps ± Vp uncertainty ± cursor resolution.
Cursor Resolution – 0.33% of selected range.
Display Ranges – 15 display ranges plus single-button zoom window. Ranges are user definable in manual mode.
Display Modes – Test, Splits (Crosstalk), Test/Reference, Test/Difference/Reference, Difference, Intermittent, Saved, Test/Saved, Test/Difference/Saved, Reference.
Event Marking – TestWizard™ automatic multiple event marking.

GENERAL CHARACTERISTICS

ENVIRONMENTAL

Temperature –
Operating: –15°C to + 60°C.
Nonoperating: –30°C to +65°C.
Performance Characteristics: 0°C to +45°C.

Humidity – 95% RH, non-condensing.

Shock – Survives drop of 2 m (6.6 ft.) to concrete in standard soft case.

STANDARDS COMPLIANCE

ISO9001.
CE.
UL 3111.1.
CAN/CSA-C22.2 #1010.1.
89/336/EEC.
73/23/EEC.
EN55011.

POWER

Mains Operation – Voltage Ranges: 100 V, 110 V, 230 V, 240 V with appropriate AC to DC adapter.

Battery Operation –
Operating Time: 8 hours at 50% duty cycle with internal NiMH battery.
Battery Saver: Selectable from 1 to 30 minutes or disabled.
Removable Battery Holder: Supports "AA" (LR6) alkaline batteries.

PHYSICAL CHARACTERISTICS

Dimensions	cm	in.
Height	22	8.5
Width	25	10
Depth	7	2.7
Weight	**kg**	**lb.**
Net	2.4	5.4

INTERFACES

Display – High resolution VGA, 640 x 480 pixels, 6.2-inch high contrast. Operator switchable backlight.
Serial Port – 9-pin D-type serial connector.
Speaker – In POTS only or combo configurations (Options 02 and 03).

WARRANTY

One year parts and labor.

ORDERING INFORMATION

For price information: Outside the U.S. contact your local Tektronix representative, inside the U.S. see the price list in the back of this catalog.

TELSCOUT TS200 ACCESS NETWORK ANALYZER

Includes: Test Leads (012-1552-00), Soft Carrying Case (016-1690-00), U.S. AC Adapter/Charger (119-6031-00), U.S. Line Cord (161-0228-00), Vehicle DC Adapter (012-1553-00), Internal NiMH Battery (146-0126-00), Alkaline Battery Adapter (352-1071-00), User Manual (071-0069-00), TANM Application Primer (071-0546-00).

TS200 FUNCTIONALITY OPTIONS

(must choose one)

Opt. 01 – TDR capability.

Opt. 02 – xDSL/ISDN/POTS capability (includes Waist Strap, 346-0292-00).

Opt. 03 – TDR and xDSL/ISDN/POTS capability (includes Waist Strap, 346-0292-00).

Opt. 04 – Identify missing loads capability*[1].

[1] Must specify Opt. 02 or 03 with this option.

INTERNATIONAL POWER PLUGS

Opt. 1C – Universal Euro 220 V, 50 Hz (161-0066-09).
Opt. 2C – UK 240 V, 50 Hz (161-0066-10).
Opt. 3C – Australian 240 V, 50 Hz (161-0066-11).
Opt. 6C – Japan 110 V, 50 Hz (161-0288-00).
See page 619 for description.

TS200 RECOMMENDED ACCESSORIES

Hard Travel Case – Order 016-1210-00.
Strand Hook – Order RFMSHA.
D-Ring Hook – Order 354-0745-00.
Waist Strap – Order 346-0202-00.
PC Software for TDR – Order MCTAP.
Serial Printer Cable, DB9-to-DB9 – Order 012-1379-00.
Serial Printer Cable, DB9-to-DB25 – Order 012-1313-00.
Coaxial Cable Adapter, 75 Ω Banana-to-Type F – Order 174-3525-00.
Service Manual – Order 071-0070-00.
Extra Battery Pack – Order 146-0126-00.

INTERNATIONAL LANGUAGE OPTIONS

Standard – English.
Opt. L1 – French.
Opt. L3 – German.
Opt. L4 – Spanish.
Opt. L5 – Japanese.
Opt. L6 – Portuguese.
Opt. L7 – Chinese (Simplified).
Opt. LA – Australian.
Opt. LC – Czech.
Opt. LD – Dutch.
Opt. LF – Finnish.

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-462-2200.

CE

ISO 9001

Tektronix measurement products are manufactured in ISO registered facilities.

TDR Cable Tester for CATV

CableScout™ TV220



Features – Benefits

- Excellent for Digital Services Provisioning
- Easy to Use – Anyone Can Use It
- TestWizard™ – One-button Testing
- Automatic Return Loss Measurements
- Automatic Multiple Event Marking
- High-resolution, Short Pulse Width (1 ns)
- Withstands a Two Meter Drop
- Large, Backlit, High-resolution Display (640 X 440), 7.2 in. Diagonal
- Internal Memory for 20 Waveforms and Notes
- Serial Printer Output for Stored or Displayed Waveforms

Applications

- Digital Service Provisioning
- Locate Sources of Signal Reflections
- Find Bad Splices, Poor Connections that Can Degrade BER

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: TVC Technology Group, Phone: 1-800-233-7600, FAX: 1-717-263-1547.

CE

ISO 9001

Tektronix measurement products are manufactured in ISO registered facilities.

The TV220 delivers high performance, yet is so easy to use that little or no training is required. This leading edge TDR can test more system bandwidth and expose faults that have been previously invisible to TDR yet still an impairment to digital signals, and the TV220 introduces one-button testing.

TESTING AT HIGHER BANDWIDTH

Because the TV220 tests at a high bandwidth (it uses a 400 MHz acquisition system), it tests more of your system capacity. This enables users to pinpoint more faults that can cause micro-reflections which can degrade digital transmission BER. Only the TV220 has the bandwidth to enable you to find problems that may exist only at higher frequencies.

HIGH SNR

The TV220 also has extremely high signal-to-noise ratio (SNR). Tektronix proprietary circuit designs reduce the noise level so that "bumps" on the trace represent real faults, not just noise. Events that were previously difficult or impossible to find are clearly visible (because the noise is much lower) with the TV220. This means that you can clearly see faults further away.

HIGH RESOLUTION

High-resolution performance allows the TV220 to locate problem components in the customer drop. The TV220 uses a pulse width of only 1 ns which means the operator can clearly identify multiple events that are less than 2 feet apart. This enables the technician to tell which of two components on a cable is causing the problem, even when they're close together. This is particularly important in troubleshooting drops, because components such as splitters and ground blocks can be very close together.

TESTWIZARD™ TESTING

But the most innovative feature in the TV220 is TestWizard automated testing and event marking. Now, instead of meticulously setting up the TDR and then carefully interpreting the meaning of the displayed waveform, you push one button to get a high-resolution, low-noise trace, with the

events clearly marked. This means substantial savings in training time and reduced time to get accurate, repeatable measurements.

CHARACTERISTICS

OUTPUT

Test Signal Output – 1/2 Sine.
Amplitude – 4 V into 75 Ω.
Pulse Width – 1 ns, 5 ns, 25 ns.
Output Impedance – 75 Ω.
Acquisition System Bandwidth – 400 MHz.

TESTWIZARD™ TESTING

Automatically marks faults. Operator choice of three levels of event marking:
Mark largest event.
Mark three largest events.
Mark all events.

Return Loss –
Automatic at cursor location.
Resolution: ±1 dB.

Input Protection – ±400 VDC + peak AC up to 440 Hz, 30-second duration.

Gain – 0 to 72 dB.

Waveform Storage – Minimum of 20 waveforms with notes.

Distance Accuracy –
Feet:
0 to 2,000 ft.: ±2 ft. ± uncertainty in Vp.
2,001 to 6,000 ft.: ±3 ft. ± uncertainty in Vp.
6,001 to 12,000 ft.: ±4 ft. ± uncertainty in Vp.
Meters:
0 to 610 m: ±0.6 m ± uncertainty in Vp.
610 to 1830 m: ±0.9 m ± uncertainty in Vp.
1830 to 3658 m: ±1.2 m ± uncertainty in Vp.

ENVIRONMENTAL, EMC, SAFETY

Temperature –
Operating: –10°C to +40°C (+11°F to +104°F).

Humidity – 10% to 95% (noncondensing).

Field Usage – Shock, water and dust resistant.

Durability – Survives drop of 2 meters (6 ft.) to concrete in standard soft case. Drip proof, dust resistant.

Safety –
UL3111-1, CSA1010.1, EN61010-1.
CE (Low Voltage Directive).

POWER

AC Operation –
Voltage Ranges: 110 V, 220 V or 240 V with appropriate AC to DC adapter.
Line Frequency: 50 Hz to 60 Hz.

DC Operation –
Voltage Range: 9 to 16 VDC @ 1 A (charging and operating).

Battery Operation –
Type: Internal lead acid rechargeable battery.
Operating Time: Typically 8 hours continuous operation (backlight off).

PHYSICAL

Dimensions	cm	in.
Height	24	9.5
Width	30	11.5
Depth	9	3.5
Weight	**kg**	**lb.**
Net	3	6.4

WARRANTY

One year.

ORDERING INFORMATION

For price information: Outside the U.S. contact your local Tektronix representative, inside the U.S. see the price list in the back of this catalog.

CABLESCOUT TV220 TDR

Includes: BNC-to-Alligator Clips Test Leads, 2 m Coaxial Jumper Cable, F-to-BNC Barrel Adapter, F-to-F Barrel Adapter, F-Type to KS Test Adapter, Soft Carrying Case with Shoulder Strap, U.S. AC Adapter/Charger (120 VAC, 60 Hz, 9 V @ 1 A), DC Cigarette Lighter Adapter Cable, User Manual, Quick Reference Card, Rechargeable Internal Battery.

OPTIONS

Opt. 1C – Changes Adapter/Charger to 119-4240-00 Universal Euro Adapter/Charger (220 VAC).
Opt. 2C – Changes Adapter/Charger to 119-4239-00 United Kingdom Adapter/Charger (240 VAC).
Opt. 3C – Changes Adapter/Charger to 119-4238-00 Australian Adapter/Charger (240 VAC).
Opt. 6C – Changes Adapter/Charger to 119-4241-00 Japanese Adapter/Charger (240 VAC).
Opt. L2 – Italian language.
Opt. L4 – Spanish language.
Opt. R3 – Extends repair protection to three years.

OPTIONAL ACCESSORIES

Hard Travel Case – Order 016-1210-00.
Service Manual – Order 070-9946-00.

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: TVC Technology Group, Phone: 1-800-233-7600, FAX: 1-717-263-1547.

CE

ISO 9001

Tektronix measurement products are manufactured in ISO registered facilities.

TDR Cable Tester for CATV

CableScout™ TV90



Features – Benefits

- Large, High-resolution, Backlit Display
- Splash, Dust and Shock Resistant Packaging
- Easy to Use – Anyone Can Use It
- One Button Expand/Full-view Function
- 75 Ω F Connector
- Intermittent Fault Location
- Context-sensitive Help (Help Screens Available for All Functions)
- Small, Portable, Lightweight Package (2.2 lbs.)
- Accurate (±2 ft. up to 200 ft., 1% beyond)
- 4000-Foot Fault-location Capability
- Internal Cable Types for Fast, Accurate Testing

Applications

- Find Location of Damage In Drops
- Find Impedance Mismatches
- Locate Bad Passive Devices
- Determine Length of Cable

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: TVC Technology Group, Phone: 1-800-233-7600, FAX: 1-717-263-1547.

CE

ISO 9001

Tektronix measurement products are manufactured in ISO registered facilities.

If your job is to find faults on coaxial cable, the new Tektronix CableScout TV90 is built for you. Designed specifically for CableTV and other coaxial cable applications, the TV90 applies the newest technology to provide both ease of use and coaxial cable testing performance not found in any other TDR.

With the TV90, you'll spend less time operating the TDR and more time repairing faults. Simply select the cable type to be tested and the TV90 does the rest. Pulse width, Vp, gain and vertical position are automatically selected and adjusted as you scan the cable. Finding the fault couldn't be faster, just move the cursor to the fault and use the one-button zoom function to pinpoint its location.

The TV90 employs optimized pulsing and sampling, coupled with advanced filtering and signal-processing techniques. You always have a clean waveform for easiest event identification.

SHORT PULSE WIDTH

The TV90 uses a 6 ns pulse width for close-in resolution. Faults as near as 3 feet from the pedestal are located with ease.

RUGGED PACKAGE

Best of all, you get all this performance and ease of use in a small, light, rugged TDR package. Come snow, rain, heat or humidity, the TV90 keeps working because you have to.

Characteristics

Test Signal Output –
1/2 sine.
Amplitude (into 75 Ω) –
6 ns pulse: 5 V.
12 ns pulse: 6 V.
Pulse Widths – 6 and 12 ns.
Output Impedance – 75 Ω.

Input Protection – 200 V, DC + peak AC to a maximum of 440 Hz, 30 second duration.

Display Ranges – Eight automatic display ranges.

Gain – 0 to 63 dB.

Filter – High pass, cutoff frequency 150 kHz, plus averaging.

Distance Accuracy –
0 to 200 ft: ±2 ft .
Beyond 200 feet: 1% + zero offset.

Display –
Resolution: 520 x 200 pixels.
Size: 5.25 inches.
Type: High contrast LCD.
Backlight: Operator switchable.

Distance Measurements – Meters, feet, nanoseconds.

Auto Shutoff Time –
Operator selectable:
5 to 30 minutes.
Disabled.

ENVIRONMENTAL

Temperature Range –
Operating: 0°C to +45°C.
Nonoperating: –20°C to +60°C.

Humidity – Operating: 95% RH, non-condensing at +30°C to +40°C.

Field Usage – Shock, splash and dust resistant.

EMI EMISSIONS

EN55011, Class A.
FCC Part 15, Subpart B, Class A.

POWER

Battery Operation –
Battery Type: Six AA alkaline.
Operating Time: Over 4.5 hours with backlight off.

PHYSICAL CHARACTERISTICS

Dimensions	mm	in.
Height	141	5.6
Width	211	8.3
Depth	43	1.8
Weight	**kg**	**lb.**
Net	1	2.2

WARRANTY

One year parts and labor.

Ordering Information

For price information: Outside the U.S. contact your local Tektronix representative, inside the U.S. see the price list in the back of this catalog.

TV90
CableScout TDR.

Includes: BNC Female-to-Alligator Clips, 2 m Coaxial Jumper Cable, F-to-BNC Barrel Adapter, F-to-F Barrel Adapter, F-to-KS Test Adapter, Soft Carrying Case, Users Manual, Six AA Alkaline Batteries.

OPTIONS

Opt. C3 – Three years of Calibration Services.
Opt. D1 – Cal Data Report.
Opt. D3 – Test Data (requires Opt. C3).
Opt. R3 – Extends repair protection to three years.

RECOMMENDED ACCESSORIES

Strand Hook (D-Ring) – Order 354-0745-00.
Service Manual – Order 071-0095-01.
Rechargeable NiCad Battery Pack – THM5BAT.
External Charger for NiCad Battery Pack – THM5CHG. Includes: DC Adapter, Charger, Pedestal and one of the following wall transformers (specify when ordering):
Standard – 110 V US.
Opt. A1 – 220 V Universal Europe.
Opt. A2 – 240 V UK.
Opt. A3 – 240 V Australia.
Opt. A6 – 110 V Japan.

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: TVC Technology Group, Phone: 1-800-233-7600, FAX: 1-717-263-1547.

CE

ISO 9001

Tektronix measurement products are manufactured in ISO registered facilities.

Subscriber Loop Portable Test Set

CrafTek™ CT-100 • Opt. 2A • Opt. 3B



Features – Benefits	Applications
Automated BER Testing	Telephony
Dual Simultaneous Call Control	ISDN Performance
Sealing Current	PC Communication
P-Phone EBS Verification	
Signaling Channel	
DC Voltage	
Internet Access Testing	

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-462-2200.

NOT AVAILABLE IN EUROPE.

ISO 9001

Tektronix measurement products are manufactured in ISO registered facilities.

Subscriber Loop Portable Test Set CrafTek CT-100

The CrafTek Subscriber Loop Test Set is designed to meet the changing needs of the telephony craftsperson, with flexibility to handle rapidly evolving and increasingly sophisticated digital technologies.

The CrafTek CT-100 allows today's work force to troubleshoot problems in the subscriber loop, without retraining. An easy-to-understand human interface, backed by a self-prompting, plain English display featuring extensive error messaging, allows the instrument to be put to work within minutes.

As the craftperson's primary installation and maintenance tool, the CrafTek CT-100 meets high standards for ruggedness, portability and reliability. In addition to traditional analog POTS service, the portable test set provides comprehensive ISDN and P-Phone measurements and indicators for rapid performance verification and fault diagnosis. New services can be provided more efficiently, customer downtime minimized and problems quickly resolved using the CrafTek CT-100 servicing solution.

CrafTek CT-100 RS-232 Serial Interface Troubleshooting Opt. 2A

PACKET DATA TESTING OVER RS-232

In the data sourcing mode, the RS-232 interface allows the user to connect a terminal and initiate X.25 packet-switched data calls over an ISDN data channel. This mode is useful when accessing packet gateways requiring more than a simple phone number (e.g., passwords) or to more fully verify D-channel user applications.

The operator connects their computer's serial interface to the unit's auxiliary jack (DB25-to-RJ45 adapters included). A PC communications software package can then be used to send standard Hayes-compatible modem commands to setup and maintain a D-channel packet call.

Characteristics

OPERATING

Display – Supertwist Liquid Crystal (LCD), Backlit.
User Interface – Easy-to-use menus with extensive user prompts and error messages via 4-line x 20 character LCD.
Easy Configuration – Provides a step-by-step procedure for instrument setup.
Easy View – Provides a convenient way to review CrafTek status and settings.

Power Supply – Rechargeable NiCad battery pack. Alkaline "C" cells or 120 VAC with adapter. "Low Battery" and "Charging" indicators via LCD. Automatic shut-off.
Interface Ports – Four RJ45 type jacks (LINE, S/T(NT1), S/T(TE), Auxiliary).
Speed Dial – Storage for ten numbers (up to 22 digits per number) plus last number redial.

POTS

Dial Modes – DTMF, Pulse.
Functions – Meets monitor mode, talk mode and acoustic response requirements as specified in Bellcore TR-TSY-000344.
Measurements – Polarity.
CLASS – Support of "Customized Local Access Signaling Services" (Calling Line ID, Calling Name; with buffer).

ISDN TE

TE Compatibility – AT&T terminal equipment, NORTEL terminal equipment and National ISDN equipment.
Software Generics – Currently compatible with AT&T software generics up to and including 5E9, NORTEL DMS-100 up to and including BCS-36; National ISDN-1 (AT&T, NORTEL, Siemens).
TE Functions – Provides basic voice services plus redirect. Supports BRITL (Basic Rate Interface Test Line). Supports D channel X.25 Packet Data testing. Supports call setup for multiple bearer services (speech, 3.1 kHz audio, 64 kbps and 56 kbps circuit switched data). Allows both B channels to be active simultaneously.
S/T Interface – Complies with T1.605-1991 ISDN Basic Rate Interface Specifications.
"T" Terminations – Selectable: Bridged, 100 Ω.
"T" Pad Attenuation – Range: 0 to 15 dB; Resolution: 1 dB.
"T" Synchronization – LED: Red=No sync; Orange=Sync, not activated; Green=Sync, activated.
Hook LED – Red=awaiting dial tone; Orange=negative acknowledgement; Green=dial tone/active call.

ISDN NT1

AMI Interface (Opt. 1B) – Meets specifications defined in AT&T Technical Reference 801-802-100 for AMI Loop Interface.
2B1Q Interface – Meets specifications defined in ANSI T1.601-1992 Standard. Complies with all 15 defined ANSI "U" loops. Supports Quiet and Insertion Loss modes (AC/DC Triggers).
S/T Terminations – Selectable: Bridged, 100 Ω, 50 Ω.
"U" Pad Attenuation – Range: 0 to 42 dB; Resolution: 1 dB.
"U" Synchronization – LED: Red=No Sync; Orange= Sync, not transparent; Green=Sync, transparent.

ISDN MEASUREMENT AND INDICATORS

Block Errors (NEBE/FEBE) – Total errors, errored seconds, selectable elapsed time.
Sealing Current – Presence with polarity indication.
2B1Q Battery – Presence with polarity indication.
Local Power – Presence with polarity indication.
S/T Power Sources 1, 2 and 3 – Presence with polarity indication.
TE Receive Level – Range: –9 dB to +3 dB; Resolution 0.5 dB.
Indicators via LCD – INFO ("F" and "G") States, LAPD and CALL States, B channel, Current Call (A or B), TEI Number, ANI Number, CAUSE and EOC messages, Sealing Current.
BER Testing – Provides 64 kbps and 56 kbps BER Testing on either B channel or both B channels simultaneously.
B-Channel Loopback – Allows either B channel to be placed on loopback mode.
D-Channel – Provides X.25 packet data testing, including integrated "fox" message transmission.
40 kHz Test Tone Generation – Output 0 dBm ±2 dB.

P-PHONE (EBS)

P-Phone Interface (Opt. 3B) – Provides support for NORTEL "Enhanced Business Service", including phone emulation for primary set, add-on sets and Monitor mode (allows monitoring of voice and signaling channels); 2 x 16 message display.
P-Phone Measurements – DC Voltage and Polarity; Peak signal level of 8 kHz signaling channel; Signaling message elements (hex and decoded displays, with buffer).

RS-232 SERIAL PORT

RS-232 Interface (Opt. 2A) – Provides an RS-232 interface for D-channel packet data sourcing. Also supports data logging to a printer or terminal (ISDN protocols; measurements; EBS signaling; CLASS messages).

ENVIRONMENTAL

Physical Environment – Designed for rugged field use. Weather, moisture, dust and shock resistant.

PHYSICAL CHARACTERISTICS

Dimensions	mm	in.
Length	27.31	10.75
Width	8.38	3.3
Depth	8.26	3.25
Weight	**kg**	**lbs.**
Net w/NiCad battery pack	1.53	3 lbs. 6 oz.

Safety – UL1244, CSA231.

ORDERING INFORMATION

For price information: Outside the U.S. contact your local Tektronix representative, inside the U.S. see the price list in the back of this catalog.

CRAFTEK CT-100
Subscriber Loop Portable Test Set.

MEASUREMENT SERVICE OPTIONS
Opt. R3 – Repair warranty extended to cover three years.

ACCESSORIES
User Manual – Order 070-7895-08.
Reference Guide – Order 070-7921-08.
Pocket Reference – Order 070-9632-00.
Rechargeable Battery Pack – Order 016-1072-01.
AC Adapter/Charger – Order 119-2731-00.
D6AM (6-Pin Jack) Cord – Order 012-1363-00.
D8W (8-Pin Jack) Cords – Order 012-1364-00.
RJ11 to Angled-Bed-Of-Nails Clips – Order 012-1365-01.
Soft Padded Carrying Case – Order 016-1073-00.
Warranty – One year.

FIELD UPGRADES
For upgrading existing units with new interface options and firmware features, contact your Tektronix Representative.

OPTIONAL ACCESSORIES
Opt. 1B – AT&T AMI "U" Interface.
Opt. 2A – RS-232 Interface.
Opt. 3B – EBS P-Phone Interface.
Opt. 46 – RJ45 to Angled-Bed-Of-Nails Clips. Order 012-1366-01.
Portable RS-232 Printer – Order 119-4594-00.

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-462-2200.

ISO 9001
Tektronix measurement products are manufactured in ISO registered facilities.

Cable TV RF Analyzer

SignalScout™ RFM151



Features – Benefits

- Digital Channel RF Measurement Suite Includes Average Power Level Plus Noise/Distortion Measurement
- Exclusive Ingress Monitor Mode Records Ingress Violations of up to 32 User-defined Frequency and Level Windows
- Enhanced Spectrum Mode Increases Ability to Capture Low-level and Bursty Signals
- User-changeable Battery Pack with Optional External Charger for Uninterrupted Use
- Control and Analysis Software Includes Ingress/Spectrum Analysis Capability and Report Generation

Applications

- Digital Channel Level and Noise Testing
- Ingress Monitoring and Troubleshooting
- Cable System Leak Tracking
- Analog Channel Performance Verification and Troubleshooting

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: TVC Technology Group, Phone: 1-800-233-7600, FAX: 1-717-263-1547.

CE

ISO 9001

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DVB Digital Video Broadcasting

The Cable TV RF Anaylyzer RFM151 provides all of the basic signal level measurement capabilities, plus spectrum analysis, ingress and digital channel RF measurement capabilities not available in comparable products!

DIGITAL CHANNEL AVERAGE POWER

The RFM151's stepped integration method efficiently and accurately delivers the true average power of QAM, QPR, QPSK or VSB digital channels.

The Peak Analog-to-Digital Average Power Level Difference measurement makes short work of verifying power loading in mixed analog and digital systems. Use it to set digital modulator levels referenced to the analog carriers.

DIGITAL IN-CHANNEL NOISE

The Desired-to-Undesired Signal Ratio is an in-channel (out of service) average power-to-noise measurement that includes noise, as well as distortion signals, such as ingress and analog system-generated CSO and CTB.

ENHANCED SPECTRAL ANALYSIS

The RFM151's Spectrum Mode allows technicians to troubleshoot most problems before calling for more advanced equipment. Spectrum Mode Features include:

- AM and FM demodulators
- Dual markers
- Noise marker
- Window Sweep (fast sweep)
- Max hold
- Preamp control
- Peak/average detection

INGRESS TROUBLESHOOTING

Low-level ingress measurements can be taken in common path locations – such as a tap or seizure screw. The RFM151 is able to display return-path bursty signals and low-level ingress down to –65 dBmV (–5dBμV) to help locate the ingress source.

INGRESS MONITORING

Another unique RFM151 feature is the Ingress Monitor Mode which allows up to 32 frequency windows to be defined within the displayed spectrum, each with its own level threshold.

MEASUREMENT MODES

The RFM151 also performs the following measurements: Carrier-to-Noise, Hum, FM Deviation and Field Strength. Carrier-to-Noise can be configured for either In-Service (using the guard band) or Out-of-Service (with a user-settable frequency offset).

The Relative Field Strength mode allows the user to select a frequency between 5 and 1080 MHz and use an optional antenna to locate a leak of the signal of interest.

THREE-YEAR WARRANTY

RFM151 performance is backed by a Tektronix warranty covering parts and labor for three years. Accessories for the RFM151 are covered for a period of 90 days. Warranty specifics can be obtained from Tektronix or its subsidiaries.

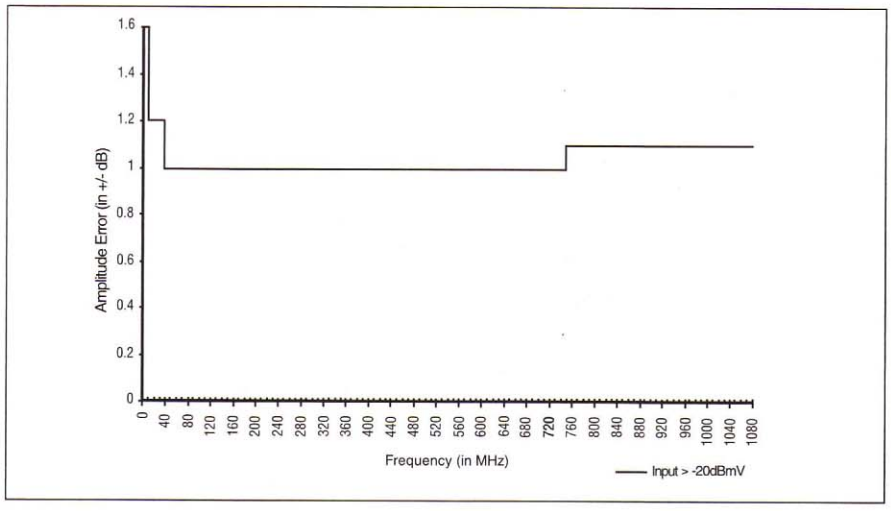

Chart 1. Analog/digital amplitude accuracy.

CHARACTERISTICS

FREQUENCY

Range – 5 to 1080 MHz.
Accuracy – ±5 kHz or $\pm 10^{-5}$ of tuned frequency, which ever is greater.

ANALOG AND DIGITAL LEVEL MEASUREMENTS

Sensitivity – -35 to 60 dBmV (+25 to +120 dBµV).
Repeatability – ±0.5 dB.
Accuracy – See Chart 1.

DIGITAL-TO-ANALOG CARRIER DIFFERENCE

Accuracy – ±2 dB.

IN-BAND CARRIER TO NOISE

Accuracy – ±2 dB.
Range – Up to 51 dB with carrier amplitude >5 dBmV, modulation removed.

GUARD BAND CARRIER TO NOISE

Accuracy – ±2 dB.
Range – Up to 47 dB with carrier amplitude >0 dBmV.

DESIRED TO UNDESIRED

Measurement Location – In channel (Out of Service).
Accuracy – ±2%.

HUM

Accuracy – ±1%.

ENVIRONMENTAL

Temperature – Operating: 0 to +50°C (+32 to +122°F).
Humidity – Operating: 5 to 95% from 0 to +50°C.

POWER

DC Input Range – +10 to +15 VDC.
Power Requirement – 10 W maximum.
Battery Type – User replaceable.
Battery Life – 2.75 Hr.

PHYSICAL CHARACTERISTICS

Dimensions	mm	in.
Height	200.0	8.0
Width	285.0	11.2
Depth	114.0	4.5
Weight	**kg**	**lb.**
Net	3.86	8.5

WARRANTY

Three year parts and labor.

ORDERING INFORMATION

For price information: Outside the U.S. contact your local Tektronix representative, inside the U.S. see the price list in the back of this catalog.

RFM151
SignalScout Cable TV RF Analyzer.
Includes:
Instruction Manual (070-9959-00),
Quick Reference Card (061-4121-00),
120 VAC Power Pack (119-4855-00),
Precision Female-Female Type F Adapter (103-0301-00),
RS232C DB-9-Male-Female Cable,
Padded Carrying Case (016-1642-00),
Vehicle Power Adapter (119-4860-00),
CSS151 Software (070-9959-00).

RFM151 OPTIONS
Opt. C3 – Three years of calibration services.

INTERNATIONAL POWER SUPPLY OPTIONS
Opt. A1 – Universal Euro 220 VAC.
Opt. A2 – UK 240 VAC.
Opt. A3 – Australian 240 VAC.
Opt. A6 – Japan 120 VAC.

RFM151 RECOMMENDED ACCESSORIES
Replaceable Battery Pack – Order RFMBAT.
External Battery Charger for RFMBAT – Order RFMCHG.
Strand Hook Adapter – Order RFMSHA.
Sniffer Antenna – Order RFMANT.
Thermal Printer – Order DMAPRN.
Precision BNC-to-F Series Adapter – Order 103-0310-00.

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: TVC Technology Group, Phone: 1-800-233-7600, FAX: 1-717-263-1547.

CE

ISO 9001

Tektronix measurement products are manufactured in ISO registered facilities.

Cable TV Spectrum Analyzer

2715



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CE

ISO 9001

Tektronix measurement products are manufactured in ISO registered facilities.

GPIB IEEE-488

Product(s) complies with IEEE Standard 488.1-1987, and with Tektronix Standard Codes and Formats.

Features – Benefits

IN-SERVICE RF TESTING FROM TEKTRONIX

Digital Channel Measurements Are Ready When You Are – Characterize Averaged Power; Check Noise and Distortions that Can Worsen BER – Applicable to QAM, QPSK, QPR, VSB and OFDM Signals

Addresses All FCC Proof of Performance Measurements

Enhanced Troubleshooting Power with Built-in Preamplifier, Audio and Video Demodulation – All Standard

Frequency Coverage to 2.15 GHz, with Opt. 50 and 75, Can View Downconverted Satellite Signals (L-Band)

Includes Windows-compatible PC Software for Programmed Measurement Configuration, Data Collection, Measurement Results Printouts, Limits Checking, Alarming and Control of a Locally or Remotely-located 2715

High Portability, Four Digital Displays for Spectral Display Storage and Comparison, Plus True Analog, Continuous Gray Scale Display for Detecting Low Level Beats and Spurs Amidst Noise and Active Video

Applications

In-service Proof-of-performance Tests

Digital Service Installation and Troubleshooting

Ingress Detection

DIGITAL AND ANALOG TESTING FOR HYBRID NETWORKS

The 2715 Cable TV Spectrum Analyzer now includes automated tests for both analog and digitally-modulated channels. When you are ready to begin installing digital transmission of video, data or voice, the 2715 is ready to help. After setting up the 2715 with the new, companion Cable TV RF Measurement Software for Windows, the analyzer automatically determines the correct measurements for each channel type – analog, digital, FM or pilot.

DEPENDABLE, IN-SERVICE ANALOG CARRIER MEASUREMENTS AT AN AFFORDABLE PRICE

Now you can make more proof of performance and other cable system measurements without disruption of service to subscribers. And you can minimize the inconvenience of making measurements at the output of set-top converters. The 2715 provides accurate and automated measurement of carrier-to-noise, in-channel response and coherent distortion signals as well as carrier levels, frequencies and more...

without removal of video carriers or modulation. In-service measurement of CTB requires an unoccupied channel adjacent to the test channel.

CHARACTERIZE YOUR DIGITAL CHANNELS

Channel averaged power, noise and distortions on digitally modulated channels can all be measured by the 2715. It's important to understand the performance of each of the digital channels in your system as well as their interaction with your analog channels. Both broadband random noise-like distortions and coherent distortions – plus noise – can be measured. They all can degrade the bit-error-rate behavior of your digital signals. The 2715 includes digital channel averaged power, desired-to-undesired signal power ratio (D/U) and CTB/CSO measurement. You also can verify the spectral occupancy of your digital modulators with an adjacent channel leakage (ACL) measurement. The distortion and noise measurements require a brief removal of the digital signal. You get all this capability in a 23.5 lb., compact, easy-to-carry package . . . at an attractive price. All of the common cable system spectral measurements are built in and menu-selectable including those needed to address field FCC proof of performance requirements. An accompanying Microsoft Windows-compatible PC software package adds measurement configuration, data collection, measurement results printouts, limits checking, alarming and more.

What used to be complicated measurement procedures, even for engineering, are now push-button simple. Technicians can easily perform extensive cable system analysis and data collection in the field, all automatically.

Measurements and data collection can also be done remotely under computer control. Or the 2715 can be left unattended to run automatic measurements and data collection initiated by the built-in real-time clock. Data collected in the field can be transferred from the 2715's memory via an RS-232 or GPIB interface to a PC. The 2715's accompanying Windows PC software package includes easy transfer of data to your choice of Windows-compatible spreadsheet or database programs for customizing analysis or reports.

CHARACTERISTICS

The following specifications and features apply after a 15 minute warm-up period and after all normalizations, including reference normalizations, have been performed. CATV characteristics represent typical performance and are dependent on general spectrum analyzer specifications. CATV characteristics need not be verified independently providing that all spectrum analyzer specifications are verified.

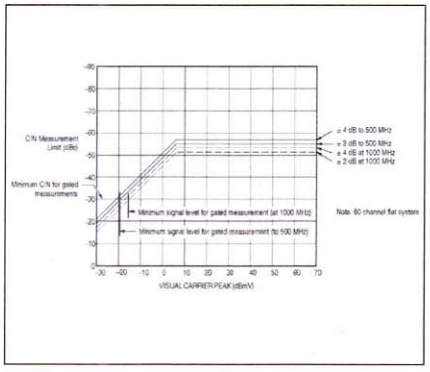

Figure 1.

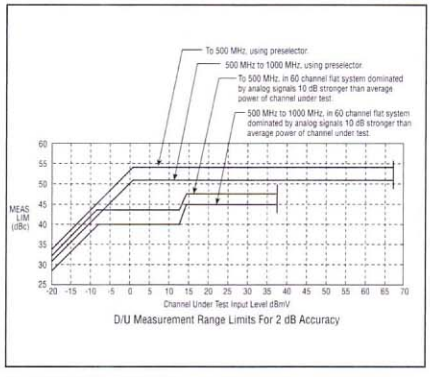

Figure 2.

CABLE TV MEASUREMENTS

Channel Selection –
Visual and aural carriers displayed when channel number is entered or front-panel selected.
Channel Range: 0 to 999; configured using 2715 PC software.
Frequency Range: 1 MHz to 2.15 GHz; dependent on selected Channel Table.

Visual Carrier Frequency –
Measured with internal counter to 1 Hz resolution with accuracy of $5x10^{-7}$ x Carrier Frequency ±10 Hz ±1 Least Significant Digit.

Visual-to-aural Carrier Frequency –
Aural carrier measured with internal counter relative to visual carrier.
Accuracy: ±15 Hz for visual-to-aural carrier difference ≤8 MHz.

Visual Carrier Peak Level –
Absolute Accuracy: ±2.5 dB for visual carrier to noise ≥30 dB (300 kHz RBW); for FM signals, carrier to noise ≥33 dB (100 kHz RBW).
Relative Accuracy: ±0.5 dB relative to adjacent channel, ±1.2 dB relative to all others.

Visual-to-aural Carrier Level Difference –
Accuracy: ±0.75 dB for aural carrier to noise ≥15 dB (300 kHz RBW).

Digital Channel Averaged Power –
Absolute accuracy: ±2.5 dB.

Carrier to Noise –
Range and Accuracy: See Figure 1.
Gated, in-service measurement is in-band; non-gated, in-service measurement is at guard band below channel boundary.

Digital Channel Desired to Undesired Ratio –
Channel averaged power is divided by total noise plus distortion power in the channel.
Range and Accuracy: See Figure 2.

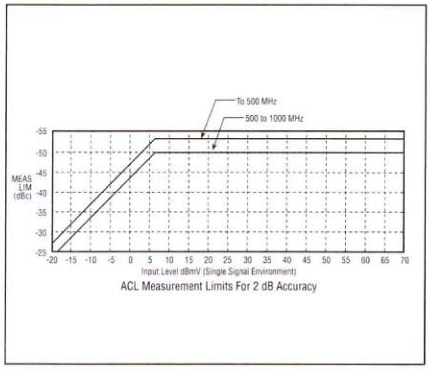

Figure 3.

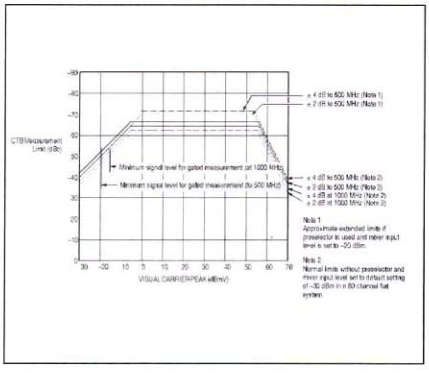

Figure 4.

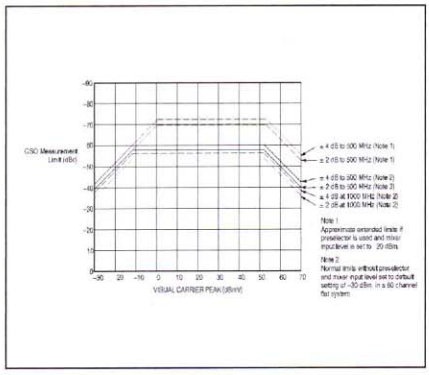

Figure 5.

Modulation Depth –
% AM measured from sync tip to lowest white level in 10 sweeps (VITS line used if defined in channel table).
Accuracy: ±2% for visual carrier to noise ≥40 dB (300 kHz RBW).

Hum/Low-frequency Disturbance –
Accuracy: ±1% for hum ≤5% and visual carrier to noise ≥25 dB (300 kHz RBW); ±2% for hum <10% and visual carrier to noise ≥25 dB (300 kHz RBW).

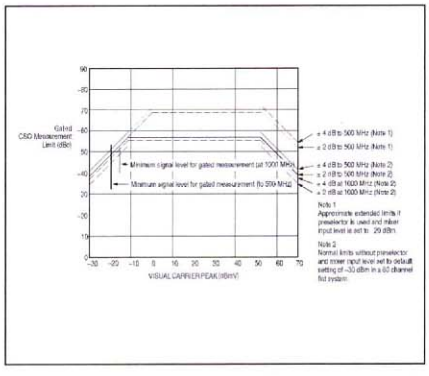

Figure 6.

In-channel Response –
Accuracy: ±0.5 dB.
Test signal line number must be specified for in-service measurements.

Digital Channel Adjacent Channel Leakage –
Averaged power in adjacent channel(s) is divided by averaged power for the test channel.
Range and Accuracy: See Figure 3.

Carrier Survey –
Absolute peak amplitude of each visual carrier is measured and each associated aural carrier level is measured relative to the visual carrier for selected channels. Frequency counted only in ACCUR FREQ/AMPL mode.

Visual Carrier (FREQ/AMPL and ACCUR AMPL modes).
Absolute Accuracy: ±2.5 dB for visual carrier to noise ≥30 dB (300 kHz RBW); for FM signals, carrier to noise ≥33 dB (100 kHz RBW).
Relative Accuracy: ±0.5 dB relative to adjacent channel, ±1.2 dB relative to all others.
Aural Carrier (FREQ/AMPL and ACCUR AMPL modes).
Accuracy: ±0.75 dB for aural carrier to noise ≥15 dB (300 kHz RBW).

Analog Channel CTB and CSO –
Measured relative to visual carrier peak according to NCTA recommendations.
Range and Accuracy for INTERACTIVE and AUTO modes: See Figures 4, 5 and 6.
Only ±4 dB curve applies to SINGLE SWEEP and CONTINUOUS modes.

Digital Channel CTB and CSO –
Measured relative to the averaged power of the test channel.
Range and Accuracy: See Figures 7 and 8.

Aural (FM) Deviation –
Accuracy: ±4 kHz.

Cross Modulation –
Peak of fundamental component of 3rd order distortion at horizontal sync frequency (AM) measured on the unmodulated visual carrier.
Range: 48 dB. For cross modulation levels below –20 dBc, equivalent frequency domain measurement of cross modulation results in a range of 58 dB.
Accuracy: ± 2 dB for cross modulation <36 dB; ±3 dB for cross modulation <48 dB.

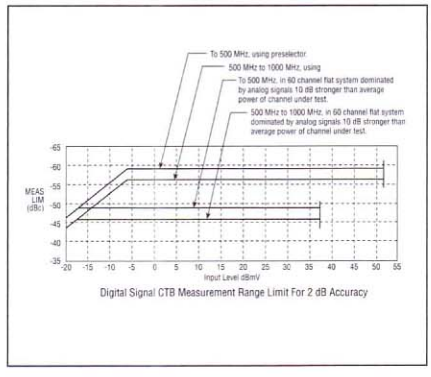

Figure 7.

SPECTRUM ANALYZER SPECIFICATIONS

FREQUENCY RELATED

Frequency Range –
9 kHz to 1800 MHz.
Opt. 50 and 75: 9 kHz to 2150 MHz.

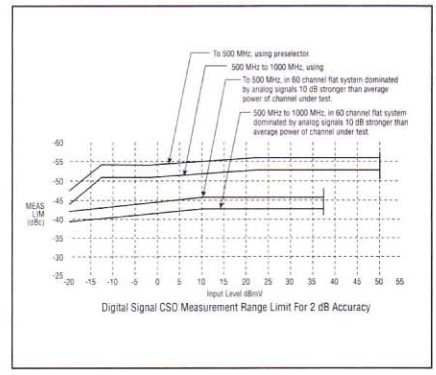

Figure 8.

Frequency Counter Accuracy – 5 x 10^{-7} of center frequency ±10 Hz ±1 LSD (least significant digit).

Resolution Bandwidth (–6 dB) –
5 MHz, 1 MHz, 300 kHz, 100 kHz, 30 kHz, 10 kHz, 3 kHz, 1 kHz and 300 Hz.

Noise Sidebands –
≤-70 dBc at 30 x RBW for RBW ≤100 kHz.
Opt. 50 and 75: ≤69 dBc above 1.8 GHz.

AMPLITUDE RELATED

Flatness –
±2 dB (relative to reference level at 100 MHz) measured with 10 dB internal RF attenuation (preamp off).
Opt. 50 and 75: ±3 dB above 1.8 GHz.

Measurement Range – -90 dBmV (preamp on) to +68.8 dBmV (–139 to +20 dBm).

Display Dynamic Range –
80 dB maximum (Log Mode); 8 divisions maximum (Linear mode).
Opt. 50 and 75: Dynamic range reduced if there is signal energy at or near 2.11 GHz. Baseline will typically rise to within 10 to 20 dB of signal applied near 2.11 GHz.

Maximum Sensitivity (at 300 Hz RBW) – -78 dBmV (–127 dBm); –90 dBmV (–139 dBm) with preamp on.

SPURIOUS RESPONSE (PREAMP OFF)

Residual Spurious Response –
≤-51 dBmV (≤-100 dBm) with 0 dB RF attenuation, except at 1780 MHz where the spurious response is ≤-41 dBmV (≤-90 dBm).
Opt. 50 and 75: ≤-26 dBmV (–75 dBm) at 2.0 GHz.

3rd Order IM Distortion –
≤-70 dBc from any two on-screen signals with any frequency span.
Opt. 50 and 75: typically ≤65 dBc at 2.15 GHz.

INPUT RELATED

RF Input –
75 Ω BNC with quick change to 75 Ω type F connector.
Opt. 50: 50 Ω Type N connector.

VSWR –
With RF Attenuation ≥10 dB: 1.5:1 maximum to 1 GHz.
With 0 dB RF Attenuation: 2:1 maximum to 1 GHz.

Maximum Safe Input – +70 dBmV (0.1 W or 2.2 V) continuous peak with 100 VDC blocking capacitor.

ENVIRONMENTAL

Temperature –
Operating: 0° to +50°C (MIL T-28800E).
Nonoperating: –55° to +75°C.

Humidity – Nonoperating: Five cycles (120 hrs) in accordance with MIL-Std-28800E, Class 5.

Vibration – Meets MIL T-28800E, Method 514, Procedure X (modified).

Shock – Operating and nonoperating: Three guillotine-type shocks of 30 g, one-half sine, 11 ms duration each direction along each major axis; total of 18 shocks.

Altitude –
Operating: 15,000 ft.
Nonoperating: 50,000 ft.

PHYSICAL CHARACTERISTICS

Dimensions*1	mm	in.
Height	137	5.4
Width	361	14.2
Depth	445	17.5
Weight	**kg**	**lbs.**
Net	<10.6	23.5

**1 Cover with Feet, Handle and Front-Panel.*

Direct Entry of Control Parameters – Frequency, span/div, reference level; RBW, video filter, vert. scale and sweep rate via menu.

Constant Rate Tuning – Same on-screen tuning sensitivity regardless of span/div selection.

Graticule Illumination – Contrast enhancement for CRT photography.

External Tracking Generator Opt. 5 – Provides scalar analysis for checking/aligning filters, amplifiers, cables or most 2-port networks. Includes LO output port.

TV Sideband Analyzer/LO Output Opt. 15 – Provides a 1st LO output for a 1405 TV Sideband Analyzer for frequency-agile modulator sweep.

Rackmount Opt. 30 – Converts unit to a rackmounted installation; 5.25-in. rack height, 19-in. rack width.

Portable-to-Rack Adapter Opt. 34 – Provide rackmounting of instrument in standard enclosure with handle, offering immediate instrument portability when needed; 7-in. rack height, 19-in. rack width.

ORDERING INFORMATION

For price information: Outside the U.S. contact your local Tektronix representative, inside the U.S. see the price list in the back of this catalog.

2715
Cable TV Spectrum Analyzer.

Includes: Windows-compatible PC Software, Power Cord (U.S. 115 V/60 Hz), User Manual, Programmer Manual, Reference Manual, Front Cover, 75 Ω BNC Connector, 75 Ω F Connector and Choice of GPIB or RS-232 Interface (Opt. 03 or Opt. 08). Opt. 50 includes a 50 Ω Type N-to-BNC adapter in place of 75 Ω connectors.

OPTIONS

Opt. 03 – Provides an IEEE-488 General Purpose Interface Bus (GPIB) as a no-cost option (not compatible with Opt. 08).

Opt. 05 – 100 kHz-1.8 GHz 75 Ω External Tracking Generator with mechanical mating kit (includes Opt. 15). Cannot be mounted to 2715 simultaneously with Opt. 07 Battery Pack.

Opt. 07 – Battery Pack/Inverter.

Opt. 08 – Provides an RS-232 port as a no-cost option (not compatible with Opt. 03).

Opt. 15 – 1st Local Oscillator Output for a 1405 TV Sideband Analyzer or 2707 External Tracking Generator.

Opt. 30 – Rackmount Adapter for 19 x 5.25 in. Rack Dimensions.

Opt. 33 – Travel Line package.

Includes: Rain Cover, Accessory Pouch, Gray Filter and Carrying Strap.

Opt. 34 – Portable-to-rackmount Adapter for 19 x 7 in. Rack Dimensions.

Opt. 50 – Frequency extension to 2.15 GHz, 50 Ω input impedence with Type N connector.

Opt. 75 – Frequency extension to 2.15 GHz, 75 Ω BNC with quick change to 75 Ω Type F connector.

INTERNATIONAL POWER PLUGS

Opt. A1 – Universal Euro 220 V, 50 Hz.

Opt. A2 – UK 240 V, 50 Hz.

Opt. A3 – Australian 240 V, 50 Hz.

Opt. A4 – North American 240 V, 60 Hz.

Opt. A5 – Switzerland 220 V, 50 Hz.

See page 619 for description.

MEASUREMENT SERVICE OPTIONS

Opt. C3 – Three years of Calibration Services.

Opt. D3 – Test Data (requires Opt. C3).

Opt. R3 – Repair warranty extended to cover three years.

OPTIONAL ACCESSORIES

75 Ω Coaxial Cable, BNC, 24 in. – Order 012-1339-00.

75 Ω Coaxial Cable, BNC, 42 in. – Order 12-0074-00.

F Series Input Adapter/Connector Replacement – Order 103-0301-00.

BNC Input Adapter/Connector Replacement – Order 103-0310-00.

RS-232 Cables –
9-Pin to 9-Pin Null Modem. Order 012-1379-00.
25-Pin to 9-Pin Null Modem. Order 012-1380-00.
25-Pin to 9-Pin RS-232 Cable. Order 012-1214-00.

GPIB Cables –
1 meter. Order 012-0991-01.
2 meter. Order 012-0630-01.

Rain Cover – Order 200-2500-00.

Accessory Pouch – Order 016-0677-02.

Viewing Hoods –
Collapsible. Order 016-0592-00.
Polarized. Order 016-0180-00.
Binocular. Order 016-0566-00.

Carrying Strap – Order 346-0199-00.

CRT Light Filter (Gray) – Order 337-2775-02.

Transit Case – Order 016-0792-02.

Front Panel Cover – Order 200-2520-00.

Softside Carrying Case – Order 016-1158-01.

Service Manual – Order 070-9096-00.

User Manual – Order 070-9115-00.

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: TVC Technology Group, Phone: 1-800-233-7600, FAX: 1-717-263-1547.

CE

ISO 9001

Tektronix measurement products are manufactured in ISO registered facilities.

GPIB IEEE-488

Product(s) complies with IEEE Standard 488.1-1987, and with Tektronix Standard Codes and Formats.

Protocol Analyzers

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ATM. 409
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Test Tools. 418
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Cable and Accessory
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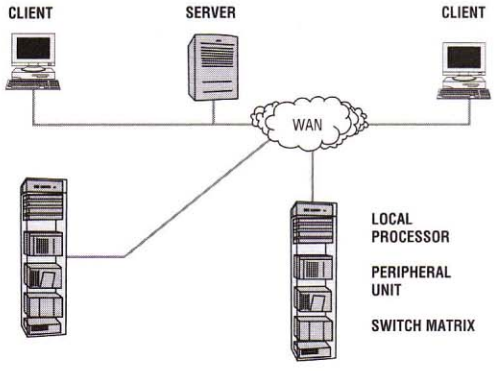
Protocol analyzers monitor, emulate and simulate the exchange of data between telecommunications and information technology facilities, measuring and testing standardized interfaces of network components and instruments. ISDN test sets measure and test the transmission-relevant parameters, properties and power-feeding conditions at ISDN interfaces. Tektronix' Service test equipment tests the transfer of digital data on different media.

Monitoring System

New Net-C



Features – Benefits

Quality Data Analysis: Data Are Collected by Peripheral Units and then Processed by the Central Unit in Order to Assess the Quality of Service Offered and Overall Performance of the Entire Network

Fraud Detection: Net-C Detects Out-of-band and In-band Activities as Call-Back, Blue Box, Subscription and Technical Frauds, and so on

Clone Activities and Roaming Frauds: Net-C Detects Alone Activities and Roaming Frauds in the Wireless Network

Distributed System: Peripheral Units Provide Simultaneous Monitoring of a Number of E1/T1, Collecting and Decoding Signaling Information, Alarms and In-band Information. System Functions are Completely Automatic and User Intervention Is not Required for Normal Operation

Standalone Transportable Unit: the Entry-level Net-C Product Is a Self-contained Transportable Unit Containing Monitoring and Analysis Capabilities in a Single Box

Per-call-based Monitoring: Data Collected are Organized in Call Detail Records Containing Information on Traffic Activity, Quality of Service and Service Usage

Applications

Mobile Networks

Real-time Traffic Analysis at the 2 Mb/s – 1.44 Mb/s Level: Data Collection at Different Network Levels (GMSC, MSC and BSC)

Quality of Service Evaluation (In-service Non-Intrusive Measurement Device, ITU-T P.561): Analysis of Transmission Quality Parameters

Real-time Monitoring of Subscriber Activities: Roaming Analysis (MAP Protocol)

Real-time Fraud Detection and Blocking: Call-Back, Blue Box and Other In-band Fraud; "Clone" Activities; Roaming Fraud

Fixed Networks

Real-time Traffic Analysis at the 2 Mb/s – 1.44 Mb/s Level: Signaling Monitoring on Both Local and Transit Switch

Quality of Service Evaluation (In-service Non-intrusive Measurement Device, ITU-T P.561): Analysis of Transmission Quality Parameters

Fax Quality Analysis: According to ITU-T E.45x

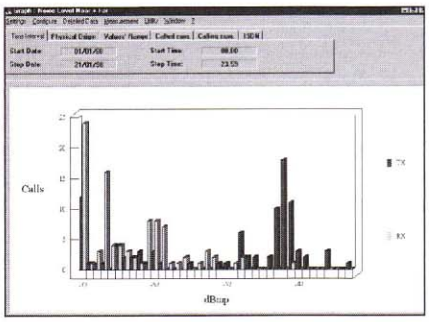
Real-time Fraud Detection: Call-Back, Blue Box and Other In-band Fraud, Illegal Landing

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

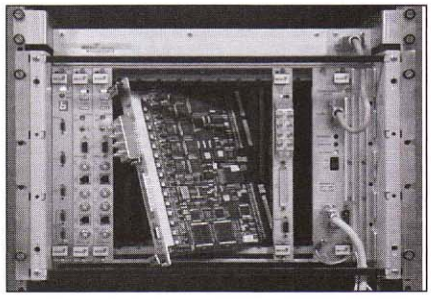
CE

Net-C is an in-service, non-intrusive monitoring system that interfaces to telecommunication networks at the E1/T1 level. The system assists network managers in obtaining and maintaining high network efficiency, optimizing investment, measuring quality of service, and reducing revenue loss due to fraud or network abuse.

Net-C operates independently of the network equipment and is external to the network it monitors. This ensures data collection at strategic nodes even during peak hours, independence from network faults and uniformity of data collected from different parts of the network.







Net-C is available as a standalone transportable instrument and as a distributed system. Its scalable and open architecture makes it easy to adapt to different network structures and interface with different operating systems.

SYSTEM ARCHITECTURE

Net-C is modular and scalable for maximum flexibility. System configuration ranges from small, standalone units to a fully distributed system.

The main building blocks for the system version are:

- Central Unit to collect and analyze data from the Remote Control Units or Peripheral Units and to display network information to the users
- Remote Control Units for local management and data collection from the Peripheral Units
- Peripheral Units connected to the network under observation and host monitoring resources
- Access matrix for distributed monitoring capability between E1 for different time intervals.

The Central Unit comprises one UNIX server with an Oracle database and one or more Windows clients, providing:

- Management and control of all Peripheral Units and Remote Control Units
- Collection of system-wide measurement records
- Elaboration of network-wide information based on individual site data
- Data presentation to the user
- Interfaces to other applications

The optional Remote Control Unit is a rack-mounted UNIX PC, providing:

- Management and control of Peripheral Units
- Collection of local measurement records

The Peripheral Unit is a 19" VME card cage with 13 slots for interface and application boards, providing:

- E1/T1 links interface (monitor or drop-insert)
- Signaling analysis
- Speech analysis
- Traffic monitoring
- Fax protocol analysis
- INMD measurements
- Roaming monitoring
- Fraud or Call-Back detection and blocking
- Evaluation and storage of basic measurement records

Interface and application boards include:

- Demux board for interface to the 2 Mb/s PCM E1s
- Stream Interface board for functionality similar to the Demux board on a single bi-directional E1 per board, but with the additional capability of being inserted in series with the E1
- Fax Monitoring board for fax quality evaluation through analysis of the V.21 T.30 protocol between Group 3 machines according to ITU-T E.45x standards
- INMD (In-service Non-intrusive Monitoring Device) board for all the measurements specified by the ITU-T P.461 recommendation for the evaluation of voice transmission quality over in-service live traffic
- Scanner access module for an optional interface to the E1/T1 level. The module implements a switch matrix with a selectable combination of inputs and outputs

The Net-C system can be upgraded and expanded in several ways, from a standalone, transportable unit to a network-wide multi-site and multi-user system. Your system can grow from entry-level to a complete system, preserving the hardware investment of the initial installation.

At the peripheral level, you can increase the number of monitored E1s simply by adding interface boards into available slots or adding more Peripheral Units. In the same way, measurement capabilities can be upgraded by means of additional measurement boards. The system also can grow by upgrading the software and adding new application boards to the existing installation.

Protocol Tester

K1103



Features – Benefits

CUSTOMIZED SIGNALING ANALYSES OF CCS#7, GSM, CDMA, ISDN D-CHANNEL, X.25, V5.1, V5.2, PHI

Monitoring of up to Eight Signaling Channels on Four PCM Links

For PCM30, PCM24 and V./X. (V.24, V.35, X.21)

Simple Operation as with a PC with MS-DOS and Windows

Programmed Applications For Fast Problem Analysis

Applications

The Protocol Tester K1103 has been developed for network supervision and network analysis of CCS#7, GSM, CDMA, ISDN D-channel, X.25 and V5.x protocols. A maximum of four different PCM links ($T1/S_{2M}$) or V./X. links with up to eight signaling links (64 kbit/s, 56 kbit/s, 16 kbit/s) can be supervised simultaneously

The Protocol Tester K1103 features a Windows 3.11 based user interface

Analysis of the different layers of the communications protocols can be performed online or offline. The auto-restart mechanism enables long-term measurements to be carried out, e.g., following a power failure. User-specific prepared measurement tools for supporting measurements in the field are also supplied. Automatic evaluation of these measurements, alphanumerically and/or in graphics form, is performed by a special statistics program package. A storage capacity of 2.5 MB in the main memory and 500 MB on the hard disk is available for recording the measurement data. A floppy disk drive can additionally be used for recording measured data

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

CE

Product manufactured in ISO 9001 registered facilities.

DESIGN

The Protocol Tester K1103 consists of a PC card with 8 MB RAM, a 540 MB hard disk and a 1.44 MB floppy disk. A TFT color display, which can be read without impairment even under bad lighting conditions, is used as the display. Graphics control is by means of a VGA card.

The keyboard can, if necessary, be removed from the tester in order to enable more comfortable working. MS-DOS 6.2 is used as the operating system.

Line activities are displayed on LEDs on the front of the instrument.

The actual measuring hardware employs obsolescence-proof technology. The processing power, for example, is increased by using transputers.

A serial interface for remote control, a printer interface (serial/parallel), as well as a VGA interface for external monitors, are available.

SPECIAL FEATURES

The K1103 features particularly easy handling. This comprises:

- Putting the test hardware and software into service
- Connecting to the PCM links (S_{2M}/T1) or V./X. links
- Protocol detection
- Link selection

The test modules can be inserted in the Protocol Tester K1103 simply by plugging them in. No further hardware settings or reconfiguration is required as this is executed at a keystroke by the testing software provided. When the K1103 is connected to the PCM links, the autoconfiguration function determines the signaling channel search and the framing search. No preliminary manual settings are required. As soon as the autoconfiguration is completed, all the active signaling channels are available and can be displayed simultaneously or separately on the screen. Again a keystroke is all that is needed to select a particular link and thus reduce the screen display to the required data.

The Protocol Tester K1103 also has a wide and impressive range of powerful display formats. Message components from any source are decoded on-line and to the maximum possible depth if required. All the important message parts are output not only in binary or hexadecimal but also in mnemonic form (on-line and off-line in parallel). Special search functions permit selective tracing of any desired message parts, e.g. an IMSI/TMSI (International/Temporary Mobile Subscriber Identification).

DESCRIPTION OF APPLICATION OPTIONS FOR CCS#7

Analysis of signaling over a linkset between two switching systems

Interexchange signaling with CCS#7 is not performed via one signaling link during real operation, since failure of this link would result in failure of up to 1000 traffic channels. A number of signaling links – 2 to 4 depending on traffic – are therefore combined to form a so-called linkset. Since the loadsharing mechanism in the switching system does not allow the signaling link for a particular call to be predicted within a signaling linkset, all signaling links between two switching systems must be supervised simultaneously.

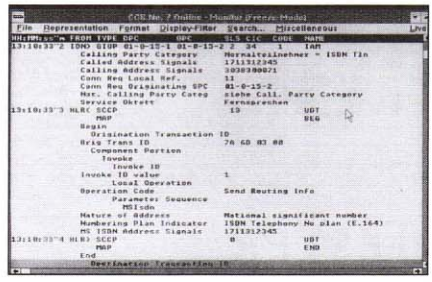


Fig. 1 SCCP-HLR data exchange in the GSM.

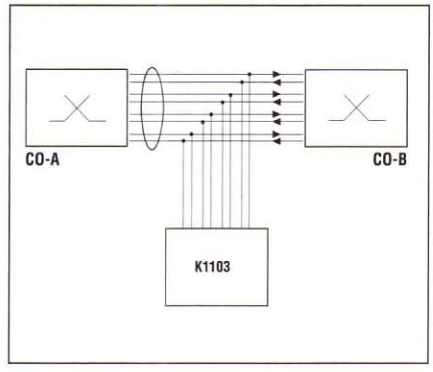


Fig. 2 Analysis of a linkset with 4 signaling links.

Analysis of signaling on two linksets

In order to test the operability, behavior and switching times of a switching system, its input and output linksets must be analyzed simultaneously. Since, as a rule, 2 signaling links are combined in a linkset, 4 signaling links must be supervised simultaneously.

CO-A National switching system

CO-B Foreign switching system

CO-C International switching system

Another application consists of observing network interfaces (from national to international network). It must be possible to analyze different protocols simultaneously for this application.

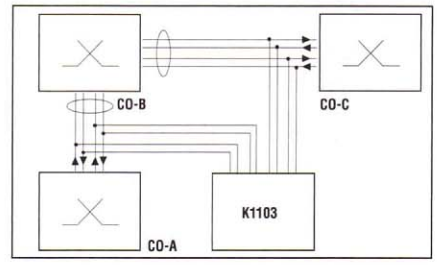


Fig. 3 Analysis of two linksets each with two signaling links.

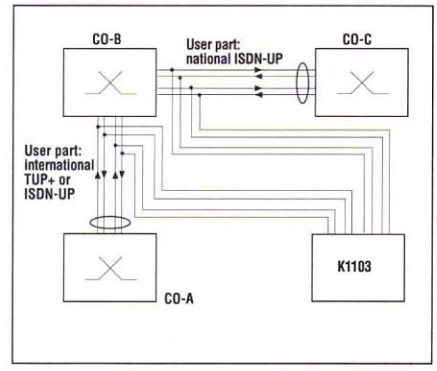


Fig. 4 Analysis of two linksets on two international interfaces.

INTERFACES

Connections –
4 x PCM30 or PCM24
4 x D-sub 9-contact
or 4 x V./X. (V.35, V.24, X.21)

Software/Operating modes –
Measurement tools
Statistics
Monitor

Protocols –
MTP Q.701-Q.704, Q.707-Q.709 Red Book, Blue Book, White Book
TUP Q.721-Q.724 Red Book, Blue Book, White Book
ISUP Q.763/Q.764 Blue Book, White Book
SCCP Q.711– Q.714 Blue Book, White Book
MoU-ISUP Q.767 ETS 300 356-1

National variants –
FTZ 1TR7 (ISUP, TF), 3.90x, 3.91x, 3.92x
FTZ 163TR8 (TUP+) ETSI/CEPT TUP+
FTZ 163TR73
FTZ 163TR75 (4/89, 3/93, 4/94, 4/95, 4/96, 4/97)
FTZ 163TR76
TUP Brazil (TELEBRAS TUP and EWSD-BRA-V4.2 TUP)
TUP Italy (CSELT TUP-E, TUP-N)
TUP Finland

TUP France (France Telecom SSUTR for VN5)
TUP Great Britain (British Telecom national User Part BTNR167 and BTNR5167)
TUP Switzerland (Swissnet 1 TUP national)
TUP Uruguay
ISUP Holland (PTT NL NL1, NL2)
ISUP Israel
ISUP Colombia
ISUP Uruguay
ISUP Austria OEFEG SP
ISUP China
ISUP Poland
ISUP Portugal
ISUP Slovakia
ISUP Pakistan
ISUP Czech Republic
ISUP Hungary
ISUP GUS
ISUP/TUP Australia
ISUP/TUP Belgium
ISUP/TUP Spain
ISUP/TUP Denmark
MCI 075-0002-01.5R-ES (ISUP)
MCI 005-0004-07.5F-ER (ISUP)
MTP Uruguay
MTP/TUP China
MTP/ISUP Hong Kong
IGAP (Iridium Gateway Application Part)
ANSI MTP (ANSI T1.111 Layer 2 and 3)
ANSI SCCP (Bellcore T1.112)
ANSI ISUP (Bellcore T1.113)
ANSI TCAP (Bellcore T1.114)
TR-NWT-000246, issue 3, 1993
TR-TSY-000533, July 1987
IS-41B/IS-41C/IS-41D
Chinese INAP, Spanish INAP, French INAP, Austrian INAP, Italian INAP

INAP (TN70, TN80, TN90, TN100, ETS 300 374-1, ETS 300 356-18/4, ITU-T Q.1218, SINAP2-SINAP5, SINAP5M, INAP for Argentina (acc. Alcatel SESA 214 82811 AAAA DS 3/94), INAP 163 TR 78

Data User Part DUP-DFS
ITU-T Data User Part X.61
NMT 900 MUP/HUP

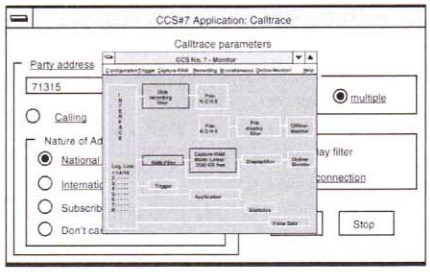


Fig. 5 Setting window for call tracing application.

D-Channel Protocols –
Deutsche Bundespost 1TR3 (1TR6, issue 1.90 (12.91)). VN3 (ST/LAA/RSM/144). ETSI ISDN Layer 3 ETS 300 102-1 Dec. 90. ETSI ISDN Layer 3 ETS DE/SPS 5034-1, June 93. QSIG ISDN Layer 3 ETS 300 170, Feb. 93. CorNet-N Version 1.3c, Nov. 93. Blue Book Q.921, Blue Book Q.931.

X.25/LAPB

PHI (ETS 300 099, August 92)

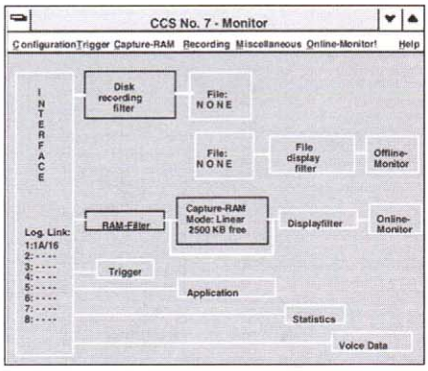
DPNSS1, DASS2

V5.1 (ETS 300 324-1), V5.2 (ETS 300 347-1)

More CCS#7 user parts on request.

SOFTWARE SUPPORTED SOLUTIONS FOR NUMEROUS PRACTICAL APPLICATIONS

- Call tracing using a/b directory number (Fig. 5)
- Traffic measurements, load distribution and telephone traffic
- Load distribution between two switching systems via a linkset
- Distribution of service features
- Evaluation of call attempts
- Distribution on STP or link-per-link signaling
- Measurement of switching times in the switching systems
- Change over and change back measurements
- Supervision of the availability of traffic channels, etc.
- Q752



CHARACTERISTICS

DESCRIPTION OF APPLICATION OPTIONS FOR GSM

The Protocol Tester K1103 is designed for monitoring at the following PCM links (S_{2M}/T1) in the GSM:

Interface	Network components	
Abis	BSC	BTS
A	MSC/VLR	BSC
M	TCU	BSC
C/D	MSC/VLR	HLR/AC
E/G	MSC/VLR	MSC/VLR
B/C	MSC/VLR	PSTN

The location of the PCM links between the relevant GSM system components is shown in Fig. 6.

It is necessary to view several of these interfaces at the same point in time in order to assess the interoperation of the network components. One example is shown in Fig. 7 where the K1103 analyzes the signaling from the base station via the base station controller and the mobile switching center into the public telephone network. In parallel with this, a check is made as to whether the mobile telephone of the calling subscriber is entered in the HLR, i.e., whether the MSC executes this request. Another example for the use of the K1103 is to test handover procedures.

It is possible to test any combination of up to four PCM links with up to eight signaling links simultaneously.

Except for the protocol of the Abis interface (LAPD) the GSM protocols are based on CCS#7 signaling DTAP, BSSMAP, MAP, TCAP (see Fig. 8). The following table summarizes the implemented protocols for the interfaces, the protocol stacks as well as the standard and version references.

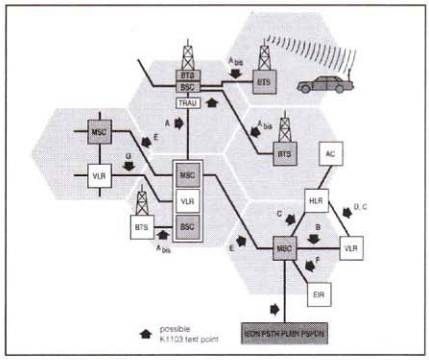


Fig. 6 Architecture of the GSM network.

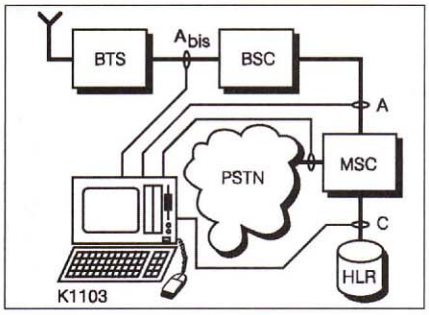


Fig. 7 Typical GSM analysis.

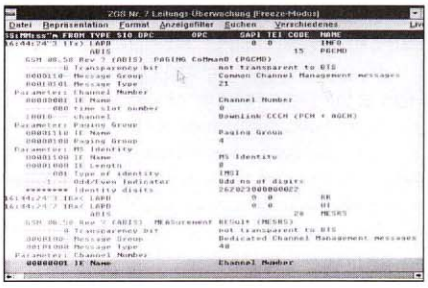


Fig. 8 Complete decoding of layer 3 at the A_{bis} interface.

For a number of tests on the A– and A_{bis}– interface, it is intended to provide special testing programs, e.g., to facilitate or automate:

- Call tracing (incl. handover)
- Mobile terminating call (MTC)
- Mobile originating call (MOC)
- Location update

The GSM software of the K1103 also provides the user with a statistics tool permitting monitoring analysis in accordance with ITU-T Recommendation Q.791.

REMOTE CONTROL OF THE K1103 VIA ISDN, MODEM (CARBON COPY) OR ETHERNET (PC-NFS)

As a further option, the K1103 can also be controlled via the ISDN, modem or Ethernet. The software provides the following features:

Remote control of the measuring software on the K1103

- from another K1103
- from a PC-compatible computer

File transfers between

- two Protocol Testers K1103
- a K1103 and a PC-compatible computer

Execution of DOS commands on a

- distant K1103
- distant PC-compatible computer

TABLE 1

Interface	Protocol	GSM/ITU-T Standard/Recommendation
A_{bis}	L2 LAPD	08.56
	RSL	08.58
	RSL for Siemens	
	RSL and O & M for Alcatel	
	GSM 12.21	
	Motorola Mobis	
	Ericsson O & M (R2-R6)	
	Nokia O & M	
	Siemens O & M	
	Lucent O & M	08.60
	16 kbit/s frame analysis	08.60
A	DTAP	04.08
	BSSMAP	08.08
	SCCP	Q.711 to Q.714
	MTP	Q.701 to Q.704, Q.706 and Q.707
	Supplementary Services	04.80
	Short Messages Control Protocol	04.11
	Short Messages Relay Protocol	04.11
	Short Messages Transfer Protocol	03.40
B/C/D/E/F/G	CAP	09.78
	MAP	09.02
	TCAP	Q.771 to Q.774
	SCCP	Q.711 to Q.714
	MTP	Q.701 to Q.704, Q.706 to Q.707
	ISUP/TUP	any

Table 1. Protocol stacks for the various GSM interfaces are available (GSM Phase 1, Phase 2, Phase 2+, PCS 1900 and CDMA). The protocols for GSM Phase 2 and Phase 2+ are for 900 MHz and 1800 MHz available.

ORDERING INFORMATION

For price information: Outside the U.S. contact your local Tektronix representative, inside the U.S. see the price list in the back of this catalog.

Ordering data	Order No.				
Protocol Tester K1103 Monitor unit for up to 4 links, with floppy-disk drive (3.5 inch), 80486 DX, a 540-Mbyte hard disk, 8-Mbyte RAM, Windows, Microsoft mouse and CCS#7 basic software (1- to 4-link monitoring)	**7KK1103-0**	x	x	x	x
•Interface module with documentation					
- ISDN primary rate access module S_{2M}/T1 (2-link monitoring) comprising 1 interface module and 1 transputer basic card		A			
- ISDN primary rate access module S_{2M}/T1 (4-link monitoring) comprising 2 interface modules and 1 transputer basic card		B			
- V./X. interface module (2-link monitoring) comprising 1 interface module, 1 transputer basic card and 2 V.35 adapters.		C	X		
- V./X. interface module (4-link monitoring) comprising 2 interface modules, 1 transputer basic card and 4 V.35 adapters		D	X		
- ISDN primary rate access module S_{2M}/T1 (2-link monitoring) and V./X. interface module (2-link monitoring) comprising 2 interface modules, 1 transputer basic card and 2 V.35 adapters.			E		
- no interface module		X	X		
•PCM frame basic setting (preset at factory)					
- S_{2M} (PCM30)			A		
- T1 (PCM24)			B		
- no presetting			X		
Power supply 47 to 63 Hz 230 V 47 to 63 Hz 110 V				1 2	
Manual/MS-DOS/Windows/ CCS#7 basic software					
in German					0
in English					1
in French (manual in English)					2
Training					
GSM seminar	**7KK1103-5AA00**				
CCS#7 seminar	**7KK1103-5BA00**				

SOFTWARE

GSM Phase 1 Extension Software – (1- to 4-link monitoring).
With manual in German. Order 7KK1103-6BA10.
With manual in English. Order 7KK1103-6BA11.

Motorola A_{bis} Mobis GSM –
(Condition: Software -6BA.. or -6KA..or -6LA..).
Order 7KK1103-6BB11.

Motorola A_{bis} Mobis USA –
(Condition: Software -6BA.. or -6KA.. or -6LA..).
Order 7KK1103-6BC11.

Ericsson A_{bis} O & M –
(Condition: Software -6BA.. or -6KA..or -6LA..).
Order 7KK1103-6BD11.

Nokia A_{bis} O & M –
(Condition: Software -6BA.. or -6KA.. or -6LA..).
Order 7KK1103-6BE11.

Lucent A_{bis} O & M –
(Condition: Software -6BA.. or -6KA.. or -6LA..).
Order 7KK1103-6BF11.

Alcatel A_{bis} O & M –
(Condition: Software -6BA.. or -6KA.. or -6LA..).
Order 7KK1103-6BG11.

DUP-DFS/Q.741 –
Order 7KK1103-6CA11.

ISDN Extension Software –
As per Q.931, 1TR6, Euro-ISDN, VN3, QSIG, CorNet.
With manual in German. Order 7KK1103-6DA10.
With manual in English. Order 7KK1103-6DA11.

Extension Software for PHI –
As per ETS 300 099.
With manual in German. Order 7KK1103-6DB10.
With manual in English. Order 7KK1103-6DB11.

Extension Software for V5.1 Interface –
As per ETS 300 324-1.
With manual in German. Order 7KK1103-6DC10.
With manual in English. Order 7KK1103-6DC11.

DASS2 – Order 7KK1103-6DD11.

Extension Software for V5.2 Interface –
As per ETS 300 347-1.
With manual in German. Order 7KK1103-6DE10.
With manual in English. Order 7KK1103-6DE11.

DPNSS – Order 7KK1103-6DF11.

ANSI/Bellcore – (USA protocol for CCS#7 signaling), IS41. Order 7KK1103-6EA11.

CDMA (USA-Mobil) Acc. IS41 B,C, IS 634, IS 637 TSB 80 – Order 7KK1103-6EB11.

MCI ISUP – Order 7KK1103-6EC11.

X.25/LAPB –
With manual in German. Order 7KK1103-6GA10.
With manual in English. Order 7KK1103-6GA11.

INAP –
Chinese INAP, Spanish INAP, French INAP, Austrian INAP, Italian INAP.

(TN70, TN80, TN100 INAP prETS 300 374-1, ITU-T Q.1218, CCBS INAP prETS 300 356-18/4, SSP, OEFEG). SINAP 2-5.5M , 163TR 78 Order 7KK1103-6HA11.

NMT 900 MUP/HUP(Including Ericsson MUP 3/56) – Order 7KK1103-6JA11.

GSM Phase 2 Extension Software –
(1-to 4-link monitoring)
With manual in German. Order 7KK1103-6KA10.
With manual in English. Order 7KK1103-6KA11.

GSM Phase 2+ Extension Software –
(1-to 4-link monitoring)
With manual in German. Order 7KK1103-6KB10.
With manual in English. Order 7KK1103-6KB11.

DCS 1800 Extension Software –
(1-to 4-link monitoring)
With manual in German. Order 7KK1103-6LA10.
With manual in English. Order 7KK1103-6LA11.

DCS 1800 Extension Software Phase 2+ –
(1-to 4-link monitoring)
With manual in German. Order 7KK1103-6LB10.
With manual in English. Order 7KK1103-6LB11.

TOOLS AND EXTENSIONS (HW + SW)

Software – For remote control via ISDN. Order 7KK1103-7AA10.

File-Tools – For K1103, K1195 and K1197 recording files. Order 7KK1103-7BA11.

Ethernet Remote Control Software –
Order 7KK1103-7DA11.

HARDWARE

4-MB RAM Extension – For transputer basic card. Order 7KK1103-8AB.

INTERFACE MODULES FOR RETROFITTING

ISDN Primary Rate Access Module S_{2M}/T1 –
(2-link monitoring)
With manual in German. Order 7KK1103-2AW00.
With manual in English. Order 7KK1103-2AW01.

V./X. Interface Module –
(2-link monitoring) comprising
1 interface module and 2 V.35 adapters.
With manual in German. Order 7KK1103-2CW00.
With manual in English. Order 7KK1103-2CW01.

Transputer Basic Card – For post-processing protocol data on PC. Order 7KK1103-2WW00.

ACCESSORIES (AS REQUIRED)

Transport Bag – Order 7KK1200-5BA11.

Transport Box – Order 7KK1200-5BB11.

Symmetrical Connecting Cable – Shielded, 120 Ω, with open ends (2 off required per s_{2M} module). Order 7KK1200-5CE11.

Symmetrical Connecting Cable – Shielded, 120 Ω, with 2 three-contact plugs (2 off required per s_{2M} module). Order 7KK1200-5CD11.

Symmetrical Connecting Cable – Shielded, 120 Ω, with 2 bantam plugs (2 off required per s_{2M} module). Order 7KK1200-5CB11.

Coaxial Connecting Cable – Floating, 75 Ω, 1.6/5.6 (2 off required per S_{2M} module). Order 7KK1200-5CC11.

Adapter BNC – 1.6/5.6 – (2 off required per coaxial cable). Order 7KK1200-5CA11.

Prices and ordering codes for updates and upgrades are available upon request.

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

CE

Product manufactured in ISO 9001 registered facilities.

Protocol Tester

K1205



Features – Benefits

Portable Multi-protocol Tester for Monitoring at a Variety of Interfaces

Simultaneous Connection of up to 16 PCM30/PCM24 with up to 32 Time Slots

Automatic Recognition of the Measuring Configuration

State-of-the-art Modular Design Enables Easy Expansion

Simple Operation under Windows NT

User-friendly Help System

Large Number of Country-specific And Manufacturer-specific Protocols

Graphical and Flexible Protocol Stack Editor

Applications

The K1205 Protocol Tester has Been Developed for the Network Monitoring and Network Analysis of CCS#7, GSM900, DCS1800, PCS1900, CDMA, ISDN D-channel and V5.x Protocols. It is a Passive Piece of Equipment and can Therefore be Used Safely in Operational Mode. Larger Areas can be Monitored Completely Since it is Possible to Monitor Simultaneously the Tester's 16 Different Interfaces With up to 32 Time Slots

The K1205 can be Integrated into an LAN Network or Remote Controlled via ISDN or Modem

The Analysis of the Communication Protocols' Different Layers can be Carried Out Online as Well as Offline

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

CE

Product manufactured in ISO 9001 registered facilities.

EQUIPMENT CONFIGURATION

SYSTEM COMPONENTS

The K1205 is based on a compact and state-of-the-art hardware design belonging to the same family as the K1297 Protocol Tester. The K1205 is a very small, compact and portable VME bus system with 5 slots. Slot 1 is occupied by a Pentium PC based on VME, with a PC card, external VGA connection, SCSI interface, Ethernet connection for 10 Base 2 and 10 Base T, as well as two serial and one parallel interfaces.

The PCMCIA slot allows the user to install various communication interfaces (e.g., modem card for remote control).

MEASURING MODULES

The test hardware includes VME bus cards with T1 (1.544 Mbit/s, PCM24) or E1 (2.048 Mbit/s, PCM30) interfaces (PRIMO module).

Additional modules in the narrowband ISDN area such as S_0, U_{2B1Q} and V./X. are also available.

PRIMO MODULE (PRIMARY RATE MONITORING)

The VME bus card with 4*T1 or 4*E1 interfaces is called PRIMO. The interface configuration as E1 or T1 interface is made via the configuration software. The interfaces are connected to the transmission lines via 9-pole D-SUB connectors and the corresponding adapter cables. In the monitoring mode, the K1205 can be connected to protected or unprotected monitoring points. The PRIMO module has an integral adaptive preamplifier for testing the input signals which can be damped to varying degrees. The software allows the user to connect the test modules either via a high impedance or a low impedance. Up to four interfaces with 8 time slots (received in full-duplex operation) can be analyzed simultaneously. With four PRIMO's 16 interfaces with 32 time slots can be monitored simultaneously. The activities on the lines are displayed by LEDs on the module.

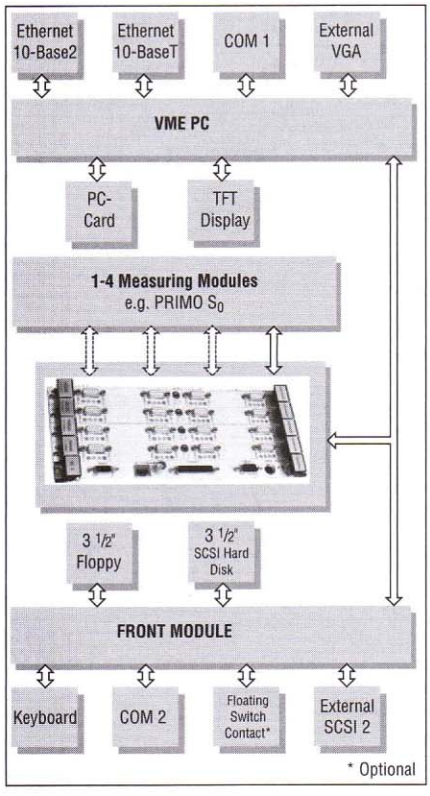


Figure 1 – K1205 Block Diagram.

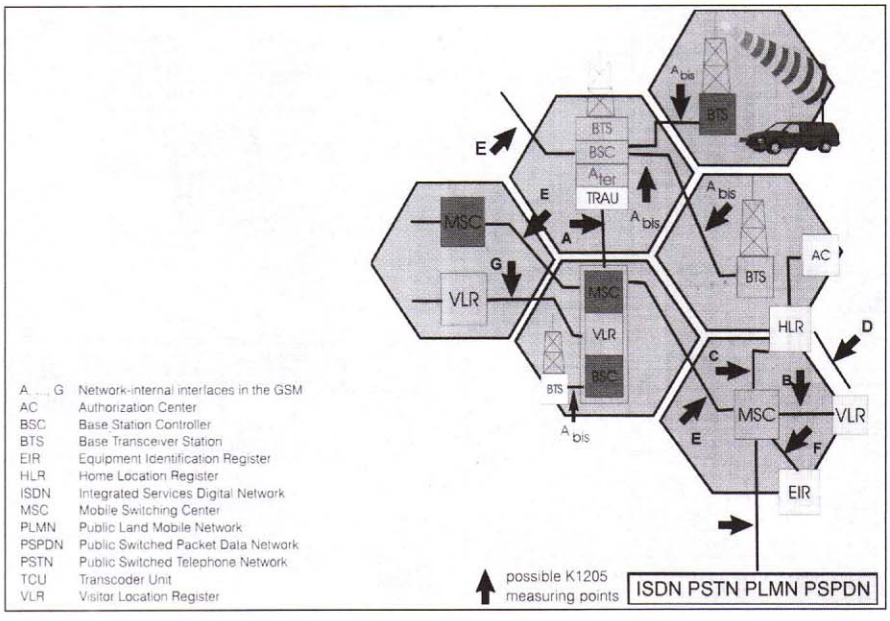


Figure 2 – Mobile radiocommunication network architecture.

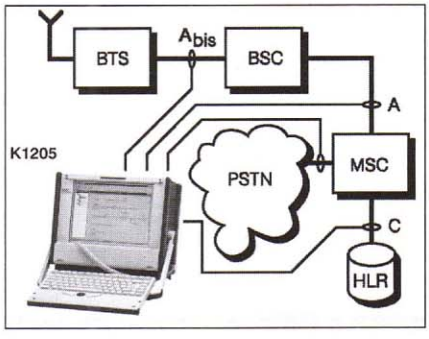


Figure 3.

Interface	Network Components
A_{ter}	MSC_BSC
A_{bis}	BSC_BTS
A	MSC/VLR_BSC
M	TCU_BSC
C/D	MSC/VLR_HLR/AC
E/G	MSC/VLR_MSC/VLR
B/C	MSC/VLR_PSTN

SPECIAL PERFORMANCE FEATURES

The K1205 is easy to use. This includes the commissioning of the test hardware and the software, the connection to the PCM sections (E1/T1) or narrow-band ISDN sections, the protocol recognition as well as the link selection.

The measuring modules can be installed in the K1205 simply by plugging them in. No further hardware settings or reconfigurations are necessary. When the K1205 is connected to the PCM sections, the automatic configuration function determines the signaling channels and the framing of the PCM sections. Manual pre-settings are no longer necessary. All active signaling channels are available and can be displayed on the screen simultaneously or separately as soon as the automatic configuration has been completed.

The received data can be reduced to the essential data with the help of powerful filters.

The K1205 Protocol Tester provides several powerful display formats.

Message components from random sources are decoded online or, if required, in the maximum possible depth. All important message components are interpreted and issued not only binarily or hexa-decimally but also in a mnemonic form (parallel online and offline). Special search functions make target tracking of any message components, e.g. an IMSI/TMSI (International/Temporary Mobile Subscriber Identification), possible.

Another highlight of the K1205 is its graphical protocol stack editor with which the required protocols can be compiled out of the numerous protocols implemented in the K1205.

APPLICATION FIELDS

MOBILE RADIOCOMMUNICATIONS

The K1205 Protocol Tester can be used in the following mobile radiocommunication networks:

- GSM 900
- DCS 1800
- PCS 1900
- CDMA
- NMT900

The K1205 has been designed for monitoring at all line interfaces.

The layout of the interfaces between the relevant system components is shown in Figure 2.

The K1205 monitors several of these interfaces simultaneously in order to evaluate the interaction of the network components. Two examples are shown in Figures 3 and 4. In the application

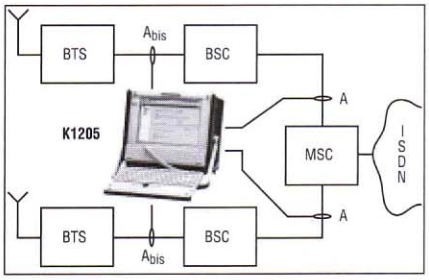


Figure 4.

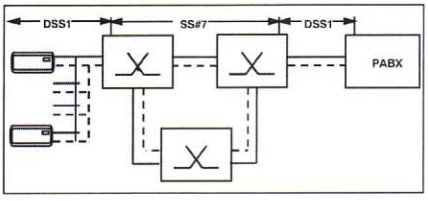


Figure 5.

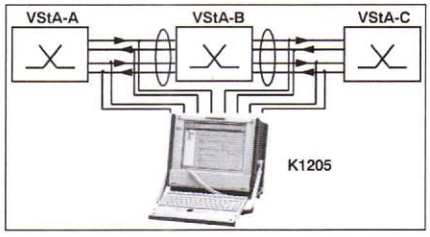


Figure 6.

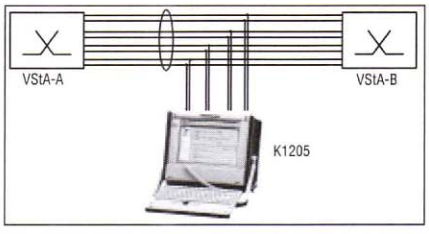


Figure 7.

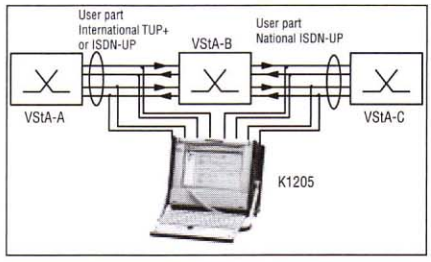


Figure 8.

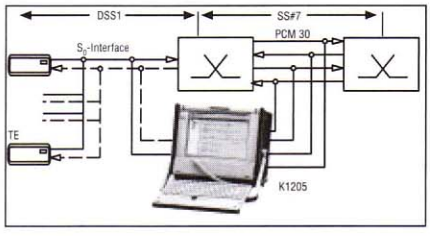


Figure 9.

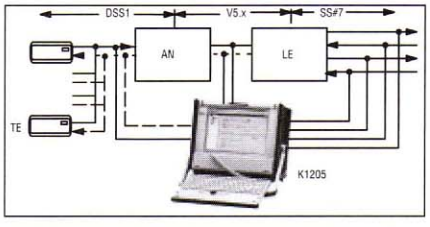


Figure 10.

example shown in Figure 3 the K1205 analyzes the signaling from the base station via the base station controller and the mobile switching center through to the public telephone network.

At the same time monitoring determines if the radiotelephone of the calling mobile subscriber is entered in the home location register (HLR), i.e. if the mobile switching center (MSC) is carrying out this request.

In the application example shown in Figure 4 it is established whether the handover of a mobile subscriber from one base transceiver station (BTS) to the other is working. The two BTSes are connected to two different BSCs on the same MSC for this (Inter BSC, Intra MSC Handover).

FIXED NETWORK

Signaling in the fixed network is divided into two areas (Fig. 5):

- Signaling between switching center and terminal (DSS1 or also D-channel protocol)
- Signaling between the switching centers (SS#7)

Some examples of where the K1205 may be used:

- Monitoring the signaling between two switching centers. All links between the switching centers are monitored simultaneously. This is necessary since it is not possible to know in advance on which link of the link set the signaling traffic for a certain call will be, due to the load sharing mechanism implemented in the switching center (Fig. 6)
- Simultaneous monitoring of up to 8 signaling links with 2-4 signaling links in one link set. The functionality, the performance and the through switching time of the switching center with input and output link sets are analyzed (Fig. 7)
- Simultaneous decoding of several protocols.
  Not only gateways from national to international networks are monitored by the protocol tester, but also those from the fixed network to the mobile radiocommunication network (Figure 8)
- Signaling SC <—> TE
  The protocol tester checks the interaction of switching centers and signaling in the subscriber terminal. Here, the protocol tester analyzes different protocols (DSS1 and SS#7) simultaneously, e.g., at the S_0 and PCM30 interface (Fig. 9)
- Access networks
  The protocols of the V5.x interface are implemented for the analysis of the access network (Fig. 10)

INTERWORKING

The K1205 Protocol Tester is also well suited for interworking measurements due to its numerous different protocols.

With the K1205 it can be defined for every link which protocol stack is required for that particular link. An application example is shown in Figure 11.

The data decoded with different protocol stacks can be displayed in one common window.

The K1205 is able to measure at different physical interfaces such as PCM30 and PCM24.

SOFTWARE-SUPPORTED SOLUTIONS

The K1205 Protocol Tester offers various tools to support the user:

- Graphic display of the complete channel assignment of a PCM30/PCM24. At a glance it can be seen which time slot is currently occupied and where there is signaling

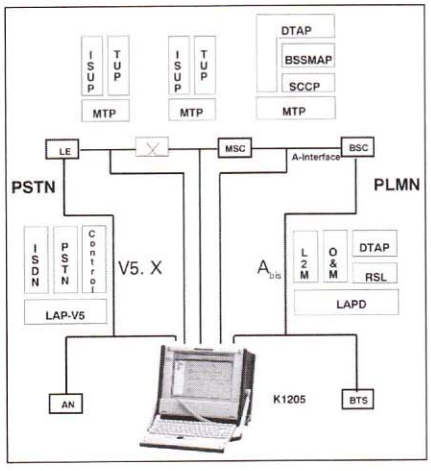


Figure 11.

- Call tracing with a subscriber number or in mobile radio communications also with an IMSI
- Automatic configuration: Automatic recognition of the signaling as well as the framing
- 50 online and 200 offline counters which are available for statistics; they can be defined by the user as required
- Display of the signaling load per link; here, the Erlang value of the individual signaling links is measured

REMOTE CONTROL

The K1205 can be remotely controlled via ISDN, Ethernet or modem. (See Figure 12) The software offers the following performance features:

- Remote control of the test software on the K1205
  - From another K1205
  - From a PC with Windows NT
- File transfer between
  - Two K1205 Protocol Testers
  - A K1205 and a PC with Windows NT
- Execution of commands on a
  - Remote K1205
  - Remote PC with Windows NT/95/98

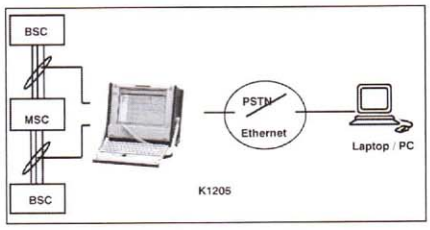


Figure 12.

CHARACTERISTICS

HARDWARE

Description –
Portable protocol tester with built-in color TFT display and keyboard. The K1205 is based on a VME bus with 5 slots. The first slot is reserved for a PC module while the remaining four slots are for interface modules.

Central Computer –
AT-compatible VME bus PC.
CPU Pentium 133 MHz with 32 MB RAM.

Connections –
2 x serial.
1 x parallel (Centronics).
Keyboard.
SCSI.
VGA (external monitor).
Ethernet (10Base-2, 10Base-T, 2xType II).
PC card interface.

Mass Storage –
A 3.5 in. disk drive (1.44 MB formatted overall capacity).
A SCSI hard disk.
(≥ 2 GB formatted overall capacity).

Monitor –
Built-in active TFT display (12.1 in.).
Resolution 1024 X 768 pixels.
External monitor connection (DIN).

Keyboard – PS/2-Compatible keyboard with trackball.

POWER SUPPLY

Line Adapter – Protection class I (protective grounding).

Line Voltage –
Rated Range of Use: 230 V/115 V –15 % to +10%.
Automatic changeover.

Line Frequency – Rated Range of Use: 47 to 63 Hz.

Power Consumption – Maximum Value: 460 VA.

ENVIRONMENTAL CHARACTERISTICS

Ambient Temperature –
Reference Value: 23°C ± 5%.
Rated Range of Use: 4 to 40°C.
Limit Range for Storage and Transportation: –20 to +55°C at 85% relative humidity.

Barometric Pressure, Altitude –
Reference Value: 101.3 kPa (1013 mbar).
Rated Range of Use I: 70.0 to 106.0 kPa (up to 2200 m) (700 to 1060 mbar).
Limit Range of Operation: 53.3 to 106.0 kPa (up to 4300 m) (533 to 1060 mbar).

INTERFACE MODULES

PRIMO –
Interface module for carrying out measurements on PCM30/PCM24 lines.
Connections 4 x monitor (duplex).

Radio Interference Suppression – In accordance with EC guidelines 89/336/EEC and their modifications.

SOFTWARE

Operating System – Windows NT 4.0.

Application Software –
Operation of the protocol tester is via a graphical menu system in Windows NT, context-sensitive online help.
All tools required for evaluated passive monitoring and interactive protocol testing are provided.

Automatic Configuration – Searches the signaling channels in the connected PCM sections automatically.

Protocol Stack Editor – The protocol stack can be selected from numerous supplied protocol stacks or combined with the help of a graphic editor.

DATA ACQUISITION

Time Stamps – Received data with a resolution of 10 µs, unique assignment of the events in different channels.

Protocol Data Acquisition Buffer – max. 30 MB per PRIMO module.

Data Recording – Designation with time stamps, also with online recording on disk/hard disk.

Control Possibilities –
Identical for online and offline applications.
Pipeline at trigger event.
Acquisition of all or filtered data.
Trigger and filter depth up to every detail of every defined message (e.g., the value of the satellite indicator or the number of the called subscriber).
Trigger-controlled actions such as start/stop of the data recording.

Data Reproduction –
Cyclic passive monitoring/holding.
Representation of all or filtered data.
Change of the methods of representation.
Printing of a selected range.
Saving the data on disk/hard disk.
Representation of the RAM or file contents by scrolling, jump to the beginning or end.
Searching with search mask.
Positioning on time.
Display of all messages to one connection by pressing a key.

Application Programs –
Evaluation and graphic display of the signaling information in accordance with different criteria both in online and offline operation.
Several applications are carried out simultaneously.

PHYSICAL CHARACTERISTICS*1

Dimensions	mm	in.
Height	344	13.5
Width	288	11.3
Depth	190	7.5
Weight	**kg**	**lbs.**
Net	≈ 8 to 10*2	17 to 20*2

*1 *Keyboard attached, no carrying handle.*
*2 *Depending on equipment.*

ORDERING INFORMATION

For price information: Outside the U.S. contact your local Tektronix representative, inside the U.S. see the price list in the back of this catalog.

K1205 PROTOCOL TESTER
Basic unit.
Includes: Keyboard, TFT color display, 1.44 MB floppy disk drive, SCSI hard disk.
With German Windows NT: Order 7KK1205-1SA10.
With English Windows NT: Order 7KK1205-1SA11.

INTERFACES
Primo Board with 4 * PCM-Interfaces –
PRIMO installed in K1205. Order 7KK1205-2MM01.
PRIMO packed separately. Order 7KK1205-2MM11.

Ordering data	Order No.
ISDN Basic Rate Interface Board modules combined with power module for line feeding, different jacks for Simulation and Monitoring	7KK1200-
RJ45 jack type with two S–Interfaces	2SS _ 1
RJ45 jack type with one S–Interface and one U(2B1Q)–Interface	2SQ _ 1
RJ45 jack type with two U(2B1Q)–Interfaces	2QQ _ 1
ready installed in K1205	0
separate delivery (for later installation/reconfiguration by customer) with English documentation	1
V./X. Interface Board for V.24, X.21 and V.35 with two V. / X. Interfaces	7KK1200 - 2VV _ 1
ready installed in K1205	0
separate delivery (for later installation/reconfiguration by customer) with English documentation	1

K1205 SUPPORT
Service Options –
Service contract per year and basic device without module. Repair, Update, Hotline and maintenance for one year. Order 7KK1205-4SC11.
Service contract per year and module (without calibration). Repair, Update, Hotline and one maintenance per year on condition that a service contract for the basic device exists. Order 7KK1205-4SE11.
Extended Warranty – For 2 years. Order 7KK1205-4SD11.
Calibration – Calibration including certificate. Order 7KK1205-4CD11.
Annual Calibration – Per module (service contract prerequisite). Order 7KK1205-4CC11.
Post Calibration – Including certificate. Order 7KK1205-4CS11.

TRAINING COURSES
Introductory training course for K1205 Protocol Tester. Order 7KK1205-4XG00.
Protocol Analysis – In the CCS#7. Order 7KK1205-4XB00.
Protocol Analysis – In the GSM. Order 7KK1205-4XA00.

ACCESSORIES
CD-ROM Drive – Order 7KK1205-5AA00.
Carrying Case – Transport bag. Order 7KK1205-5BA00.
Alarm & Sync Option – Order 7KK1205-5HC00.
Remote Control –
Remote Control Software ReachOut (English). Order 7KK1205-5DA01.
PCMCIA/PC card modem for K1205. Order 7KK1205-5EA00.
External ISDN modem for K1205. Order 7KK1205-5EC00.

Cables –
Coax –asymm. 75 Ω. Order 7KK1200-5CC11.
Symm., 120 Ω, open end. Order 7KK1200-5CE11.
Symm., 120 Ω, 3-pole. Order 7KK1200-5CD11.
Symm., 120 Ω, bantam. Order 7KK1200-5CB11.
Adapter BNC coax. Order 7KK1200-5CA11.

K1205 SOFTWARE
German Standard Software – Monitor software including SS#7 signaling, contains country variants including ANSI/Bellcore. Order 7KK1205-6AA10.
English Standard Software – Monitor software including SS#7 signaling, contains country variants including ANSI/Bellcore. Order 7KK1205-6AA11.
Mobile Communications Software – Contains GSM Phase 1, GSM Phase 2, GSM Phase 2+, DCS 1800, PCS 1900, CDMA, NTM900. Order 7KK1205-6BA11.
Access Network Software – Contains ISDN D-channel, V5.1, V5.2, PHI, DASS2, DPNSS. Order 7KK1205-6CA11.
INAP Software – Country Variants. Order 7KK1205-6DA11.
Manufacturer Specific –
Motorola (A_{bis} Europe, USA). Order 7KK1205-6EA11.
Nokia (A_{bis} O&M). Order 7KK1205-6EB11.
Lucent (A_{bis} O&M). Order 7KK1205-6EC11.
Alcatel (A_{bis} O&M). Order 7KK1205-6ED11.
Ericsson (A_{bis}). Order 7KK1205-6EE11.
MCI (ISUP). Order 7KK1205-6EF11.
Siemens A_{bis} O&M, RSL, A_{sub}. Order 7KK1205-6EG11.

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

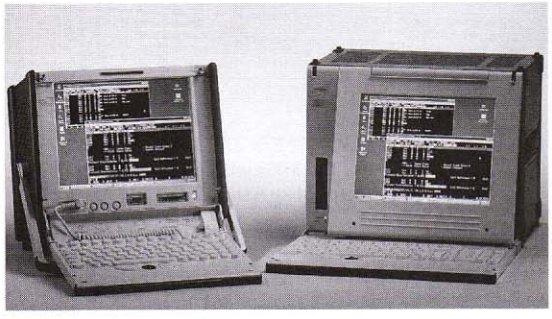
CE

Product manufactured in ISO 9001 registered facilities.

Protocol Tester

Compact Protocol Tester

K1297



Features – Benefits

Portable Multi-protocol/Multi-interface Tester for Broadband and Narrowband Networks

Monitoring, Simulation/Emulation, Conformance Tests – One Unit for All Tests

Up to 4/3 Parallel Test Interface Boards (for example incl. 16/12 PCM links for simulation) in One Unit Are Possible (K1297/K1297 Compact)

Separation of Testing Processes from Operating Processes Results in High Testing Speed and Maximum Testing Accuracy

The Modular Design Provides for Simple, Cost-effective Expansion and Ability to Adapt to Future Standards

Access to and Compatibility with Other Applications Provided via a Standard User Interface Supported by MS-WINDOWS NT

Applications

The following list outlines the various fields of application in which the K1297 is primarily employed:

Manufacturers of Communication Systems and Components involved in the Following Fields of Activity:
- Development
- Integration/Testing
- Acceptance and Conformance Tests

Private and Public Network Operators
- Testing
- Acceptance and Conformance Tests

Private and Public Test Laboratories
- Testing
- Acceptance and Conformance Tests

Research & Teaching
- Development
- Acceptance and Conformance Tests

Consulting
- Development
- Acceptance and Conformance Tests

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

CE

Product manufactured in ISO 9001 registered facilities.

The K1297 Protocol Tester has been designed for development purposes and use in test laboratories. In addition, the K1297's portable design makes it ideal for service engineers required to perform difficult measuring tasks in the field (installation, maintenance, etc.). This unit can be deployed for testing signaling protocols of layers 2 to 7 of the ISO/OSI 7-layer model.

The K1297 hardware and software permit both subscriber and network simulation.

A wide range of software tools for generating test scenarios is available for the various different kinds of test programs for the above mentioned test modes. The following development tools are available as additional options for performing the measurement tasks:

- SDL-style test manager
- Message building system
- ASN.1-processing concurrent TTCN.MP compiler

The K1297 Protocol Tester can especially be used in all systems that employ:

- High-capacity signaling channels
- Traffic channels incorporating bit rate adaptation and embedded transmission protocols
- Extremely complex signaling protocols

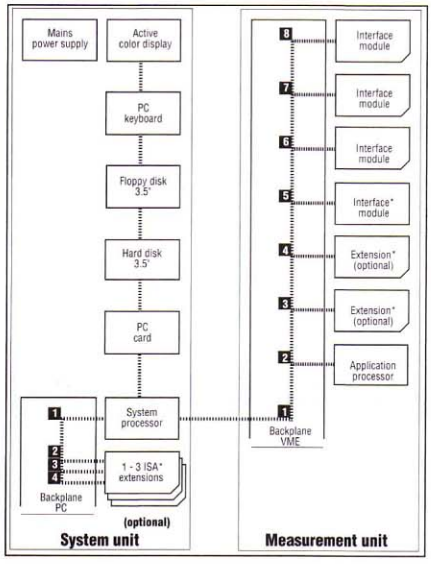


Figure 1. K1297 with system unit and measurement unit (not ATM). *Not in K1297 Compact.

The K1297 supports the following test modes:

- Monitoring
- Simulation/emulation
- Conformance tests (acceptance, validation and compatibility tests)

Equipment Configuration

SYSTEM COMPONENTS

The K1297 equipment concept is based on a compact and modern hardware design that incorporates powerful processors and communication controllers. The testing and user processes are divided up among several microcomputer systems. The test processes run on Motorola 68040 processors (VME bus cards) and the user interface on an Intel Pentium processor (also VME bus card). The K1297 comprises two bus systems that are provided by a VME backplane and a second PC backplane. Besides the system processor (PC) and application processor (AP) cards, the VME backplane also accommodates the test interface cards.

The PC backplane enables the user to install various communication interfaces, for example, an ISDN PC card for remote control.

The K1297 is supplied in an ergonomically designed housing. The standard

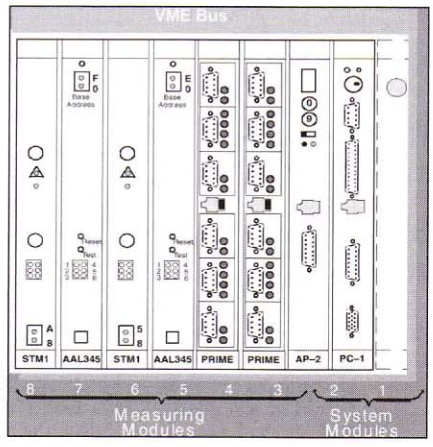


Figure 2. K1297 Compact rear view.

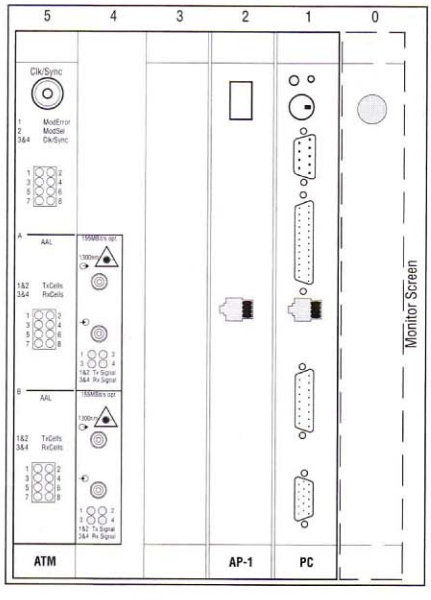


Figure 3. K1297 Compact top view with monitor screen orientation.

version of the K1297 is equipped with a high-contrast VGA-compatible color TFT display, a keyboard and an external CD-ROM drive. The necessary application software and user documentation are installed from a CD-ROM.

The K1297 is thus ideally suited for use in a network with remote control (LAN, ISDN, modem).

The K1297 is delivered with a matching carrying case that has storage compartments for stowing the basic documentation and accessories.

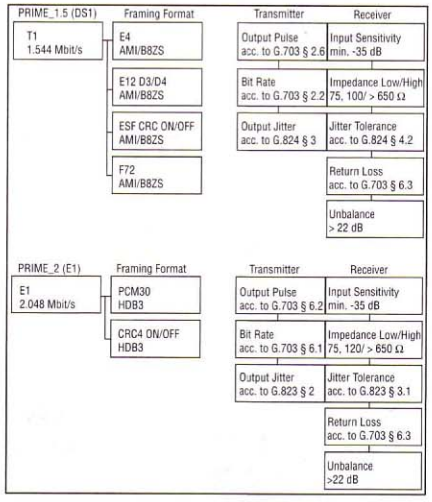


Figure 4. PRIME module framing formats and electrical specifications.

Narrowband Boards

The available test hardware includes VME bus cards with T1 (1.544 Mbit/s, PCM24) or E1 (2.048 Mbit/s, PCM30) interfaces (PRIME modules) and modules for narrowband ISDN with S_0 and U_{2B1Q} interfaces as well as for broadband ISDN with up to STM4 interface. A V./X. interface for X.21/V.24/V.35 applications is also available.

PRIME BOARDS

The protocol tester can also carry out measurements on PCM sections via the available PRIME modules (Primary Rate Monitor and Emulation). Two transmission rates are supported, 1.554 Mbit/s and 2.048 Mbit/s:

- For 1.544 Mbit/s, the module PRIME_1.5 (DS1) is applied
- For 2.048 Mbit/s the module PRIME_2 (E1) is applied

The overview above shows the supported framing formats and the electrical specifications of the two versions.

The interfaces of the PRIME modules implement the physical and electrical connections to the PCM section. For simulation, the sockets feature a transmitter and receiver each for PCM signals. For monitoring, two receivers of the adjacent simulations each are used and combined on a socket.

The status of the ports and lines is indicated by means of two LEDs. In order to

indicate the various states, that is port selected/deselected, signal good, signal poor, etc., the LEDs may be switched off or on, or they may also flash.

V./X. BOARD

The following modes of operation are available with the V./X. interface module:

1. Carry out a DCE emulation
2. Carry out a DTE emulation

The DCE and DTE emulation modes of operation can be executed at the same time, however each mode needs its own application (i.e., X.25 emulation).

3. Monitor lines with the V./X. interface module

Each terminal socket is equipped with two LEDs for displaying the line status. Each of the line connectors "to DTE" and "to DCE" are assigned two LEDs.

BAI BOARD

The BAI Board (Basic Access Interface) is required for measurements on ISDN lines and connections.

The supply voltage necessary for supplying power to the terminal equipment to be tested is supplied by a separate supply module which is plugged into the interface modules and connected to the base module.

The BAI board can be fitted with up to two interface modules depending on the purpose of application. The interface modules establish the necessary different circuits dependent on the interface standard.

The BAI Board also features the following auxiliary connections:

- One auxiliary connection for the supply voltage
- One B channel connection: The B channels can be accessed externally with the appropriate setting in the configuration menu
- Handset and headphones: One voice connection can be established in a B channel via a connected handset. A B channel can be monitored bidirectionally via stereo headphones

S_0 Interface Module

- NT
- TE/NT
- MON

The following modes of operation are available with the S_0 interface module:

- Carry out a TE emulation
- Carry out an NT emulation
- Monitor lines with the S_0 interface module
- The Dual TE Emulation is a special mode in which the protocol tester uses one interface module to emulate the function of two TEs

Two LEDs, "L1" (Layer-1 activated) and "PF" (Power Feeding), are assigned to each line connector which show the line status.

In NT emulation operating mode, the auxiliary supply voltage source present on the supply module can be activates. According to the S_0 lines specification, the specified supply voltage at the power feeding point for terminal equipment is 40 V (+2/–6 V).

U_{2B1Q} Interface Module

- NT
- NT/LT

The following four modes of operation are available with the U_{2B1Q} interface module:

- Carry out an LT emulation
- Carry out an NT emulation
- Monitor lines with U_{2B1Q} interface module

The interface module responds in the line like a U-repeater.

- The Dual NT emulation is a special mode in which one interface module is used to emulate the function of two NTs

Two LEDs "L1" (Layer-1 activated) and "PF" (Power Feeding), are assigned to each line connector which show the line status.

In LT emulation operating mode, the auxiliary supply voltage source present on the supply module can be activated. For standard power feeding of NTs with short line connections to the LT, a supply voltage of 55 V is used.

When using longer line connections to the NT, high supply voltages are necessary. In this case power feeding voltages of 80 V, 95 V or 110 V may be generated by the supply source using the voltage sources of the two interface modules switched together.

ATM Boards

The ATM interfaces are composed of up to three VME-boards as standard configuration. This is the Power-AAL board and one or two Line interface boards.

POWER-AAL BOARD

The Power-AAL board provides the following features:

- AAL segmentation and reassembly functions are hardware-supported
- Real-time processing at 155.52 Mbit/s
- Complete AAL5 processing is provided as defined by ANSI T1S1.5 and ITU I.363, including the convergence sublayer functions
- Up to 4000 virtual circuits (VPI/VC), NNI, VPI addresses are supported
- AAL3/4, 5 board
- Supports up to two line interfaces

LINE INTERFACES

STM-4 Opt. Single/Multi-mode –

ATM Interface: 622 Mbit/s ±20 ppm, SDH, STM-4, Oc12c, optical, 1 Rx, 1 Tx.

Two interfaces are needed for monitoring.

Requires: Hardware -3BB11-0C.

Double STM-4 Opt. Single/Multi-mode –

ATM Interface: 622 Mbit/s ±20 ppm, SDH, STM-4, Oc12c, optical, 2 Rx, 2 Tx.

Requires: Hardware –3BB11-0C.

STM-1/SONET OC-3 Electrical –

ATM Interface: 155.520 Mbit/s ±20 ppm, SDH, STM-1 according to ITU-T Rec. G.703 electrical, CMI coding.

Connector: DIN 47295, 1 Rx, 1 Tx.

Two interfaces are needed for monitoring.

Requires: Hardware –3BB11-0C.

STM-1/SONET OC-3 Opt. Single/ Multi-mode –

ATM Interface: 155.520 Mbit/s ±20 ppm, SDH, STM-1, optical, 1 Rx, 1 Tx.

Two interfaces are needed for monitoring.

Requires: Hardware –3BB11-0C.

DS3 –

ATM Interface: 44.736 Mbit/s ±20 ppm, DS3 according to ITU-T Rec. G.703 electrical, B3ZS coding.

Connector: BNC, 1 Rx, 1Tx.

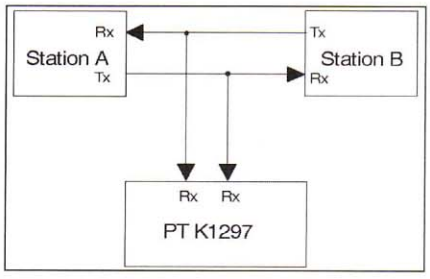


Figure 5. Functional diagram monitoring.

Two interfaces are needed for monitoring.

Requires: Hardware –3BB11-0C.**E3 G.703 –**

ATM Interface: 34.368 Mbit/s ±20 ppm, PDH, E3 according to ITU-T Rec. G.703 electrical, HDB3 coding.

Connector: BNC, 1 Rx, 1 Tx.

Two interfaces are needed for monitoring.

Requires: Hardware –3BB11-0C.

DS1 –

ATM Interface: 1.544 Mbit/s ±20 ppm, E1 according to ITU-T Rec. G.703 electrical, 1 Rx, 1 Tx.

Two interfaces are needed for monitoring.

Requires: Hardware –3BB11-0C.

E1 G.703 –

ATM Interface: 2 Mbit/s ±20 ppm, PDH, E1 according to ITU-T Rec. G.703 electrical, 1 RX, 1 Tx.

Two interfaces are needed for monitoring.

Requires: Hardware –3BB11-0C.

IBM 25 –

ATM Interface: 25.6 Mbit/s ±100 ppm, according to ATM Forum Technical Committee.

HDB3 coding.

Connector: RJ48C acc. IEC 603-7, 1 Rx, 1 Tx.

Two interfaces are needed for monitoring.

Requires: Hardware –3BB11-0C.

SOFTWARE

The software is subdivided into system software and application software. MS-WINDOWS NT 4.0 is supplied as system software. The application software is supplied in the form of loadable programs; it is based on Vx-Works which is a real-time, multi-tasking and multiprocessing operating system.

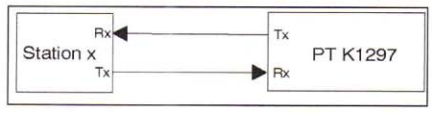


Figure 6. Functional diagram simulation/emulation.

USER INTERFACE

The software user interface for the test programs is comprised of menus, function keys and software commands as executable FORTH words. Depending on the type of the application program, integral software tools such as the SDL-style test manager and message building system also provide user interfaces. In order to generate test scenarios in SDL it is possible, for example, to use either the WORDPAD text editor supplied in WINDOWS NT 4.0 or any other editor with an ASCII mode. The language facilities offered by the SDL-style test manager are employed for programming the test scenarios via an editor.

APPLICATION SOFTWARE

Application software is available as monitoring, simulation/emulation, compiler and conformance testing programs. The application software runs on the interface modules and the application processor module.

Monitoring –

A monitoring program is loaded to allow passive reading of the data on the signaling lines. In most cases, the K1297 is connected via special monitor jacks, as in the case of the PRIME module. The relevant program (for example SS#7 ISUP monitor) has to be loaded and started.

Simulation/Emulation –

In this operating mode, the K1297 protocol tester is active and replaces one or more communication partners. A K1297 that has been configured with four PRIME modules can simulate up to 16 (12 for K1297 Compact) physical links.

The K1297 simulation/emulation programs allow the behavior of both stations A and B to be replaced as shown in Fig. 5, for example, to be simulated on either the subscriber or network side (see Fig. 6).

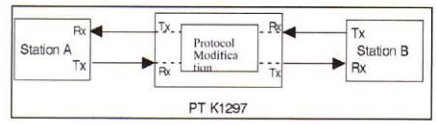


Figure 7. Functional diagram drop & insert.

The K1297's drop and insert mode constitutes a special form of simulation. Unlike active monitoring, where no changes are made to the protocol, this mode allows the user to intervene in the protocol sequence (see Fig. 7).

Conformance Tests –

Conformance tests are based on the principle of simulation/emulation and comprise a series of test cases that are in turn based on corresponding test specifications, e.g., ETS 300 324-3 for V5.1. A distinction is made between traditional conformance tests, acceptance tests, validation tests and compatibility tests. A test series (test suite) mainly consists of several test groups, subgroups and test cases. Similarly, test cases can also consist of initialization sequences, preambles, test steps (partial tests), verification sequences and postambles. After being executed, each test step, test case, test group and test suite is given a verdict, which can be either PASS, FAIL or INCONCLUSIVE. Before they are executed, test suites are parameterized in PICS and PIXIT menus. The generated conformance test reports are ISO IS9646-3 compatible.

ASN.1-Compatible Concurrent TTCN.MP Compiler

Besides the software tools (SDL-style test manager and message building system) supplied in the application software packages, a TTCN.MP compiler which complies with ISO IS9464-3 TTCN, reference number ISO/IEC 9646-3: 1992(E) and the changes in TTCN Edition 2, Delivery 6, is also available as an additional option for the K1297. The TTCN.MP compiler is also capable of processing and converting ASN.1 data structures into K1297 format.

Characteristics

HARDWARE

Portable protocol tester with integral color TFT and keyboard. The tester consists of a PC system and A VMEBUS system in a single housing. Various measurement interface modules can be plugged into the VMEBUS system in a single housing. Various measurement interface modules can be plugged into the VMEBUS system. Up to four interface modules can be freely configured and run simultaneously.

System Unit –
System processor (PC-3):
VMEBUS PC CPU Pentium with 64 MB RAM.
Connectors:
- 2 X serial SUB D9.
- 1 X parallel (Centronics).
- Keyboard.
- VGA (for integral flat screen or ext. monitor).
- SCSI.
- Ethernet (10Base-2, 10Base-T).

Extensions (not for K1297 Compact):
- 3 free ISA slots.
- 3 X 2/3 Length.

Mass storage:
- One 3.5 inch floppy disk drive.
- (1.44-MB formatted total capacity)
- One SCSI hard disk drive.
- (≥ 2 GB formatted total capacity)
- External CD-ROM drive.

Monitor:
- Integral active 12.1 in. TFT display, resolution 1024 X 768 pixels, external monitor connection.

Keyboard: standard with 102 keys.

VME-Bus Backplane – 8-Fold multilayer with automatic daisy chain.
8/5 VME slots:
- Slot 1 for system computer.
- Slot 2 for application processor.

For K1297:
- Slots 3 and 4 for extensions.
- Slots 5 To 8 for interface modules.

For K1297 Compact:
- Slots 3, 4, 5 for interface modules

Application Processor (AP-1) –
CPU 68040 (33 MHz) with 32 MB RAM.
Connectors: 1 X Serial (V.24).

SYSTEM SOFTWARE

Operating System –
User system (PC):
- MS-WINDOWS NT 4.0.

Application system (AP):
- Proprietary multi-tasking operating system based on VX-Works O/S-Kernels.

WINDOWS/DOS Support For K1297 Applications –
File editing (DOS-EDIT, WRITE...).
File management.
File printing of:
- Source files.
- Record (data) files (ASCII, postscript).

Setup:
- System.
- Date/time.
- Printer.

Measurement application loading via WINDOWS application.

OPERATIONAL FEATURES

Report Generation –
Decodes of OSI-layer 1 to 7.
By length:
- Off.
- Short.
- Medium (several densities).
- Complete.

By Code:
- Hexadecimal.
- Decimal.
- Character (ASCII, EBCDIC).
- Mnemonic.
- Block or time.

Split screen for separation of user/network side data.

Time Stamps – Transmit and receive data and signal state changes of control lines are provided with time stamps.
Resolution: Min. 1 µs.
Accuracy: Min. 125 µs.

Data Acquisition – Data signals can be acquired and passed on To 3 destinations at the same time.

Trigger/Filter –
Separate filters for screen issue, disk recording, capture RAM.
Filters for interface events, frame events and trace messages.
Up to four independent triggers.
Triggering on interface events, frame events, time, full capture RAM, full disk.

Disk Functions –
Data recording in wrap and full mode.
Data playback.
Direction of data in capture RAM to disk and vice versa.

Simulation Features – (Depending on application software) –
Layer 1:
- Blue and yellow alarm.
- Framing bits.
- International bit.
- SI 1/2 bit.
- National bits.
- Idle character.
- Error generation.

Layer 2:
- Establishment/release.
- Sending of frames with various settings.
- Frame discarding.
- Busy condition simulation.

Layer 2 initialization:
- Address.
- State variables.
- Counters.
- Window size.
- States, flags, timers.

Address Management –
Simulation of:
- Identity request.
- Identity assigned.
- Identity denied.
- Identity check request.
- Identity remove.
- Send XID frame.

Message Building System for: SS#7 level 2 MTP and upwards, ISDN layer 3, B-ISDN 3, B-ISUP. Fully menu controlled creation and storage of frames and messages, user and application parts in message pools.
- Editing in HEX and mnemonic form.
- Pasting of messages from monitor to Message Pool.
- Display of generated messages.
- Renaming, deletion and insertion of messages in pool.
- Auto and manual mode for information element sequencing.

Level 3 Link Setup – Exchange of SS#7 SLTM/SLTA messages.

Simulation Principle-
The SDL-style test manager utilizes the STATE MACHINE concept (Cf. CCITT Z.101 to 104 (today ITU-T), SDL) for protocol simulation and performing interactive tests with triggers and data filters.
The elements of the STATE MACHINE include:
- The current state.
- The actions to be executed.
- State changes.
- The follow-up state.

Test Manager –
Up To eight independent test managers per application.
SDL style programming.
Up To 256 states per test manager.
Test manager status window with state.
Level 2/layer 2 address information and layer 3 CR/PD information.

Status Windows – (Depending on application software)
Layer 2 connection parameters.
MDL error indication error code table.
Commands for change of layer 2 variables.
Contents of data fields.

Link Usage Module – (Depending on application software)
Graphical and tabular representation over time:
- Up to four graphs in parallel.
- Freely assignable graphs.
- Graphs in count(S), length, percentage of count(S)/bytes.
- Scaling linear or logarithmic.
- Table for all frame/message types.
- Counts: latest, max., min., last 30 seconds.

Adjustable measurement duration.

Other Features –
Setup:
Various items can be set up, saved and loaded again, for example:
Data Capturing Mode (full/wrap).
- Interface:
  - Number of interface.
  - Port selection on interface.
- Impedance: 120 Ω, 75 Ω, high.
- Framing format:
  - PCM double framing.
  - Multiframing with/without CRC4.
  - Line code, E.G. HDB3, AMI.
  - Bit inversion yes/no.
  - Time slot number.
- Interface mode: user, network,
- Drop & insert.

Type of layer 3 protocol, e.g., ITU-T, ETSI, ANSI, national, vendor specific.
Installation of TTCN environment and loading of executable test suites.
Editing of link names and colors.

Print Function –
Printing of:
- Capture RAM contents.
- Recording files.
- Message pools.

Print function interfaces with MS-WINDOWS print function.

Data Transfer Rates – Depending on version: 8 kbit/s, 16 kbit/s, 56 kbit/s, 64 kbit/s or multiples with internal or derived clocks.

CRC-Check – Depending on version: CRC-4, CRC-16, VRC/LRC.

Parities – Depending on version: Odd, even, none, ignore.

Data Codes – Depending on version: ASCII, EBCDIC, HEX, binary, raw data.

Counters – Unlimited number of programmable counters (depending on RAM capacity).

Timers – 128 programmable software timers, resolution: 20 ms.

Self-Test – The system software comprises extensive self-test programs that run automatically after the system is switched on.

GENERAL DATA

Power Supply –
AC line adapter: Protection class I (protective grounding).
Line voltage:
- Rated range of use: 230 V/115 V –15 % to +10 % automatic changeover.

Line frequency:
- Rated range of use: 47 to 63 Hz.

Power Consumption – Max. 650 VA (460 VA for K1297 Compact).

ENVIRONMENTAL CONDITIONS

Ambient Temperature –
Reference value: 23°C ±5%.
Rated range of use: +4°C to +40°C.
Limit range for storage and transport: –20°C to +55°C At 85% relative humidity.

Barometric Pressure, Altitude –
Reference value: 101.3 kPa (1013 mbar).
Rated range of use: 70.0 To 106.0 kPa (up to 2200 M) (700 To 1060 mbar).
Limit range of operation: 53.3 To 106.0 kPa (Up To 4300 M) (533 To 1060 mbar).

Radio Interference Suppression – As per 89/336/EEC.

Physical Characteristics for K1297:

Dimensions (with keyboard attached)	mm	in.
Width	400	15.75
Height	321	12.64
Depth	275	9.68
Weight*1	**kg**	**lb.**
approximately	14 to 18	6.3 to 8.2

**1 Depending on number of equipped interfaces.*

Physical Characteristics for K1297 Compact:

Dimensions	mm	in.
Width	288	11.34
Height	344	13.54
Depth	190	7.45
Weight*1	**kg**	**lb.**
approximately	8 to 10	17.63 to 22.04

**1 Depending on number of equipped interfaces.*

Ordering Information

For price information: Outside the U.S. contact your local Tektronix representative, inside the U.S. see the price list in the back of this catalog.

Ordering data	Order No.
K1297 Compact Protocol Tester, 5 slot instrument Pentium CPU with color TFT display, external CD ROM drive, 1.44 MB floppy disk, ≥ 2 GB hard disk, one PC board, one AP board, keyboard, autorange power supply unit 230 V/115 V, Windows NT 4.0, basic measurement system, transport case and monitoring software packages for MTP and SCCP (7KK1297–6AW11) and ISDN (7KK1297–6FW11) with English documentation	**7KK1297-1CA01**
K1297 Protocol Tester, 8 slot instrument Pentium CPU with color TFT display, external CD ROM drive, 1.44 MB floppy disk, ≥ 2 GB harddisk, one PC board, one AP board, keyboard, autorange power supply unit 230 V/115 V, Windows NT 4.0, basic measurement system, carrying bag and monitoring software packages for MTP and SCCP (7KK1297–6AW11) and ISDN (7KK1297–6FW11) with English documentation	**7KK1297-1PA01**

NARROWBAND BOARDS

Ordering data	Order No.
ADSP – 1 board, e.g. for GSM V.110/TRAU analysis (only one per K1297 possible) (Condition: 7KK1297–2PE01 or 7KK1297–2PT01)	**7KK1297-2DW_1**
ready installed in K1297	0
separate delivery with English documentation	1
jacks for simulation and monitoring including codec for voice channel in–/output	
E1 (2.048 Mbit/s)	E
T1 (1.544 Mbit/s)	T
ready installed in K1297	0
separate delivery (for later installation/reconfiguration by customer) with English documentation	1
PRIME – 1 board (4 x SIM or 2 x MON) with different jacks for simulation and monitoring including codec for voice channel in–/output for E1 (2.048 Mbit/s) and T1 (1.544 Mbit/s)	**7KK1297-2T E _ 1**
ready installed in K1297	0
separate delivery (for later installation/reconfiguration by customer) with English documentation	1
jacks for simulation and monitoring	
RJ45 jack type with two S–Interfaces	2SS_1
RJ45 jack type with one S–Interface and one U(2B1Q)–Interface	2SQ_1
RJ45 jack type with two U(2B1Q)–Interfaces	2QQ_1
ready installed in K1297	0
separate delivery (for later installation/reconfiguration by customer) with English documentation	1
V./X. Interface Board for V.24, X.21 and V.35 with two V. / X. Interfaces	**7KK1200 - 2VV _ 1**
ready installed in K1297	0
separate delivery (for later installation/reconfiguration by customer) with English documentation	1

BROADBAND BOARDS

Power AAL – Order 7KK1297-3BB11-0C.

STM-4 Opt. Single/Multi-mode – Order 7KK1297-3AV11-0C.

Double STM-4 Opt. Single/Multi-mode – Order 7KK1297-3AX11.

STM-1/SONET OC-3 Electrical – Order: 7KK1297-3AS11-0C.

STM-1/SONET OC-3 Opt. Single/Multi-mode – Order 7KK1297-3AR11-0C.

DS3 – Order 7KK1297-3AD11-0C.

E3 G.703 – Order 7KK1297-3AE11-0C.

DS1 – Order 7KK1297-3AB11-0C.

E1 G.703 – Order 7KK1297-3AF11-0C.

IBM25 – Order 7KK1297-3AU11-0C.

SOFTWARE AVAILABLE FOR THE K1297 PROTOCOL TESTER

Data Services for GSM, ISDN, Packet Services for ISDN, ATM, GPRS, SS#7/IN, Test-Tools, Mobile Radio Network, V5.1/V5.2.

For the most up to date information on cables and accessories see the Cable and Accessories Guide at: http://www.tektronix.com/Measurement/accessories/

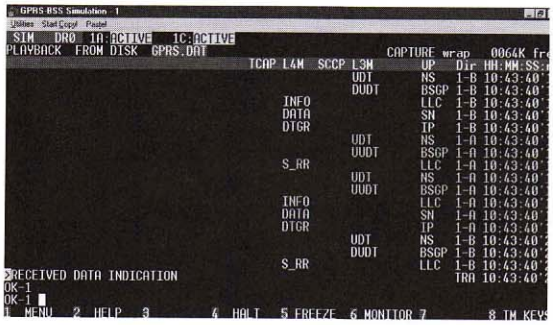
For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

CE

Product manufactured in ISO 9001 registered facilities.

Software for K1297 Protocol Tester

GPRS



Features – Benefits

Uses E1 or T1 Interface

GPRS Gb Interface

GPRS Gi Interface

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

Product manufactured in ISO 9001 registered facilities.

Software Packages

MONITORING

- Monitoring of up to 16 communication channels on up to 8 links (up to 4 links in one window, up to 4 communication channels on up to 2 links per PRIME-board)
- Different depth of decoding for each layer available
- Selectable trigger and filter mechanism
- Frame relay with channelized, unchannelized and fractional mode

SIMULATION/EMULATION

- Simulation on up to 32 communication channels on up to 16 links at the same time (up to 4 links in one window, up to 8 communication channels on up to 4 links per PRIME-board)
- Simulation of all GPRS Gb (FR (only GPRS), NS, BSSGP, LLC, SNDCP, GMM/SM, IP) and Gi (FR (complete), RFC1490, IP) Interface Protocols up to IP header
- Flexible state oriented programming interface
- Emulations on Gb Interface (BSS and SGSN side): FR (only GPRS), NS, BSSGP, LLC, SNDCP
- Emulations on Gi Interface (GGSN and PDN side): FR (complete)
- IP or SNDCP packet generator and comparator
- Frame relay with channelized, unchannelized and fractional mode
- Simulation and emulation of different GPRS connections at the same time
- Up to eight simultaneous and independent state machines per application (Test Manager), up to eight applications running in parallel with interprocess communication
- Communication mechanisms between different test managers
- TTCN compiler, concurrent TTCN compiler and editor with ASN.1 ability available

CONFORMANCE TESTING

- Implementation of test suite developed by leading GPRS manufacturers and Tektronix
- Gb Interface NS and BSSGP protocol
- IUT is BSS
- Test suite with 200 test cases

Ordering Information

For price information:
Outside the U.S. contact your local Tektronix representative, inside the U.S. see the price list in the back of this catalog.

MONITORING

GPRS Gb – Order 7KK1297-6ZA11.

GPRS Gi – Order 7KK1297-6ZB11.

SIMULATION/EMULATION

GPRS Gb – Order 7KK1297-7ZA11.

GPRS Gi – Order 7KK1297-7ZB11.

CONFORMANCE TESTING

GPRS Gb (BSS) – Order 7KK1297-8ZA11.

Software for K1297 Protocol Tester

ATM



Features – Benefits

Uses ATM-boards

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

Product manufactured in ISO 9001 registered facilities.

Software Packages

MONITORING/SIMULATION/EMULATION

- Monitoring/Simulation of up to 2 links
- Simulation on up to 32 k communication channel at the same time
- Emulation of SSCOP-8 times simultaneously
- Simulation of Q.2931 (DSS2) CS1 and CS2.1, Q.2763 (B-ISUP) CS1 and CS2.1, UNI4.0, UNI.3.1, PNNI V1.0 signaling part, B-ICI V2.1, MTP Broadband, SSCF and SSCOP
- Flexible state oriented programming interface
- Up to 8 simultaneous and independent state machines (Test Manager)
- Communication mechanisms between different Test Managers
- TTCN compiler and editor with ASN.1 ability available
- Different depth of decoding for each layer available
- Selectable trigger and filter mechanism
- Multicolor display

CONFORMANCE TESTING

- Core network
- NNI protocols: Q.2763 (B-ISUP) CS1, MTP L3 Broadband, SSCF and SSCOP
- UNI protocols: Q.2931 (DSS2) CS1, Q.2961, Q.2963, Q.2971, UNI 3.1, SSCF and SSCOP

Ordering Information

For price information:
Outside the U.S. contact your local Tektronix representative, inside the U.S. see the price list in the back of this catalog.

MONITORING/SIMULATION/EMULATION

UNI Q.2931 DSS2 CS2.1 and UNI3.1 and UNI 4.0 – ATM UNI Software for ATM Interfaces: Simulation and monitoring according to ITU-T Rec. Q.2931 SCS2.1, Q.2110, Q.2130 and Q.2120 and ATM-Forum UNI3.1 and UNI 4.0. Emulation of SSCOP– 8 times simultaneously is included. SCS2.1-supplem. services are supported.

Order: 7KK1297-7MW11.

Upgrade UNI Q.2931 DSS2 to CS2.1 – ATM CS2.1 Upgrade UNI Software for ATM Interfaces: Upgrade Simulation and monitoring according to ITU-T Rec. Q.2931 to SCS2.1. SCS2.1-supplem. services are supported. (Condition: Software –7MW11 or –7NW11.)

Order: 7KK1297-7MW41.

NNI Q.2763 B-ISUP CS2.1 – ATM NNI Software for ATM Interfaces: Simulation and monitoring according to ITU-T Rec. Q.2763 SCS2.1, Q.2110, Q.2140 and Q.2210. Emulation of SSCOP– 8 times simultaneously – is included. SCS2.1-supplem. services are supported.

Order: 7KK1297-7PW11.

Upgrade NNI Q.2763 B-ISUP to CS2.1 – ATM CS2.1 Upgrade NNI Software for ATM Interfaces: Upgrade Simulation and monitoring according to ITU-T Rec. Q.2763 to SCS2.1. SCS2.1-supplem. services are supported. (Condition: Software –7PW11 or –7NW11.)

Order: 7KK1297-7PW41.

ORDERING INFORMATION CONTINUED

For price information: Outside the U.S. contact your local Tektronix representative, inside the U.S. see the price list in the back of this catalog.

UNI Q.2931 DSS2 CS2.1, UNI3.1 and UNI 4.0 and NNI Q.2763 CS2.1 B-ISUP – ATM NNI Software for ATM Interfaces: Simulation and monitoring according to ITU-T Rec. Q.2763 SCS2.1, Q.2110, Q.2140 and Q.2210. Emulation of SSCOP 8 times simultaneously – is included. SCS2.1-supplem. services are supported.

ATM UNI Software for ATM Interfaces: Simulation and monitoring according to ITU-T Rec. Q.2931 SCS2.1, Q.2110, Q.2130 and Q.2120 and ATM-Forum UNI3.1 and UNI 4.0. Emulation of SSCOP 8 times simultaneously – is included. SCS2.1-supplem. services are supported.

Order 7KK1297-7NW11.

Upgrade UNI Q.2931 DSS2 to CS2.1 and NNI Q.2763 to CS2.1 B-ISUP – ATM CS2.1 Upgrade UNI Software for ATM Interfaces: Upgrade Simulation and monitoring according to ITU-T Rec. Q.2931 to SCS2.1. SCS2.1-supplem. services are supported.

ATM CS2.1 Upgrade NNI Software for ATM Interfaces: Upgrade Simulation and monitoring according to ITU-T Rec. Q.2763 to SCS2.1. SCS2.1-supplem. services are supported. (Condition: Software –7NW11.)

Order 7KK1297-7NW41.

NNI Deutsche Telekom G-B-ISUP basierend auf Q.2763 CS2.1 – ATM NNI Software for ATM Interfaces: Simulation and monitoring according to Technische Richtlinie 163 TR 82 and 163 TR 88 Deutsche Telekom. Emulation of SSCOP– 8 times simultaneously – is included.

Order 7KK1297-8AR11.

Upgrade B-ISUP to NNI Deutsche Telekom T-B-ISUP basierend auf Q.2763 CS2.1 – ATM NNI Software upgrade for ATM Interfaces: Simulation and monitoring according to Technische Richtlinie 163 TR 82 and 163 TR 88 Deutsche Telekom. Emulation of SSCOP– 8 times simultaneously – is included. (Condition: Software –7PW11 or –7NW11.)

Order 7KK1297-8AR41.

PNNI ATMF V1.0 – ATM NNI Software for ATM Interfaces: Simulation and monitoring according ATM-Forum PNNI V1.0. Emulation of SSCOP– 8 times simultaneously – is included.

Order 7KK1297-7XW11

Upgrade UNI to PNNI ATMF V1.0 – ATM PNNI V1.0 Upgrade for UNI Software for ATM Interfaces: Upgrade Simulation and monitoring according ATM-Forum UNI 3.1 to PNNI V1.0. Emulation of SSCOP– 8 times simultaneously is included. (Condition: Software –7MW11 or –7NW11.)

Order 7KK1297-7XW41.

B-ICI – ATM NNI Software for ATM Interfaces: Simulation and monitoring according ATM-Forum B-ICI V2.1. Emulation of SSCOP– 8 times simultaneously is included.

Order 7KK1297-7RW11.

B-ICI Upgrade – ATM B-ICI V2.1 Upgrade for NNI Software of ATM Interfaces: Simulation and monitoring according ATM-Forum B-ICI V2.1. Emulation of SSCOP– 8 times simultaneously is included. (Condition: Software –7PW11 or –7NW11.)

Order 7KK1297-7RW41.

ATM ANSI-NNI MTP-3b – ATM ANSI MTP-3b NNI Software for ATM Interfaces: Simulation and monitoring according to MTP-3b for 24 Bit SPC.

Order 7KK1297-7NV11.

CONFORMANCE TESTING

ETS Q.2931 (usr+ntwk) SCS1 Part A – ATM Q.2931SCS1 Conformance Tests ETS, according draft UNI 3.1 Conformance Tests of the ATM Forum, for user and network side: 95-0584R1.mp, 95-0858.mp, 95-1131.mp, 95-1145.ps and 96-335.mp. (Condition: Software –8DA11 or –8DP11 and 7MW11 or 7NW11.)

Order 7KK1297-8TC11.

ETS UNI 3.1 (usr+ntwk) Part A – ATM UNI 3.1 ETS ATM Forum Conformance Tests, for user and network side according: 95-0584R1.mp, 95-0858.mp, 95-1131.mp, 95-1145.ps and 96-335.mp. (Condition: Software –8DA11 or –8DP11.)

Order 7KK1297-8TD11.

ETS Q.2931 SCS1 + UNI 3.1 (usr+ntwk) Part A – ATM Q.2931SCS1 and UNI 3.1 Conformance Tests ETS, according draft UNI 3.1 Conformance Tests of the ATM Forum, for user and network side: 95-0584R1.mp, 95-0858.mp, 95-1131.mp, 95-1145.ps and 96-335.mp.(Condition: Software –8DA11 or –8DP11 and 7MW11 or 7NW11.)

Order 7KK1297-8TE11.

ETS Q.2961 – ATM Q.2961 ETS, Additional Traffic Parameter, ITU Conformance Tests, own design. (Condition: Software –8DA11 or –8DP11 and 7MW11 or 7NW11.)

Order 7KK1297-8TN11.

ETS Q.2963 – ATM Q.2963 ETS, Renegotiation, ITU Conformance Tests, own design. (Condition: Software –8DA11 or –8DP11 and 7MW11 or 7NW11.)

Order 7KK1297-8TG11.

ETS Q.2971 – ATM Q.2971 ETS, Point to Multipoint, ITU Conformance Tests, own design. (Condition: Software –8DA11 or –8DP11 and 7MW11 or 7NW11.)

Order 7KK1297-8TF11.

ETS Q.2763 SCS1 Part A – ATM Conformance Test ETS according ITU Rec. Q.784, Part 2, adapted to Q.2763 CS1, Part A.(Condition: Software –8DA11 or –8DP11 and 7PW11 or 7NW11.)

Order 7KK1297-8TJ11.

ETS Q.2110+Q.2130+Q.2140 – ATM SSCOP ETS for UNI 3.1 Conformance Tests according ATM Forum doc. af-test-0067.000 and SSCOP for UNI 3.1 Conformance Tests according ATM Forum doc. af-test-0067.000, adapted to ITU Rec. Q.2130 and Q.2140. (Condition: Software –8DA11 or –8DP11 and 7NW11.)

Order 7KK1297-8TK11.

TTCN RTE – ATM TTCN RTE (Run Time Environment), for execution of ATM TTCN Test Suites created with the Siemens TTCN.MP ATM compiler on a different K1297 ATM than the one the package is ordered for.

Order 7KK1297-8DP11.

TTCN Compiler – ATM TTCN.MP Compiler for ATM; including ASN.1 support, according to ISO IS9646-3/ ITU X.292 Tree & Tabular Combined Notation.

Order 7KK1297-8DA11.

ETS MTP L3 – ATM MTP L3 Conformance Test ETS acc. ITU Rec. Q.782, adapted to the B-ISUP stack. (Condition: Software –8DA11 or –8DP11 and 7PW11 or 7NW11.)

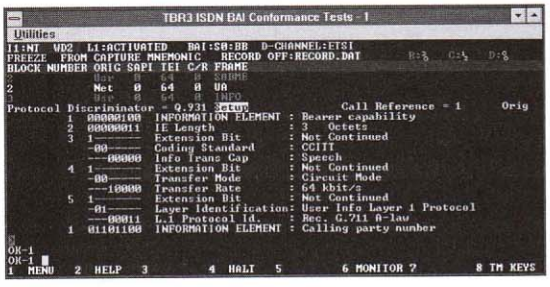
Order 7KK1297-8TM11.

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

Product manufactured in ISO 9001 registered facilities.

Software for K1297 Protocol Tester

ISDN



Features – Benefits

Uses E1, T1, S_0 or U_{2B1Q} Interfaces

DSS1, E-DSS1, QSIG (LAPD, ETSI/ITU Bluebook and Whitebook, Supplementary Services), X.25 in D-Channel

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

Product manufactured in ISO 9001 registered facilities.

Software Packages

MONITORING

- Monitoring of up to 8 E1/T1 links or up to 6 S_0/U_{K0} interfaces
- Different depth of decoding for each layer
- Variable trigger and filter mechanism
- Multicolor display

SIMULATION/EMULATION

- Simulation on up to 16 E1/T1 links or up to 12 S_0/U_{K0} interfaces at the same time
- Simulation of NET (NT) and/or USER (TE) side
- Flexible state oriented programming interface
- Emulation of LAPD Layer 2 protocol
- Simulation of different ISDN L3 and L2 connections on the same interface
- Up to eight simultaneous and independent state machines (Task Manager)
- Communication mechanisms between different Task Managers
- TTCN compiler and editor with ASN.1 ability available

CONFORMANCE TESTING

- Running of entire test suites or selection of particuar test groups and cases
- Report and logging options for every purpose
- International, European and national test standards
- Easy formulation of complete test suites
- Implementation of various test suites: See Ordering Information

National Variants

Package	Description
European Variants	
1TR6	Deutsche Telekom 1TR3 (01/90 and 12/91)
12TR7 (DKZE)	Deutsche Telekom 12TR7 (05/90)
VN2	ST/LAA/ELR/TRA/743 (09/89)
VN3	ST/PAA/TPA/CRE/1931 (03/90)
VN4	ST/LAA/RSM144 (06/91)
ECMA	ETS 300 172-1 (12/92) (ECMA-143) ETS 300 172-2 (01/94) and ETS 300 239-1 (06/93) ETS 300 172-3 (11/95) and ETS 300 239-2 (11/95)
CORNET N	SIEMENS V1.3e (01/96) (PBSCNN.86.F10)
CORNET NQ	SIEMENS V2.0a (12/95) SIEMENS V2.1 (12/96)
CORNET T	SIEMENS V2.6d (07/93) (PBSCVNT.84.D11)
CORNET-T-Radio	
Polish Variant	DSS1 Protocols in the Polish National Public ISDN Network (01/93)
North American Variants (U.S.A. and Canada)	
AT&T 5ESS	PRI: TR41459 (08/96) + SS PRI: AT&T 235 900 332 (08/92) BRI: AT&T 235 900 341 (02/93) BRI: AT&T 235 900 343 (02/93)
Other Variants	
NTT Japan	INS-Net (Interface and Services) (03/93)
V1 (Israel)	BEZEQ (05/94)

ORDERING INFORMATION

For price information: Outside the U.S. contact your local Tektronix representative, inside the U.S. see the price list in the back of this catalog.

SOFTWARE PACKAGES

MONITORING

ISDN D Channel Monitoring – With X.25 in D Channel (SAPI=16; for BAI only).
Supported Interfaces: BAI/PRI.
Order: 7KK1297-6FW11.

TABLE 1: ISDN D CHANNEL MONITORING STANDARDS

ETSI	ETS 300 125 (09/91) and ETS 300 102 (02/92) ETS 300 403 (03/95) Suppl. Services See Table 3
ITU	Q.921/Q.931 BB Q.921/Q.931 WB (03/93)
NI-1	Bellcore SR-NWT-001953 (12/91)
NI-2	BRI: Bellcore SR-NWT-002661 (06/93) PRI: Bellcore TR-NWT-0001268 R4 (03/98)
ANSI	ANSI T1.607 1990

DPNSS1 – According to BTNR 188 Issue 6 1995.
Supported Interfaces: PR-E1.
Order: 7KK1297-6WW11.
NMDS – Specification: EN301 141-1 V1.2.1 (07/98).
Supported Interfaces: BAI/PRI.
Order: 7KK1297-6LW11.

SIMULATION/EMULATION

ISDN D Channel Simulation – With X.25 in D Channel (SAPI=16; for BAI only).
Supported Interfaces: BAI/PRI.
Order: 7KK1297-7FW11.

TABLE 2: ISDN D CHANNEL SIMULATION STANDARDS

ETSI	ETS 300 125 (09/91) and ETS 300 102 (02/92) ETS 300 403 (03/95) Suppl. Services See Table 3
ITU	Q.921/Q.931 BB Q.921/Q.931 WB (03/93)
NI-1	Bellcore SR-NWT-001953 (12/91)
NI-2	BRI: Bellcore SR-NWT-002661 (06/93) PRI: Bellcore TR-NWT-0001268 R4 (03/98)
ANSI	ANSI T1.607 1990

DPNSS1 – According to BTNR 188 Issue 6 1995.
Supported Interfaces: PRI-E1.
Order: 7KK1297-7WW11.
NMDS – Specification: EN301 141-1 V1.2.1 (07/98).
Supported Interfaces: BAI/PRI.
Order: 7KK1297-7LW11.

NATIONAL VARIANTS

European Variants –
Prerequisite Software: 7KK1297-6FW11 or 7KK1297-7FW11.
Order: 7KK1297-8AK11.
North American Variants (U.S.A. and Canada) –
Prerequisite Software: 7KK1297-6FW11 or 7KK1297-7FW11.
Order: 7KK1297-8AL11.
Other Variants –
Prerequisite Software: 7KK1297-6FW11 or 7KK1297-7FW11.
Order: 7KK1297-8AM11.

ISDN D CHANNEL SOFTWARE SUPPLEMENTARY SERVICES

For Order Numbers 7KK1297-6FW11 (Monitoring) and 7KK1297-7FW11 (Simulation).

TABLE 3:

Supplementary Service		Specification
MSN	Multiple Subscriber Number	ETS 300 052 (06/98)
TP	Terminal Portability	ETS 300 055 (06/98)
CW	Call Waiting	ETS 300 058 (06/98)
SUB	Sub-addressing	ETS 300 061 (06/98)
DDI	Direct Dialing In	ETS 300 064 (06/98)
CLIP	Calling Line ID Presentation	ETS 300 092 (06/98)
CLIR	Calling Line ID Restriction	ETS 300 093 (06/98)
COLP	Connected Line ID Presentation	ETS 300 097 (06/98)
COLR	Connected Line ID Restriction	ETS 300 098 (06/98)
MCID	Malicious Call Identification	ETS 300 130 (06/98)
CUG	Closed User Group	ETS 300 138 (06/98)
Hold	Call Hold	ETS 300 141 (06/98)
AOC	Advise of Charge with Extensions	ETS 300 18x (06/98)
CONF	Conference Call	ETS 300 185 (06/98)
3PTY	Three Party	ETS 300 188 (06/98)
UUS	User-User-Service Request	ETS 300 195 (10/98)
GFP	General Funtional Protocol	ETS 300 196 (04/98)

TABLE 4: CONFORMANCE TESTING

Package	Description	ATS Standard	Tested Protocol Standard	Supported Interfaces	No. of Test Cases	Order No.	Prerequisite of Software
ZV25	ISDN TE Conformance Tests for Supplementary Services	Not TTCN based	BAPT 223 ZV25, (10/94) (HOLD, RETRIEVE, 3PTY, RESTART)	BAI	20	7KK1297-8UG11	7KK1297-7FW11 and 7KK1297-8AK11
RTP for BAI	RTP Conformance Tests for BAI	CSE P 10-21A, edition 1, (07/94)		BAI		7KK1297-8UM11	7KK1297-7FW11
RTP for PRI	RTP Conformance Tests for PRI	CSE P 10-21A, edition 1, (07/94)		BRI		7KK1297-8UN11	7KK1297-7FW11
ECMA QSIG Basic Call	ECMA QSIG Conformance Tests for Basic Call (Concurrent TTCN)	DE/ECMA 00109.1/2, (08/94)	ETS 300 172 2nd edition (01/94)	BAI/PRI	409	7KK1297-8UP11	7KK1297-7FW11

ORDERING INFORMATION CONTINUED

For price information: Outside the U.S. contact your local Tektronix representative, inside the U.S. see the price list in the back of this catalog.

TABLE 4: CONFORMANCE TESTING CONTINUED

Package	Description	ATS Standard	Tested Protocol Standard	Supported Interfaces	No. of Test Cases	Order No.	Prerequisite of Software
ECMA QSIG Generic Functions	ECMA QSIG Conformance Tests for Generic Functions (Concurrent TTCN)	DE/ECMA 00110.1/2, (05/95)	ETS 300 239 1st edition (06/93)	BAI/PRI	215	7KK1297-8UQ11	7KK1297-7FW11
ISO QSIG Basic Call – Release End 1999	ISO QSIG Conformance Tests for Basic Call (Concurrent TTCN)	ETS 300 805-2	ETS 300 172 3rd edition (11/95)	BAI/PRI		7KK1297-8UR11	7KK1297-7FW11
ISO QSIG Generic Functions-Release End 1999	ISO QSIG Conformance Tests for Generic Functions (Concurrent TTCN)	ETS 300 806-2	ETS 300 239 2nd edition (11/95)	BAI/PRI		7KK1297-8US11	7KK1297-7FW11
NI1 BCC	NI1 Conformance Tests for L3, Basic Call, Userside		SR-NWT-001953	BAI	240	7KK1297-8UY11	7KK1297-7FW11
NET3	ISDN TE Conformance Tests for Basic Call BAI	NET 3, Not TTCN based	NET 3 ETS300 104 (L3) 7'91 and Ammendments, ETS300 153 (L2) (07/92)	BAI	L2: 45, L3: 150	7KK1297-8UA11	7KK1297-7FW11
NET5	ISDN TE Conformance Tests for Basic Call PRI	NET 5, Not TTCN based	NET 5 ETS300 156 (09/92)	PRI	L2: 47, L3: 132	7KK1297-8UB11	7KK1297-7FW11
TBR3/CTR3	ISDN TE Conformance Tests for Basic Call (CTR3 mandatory tests)	TBR 3, V1.0 (02/97)	TBR 3	BAI	L2: 34, L3: 71	7KK1297-8UC11	7KK1297-7FW11
TBR4/CTR4	ISDN TE Conformance Tests for Basic Call PRI (CTR4 mandatory tests)	TBR 4, V1.0 (02/97)	TBR 4	PRI	L2: 38, L3: 61	7KK1297-8UD11	7KK1297-7FW11
NET3 to TBR3	Cross-upgrade of Software: ISDN Conformance Tests: NET3 to CTR 3 (TBR3)	TBR 3, V1.0 (02/97)	TBR 3	BAI	L2: 34, L3: 71	7KK1297-8UC51	7KK1297-8UA11
NET5 to TBR4	Cross-upgrade of Software: ISDN Conformance Tests: NET5 to CTR 4 (TBR4)	TBR 4, V1.0 (02/97)	TBR 4	PRI	L2: 38, L3: 61	7KK1297-8UD51	7KK1297-8UB11
ZV9	ISDN TE Conformance Tests for X.25 in D Channel	Not TTCN based	BAPT 224 ZV9, (06/94)	BAI	44	7KK1297-8UH11	7KK1297-7FW11 and 7KK1297-8AK11
TBR33	TBR33 Conformance Tests, Layer 2/3, for ISDN Data-TE (BAI)	TBR33 (DTBR/SPS-05119)	TBR33 (12/97)	BAI	L2: 36, L3: 56	7KK1297-8UK11	7KK1297-7FW11
TBR34	TBR34 Conformance Tests, Layer 2/3, for ISDN Data-TE (PRI)	TBR34 (DTBR/SPS-05120)	TBR34 (12/97)	PRI	L2: 32, L3: 55	7KK1297-8UL11	7KK1297-7FW11
ZV9 to TBR33	Cross-upgrade of Software BAPT ZV9 to ISDN Conformance Tests TBR 33	TBR33 (DTBR/SPS-05119)	TBR33 (12/97)	BAI	L2: 36, L3: 56	7KK1297-8UK51	7KK1297-8UH11
CTS2	ISDN TE Conformance Tests for Basic Call BAI	CTS 2, Not TTCN based	ETS 300 125, ETS 300 102	BAI	L2: 411, L3: 355	7KK1297-8UE11	7KK1297-7FW11
CTS2bis	ISDN TE Conformance Tests for Basic Call PRI	CTS-2BIS PD211.6 and PD311.6 (10/93)	ETS 300 125, ETS 300 102	PRI	L2: 470, L3: 334	7KK1297-8UF11	7KK1297-7FW11
DSS1 NT/TE Side Basic Call L2	ISDN Conformance Tests for L2, TE and Networkside	ETS 300 402-7	ETS 300 402-1/2	BAI/PRI	565	7KK1297-8UX11	7KK1297-7FW11
DSS1 Userside Basic Call L3	ISDN TE Conformance Tests for Layer3 Basic Call	ETS 300 403-5	ETS 300 403-1/2	BAI/PRI	668	7KK1297-8UW11	7KK1297-7FW11

ORDERING INFORMATION

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TABLE 4: CONFORMANCE TESTING CONTINUED

Package	Description	ATS Standard	Tested Protocol Standard	Supported Interfaces	No. of Test Cases	Order No.	Prerequisite of Software
DSS1 Networkside Basic Call L3	ISDN Networkside Conformance Tests for Layer3 Basic Call (Concurrent TTCN)	ETS 300 403-7	ETS 300 403-1/2	BAI/PRI	652	7KK1297-8UT11	7KK1297-7FW11
CTS2 or CTS2bis to DSS1 L2 NT/TE	Cross-upgrade of Software CTS2 or CTS2bis to ISDN Conformance Tests, Layer 2, NT- and TE	ETS 300 402-7	ETS 300 402-1/2	BAI/PRI	565	7KK1297-8UX51	7KK1297-8UE11 or 7KK1297-8UF11
CTS2 or CTS2bis to DSS1 L3 BC TE	Cross-upgrade of Software CTS2 or CTS2bis to ISDN Conformance Tests, Layer3, Basic Call, TE	ETS 300 403-5	ETS 300 403-1/2	BAI/PRI	668	7KK1297-8UW51	7KK1297-8UE11 or 7KK1297-8UF11
PT56 Suppl. Serv., Networkside	ISDN Networkside Conformance Tests for Supplementary Services	For more info, see table 7	For more info, see table 7	BAI/PRI	1224	7KK1297-8UU11	7KK1297-7FW11
PT56 Suppl. Serv., Networkside	ISDN Networkside Conformance Tests for Supplementary Services Part 1	For more info, see table 7	For more info, see table 7	BAI/PRI	538	7KK1297-8VF11	7KK1297-7FW11
PT56 Suppl. Serv., Networkside	ISDN Networkside Conformance Tests for Supplementary Services Part 2	For more info, see table 7	For more info, see table 7	BAI/PRI	686	7KK1297-8VG11	7KK1297-7FW11
CTS4	ISDN TE Conformance Tests for Supplementary Services	CTS 4 SS, Tranche 1+2, Not TTCN based	CNET ST/CSE P11-93A and 9 (DDI, MSN, TP, CLIP, CLIR, COLP, COLR, CW, SUB, HOLD)	BAI/PRI	139	7KK1297-8UJ11	7KK1297-7FW11
PT56 Suppl. Serv., Userside Complete Test list – Release End 1999	ISDN TE Conformance Tests for Supplementary Services	For more info, see table 8	For more info, see table 8	BAI/PRI	1003	7KK1297-8UV11	7KK1297-7FW11
PT56 Suppl. Serv., Userside; – Release End 1999	ISDN TE Conformance Tests for Supplementary Services Part 1	For more info, see table 8	For more info, see table 8	BAI/PRI	255	7KK1297-8VB11	7KK1297-7FW11
PT56 Suppl. Serv., Userside; – Release End 1999	ISDN TE Conformance Tests for Supplementary Services Part 2	For more info, see table 8	For more info, see table 8	BAI/PRI	266	7KK1297-8VC11	7KK1297-7FW11
PT56 Suppl. Serv., Userside; – Release End 1999	ISDN TE Conformance Tests for Supplementary Services Part 3	For more info, see table 8	For more info, see table 8	BAI/PRI	307	7KK1297-8VD11	7KK1297-7FW11
PT56 Suppl. Serv., Userside; – Release End 1999	ISDN TE Conformance Tests for Supplementary Services Part 4	For more info, see table 8	For more info, see table 8	BAI/PRI	175	7KK1297-8VE11	7KK1297-7FW11
CTS4 to PT56 SS	Cross-upgrade of Software CTS4 to ISDN TE Conformance Tests for Supplementary Services Part 4	For more info, see table 8	For more info, see table 8	BAI/PRI	175	7KK1297-8VE51	7KK1297-8UJ11
ISO X.25; will be released Middle 1999	ISO X.25 Conformance Tests, Layer 2/3 Userside	ISO/IEC 8882-2, ISO/IEC 8882-3	ISO/IEC 7776 (X.25), ISO/IEC 8208 (X.25)	BAI/PRI/VX	L2: 290, L3: 455	7KK1297-8VA11	7KK1297-7FW11

ORDERING INFORMATION CONTINUED

For price information: Outside the U.S. contact your local Tektronix representative, inside the U.S. see the price list in the back of this catalog.

TABLE 7: PT56 NETWORKSIDE SUPPLEMENTARY SERVICES

Ordering Number	Supplementary Service		Specification	Number of Test Cases
7KK1297-8VF11 and 7KK1297-8UU11	DDI	Direct Dialing In	ETS 300 064	4
	UUS	User-to-User Signaling	ETS 300 286	245
	MCID	Malicious Call Identification	ETS 300 130	20
	7 kHz FB	7 kHz Fallback	ETS 300 267	45
	CUG	Closed User Group	ETS 300 138	95
	CCBS	Completion of Calls to Busy Subscriber	ETS 300 359	120
	SEGM	Segmentation	ETS 300 403	9
7KK1297-8VG11 and 7KK1297-8UU11	CONF	Conference Call	ETS 300 185	64
	3PTY	Three Party	ETS 300 188	45
	CLIP	Calling Line ID Presentation	ETS 300 092	26
	CLIR	Calling Line ID Restriction	ETS 300 093	5
	COLP	Connected Line ID Presentation	ETS 300 097	24
	COLR	Connected Line ID Restriction	ETS 300 098	5
	CW	Call Waiting	ETS 300 058	18
	DIV	Call Diversion	ETS 300 207	344
	SUB	Sub-addressing	ETS 300 061	4
	MSN	Multiple Subscriber Number	ETS 300 052	3
	TP	Terminal Portability	ETS 300 055	18
	Hold	Call Hold	ETS 300 141	43
	AOC	Advise of Charge	ETS 300 182	87

TABLE 8: PT56 USERSIDE SUPPLEMENTARY SERVICES

Ordering Number	Supplementary Service		Specification	Number of Test Cases
7KK1297-8VB11 and 7KK1297-8UV11	UUS	User-to-User Signaling	ETS 300 286	156
	CONF	Conference Call	ETS 300 185	74
	3PTY	Three Party	ETS 300 188	25
7KK1297-8VC11 and 7KK1297-8UV11	DIV	Call Diversion	ETS 300 207	266
7KK1297-8VD11 and 7KK1297-8UV11	MCID	Malicious Call Identification	ETS 300 130	12
	CCBS	Completion of Calls to Busy Subscriber	ETS 300 359	100
	7 kHz FB	7 kHz Fallback	ETS 300 267	21
	AOC	Advise of Charge	ETS 300 182	154
	CUG	Closed User Group	ETS 300 138	11
	SEGM	Segmentation	ETS 300 403	9
7KK1297-8VE11 and 7KK1297-8UV11	Hold	Call Hold	ETS 300 141	72
	TP	Terminal Portability	ETS 300 055	10
	MSN	Multiple Subscriber Number	ETS 300 052	10
	DDI	Direct Dialing In	ETS 300 064	15
	CW	Call Waiting	ETS 300 058	12
	SUB	Sub-addressing	ETS 300 061	12
	CLIP	Calling Line ID Presentation	ETS 300 092	20
	CLIR	Calling Line ID Restriction	ETS 300 093	2
	COLP	Connected Line ID Presentation	ETS 300 097	20
	COLR	Connected Line ID Restriction	ETS 300 098	2

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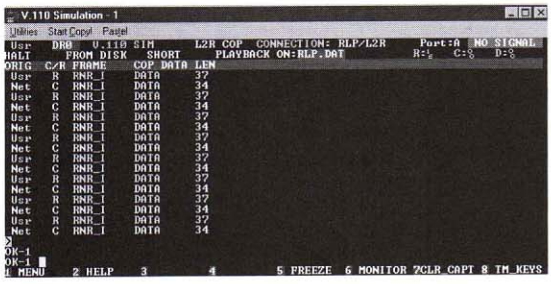
Product manufactured in ISO 9001 registered facilities.

Software for K1297 Protocol Tester

Data Services for GSM



Features – Benefits

Uses E1 Interface and ADSP Board

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

Product manufactured in ISO 9001 registered facilities.

Software Packages

MONITORING

- Monitoring of 1 link (Up to 64 kbit/s)
- Different depth of decoding for each layer available
- Selectable trigger and filter mechanism
- Multicolor display
- GSM V.110': (RLP, L2R, BOP, COP, including V.110 up to 9600 bit/s) according to GSM Phase 1 and 2: 08.20 V3.1.1, 04.22 V3.6.0, 07.01 V3.10.0, 07.02 V3.6.0, 07.03 V3.2.0
- GSM TRAU (Transcoder Rate Adapter Unit): according to GSM 08.60 V3.2.0

SIMULATION/EMULATION

- Simulation of 1 link (Up to 64 kbit/s)
- GSM V.110': (RLP, L2R, BOP, COP, including V.110 up to 9600 bit/s) according to GSM Phase 1 and 2: 08.20 V3.1.1, 04.22 V3.6.0, 07.01 V3.10.0, 07.02 V3.6.0, 07.03 V3.2.0
- GSM TRAU (Transcoder Rate Adapter Unit): according to GSM 08.60 V3.2.0

DATA GENERATOR

- Generation of user data for V.110
- Test tool for synchronous and asynchronous data connections

Ordering Information

For price information:
Outside the U.S. contact your local Tektronix representative, inside the U.S. see the price list in the back of this catalog.

MONITORING

V110' – Order 7KK1297-6WA11.
TRAU – Order 7KK1297-6WC11.

SIMULATION/EMULATION

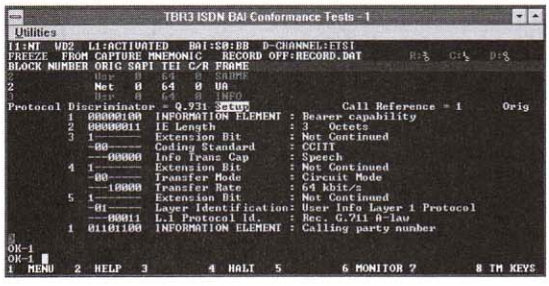
V110' – Order 7KK1297-7WA11.
TRAU – Order 7KK1297-7WC11.

DATA GENERATOR

For V110' – Order 7KK1297-7WB11.

Software for K1297 Protocol Tester

Packet Services for ISDN



Features – Benefits

Uses E1, T1, S_0 or U_{2B1Q} Interface

X.25 B Channel Monitoring Software
- According to Red ('84) and Yellow Book ('80)
- BAI, PRI, V./X. Interfaces

X.75 Monitoring Software
- BAI, PRI, V./X. Interfaces

PHI Monitoring Software
- According to ETS 300 099 from April 1998
- BAI, PRI Interfaces

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

Product manufactured in ISO 9001 registered facilities.

Software Packages

MONITORING

- Monitoring of up to 8 E1/T1 links or up to 6 S_0/U_{K0} interfaces
- Different depth of decoding for each layer
- Variable trigger and filter mechanism
- Multicolor display

SIMULATION/EMULATION

- Simulation on up to 16 E1/T1 links or up to 12 S_0/U_{K0} interfaces at the same time
- Simulation of NET (NT) and/or USER (TE) side
- Flexible state oriented programming interface
- Emulation of LAPD Layer 2 protocol
- Simulation of different ISDN L3 and L2 connections on the same interface
- Up to eight simultaneous and independent state machines (Task Manager)
- Communication mechanisms between different Task Managers

CONFORMANCE TESTING

- Implementation of X.25 conformance test according to ISO 8882

Ordering Information

For price information:
Outside the U.S. contact your local Tektronix representative, inside the U.S. see the price list in the back of this catalog.

MONITORING

X.25 – Order 7KK1297-6WG11.

X.75 – Order 7KK1297-6WJ11.

ISDN PHI – Order 7KK1297-6WH11.

SIMULATION/EMULATION

X.25 – Order 7KK1297-7WG11.

X.75 – Order 7KK1297-7WJ11.

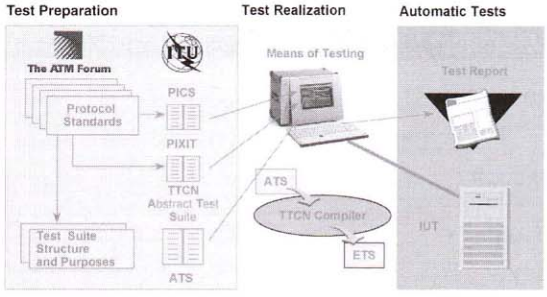
ISDN PHI – Order 7KK1297-7WH11.

CONFORMANCE TESTING

X.25 – Order 7KK1297-8VA11.

Software for K1297 Protocol Tester

Test – Tools



Features – Benefits

TTCN (according to ISO 9646-3) is an abstract test description language. Test suite specific adaptations are inevitable and always necessary to adapt an ATS (Abstract Test Suite) to a particular protocol tester platform

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

Product manufactured in ISO 9001 registered facilities.

Software Packages

TTCN

- Abstract test description language
- Conforms to ISO/IEC 9646/1-7
- Full ASN.1 support
- Including concurrent TTCN

TTCN-RTE

- Is needed to run TTCN test cases on other K1297
- Is already included in conformance test packages

TTCN EDITOR

- Graphical Editor for TTCN
- Import of different file formats
- Handling of *.MP and *.GR file formats
- Print of graphical representation

ADAPTATION FILE PREPARATION

In the K1297, two files are used to realize those adaptations: SPECIAL and INI files. Both files are necessary for compilation of an ATS on the K1297 with the TTCN compiler (7KK1297-8DT11) and have to be modified to each ATS.

Tektronix can prepare custom SPECIAL and INI files on request.

Abbreviations

TTCN:	Tree and Tabular Combined Notation
RTE :	TTCN-Run Time Environment
ATS:	Abstract Test Suite
ETS:	Executable Test Suite
PICS:	Protocol Implementation Conformance Statement
PIXIT:	Protocol Implementation extra information
IUT:	Implementation Under Test
MP:	Machine processing format of TTCN
GR:	Graphical representation of TTCN

ORDERING INFORMATION

For price information: Outside the U.S. contact your local Tektronix representative, inside the U.S. see the price list in the back of this catalog.

TTCN

Narrowband –

Software tool: TTCN.MP compiler with ASN.1 and concurrent TTCN support.

Specification: IS ISO 9646-3, ITU X.292.

Prerequisites: 7KK1297-7AW11, 7KK1297-7BW11, 7KK1297-7CW11, 7KK1297-7EW11, 7KK1297-7FW11, 7KK1297-7JW11 or 7KK1297-7KW11.

Order 7KK1297-8DT11.

Broadband –

TTCN MP Compiler F. ATM including ASN.1 support, according to ISO IS9646-3/ITU X.292 three & tabular combined notation.

Prerequisites: 7KK1297-7MW11; 7KK1297-7NW11; 7KK1297-7PW11; 7KK1297-7RW11; 7KK1297-7XW11 or 7KK1297-8AN11.

Order 7KK1297-8DA11.

RTE

Narrowband –

Software tool RTE for TTCN.MP compiler (for execution of TTCN test suites, created with the Tektronix TTCN.MP compiler an another K1297 than the one the package is ordered for).

Specification: ISO 9646-3.

Prerequisites: 7KK1297-7AW11, 7KK1297-7BW11, 7KK1297-7CW11, 7KK1297-7EW11, 7KK1297-7FW11, 7KK1297-7JW11 or 7KK1297-7KW11.

Order 7KK1297-8DJ11.

Broadband –

TTCN RTE for ATM for execution of ATM TTCN test SUITESCONFIG_ITEMEATED with the Siemens TTCN.MP ATM compiler on a different K1297 ATM than the one the package is ordered for.

Prerequisites : 7KK1297-7MW11; 7KK1297-7NW11; 7KK1297-7PW11; 7KK1297-7RW11; 7KK1297-7XW11 or 7KK1297-8AN11.

Order 7KK1297-8DP11.

TTCN EDITOR

Narrow and Broadband –

TTCN Expert Editor.

Order 7KK1298-8BA11.

ADAPTATION FILE PREPARATION

Narrow and Broadband –

SPECIAL and INI-File preparation for TTCN compiler, Package 1 (on request).

Prerequisite: 7KK1297-8DT11.

Order 7KK1297-8DC11.

SPECIAL and INI-File preparation for TTCN compiler, Package 2 (on request).

Prerequisite: 7KK1297-8DT11.

Order 7KK1297-8DD11.

SPECIAL and INI-File preparation for TTCN compiler, Package 3 (on request).

Prerequisite: 7KK1297-8DT11.

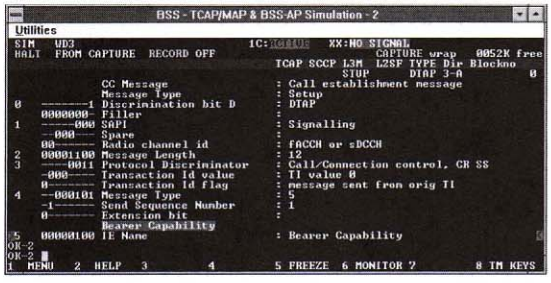
Order 7KK1297-8DE11.

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

Product manufactured in ISO 9001 registered facilities.

Software for K1297 Protocol Tester

Mobile Radio Network



Features – Benefits

Uses E1 or T1 Interface

GSM/DCS 1800/PCS 1900:
- Phase 2, BSSAP, DTAP, TCAP/MAP, SS PROTOCOL, SMCP, SMRP, SMTP
- A_{bis} (64 KBit and 16 KBit)
- CAMEL AP
- MAPV3

CDMA:
- APLUS, IS41B, IS41C, SMS TR, SMS TS

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

Product manufactured in ISO 9001 registered facilities.

Software Packages

MONITORING

- Monitoring of up to 8 E1/ T1 links
- Selectable from short to complete depth of decoding for each layer
- Trigger and filter mechanism
- Selectable color per data direction

SIMULATION/ EMULATION

- Simulation on up to 16 E1/ T1 links at the same time
- Flexible state oriented programming interface
- Emulation of MTP Layer 2 protocol
- Simulation of different SS#7 L3 connections on the same interface
- Up to eight simultaneous and independent state machines (Test Manager)
- Communication mechanisms between different Test Managers
- Message Building System

NATIONAL VARIANTS

- ICO
- IGAP

Ordering Information

For price information:
Outside the U.S. contact your local Tektronix representative, inside the U.S. see the price list in the back of this catalog.

MONITORING

GSM Phase 2 – Order 7KK1297-6EW11.
TCAP/MAP Version 3 – Order 7KK1297-6GW11.
Camel AP – Order 7KK1297-6HW11.
CDMA – Order 7KK1297-6QW11.
A_{bis} – Order 7KK1297-6DW11.

SIMULATION/EMULATION

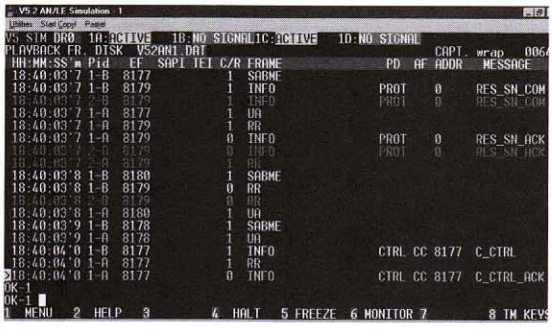
GSM Phase 2 – Order 7KK1297-7EW11.
TCAP/MAP Version 3 – Order 7KK1297-7GW11.
Camel AP – Order 7KK1297-7HW11.
CDMA – Order 7KK1297-7QW11.
A_{bis} – Order 7KK1297-7DW11.

NATIONAL VARIANTS

ICO – Order 7KK1297-8AE11.
IGAP – Order 7KK1297-8AD11.

Software for K1297 Protocol Tester

V5.1/ V5.2



Features – Benefits

Uses E1 Interface

V5.1 (ETS 300 324 – x) and V5.2 (ETS 300 347 – x)

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

Product manufactured in ISO 9001 registered facilities.

Software Packages

MONITORING

- Monitoring of up to 8 links (up to 4 links in one window)
- Different depth of decoding for each layer available
- Selectable trigger and filter mechanism

SIMULATION/ EMULATION

- Simulation on up 32 communication channels on up to 16 links at the same time
- Simulation of all V5.1 (CONTROL, PSTN, ISDN DSS1) and V5.2 (V51 plus LINK CONTROL incl. SA7, PROTECTION, BCC) Layer 3 protocols
- Flexible state oriented programming interface
- Emulation of V5 (V5LAPD, EF-Address) and ISDN (LAPD) Layer 2 protocols
- Simulation of different ISDN L3 and L2 connections on the same communication channel
- Up to eight simultaneous and independent state machines (Test Manager)
- Communication mechanisms between different Test Managers
- Concurrent TTCN compiler and editor with ASN.1 ability available

NETWORK ELEMENT EMULATION

- Emulation of V5.1/V5.2 Access Network (AN) network element with up to 10 virtual automated subscribers
- Emulation of V5.1/V5.2 Local Exchange (LE) network elements with up to 10 subscribers in the AN and up to 10 virtual automated subscribers in the LE

CONFORMANCE TESTING

Implementation of ETSI test suites testing:

- Local exchange
- Access network
- Datalink of local exchange and access network
- Always up to date implementation of ETSI test suites available (currently the on vote version 0.5 of ETSI's V5.x test suites)

Ordering Information

For price information:
Outside the U.S. contact your local Tektronix representative, inside the U.S. see the price list in the back of this catalog.

MONITORING
V5.1/V5.2. Order 7KK1297-6JW11/-6KW11.

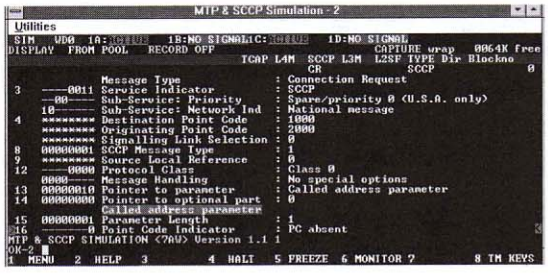
SIMULATION/EMULATION
V5.1./V5.2 Order 7KK1297-7JW11/-7KW11.

NETWORK ELEMENT EMULATION
V5.1/V5.2 LE – Order 7KK1297-8QC11.
V5.1/V5.2 AN – Order 7KK1297-8QD11.

CONFORMANCE TESTING
L3 LE – V5.1/V5.2. Order 7KK1297-8JB11/-8JE11.
L3 AN – V5.1/V5.2. Order 7KK1297-8JC11/-8JF11.
L2 LE & AN – V5.1/V5.2. Order 7KK1297-8JD11/-8JG11.

Software for K1297 Protocol Tester

SS#7/IN



Features – Benefits

Uses E1 or T1 Interface

ITU Blue Book and White Book, ANSI, Bellcore, MOU, ETSI

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

Product manufactured in ISO 9001 registered facilities.

Software Packages

MONITORING

- Monitoring of up to 8 E1/T1 links, 16 timeslots
- Selectable from short to complete depth of decoding for each layer
- Trigger and filter mechanism
- Selectable color per data direction

SIMULATION/EMULATION

- Simulation on up to 16 E1/ T1 links at the same time, 32 timeslots
- Flexible state oriented programming interface
- Emulation of MTP Layer 2 protocol
- Simulation of different SS#7 L3 connections on the same interface
- Up to eight simultaneous and independent state machines (Test Manager)
- Communication mechanisms between different Test Managers
- TTCN compiler and editor supporting ASN.1 and Concurrent TTCN available
- Message Building System

CONFORMANCE TESTING

- ITU: ISUP, TUP, MTP 2+3, End-to-end
- ETSI: CORE INAP
- BAPT: SCCP, ISUP
- Running of entire test suites or selection of particular test groups and cases
- Report and logging options for every purpose
- International, european and national test standards
- Easy formulation of complete test suites

NATIONAL VARIANTS

- **European Variants:** Like ISUP: CS, POL, Denmark, Austria, Portugal, Hungarian, EWSD, HOL; BT: NUP, 5167; TUP: Spain, Italy, Denmark, PLUS, VN4, VN5; 1TR7; SCCP TF 163 TR 73, INAP: Austria, Finland, Spain, Siemens
- **USA Variants:** Like ISUP NWT, ISUP TSY, ANSI ISUP T113, TCAP AIN, TCAP B800, TCAP BELL
- **Other Variants:** Like MTP China, MTP Hong Kong, ISUP Columbia, ISUP Australia, ISUP Hong Kong, ISUP ISR, ISUP GUS, ISUP MEX, ISUP THL, +ISUP PAK, SCCP Australia, TUP Australia, TUP China, TCAP SSP ITATEL, TCAP TEST USR, ISUP Australia Interconnect

ORDERING INFORMATION

For price information: Outside the U.S. contact your local Tektronix representative, inside the U.S. see the price list in the back of this catalog.

MONITORING

SS#7 (MTP/SCCP) – Order 7KK1297-6AW11.
SS#7 (TUP/ISUP) – Order 7KK1297-6BW11.
SS#7 (TCAP/INAP) – Order 7KK1297-6CW11.

SIMULATION/EMULATION

SS#7 (MTP/SCCP) – Order 7KK1297-7AW11.
SS#7 (TUP/ISUP) – Order 7KK1297-7BW11.
SS#7 (TCAP/INAP) – Order 7KK1297-7CW11.

CONFORMANCE TESTING

SS#7 ISUP Q.784/5 – Order 7KK1297-8PA11.
SS#7 MTP – Order 7KK1297-8PC11.
SS#7 TUP – Order 7KK1297-8PD11.
SS#7 ISUP BAPT – Order 7KK1297-8PE11.
SS#7 SCCP – Order 7KK1297-8PF11.
SS#7 ETSI Core INAP – Order 7KK1297-8PG11.
SS#7 End-to-End Q.788 – Order 7KK1297-8PH11.

NATIONAL VARIANTS

SS#7 Europe – Order 7KK1297-8AA11.
SS#7 USA & Can. – Order 7KK1297-8AB11.
SS#7 World – Order 7KK1297-8AC11.

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

Product manufactured in ISO 9001 registered facilities.

ISDN S_0 Analyzer

K1403



Features – Benefits

Certified Conformance Tester for Layer of ISDN S_0 Interface

Measurements on TE and NT in Accordance with ITU-T

Testing of Functional and Procedural Characteristics

Transmission Parameters and Power Feeding Measurements

Trace Analysis of the TTCN Tests

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

CE

Product manufactured in ISO 9001 registered facilities.

The K1403 ISDN S_0 Analyzer is a test set for measurements on the S_0 bus. It is compact and equally suited for use in development and test departments as well as by maintenance personnel.

The K1403 is used to perform functional and procedural tests on TEs and NTs in order to verify that equipment conforms to ITU-T I.430. The K1403 is able to measure the receiver sensitivity by bit error testing on TEs and NTs.

The K1403 provides all the test facilities defined in the guidelines ITU-T I.430, ETS 300 012, CTS-2, NET3, and TBRs. Its modular design is expandable and adaptable to special measuring tasks. It combines all the modules, signals, auxiliary signals, and analyzers required for performing the measuring tasks into one compact instrument.

Transmission Measurement Option

This option is used to expand the transmission measurement capability of the K1403. The electrical tests described in ITU-T I.430 and ETS 300 012 can thus be performed in their entirety.

DESIGN AND MODE OF OPERATION

This option comprises three plug-in modules, Analog 1, Analog 2, and Jitter.

The Analog 1 Module is used to perform the impedance and balance measurement modes. It incorporates a synthesizer with high spurious signal suppression for generating the required sinusoidal signals in the range 2 kHz to 1 MHz under crystal control. The receiver operates selectively. The bandwidth is <25 Hz and realized with a mechanical filter. The control panel allows the test modules to be coupled to the item under test. The control panel incorporates a relay switching panel as well as all the reference test items and instrument transformers.

Further analog measurements can be performed using the Analog 2 Module which incorporates the functions of a digital storage oscilloscope, a high-frequency counter, as well as various test pattern generators and detectors.

The plug-in jitter module accommodates two functional blocks. One of these blocks contains a phase jitter meter which evaluates the jitter in peak or RMS terms and displays the frequency components in spectral form. The other block generates jitter with an adjustable amplitude and frequency.

S_0 Bus Simulator Option

To measure the layer 1 characteristics of the terminal equipment (TE) or network terminations (NT) the international recommendation ITU-T I.430 calls for the use of an artificial line to simulate the "worst case" behavior of a line taking into account simulated TE loads, terminating resistors associated with the installation, and noise on the line.

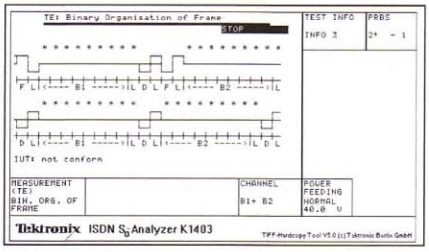


Figure 1. Presentation of result for binary organization of frame measurement.

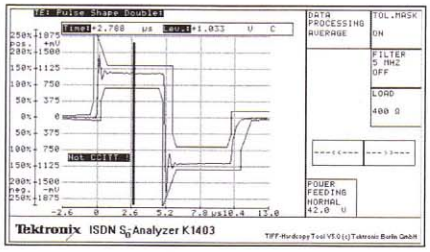


Figure 2. Presentation of results for pulse shape measurement.

Measurement mode	Item under test	
	TE	NT
Measuring the transmission parameters		
Receiver sensitivity	X	X
Receiver input delay		X
Measuring the functional characteristics		
Basic interconnection tests	X	
Binary organization of frame	X	X
Interframe time fill	X	
D-echo channel response	X	
D-channel access control	X	
Activation/deactivation	X	
Timer tests	X	
Frame alignment procedure	X	
Multiframing procedure	X	
Idle channel code on the B-channel	X	
Measuring the power conditions		
Power consumption	X	
Output power		X
Current/transient measurement	X	
Current/time measurement	X	
Power-up tests	X	
Power-on/switchover tests	X	X
Power interruption	X	
Overload tests in restricted mode		X
Requirements on NTs of type "a"		X
Load variation tests		X
Options		
Transmission measurements	X	X
S_0 bus simulator	X	X
Jitter measurement/generation	X	X

Using the S_0 bus simulator as an option in the K1403 ISDN S_0 Analyzer, it is possible to check the functionality of the terminal equipment and network terminations taking into account the transmission medium without having to connect an additional unit.

DESIGN AND MODE OF OPERATION

The S_0 bus simulator option comprises a number of cascaded modules, each simulating 50 m of cable. All the modules are of identical design and comprise a balanced network of closely toleranced passive components. This arrangement precisely simulates the attenuation, delay, and characteristic impedance of a cable over the frequency range from DC to 1 MHz. In addition to the line modules, the simulator incorporates a noise generator providing sinusoidal noise in accordance with ITU-T I.430. External noise signals can be injected via a BNC jack.

The S_0 bus simulator is operated directly via the menu of the K1403. The touch screen is used to select the various bus configurations, noise injection circuits, terminating resistors and TE dummy loads before the actual measurement is performed.

PC REMOTE CONTROL SOFTWARE OPTION

The PC remote control software permits convenient setting and control of the K1403 via the GPIB interface. Measurement and sequence settings can be stored for automating the tests.

This inexpensive "plug and go" Microsoft Windows program allows measurement results to be exported to other Windows applications for further processing.

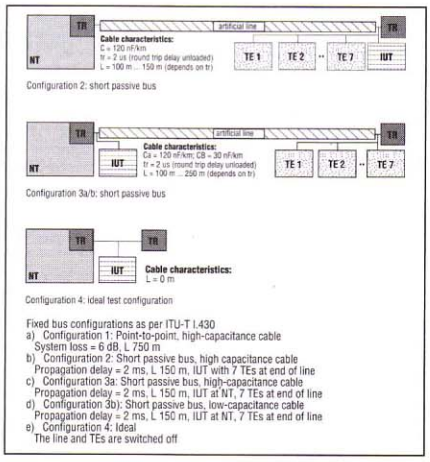


Figure 3. Possible S_0 bus configurations.

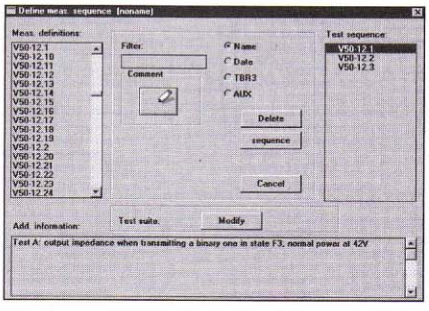


Figure 4.

FUNCTIONALITY

This package allows the user to set all relevant parameters for the TE measurement modes available on the K1403. Generated measurement settings can be saved, copied, and deleted after being named. The selection group "measurement settings" is subdivided into:

- Measurement settings as per CTS-2 or TBR3. Appropriate software libraries with the defined initial instrument settings are included in the package
- User-specific measurement settings. There are no restrictions on presetting user-specific measurements within the scope allowed by the K1403

The measurement modes at the TE are subdivided into the following measuring groups:

- Electrical characteristics
- Power conditions
- Functional tests
- Jitter measurements
- Bus simulation

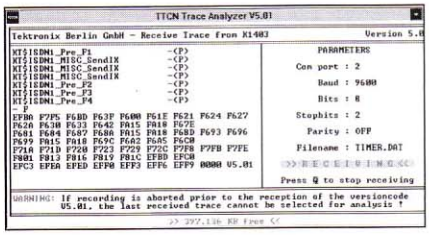


Figure 5.

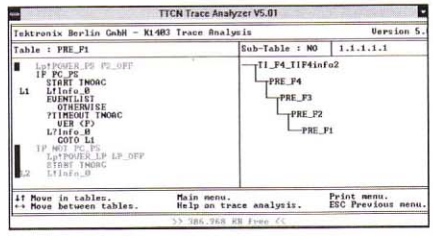


Figure 6. TTCN data analysis.

The software package allows the user to edit test sequences. The objects of the test sequences are the measurement settings. Generated test sequences can be saved, copied, and deleted after being named.

Depending on whether the "Tests as per CTS-2 or TBR3" or "General user-specific tests" function is selected, all measurement definitions are available for selection from one group or the other.

In addition to the name, it is possible to select the date and references to standards in order to facilitate searching for specific entries. A filter function allows the number of measurement definitions to be narrowed down, e.g., by entering partial qualifications to the search. The test sequence is assembled in a separate list in the form of measurement definitions.

TRACE ANALYZER SOFTWARE OPTION

After a functional test has been performed, the result is displayed on the K1403 as P for "passed," F for "failed," or I for "inconclusive." The Trace Analyzer Software presents the cause of the result in TTCN syntax.

FUNCTIONALITY

The commands from the K1403 and the response of the item under test are recorded in the K1403 during the functional tests. After the measurement, the data is transmitted via the V.24 interface to the PC with the aid of the trace analyzer software.

The main menu contains three windows. The data collected by the K1403 are presented on the left-hand side in hex format giving preamble tests. The name of the preamble test is followed by an entry for the relevant result (P/F). Displayed on the right is the parameter menu for the V.24 data transmission. Further menu options are set in the lower window, e.g., writing the receive data to a file.

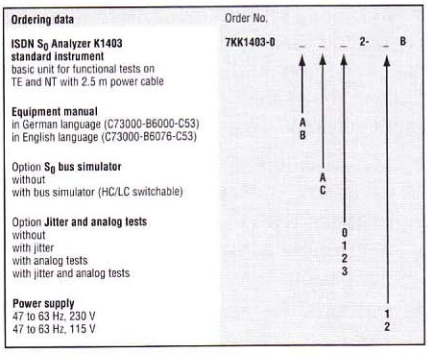
The received hexadecimal data from the K1403 is compiled into a tree diagram.

The analysis menu also contains three windows. The left-hand window displays the data in TTCN syntax. The actual path being used is made visible by being displayed in a different color and identified by a vertical bar at the edge of the screen. This eases investigation in the event of a fault. The right-hand side shows the preamble tests. The lower window contains further menu settings such as help or print menus.

Either the TTCN table currently under investigation or a result indication showing the cause of the P/F/I verdict can be printed out.

ORDERING INFORMATION

For price information: Outside the U.S. contact your local Tektronix representative, inside the U.S. see the price list in the back of this catalog.



ISDN S_0 ANALYZER K1403

Includes: basic unit for functional tests on TE and NT with 2.5 m power cable, one cable with 2 RJ45 plugs, 1.5 m (7KK1200-5CL11), one cable V24 for Hardcopy Function (7KK1400-5CA11).

MODULES FOR RETROFITTING

(comprised of hardware, software, and manuals on CD-ROM).

S_0 Bus Simulator – (HC/LC switchable) Order 7KK1403-2AA40.

Jitter – Order 7KK1403-2AB00.

Functional Tests – Order 7KK1403-2AC10.

Analog Tests – Order 7KK1403-2AE00.

ADDITIONAL SOFTWARE

PC Remote Control Software for K1403 – with manual in German language. Order 7KK1403-6BA10.

PC Remote Control Software for K1403 – with manual in English language. Order 7KK1403-6BA11.

Trace Analyzer Software – with manual in English language. Order 7KK1403-6AB11.

Switch Between TBR3 and prTBR3 – Order 7KK1403-6AE00. (Requires: K1403 Software V5.0).

Switch Between TBR3 and CTS2 – Order 7KK1403-6AF00. (Requires: K1403 Software V5.0).

SW V5.0 (for K1403 SW Version V3.03) TBR3/CTR3 Tests – Order 7KK1403-6AD10.

SW V5.0 (for K1403 SW Version V4.0) TBR3/CTR3 Tests – Order 7KK1403-6AD40.

CALIBRATION AND SERVICE

Hardware Service – preventive maintenance and repair. Order 7KK1403-8AA04.

Hardware Service –

Maintenance and Repair: Annual service contract. Order 7KK1403-8AA04.

Maintenance, Repair, and Calibration: Annual service contract. Order 7KK1403-8AA05.

Calibration of the Analog Tests – first calibration. Order 7KK1403-8AB01.

Calibration of the Analog Tests – further calibration. Order 7KK1403-8AB02.

Toolkit – Order 7KK1403-8AD.

DC Current Unbalance Box – Order 7KK1403-8AE.

ISDN Testkit – Order 7KK1403-8AF.

L1 Active Box – Order 7KK1403-8AG.

ACCESSORIES (AS REQUIRED)

V24 Cable for Hardcopy Function – Order 7KK1400-5CA11.

User Manuals on CD-ROM – Order 7KK1400-5DA10.

Power Supply for Test Boxes – Order 7KK1400-5PA11.

Carrying Bag – Order 7KK1200-5BA11.

Transport Container – Order 7KK1200-5BB11.

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

CE

Product manufactured in ISO 9001 registered facilities.

ISDN U Analyzer

K1404



Features – Benefits

Measurements on ISDN Components such as NT, LT, RR and TE with U_{2B1Q} and U_{4B3T} Interface in Accordance with ANSI T.601 and ETSI ETR 80

Transmission Parameter Measurements, Functional Testing, and Power Condition Measurements

Menu-assisted Operation with Touch Screen

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

CE

Product manufactured in ISO 9001 registered facilities.

DESIGN AND MODE OF OPERATION

The K1404 ISDN U Analyzer provides a test set for measuring at the ISDN U interface. It is a compact design suited for development, test, and maintenance departments.

The K1404 can perform measurements on ISDN components in accordance with the ANSI T.601 and ETSI ETR 80 standards. Its modular design is expandable, allowing it to be adapted to perform special measuring tasks.

The measuring functions such as frequency-dependent measurements, functional tests, power conditions and jitter measurements are divided among several measuring modules. For the frequency-dependent measurements such as return loss and balance, there are two bridges provided on the measuring panel module. A selective test set inside the instrument with selective bandwidths of 25 Hz and 1 kHz produces the source signal for the bridges and evaluates the test result. The selective bandwidth of 25 Hz can be used to perform measurements in the gaps of an active item under test (e.g., IUT sending individual pulses). Spectrum analysis, total power, interfering voltage, and common mode levels can also be determined using the switching panel and selective test set in combination.

Modules for functional testing at the U_{2B1Q}, U_{4B3T}, and U_P interfaces can activate and deactivate the item under test. The K1404 can be operated with two different interfaces; the required interface is set in the main menu.

A built-in pseudo-random generator and bit error evaluation circuit can be used to determine the bit errors for varying line lengths and interference sources. An external cable simulator is interposed for this purpose in two jack pairs between the IUT and K1404.

For testing NTs with an S_0 interface, the instrument provides a TE-S_0 interface, a second bit error evaluation circuit and a pseudo-random generator for measuring bit errors in both directions. For measurements on LTs, the Functional Test module operates as an NT with U and S_0 interfaces. The K1404 can thus initiate an "upstream activation" through its internal S_0 interface.

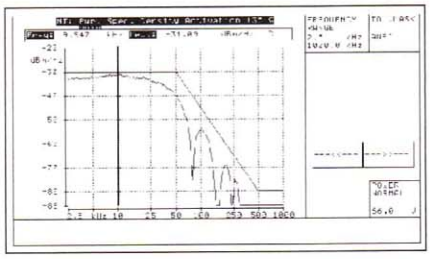
Static and dynamic measurements with the components under power and load are performed using the power conditions measuring module. Bit error measurement, spectrum analysis, return loss, and balance measurements can be performed as a function of power and load.

With the "jitter option" module, it is possible to measure the receiver sensitivity on NTs employing U_{2B1Q} and U_{4B3T} code. This module can also be used to measure the phase jitter of NTs,

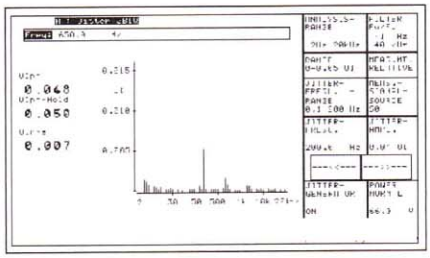
regenerators, and LTs (only LTs with 15.36-MHz timing). The jitter measurement at the U interface is performed using the "jitter box option" which is connected externally between the "jitter option" and "switching panel" modules.

The measurements performed with the K1404 ISDN U Analyzer are listed in the following table "Measurement modes."

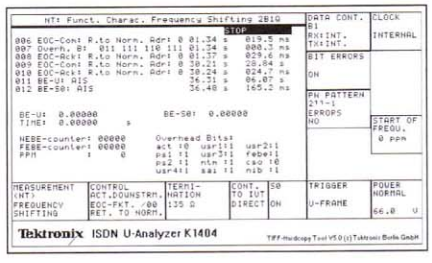
Measurement Mode	NT under Test	LT under Test
Measurement of Electrical Parameters		
Return loss	x	x
Balance	x	x
Common mode level	x	x
Spectrum analysis	x	x
Total power	x	x
Noise voltage	x	x
Transmitter linearity	x	x
Jitter	x	x
Functional Tests		
L1 – Activation/deactivation	x	x
Establish a call	x	x
Overhead bits monitoring	x	x
EOC control/addressing	x	
EOC monitoring		x
CRC test	x	x
Bit Error Measurement		
As a function of:		
jitter	x	x
of frequency offset	x	x
Short time interruption	x	x
Clock accuracy	x	x
Measurement of Power Conditions		
Power consumption	x	
Power output		x
Switch-on test	x	
Maintenance modes	x	x
Metallic termination	x	x



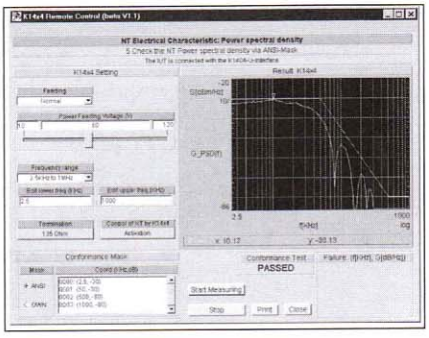
Spectrum analysis of the 2B1Q signal.



Result displayed for jitter measurement.



Result of the functional tests.



PC Remote Control Software Option

The PC remote control software with the graphical user interface provides a convenient means of setting and controlling the K1404 via the GPIB interface. Test parameters and sequence settings can be stored to automate the tests. A sequence setting can comprise several tests which are executed by the K1404 automatically in the specified order.

FUNCTIONALITY

The software contains a setting facility for all the relevant parameters of the NT/LT measurement modes of the K1404 ISDN U Analyzer. Once the measurement settings are created, they can be saved as a test case by assigning a name. It is also possible to enter definitions of general and IUT-specific information in the test record. A software library with the defined initial instrument settings is included in the package.

The software package can be used to create and execute test sequences. The objects of the test sequences are the test cases. After a test suite has been started, the K1404 executes the test cases automatically in the specified order.

After a test case has been executed, the results are presented on the screen by outputting the main measured values and are stored in ASCII format on the hard disk. This ensures that there is a backup of the test results in the event of a power failure.

Ordering Information

For price information: Outside the U.S. contact your local Tektronix representative, inside the U.S. see the price list in the back of this catalog.

Ordering data	Order No.					
K1404 ISDN U Analyzer for tests on NT and LT, with Layer 2/3 protocol, EOC programming, transmitter linearity, maintenance modes, metallic termination with 2.5 m power cable	7KK1404-1B	_	_	_	-_	A
Functional tests with						
U_{2B1Q} interface		A				
U_{4B3T} interface		B				
U_{4B3T} + U_{2B1Q} interface		C				
Jitter tests						
without			0			
with jitter generator and meter			1			
Equipment manual						
in German (C73000-G6000-C73)				0		
in English (C73000-G6076-C73)				1		
Power supply						
47 to 63 Hz / 230 V					1	
47 to 63 Hz / 115 V					2	

K1404 ISDN U ANALYZER

Includes: Basic unit with 2.5 m power cable, one cable with 2 RJ45 plugs, 1.5 m (7KK1200-5CL11), one cable V24 for Hardcopy Function (7KK1400-5CA11), one cable RJ45 – 2 Banana (7KK1200-5CP11).

UPGRADES

(comprised of hardware and software).

Jitter Generator and Meter with Manuals on CD-ROM – Order 7KK1404-2AA00.

U_{2B1Q} Interface with Manuals on CD-ROM – Order 7KK1404-2AB00.

U_{4B3T} Interface with Manuals on CD-ROM – Order 7KK1404-2AC00.

ADDITIONAL SOFTWARE

SW V6.0 (for K1404 SW version V4.1/V5.0) – Layer 2/3 protocol, EOC programming, transmitter linearity, maintenance modes, metallic termination with manuals on CD-ROM. Order 7KK1404-6AB10.

SW V6.0 (for K1404 SW version < V4.1) – NT & LT tests, layer 2/3 protocol, EOC programming, transmitter linearity, maintenance modes, metallic termination with manuals on CD-ROM. Order 7KK1404-6AC10.

PC Remote Control Software for K1404 with Manual in English –

for K1404 Software V5.0. Order 7KK1404-6BA11.

for K1404 Software V6.0. Order 7KK1404-6BB11.

CALIBRATION AND TESTING FACILITIES

Calibrating the Analog Tests –

First calibration. Order 7KK1404-8AA01.

Further calibration. Order 7KK1404-8AA02.

Jitter Box – Order 7KK1404-8AB.

Box for Short Time Interruption – Order 7KK1404-8AC.

OPTIONAL ACCESSORIES

Carrying Bag – Order 7KK1200-5BA11.

Transport Container – Order 7KK1200-5BB11.

GPIB Bus Cable, 2 m Long, with 24-contact Connectors – Order 7KK1400-5CB11.

U-connecting Cable, RJ45-2 Banana – Order 7KK1200-5CP11.

S_0-connecting Cable – with 2 RJ45 plugs.

1.5 m – Order 7KK1200-5CL11.

3 m – Order 7KK1200-5CM11.

V24 Cable for Hardcopy Function – Order 7KK1400-5CA11.

User Manuals on CD-ROM – Order 7KK1400-5DA10.

Power Supply for Testboxes – Order 7KK1400-5PA11.

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

CE

Product manufactured in ISO 9001 registered facilities.

ISDN S_0 Simulator/Monitor

K1405



Features – Benefits

TE and NT Simulator with Selectable Physical Characteristics

Simulation of a Conforming Terminal Equipment (Reference TE) for Validating an S_0 Tester

Simulation of a Deliberately Non-conforming Terminal Equipment for "Worst-case" Tests on PBXs

S_0 Bus Monitor with Layer 1 Status Display for Fault Analysis in Existing Systems

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

CE

Product manufactured in ISO 9001 registered facilities.

The K1405 ISDN S_0 Simulator/Monitor is designed for carrying out investigations at the S_0 interface. The K1405 simulates the ISDN components such as a Network Terminator (NT) or Terminal Equipment (TE) with selectable layer 1 characteristics. In addition, the K1405 can be connected to the S_0 bus as a monitor.

The K1405 provides a large degree of freedom in manipulating the characteristics defined as per Recommendations ITU-T I.430. It is possible to set it up for "worst case" values.

The K1405 contains a universal ISDN S_0 interface whose characteristics are programmable and conveniently controllage in-service via a PC. The user interface is Microsoft Windows. A multiplicity of connection options make numerous different applications possible.

The K1405 can be operated as an automatic "state machine," both in the TE and NT mode or can be controlled by the user manually in all functions. All the important physical characteristics such as reaction times, delays, or output amplitude can be set. In addition, standardized, error-free or errored output sequences (INFOs) can be transmitted and detected. Several transmit patterns are provided for the B channels.

DESIGN AND MODE OF OPERATION

The K1405 is comprised of the mainframe with an S_0 interface card, two connection modules, an instrument panel and a built-in AC line adapter.

The setting of the required operating mode and all the instrument parameters is effected via the V.24 interface. The required commands, parameter settings, and result fields are managed by the PC software supplied. This enables all the functions of the instrument to be used to the full.

The K1405 is accommodated in a case that can be mounted in 19 in. bays.

Operating Systems

K1405 AS TE/NT SIMULATOR

The S_0 simulator is used to simulate reproducible, field-oriented, and flexibly configurable environmental conditions at the basic access, including not only the procedural operations but also the electrical characteristics of the item under test. The following parameters can be set in the TE/NT simulation mode.

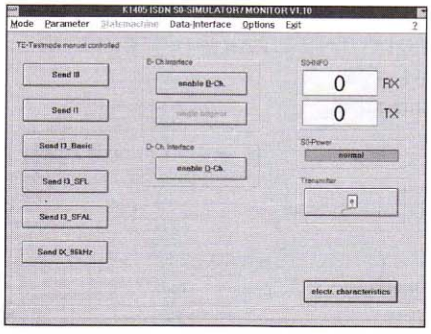


Figure 1. Menu for manually controlled TE.

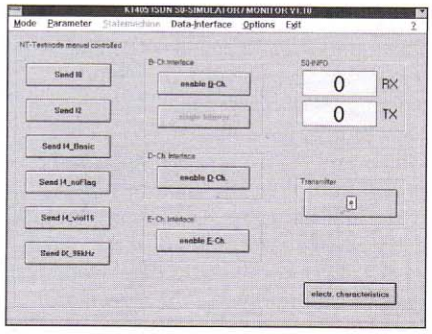


Figure 2. Menu for manually controlled NT.

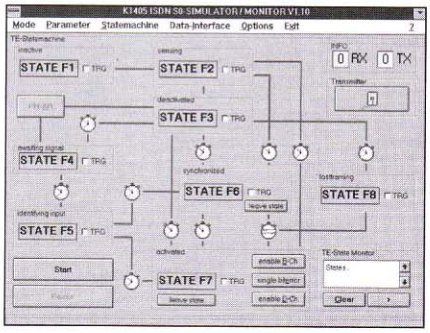


Figure 3. Menu for TE "state machine" mode.

Parameter	Measurement	Mode
Round-trip delay	Delay of the K1405 output signal	TE
Phase jitter	Jitter amplitude of the K1405 output signal	TE
Output amplitude	Output signal amplitude of the K1405	TE/NT
Terminating resistor	TR on/off	TE/NT
DATA INTERFACE		
Enable B channels	The B channels (B1, B2 or B1+B2) are added or dropped. PRBS, and also fixed bit patterns, can be selected	TE/NT
Data loop	The received B channel data can be looped back	TE/NT
Enable D channels	The D channels are added and dropped. Fixed output pattern is selectable	TE/NT
Enable E channel	The internal adding and dropping of E channel is activated. It is possible to choose between fixed data pattern and data loop (from D channel into E channel)	NT

K1405 AS MANUALLY CONTROLLED TE/NT

In the TE/NT test mode the K1405 can be operated under manual control, allowing the layer 1 states to be halted. All the functions are executed regardless of the response of the NT or other TEs on the S_0 bus. This operating mode eases the task of analyzing and troubleshooting on ISDN systems.

In the TE test mode the following transmit INFO can be selected and sent:

INFO0	All-zeros level is sent
INFO1	The TE activation signal is sent to NT. This is a string of double pulses with 24-kHz repetition frequency
INFO3_BASIC	INFO3 is sent with binary '1 in the B and D channels
INFO3_SFL	INFO3 is sent without F/L bits
INFO3_SFAL	INFO3 is sent without FA/L bits
IX_96 kHz	Binary '0' is sent continuously

In the NT test mode the following transmit INFO can be selected and sent:

INFO0	All-zeros level is sent.
INFO2	The NT activation signal and synchronizing signal is sent to TE. This is a string of double pulses with a code violation at the start of the frame (high density pattern)
INFO4_BASIC	An INFO4 is sent with binary '1' in the B and D channels
INFO4_noFlag	An INFO4 is sent without F/L bits
INFO4_viol16	An INFO4 is sent with a code violation in the 16th frame bit
IX_96 kHz	Binary '0' is sent continuously

K1405 IN THE TE/NT "STATE MACHINE" MODE

Generating the conforming and deliberately non-conforming state diagrams provides the K1405 with the characteristics required of a "functional layer 1 reference." A conforming state change is green and a non-conforming state red. The parameter sets with the supplementary information can be stored. This menu item is used to set all the settable timers of the state machine, to select trigger events, and to define the synchronization characteristics of the K1405. The following parameters can be set:

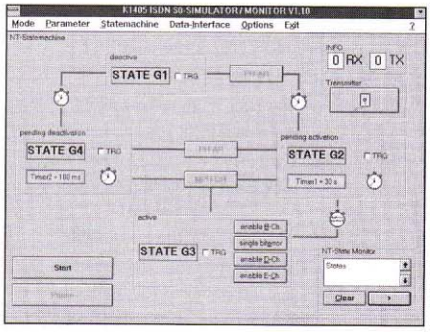


Figure 4. Menu for NT "state machine" mode.

IN THE TE MODE:

Interstate reaction times	F2->F6, F2->F7, F3->F6, F3->F7, F4->F5, F5->F6, F5->F7, F6->F3, F6->F7, F7->F6, F7->F3, F8->F3
Timers	T3
Trigger signals	F1, F2, F3, F4, F5, F6, F7, F8
Frame count n, m	'n' sets the frame count for the change to F8, and 'm' the count for the change to F7

IN THE NT MODE:

Interstate reaction times	G1 –> G2, G4 –> G1
Timers	T1, T2
Trigger signals	G1, G2, G3, G4
Frame count n, m	'n' sets the frame count for the change G3 to G2, and 'm' the count for the change G2 to G3

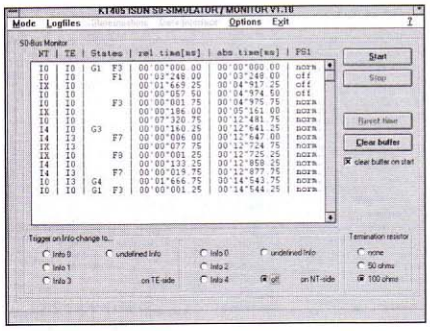


Figure 5. Menu for layer 1 monitor.

THE FOLLOWING COMMANDS CAN BE SENT IN THE "STATE MACHINE" MODE:

START	The "state machine" is activated, i.e. the automatic run has started.
PAUSE	The automatic run is interrupted. The "state machine" can thus be frozen in certain states.
CONTINUE	The automatic run is resumed.
STOP	The "state machine" is deactivated, i.e., the automatic run is ended.
PH-AR	With the "state machine" activated, this command causes layer 1 to be activated towards NT/TE (call upstream/downstream). The activation signal INFO1/INFO2 is sent.
MPH-DR	This command causes layer 1 to be deactivated towards TE.

K1405 AS LAYER 1 MONITOR

The monitor mode enables the user to test and analyze layer 1 problems on existing ISDN S_0 systems. In the monitor window, the detected TE and NT INFOs and the TE and NT states interpreted from them are each recorded with time stamping. The time difference between two events and also the detected S_0 power are likewise displayed. The buttons on the right of the screen are used to start, stop, reset, and delete the recording. The recorded data can be printed and stored as ASCII logfiles.

IN THE MONITOR MODE THE FOLLOWING PARAMETERS CAN BE SET:

Trigger signal	This is used to select an INFO which, when detected by the K1405, results in a trigger signal at the TRIG jack
Terminating resistor	TR on/off

PHYSICAL CHARACTERISTICS

Dimensions	**mm**
Width	343
Height	191
Depth	540
Weight	**kg**
Net	≈ 9

ORDERING INFORMATION

For price information: Outside the U.S. contact your local Tektronix representative, inside the U.S. see the price list in the back of this catalog.

K1405 ISDN S_0 SIMULATOR/MONITOR
Includes: Power cable, 2.5 m, one cable RJ45 with 2 plugs, 1.5 m (7KK1200-5CL11).

With 230 V Power Supply – AC 48 to 63 Hz –
Order 7KK1405-8AA.

With 115 V Power Supply – AC 48 to 63 Hz –
Order 7KK1405-8AB.

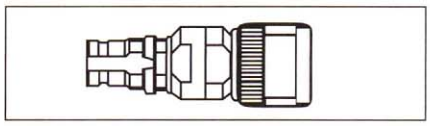
For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

CE
Tektronix measurement products are manufactured in ISO registered facilities.

CABLES & ADAPTERS FOR THE PRIMARY ACCESS INTERFACE

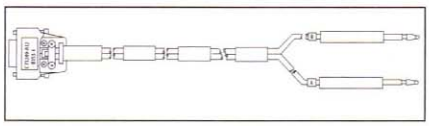
Note: Drawings not to scale.

←Tester DUT→



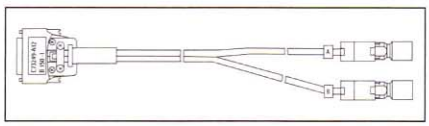
Order – 7KK1200-5CA11.
Adapter: Coax to BNC. 75 Ω.
Product – K1103, K1197, K1205, K1297.

←Tester DUT→



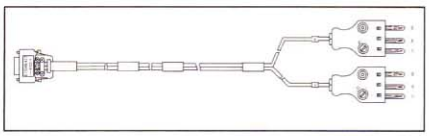
Order – 7KK1200-5CB11.
Bantam. Used in balanced E1/DS1 applications. 3 m. 120 Ω.
Product – K1103, K1197, K1205, K1297.

←Tester DUT→



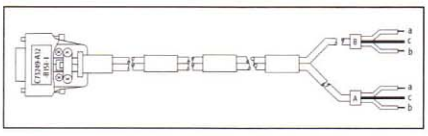
Order – 7KK1200-5CC11.
Coax. Typically unbalanced applications.
Typically uses two 7KK1200-5CA11 Coax-to-BNC adapters per cable. 1.5 m. 75 Ω.
Product – K1103, K1197, K1205, K1297.

←Tester DUT→



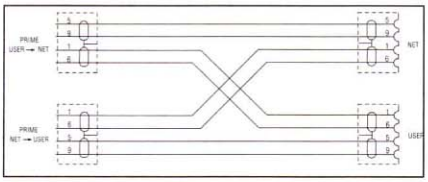
Order – 7KK1200-5CD11.
3 Poles. Used in older E1 balanced applications. 3 m. 120 Ω.
Product – K1103, K1197, K1205, K1297.

←Tester DUT→



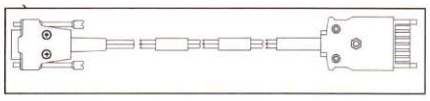
Order – 7KK1200-5CE11.
Open end. For custom DUT connectors. 3 m. 120 Ω.
Product – K1103, K1197, K1205, K1297.

←Tester DUT→



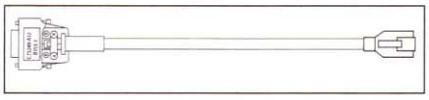
Order – 7KK1200-5CJ11.
Drop and insert. Used to intercept a call, modify it, and send it on (drop and insert). 0.3 m.
Product – K1297.

←Tester DUT→



Order – 7KK1200-5CS11.
(Siemens only)
Cable with disconnect plug. 3 m.
Product – K1103, K1205, K1297.

←Tester DUT→

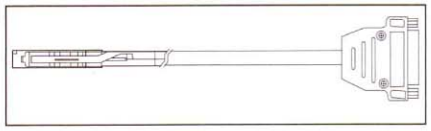


Order – 7KK1200-5CZ11.
RJ45. ISDN and SS7 applications. 2 m.
Product – K1103, K1197, K1205, K1297.

CABLES & ADAPTERS FOR THE S_0 AND U BASIC ACCESS INTERFACE

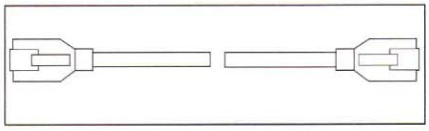
Note: Drawings not to scale.

←Tester DUT→



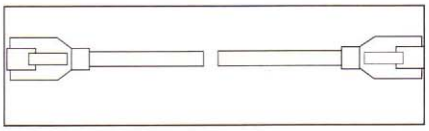
Order – 7KK1200-5CK11.
Cable for B-Channel access to add an external device such as a BERT; has a special high-density connector for the K1297 and a 15-pin D-sub for the DUT. 0.2 m.
Product – K1297.

←Tester DUT→



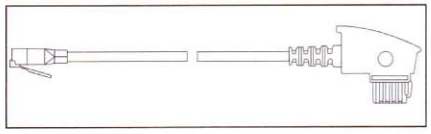
Order – 7KK1200-5CL11.
RJ45-to-RJ45. 1.5 m.
Product – K1197, K1297, K1403, K1404, K1405.

←Tester DUT→



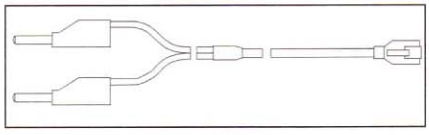
Order – 7KK1200-5CM11.
RJ45-to-RJ45. 3 m.
Product – K1197, K1205, K1297, K1403, K1404, K1405.

←Tester DUT→



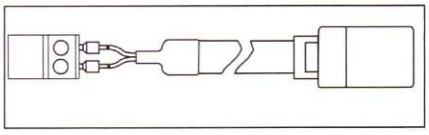
Order – 7KK1200-5CN11.
RJ45-to-TAE8. Only for S interface. 1.5 m.
Product – K1197, K1297, K1403, K1405.

←Tester DUT→



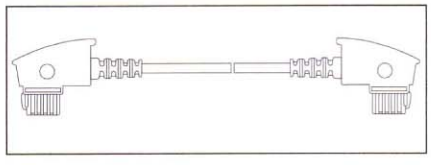
Order – 7KK1200-5CP11.
Dual banana-to-RJ45. 1.5 m.
Product – K1404.

←Tester DUT→



Order – 7KK1200-5CQ11.
Adapter RJ45. Connects from a U-interface to an RJ45. 0.2 m.
Product – K1197, K1297.

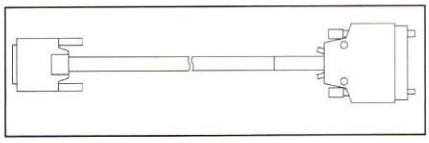
←Tester DUT→



Order – 7KK1200-5CR11.
TAE8-to-TAE8. 3 m.
Product – K1197, K1403, K1405.

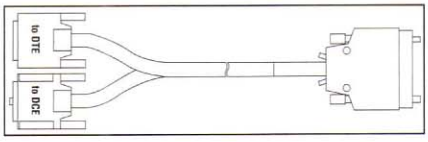
ADAPTERS FOR THE V. AND X. INTERFACES

←Tester DUT→



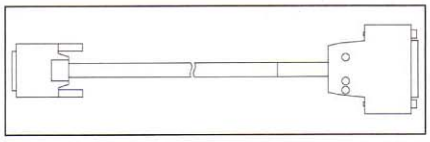
Order – 7KK1200-5CT11.
SIM V.35. For V.35 interface simulation only; female 34-pin Amp V.35 connector. 0.5 m.
Product – K1297.

←Tester DUT→



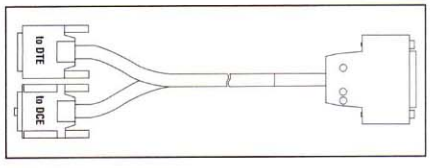
Order – 7KK1200-5CU11.
MON V.35. For V.35 interface monitoring only; female 34-pin Amp V.35 connector. 0.5 m.
Product – K1297.

←Tester DUT→



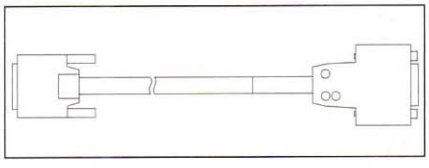
Order – 7KK1200-5CV11.
SIM V.24. For V.24 interface simulation only; female DB25 connector. 0.5 m.
Product – K1297.

←Tester DUT→



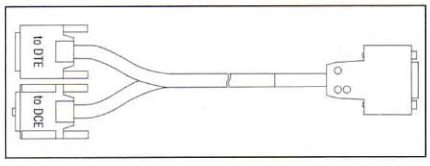
Order – 7KK1200-5CW11.
MON V.24. For V.24 interface monitoring only; female DB25 connector. 0.5 m.
Product – K1297.

←Tester DUT→



Order – 7KK1200-5CX11.
SIM X.21. For X.21 interface simulation only; female DB15 connector. 0.5 m.
Product – K1297.

←Tester DUT→



Order – 7KK1200-5CY11.
MON X.21. For X.21 interface monitoring only; female DB15 connector. 0.5 m.
Product – K1297.

ACCESSORIES

Order Number	Description	Product
7KK1200-5BA11	Transport Bag	K11XX, K14XX
7KK1200-5BB11	Transport Box	K11XX, K14XX
7KK1200-5BG11	Transport Bag	5 Slot K12XX
7KK1200-5BR11	Transport Case	8 Slot K12XX
7KK1200-5HA11	Alarm & Sync. Option	5 Slot K12XX
7KK1200-5HC11	External SCSI CD-ROM Drive	K12XX
7KK1200-5HP11	PCMCIA/PC-Card Modem 56 k	K12XX
7KK1200-5HR11	External ISDN-Modem	K12XX
7KK1200-5HS11	Telephone Handset Interface: BAI, PRI	K12XX
7KK1200-5MM11	Mounting Set for Installation into 19-in. Rack	8 Slot K12XX
7KK1200-5MS11	Universal Shelf for 19-in. Rack	K11XX, K12X, K14XX
7KK1200-5SR11	Remote Control SW Reachout with Manual, in English	K12XX
7KK1400-5CA11	DB25-to-DB9 Hardcopy Cable	K1403, K1404

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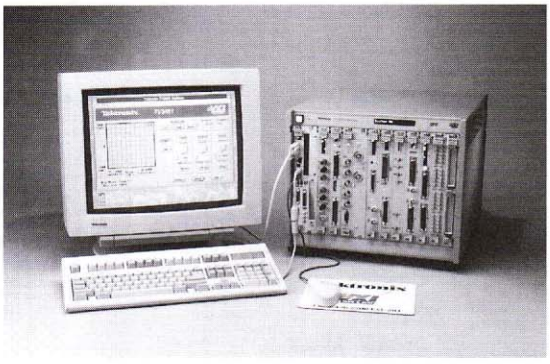
Product manufactured in ISO 9001 registered facilities.

VXI Products



Features – Benefits	Applications
Interoperability	Manufacturing Line Test and Verification
Broad Range of Instrument Choices	Depot Testing
Open Architecture Supports Multi-vendor System Configurations	High Energy Physics Research
VXI*plug&play* Software	Communications Test Equipment
Worldwide Service and Support	Computer and Peripherals Testing
	Avionics
	Automotive
	Medical Manufacturing

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CE

ISO 9001

Tektronix measurement products are manufactured in ISO registered facilities.

VXI (VME eXtensions for Instrumentation) has emerged as the principal force for open systems in the test and measurement market. From strong beginnings in the military/aerospace arena, the VXI presence in commercial applications has expanded dramatically. VXI is of extreme importance to the marketplace. Its growing popularity is based on three key factors:

- Users need access to a comprehensive selection of products that meet their application requirements
- VXI offerings achieve higher system performance for the price
- VXI*plug&play* offers open systems with standardized software interfaces for compatibility

As one of the founding members of the VXI standards movement, Tektronix provides a portfolio of VXI instrument modules and mainframes, setting price/performance benchmarks and driving the test industry to create and support open system architectures.

A BROAD PRODUCT PORTFOLIO

Today's Tektronix VXI product line includes a broad selection of VXI products capable of meeting widely varying customer needs and covering a major part of VXI market requirements. Many Tektronix VXI products have completed the intense development process required for extremely high-performance products and are making important contributions to new markets.

The Tektronix VXI product portfolio includes:

- Avionics bus testing instruments
- Switching and scanning instruments and accessories
- Stimulus instruments: pulse generators, arbitrary waveform generators, D/A converters and function generators
- Measurement instruments: waveform digitizers/analyzers, digital multimeters and universal counters
- Digital I/O Instruments
- Mainframes

AVIONICS

Tektronix has a long history of commitment to aerospace and avionics testing. This year, Tektronix offers a range of products and services tailored to the avionics community. Whether you are a self-integrator of avionics ATE systems or need avionics test system integration services and expertise, Tektronix has the experience, products and services to get you off the ground quickly and reliably.

Tektronix offers a range of VXI-based instrumentation and communication interfaces specifically designed for avionics test and simulation. Our products include ARINC 429, ARINC 629, and MIL-STD-1553 VXI modules. These products are used by airlines and depot repair facilities worldwide.
Tektronix VXI instruments are included in avionics ATE systems supplied by leading avionics and aircraft manufacturers worldwide.

TEKTRONIX SurePath™ FAMILY OF RELAY SWITCHING

In virtually all automatic test applications, the test engineer must evaluate signal routing and switching requirements. The VXI platform or architecture offers a variety of integration options for the test engineer to consider. Tektronix offers a wide array of different switching solutions ranging from matrices, scanners, multiplexers, RF switching, and an assortment of general purpose independent relay switches. Tektronix offers a switching solution for virtually any ATE requirement needing high density, excellent signal fidelity, and ease of integration and programming.

The SurePath VXI switching architecture from Tektronix combines exceptional reliability, uncompromising performance, and increased channel density with superb value to provide you with world-class signal switching and routing to meet the demands of manufacturing test applications.

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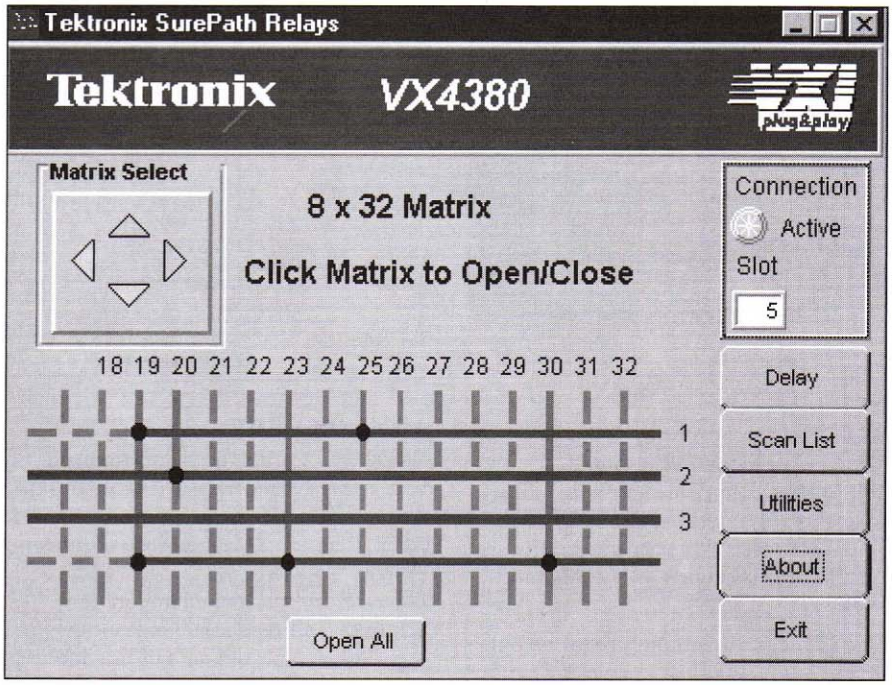
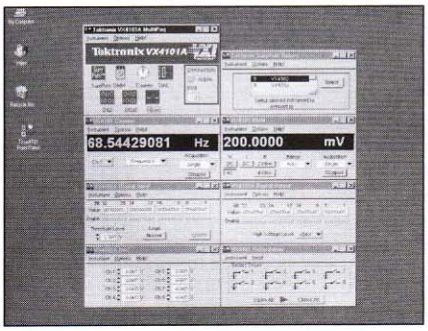


AVIONICS PRODUCT SELECTION GUIDE

Type	Description	Applications
VX4428	Quad ARINC 429 Transmitter and Receiver	Test and control LRUs via ARINC 429 Transmitter and Receiver
VX4469A	ARINC 629 Simulator with Enhanced Error Injection	Up to 3 terminals with full error injection. Emulate multiple terminals in real time
73A455	Dual-channel MIL-STD-1553	Simulate bus controller, remote terminal or bus monitor

SWITCHING AND SCANNING SELECTION GUIDE

Type	Configuration	No. of Channels	$I_{switch\ max}$	V_{max} DC/AC
Relay Switching				
VX4350 SurePath	SPDT	64	2 A	220/250
VX4351 SurePath	SPST	40	10 A	250/250
VX4357	SPDT	32	5 A	48/250
Scanner/Multiplexer				
VX4330 SurePath	Programmable	120 2-wire	2 A	220/250
Matrix				
VX4380 SurePath	Selectable	256-cross Points	2 A	220/250
RF Switch				
VX4320 SurePath	Tree	8 groups of 1x4	10 W	28 VDC
Relay Control				
73A308	Open Collector	80 outputs	300 mA	50 VDC
VX4101A SurePath	Open Collector	8 outputs	100 mA	35 VDC

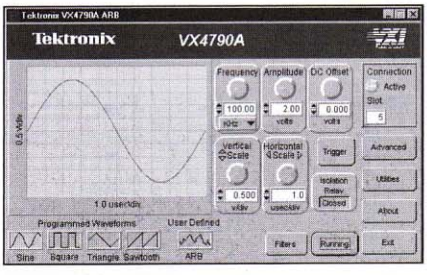


Sources

When looking for information, it is always best to go to the source. Tektronix has long mastered the ability to design high performance, high value signal sources. This tradition continues into Tektronix' family of VXI signal sources.

One of the most common requirements of any automated test system is to simulate the operating environment the Unit Under Test (UUT) will encounter in actual use.

Whether you are involved with testing Defense, Aerospace, Automotive or Medical electronics, or just have the need to supply a unique analog stimulus to the UUT, Tektronix has a VXI-based signal source to meet your needs.



25 MS/s Arbitrary Waveform Generator.

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VXI SOURCE INSTRUMENTS SELECTION TABLE

Instrument	Function	Key Specs	Key Features
73A270	D/A	2 Channel	User Defined Serial Patterns
VX4101A	D/A	8 Channel	12-bit, ±14 V with memory, MultiPaq™ Instrument: DMM, Universal Counter, Digital I/O, D/A, Relay Drivers and SurePath controller
VX4730	D/A Output	12 Channel	16-bit , ±16 V, 400 mA
VX4750	Function Generator	25 MHz	Modulation, Frequency Sweep, Isolated Output
VX4790A	Arbitrary Waveform Generator	25 MS/s	12-bit, ±10 V, built-in sine, square, & sawtooth function

Measurement

Whether it's micro amps or hundred volt signals, your measurement subsystem is one of the most important functions of your VXI test and measurement system. Easy programming, well behaved and predictable operation, accuracy and repeatable measurements are the key requirements of this kind of equipment. With Tektronix' many years of experience with user signals and demands, you are assured of satisfying performance in these areas, not to mention functions and specs that are hard to beat. As a founding member of both the VXI Consortium and VXIplug&play Systems Alliance, Tektronix is committed to making instruments that are built upon an open architecture and that are easy to integrate.

VXI MEASUREMENT INSTRUMENTS TABLE

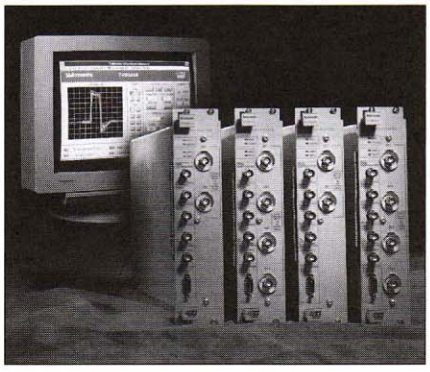
Instrument	Function	Key Specs	Key Features
VX4101A	DMM, Universal Counter	5.5 Digits with memory, 250 or 500 MHz/ 3 GHz prescaler, with memory	MultiPaq™ Instrument DMM, Universal Counter, Digital I/O, D/A, Relay Drivers and SurePath™ Controller
VX4286	A/D Comparator	32 Channels	Single-ended inputs
VX4287	A/D Comparator	32 Channels	Differential inputs

Digital Testing

Due to the ever-increasing amount of digital testing required for today's electronic products, modularity and functionality are two key aspects in designing today's test systems. VXI is ideal in addressing both of those requirements. Tektronix digital test instruments are designed to provide the maximum amount of functionality in a form factor that was developed as an industry standard for modularity. These instruments are used in applications ranging from manufacturing process control to aerospace and telecommunications. Like all of our instruments, the digital test instruments are designed to provide maximum reliability and maximum flexibility in test system design.

VXI DIGITAL SELECTION TABLE

Instrument	Function	Key Specs	Key Features
73A270	Arbitrary Pulse/ Pattern Generator	2 Fast Serial Channels	Complex pulse trains
VX4101A	Digital I/O	32 Programmable threshold I/O's	MultiPaq™ Instrument: DMM, Universal Counter, Digital I/O, D/A, Relay Drivers and SurePath™ Controller
VX4801	Isolated Digital I/O	48-CH TTL/CMOS	Byte-by-byte I/O programming
VX4802	Digital I/O	80-CH TTL/CMOS	User masks



VXI DIGITIZERS/WAVEFORM ANALYZERS SELECTION TABLE

Instrument	Bandwidth	Channels	Sample Rate	Vertical Resolution	Record length (samples)
TVS645A	1 GHz	4	5 GS/s	8-bit	15 K
TVS625A	1 GHz	2	5 GS/s	8-bit	15 K
TVS641A	250 MHz	4	1 GS/s	8-bit	15 K
TVS621A	250 MHz	2	1 GS/s	8-bit	15 K
VX4240	5 MHz	1	10 MS/s	12-bit	256 K to 1 M
VX4244	300 kHz	16	200 kS/s	16 bit	64 K
		8	200 kS/s		128 K
		4	200 kS/s		256 K
VX4780	200 kHz	16	Signal Conditioner for VX4244	Signal Conditioner for VX4244	Signal Conditioner for VX4244

Digitizers/Waveform Analyzers

Tektronix offers a complete portfolio of digitizing products covering a broad spectrum of applications. These self-contained instruments include flexible signal conditioning to accurately capture a wide range of signals. Sophisticated trigger, timebase and memory features reliably capture events of interest. Built-in signal processing and analysis functions quickly reduce raw data to answers, simplifying system integration and enhancing test throughput.

All modules are fully compliant with VXI*plug&play* WIN, WIN95 and WINNT frameworks. Each instrument driver provides full access to product functions, and the installation disk includes driver source code, pre-compiled DLL and a help file describing each function call. The soft front panel application provides a graphical interactive control panel that simplifies system integration and product familiarization. Each digitizer is message-based with enhancements for fast waveform transfer, simplifying integration into non-VXI*plug&play* environments.

VXI Mainframes

The mainframe can be viewed as the most important VXI instrument in a system. It is responsible for the complete environment for VXI modules: power, cooling, EMI, mechanical, and backplane communication/timing. The performance of the mainframe directly impacts the performance of the modules. The Tektronix VXI mainframes have been designed to include the following features:

- More available power (875 watts of usable power) which allows greater flexibility for future instrument selection
- Better mainframe cooling to extend the life of the instruments
- More EMI protection which improves measurement accuracy
- Better mechanical design to simplify maintenance and system integration
- Superior backplane CLK10 distribution to improve system timing accuracy

The Tektronix family of VXI IntelliFrame® Mainframes covers a broad range of applications and requirements. The VX1420A SuperCooler has massive cooling capabilities that can satisfy even the most stringent requirements. With both the enhanced monitor and fluorescent display standard, the VX1420A SuperCooler is the premier VXI mainframe product.

The VX1410A mainframe replaces the popular VX1410 mainframe with improvements made to the cooling, EMI protection and the enhanced monitor (which is now standard).

VX1420A/VX1410A Enhanced Monitor Provides Readout of:

- Input air temperature
- Temperature rise for each slot
- Each power supply voltage
- Each power supply current
- Fan speeds
- Hours of operation timer
- Air filter cleaning timer

And:

- Allows user selection of alarm conditions
- Communicates as a message-based instrument and via RS-232
- Includes VXI*plug&play* software driver

The VX1411A benefits from many of the improvements implemented in the VX1410A which makes this mainframe a high performance/low cost leader.

All Tektronix VXI mainframes have Options A1 through A5 for non-U.S. power cords.

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Mixed Signal Sources

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Arbitrary Waveform Generators

Tektronix offers a wide variety of Arbitrary Waveform Generators that have the capabilities to earn the title of "Mixed Signal Source." From the powerful and easy to use 2000 Series Benchtop to the fast high-performance 600 series, Tektronix has an arbitrary signal source to solve your application requirements.

Arbitrary waveform generators are used to generate "real world" signals. They can generate signals with all the glitches, drift, noise, and other anomalies that a device under test will encounter when it leaves the lab or manufacturing floor. AWGs are being used for disk drive testing, serial communiction simulation, automotive anti-lock brakes and engine control modules, fax testing, biomedical simulations and more.

"What if" scenarios are straightforward since waveforms can be captured from a digital scope and then modified to see when a device under test fails. They also make it easy to simulate transducers that can be difficult or expensive to use.

Arbitrary Waveform Generators have evolved from simple D/A converters to sophisticated signal sources with powerful creation, editing and triggering capabilities.

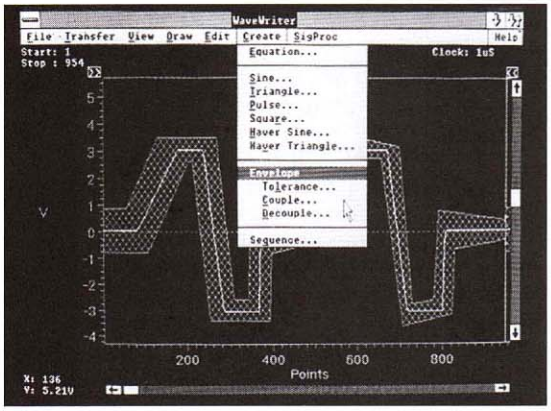
Arbitrary Waveform Generator Selection Guide

	AWG 610	AWG 510/520	AWG 2021	AWG 2005	AFG 310/320
Maximum Clock Rate (Point Rate)	2.6 GS/s	1 GS/s	250 MS/s	20 MS/s	16 Ms/s
Output Channels	1	1 or 2	1 std.; 2 total opt.	2 std.; 4 total opt.	1 or 2
Ampl V p-p into 50 Ω	2 V_{p-p}	2 V_{p-p}	5 V_{p-p}	10 V_{p-p}	10 V_{p-p}
Region Shift	400 fs	2 ps	4 ps	50 ps	Phase Shift
Vertical Resolution (bits)	8-Bit	10-Bit	12-Bit	12-Bit	12-Bit
Sine, Sqr, Tri, Ramp, DC	26 MHz Synthesized	10 MHz Synthesized	2.5 MHz Synthesized	200 kHz Synthesized	16 MHz Synthesized (100 kHz for Tri, Ramp)
Execution Memory	8 M word	4 M word	256 kB/CH	64 kB/CH	16 kB/CH (4 pages total)
Built-in Waveform Editing	Graphical, Equation, Digital Timing, Table, Autostep Sequencing, Enhanced Math				
Direct DSO Transfer	Yes	Yes	Yes	Yes	Yes (with S/W)
Parallel Digital Output	2-Bit	12-Bit @ 1 GHz	12- or 24-Bit (TTL @ 100 MHz) 12-Bit (ECL @ 250 MHz) + 2 markers (Opt. 03 or 04)	24-Bit TTL + 2 markers (Opt. 04)	No
Software Support	WaveWriter™	WaveWriter™	WaveWriter™ IQSMK; LabVIEW	WaveWriter™ IQSMK; LabVIEW	WaveWriter™
Temperature	Operating: +10°C to +40°C Nonoperating: –20°C to +60°C				
Humidity	Operating: 20% to 80% (no condensation) Nonoperating: 5% to 90% (no condensation)				
Altitude	Operating: To 4.5 km (15,000 ft.)*1 Nonoperating: To 15 km (50,000 ft.)				
Vibration	Operating: 0.33 mm p-p, 10 Hz to 55 Hz for 15 minutes				
Shock	Nonoperating: 30 g (1/2 sine) 11 ms duration				
Safety	UL1244, CSA231, EN61010-1, IEC61010-1.				
Voltage Range	90 to 127 V AC, 90 to 250 V AC				
Line Frequency	48 to 63 Hz				
Where to find more info	Page 443	Page 446	Page 449	Page 451	Page 453

**1 Maximum operating temperature decreases 1°C for each 300m above 1.5 km.*

Waveform Editing Software

WaveWriter™



Features – Benefits

Create Custom Waveforms

Edit Waveforms Graphically

WaveWriter Software Automatically Scales Record Size, Resolution, etc., to Single or Double Target Instruments

Applications

Create/Modify/Document Waveforms for DSOs and Arbitrary Generators

Use WaveWriter Standalone or Integrated into Appplication Development Environments

Runtime Environment for Margin Testing

Pass/Fail Limit Testing

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

WAVEFORM GENERATION

WaveWriter is a software package for creating and modifying waveforms for the Tektronix Arbitrary Waveform Generators and Digital Oscilloscopes. WaveWriter software represents a major step forward in allowing easy creation of the real world signals which are increasingly being used to test circuit tolerances, drive vibration/shake tables, and simulate other non-ideal or corrupted signals.

WaveWriter software offers an easy to use alternative to general-purpose programming languages for waveform definition. Its user interface is based on Microsoft Windows, with pull-down menus and mouse-selected icons. (Alternatively, you can use a command-driven interface.) It can operate independently, or as an integral part of a system program.

ACQUIRE OSCILLOSCOPE SIGNALS

Signals may be acquired from a variety of Tektronix TDS Series, DSA Series, 11000 Series, 2200 Series, 2400 Series digital oscilloscopes. The signals may then be modified, stored, or recreated with an arbitrary waveform generator.

EDIT WAVEFORMS GRAPHICALLY

By defining sections of a waveform with WaveWriter software markers (which work like the cursors on an oscilloscope display), you can perform mathematical functions, including inversion; scale vertically and horizontally; and cut and paste. For example, you can add harmonically related sinusoids to construct a signal from its Fourier components. Or, starting with a signal captured by an oscilloscope, you can add glitches and distortion to test a circuit's response to specific kinds of signal aberrations.

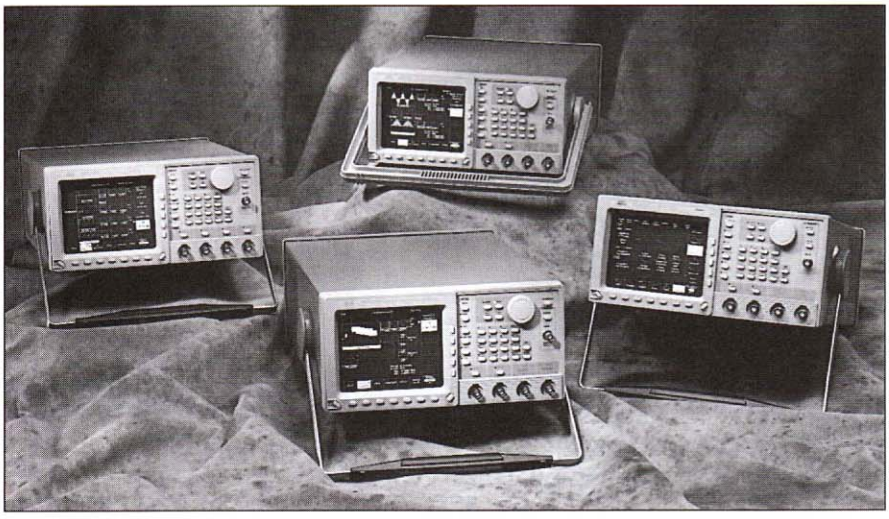
PASS/FAIL LIMIT TESTING

WaveWriter software also supports digital storage oscilloscopes with template generation for waveform documentation. Therefore, with WaveWriter software, the user can create the exact tolerances of templates with which to capture a differentiated signal or automatically identify a failure. This is a great feature for margin test applications where fast test windows can be created in seconds.

Ordering Information

For price information:
Outside the U.S. contact your local Tektronix representative, inside the U.S. see the price list in the back of this catalog.

S3FT400 Tektronix WaveWriter System Software. WaveWriter is provided on 1.44 MB, 3.5 in. diskettes.



AWG Series

APPLICATIONS

- Simulate Wireless I & Q Signals
- Simulate Media Read/Write Signals
- Simulate Biomedical Waveforms
- Simulate Network Physical Layer
- Avionics Simulation
- Automotive Simulation

AWG OVERVIEW

Standard function generators offer limited capability when compared to the robust capabilities offered in modern Arbitrary Generators. Today, in fact, we can consider the powerful AWG Series as truly Mixed Signal Sources. In addition to the AWG's ability to replace conventional generators in applications, AWGs also provide other powerful capabilities.

REGION SHIFT FUNCTION

This capability provides an editing technique for simulating timing impairments for testing a design's response to a variety of frequency, timing or phase violations. This powerful capability should hold significant appeal to designers of magnetic media, physical layer, wireless and other products requiring jitter tolerance or timing shift testing.

REAL TIME SEQUENCING

Sequencing—seamlessly transitions from one waveform segment to the next with no discontinuities between segments. All segments in a sequence are executed from memory. Using the Auto Step and Waveform Advance modes, users can modify the output of the arbitrary generator using an external event.

Applications include serial or parallel pattern generation for digital test, building complex modulated signals such as FSK/PSK/PWM, magnetic media design/test, and filter design/test.

FFT EDITOR AWG 2000 SERIES – (OPT. 09)

The FFT editor allows easy modification of waveform frequency and phase components. Six different FFT windows are available including Rectangle, Triangle, Hanning, Hamming, Blackman, and Blackman-Harris. The filter menu allows the user to view the impact of a user-definable filter network on a waveform.

DIGITAL TIMING AND TABLE EDITOR

The combination of the timing and table editor with the optional AWG data generator port is ideal for digital circuit testing and control of ASICs, DACs, etc.

EQUATION EDITOR

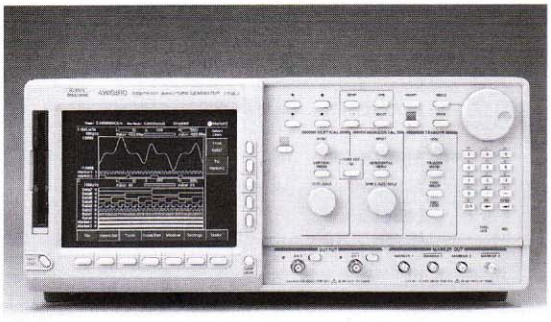
The equation editor creates waveforms based upon polynomial formulas.

SWEEP EDITOR

The sweep editor allows generating linear, logarithmic or user-definable sweeps by using a simple graphical editor.

Arbitrary Waveform Generator

New AWG 610



Features – Benefits	Applications
Sample Rate to 2.6 GS/s Tests High-speed Devices and Subsystems	Disk Drive Read/Write Design and Test – Head, Pre-amplifier, Read/Write and servo test
Output Bandwidths Available to Over 800 MHz	Communications Design and Test
Record Length to 8 M Words for Longest Signal Simulations	Pulse Generation
8-Bit Vertical Resolution Provides Precise Signal Replication	Real-world Simulations
1 Channel with Complementary Output	
2 Marker Outputs per Channel, Variable and Complementary for Mixed Signals	
400 fs Resolution Edge Shift Control for Greater Timing Precision	
Direct Waveform Transfers from DSO	

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

CE

SONY Tektronix

ISO9002 Certified JMI-0113

GPIB IEEE-488

High Performance AWG Family

The High performance AWG family of Arbitrary Generators from Tektronix can create ideal signals conforming to specific standards or "real-world" signals with speed, precision and ease. They provide the highest clock speeds from 1 GS/s to 2.6 GS/s, 10 or 8 bit DAC resolution and up to 8 Mega bytes of memory depth. They combine waveform generation and editing in one package that enables you to:

- Create waveforms
- Automatically transfer a waveform from DPO or DSO oscilloscopes
- Download signals created via computer simulation tools
- Modify a signal using built-in editors

These instruments can simulate "real-world" signal impairments such as Noise, Jitter, Fading and more.

Their unique design integrates a graphical editing display with the most powerful hardware output capabilities available. This allows on-screen viewing of waveform editing and simplifies "what-if" test scenarios by easily allowing the creation of composite signals. The family uses a graphical user interface to overcome the historical difficulties associated with developing arbitrary and complex waveforms. Several intuitive and powerful techniques are built-in to develop and edit custom waveforms.

AWG 610

As a premier member of the Tektronix family of arbitrary generators, the AWG 610 is the easy-to-use, high performance, flag-ship product. The AWG 610 provides the world's fastest and deepest memory with its 2.6 GS/s sample clock rate and 8 Mega-points of execution memory.

The AWG 610 provides up to a 2 V output or 4 V into a differential input with 460 MHz bandwidth in normal mode, or 875 MHz bandwidth in direct mode, each with 8-Bits vertical resolution. The AWG 610 provides 2 complementary 2.5 V variable markers (Tr/Tf : <150 ps @ 2 V_{p-p}) with 100 ps deskew resolution at up to 2.6 GHz.

COMMUNICATIONS DESIGN AND TEST

The AWG 610 generates predefined waveforms that simulate pseudo random bit streams (PRBS) for physical layer testing to the following electrical standards:

ITU-T	T1.102	Fibre Channel	SDH/Sonet	Misc
STM1E	STS-#	FC1063E	OC48/STM16	D2
E5 CEPT	STS-1	FC531E	OC36	D1
E4	DS4NA	FC266E	OC24	FDD1
E3	DS3	FC133E	OC18	100 Base-TX
E2	DS2		OC12/STM4	Gigabit Ethernet
EI	DS1/1C/1A		OC3/STM1	
			OC1/STM0	

SYSTEM CONSIDERATIONS

The high performance AWG 610 is fully programmable via GPIB. For throughput critical applications, the AWG 610 is also programmable via the 10 Base-T Ethernet port. As a result, the AWG 610 is an ideal addition to provide standard and arbitrary waveform generation for your system environment. An optional rack mount is available for easy hardware integration into your test system.

CHARACTERISTICS

ARBITRARY WAVEFORMS

Waveform Length – 512 to 8,100,032 points in multiples of eight.
Sequence Length – 1 to 8,000 steps.
Sequence Repeat Counter – 1 to 65,536 or infinite.

CLOCK GENERATOR

Sampling Frequency – 50.000000 kHz to 2.6000000 GHz.
Resolution – 8 digits.
Internal Clock – Accuracy: ±1 ppm.
Phase Noise – (data clock is 1/4th of the output sample rate)
At 650 MHz, 10 kHz offset: –80 dBc/Hz.
At 650 MHz, 100 kHz offset: –100 dBc/Hz.

OPERATING MODES

Continuous – Waveform is iteratively output. If a sequence is defined, the sequence order and repeat functions are applied.
Triggered – Waveform is output only once when an external, internal, GPIB, LAN or manual trigger is received.
Gated – Waveform begins output when gate is true and resets to beginning when false.
Enhanced – Waveform is output as defined by the sequence.

INTERNAL TRIGGER GENERATOR

Internal Trigger Rate –
Range: 1.0 µs to 10.0 s.
Resolution: 3 digits, 0.1 µs minimum.
Accuracy: ±0.1%.

MAIN OUTPUT

Output Signal – Complementary; CH1 and channel/inverse.
Digital to Analog Converter –
Resolution: 8 bits.
Differential Non-Linearity: ± 1/2 bit.
Integral Non-Linearity: ±1 bit.
Output Connector – Front Panel SMA.

NORMAL OUT

Amplitude –
Output Voltage: –2.0 V to +2.0 V into 50 Ω.
Amplitude: 20 mV to 2.0 V into 50 Ω.
Resolution: 1 mV.
DC Accuracy: ±(1.5% of Amplitude + 2 mV) at offset = 0 V.
Offset –
Range: –1.000 V to +1.000 V into 50 Ω.
Resolution: 1 mV.
Accuracy: ±(1% of offset + 10 mV) at amplitude = 20 mV.
Pulse Response (–1 and 1 waveform data, 0 V offset, Through filter at 1 V_{p-p}):
Rise time (10 to 90%): ≤750 ps.
Fall time (10 to 90%): ≤750 ps.
Aberrations (at 1000 MHz): At 1.0 V_{p-p} Amplitude: ±10%.
Flatness (after 20 ns from rise/fall edge): ±3%.
Sinewave Characteristics (2.6 GS/s clock, 32 waveform points, 81.25 MHz signal frequency, 0.5 V amplitude, 0 V offset, Through filter) –
Harmonics – ≤ –40 dBc, DC to 800 MHz.
Noise – ≤ –50 dBc, DC to 800 MHz.
Phase Noise – ≤ –85 dBc/Hz at 10 kHz offset.

FILTER

Type – 20, 50, 100, 200 MHz Bessel low-pass.
Rise time (10 to 90%) – 20 MHz, 17 ns; 50 MHz, 7.0 ns; 100 MHz, 3.5 ns; 200 MHz, 1.75 ns.
Delay from trigger – 20 MHz, 50 ns + 22 clocks; 50 MHz, 40 ns + 22 clocks; 100 MHz, 35 ns + 22 clocks; 200 MHz, 33 ns + 22 clocks; Through, 30 ns + 22 clocks.

DIRECT D/A OUT

AMPLITUDE

Output Voltage – -0.5 V to +0.5 V into 50 Ω.
Amplitude – 20 mV_{p-p} to 1.0 V_{p-p} into 50 Ω.
Resolution – 1 mV.
DC Accuracy – ± (2% of Amplitude + 2 mV).
Offset – no function.
DC Offset Accuracy – 0 V ±10 mV (waveform data = 0).
Pulse Response (–1 and 1 waveform data, at 0.5 V_{p-p}) –
Rise time (10 to 90%): ≤ 400 ps.
Fall time (10 to 90%): ≤ 400 ps.
Output Impedance – 50 Ω.

AUXILIARY OUTPUTS

MARKER

Number – 2 (complementary).
Level –
Hi/Lo – 1.1 V to 3.0 V into 50 Ω (Max. 2.5 V_{p-p}).
-2.2 V to 6.0 V into 1 MΩ. (Max. 5 V_{p-p}).
Resolution – 0.05 V.
Accuracy – Within ± 0.1 V +5% of setting.
Rise/Fall Time (20 to 80%) – 150 ps (2 V_{p-p}, Hi +1 V, Lo –1 V) into 50 Ω.
Variable Delay –
Range: 0 ns to +1.5 ns.
Accuracy: –30% to +10% at 1.5 ms setting.
Resolution: 100 ps.
Marker Skew: 70 ps (typical).
Connector – Front-panel SMA.
10 MHz Reference Clockout –
Amplitude: ≥1 V_{p-p} into 50 Ω. Max 3 V_{p-p} open.
Impedance: 50 Ω, AC coupling.
Connector: Rear-panel BNC.
1/4 Clock Out –
Level: ECL 100 K compatible.
Connector: Rear-panel BNC.
Trigger In –
Impedance: 1 kΩ or 50 Ω.
Polarity: POS or NEG.
Input Voltage Range –
1 kΩ: ±10 V.
50 Ω: ±5 V.
Threshold –
Level: –5.0 V to 5.0 V.
Resolution: 0.1 V.
Accuracy: ±(5% of level + 0.1 V).
Pulse Width (0.2 V amplitude): 10 ns minimum.
Trigger Holdoff: ≥576 clocks + 450 ns.
Delay to Marker: 28 ns + 22 clocks.
Delay to Analog Out: (typical).
(filter through).
30 ns + 22 clocks (trigger).
30 ns + 880 clocks (gate).
Connector: Rear-panel BNC.

Event Trig Input –
Number of Events: 4 bits.
Input Signals: 4 event bits, strobe.
Threshold: TTL level.
Pulse Width: 128 clocks minimum.
Maximum Input: 0 V to +5 V (DC + peak AC).
Delay to Analog Out: 850 clocks + 20 ns (ASYNC mode).
Impedance 2.2 kΩ, pull-up to +5 V.
Connector: Rear-panel 9-Pin D-sub.

Reference 10 MHz Clock IN –
Input Voltage Range: 0.2 V to 3.0 V_{p-p}, ±10 V maximum.
Impedance: 50 Ω, AC coupled.
Frequency Range: 10 MHz ±0.1 MHz.
Connector: Rear-panel BNC.

GENERAL CHARACTERISTICS

DISPLAY

Area – 13.2 cm (5.2 in.) horizontal by 9.9 cm (3.9 in.) vertical.
Resolution – 640 horizontal by 480 vertical pixels.

DATA STORAGE

Internal Hard disk Drive –
2.1 GB (standard).

Floppy Disk Drive – 3.5 in., 1.44 MB.
Option 10 – Flash Disk replaces HDD, 78 MB.

ENVIRONMENTAL, EMC, SAFETY

Temperature –
Operating: 10°C to +40°C.
Nonoperating: –20°C to +60°C.

Humidity –
Operating: 20 to 80%, non-condensing.
Nonoperating: 5 to 90%, non-condensing.

Altitude –
Operating: Up to 4,500 m. (15,000 ft.). Maximum operating temperature decreases 1°C per 300 m above 1.5 km.
Nonoperating: Up to 15,000 m (50,000 ft.).

Vibration (test limits) –
Operating: 0.27 g RMS from 5 to 500 Hz, 10 minutes.
Nonoperating: 2.28 g RMS from 5 to 500 Hz, 10 minutes.

Shock (test limits) –
Non-operating: 294 m/s^2 (30 g), half-sine, 11 ms duration.

EMC Compliance –
EN50081-1, EN50082-1.
AS/NZS 20641/2.

Safety – UL3111-1, CSA1010.1, EN61010-1, IEC61010-1.

POWER

Source Power –
Line Voltage Range: 100 to 240 VAC.
Line Frequency: 48 to 63 Hz.

Power Consumption – 600 W at 8 A.

PHYSICAL CHARACTERISTICS

Dimensions	mm	in.
Height	178	7.6
Width	422	16.6
Depth	560	22.0
Weight	**kg**	**lb.**
Net	17	37.5

WARRANTY

One year parts and labor.

OTHER

Programmable Interface –
GPIB: 24-Pin IEEE488.1 connector.
Ethernet: 10 Base-T, RJ-45 connector.
Keyboard Connector – 6-Pin mini-DIN connector.

ORDERING INFORMATION

For price information: Outside the U.S. contact your local Tektronix representative, inside the U.S. see the price list in the back of this catalog.

AWG 610–
2.6 GS/s, Single-channel Arbitrary Waveform Generator.

Includes: User Manual (071-0554-00), Programmer Manual (071-0555-00), GPIB Programming Examples Disk (063-3216-00), Sample Waveform Library Disk (063-3217-00), Performance Verification Disk (063-3218-00), Power Cable (U.S. 115 V), Fuse (159-0407-00).

OPTIONS

Opt. 10- Flash Disk (78 Mb) remove HDD and STBY switch.
Opt. 1R – Rack mount.

MEASUREMENT SERVICE OPTIONS

Opt. C3 – Three years of Calibration Services.
Opt. D1 – Calibration data certificate.
Opt. D3 – Test Data; Requires C3.
Opt. R3 – 3 Year extended repair warranty.

INTERNATIONAL POWER PLUGS

Opt. A1 – Universal Euro 220 V, 50 Hz.
Opt. A2 – UK 240 V, 50 Hz.
Opt. A3 – Australian 240 V, 50 Hz.
Opt. A4 – North American 240 V, 60 Hz.
Opt. A5 – Switzerland 220 V, 50 Hz.
See page 619 for description.

RECOMMENDED ACCESSORIES

Service Manual – Order 071-0556-00.
Protective Cover – Order 200-3696-01.
50 Ω SMA Cable (1.0 m) – Order 174-1341-00.
WaveWriter™ Software – Order S3FT400.

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

CE

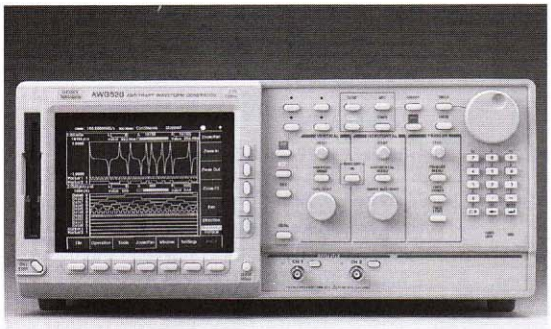
SONY Tektronix

ISO9002 Certified
JMI-0113

GPIB IEEE-488

Arbitrary Waveform Generator

AWG 510 • AWG 520



Features – Benefits

Versatile 1 GS/s AWG

One or Two Channels with 10-Bit Vertical Resolution

10-Channel Data Generation (Opt. 03)

Real-Time Noise Generation

Waveform Transfers from DSO

File Transfers from GPIB, Floppy Disk, or 10 Base T Ethernet

On-Screen Waveform Editing

Unique Real-Time Sequencing Extends Record Lengths

Built-in 1.4 GB Hard Drive for Mass Data Storage

Applications

Communications Design and Test:
- Low frequency modulated RF
- Digital information encoding using FSK and PSK (Quadrature modulation) for cellular, fax and modem communications

Optical Communications Design and Test:
- Reflections, crosstalk, and ground bounce simulation

Real-world Simulations:
- Corrupt ideal waveforms
- EMP/EMI and other system noise
- Power supply noise and ripple
- Transducer simulation

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

CE

SONY Tektronix

ISO9002 Certified JMI-0113

GPIB IEEE-488

As a member of the Tektronix family of arbitrary generators, the AWG 500 Series is a high performance, mixed-signal source. The AWG 500 Series provides 1 GS/s sample clock rate and 4 Mword execution memory.

Its unique design integrates a graphical editing display with the most powerful hardware output capabilities available. This allows on-screen viewing of waveform editing and simplifies "what-if" test scenarios by easily allowing the creation of composite signals.

The AWG 500 uses a graphical user interface to overcome the historical difficulties associated with developing arbitrary and complex waveforms. Several intuitive and powerful techniques are built-in to develop and edit custom waveforms.

The standard AWG 510 configuration provides up to 2 V output or 4 V into a differential input with the complementary output, each with 10-Bits vertical resolution. Option 03 adds an independent 10-Bit-wide digital data port which can be used in conjunction with the marker outputs for data generation up to 12-Bits wide at up to 1 GHz (24-Bits AWG520).

The standard AWG 520 configuration provides 2 channels. Each channel provides 10-Bit vertical resolution with amplitudes up to 2 V_{p-p}.

CHARACTERISTICS

OPERATING MODES

Continuous – Waveform is iteratively output. If a sequence is defined, the sequence order and repeat functions are applied.
Triggered – Waveform is output only once when an external, internal GPIB, or manual trigger is received.
Gated – Waveform begins output when gate is true and resets to beginning when false.
Enhanced – Waveform is output as defined by the sequence.

ARBITRARY WAVEFORMS

Waveform Length – 256 to 4,194,048 points in multiples of four.
Sequence Length – 1 to 8,000 steps. Both CH1 and CH2 operate same sequence (AWG 520).
Sequence Repeat Counter – 1 to 65,536 or infinite.

CLOCK GENERATOR

Sampling Frequency – 50.000000 kHz to 1.0000000 GHz.
Resolution – 8 digits.
Internal Clock –
Accuracy: ±1 ppm.
Phase Noise:
At 1 GHz, 10 kHz offset: –80 dBc/Hz.
At 1 GHz, 100 kHz offset: –100 dBc/Hz.

INTERNAL TRIGGER GENERATOR

Internal Trigger Rate –
Range: 1.0 µs to 10.0 s.
Resolution: 3 digits, 0.1 µs minimum.
Accuracy: ±0.1%.

MAIN OUTPUT

Output Signal –
AWG 510: Complemental; CH1 and CH1.
AWG 520: Single-ended; CH1 and CH2.
DA Converter –
Resolution: 10 Bits.
Differential Non-Linearity: ±1 LSB.
Integral Non-Linearity: ±1 LSB.

Normal Out –
Pulse Response (–1 and 1 waveform data, 0 V offset, Through filter):
Rise time (10 to 90%): Amplitude >1.0 V, ≤2.5 ns; Amplitude ≤1.0 V, ≤1.5 ns.
Fall time (10 to 90%): Amplitude >1.0 V, ≤2.5 ns; Amplitude ≤1.0 V, ≤1.7 ns.
Aberrations (at 500 MHz): Amplitude >1.0 V, ±10%; Amplitude ≤1.0 V, ±7%.
Flatness (after 50 ns from rise/fall edge): ±3%.
Small signal bandwidth (–3 dB, Amplitude 0.5 V): 300 MHz.
Sinewave Characteristics (1 GS/s clock, 32 waveform points, 31.25 MHz signal frequency, 1.0 V amplitude, 0 V offset, Through filter):
Harmonics: ≤-50 dBc, DC to 400 MHz.
Noise: ≤-53 dBc, DC to 400 MHz.
Phase Noise: ≤-90 dbc/Hz at 10 kHz offset.
Filter:
Type: 10, 20, 50, 100 MHz Bessel low-pass.
Rise time (10 to 90%): 10 MHz, 35 ns; 20 MHz, 17 ns; 50 MHz, 7.0 ns; 100 MHz, 3.5 ns.
Delay from trigger: 10 MHz, 77 ns + 1 clock; 20 MHz, 57 ns + 1 clock; 50 MHz, 45 ns + 1 clock; 100 MHz, 42 ns + 1 clock; Through, 37 ns +1 clock.

Direct DA Out –
Output Voltage: 0.5 V_{p-p} (with –0.27 V offset) into 50 Ω.
Amplitude Accuracy: 0.5 V_{p-p} ±10%.
DC Offset Accuracy: –0.27 V ±10% (waveform data = 0).
Pulse Response (–1 and 1 waveform data):
Rise time (10 to 90%): ≤700 ps.
Fall time (10 to 90%): ≤700 ps.
Output Impedance – 50 Ω.
Connector – Front Panel BNC.

AUXILIARY OUTPUTS

Marker –
Number:
AWG510: 2.
AWG 520: 4.
Level:
Hi/Lo: –2.0 V to 2.0 V into 50 Ω; –4.0 V to 4.0 V into 1 MΩ.
Resolution: 0.05 V.
Accuracy: Within ±0.1 V ±5% of setting.
Rise/Fall Time (10 to 90%):
At 1 V_{p-p}, Hi +0.5 V/Lo –0.5 V: 0.5 ns.
At 2 V_{p-p}, Hi +1 V/Lo –1 V: 1.0 ns.
At 4 V_{p-p}, Hi +2 V/Lo –2 V: 2.0 ns.
Variable Delay:
Range: 0 ns to +2 ns.
Resolution: 20 ps.
Marker Skew: 32 ps.
Connector: Rear-panel SMB.

Clock Out –
Level: ECL 100 K compatible.
Connector: Front-panel BNC.

Noise –
Level:
Range: –145 dBm/Hz to –105 dBm/Hz.
Resolution: 1 dB.
Accuracy: ±2.5 dB at 100 MHz.
Flatness: ±2.5 dB, 1 MHz to 300 MHz (referenced to –105 dBm/Hz at 100 MHz).
Type: Gaussian.
Connector: Front-panel BNC.

Digital Data Out (Opt. 03) –
Output Signals: D0 to D9 (10 Bits).
Level:
Hi/Lo: –2.0 V to 2.0 V into 50 Ω; –4.0 V to 4.0 V into 1 MΩ.
Resolution: 0.1 V.
Accuracy: Within ±0.1 V ±5% of setting.
Rise/Fall Time (10 to 90%):
At 1 V_{p-p}, Hi +0.5 V/Lo –0.5 V: 0.5 ns.
At 2 V_{p-p}, Hi +1 V/Lo –1 V: 1.0 ns.
At 4 V_{p-p}, Hi +2 V/Lo –2 V: 2.0 ns.
Skew Between Data: ≤1 ns, 330 ps typical.
Delay:
Data to marker: 4.4 ns.
Clock to data: 3.7 ns.
Connector: Rear-panel SMB.

AUXILIARY INPUTS

Trigger In –
Impedance: 1 kΩ or 50 Ω.
Polarity: POS or NEG.
Input Voltage Range:
1 kΩ: ±10 V.
50 Ω: ±5 V.
Threshold:
Level: –5.0 V to 5.0 V.
Resolution: 0.1 V.
Accuracy: ±(5% of level + 0.1 V).
Pulse Width (0.2 V amplitude): 10 ns minimum.
Trigger Holdoff: 500 ns maximum.
Delay to Marker: 30 ns + 1 clock.
Connector: Front-panel BNC.

Event Trig Input –
Number of Events: 4 Bits.
Input Signals: 4 event Bits, strobe.
Threshold: TTL level.
Pulse Width: 64 clocks minimum.
Maximum Input: 0 V to +5 V (DC + peak AC).
Delay to Analog Out: ≤384 clock + 20 ns.
Impedance 2.2 kΩ, pull-up to +5 V.
Connector: Rear-panel 9-Pin D-sub.

CH1 ADD Input –
Input Voltage Range: –1 V to 1 V (DC + peak AC).
Impedance: 50 Ω.
Bandwidth (–3 dB): DC to 200 MHz at 1 V_{p-p} input.
Amplitude Accuracy: ±5%.
Connector: Front-panel BNC.

Reference 10 MHz Clock IN –
Input Voltage Range: 0.2 V to 3.0 V_{p-p}, ±10 V maximum.
Impedance: 50 Ω, AC coupled.
Frequency Range: 10 MHz ±0.1 MHz.
Connector: Rear-panel BNC.

ENVIRONMENTAL, EMC, SAFETY

Temperature –
Operating: 10°C to +40°C.
Nonoperating: –20°C to +60°C.

Humidity –
Operating: 20 to 80%, non-condensing.
Nonoperating: 5 to 90%, non-condensing.

Altitude –
Operating: Up to 4,500 m. (15,000 ft.). Maximum operating temperature decreases 1°C per 300 m above 1.5 km.
Nonoperating: Up to 15,000 m (50,000 ft.).

Vibration (test limits) –
Operating: 0.27 g RMS from 5 to 500 Hz, 10 minutes duration.
Nonoperating: 2.28 g RMS from 5 to 500 Hz, 10 minutes duration.

Shock (test limits) –
Nonoperating: 294 m/s2 (30 g), half-sine, 11 ms duration.

EMC Compliance –
EN50081-1.
EN50082-1.
FCC Part 15, Subchapter B Class A.
AS/NZS 20641/2.

Safety – UL3111-1, CSA1010.1, EN61010-1, IEC61010-1.

POWER

Source Power –
Line Voltage Range: 100 to 240 VAC.
Line Frequency: 48 to 63 Hz.

Power Consumption –
AWG 510: 400 W at 5 A (standard).
AWG 520: 600 W at 8 A maximum.

PHYSICAL CHARACTERISTICS

Dimensions	mm	in.
Height	178	7.6
Width	422	17.5
Depth	560	25.8
Weight	**kg**	**lb.**
Net	17	37.5

WARRANTY

One year parts and labor.

OTHER

Programmable Interface –
GPIB: 24-Pin IEEE488.1 connector.
Ethernet: 10Base-T, RJ-45 connector.

Keyboard Connector – 6-Pin mini-DIN connector.

ORDERING INFORMATION

For price information: Outside the U.S. contact your local Tektronix representative, inside the U.S. see the price list in the back of this catalog.

AWG 510
Programmable Single-channel Arbitrary Waveform Generator.

AWG 520
Programmable Dual-channel Arbitrary Waveform Generator.

Both Include: User Manual (071-0099-00), Programmer Manual (071-0100-00), GPIB Programming Examples Disk (063-2982-00), Sample Waveform Library Disk (063-2981-00), Performance Verification Disk (063-2983-00), Power Cable (U.S. 115 V), Fuse (159-0239-00).

OPTIONS
Opt. 03 – Ch 2 10-Bit output up to 1 GHz.
Opt. 1R – Rack mount.

INTERNATIONAL POWER PLUGS
Opt. A1 – Universal Euro 220 V, 50 Hz.
Opt. A2 – UK 240 V, 50 Hz.
Opt. A3 – Australian 240 V, 50 Hz.
Opt. A4 – North American 240 V, 60 Hz.
Opt. A5 – Switzerland 220 V, 50 Hz.
See page 619 for description.

RECOMMENDED ACCESSORIES
Service Manual – Order 071-0101-00.
Protective Cover – Order 200-3696-01.
GPIB Cable – Order 012-0991-01.
50 Ω BNC Cable – Order 012-1341-00.
Keyboard – IBM-compatible 4-Pin mini DIN connector.

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

CE

SONY Tektronix

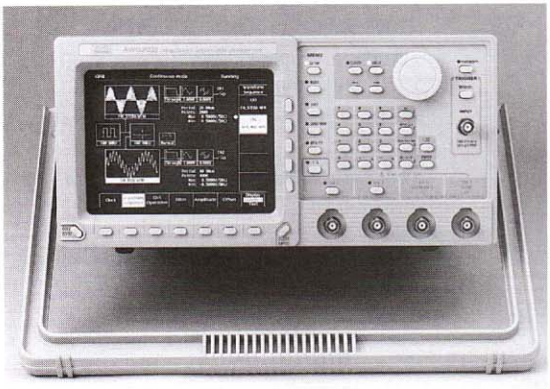
ISO9002 Certified
JMI-0113

GPIB IEEE-488

Product(s) complies with IEEE Standard 488.1-1987, RS-232-C, and with Tektronix Standard Codes and Formats.

Arbitrary Waveform Generator

AWG 2021



Features – Benefits

- 250 MS/s Clock Rate Provides up to 125 MHz Waveforms
- 256 k (262,144 Points) Record Length
- 12-Bit (1/4096) Vertical Resolution
- Direct DSO Waveform Transfers
- Optional 12-Bit 250 MHz (ECL) or 12/24-Bit 100 MHz (TTL) Digital Data Generator
- Built-in 1.4 MB, 3.5 in. Floppy Disk
- FFT Editor
- Real Time Waveform Sequencer
- Formula Entry of Waveforms
- RS-232 and GPIB (IEEE 488.2)

Applications

- Analog and Digital Modulation
- Wireless Communication
- All Forms of Fading Simulation
- Navigation
- I and Q Impairment
- Audio
- Computer Peripherals
- Automotive
- Converter Testing
- Filter Design
- Semiconductor Logic (ASIC/DAC/FPGA)
- CCD, LCD

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

CE

GPIB IEEE-488

Product(s) complies with IEEE Standard 488.2-1987, and with Tektronix Standard Codes and Formats.

SONY Tektronix

ISO9002 Certified JMI-0113

AWG 2021 Arbitrary Generator

The AWG 2021 is our median performance product offering fast (250 MS/s) and deep memory (256 k). As with the entire 2000 Series family, the graphical user interface allows on-screen viewing of waveform editing and simplifies "what if" test scenarios by easily allowing the creation of composite signals.

The standard AWG 2021 configuration provides one 5 V output or a second independent 5 V output (Opt. 02) each with 12-Bits vertical resolution. Frequency of channel 2 is also independently programmable. Option 03 adds a 12-Bit-wide differential ECL digital port which can be used in conjunction with the marker outputs for data generation up to 14-Bits-wide at up to 250 MHz. Or if you prefer, Option 04 provides TTL digital levels with up to two 12-Bit, 100 MS/s ports for a total of 28-Bits wide.

The built-in frequency domain (FFT) editor (Opt. 09) is a perfect addition for customers performing proprietary or standard modulation simulations, filter design or in testing physical layer. Real-time waveform sequencing extends the effective record length output to over a billion points!

The AWG 2021 easily simulates signals where moderate point definition and long records are required for simulating very complex waveform conditions. Direct waveform transfer capability makes the AWG 2021 the perfect accessory for Tektronix DSOs.

Characteristics

STANDARD WAVESHAPES
Sine, square, triangle, ramp, pulse, arbitrary, linked sequence and DC.

ARBITRARY WAVEFORMS
Execution Memory –
Waveform: 256 Kwords. Marker: 256 Kwords x 2-Bits.
Data Points of Waveform Size: 64 to 256 K in multiples of 8.
Real-Time Sequencer Memory –
8 K individual waveforms.
Loop Counter: 1 to 65,535 repeats.
Burst Mode Counter: 1 to 64 K cycles.

CATALOG MEMORY CLOCK

Frequency Range – 10 Hz to 250 MHz.
Resolution – 4 digit.
Accuracy – 50 ppm (+15°C to +30°C).
Skew between CH 1 and CH 2 (Opt. 02 only) – Within 4 ns.

OPERATING MODES

MAIN OUTPUT

Amplitude (Excluding ADD and Multiply Operation) –
Digital-to-Analog Resolution: 1/4096 (12-Bits).
Range: 0.05 V to 5 V_{p-p} into 50 Ω DC.
Accuracy: 0.05 V to 0.5 V, ±(0.5% of amplitude +5 mV); 0.501 V to 5 V, ±(1% of amplitude +25 mV).

Offset –
Range: –2.5 V to +2.5 V into 50 Ω, (–100 mA to +100 mA).
Resolution: 0.2 mA.
Accuracy: ±(1% of offset +0.2 mA).

Pulse Response –
15°C to +30°C: Flatness, within 3% after 20 ns from rise/fall edges; Aberrations, within 7% +10 mV.
+10°C to +40°C: Rise/Fall Time, <4.2 ns; Flatness, within 5% after 20 ns from rise/fall edges; Aberrations, within 9% +10 mV.

Impedance – Typically 50 Ω.

Sinewave (Amplitude 1 V, 100 kHz Reference) – Flatness: Within 4%.
THD: 1.0 V, ≤50 dBc, 0.5 V, ≤66 dBc;
Spurious: ≤66 dBc.

CHANNEL SUMMING (OPT. 02 ONLY)

AM (Multiply) – Output: Within 5%.
Frequency Response: DC to 30 MHz.

External AM – Sensitivity: 2 V_{p-p} (±5%) signal produces 100% modulation.
Frequency Response: CH 1, DC to 30 MHz; Ext. Signal, DC to 4 MHz.

Add – Output: Within 5%.
Frequency Response: DC to 30 MHz.

FILTERS

3 dB Cutoff Frequency – 1 MHz: Within 20%. 5 MHz: Within 20%. 20 MHz: Within 20%. 50 MHz: Within 20%.

AUXILIARY OUTPUTS

Markers 1 and 2 – Amplitude: 1 V ±0.3 V into 50 Ω. Impedance: 50 Ω. Marker to Signal Delay: Within 15 ns.

Sync – Amplitude: 1 V ±0.3 V into 50 Ω. Impedance: 50 Ω. Sync to Signal Delay: Within 15 ns.

Clock – Amplitude: 1 V ±0.3 V into 50 Ω. Impedance: 50 Ω.

Digital Data Out (Opt. 03) –
Level: Differential ECL compatible.
Output Signals: Data (D0 to D11).
Skew Between Data: Within 1 ns.
Clock to Data Delay: Within 3 ns.
Connector: 68-Pin mini-D sub.

AUXILIARY INPUTS

Trigger – Threshold Level: –5 V to +5 V.
Resolution: 0.1 V.
Accuracy: ±(5% x Level + 0.1 V).
Pulse Width: 15 ns minimum.
Input Swing: 0.2 V minimum.
Maximum Input Volts: 10 V_{p-p} when 1 MΩ selected; 5 V RMS when 50 Ω selected.
Impedance: 1 MΩ with 30 pF max.
Trigger to Output Signal Delay: External Clock, 100 ns maximum +1 clock.

Trigger Holdoff – 5 µs maximum.

AM (Opt. 02 only) –
Range: 2 V_{p-p} (–1 V to +1 V) for 100% modulation.
Maximum Input: ±5 V_{p-p}, 10 kΩ impedance.

System Clock – Threshold Level: 0.3 V ±0.1 V. Input Swing: 0.8 V minimum. Pulse Width: 2 ns minimum. Maximum Input Voltage: ±2 V_{p-p}. Impedance: 50 Ω. Frequency Range: Up to 250 MHz phase coherent.

PROGRAMMABLE INTERFACE

GPIB – IEEE 488.2-1987 compatible.
RS-232 – 9-pin D connector.

ENVIRONMENTAL

Temperature – Operating: +10°C to +40°C. Nonoperating: –20°C to +60°C.

Humidity – Operating: 20% to 80% (no condensation).
Nonoperating: 5% to 90% (no condensation).

Altitude – Operating: To 4.5 km (15,000 ft.). Maximum operating temperature decreases 1°C for each 300 m above 1.5 km.
Nonoperating: To 15 km (50,000 ft.).

Vibration – Operating: 0.33 mm p-p, 10 Hz to 55 Hz for 15 minutes.

Shock – Nonoperating: 30 g (1/2 sine) 11 ms duration.

Bench Handling – Operating: Drop from 10 cm (4 in.) tilt or 45°, whichever is less.

EMC –
Emissions: Within limits of FCC CFR 47, Part 15, Subpart B, Class A; VFG 243; EN55022, B; EN6055-2.
Immunity: Within limits of IEC 801-3, IEC 801-2, IEC 801-4.

Electrical Discharge – Operating max test voltage: 15 kV (150 pF through 150 Ω).

Safety – UL1244, CSA231, EN61010-1, IEC61010-1.

POWER

Source Power – Voltage Ranges: 90 to 127 V AC or 90 to 250 V AC.

PHYSICAL CHARACTERISTICS

Dimensions	mm	in.
Height (with feet)	164	6.4
Width (with handle)	362	14.3
Length (with front cover)	491	19.25Leng
(with handle extended)	576	22.2
Weight	**kg**	**lbs.**
Net	10.7	23.6

ORDERING INFORMATION

For price information: Outside the U.S. contact your local Tektronix representative, inside the U.S. see the price list in the back of this catalog.

AWG 2021

250 MS/s Arbitrary Waveform Generator.

Includes: User/Programmer's Manual (070-9097-01/070-8657-04), GPIB Programming Examples Disk, Sample Waveform Library Disk, Cal. Certificate, Power Cable.

Opt. 02 – Independent, 256 K Second Channel.
Opt. 03*1 – 12-Bit, ECL Digital Data Out.
Opt. 04*1*2 – 12/24-Bit, TTL Digital Data Out.
Opt. 09*1 – Add FFT Editor. Allows editing waveforms in the frequency domain.
Opt. 1R – Rackmount. Floppy moved to front.
Opt. 1S – Adds WaveWriter™ Software.

MEASUREMENT SERVICE OPTIONS

Opt. C3 – Three years of Calibration Services.
Opt. D1 – Cal DAT Report.
Opt. D3 – Test Data (requires Opt. C3).
Opt. R3 – Repair warranty extended to cover three years.

INTERNATIONAL POWER PLUGS

Opt A1 – A5 available.
See page 619 for description.

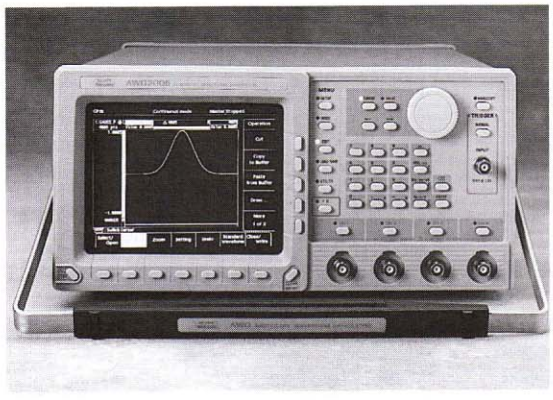
ACCESSORIES

Accessory Pouch – Order 016-1159-00.
Front Cover – Order 200-3232-01.
RS-232-C Cable – 9-Pin to 25-Pin. Order 174-1453-00.
Rackmount Kit – Order 040-1444-00.
12-Bit Digital Cable – Order 174-3192-00. 12-Bit ECL 174 (Opt. 03) – Digital Cable.
GPIB Cable – Order 012-0991-00.

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

Arbitrary Waveform Generator

AWG 2005



Features – Benefits

- 20 MS/s (50 ns) Clock Rate Provides up to 10 MHz Waveforms
- Up to Four Channels of 64 k Record Length
- 12-Bit (1/4096) Vertical Resolution
- Direct DSO Waveform Transfers
- 50 ps Edge Placement
- 24-Bit Channel, TTL Digital Data Generator (Opt. 04)
- Linear, Log and User Definable Sweep Generation (Opt. 05)
- Built-in 1.44 MB, 3.5 in. Floppy Disk
- FFT Editor (Opt. 09) Frequency Domain Editing
- Real Time Waveform Sequencer
- Formula Entry Waveforms
- RS-232 and GPIB (IEEE 488.2)

Applications

- Analog & Digital Modulation
- Digital Baseband Modulation
- Sonar Testing
- Transducer Simulation
- Motor Control
- Automotive
- Industrial
- Sensors
- Semiconductor/Logic

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

CE

GPIB IEEE-488

Product(s) complies with IEEE Standard 488.2-1987, and with Tektronix Standard Codes and Formats.

SONY Tektronix

ISO9002 Certified JMI-0113

The AWG 2005 is our best value product and offers 20 MS/s and 64 k deep memory. As with the entire 2000 Series family, the graphical user interface allows on-screen viewing of waveform editing and simplifies "what if" test scenarios by easily allowing the creation of composite signals.

The standard AWG 2005 configuration provides two independent 10 V outputs or a third and fourth 10 V output (Option 02) each with 12-Bits vertical resolution. Option 04 adds TTL digital levels with (2) 12-Bit, 100 MS/s ports and combines with the marker outputs to provide a total of 28-Bits wide.

The built-in sweep generator provides even more flexibility by offering linear and logarithmic swept frequencies, but even more significantly the AWG 2005 has user definable sweep capability. This allows creation of digitally modulated signals at IF frequencies.

The built-in frequency domain (FFT) editor (Option 09) is a perfect addition for customers performing proprietary or standard I & Q modulation simulations, filter design or in circuit testing of physical layer. Real time waveform sequencing extends the effective record length output to over a billion points!

The AWG 2005 easily simulates signals where moderate point definition and long records are required for simulating complex waveform conditions. Direct waveform transfer capability makes the AWG 2005 the perfect accessory for Tektronix DSOs.

Characteristics

STANDARD WAVESHAPES

Sine, square, triangle, ramp, noise, arbitrary, linked sequence, and DC.

ARBITRARY WAVEFORMS

Execution Memory – Waveform: 64 k (65,535) for each channel. Marker: 64 k for each channel.
Waveform Size: 16 to 64 k in multiples of 16.

Real Time Sequence Memory – 8 k individual waveforms.

Loop Counter – Waveform: 1 to 64 k repeats. Sequence: 1 to 64 k repeats.
Catalog Memory – 2 MB.

CATALOG MEMORY CLOCK

Frequency Range – 0.01 Hz to 20 MHz.
Resolution – Standard: 4 digits. With Option 05: 7 digits.
Accuracy – Standard: 50 ppm (+15°C to +30°C). Option 05: 5ppm (+15°C to +30°C).

OPERATING MODES

Continuous, Triggered, Gated, Seq/Wfm Advance, Master/Slave Operation, Step, Auto Step.

MAIN OUTPUT

Digital-to-Analog Resolution – 12-Bits.
Output Impedance – 50 Ω.
Amplitude (1 MHz clock, 000 and FFF waveform data, norm, no filter, no offset, excluding and ADD operation) – Range: 0.05 V to 10 V p-p into 50 Ω. Resolution: 1 mV (4 digits). DC Accuracy: 0.050 V to 0.999 V, ±(0.5% of amplitude + 5 mV); 1.000 V to 10.000 V, ±(1% of amplitude + 50 mV).
Offset – Range: –5.0 V to +5.0 V into 50 Ω (–200 mA to +200 mA). Resolution: 5 mV (4 digits). Accuracy (1 MHz clock, 7FF waveform data, norm, no filter, amplitude range 0.05 V): –±(1% of offset + 10 mV).
Pulse Response (20 MHz clock, 000 and FFF waveform data, norm, no filter, amplitude 5 V, no offset) – Rise/Fall Time: <35 ns. Flatness: Within ±3% after 150 ns from rise/fall edges. Aberrations: Within ±7%.
Cross Talk Between Channels – 512-point sine, 20 MHz clock, norm, no filter, amplitude offset. <70 dBc.
Noise Floor – 20 MHz clock, 7FFF waveform data, norm, no filter, no offset. 0.5 V: ≤110 dBm/Hz at 1 MHz. 5.0 V: ≤95 dBm/Hz at 1 MHz.
Sinewave Characteristics – Function Generator mode, 100 Hz to 200 kHz, no offset. Flatness (1 V amplitude, 1 kHz reference): Within –4%. T.H.D. (Including up to 4th harmonics): ≤55 dBc at 5.0 V.

AUXILIARY OUTPUTS

Marker – Amplitude: >2 V into 50 Ω. Impedance: 50 Ω. Marker to Signal Delay: 35 ns.
Clock – Amplitude: >2 V into 50 Ω. Impedance: 50 Ω.
Control Sig. – Amplitude: >2 V into 50 Ω. Impedance: 50 Ω.
Sweep (Option 05) – Waveshape: Same waveshape as selected sweep. Amplitude: 0 to 5 V (amplitude is dependent upon start and stop frequencies with a 5 V maximum limit). Impedance: 600 Ω.
24-Bit TTL Digital Data Out (Option 04) – – Output Signals (CH 1 and CH 2): D0 to D11, Clock. Level: TTL. Amplitude: É2 V into 50 Ω. Skew Between Data: Within ±10 ns. Clock to Data Delay: Within ±10 ns. Impedance: 50 Ω.

AUXILIARY INPUTS

Trigger – Threshold Level: –5 V to +5 V. Resolution: 0.1 V. Accuracy: ±(5% of Level + 0.1 V). Minimum Pulse Width: 150 ns. Minimum Input Swing: 0.2 V p-p. Maximum Input Volts: ±10 V (DC + peak AC). Impedance: 10 kΩ. Trigger to Signal Delay: Internal Clock, 400 ns (excluding clock sweep mode).
AM (512-point sine, 20 MHz clock, AM, no filter, 5 V amplitude, no offset) – Range: 2 V p-p (–1 V to +1 V) for 100% modulation. Amplitude Accuracy: Within 5%. Maximum Input Volts: –5 V (DC + peak AC). Impedance: 10 kΩ.
ADD (512-point sine, 20 MHz clock, Add, no filter, 5 V amplitude, no offset – Range: 10 V p-p (–5 V to +5 V). Amplitude Accuracy: Amplitude specification plus 5%. Maximum Input Volts: –5 V (DC + peak AC). Impedance: 50 Ω.
Control Sig. – Threshold Level: TTL level (0.8 V to 2.0 V). Minimum Pulse Width: 40 ns. Maximum Input Volts: 5 V to 0 V. Impedance: 10 kΩ.
Clock – Threshold Level: TTL level (0.8 V to 2.0 V). Minimum Pulse Width: 20 ns. Maximum Input Volts: 5 V to 0 V. Impedance: External Clock, 330 Ω; Slave Mode, 10 kΩ. Frequency Range: 1 Hz to 20 MHz.
Sweep (Opt. 05 only) – Type: Linear, log, arbitrary. Mode: Continuous, triggered, gated. Update Rate: 1 s to 65,535 ms. Points per Sweep: 8 K maximum.

FUNCTION GENERATOR

Waveform Shape – (Predefined 100 pt. waveforms). Sine, Triangle, Square, Ramp, Pulse (1 MHz filter is inserted when Sine is selected).
Frequency – 1.000 Hz to 200 kHz.
Duty Cycle – 0% to 100%, Pulse only.

PROGRAMMABLE INTERFACE

GPIB – IEEE 488.2-1987 compatible.
RS-232 – 9-Pin D connector.

See page 440 for Environmental Characteristics.

ORDERING INFORMATION

For price information: Outside the U.S. contact your local Tektronix representative, inside the U.S. see the price list in the back of this catalog.

AWG 2005
Programmable Arbitrary Waveform Generator.
Includes: User/Programmer's Manual 070-8958-00/070-8657-03, GPIB Programming Examples Disk, Sample Waveform Library Disk, Cal. Certificate, Power Cable.
Opt. 02 – Add Two Channels (Four Total).
Opt. 04 – 24-Bit, TTL Digital Data Out*[1].
Opt. 05 – Add Clock Sweep.
Opt. 09 – Add FFT Editor. Allows editing waveforms in the frequency domain*[1].
Opt. 1R – Rackmount. Floppy Drive Access Moved to Front.
Opt. 1S – Adds WaveWriter™ Software.
Opt. B1 – Service Manual.

MEASUREMENT SERVICE OPTIONS

Opt. C3 – Three years of Calibration Services.
Opt. D1 – Cal Data Report.
Opt. D3 – Test Data (requires Opt. C3).
Opt. R3 – Repair warranty extended to cover three years.

INTERNATIONAL POWER PLUGS

Opt. A1 – A5 available.
See page 619 for description.

ACCESSORIES

Accessory Pouch – Order 016-1159-00.
Front Cover – Order 200-3232-01.
RS-232-C Cable – 9-Pin to 25-Pin. Order 174-1453-00.
Service Manual – Order 070-8958-00.
Rackmount Kit – Order 040-1444-00.
GPIB Cable – Order 012-0991-00.
50 Ω BNC Cable – Order 012-1342-00.
12-Bit Word Generator Cable (Opt. 04) – Order 174-3192-00.
SMA to BNC Adapter – Order 015-0554-00.
50 Ω Termination – Order 011-0049-01.

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

CE

GPIB IEEE-488

Product(s) complies with IEEE Standard 488.2-1987, and with Tektronix Standard Codes and Formats.

SONY Tektronix

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JMI-0113

Arbitrary Function Generator

AFG310 • AFG320



Features – Benefits

- Two Functions in One Instrument
  - Function Generator
  - Arbitrary Waveform Generator
- AFG320 Offers Two Independent Channels
- Load Waveforms Directly from Any Tektronix Digital Oscilloscope via the GPIB Interface
- Windows-based WaveWriter™ Waveform Editing Software Package
- Optional Rack Mount Kit for System Applications

Applications

- Design and Test
- Automotive
- Industrial
- Biomedical
- Sensor Simulation
- Manufacturing Test

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

CE

GPIB IEEE-488

Product(s) complies with IEEE Standard 488.1-1987, and with Tektronix Standard Codes and Formats.

SONY Tektronix

ISO9002 Certified JMI-0113

FUNCTION GENERATOR

The AFG300 Series is an excellent 16 MHz function generator with built-in arbitrary waveform capabilities. The instruments support standard waveforms including sine, square, triangle, ramp, pulse, DC, and noise. In addition, it has a frequency sweep function and three operating modes: Continuous, Triggered, and Burst.

ARBITRARY WAVEFORM GENERATION

With a sampling rate of 16 MS/s, 12-bits vertical resolution, and a non-volatile memory that holds four 16,384-point waveforms, the AFG300 Series are powerful tools for simulating complex waveforms. Waveshapes can be downloaded directly from a Tektronix DSO, created with the included WaveWriter for Windows waveform editing software package, or entered via the front panel.

WAVEFORM IMPORT FUNCTION

The AFG300 Series supports waveform import function to receive waveforms from Tektronix DSOs (TDS Series and 2400 Series) and arbitrary waveform generators (AWG 2000 Series and AFG 2000 Series) via GPIB. This capability makes the AFG300 Series perfect accessories for Tektronix DSOs.

Characteristics

Output Channels –
AFG310: 1.
AFG320: 2.

Standard Waveforms – Sine, square, triangle, ramp, pulse, DC and Noise.

Arbitrary Waveforms –
Waveform Length: 10 to 16384 points.
Vertical Resolution: 12-Bit.
Sample Rate: 16 MS/s.
Nonvolatile Memory: Four 16 k waveforms.

Output Frequency –
Sine, Square: 0.01 Hz to 16 MHz.
Triangle, Ramp, Pulse: 0.01 Hz to 100 kHz.
Noise (Gaussian): Maximum 8 MHz bandwidth.
Arbitrary Waveform:
Repetition Rate: 0.01 Hz to 1.6 MHz.
Resolution: 7 digits.
Accuracy: 50 ppm.

Output Characteristics –
Amplitude (into 50 Ω): 50 mV_{p-p} to 10 V_{p-p}.
Accuracy: ±(1% of setting + 5 mV) at 1 kHz, no offset.
Flatness (at 1 V amplitude relative to 1 kHz):
<100 kHz: ±1%.
100 kHz to 1 MHz: ±1.5%.
1 MHz to 16 MHz: ±3%.

Offset (into 50 Ω):
505 mV_{p-p} to 10 V_{p-p} amplitude: peak amplitude + offset is limited to +5 V or –5 V.
50 mV_{p-p} to 500 mV_{p-p} amplitude: –0.75 V to +0.75 V.
Accuracy: ±(1% of setting +5 mV).
Resolution: 5 mV.
Output Impedance: 50 Ω.
Isolation: 42 V peak maximum relative to earth ground.
Phase:
Range: ±360°.
Resolution: 1°.

Sine Wave Spectral Purity –
Harmonic Distortion:
DC to 20 kHz: –70 dBc.
20 kHz to 100 kHz: –60 dBc.
100 kHz to 1 MHz: –45 dBc.
1 MHz to 16 MHz: –35 dBc.
Total Harmonic Distortion:
20 kHz: 0.05% at 1 V amplitude.

Signal Characteristics –
Square:
Rise/Fall Time: ≤20 ns.
Overshoot: <2%.
Pulse:
Rise/Fall Time: <100 ns.
Duty Cycle: 1% to 99% of period.
Triangle, Ramp, Pulse, Arbitrary:
Jitter: 2 ns at 100 kHz.

Modulation –
AM:
Source: External only.
Carrier: Up to 16 MHz.
Modulation: Any internal waveform plus Arb.
Frequency: DC to 200 kHz.
Depth:
1 V: 100%.
0 V: 50%.
-1 V: 0%.
2 Vp-p for 100% modulation.

FM:
Source: Internal only.
Modulation: Sine, Square, Triangle, Arb.
Frequency: 0.01 Hz to 10 kHz.
Deviation: 0.01 Hz to 8 MHz.
FSK (frequency shift keying):
Source: Internal only.
Mode: Trigger, Burst.
Frequency range: 0.01 Hz to 16 MHz.
Key rate: 0.01 Hz to 50 kHz.
Number of keys: 2.

Frequency Sweep –
Type: Linear or logarithmic.
Direction: Up or down.
Start/Stop Frequency: 0.01 Hz to 16 MHz.
Time: 1 ms to 100 s.
Mode: Continuous, Trigger, Burst.

Operating Mode –
Continuous: The selected waveform is output continuously.
Triggered: One period of the selected waveform is output each time a trigger occurs.
Trigger source: Manual, External.
Burst: The selected waveform is output with a specified number of cycles each time a trigger occurs.
Carrier frequency: Up to 1 MHz.
Count: 1 to 60,000 cycles/burst (100 s maximum except sine wave or square wave) or infinite.
Start phase: –360 to +360°.
Trigger source: Manual, External.

Inputs/Outputs –
Front Panel:
Main output: Ch 1, Ch 2 (AFG320 only).
External Trigger (Burst) input:
TTL input.
Pulse Width: 1 µs minimum.
10 kΩ input impedance.
Rear Panel:
Sync Output: TTL level.
External AM modulation:
2 V_{p-p} = 100% modulation.
10 kΩ input impedance.
GPIB Interface (IEEE 488.2).

Memory –
Type: Non-volatile.
Setup Storage: 20.
Arbitrary Waveform Storage: 4.

ENVIRONMENTAL, EMC, SAFETY

Temperature Range –
Operating: 0° to +50°C.
Nonoperating: –20° to +60°C.

Humidity –
Operating:
At or below +40°C: 0 to 95%.
+40° to +50°C: 0 to 75%.

Random Vibration –
Operating: 0.31 g_{RMS} from 5 to 500 Hz, 10 minutes.
Nonoperating: 2.46 g_{RMS} from 5 to 500 Hz, 10 minutes.

Shock –
Nonoperating: 294 m/s^2 (30 G), half-sine, 11 ms duration.

EMC Compliance –
Meets intent of Directive 89/396/EEC for Electromagnetic Compatibility.
Australian AN/NZS 2064.1/2.

Safety – UL1244, CSA231, EN61010-1, IEC61010-1.

POWER

Line Voltage – 90 to 132 V AC, 180 to 250 V AC.

Line Frequency –
90 to 250 V: 48 to 63 Hz.
90 to 127 V: 48 to 440 Hz.

PHYSICAL CHARACTERISTICS

Dimensions	mm	in.
Height	99	3.9
Width	214	8.4
Depth	411	16.2
Weight	**kg**	**lb.**
Net: AFG310	5.4	11.9
Net: AFG320	5.6	12.3

ORDERING INFORMATION

For price information: Outside the U.S. contact your local Tektronix representative, inside the U.S. see the price list in the back of this catalog.

AFG310 – Single-channel Programmable Arbitrary Function Generator.

AFG320 – Dual-channel Programmable Arbitrary Function Generator.

Includes: User Manual, Calibration Certificate, Power Cord (U.S. 115 V), WaveWriter™ Software and Manual.

WARRANTY
Three years parts and labor.

RECOMMENDED ACCESSORIES
Rack Mount Kit – Order 016-1674-00.

INTERNATIONAL POWER PLUGS
Opt. A1 – A5 available.
See page 619 for description.

TEKTRONIX MEASUREMENT SERVICE
Tektronix CAL and REP Service programs allow you to pre-purchase genuine Return to Tektronix Service. Ask your Distributor for details.

CALIBRATION DATA REPORT
Opt. C3 – Three years of Calibration Services.
Opt. D1 – Cal Data Report.
Opt. D3 – Test Data (requires Opt. C3).

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

SONY Tektronix

ISO9002 Certified
JMI-0113

Logic Sources

The concept of "real-world" signals has often been associated with Arbitrary Generators; however, digital applications also have a need to simulate both ideal and "real-world" conditions. For this reason, Tektronix offers a variety of Logic Sources. Each of these products is designed to provide digital signals with precise edge placement and amplitudes to meet a variety of digital stimulus needs.

HFS Series Stimulus System

These instruments offer the features of a high performance pulse generator and offer data generation capabilities as well. It is based on a Tektronix modular architecture which makes it easy to configure and maintain a digital stimulus system. This instrument supplants the need for switching matrices and DC power supplies. Logic levels are available directly at the outputs with no need for Auxiliary Pods. These programmable instruments allow more flexibility in pulse edge placement and control, including duty, period, repetition rate and transition times. In addition, each channel has powerful independent skew control capabilities. This makes the HFS ideal for precise high performance characterization and evaluation applications.

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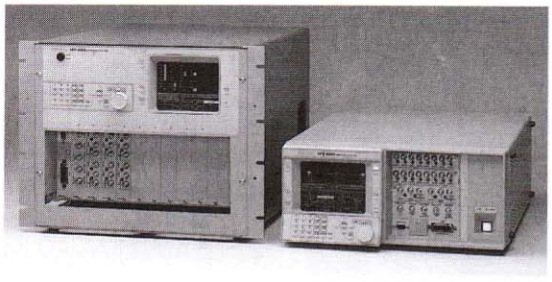
	HFS 9DG1 Data Time Generator	HFS 9DG2 Data Time Generator	DG2020A Data Generator	DG2030 Data Generator	DG2040 Data Generator
Package Style	HFS 9000 Module	HFS 9000 Module	Portable	Portable	Portable
Max. Data Rate	630 Mbps	350 Mbps	200 Mbps	400 Mbps	1.1 Gbps
Period	1.6 ns~20 µs	2.8 ns~20 µs	5 ns	2.5 ns	0.909 ns
Clk Gen. Resolution			4 digits	7 digits	7 digits
Output Channels	4/Module (Max: 36)	4/Module (Max: 36)	12/24/36	4/8	2 complimentary output & clock complimentary output
Pattern Depth	64 k	64 k	64 k	256 k	256 k
Looping	No	No	Yes, 2 k step/ 256 block	Yes, 4 k step/ 256 block	Yes, 4 k step/ 256 block
Ext. Jump	No	No	Yes	Yes	Yes
Output(V)(Open)	Max: 3.00 V_{p-p}	Max: 5.50 V_{p-p}	max: 9.0 V_{p-p} (open)	Max. 5.0 V_{p-p} (50 Ω)	Max. 2.5 V_{p-p} (50 Ω)
Tr/Tf	≤250 ps	800 ps~6 ns	P3410 (≤5 ns), P3420 (≤4 ns @ 5 V_{p-p})	500 ps to 8 ns	≤ 150 ps
Output Connector	SMA	SMA	P3410 (Header) P3420 (SMB)	BNC	SMA
Ch. Delay Timing Control	Full	Full	4 ch./ output pod	Full independent	Full independent
Resolution	1 ps	1 ps	100 ps	20 ps	10 ps
Data Format	DNRZ2 or RZ, R1	DNRZ2 or RZ, R1	NRZ 8ch/pod or DNRZ, 4ch/pod	All CH. DNRZ2	All CH. DNRZ2

Programmable Stimulus System

HFS 9003 • HFS 9009 • HFS 9DG1 • HFS 9DG2



Features – Benefits	Applications
HFS 9000 SERIES	Characterize CMOS, ECL, ACL, BiCMOS and GaAs Devices
Complete Stimulus Setup in Just Minutes	Precise Clock Source
Specify Data and Timing on Every Pin	
Up to 630 MHz Repetition Rate	
Fully Digital Implementation	
Multi-channel Architecture – Up to 640 or More Phase-locked Channels	
Independent Edge Placement	
Channel Deskew	
Precision Channel-to-Channel Timing Alignment	
1 ps Timing Resolution	
GPIB (IEEE 488) Programmable	
Modular Construction	
Upgrade Capability	
Maximum Control and Flexibility	

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

NOT AVAILABLE IN EUROPE.

ISO 9001

Tektronix measurement products are manufactured in ISO registered facilities.

GPIB IEEE-488

Product(s) complies with IEEE Standard 488.1-1987, and with Tektronix Standard Codes and Formats.

HFS 9000 Stimulus System

When product designs were simple, and time-to-market not so critical, designers could afford the days, or even weeks, necessary to assemble, program, debug and characterize the various elements of a stimulus system and its fixturing. As product design complexity and market pressures have increased, however, designers of high-speed, high-performance circuits simply cannot afford this expenditure in time.

Now there's a solution. With Tektronix HFS 9000 Stimulus Systems we've taken the features of a high-performance pulse generator, made them better and added complete data generation capabilities as well. We've eliminated the need for a switch matrix since we have data and timing on every pin. And the need for a separate power supply is gone, as the HFS 9000 has the ability to produce the DC levels needed to drive logic lines directly. Finally, all these capabilities are present on every pin simultaneously, so you get extremely flexible formatting. Now you can set up a complete stimulus system in minutes, rather than hours or days, and test products more thoroughly throughout the development cycle.

DIGITAL ARCHITECTURE

The HFS 9000 Series products were designed as completely programmable digital instruments rather than being based on traditional monostable analog architecture. This allows more capability and flexibility in pulse edge placement without the restrictions that analog instruments commonly impose. Now you can adjust both Delay and Width from 0 to 20 µs over all frequencies.

MODULAR DESIGN

You can build a stimulus system with from 4 to 36 channels in one mainframe, and 640 or more

channels across multiple phase-locked mainframes. Choose from the HFS 9003 mainframe with 3-slot, 12-Channel capability, or the HFS 9009 mainframe with 9-slot, 36-Channel capability. Both systems can include the 4-Channel HFS 9DG1 and HFS 9DG2 Data Time Generator cards in any combination.

All channels are slaved to a common clock, resulting in highly accurate channel-to-channel edge placement. This makes the HFS 9000 ideal for precise characterization and evaluation of synchronous devices having multiple, and possibly interactive, inputs.

FULL CHANNEL DESKEW CAPABILITY

All HFS 9000 channels have independent, wide deskew ranges to allow precise pulse alignment and timing at the device under test (DUT). Deskew compensates for the timing differences caused by cabling and fixturing so your analysis can be focused on the relative timing at the DUT.

1 ps TIMING RESOLUTION

No other system lets you generate whatever combination of signals is required, with data and timing on every pin with 1 ps resolution. Now you can create data buses, clocks, strobes, gated clocks, logic level sources, pseudorandom bits and other stimuli with unequaled accuracy. You can perform setup and hold time margin tests by providing the clock, data, set and reset signals to the DUT. And you can hold inactive signals at programmable high or low logic levels, eliminating the need for external DC voltage sources and microwave switches.

630 MHz REPETITION RATE

Accurate and repeatable AC measurements of prop delay, setup and hold time, and maximum operating frequency (fmax) require fast rep rates and edge speeds. With repetition rates up to 630 MHz, the HFS 9000 is ideal for characterizing the most advanced logic families, and it can be used for testing component compliance with the SONET telecommunications standard. Transition times as fast as 250 ps (20%-80%) enable repeatable and accurate testing of the highest-speed ECL and GaAs digital devices. Variable transition time control from 800 ps to 6 ns is also available with the appropriate output levels for testing advanced CMOS, BiCMOS and TTL logic families.

FULLY PROGRAMMABLE

Programmability is important in developing automated, repeatable tests in R&D, incoming inspection and production of high-speed components. Therefore, the HFS 9000 offers full implementation of the IEEE 488.2 standard and utilizes Tektronix Codes and Formats. GPIB/RS-232 ports provide for remote, fully programmable control. Coupled with a high-speed acquisition system, such as the TDS694D DSO, 11801B Digital Sampling Oscilloscope, or the most advanced logic analysis system on the market – the Tektronix TLA700, a fully automated test system can be developed with unequaled accuracy and repeatability.

PHASE LOCK MODE

Phase lock-in allows the internal time base to be phase-locked to an external frequency source. This "supercharger" capability can be used to augment the speed performance of automated component test systems by creating synchronized signals as fast as 630 MHz.

CONFIGURATION OPTIONS

Card-modular design lets you adapt to any logic family from within the same mainframe. Choose the HFS 9DG1 Data Time Generator card for 630 MHz bandwidth and ≤250 ps fixed rise time. The 9DG1 provides four channels of stimulus. This card is ideal for ECL and GaAs device characterization.

Or, choose the HFS 9DG2 Data Time Generator card for up to 315 MHz bandwidth and variable transition times from 800 ps to 6 ns. The 9DG2 provides four channels of stimulus. This card is ideal for simulating TTL, CMOS and BiCMOS logic signals.

Combine these cards in any combination for testing a broad range of components or systems with mixed logic families.

APPLICATIONS

From verifying critical parameters to full characterization, from developing manufacturing test vectors on the bench to phase-locked at-speed testing in conjunction with production test systems, the HFS 9000 Data Time Generator simplifies the process while adding unmatched capabilities. You can, for example, create complex stimuli that are impossible with other systems. Download test vectors and timing parameters to the HFS 9000 to set up worst-case conditions and to stimulate each pin in isolation. Vary voltage levels, pulse widths and timing relationships independently for each channel. Mix high-speed and variable transition time modules to fit your logic family and obtain channel counts unavailable in any other discrete instrument.

The Data Time Generator also provides a new dimension of assistance in characterizing pattern sensitivity. It provides the data stream while also creating the varying signal levels, timing relationships or signal characteristics required to detect pattern sensitivity across worst-case operating conditions.

Capabilities like these allow you to perform full characterizations on the first run, lowering your development costs and reducing your time to market.

CHARACTERISTICS

Level Resolution – 0.01 V.
HIGH Level Accuracy – ±2% of level ±50 mV.
LOW Level Accuracy – ±2% of HIGH level ±2% of amplitude ±50 mV.
Output Aberrations (200ps after 50% pt.) – Overshoot: +15% +20 mV.Undershoot: –10% –20 mV.

TIME BASE PERFORMANCE

Frequency Range – 50 kHz to 630 MHz.
Frequency Resolution – ≤0.1% of programmed value.
Frequency Accuracy – ±1% of programmed value.
RMS Jitter – 15 ps ±0.05% of interval.
PHASE LOCK IN Frequency Range – 6 MHz to 630 MHz.
PHASE LOCK IN Amplitude Range – 0.8 V to 1.0 V_{p-p}.
Output Frequency Range – any 2^n multiple or submultiple of PHASE LOCK IN frequency. Must remain inside the allowed frequency range for installed cards.
FRAME SYNC IN – Initiates a burst when using PHASE LOCK IN external frequency reference.

OUTPUT EDGE PLACEMENT PERFORMANCE

Channel Deskew Range – Minus 60 ns to 2.0 µs.
Channel Deskew Resolution – 1 ps.
DELAY Adjust Range – 0 to 20 µs.
DELAY Adjust Resolution – 1 ps.
DELAY Accuracy – 1% ±50 ps.
WIDTH Adjust Range – 0 to 65,536 x one period.
WIDTH Adjust Resolution – 1 ps.
WIDTH Accuracy – HFS 9DG1: 1% of width ±50 ps; HFS 9DG2: 1% of width +50 ps –250 ps.

OUTPUT PERFORMANCE

	HFS 9DG1	HFS 9DG2
Outputs	4 differential	4 single-ended
Maximum HIGH level	+5.00 V	+5.50 V
Minimum LOW level	-2.50 V	-2.00 V
Max p-p amplitude	3.00 V	5.50 V
Min p-p amplitude	0.01 V (10 mV)	0.01 V (10 mV)
Output transition time (20% to 80%)	≤250 p (≤1 V_{p-p})	variable (800 ps to 6 ns)

TRIGGER INPUT PERFORMANCE

Input Resistance – 50 Ω.
Input Voltage Range – ±5 V maximum.
Programmable Threshold Range – 4.70 V to +4.70 V.
Programmable Threshold Resolution – 100 mV.
Programmable Threshold Accuracy – ±100 mV ±5% of level.
Minimum Input Pulse Width – 1 ns.
Input Rise/Fall Time Requirement – ≤10 ns.
Sensitivity – ≤500 mV.

POWER REQUIREMENTS

Line Voltage Ranges – 90 V AC to 130 V AC RMS, and 180 V AC to 250 V AC RMS; range switched automatically for HFS 9003 (factory configured for HFS 9009).
Line Frequency – 48 Hz to 63 Hz.

POWER CONSUMPTION –

	HFS 9003	HFS 9009
Maximum	540 W	900 W
Typical	400 W	750 W

ENVIRONMENTAL

Temperature – Operating: 0° to +50°C (HFS 9003); 0° to +40°C (HFS 9009). Non-operating: –40° to +75°C.
Humidity – 10°C to +30°C up to 95% relative humidity. 30°C to 40°C up to 75% relative humidity.
Altitude, Shock non-operating, Bench Handling – C Meets MIL-T-28800 Type III, Class 5.

PHYSICAL CHARACTERISTICS

HFS 9003	Cabinet	
Dimensions	**mm**	**in.**
Width	414	16.3
Height	178	7
Depth	629	24.75
Weight*[1];	**kg**	**lbs.**
Net	20.5	45
Shipping	27.3	60

*[1] Maximum configuration.

HFS 9009	Cabinet	
Dimensions	**mm**	**in.**
Width	426	16.75
Height	356	14
Depth	610	24
Weight	**kg**	**lbs.**
Net	36.8	81
Shipping	45.5	100

HFS 9DG1, HFS 9DG2	Cabinet	
Dimensions	**mm**	**in.**
Width	51	2
Height	267	10.5
Depth	356	14
Weight	**kg**	**lbs.**
Shipping	1.36	3

ORDERING INFORMATION

For price information: Outside the U.S. contact your local Tektronix representative, inside the U.S. see the price list in the back of this catalog.

HFS 9003
3-Slot Mainframe.
Includes: Traceable Calibration Certificate; User Reference Manual; Service Reference Manual; Power Cord; RS-232 Pigtail; SMA-BNC Adapter; Zip-Lock Pouch; Two Replacement Fuses; and One 50 Ω SMA Coaxial Cable.
Opt. 1R – Rackmount.
Opt. D1 – Calibration Data Report

HFS 9009
9-Slot Mainframe.
Includes: Traceable Calibration Certificate; User Reference Manual; Service Reference Manual; Power Cord; RS-232 Pigtail; SMA-BNC Adapter; Zip-Lock Pouch; Two Replacement Fuses; and One 50 Ω SMA Coaxial Cable.
Opt. D1 – Calibration Data Report.

ACCESSORIES
See page 495 for Cables, Adapters, and Terminators.

HFS 9DG1
Four differential data time outputs per card with ≤250 ps transition time, 630 MHz.
Includes: Installation Instructions and Two Clock Cables.

HFS 9DG2
Four single-ended data time outputs per card with 800 ps to 6 ns variable transition time.
Includes: Installation Instructions and Two Clock Cables.

S85HFS1
BitWriter® Software.

INTERNATIONAL POWER PLUGS
Opt. A1 – Universal Euro 220 V, 50 Hz.
Opt. A2 – United Kingdom 240 V, 50 Hz.
Opt. A3 – Australian 240 V, 50 Hz.
Opt. A4 – North American 240 V, 60 Hz
Opt. A5 – Switzerland 220 V, 50 Hz
See page 619 for description.

MEASUREMENT SERVICE OPTIONS
Opt. C3 – Three years of Calibration Services.
Opt. D1 – Cal Data Report.
Opt. D3 – Test Data (requires Opt. C3).
Opt. R3 – Repair warranty extended to cover three years.

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

NOT AVAILABLE IN EUROPE.

ISO 9001
Tektronix measurement products are manufactured in ISO registered facilities.

GPIB IEEE-488
Product(s) complies with IEEE Standard 488.1-1987, and with Tektronix Standard Codes and Formats.

Data Pattern Generator

New DG2040 • DG2030 • DG2020A • P3410/P3420



Features – Benefits

- Data Rate to 1.1 Gbps Tests High-speed Logic Devices and Circuits
- Data Pattern Depth to 256 k/channel Speeds Characterization
- Multiple Output Channels Increases Flexibility
  - DG2040: 2
  - DG2030: 4 or 8
  - DG2020A: 12, 24, or 36
- Control of Edge Timing (DG2040) Permits Jitter Simulation in Serial Data Streams
- Precise Control of Output Parameters
- Fast Transition Times to 150 ps (DG2040) Aids Fast Logic Evaluation
- Complementary Output (DG2040) Assures Excellent Signal Fidelity
- Flexible Sequence Control with Jump, Event, and Nested Loops
- Large Display for Easy-to-Use Data Editing
- Import Pattern Data with DG-Link Software Utility

Applications

- Ultra Low Jitter for Clock Substitution
- Characterize Device Timing for TTL, CMOS, ECL Families
- Create Complex Data Patterns with Sophisticated Sequence, Looping, Jump on Event, & Tri-state Output Control
- Characterize & Verify ASIC, FPGA, & DACs
- Evaluate Media Storage Devices and Components (HDD, FDD, ODD, DVD)
- Test Printer Engines or LCD Display Drivers
- Construct Logic Verification Systems utilizing Tektronix Oscilloscopes or Logic Scopes
- Use in Conjunction with TLA Logic Analyzer to Provide Digital Stimulus

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

CE

GPIB IEEE-488

SONY Tektronix

ISO9002 Certified JMI-0113

The DG2000 Series of digital pattern generators provide digital designers with the high performance tools needed to evaluate advanced digital semiconductors and logic circuits. Whatever you call your design process – characterization, debug, validation, or verification – as a digital designer you must have state-of-the-art digital pattern generation as you push the edge of the technology envelope and race to market.

CHOOSE THE BEST FIT

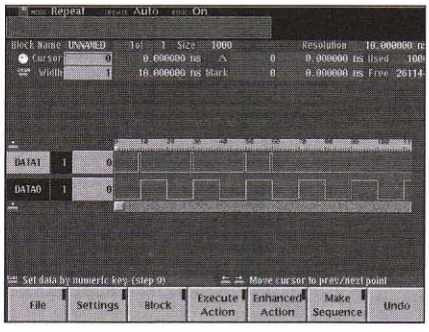
The DG2000 Series is remarkable for the balanced approach to providing the appropriate class of instrument for a wide variety of digital design applications. Performance ranges from 1.1 Gbits per second to 200 Mbits per second and from 2 to 36 channels. The table illustrates the principal specifications for members of the DG2000 Series.

CRITICAL TIMING

The DG2000 Series is the ideal solution for applications where you must characterize device or circuit timing and amplitude margins. The DG2000 Series is perfect for simulating setup and hold violations or conditions of metastability. The DG2000 graphical user interface allows you to quickly create complex data patterns with

	DG2040	DG2030	DG2020A
Data Rate	1.1 Gbps	400 Mbps	200 Mbps
Pattern Depth	256 k/ch.	256 k/ch.	64 k/ch.
Rise & Fall Time (20% to 80%)	150 psecs	1.5 ns at 2.5 V_{p-p}	2 ns
No. of channels	2	4 or 8	12, 24 or 36
Features	Edge control	Variable tr & tf time	Bus wide testing

a few keystrokes on the front panel. Use the advanced sequence editing capability of the DG2000 Series to insert infrequent faults or glitches in your data patterns to verify device or circuit recovery. The DG2000 Series is an invaluable tool, allowing you to simulate missing system functionality while meeting critical market windows. With the introduction of the DG2040, new capabilities are available to control clock and data jitter or modulate pulse edges on a selective basis.



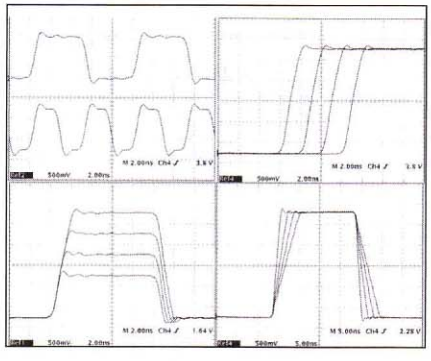
The DG2040 allows specific edges to be identified and time adjusted or jittered by ± 100 ps. An external modulation source can be used to provide continuously variable jitter.

EXCELLENT SIGNAL FLEXIBILITY

Each DG2040 complementary output generates data rates up to 1.1 Gbps. The DG2040 defines high performance with ≤150 ps transition times, 10 ps delay timing resolution and programmable output levels of 250 mV_{p-p} to 2.5 V_{p-p} (–1.125 mV to +3.5 V) in 5 mV steps. Pattern edges can be moved ± 100 ps in 5 ps steps or modulated by an external source. SMA connectors are used for each complementary output channel and clock output. Figure 2 illustrates a number of adjustable signal parameters.

The DG2030 offers data rates up to 400 Mbps on four or eight output channels with independently programmable timing delay with 20 ps resolution. Each channel provides variable output level of 250 mV_{p-p} to 5 V_{p-p} (–1.5 V to +3.5 V) in 5 mV steps. Front panel BNC connectors are used for each channel.

The DG2020A outputs data at rates up to 200 Mbps with 64 k data word length on up to 36 channels (12 standard) in 12-channel increments with 100 ps timing control. The P3410 output pod provides TTL-level signals from a pin-header connector. The P3420 variable output pod provides 500 mV_{p-p} to 9 V_{p-p} (–3 V to 7 V) in 100 mV steps. SMB connectors are used for each channel. The P3420 is capable of sourcing >30 mA current per channel – enough for your most demanding applications.

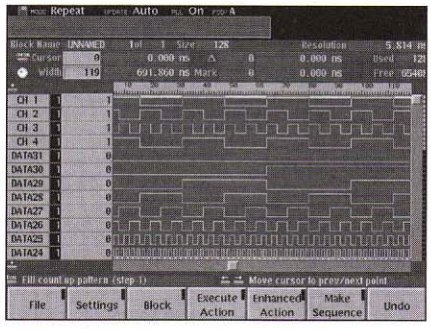


Modify timing & pulse parameters such as level, delay, and transition time.

PATTERN EDITING

The DG2000 Series is for the serious digital designer who create their own digital patterns or rely on a logic simulator to supply digital vectors. A large graphical display simplifies data entry and editing functions allowing the user to easily view and shape large segments of the data pattern. A wide variety of commonly used data patterns are built into the data editor to further simplify data creation. Built-in data functions include counters, shift registers, serial data converters, and clocks.

Easy to use menu driven editing functions are provided to define data bit, cursor location, and data width. Data can be manipulated at the bit, byte, or word level. Various functions such as data cut/copy/paste/ invert, magnify, insert, delete are supported as are data shift, add, and rotate. Advanced functions are used to create clock patterns and PRBS data. A variety of data presentations are available to clearly illustrate the data pattern including table, timing, binary, and numeric.



Examples of data entry displays. Data is entered easily as hex data or diagrammatically.

PATTERN SEQUENCING

All members of the DG2000 Series combine deep memory with advanced data flow sequencing to provide the designer with a flexible digital stimulus source.

Pattern sequencing is a capability that can extend the deep DG2000 Series pattern memory almost to infinity. Sequencing allows segments of pattern memory to be looped or repeated until some internal or external event occurs when pattern execution then continues. Each line in the sequence list can be controlled by an external event that can cause a jump to a different block of data. The DG2000 Series can have up to 4000 jumps at full clock rates. External event and inhibit Input signals are also used to control the flow and impedance of the DG2020A and DG2030 output.

IMPORT DATA

Tektronix' DG-Link software accessory imports data from Tektronix TDS oscilloscopes, TLS logic scopes, or TLA logic analyzers for use as data pattern

sources by the DG2000 Series. Logic simulators that output Comma Separated Value (CSV) format can also be used as a source file for DG-Link and downloaded into the DG2000 Series.

CHARACTERISTICS

OUTPUT DATA

Data Rate –
DG2040: 0.1 bps to 1100 Mbits/s.
DG2030: 0.1 bps to 409.6 Mbits/s.
DG2020A: 0.1 bps to 200 Mbits/s.

Sampling Rate –
DG2040: 0.1 Hz to 1100 MHz.
DG2030: 0.1 Hz to 400 MHz.
DG2020A: 0.1 Hz to 200 MHz.

Resolution –
DG2040: 7 digits.
DG2030: 7 digits.
DG2020A: 4 digits.

Clock Period Jitter –
DG2040: ≤ 30 ps p-p at 1100 MHz. Typical.
DG2030: ≤50 ps p-p at 200 MHz. Typical.
DG2020A: ≤50 ps p-p at 200 MHz. Typical.

Accuracy –
DG2040: PLL On, ±0.0001%.
DG2030: PLL On, ±0.0001%; PLL Off, ±3%.
DG2020A: PLL On, ±0.005%; PLL Off, ±3%.

Data Depth –
DG2040: 360 to 256 kbits (1 increment).
DG2030: 90 to 256 kbits (1 increment).
DG2020A: 64 to 64 kbits (1 increment).

Data Width –
DG2040: 2-Bits (complementary outputs) via front-panel SMA connectors.
DG2030:
- Standard: 4-Bits via front-panel BNC connectors.
- Optional: 8-Bits via 4 front-panel, 4 rear-panel BNC connectors.

DG2020A:
- Standard: 12-Bits.
- Optional: 24– or 36-Bits.

SEQUENCER

Maximum Number of Blocks – 256.
Maximum Number of Sequence Steps –
DG2040: 4000.
DG2030: 4000.
DG2020A: 2048.

Block Repeats Per Line – 1 to 65536 or infinite.

INTERNAL TRIGGER GENERATOR (DG2030, DG2040)

Range – 1.0 µs to 10.0 s.
Resolution – 3 digits, 0.1 µs minimum.
Accuracy – ±0.01%.

DATA AND CLOCK OUTPUT (DG2040)

Data –
Output:
- Standard: CH 0 & CH 1 at front-panel SMA and Clock at rear panel SMA connectors.

V_{OH}: –0.875 V to +3.5 V into 50 Ω.
V_{OL}: –1.125 V to +3.25 V into 50 Ω.
Resolution: 5 mV.
Maximum Swing: 2.5 V_{p-p} into 50 Ω.
Minimum Swing: 250 mV_{p-p} into 50 Ω.
DC Accuracy: ±3% of set value ± 50 mV.
Aberrations: Overshoot ≤5% at 1.5 V_{p-p} at 10 MHz.
- Undershoot ≤ 5% ± 1.5 V_{p-p} at 10 MHz.

Impedance: 50 Ω.
Rise/Fall Time (20 to 80%): ≤ 150 ps at 1 V_{p-p} and 10 MHz.
Delay Function:
- Delay channel: CH 0 or CH 1.
- Delay time: –1 ns to +2 ns.
- Delay resolution: 10 ps.
- Accuracy: ≤ (± 3% of setting) ± |25°C – Ta| * 15 ps ±100 ps (where Ta is the ambient temperature °C).

Channel Skew: (≤ ± |25°C – Ta|* 15 ps ±100 ps) where Ta is the ambient temperature °C.

DATA AND CLOCK OUTPUT (DG2030)

Data –
Output:
- Standard: CH 0 to CH 3 and Clock at front-panel BNC connectors.
- Optional: CH 4 to CH 7 at rear-panel BNC connectors.

V_{OH}: –1.25 V to +3.5 V into 50 Ω.
V_{OL}: –1.50 V to +3.25 V into 50 Ω.
Resolution: 5 mV.
Maximum Swing: 5 V_{p-p}.
Minimum Swing: 250 mV_{p-p}.
DC Accuracy: (±3% of set value) ± 50 mV.
Aberrations: ≤5% at 3.5 V_{p-p}.
Impedance: 50 Ω.
Rise/Fall Time (20 to 80%): Variable at amplitude range from 2 V_{p-p} to 5 V_{p-p}.
- Variable Range: 2.1 ns to 4.7 ns at 3.00 V_{p-p} – depends on amplitude setting.
- Value in Fast: 0.25 V_{p-p} to 1 V_{p-p}; 500 ps. 1.7 ns at 3.00 V_{p-p}.
- Accuracy: ±10% of setting ±500 ps.

Delay Function:
- Delay channel: CH 0 to CH 7.
- Delay time: –5 ns to 18 ns.
- Delay resolution: 20 ps.
- Accuracy: ± 3% of set value ±500 ps ±60 ps (ambient temperature 25°C).

Channel Skew: ≤±300 ps (referenced to the clock output) at 10 MHz.
- De-skew Range: ±1 ns.
- Resolution: 10 ps.

Clock –
Amplitude: ±5% of setting ±50 mV at 1 MHz clock.
Aberration: ≤5% at 3.5 V_{p-p}.
Impedance: 50 Ω.
Rise/Fall Time (20 to 80%): Variable at amplitude range is 2 V_{p-p} to 5 V_{p-p}.
Variable Range: Depends on amplitude setting.
Value in Fast: 0.25 V_{p-p} to 1 V_{p-p}; 500 ps. 1.7 ns at 3.00 V_{p-p}.
Accuracy: ±10% of setting ±500 ps.

AUXILIARY INPUTS

Clock –
DG2040: Rear-panel BNC connectors (10 MHz reference).
DG2030: Rear-panel BNC connector.
DG2020A: Rear-panel SMB connector.
Frequency:
- DG2040: 10 MHz ± 0.1 MHz
- DG2030: DC to 409.6 MHz.
- DG2020A: DC to 200 MHz.

DG2040 –
Input voltage range: 0.2 V to 3.0 V_{p-p}.
Input voltage level: ±10 V_{max}.
Impedance: 50 Ω, AC coupling.

DG2020A & DG2030 –
Impedance: 50 Ω, terminated to +0.5 V.
Delay to Clock Out: 36 ns (typical).

Trigger – Front-panel BNC connector.
Level: –5.0 V to +5.0 V.
Resolution: 0.1 V.
Threshold accuracy: ± (5% of setting) ± 0.1 V.
Minimum Pulse Width: ≥10 ns.
Sensitivity: >0.5 V_{p-p}.
Impedance: 1 kΩ or 50 Ω.
Maximum Input: ±10 V into 1 kΩ, ± 5 V into 50 Ω.
Polarity: Positive or negative.
Hold Off:
- DG2040: 100 ns minimum.
- DG2030: 100 ns minimum.
- DG2020A: 500 ns minimum.

Event (DG2040 & DG2030 only) – Rear-panel BNC connector.
Threshold Level: –5.0 V to +5.0 V.
Resolution: 0.1 V.
Set-up Time to Next Block:
DG2040: 230.5 to 254.5 clocks before the next block.
DG2030: 48 to 53 clocks before the next block.
Polarity: Positive edge.
Minimum Pulse Width: 100 ns.

Inhibit (DG2030 only) – Rear-panel BNC connector.
Mode:
Off: Always enabled.
Internal: Controlled by CH 0 signal.
External: Controlled by inhibit input signal.
Both: Controlled by Ch-0 or inhibit input signal.
Threshold Level: –5.0 V to +5.0 V into 1 kΩ.
Resolution: 0.1 V.
Delay to Data Output: 34 ns to 38 ns (typical).
Delay to Clock Output: 7 ns to 11 ns (typical).

AUXILIARY OUTPUTS

SYNC –
DG2040: Rear-panel BNC connector.
DG2030: Rear-panel BNC connector.
DG2020A: Front-panel BNC connector.
Level:
V_{OH}, 2.5 V into 50 Ω; V_{OL}, 0 V into 50 Ω.
Pulse width:
DG2040: 32 to 36 clocks.
DG2030: 9 or 10 clocks.
DG2020A: 6 clocks.
Impedance: 50 Ω.

EVENT –
DG2040: Rear-panel BNC connector.
DG2030: Rear-panel BNC connector.
DG2020A: Front-panel BNC connector.
Level:
DG2040: V_{hi}, 2.5 V into 50 Ω; V_{lo}, 0 V into 50 Ω.
DG2030: V_{oh}, 2.5 V into 50 Ω; V_{ol}, 0 V into 50 Ω.
DG2020A: Positive TTL pulse, 50 Ω.
Output Term:
DG2040: 180 to 200 clocks.
DG2030: 45 to 50 clocks.
DG2020A: 8 clocks.
Delay Time:
DG2040: 194.5 to 214.5 clocks before data output change.
DG2030: 48 to 53 clocks before data output change.
DG2020A: 22 clocks before data output change.
Impedance: 50 Ω.

CLOCK –
(DG2020A only)
Rear-panel SMB connector.
Level: 1 V (typical) into 50 Ω.
Delay From Trigger Input:
PLL On:
>6.25 MHz: 15 to 40 ns.
≤6.25 MHz: 25 to 60 ns.
PLL Off:
>6.25 MHz: 15 to 45 ns.
≤6.25 MHz: 25 to 60 ns.
External: 7 ns + 1 clock to 20 ns + 0.5 clock.

PROGRAMMABLE INTERFACE

GPIB: ANSI/IEEE 488.2-1987.
RS-232C: 19.2 kbps, D-sub 9-Pin connector.

P3410 TTL DATA OUTPUT POD CHARACTERISTICS

DATA OUTPUT

Channels – 12.
Connector – 26-Pin header.
V_{OH} – >4.4 V into 1 MΩ.
V_{OL} – >0.1 V into 1 MΩ.
Rise/Fall Time – ≤5 ns into 1 MΩ, 10 pF (20% to 80%).
Internal Clock Out to Data Delay – 24 ns.
External Clock Input to Data Output Delay – 25 to 45 ns.
Trigger Input to Data Output Delay –
Internal Clock:
>6.25 MHz: 30 to 65 ns.
≤6.25 MHz: 45 to 80 ns.
External Clock: 25 ns + 0.5 clock to 45 ns + 1.5 clock.

DELAYED CHANNELS

Delay Channel – CH 8, CH 9, CH 10, CH 11.
Delay Time – 0 to 20 ns.
Delay Resolution – 0.1 ns.
Channel Skew –
CH 0 and Other Channels, Same Pod: ≤3 ns.
CH 0 and CH 0, Two Pods of Same Type: ≤2 ns.

EVENT INPUT

Threshold Level – TTL.
Delay to Data Output – ≤ 50 ns + 50 clocks.
Set-up Time to Next Block – 47 to 54 clocks.

INHIBIT INPUT

Level – TTL, 1 kΩ.
Delay to Data Output – 18 ns.
Internal Inhibit Delay – 5 ns.

PHYSICAL CHARACTERISTICS

Dimensions	mm	in.
Height*[1]	51	2
Width	150	5.9
Depth	101	4
Weight	**kg**	**lb.**
Net	0.5	1.1

*[1] *Including feet.*

P3420 VARIABLE DATA OUTPUT POD CHARACTERISTICS

DATA OUTPUT

Channels – 12.
Connector – SMB.
V_{OH} – -2.0 V to +7.0 V into 1 MΩ.
V_{OL} – -3.0 V to +6.0 V into 1 MΩ.
Resolution – 0.1 V.
Maximum Swing – 9.0 V_{p-p}.
Minimum Swing – 0.5 V_{p-p}.
Output Current –
Total Output Current: ≤500 mA.
Sink: ≤-30 mA/ch.
Source: >+30 mA/ch.
Rise/Fall Time – ≤5 ns into 1 MΩ, 10 pF, 5 V_{p-p} swing.
Internal Clock Out to Data Delay – 20 ns.
External Clock Input to Data Output Delay – 20 to 40 ns.
Trigger Input to Data Output Delay –
Internal Clock:
>6.25 MHz: 30 to 60 ns.
≤6.25 MHz: 40 to 70 ns.
External Clock: 20 ns + 0.5 clock to 40 ns + 1.5 clock.

DELAYED CHANNELS

Delay Channel – CH 8, CH 9, CH 10, CH 11.
Delay Time – 0 to 20 ns.
Delay Resolution – 0.1 ns.
Channel Skew –
CH 0 and Other Channels, Same Pod: ≤3 ns.
CH 0 and CH 0, Two Pods of Same Type: ≤2 ns.

EVENT INPUT

Threshold Level – -5.0 V to +5.0 V.
Resolution – 0.1 V.
Delay to Data Output – ≤ 45 ns + 50 clock.
Set-up Time to Next Block – 47 to 54 clocks.

INHIBIT INPUT

Threshold Level – -5.0 V to +5.0 V, 1 kΩ.
Resolution – 0.1 V.
Delay to Data Output – 16 ns.
Internal Inhibit Delay – -2 ns.

PHYSICAL CHARACTERISTICS

Dimensions	mm	in.
Height*[1]	51	2
Width	255	10
Depth	161	6.3
Weight	**kg**	**lb.**
Net	1	2.2

*[1]*Including feet.*

GENERAL CHARACTERISTICS

ENVIRONMENTAL

Temperature –
Operating: +10°C to +40°C.
Nonoperating: –20°C to +60°C.

Humidity –
Operating: 20% to 80% (no condensation).
Nonoperating: 5% to 90% (no condensation).

Altitude –
Operating: Up to 4.5 km (15,000 ft.).
Nonoperating: Up to 15 km (50,000 ft.).

Vibration –
Operating: 0.33 mm p-p, 10 to 55 Hz, 15 minutes.

Shock –
Nonoperating: 294 m/s^2 (30 g), half-sine, 11 ms duration.

CERTIFICATION AND COMPLIANCE

EC Declaration of Conformity – Meets intent of Directive 89/336/EEC for electromagnetic compatibility.
Safety – UL1244, CSA231, EN61010-1, IEC61010-1.

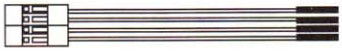
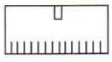
POWER

AC Line Power –
Voltage Ranges: 90 to 250 VAC.
Nominal Voltage: 100 V, 115 V, 200 V, 230 V, 240 V.
Line Frequency:
90 to 250 VAC: 48 to 63 Hz.
90 to 127 VAC: 48 to 440 Hz.

Power Consumption – 300 W maximum.

Maximum Current – 4 A.

DG2020A/P3410/P3420 AND DG2030 OPTIONAL ACCESSORIES

ITEM	DESCRIPTION	PART NUMBER
	40-inch (101.6 cm) BNC-to-BNC cable	012-0057-00
	40-inch (101.6 cm) 50 Ohm SMB-to-SMB Cable	012-1458-00
	40-inch (101.6 cm) 50 Ohm SMB-to-BNC Cable	012-1459-00
	50-inch (127 cm) 50 Ohm SMB-to-Pin Header Cable.	012-1506-00
	7.5-cm One Channel Lead Set (set of 5)	012-1508-00
	12-cm Four Channel Lead Set (set of 3)	012-1509-00
	50 Ohm SMB Female-to-BNC Male Adapter	015-0671-00
	Pin Header Connector, 26 Pins	139-5919-00

PHYSICAL CHARACTERISTICS

DG2000 Series Main Frame

Dimensions	mm	in.
Height*[1]	164	6.4
Width*[2]	362	14.3
Depth*[3]	491	8.25

*[1]*Including feet.*
*[2]*Including handle.*
*[3]*Including front cover. 576 mm (22.2 inches) with handle extended.*

Weight	kg	lb.
Net	9.7	21.4

WARRANTY

One year parts and labor.

Characteristics shown are typical. Please refer to individual product user manuals for complete specifications.

ORDERING INFORMATION

For price information: Outside the U.S. contact your local Tektronix representative, inside the U.S. see the price list in the back of this catalog.

DG2020A DATA GENERATOR

Includes: User Manual (071-0053-00), Programmer Manual (071-0054-00), 3.5-in. Performance Check Disk (063-2198-00), GPIB Sample Program (063-2919-00), DG-Link Application Software (063-2920-01), Pod Connection Cable (174-3548-00), Power Cord 125 V/6 A (161-0230-01), ISO-qualified Inspection Passed Certificate. Order P3410 or P3420 Pod separately.

DG2020A OPTIONS

Opt. 01 – Adds a 12-bit digital port for a total of 24 output channels. Includes pod connection cables (174-3458-00). Order P3410 or P3420 pod separately.

Opt. 02 – Adds two 12-bit digital ports for a total of 36 output channels. Includes two pod connection cables (174-3458-00). Order P3410 or P3420 pod separately.

Opt. 1R – Rack mount. Floppy drive moved to front panel.

INTERNATIONAL POWER PLUGS

Opt. A1 – 220V, EURO plug power cord, product set to 50 Hz.

Opt. A2 – 240V, UK plug power cord, product set to 50 Hz.

Opt. A3 – 240V, AUST plug power cord, product set to 50 Hz.

Opt. A4 – 240V, N. America plug power cord, product set to 60 Hz.

Opt. A5 – 220V, SWISS plug power cord, product set to 50 Hz.

See page 619 for description.

MEASUREMENT SERVICE OPTIONS

Opt. C3 – Three years of Calibration Services.

Opt. D1 – Cal Data Report.

Opt. D3 – Test Data (requires Opt. C3).

Opt. R3 – Repair Warranty; Extended to three years.

P3410 TTL-LEVEL POD WITH 12 OUTPUT CHANNELS

Includes: Pin Header-to-Pin Header Output Cable Set (012-1502-00) for 12 Output Channels, ISO Qualified Inspection Passed Certificate.

P3420VARIABLE-LEVEL POD WITH 12 OUTPUT CHANNELS

Includes: SMB-to-Pin Header Output Cable Set (012-1504-00) for 12 output channels, ISO Qualified Inspection Passed Certificate.

P3410 AND P3420 OPTIONS

Opt. D1 – Calibration Data Report.

Opt. R3 – Repair Warranty; Extended to three years.

DG2030 DATA GENERATOR

Includes: User Manual (071-0059-01), Programmer Manual (071-0057-01), 3.5-in. Performance Check Disk (063-2922-00), GPIB Sample Program Disk (063-2921-01), DG-Link Application Software (063-2920-01), Power Cord 125 V/6 A (161-0230-01), ISO Qualified Inspection Passed Certificate.

DG2030 OPTIONS

Opt. 01 – Eight-channel output. Adds four-channel output from rear panel.

Opt. 1R – Rack mount. Floppy Drive access moved to front panel.

MEASUREMENT SERVICE OPTIONS

Opt. C3 – Three years of Calibration Services.

Opt. D1 – Cal Data Report.

Opt. D3 – Test Data (requires Opt. C3).

Opt. R3 – Repair Warranty; Extended to three years.

DG2040 DATA GENERATOR

Includes: User Manual (071-0257-00), Programmer Manual (071-0258-00), 3.5-in. Performance Check Disk (063-3121-00), GPIB Sample Program Disk (063-3122-00), DG-Link Application Software (063-2920-01), Power Cord 125 V/6 A (161-0230-01), ISO Qualified Inspection Passed Certificate.

DG2040 OPTIONS

Opt. 1R – Rack mount. Floppy Drive access moved to front panel.

INTERNATIONAL POWER PLUGS

See page 619 for description.

MEASUREMENT SERVICE OPTIONS

Opt. C3 – Three years of Calibration Services.

Opt. D1 – Cal Data Report.

Opt. D3 – Test Data (requires Opt. C3).

Opt. R3 – Repair Warranty; Extended to three years.

DG2020A/DG2030/DG2040 OPTIONAL ACCESSORIES

DG2020A Service Manual – Order 071-0055-00.

DG2030 Service Manual – Order 071-0058-01.

DG2040 Service Manual – Order 59-00.

DG2020A Twelve-Channel Upgrade Kit (Provides same function as DG2020A Opt. 01) – Order 040-1556-00.

SMB-to-Pin Header Cable (20 in.) – Order 012-1503-00.

SMB-to-Pin Header Cable (50 in.) – Order 012-1506-00.

Pin Header-to-Pin Header Cable – Order 012-1505-00.

SMB-to-SMB Cable (40 in.) – Order 012-1458-00.

50 Ω BNC-to-BNC Cable (Single shield) – Order 012-1342-00.

50 Ω BNC-to-BNC Cable (Double shield) – Order 012-1256-00.

50 Ω BNC-to-SMB Cable (40 in.) – Order 012-1459-00.

50 Ω BNC Male-to-SMB Female Adapter – Order 015-0671-00.

One-channel Pin Lead Set (Set of 5) – Order 012-1508-00.

Four-channel Pin Lead set (Set of 3) – Order 012-1509-00.

GPIB Cable – Order 012-0991-00.

Connector (for pin-header) – Order 131-5919-00.

GPIB Cable – Order 012-0991-00.

Replacement 1.2 m POD Connection Cable (Standard accessory) – Order 174-3548-00.

50 Ω SMA male to SMA male; 12 in. – Order 174-1364-00.

50 Ω SMA male to SMA male; 20 in. – Order 174-1427-00.

50 Ω SMA male to SMA male; 60 in. – Order 174-1428-00.

50 Ω SMA male to SMA male; 2m – Order 174-0679-00.

50 Ω SMA male to SMA male; 8.5 in. – Order 174-1120-00.

50 Ω SMA male to SMA male; 1m – Order 174-1341-00.

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

ISO 9001

Tektronix measurement products are manufactured in ISO registered facilities.

SONY Tektronix

ISO9002 Certified
JMI-0113

Bench and Handheld Test Instruments

Tektronix has a complete line of low-cost bench and handheld test instruments for both basic and advanced test benches: triple output power supplies, digital multimeters, function generators, and multifunction counter.

Instrument and operator safety are all-important. Tektronix Series instruments comply with independent safety certification standards.

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Bench Test Instruments Selection Guide

Model	Function	Key Specifications
AFG310	Arbitrary Waveform Generator	One channel, 16 MS/s, 12 bits, 10 Vp-p Arbitrary Function Generator
AFG320	Arbitrary Waveform Generator	Two channel, 16 MS/s, 12 bits, 10 Vp-p Arbitrary Function Generator
CDM250	DMM	Low Cost 3.5 digit, DC & AC Volts, Current, Ohms
CFG253	Function Generator	Small size, 3 MHz Sine, Square, Triangle & Sweep
CFG280	Function Generator	11 MHz waveforms with 100 MHz Frequency Counter
CMC251	Multi-Function Counter	Frequency measurement to 1.3 GHz features high stability TCXO
CPS250	Triple Output Power Supply	Two variable 0-20V 0.5A outputs plus Fixed 5V, 2A supply
PS2520G	Programmable Power Supply	One 0 to 6V, 0 to 3A and two 0V to 36V, 0 to 1.5A
PS2521G	Programmable Power Supply	One 0 to 6V, 0 to 5A and two 0V to 20V, 0 to 2.5A
PS280	Triple Output Power Supply	Two variable 0-30V 2.0 A outputs plus Fixed 5V, 3A supply
TR210	Troubleshooting Accessory	Utilizes Analog Signature Analysis in conjunction with the TDS 200 Series Oscilloscope

Handheld Test Instruments Selection Guide

Model	Function	Key Specifications
TX3, TX1	True RMS Multimeters	0.05% to 0.07% DC Accuracy, 50,000 Counts, Backlight, Dual Readout, Temperature Measurement, Store/Recall Data, Optional PC Interface (WSTRM)
DMM900 Series	True RMS Multimeters	0.06% to 0.2% DC Accuracy, 40,000 Counts, Backlight, Dual Readout, Temperature measurement
DMM200 Series	True RMS Multimeters	0.1% and 0.3% DC Accuracy, 4,000 and 3,200 Counts
DMM150 Series	Basic Multimeters	0.5% and 0.7% DC Accuracy, 3,200 Counts, Basic meter functions. Optional CMM150 converts the DMM150 into an AC clamp meter
J17/J18	Photometer	Light and Color Measurements

TR210 Huntron Tracker

Component Testing Accessory



Features – Benefits

Performs In-circuit Component Testing

Dual Channels Offer Unique Ability to Compare Known Good Board and UUT to Find Defects

Built-in Pulse Generator Tests Gate Fired Devices such as SCRs, TRIACs, Opto-couplers

Tests In-circuit CMOS, MOS, PLCs, Other Semiconductors, Resistors, Capacitors, Inductors, Coils

Applications

Maintain Motor Controllers, Robotic Systems and Programmable Logic Controls In-plant

Debug Engineering Prototypes

Discover Manufacturing Defects – Find Wrong Values, Mis-installed Components

Troubleshoot and Repair Circuit Boards Without Schematics

Test Components and Boards Without Power – Ideal for Catastrophic Failures

Find Intermittent Component Failures

Product(s) available through your local Tektronix Distributor listed in the back of this catalog.

CE

Now you can extend the power of your TDS 200 Series oscilloscope with the Tektronix TR210 Huntron Tracker.*[1] This remarkable device simplifies the testing of components while giving you a unique current-voltage analog signature on the TDS 200 oscilloscope screen. The TR210 Huntron Tracker and TDS 200 oscilloscope provide you an excellent combination for troubleshooting circuit boards in design, manufacturing or maintenance applications. The Tektronix TR210 Huntron Tracker provides advanced troubleshooting capabilities to simplify testing of most types of active and passive electronic components. A built-in pulse generator lets you troubleshoot gate-fired devices such as SCRs, TRIACs and opto-couplers. By energizing the gate, you can test the component in an active mode.

ANALOG SIGNATURE ANALYSIS

Since the TR210 is used while the power to the circuit-under-test is turned off, you avoid an accidental short that could cause further damage. It allows you to analyze the overall health of a solid-state component, which makes it perfect for finding leakage or substrate damage that has brought a circuit board or a complete system down prematurely. Because it can compare suspect components to known-good equivalents, it's also ideal for troubleshooting when documentation is missing or incomplete. The TR210 works by applying a current-limited AC signal across two points of a component. The current flow causes a vertical deflection of the TDS 200 oscilloscope display, while the voltage causes a horizontal deflection. Together, they give you a unique current-voltage "analog signature" that represents the overall health of the device-under-test. By analyzing each signature, you can quickly tell if a component is good, bad or marginal.

REAL-WORLD TROUBLESHOOTING CHALLENGES

The Tektronix TR210 is ideal for troubleshooting Programmable Logic Controls (PLCs). In troubleshooting multi-channel input modules, technicians frequently run into a damaged channel because the IC buffers, opto-couplers and drivers have been over-stressed. Using the built-in pulse generator, the TR210 quickly troubleshoots opto-couplers and other gate-fired devices, or simply compare the analog signature of one channel against another. You'll usually find problems where you see differences in signatures.

*[1] *Tracker is a registered trademark of Huntron Instruments, Inc.*

CHARACTERISTICS

Test Frequencies – 50 or 60 Hz, 200 Hz, 2,000 Hz.

Functions – Range Selection: Auto or Manual. High Range Lockout.

Compare-A-Trace – Adjustable (0.5 Hz to 5 Hz).

Pulse Generator –
Level: 0 V to 5 V.
DC Mode: +DC or –DC.
Pulse Mode: +Pulse, –Pulse, or both; adjustable duty cycle.

ENVIRONMENTAL, EMC, SAFETY

Temperature –
Operating: 0°C to +40°C.
Nonoperating: –50°C to +60°C.

Humidity –
Operating: 0 to 70% (per IEC 1010-1).

RANGES

Range	V_s (V_{pk})	Z_s (Ω)	Current (mA_{RMS})	P_{max} (mW)	P_{diode} (mW)
High	60	74 k	0.6	6	0.2
Medium 2	20	27 k	0.6	2	0.2
Medium 1	15	1.2 k	8.5	23	2
Low 2	10	54	132	232	33
Low *1	3	10 k	0.21	0.1	0.05

*1 *Low power setting.*

Altitude –
Operating: Up to 2000 m (6,600 ft.).
Nonoperating: Up to 15,000 m (50,000 ft.).

EMC – Directive 89/336/EC.

Safety Compliance – UL3111-1, CSA1010.1, EN61010-1.

POWER

Source Power –
Voltage Ranges: 100 VAC, 230 VAC.
Line Frequency: 50 or 60 Hz.

Power – 15 W maximum.

PHYSICAL CHARACTERISTICS

Dimensions	cm	in.
Height	6.2	2.45
Width	29.1	11.45
Depth	25.9	10.2
Weight	**kg**	**lb.**
Net	2.1	4.6

WARRANTY

One year parts and labor.

ORDERING INFORMATION

For price information: Outside the U.S. contact your local Tektronix representative, inside the U.S. see the price list in the back of this catalog.

TR210
Huntron Tracker.

Includes: Instruction Manual, One Set ATL25 Test Probes, Common Test Leads, Two Mini-clip Leads, U.S. Power Cord.

INTERNATIONAL POWER PLUGS
Opt. A1 – Universal Euro 220 V, 50 Hz.
Opt. A2 – UK 240 V, 50 Hz.
See page 619 for description.

TR210 RECOMMENDED ACCESSORIES
Black Ground Leads – Order 98-0043.*2
Blue Clip Leads – Order 98-0036.*2
Foot Switch – Order 98-0314.*2
18 in. Coaxial BNC Cable – Order 012-0076-00.
36 in. Coaxial BNC Cable – Order 012-1341-00.
42 in. Coaxial BNC Cable – Order 012-0057-01.

TR210 RECOMMENDED OSCILLOSCOPES
Tektronix TDS 210 60 MHz Digital Real-time™ Oscilloscope.
Tektronix TDS 220 100 MHz Digital Real-time Oscilloscope.

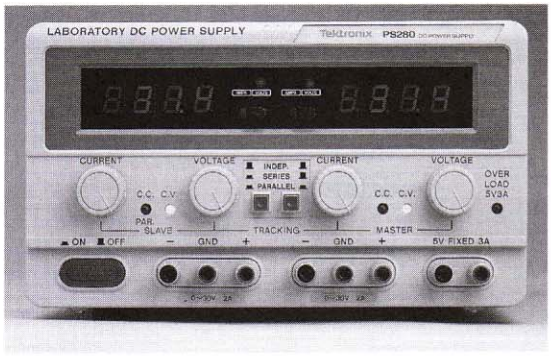
*2 *Available from:*
Huntron, Inc.
15720 Mill Creek Blvd.
Mill Creek, WA 98012
800 / 426-9265.

Product(s) available through your local Tektronix Distributor listed in the back of this catalog.

CE

Power Supply

PS 280



Features – Benefits

- Triple Output
- One Fixed 5 V, 3 A Supply
- Two Variable Outputs, 0 to 30 V, 2 A
- Variable Current Limiting
- Selectable Independent Tracking Mode
- Dual Tracking
- One Year Warranty

Applications

- Manufacturing Production Test
- Field Repair
- Bench Calibration and Repair
- Product Design
- Laboratory and Research
- Education/Training

Product(s) available through your local Tektronix Distributor listed in the back of this catalog.

CE

Product manufactured in ISO 9001 registered facilities.

The PS280 DC power supply is a multifunction benchtop or portable instrument. It is a regulated power supply that provides fixed 5 V output for powering logic circuits and two variable outputs for a wide range of test and experimental uses.

Characteristics

Output Voltage –
Two Variable: 0 to 30 VDC.
One Fixed: 5.0 V.

Output Current –
Two Variable: 0 to 2.0 A (CC).
One Fixed (foldback limited): 3.0 A max.

Line Regulation – Two Variable:
0.01% + 3 mV (CV); 0.2% + 3 mA (CC).
One Fixed: ≤ 5 mV (CV).

Load Regulation –
Two Variable: ≤ 0.01% + 5 mV, current > 3 A (CV);
≤ 300 mV 0 to 60 V single series tracking supply (CV),
0.2% + 3 mA (CC).
One Fixed: ≤10 mV (CV).

Ripple/Noise – Two Variable: ≤1 mV RMS, 5 Hz to 1 MHz (CV); ≤3 mA (CC).
One Fixed: ≤2 mV RMS.

Output in Independent Mode –
Two variable: 0 to 30 V (CV); 2.0 A (CC).

Output in Parallel Mode – One 0 to 30 V, 4.0 A max.
Tracking Error: ≤ 0.5% + 10 mV.

Series Mode – One 0 ±30 V, 2.0 A max or one 60 V, 2 A.
Tracking Error: ±0.5% +10 mV.

Displays – Two 3-1/2 digit LED (switchable) Indicators.
Overload Indicator: Yes.

Insulation –
Chassis to Terminal: ≥20 MΩ at 500 VDC.
Chassis to Power Cord: ≥30 MΩ at 500 VDC.

Safety – UL3111-1, CSA1010.1, EN61010-1, Denturi Mark.

(CC): When operated in Constant Current mode. (CV): When operated in Constant Voltage mode.

Ordering Information

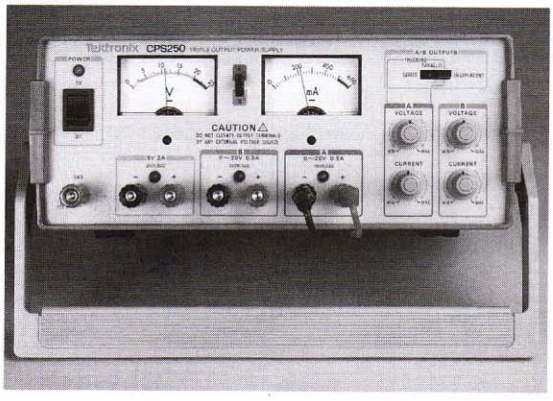
For price information:
Outside the U.S. contact your local Tektronix representative, inside the U.S. see the price list in the back of this catalog.

PS280 TRIPLE OUTPUT 0 TO 30 V/2 A POWER SUPPLY
Includes: Operator's Manual, 3 pairs of Test Leads, US Power Cord, One Year Warranty.

TEKTRONIX MEASUREMENT SERVICE
Tektronix CAL and REP Service programs allow you to prepurchase genuine Return to Tektronix Services – ask your Distributor for details.

Power Supply

CPS250



Features – Benefits

- One Fixed 5 V, 2 A Supply
- Triple Output
- Two Variable 0 to 20 V, 0.5 A Supplies
- Variable Current Limiting
- Overload Indicators
- One Year Warranty

Applications

- Manufacturing Production Test
- Field Repair
- Bench Calibration and Repair
- Product Design
- Laboratory and Research
- Education/Training

Product(s) available through your local Tektronix Distributor listed in the back of this catalog.

CE

Product manufactured in ISO 9002 registered facilities.

The CPS250 has a single fixed 5 V and 2 A supply and two variable 0 to 20 V, 0.5 A supplies.

Its compact design with tilt-bail handle takes up less bench space than most other power supplies, which makes it ideal for those no fuss fundamental supply needs.

Characteristics

Output Voltage –
Two Variable: 0 to 20 VDC.
One Fixed: 5.0 V.

Output Current –
Two Variable: 0 to 0.5 A (CC).
One Fixed (foldback limited): 2.0 A max.

Line Regulation –
Two Variable: 0.01% + 3 mV (CV); 0.2% + 3 mA (CC).
One Fixed: ≤10 mV (CV).

Load Regulation – Two Variable:
0.01% + 3 mV (CV); 0.2% + 6 mA (CC).
One Fixed: 0.1% + 5 mV (CV).

Ripple/Noise –
Two Variable: 2 mV RMS, 5 Hz to 1 MHz (CV); 3 mA RMS, 5 Hz to 1 MHz (CC).
One Fixed: 2 mV RMS.

Output in Independent Mode – Two variable 0 to 20 V (CV); 0.5 A (CC).

Output in Parallel Mode – One 0 to 20 V, 1.0 A max.
Tracking Error: ±0.2% ±20 mV.

Series Mode – One 0-40 V, 0.5 A max or one ±20 V, 0.5 A.
Tracking Error: ±0.2% ±20 mV.

Displays – Two analog meters (switchable).

Insulation –
Chassis to Terminal: >50 MΩ at 500 VDC.
Chassis to Power Cord: >50 MΩ at 500 VDC.

Safety Certification – UL3111-1, CSA1010.1, EN61010-1, T-MARK.

(CC): When operated in Constant Current mode. (CV): When operated in Constant Voltage mode.

Ordering Information

For price information:
Outside the U.S. contact your local Tektronix representative, inside the U.S. see the price list in the back of this catalog.

CPS250 TRIPLE OUTPUT POWER SUPPLY
Includes: Operator's Manual, 3 pairs of Test Leads, US Power Cord, One Year Warranty.

TEKTRONIX MEASUREMENT SERVICE
Tektronix CAL and REP Service programs allow you to prepurchase genuine Return to Tektronix Services – ask your Distributor for details.

Programmable Power Supplies

PS2520G • PS2521G



Features – Benefits	Applications
PS2520G	Training
Triple Output	Manufacturing Production Test
One 0 to 6 V, 0 to 3 A	Field Repair
Two 0 to 36 V, 0 to 1.5 A	Bench Calibration and Repair
Digital LED Output Indicator	Product Design
SCPI Compatible	Laboratory and Research
One Year Warranty	Education
PS2521G	
Triple Output	
One 0 to 6 V, 0 to 5 A	
Two 0 to 20 V, 0 to 2.5 A	
Digital LED Output Indicator	
SCPI Compatible	
One Year Warranty	

Product(s) available through your local Tektronix Distributor listed in the back of this catalog.

CE

Product manufactured in ISO 9001 registered facilities.

GPIB IEEE-488

PS2520G/PS2521G

The triple output PS2520G and PS2521G Power Supplies are versatile supplies suitable for many applications. The PS2520G has a single supply providing a maximum of 6 V and 3 A and two supplies providing a maximum of 36 V and 1.5 A. The PS2521G has a single supply providing a maximum of 6 V and 5.0 A and two supplies providing a maximum of 20 V and 2.5 A.

The supplies can be operated in one of three modes: independent, series, or parallel. In the independent mode, the output voltage and current of each supply are controlled independently. In the two tracking modes, the variable outputs are connected either in series or in parallel; the controls of the master power supply adjust the voltage or current of both power supplies.

The PS2520G and PS2521G are GPIB programmable. The GPIB command sets are SCPI compatible.

Each power supply features 100 memories to store voltage and current limits for instant recall via the front panel or GPIB. Both have a dual 4-digit LED display.

CHARACTERISTICS

KEY SPECIFICATIONS

	PS2520G	PS2521G
Number of Outputs	3	3
Output Voltage	0 to 6 V, 0 to 36 V (two)	0 to 6 V, 0 to 20 V (two)
Output Current	0 to 3 A (6 V), 0 to 1.5 A (36 V)	0 to 5 A (6 V), 0 to 2.5 A (20 V)
Voltage Accuracy	0.05% 5 mV + 25 mV	0.05% 5 mV + 25 mV
Current Accuracy	0.2% + 10 mA	0.2% + 10 mA
Programmable Voltage Resolution	10 mV	10 mV
Programmable Current Resolution	1 mA	1 mA
Display	Digital LED	Digital, LED
Auto-series/Parallel Operation	Yes	Yes
Auto-master/Slave Tracking	Yes	Yes
Internal Memory	Yes, 100	Yes, 100
GPIB (SCPI)	Yes	Yes
Constant Voltage Mode	Yes	Yes
Constant Current Mode	Yes	Yes
Variable Current Limit	Yes	Yes
Over-voltage Protection	Yes	Yes
Over-current Protection	Yes	Yes
Dual 4-Digit Panel Meter	Yes	Yes
Safety Certifications	UL1244, CSA231, EN61010-1	UL1244, CSA231, EN61010-1

ORDERING INFORMATION

For price information: Outside the U.S. contact your local Tektronix representative, inside the U.S. see the price list in the back of this catalog.

PS2520G
Triple Output Programmable Power Supply.

PS2521G
Triple Output Programmable Power Supply.

All Include: User Manual, US Power Cord, 3 Pair Black/Red Test Leads.

MEASUREMENT SERVICE OPTIONS
Please see the Customer Information page 615.

Product(s) available through your local Tektronix Distributor listed in the back of this catalog.

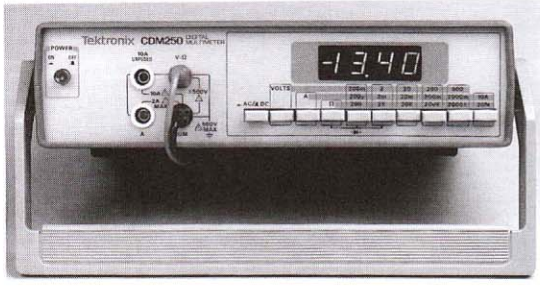
CE

Product manufactured in ISO 9001 registered facilities.

GPIB IEEE-488

Digital Multimeter (Bench)

CDM250



Features – Benefits

CDM250
AC/DC Volts (500 V Range)
Resistance (20 MΩ Range)
Current (10 A Range)
Overload Protection
One Year Warranty

Applications

Product Design
Training
Manufacturing Production Test
Field Repair
Bench Calibration and Repair
Laboratory and Research/Education

Product(s) available through your local Tektronix Distributor listed in the back of this catalog.

CE

Product manufactured in ISO 9002 registered facilities.

The CDM250 Digital Multimeter measures and displays voltage, current and resistance using a 3 1/2 digit LED display. Sine wave alternating voltages and currents are displayed in rms values. The CDM250 is safe and easy to use. This meter has overload protection and is UL listed and CSA certified. Test leads are included.

Characteristics

DC Voltage Ranges – 200 mV, 2 V, 20 V, 200 V, 500 V.
Basic DC Volts Accuracy – ±(0.5% of reading + 1 count).
Max DC Input Voltage – 500 VDC (DC + peak AC).
AC Voltage Ranges – 200 mV, 2 V, 20 V, 200 V, 500 V.
Basic AC Volts Accuracy – ±(1.0% of reading + 4 counts).
Max AC Input Voltage – 350 VAC rms; 500 V (DC + peak AC).
DC Current Ranges – 200 µA, 2 mA, 20 mA, 200 mA, 2 A, 10 A.
Basic DC Current Accuracy – ±(1.0% of reading + 1 count).
Max DC Input Current – 2 A fused, 10 A unfused.
AC Current Ranges – 200 µA, 2 mA, 20 mA, 200 mA, 2 A, 10 A.
Basic AC Current Accuracy – ±(1.5% of reading + 4 counts).
Max AC Input Current Voltage - 650 V pk, Current Input to Common.
Resistance Ranges – 200 Ω , 2 kΩ, 20 kΩ, 200 kΩ, 2 MΩ, 20 MΩ.
Basic Resistance Accuracy – ±(0.75% of reading + 1 count).
Max Resistance Input Voltage – 500 V (DC + peak AC).
Warranty – One year.
Safety – UL1244, CSA231, EN61010-1.

Ordering Information

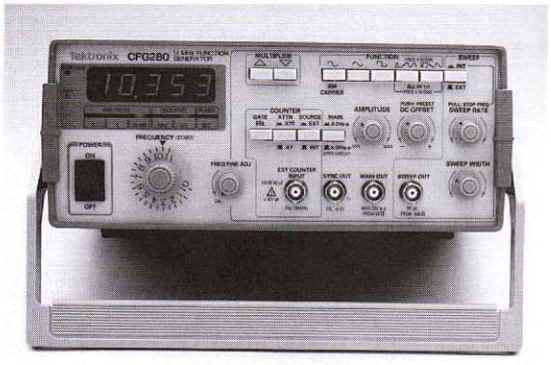
For price information:
Outside the U.S. contact your local Tektronix representative, inside the U.S. see the price list in the back of this catalog.

CDM250
Digital Multimeter.
Includes: Test Leads, Operator's Manual, US Power Cord, One Year Warranty.

TEKTRONIX MEASUREMENT SERVICE
Tektronix CAL and REP Service programs allow you to prepurchase genuine Return to Tektronix Services – ask your Distributor for details.

Function Generators

CFG253 • CFG280



Features – Benefits

CFG253

- 0.03 Hz to 3 MHz
- Square, Triangle and Sine Waves; TTL Output
- 20 dB Attenuator
- Internal or External Frequency Sweep
- Variable Duty Cycle
- Variable Symmetry (20 to 80%)
- One Year Warranty

CFG280

- 0.1 Hz to 11 MHz (Calibrated)
- 0.01 Hz to 11 MHz (Uncalibrated)
- 1 Hz to 100 MHz Counter
- Square, Triangle and Sine Waves; TTL Output
- 20 dB Attenuator
- External Gate Input
- VCF (FM) Input
- AM 0 to 100% Input for External Sine Wave

Applications

- Product Design
- Training
- Manufacturing Production Test
- Field Repair
- Bench Calibration and Repair
- Laboratory and Research
- Education

Product(s) available through your local Tektronix Distributor listed in the back of this catalog.

CE

Product manufactured in ISO 9002 registered facilities.

CFG253

Function Generators produce sine, square and triangle waves, and TTL signals for testing amplifiers, filters and digital circuits. Sweep function can be controlled internally or with an external signal. Duty cycle, DC offset, sweep rate, sweep width and amplitude are all operator controlled. The CFG253 has output bandwidth of 0.03 Hz to 3 MHz.

CFG280 11 MHz Function Generator with Counter

The CFG280 combines an 11 MHz Function Generator with a 1 Hz to 100 MHz Frequency Counter. The on-board counter allows the operator to set the frequency output of the function generator precisely. This versatile instrument conserves both bench space and budget.

CHARACTERISTICS

KEY SPECIFICATIONS

	CFG253	CFG280
Waveform Outputs	Square wave, sine wave, triangle wave, TTL pulse, sweep functions for all outputs	Square wave, sine wave, triangle wave, TTL pulse, sweep functions for all outputs
Ranges	1.0 Hz to 3.0 MHz in 7 ranges	0.1 Hz (calibrated) to 11 MHz in 8 ranges
Frequency Multiplier	Variable from 0.3 to 3.0 times the selected frequency range	Variable from 0.1 to 1 (uncalibrated) 1 to 11 (calibrated)
Dial Accuracy	±5% of full scale	±5% of full scale from 0.1 Hz to 10 MHz
Sine Wave Distortion	<1% (10 Hz to 100 kHz)	<1% (10 Hz to 100 kHz), –30 dB at all other frequencies
Triangle Wave Linearity	20 Hz to 200 kHz: ≥99%; 200 kHz to 3 MHz: ≥97%	0.1 Hz to 110 kHz: ≥99%; 110 kHz to 1 MHz: ≥97%; 1 MHz to 11 MHz: ≥95%
Square Wave Response	≤100 ns rise/fall time, maximum output into 50 Ω load	≤25 ns rise/fall time, maximum output into 50 Ω load
Main Output Amplitude	0 to 20 V p-p	0 to 20 V p-p
Attenuator	20 dB	20 dB
SYNC/TTL Output	TTL output level, rise <25 ns (20 TTL load) ≥3 V pk	<25 ns rise/fall time, maximum output into 50 Ω load
Main Output Impedance	50 Ω ±10%	50 Ω ±10%
DC Offset (continuously variable)	±10 V minimum open circuit; ±5 V minimum into 50 Ω load	±10 V minimum open circuit; ±5 V minimum into 50 Ω load
Symmetry/Duty Cycle	5 to 1 minimum symmetry change	95/5 fixed (pulse and ramp)
Internal Variable Sweep Rate	0.5 Hz to 50 Hz	0.5 Hz to 50 Hz
External Voltage-controlled Variable Sweep Range (10 kΩ Input)	100:1 minimum for 0 to +10 VDC input with frequency control set at maximum	100:1 minimum for 0 to ±10 VDC input with frequency control set at 0.1 or 11
VCF (FM) Input		±10 V input shifts frequency ≥100:1 up or down with dial set at 0.1 or 11 respectively
AM		0 to 100%, DBSC, external sine wave only
Warranty	One year	One year
Safety	UL1244, CSA231	UL1244, CSA231
CFG280 Counter Specifications		
Frequency Range (AC coupled)		1 Hz to 100 MHz
Sensitivity		30 mV rms from 1 Hz to 50 MHz; 50 mV rms from 50 MHz to 100 MHz
Period Range/Resolution		1 ms to 60 s/1 ms
Crystal Frequency		10 MHz
Time Base Stability		±0.001% (±10 ppm) from 0° to 40°C
Frequency Accuracy		±(time base error + 1 count)
Period Accuracy		±(time base error + 1 count + trigger error)
EMC		UL1244

ORDERING INFORMATION

For price information: Outside the U.S. contact your local Tektronix representative, inside the U.S. see the price list in the back of this catalog.

CFG253
3 MHz Function Generator.
Includes: Operator's Manual, US Power Cord, One Year Warranty.

CFG280
11 MHz Function Generator with 100 MHz Counter.
Includes: Operator's Manual, US Power Cord, One Year Warranty.

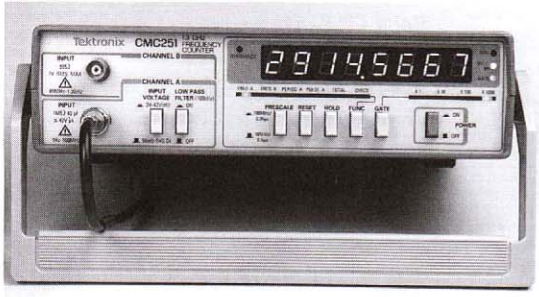
Product(s) available through your local Tektronix Distributor listed in the back of this catalog.

CE

Product manufactured in ISO 9002 registered facilities.

Counter

CMC251



Features – Benefits

CMC251

1 Hz to 100 MHz (CH 1), 80 MHz to 1.3 GHz (CH 2)

±1 ppm Time Base

Period Average, Period, Frequency, Totalize Self-test

Display Hold

Remote Start/Stop

One Year Warranty

Applications

Training

Manufacturing

Production Test

Field Repair

Bench Calibration and Repair

Product Design

Laboratory and Research

Education

Product(s) available through your local Tektronix Distributor listed in the back of this catalog.

CE

Product manufactured in ISO 9002 registered facilities.

The CMC251 1.3 GHz Multifunction Counter measures the frequency of sine, square and triangle waves from 1 Hz to 1.3 GHz. The CMC251 also provides period, totalize and pulse width measurements. The counter has two input channels. Channel A is a standard 1 MΩ input for frequency measurements up to 100 MHz. Channel B is a 50 Ω terminated input for use in high-frequency systems. This counter is of interest to radio amateurs because of its ability to measure high-frequency systems. The temperature-compensated, crystal-controlled time base is stable to ±1 part per million per year.

CHARACTERISTICS

CHANNEL A

Frequency Range – 1 Hz to 100 MHz.

Sensitivity – 20 mV rms, 1 Hz to 30 MHz; 50 mV rms, 30 MHz to 100 MHz.

Attenuation – 3 V to 42 V (HI); 50 mV to 5 V (LO).

Max. Input Voltage –
1 Hz to 5 MHz: 42 V pk.
5 MHz to 100 MHz: 4.9 V pk.

Low Pass Filter – -3 dB at 100 kHz.

Impedance – 1.0 MΩ, paralleled by 40 pF.

CHANNEL B

Frequency Range – 80 MHz to 1.3 GHz.

Sensitivity – 5 mV rms, 80 MHz to 600 MHz; 15 mV rms, 600 MHz to 900 MHz; 35 mV rms, 900 MHz to 1.3 GHz.

Impedance – 50 Ω.

Max. Input Voltage – 1 V rms.

PERIOD

Range –
Direct: 0.4 µs to 1.0 s.
Prescale: 0.04 µs to 1.0 s.

Resolution –
Direct: 100 ps to 100 ns.
Prescale: 10 ps to 10 ns.

Min. Pulse Width –
Direct: 0.2 µs.
Prescale: 20 ns.

Frequency Range –
Direct: 1 Hz to 2.5 MHz.
Prescale: 1 Hz to 25 MHz.

Events Averaged (N) – 1, 10, 100, 1000, 10,000 cycles.

Totalize Range – 0 to 99,999,999.

PULSE WIDTH

Range – 0.25 µs to 0.5 s.

Period Range – 100 ps to 100 ns.

Events Averaged (N) – 1, 10, 100, or 1000 cycles.

TIME BASE STABILITY

Temperature – <1 ppm from 0° to 40°C.

10% Line Voltage Change – <0.4 ppm.

ACCURACY

Frequency – ±(time base error + 1 count).

Period – ±(time base error + 1 count + trigger error).

Pulse Width – ±(time base error + 1 count + trigger error + 10 ns).

PLUS

Selectable Slope – No.

Ratio CH A: CH B – No.

Display Hold – Yes.

Remote Start/Stop – Yes.

Time Interval CH A: CH B – No.

Safety – UL1244, CSA231.

EMC – UL1244

ORDERING INFORMATION

For price information: Outside the U.S. contact your local Tektronix representative, inside the U.S. see the price list in the back of this catalog.

CMC251
1.3 GHz Frequency Counter with High Stability Time Base.

Includes: Operator's Manual, US Power Cord, One Year Warranty.

AVAILABLE ACCESSORIES

10X Probe, 250 MHz – Order P6106A.

TEKTRONIX MEASUREMENT SERVICE

Tektronix CAL and REP Service programs allow you to prepurchase genuine Return to Tektronix Services – ask your Distributor for details.

Product(s) available through your local Tektronix Distributor listed in the back of this catalog.

CE

Product manufactured in ISO 9002 registered facilities.

True RMS Digital Multimeters

TX3 • TX1 (with Optional WSTRM PC Interface Package)



Features – Benefits	Applications
Extra-large, Dual Numeric Display with Backlight	Electronic Circuit Design
1000 V CAT III (IEC 61010 Compliant) Input Voltage Safety Rating	Field Troubleshooting
Built-in K-type Digital Thermometer (TX3 Only)	Preventive Maintenance
Setup Menu for Custom User Defaults	Process Control
MIN/MAX/AVG/MAX-MIN Recording with Time Stamp	
Rugged Boot w/Versa-Stand™ Feature	
Traceable Calibration Certificate Included	
Easy Battery Access without Breaking Calibration Seal	

You don't need to sacrifice ruggedness, safety and quality to enjoy the accuracy and features needed in today's changing maintenance environment. The Tektronix TX-DMM™ True RMS digital multimeters feature an extra-large, dual numeric display that provides more information in fewer steps and can be viewed from across the room.

The simple user interface eliminates guesswork and allows you to view AC and DC values without changing meter function, saving troubleshooting time.

The data storage capability allows measurements to be saved into memory and later recalled or downloaded to a PC using the optional WSTRM PC interface package.

WSTRM consists of WaveStar™ for Meters software and a PC interface cable. WSTRM provides virtual digital multimeter capability, real-time data logging and easy documentation on a Windows 95/NT platform. Error-free data recording is a necessity for successful preventive maintenance programs.

TX-DMM digital rms technology provides high accuracy, 50,000 count resolution and fast AC settling time.

WSTRM Optional PC Interface Package

WSTRM is the complete solution for data transfer and analysis from the TX-DMM multimeters to a PC. The WSTRM features WaveStar for Meters software and includes an interface cable.

WaveStar for Meters software allows users to easily capture, analyze and record TX-DMM data, as well as professionally create, save and print documents. Through its unique virtual instrument interface, WaveStar software enables remote access and control of the TX-DMM data from a PC without the need for programming. WaveStar software's familiar Windows95/NT features, such as drag-and-drop, provide users a quick and simple means for inserting important DMM information into other Windows applications.

The included cable provides an interface between the TX-DMM IR port and the PC's RS-232 port.

Product(s) available through your local Tektronix Distributor listed in the back of this catalog.

CE

ISO 9001

Tektronix measurement products are manufactured in ISO registered facilities.

HANDHELD DIGITAL MULTIMETERS

TX3 – TX1 Selection Guide

	TX3	TX1
Backlight (Auto-off Time Adjustable)	Y	Y
True rms	Y	Y
Built-in Digital Thermometer Including K-type Probe	Y	
AC Volts, DC Volts, DC Amps, AC Amps, Resistance, Continuity, Diode Checker, Capitance, Frequency	Y	Y
50 Ω Range – Lead Calibration	Y	Y
4-20mA with % Readout	Y	
dBm (600 Ω) & dB (1.000V)	Y	
ΔdB – With Measured, Programmed and Stored References	Y	
Auto and Manual Ranging	Y	Y
Auto and Manual Hold	Y	Y
Δ – Relative to Measured, Programmed and Stored References	Y	Y
Nonvolatile Memory Locations	30	10
WSTRM PC Interface Package	Opt	Opt
Battery Voltage Indicator and Voltage Readout	Y	Y
Dual Display Modes:	**TX3**	**TX1**
AC Volts and Frequency	Y	Y
AC Volts and DC Volts Simultaneously	Y	Y
AC + DC (Total RMS) Volts and Frequency	Y	Y
AC Volts and dBm	Y	
AC Volts and dB (or Δ dB)	Y	
Voltage Frequence and Duty Factor (Positive or Negative)	Y	Y
Continuity (Displays Ωs and 'OPEn' or 'Shrt')	Y	Y
Probe and Ambient Temperature (°C or °F)	Y	
AC Amps and Frequency	Y	Y
AC Amps and DC Amps Simultaneously	Y	Y
AC + DC (Total rms) and Frequency	Y	Y
4-20mA and % of Full Scale	Y	
MIN/MAX/AVG/MAX-MIN and Time Stamp	Y	Y

CHARACTERISTICS

DISPLAY
Counts – 50,000 and 5000 (selectable).
Digits – 4-4/5 and 3-4/5 (selectable).
Update Rate – 4/s (5000 count mode), 1/s (50,000 count mode).

20 SEGMENT ANALOG BAR GRAPH
Update Rate – 20/s.

NONVOLATILE MEMORY
Locations – 30 (TX3); 10 (TX1).

PEAK HOLD
1 ms.

DC/AC VOLTAGE
Ranges*1 – 500.0 mV, 5.000 V, 50.00 V, 500.0 V, 1000 V CAT III.
DC Accuracy*1 – ±(0.05% + 1 ct.) (TX3), ±(0.07% + 1 ct.) (TX1).
AC Accuracy*1 – ±(0.4% + 2 ct.) (TX3), ±(0.6% + 2 ct.) (TX1).
Best Resolution – 10 µV (50,000 ct. mode).

DC/AC CURRENT
Ranges*1 – 500.0 µA, 5.000 mA, 50.00 mA, 500.0 mA, 5.000 A, 10.00 A (continuous), 15 A (30 seconds).
DC Accuracy*1 – ±(0.2% + 2 ct.).
AC Accuracy*1 – ±(0.6% + 2 ct.).
Best Resolution – 10 nA (50,000 ct. mode).

RESISTANCE
Ranges*1 – 50.00 Ω, 500.0 Ω, 5.000 kΩ, 50.00 kΩ, 500.0 kΩ, 5.000 MΩ, 50.00 MΩ.
Accuracy*1 – ±(0.1% + 2 ct.).
Best Resolution – 0.01 Ω (in 50 Ω range w/automatic lead calibration).

CAPACITANCE
Ranges – 5.000 nF, 50.00 nF, 500.0 nF, 5.000 µF, 50.00 µF, 500.0 µF, 5.000 mF, 50.00 mF.
Best Accuracy*1 – ±(1.0% + 3 ct.).
Best Resolution – 1 pF.

FREQUENCY
Range – 0.5 Hz to 1 MHz.
Accuracy*1 – ±(0.002% + 1 ct.).
Best Resolution – 0.001 Hz.
Counter – 5-digit; 100,000 count.

TEMPERATURE (TX3 ONLY)
Built-in Digital Thermometer – K-type Thermocouple.
Range – -50°C to +980°C (not including thermocouple range).
Accuracy*1 – ±3°C typical, ±1°C with quick ice bath calibration.
Safety – UL3111-1, CSA1010.1, EN61010-1.

WARRANTY
Three years.

*1 *Best accuracy stated. Ranges and accuracies are in 5000 ct. mode. Best resolution can be achieved by changing the default resolution to 50,000 ct. mode in the Setup menu.*

ORDERING INFORMATION

For price information: Outside the U.S. contact your local Tektronix representative, inside the U.S. see the price list in the back of this catalog.

TX3
True RMS Multimeter.
Includes: Boot with Stand, ATL01 Test Leads with Alligator Clips, ATK01 K-type Thermocouple Adapter, ATP01 K-type Bead Probe, User Manual, 2 AA Batteries, Traceable Calibration Certificate.

TX1
True RMS Multimeter.
Includes: Boot with Stand, ATL01 Test Leads with Alligator Clips, User Manual, 2 AA Batteries, Traceable Calibration Certificate.

USER MANUAL LANGUAGE OPTIONS
Opt. L0-L9 – English, French, Italian, German, Spanish, Japanese, Portuguese, Simplified Chinese, Traditional Chinese, Korean.

RECOMMENDED ACCESSORIES
WSTRM – PC Interface Package with WaveStar™ for Meters Software and Interface Cable.
A605 – 500 A AC Current Probe.
A621 – 2000 A AC Current Probe.
A622 – 100 A Current Probe.
ATLDX1 – Deluxe Lead Set with Tip Accessories.
ATL21 – Shielded Banana Plug Leads.
ATL22 – Plug-on Test Lead Tips.
ATL23 – Plug-on Sharp 'IC' Test Lead Tips.
ATL25 – Adjustable Test Lead Set.
ACL21 – Plug-on Safety Alligator Clips.
ACL22 – Plug-on Hook-tip Clips.
ACL23 – Plug-on Wire Clamp Clips.
ACL24 – Plug-on Jaw Clips.
AC12 – Large Nylon Soft Case.

Product(s) available through your local Tektronix Distributor listed in the back of this catalog.

CE

ISO 9001

Tektronix measurement products are manufactured in ISO registered facilities.

Handheld Digital Multimeters

DMM916 • DMM914 • DMM912



Features – Benefits

- 40,000 or 4,000 Count User-selectable Display
- 0.06% Basic DC Volts Accuracy (DMM916)
- Backlight (DMM916)
- Dual Readout (DMM914/DMM916)
- Temperature Measurement (DMM914, DMM916)
- 600 V CAT III (1000 V CAT II) Voltage Rating

Applications

- Electronic Circuit Design
- Field Troubleshooting

Product(s) available through your local Tektronix Distributor listed in the back of this catalog.

CE

Product manufactured in ISO 9001 registered facilities.

Selection Guide

	DMM916	DMM914	DMM912
True rms	Yes	Yes	Yes
Auto Power Off (Adjustable)	Yes	Yes	Yes
Analog Bar Graph Display	Yes	Yes	Yes
Auto Hold	Yes	Yes	Yes
Autoranging with Manual Ranging	Yes	Yes	Yes
Beep Guard	Yes	Yes	Yes
Continuity Check/Beeper	Yes	Yes	Yes
Diode Test	Yes	Yes	Yes
Hold	Yes	Yes	Yes
MIN/MAX/AVG/MAX-MIN	Yes	Yes	Yes
Low-battery Indicator	Yes	Yes	Yes
Overrange Indicator	Yes	Yes	Yes
Delta Mode	Yes	Yes	Yes
50/60 Hz Selection	Yes	Yes	Yes

	DMM916	DMM914	DMM912
Auto Fuse Detection (Beeper)	Yes	Yes	Yes
Memory Store/Recall	Yes	Yes	Yes
Center/Zoom Analog Bar Graph	Yes	Yes	
Delta Mode with Percent	Yes	Yes	
Duty Factor	Yes	Yes	
Temperature Measurement	Yes	Yes	
HI/LO Limits	Yes	Yes	
Time Stamp for MIN/MAX/AVG	Yes	Yes	
VAC/Hz and AAC/Hz Dual Display	Yes	Yes	
Peak Hold (1 ms)	Yes		
Backlight (Auto-off Adjustable)	Yes		
dBm and dB Readings	Yes		
Safety	UL3111-1, CSA1010.1, EN61010-1		
Warranty	3 years	3 years	3 years

The DMM910 series handheld digital multimeters from Tektronix are compact, battery-powered units with high measurement resolution and accuracy. Built-in safety features provide a high level of operator protection.

The three models share a common physical and operating format but vary in the features and accuracy. The DMM912 provides industry standard performance while the DMM914 and DMM916 provide unequalled accuracy and measurement features.

Each model includes a full complement of standard and optional accessories to meet any measurement challenge.

CHARACTERISTICS

	DMM916	DMM914	DMM912
Display Range (Selectable)	40,000 and 4,000	40,000 and 4,000	40,000 and 4,000
Display Update Rate (Selectable)	1/s to 4/s	1/s to 4/s	1/s to 4/s
Analog Bar Graph Update Rate	20/s	20/s	20/s
DC Voltage Ranges (Full Scale)*1		400.00 mV, 4.0000 V, 40.000 V, 400.00 V, 1,000.0 V	
– Best Accuracy*2	0.06% + 1 ct	0.10% + 1 ct	0.20% + 1 ct
AC Voltage Ranges, rms (Full Scale)*1		4.0000 V, 40.000 V, 400.00 V, 750.0 V	
– Best Accuracy*2	0.70% + 1 ct	0.80% + 1 ct	1.00% + 1 ct
– Crest Factor	3	3	3
DC Current Ranges (Full Scale)*1		4,000.0 µA, 400.00 mA, 10.000 A	
– Best Accuracy*2	0.30% + 1 ct	0.40% + 1 ct	0.50% + 1 ct
AC Current Ranges (Full Scale)*1		4,000.0 µA, 400.00 mA, 10.000 A	
– Best Accuracy*2	0.90% + 8 cts	0.90% + 8 cts	1.20% + 8 cts
Resistance Ranges (Full Scale)*1		400.00 Ω, 4.0000 kΩ, 40.000 kΩ, 400.00 kΩ, 4.0000 MΩ, 40.000 MΩ	
– Best Accuracy*2	0.30% + 1 ct	0.40% + 1 ct	0.50% + 1 ct
Low-voltage Ω Ranges (Full Scale)*1		4.000 kΩ, 40.00 kΩ, 400.0 kΩ, 4.000 MΩ, 40.00 MΩ	
– Best Accuracy*2	0.60% + 1 ct	0.80% + 1 ct	1.00% + 1 ct
Capacitance Ranges (Full Scale)*1		4.000 nF, 40.00 nF, 400.0 nF, 4.000 µF, 40.00 µF, 400.0 µF, 4.000 mF, 40.00 mF	
– Best Accuracy*2	1.00% + 10 ct	1.00% + 10 ct	1.00% + 10 ct
Frequency Ranges (Full Scale)*1		400.00 Hz, 4.0000 kHz, 40.000 kHz, 400.00 kHz, 2.0000 MHz	
– Best Accuracy*2	0.01% + 1 ct	0.01% + 1 ct	0.01% + 1 ct
Temperature Range	-50°C to +980°C	-50°C to +980°C	
– Best Accuracy (K-type)	2°C	2°C	

*1 *Full scale ranges listed are available on all three models.*

*2 *Accuracies are listed in 4,000 ct mode, multiply counts by 10 in 40,000 count mode.*

ORDERING INFORMATION

For price information: Outside the U.S. contact your local Tektronix representative, inside the U.S. see the price list in the back of this catalog.

DMM916, DMM914, DMM912
Handheld Digital Multimeters.
Includes: 9 V Battery, User Manual (070-9791-00), Boot, ATL01 Test Leads.

OPTIONS
Opt. 1L – Substitute Asian Languages Manual (070-9792-00).

RECOMMENDED ACCESSORIES
ATLDX1 – Deluxe Lead Set w/Tip Accessories.
ATL21 – Shielded Banana Plug Leads.
ATL22 – Plug-on Test Lead Tips.
ATL23 – Plug-on Sharp "IC" Test Lead Tips.
ATL25 – Adjustable Test Lead Set.
ACL21 – Plug-on Safety Alligator Clips.
ACL22 – Plug-on Hook-tip Clips.
ACL23 – Plug-on Wire Clamp Clips.
ACL24 – Plug-on Jaw Clips.
AC12 – Large Nylon Soft Case.
AC13 – Long Nylon Soft Case.
ATP01 – K-type Bead Probe for Temperature Measurements (ATK01 Thermocouple-to-banana Plug Adapter also required for use with DMM900s).

WARRANTY
Three years.

Product(s) available through your local Tektronix Distributor listed in the back of this catalog.

CE

Product manufactured in ISO 9001 registered facilities.

Handheld Digital Multimeters

DMM150 • CMM150 • DMM157 • DMM249 • DMM254



Features – Benefits	Applications
True RMS (DMM200 Series)	Basic Electronic Design
Compact, Rugged Design for Portability and Durability	Field Troubleshooting
Simple to Use	
Option CMM150 Converts the DMM150 Into an AC Clamp Meter	

Product(s) available through your local Tektronix Distributor listed in the back of this catalog.

Product manufactured in ISO 9001 registered facilities.

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DMM150/CMM150

The DMM150 is designed for technicians, students or hobbyists looking for a compact pocket DMM that performs standard DMM functions. The DMM150 is great for one-handed operation and measurements in tight places. The optional CMM150 clamp-on probe enables the DMM150 to make AC current measurements.

DMM157

The DMM157 is ideal for the service technician or student needing a rugged, multifunction product with good accuracy at a reasonable price.

SELECTION GUIDE

	DMM150	DMM157	DMM249	DMM254
Size	Pen Style	Pocket	Handheld	Handheld
True rms			Y	Y
AC Clamp Meter	**Use with CMM150**			Y
AC Volts, DC Volts, DC Amps, AC Amps, Resistance, Continuity Beeper, Diode Checker	Y	Y	Y	Y
Capacitance		Y		Y
Frequency				Y
Min/Max/Avg/Max-Min				Y
Relative Δ Measurement				Y
Data Hold	Y	Y	Y	Y
CAT II Input Voltage Rating	600 V	600 V	750 V	750 V
Low-battery Indicator	Y	Y	Y	Y
Auto Power Off	Y	Y	Y	Y
Over-range Indication	Y	Y	Y	Y



DMM 200 Series.

The DMM254 is designed for the professional who needs full function capabilities with exceptional accuracy. The DMM 254 also provides True RMS measurement.

CHARACTERISTICS

	CMM150/DMM150	DMM157	DMM249	DMM254
Basic DC Volts Accuracy	0.7%	0.5%	0.3%	0.1%
AC Voltage Ranges	3 V to 600 V	3 V to 600 V	3 V to 750 V	400 mV to 750 V
DC Voltage Ranges	300 mV to 600 V	300 mV to 600 V	300 mV to 1000 V	400 mV to 1000 V
True rms AC	–	–	Yes	Yes
AC Current Ranges	300 A max. (CMM150)	300 µA to 10 A	300 µA to 20 A	4 mA to 10 A
DC Current Ranges	–	300 µA to 10 A	300 µA to 20 A	4 mA to 10 A
Resistance Ranges	300 Ω to 30 MΩ	300 Ω to 30 MΩ	300 Ω to 30 MΩ	400 Ω to 40 MΩ
Capacitance Ranges	–	3 µF to 3000 µF	–	4 nF to 40 µF
Frequency Ranges	–	–	–	100 Hz to 1 MHz
Display Resolution	3200 counts	3200 counts	3200 counts	4000 counts
Features				
Analog Display	Yes	Yes	Yes	Yes
Auto Power Off	Yes	Yes	Yes	Yes
Autoranging	Yes	Yes	Yes	Yes
Delta Offset Mode	–	–	–	Yes
Continuity Check/Beeper	Yes	Yes	Yes	Yes
Data Hold	Yes	Yes	Yes (and Delay Hold)	Yes
Diode Test	Yes	Yes	Yes	Yes
Low-battery Indicator	Yes	Yes	Yes	Yes
Overrange Indication	Yes	Yes	Yes	Yes
Safety Certification	UL1244, CSA231, EN61010-1	UL1244, CSA231, EN61010-1	UL1244, CSA231, EN61010-1	UL1244, CSA231, EN61010-1
Water-resistant Case	–	–	Yes	Yes
Warranty	3 Years	3 Years	3 Years	3 Years

ORDERING INFORMATION

For price information: Outside the U.S. contact your local Tektronix representative, inside the U.S. see the price list in the back of this catalog.

DMM150
Includes: 2 AAA Batteries, Test Leads (020-2130-00), Instructions (070-9235-00), Carrying Case.

DMM157
Includes: 9 V Battery, Test Leads (196-3408-00), User Manual (070-8943-02), Holster (118-9023-00), Fuses: 240 V – 13 A (159-0357-00), 240 V – 1 A (159-0337-00) (DMM157 only).

RECOMMENDED ACCESSORIES
CMM150 AC Current Probe: (DMM150 only).
Soft Carrying Case – (016-1385-00) (DMM150 only).
AC11 – Small Soft Case.
AC13 – Long Soft Case.

DMM249
Includes: Test Leads (196-3408-00), Battery (Two AAA batteries), User Manual (070-9236-00), Holster (118-8732-00), Fuse: 1 A/600 V fast-blow (159-0337-00), 15 A/600 V fast-blow (159-0287-00).

DMM254
Includes: Test Leads (196-3408-XX), Battery (9 V), User Manual (070-9244-00), Holster (118-8732-00), Gaskets and Feet (118-8667-XX).

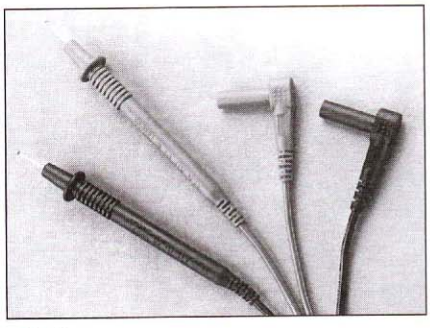
DMM 249/254 RECOMMENDED ACCESSORIES
Fuse: 1 A/600 V fast-blow: Order 159-0337-00.
15 A/600 V fast-blow: Order 159-0287-00.
A605: 500 A AC Current Probe.
ATLDX1: Deluxe Lead Set w/Tip Accessories.
ATL21: Shielded Banana Plug Leads.
ATL22: Plug-on Test Lead Tips.
ATL23: Plug-on Sharp 'IC' Test Lead Tips.
ATL25: Adjustable Test Lead Set.
ACL21: Plug-on Safety Alligator Clips.
ACL22: Plug-on Hook-tip Clips.
ACL23: Plug-on Wire Clamp Clips.
ACL24: Plug-on Jaw Clips.
AC12: Large Nylon Soft Case.
AC13: Long Soft Case.

Product(s) available through your local Tektronix Distributor listed in the back of this catalog.

Product manufactured in ISO 9001 registered facilities.

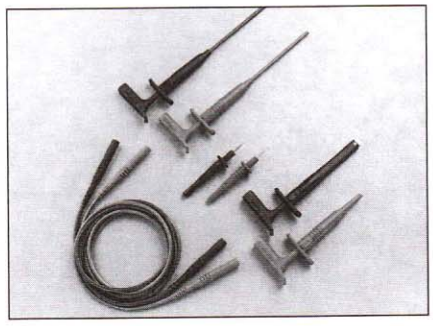
CE

Making a proper test connection is extremely important to safe, accurate measurements. Tektronix full range of leads, clips and probes give you confidence that you have the most dependable test connections for your application. Tektronix handheld accessories are compatible with all meters accepting safety-shrouded, standard-size banana plugs.



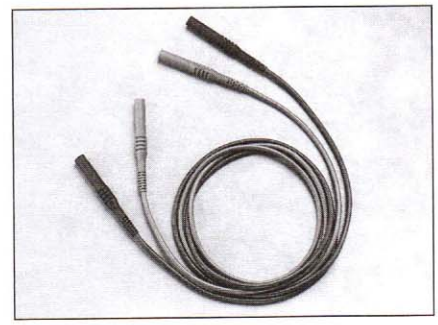
ATL01.

ATL01 Basic Lead Set – The standard test lead sets shipped with all DMM 900 Series meters. Compatible with all DMMs that accept safety-shrouded, standard-size banana plugs. One red lead and one black lead rated at 1000 V, 10 A per IEC 1010, category III, UL3111-1, CSA1010-1, EN61010-1, ENG1010-2-031.



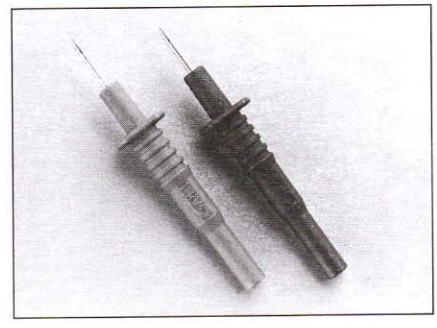
ATLDX1.

ATLDX1 Deluxe Lead Set – A complete set of test leads and clips to cover most Applications. Includes two ATL21 high-temperature, silicone test leads, two ATL22 test lead tips, one red ACL22 hook-tip clip, two ACL23 wire clips and one black ACL24 jaw clip. UL3111-1, CSA1010-1, EN61010-1, ENG1010-2-031 approved 1000 V, 10 A. The safety-shrouded standard-sized banana plugs are compatible with all DMMs. Category II.



ATL21.

ATL21 Shielded Banana Plug Lead Cables – UL3111-1 approved 1000V, 10 A. Basic building block for the following test lead components. Rugged silicone maintains flexibility and operability over a wide temperature range. One red and one black. The safety-shrouded standard-sized banana plugs are compatible with all DMMs. EN61010-2-031 category II.



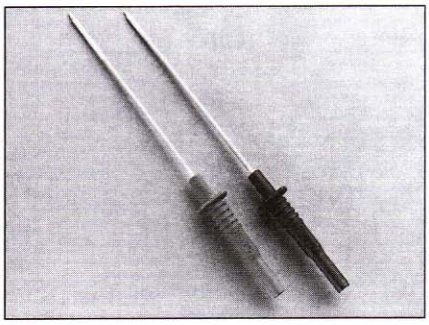
ATL22.

ATL22 Standard Test Lead Tips – One red and one black test lead tip with safety-shrouded banana plug connection to the ATL21 Lead Cables UL3111-1 approved 1000 V, 10 A. EN61010-2-031 category II.

TEST LEAD AND PROBE COMPATIBILITY CHART

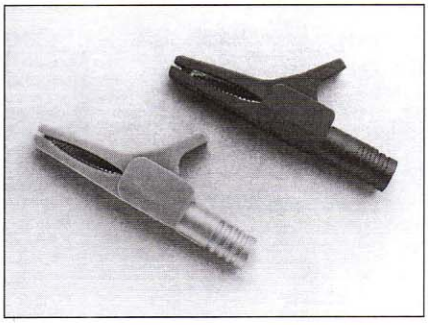
Part #	Description	DMM100 Series	DMM200 Series	DMM910 Series	THS700 Series	TX3/TX1
ATLDX1	Deluxe Lead Set	Yes	Yes	Yes	Yes	Yes
ATL01	Basic Lead Set w/Probe Tips	Yes	Yes	Yes	Yes	Yes
ATL21	Basic Test Leads	Yes	Yes	Yes	Yes	Yes
ATL22	Basic Tip	Yes*	Yes*	Yes*	Yes*	Yes*
ATL23	Extended Reach Tip	Yes*	Yes*	Yes*	Yes*	Yes*
ACL21	Alligator Clips	Yes*	Yes*	Yes*	Yes*	Yes*
ACL22	Hook Clips	Yes*	Yes*	Yes*	Yes*	Yes*
ACL23	Wire Clips	Yes*	Yes*	Yes*	Yes*	Yes*
ACL24	Jaw Clips	Yes*	Yes*	Yes*	Yes*	Yes*

** Requires ATL 21 or equivalent.*



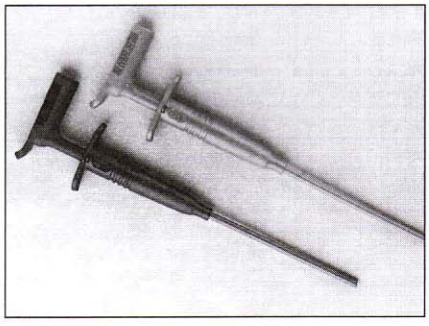
ATL23.

ATL23 Extended Test Lead Tips – One red and one black test lead tip with safety-shrouded banana plug connection to the ATL21 Lead Cables. UL3111-1 approved 1000 V, 10 A. EN61010-2-031 category II.



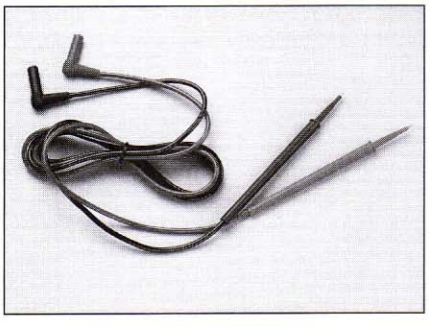
ACL21.

ACL21 Large Alligator Clips – One red and one black clip designed for safety. These durable clips provide positive electrical contact while protecting the user from electrical shock. Have safety-shrouded banana plug connection to the ATL21 Lead Cables. UL3111-1 approved 1000 V, 10 A. EN61010-2-031 category II.



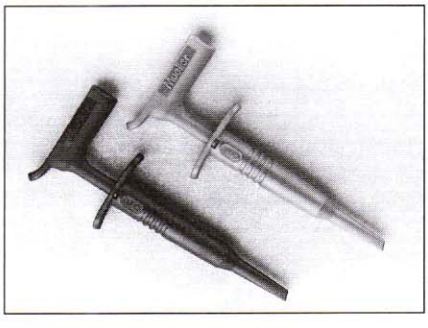
ACL23.

ACL23 Wire Clips – One red and one black clip assures positive electrical connection to your most delicate test points. Safety-shrouded banana plug connection compatible with the ATL21 Lead Cables. UL1244 approved 1000 V, 10 A. EN61010-2-031 category II.



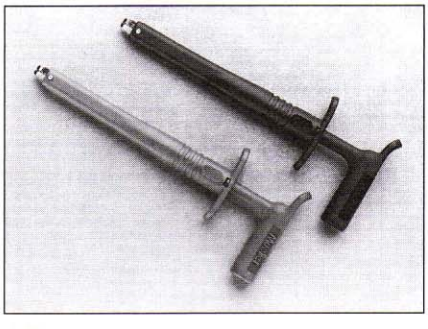
ATL25.

ATL25 Adjustable Lead Set – One red and one black test lead tip.



ACL22.

ACL22 Hook-tip Clips – One red and one black clip with BeCu hooks for solid electrical contact to most test points. Have safety-shrouded banana plug connection to the ATL21 Lead Cables. UL1244 approved 1000 V, 10 A. IEC 1010, category II.



ACL24.

ACL24 Jaw Clips – One red and one black clip for solid electrical connection to thick wires, ground leads, cable and rails for hands-off measurements. Have safety-shrouded banana plug connection to the ATL21 Lead Cables. UL1244 approved 1000 V, 10 A. EN61010-2-031 category II.

ORDERING INFORMATION

For price information: Outside the U.S. contact your local Tektronix representative, inside the U.S. see the price list in the back of this catalog.

ATL01
Basic Lead Set.

ATLDX1
Deluxe Lead Set.

ATL21
Shielded Banana Plug Lead Cables.

ATL22
Standard Test Lead Tips.

ATL23
Extended Test Lead Tips

ACL21
Large Alligator Clips.

ACL22
Hook-tip Clips.

ACL23
Wire Clips.

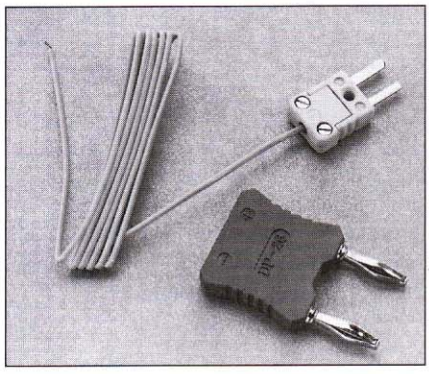
ACL24
Jaw Clips.

Product(s) available through your local Tektronix Distributor listed in the back of this catalog.

Product manufactured in ISO 9001 registered facilities.

TEST LEAD AND PROBE COMPATIBILITY CHART

Part #	Description	DMM100 Series	DMM200 Series	DMM910 Series	TX3/TX1
AC11	Small Soft Case	Yes	Yes		
AC12	Large Soft Case			Yes	yes
AC13	Long Soft Case	Yes	Yes	Yes	
ATK01	Thermocouple Adapter			Yes	yes (TX3)
ATP01	Basic Temperature Probe			Yes (914/916)	yes (TX3)



Temperature Accessories.



Soft Carrying Cases.

AC11 Small DMM Soft Case – For any DMM100/200 Series instrument with ample room for accessories and manual. Rugged tear-resistant material is lined with foam for extra shock protection.

AC12 Large DMM Soft Case – For any DMM910 Series instrument with ample room for accessories and manual. Rugged tear-resistant material is lined with foam for extra shock protection.

AC13 Long DMM Soft Case – For any DMM200, 910 Series instrument with ample room for accessories and manual. Rugged tear-resistant material is lined with foam for extra shock protection.

ATK01 Temperature Probe Adapter – Thermocouple to banana plug adapter allows use of any type K thermocouple probe to be used with DMM914/916 instrument.

ATP01 Bead Probe – Type K thermocouple. For all general purpose temperature measurements (not liquid immersion). –40 to 204°C. (DMM914/916, DTM900).

ORDERING INFORMATION

For price information: Outside the U.S. contact your local Tektronix representative, inside the U.S. see the price list in the back of this catalog.

ATK01
Temperature Probe Adapter.

ATP01
Bead Probe.

AC11
Small DMM Soft Case.

AC12
Large DMM Soft Case.

AC13
Long DMM Soft Case.

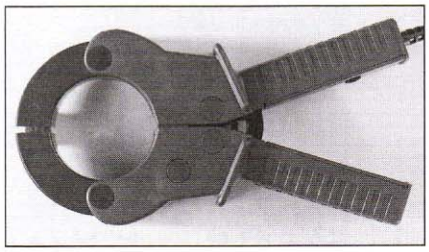
Product(s) available through your local Tektronix Distributor listed in the back of this catalog.

Product manufactured in ISO 9001 registered facilities.

CURRENT PROBES FOR ANY DMM OR OSCILLOSCOPE

- Clamp-on
- Excellent value
- AC and DC
- Easy to use

The A600 Series current probes high-value current probes are specifically designed to support measurements you make with your DMM, TekMeter® or oscilloscope.



A621.

A621 2000 AMP AC CURRENT PROBE/BNC

This industrial style clamp-on probe has a BNC connector and a shrouded banana plug adapter so it can be used on digital multimeters, TekMeter, and scopes. The A621 can measure AC currents from 100 mA to 2000 A peak over a frequency range of 5 Hz to 50 kHz. It provides a 1 mV, 10 mV, or 100 mV output for each Amp measured.



A622.

A622 100 AMP AC/DC CURRENT PROBE/BNC

This "long nose" style clamp-on probe uses a Hall Effect current sensor to provide a voltage output to oscilloscopes. It has a BNC connector and a shrouded banana plug adapter so it can also be used on digital multimeters, TekMeter and scopes. The A622 can measure AC/DC currents from 50 mA to 100 A peak over a frequency range of DC to 100 kHz. It provides 10 mV or 100 mV output for each Amp measured.

	A621	A622
Frequency Range	5 Hz to 50 kHz	DC to 100 kHz
Max Input Current	2000 A peak	100 A peak
Output	1 mV / A, 10 mV / A, 100 mV / A	10 mV / A, 100 mV / A
For	DMM TekScope	DMM TekScope
Max Conductor Diameter	54 mm (2.13 in.)	11.8 mm (0.46 in.)
Termination	BNC *1	BNC *1

*1 *With included BNC to shielded banana plug adapter.*

TEST LEAD AND PROBE COMPATIBILITY CHART

Part #	Description	DMM100	DMM200	DMM910	THS700	TX3/TX1
A621	AC Current Probe, 2000A	Yes	Yes	Yes	Yes	yes
A622	AC/DC Current Probe, 100A	Yes	Yes	Yes	Yes	yes

ORDERING INFORMATION

For price information: Outside the U.S. contact your local Tektronix representative, inside the U.S. see the price list in the back of this catalog.

A621 2000 A AC Current Probe/BNC.
A622 100 A AC/DC Current Probe/BNC.

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916
inside the U.S. call: 1-800-426-2200.

Product(s) available through your local Tektronix Distributor listed in the back of this catalog.

CE

ISO 9001

Tektronix measurement products are manufactured in ISO registered facilities.

TEK LUMACOLOR™ PHOTOMETERS

J17 • J18 • J1803 • J1810 • J1811 • J1820



FEATURES – BENEFITS

Interchangeable Pre-calibrated Heads

Accurate Spectral and Cosine Corrections

Metric and English Units User Selectable

Large LCD with Backlight

Rugged

Handheld

Adaptable to Many Light Measurement Needs

Battery Operated

J17

Auto-Ranging

Auto Zero

RS-232 Interface (Output Only)

Wide Dynamic Range

J18

Real-time Color Measurements

Ten Memories for Storing Reference Colors (with J1810 color head)

RGB Bar Graphs

D6500 Kelvin Calibration

Color Temperature Measurement

Full Control of Measurements and Output of Results (RS-232)

Analog Ouput

APPLICATIONS

Automobile Lighting

Aircraft Lighting

Computer and Television Manufacturing and Service

Medical Lighting

Commercial and Industrial Lighting

Photographic Equipment Manufacturing

Product(s) available through your local Tektronix Distributor listed in the back of this catalog.

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Tektronix measurement products are manufactured in ISO registered facilities.

The Tektronix J17 and J18 are handheld digital Photometers/Radiometers/Colorimeters for the laboratory, field or production area. A J17/J18 System consists of a J17/J18 handheld meter and one of seven interchangeable heads. At the heart of the J17/J18 is a microprocessor capable of performing several functions: Metric-to-US conversion, auto-range, auto zero, hold and conversion between color coordinate systems. The J17/J18 can be used with a PC for automated testing and data recording. The J17/J18 are powered by a 9-volt battery.

PLUG-IN HEADS PROVIDE MEASUREMENT FLEXIBILITY

Pre-calibrated plug-in heads measure illuminance, luminance and color using CIE coordinates (u' v' or xy). All heads use spectrally corrected silicon photodiodes with multi-element glass filters for long-term stability and accuracy. Connection of a

head to the J17/J18 automatically selects the correct measurement units. The backlit liquid crystal display can be read easily in dark locations.

J1803 LUMINANCE HEAD

- Video and projection screens
- Surface reflectance
- Computer displays

The J1803 measures luminance, in candelas/m^2 (nits) or footlamberts, where light scattered or emitted by a surface must be measured. Spectral response is matched to the CIE photopic curve with an f_1' value of less than 3%, ensuring accurate results even when measuring spectrally different light sources. Per CIE publication 69.

The 8° acceptance angle is determined by internal field-stop apertures.

J1811 ILLUMINANCE HEAD

- Highway illumination
- Luminaires and lamps
- Workstation illumination
- Lighting for safety

The J1811 is an illuminance head with readout in footcandles or lumens/m^2 (lux). An integral cosine diffusor corrects the angular response to 180° for an f_2 of 3% or less.

J1810 AND J1820 CHROMATICITY HEADS

- Color monitor chromaticity and white balance
- Color temperature

The J1810 and J1820 measure color coordinates in the 1931 CIE and 1976 CIE-UCS chromaticity systems. Color coordinates are automatically computed and displayed in either x and y or u' and v' units. Luminance in candela/m^2 or foot lamberts may also be measured. The J1820 works with the J17; the J1810 provides similar performance plus real-time color measurements, correlated color temperature measurement and programmable control of the J18.

CHARACTERISTICS

	J1803	J1810	J1811	J1820
Measurement	Luminance	Chromaticity, Luminance	Illuminance	Chromaticity, Luminance
Applications	Displays, Television, Medical	Displays, Television	Highway lighting, Office lighting, Transportation	Displays, Television
Ranges with J17	0.03 to 1,500,000 candelas/m^2 (Nit) 0.01 to 500,000 footlamberts	Usable with J18 only	0.001 to 5,000 footcandles	0.001*[1] to 0.999 x,y and u',v' 0.3*[1] to 300,000 candelas/m^2 (Nit)
Ranges with J18	0.3 to 300,000 candelas/m^2 (Nit) 0.1 to 100,000 footlamberts	0.001 to 0.999 x,y and u',v' 0.3 to 1,000 candelas/m^2 (Nit) 0.1 to 300 footlamberts	0.01*[1] to 5,000 lux (lm/m^2) 0.001*[1] to 500 footcandles	Usable with J17 only
Spectral Response	CIE Photopic	CIE Tristimulus	CIE Photopic	CIE Tristimulus
Spectral Accuracy	$f_1' =<$ 3% (DIN Class A)	$f_1' =<$3% (DIN Class A)	$f_1' =<$3% (DIN Class A)	$f_1' =<$3% (DIN Class A)
Accuracy	5% ±2 digits	0.009 at D6500	5% ±2 digits	0.018 at Illum A
Acceptance Angle	8°	16°	180° (Cosine)	16°
Other Features	Suction cup	Suction cup	Level and cover	Suction cup
Cable Length	3.5 ft.	3.5 ft.	6 ft.	3.5 ft.

*[1] *Luminance Only. Minimum chromaticity is 3 cd/m^2 or 1.0 fl.*

ORDERING INFORMATION

For price information: Outside the U.S. contact your local Tektronix representative, inside the U.S. see the price list in the back of this catalog.

J17
Tek LumaColor™ Photometer.

J18
Tek LumaColor™ Photometer.
Both Include: Battery, Operator's Manual. J17 and J18 require one or more of the following heads:

J1803
Luminance Head.
Includes: Operator's Manual, Spectral Curve, Suction Cup, Retainer/Filter Holder, Light Occluder.

J1811
Illuminance Head (cosine corrected).
Includes: Operator's Manual, Spectral Curve.

J1810
Color Head (For Use With J18 only).
Includes: Operator's Manual, Spectral Curve, Suction Cup.

J1820
Color Head (For Use With J17 only).
Includes: Operator's Manual, Spectral Curve.

AVAILABLE ACCESSORIES

RS-232 Cable – Order 012-1411-00.
120 VAC Supply – Order 119-5032-00.
220 VAC Supply – Order 119-3297-00.

Product(s) available through your local Tektronix Distributor listed in the back of this catalog.

CE

ISO 9001

Tektronix measurement products are manufactured in ISO registered facilities.

SEMICONDUCTOR DC CHARACTERIZATION

CONTENTS

370A 491
371A 491
Device Adapters 494



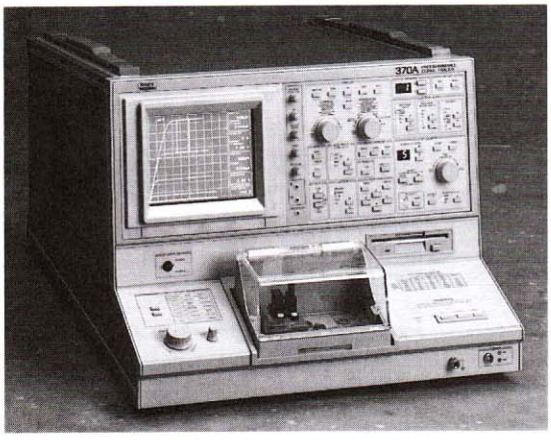
CHARACTERIZATION AND TEST SOLUTIONS FOR SEMICONDUCTOR DESIGN, MANUFACTURE AND QUALITY ASSURANCE

- The 370A provides a broad measurement range with up to 20 A capability.
- The 3000 Watt 371A has all the power you will need for high power semiconductors.
- Metrics ICS*1 software for interactive computer control of the 370A and 371A curve tracers.

*1 *Metrics ICS software is a trademark of Metrics Technologies.*

Curve Tracers

370A • 371A



Features – Benefits

High Precision Measurements of Semiconductor Devices
- Up to 2000 Volts or 10 Amp Sourcing (370A)
- Up to 3,000 Volts (371A)
- Up to 220 Watts (370A)
- Up to 3,000 Watts (371A)
- 1 Nanoamp Measurement Resolution (370A)
- Up to 400 Amps (371A)

Waveform Comparison

Envelope Display

Waveform Averaging

Kelvin Sense Measurements

Fully Programmable

3.5 Inch MS-DOS Compatible Disk Storage to Save and Recall Setups

Dot Cursor (370A)

Down to 2 Millivolt Measurement Resolution (370A)

Applications

Manual or Automated High Resolution DC

Parametric Characterization of Semiconductors

Incoming Inspection

Manufacturing Test

Process Monitoring and Quality Control

Data Sheet Generation

Component Matching

Failure Analysis

Engineering

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

CE

GPIB IEEE-488

Product(s) complies with IEEE Standard 488.1-1987, and with Tektronix Standard Codes and Formats.

SONY Tektronix

ISO9002 Certified JMI-0113

370A/371A Programmable Curve Tracers

INTERACTIVE PROGRAMMABLE CONTROL

Interactive control of all measurements is accomplished from the full featured front panel or over the GPIB. Operating parameters can be adjusted and stored and recalled using several storage methods including the 370A nonvolatile memory, the built-in DOS compatible floppy disk or to an external controller.

TEST AND MEASUREMENT SOFTWARE

Metrics software offers computer-controlled DC parameter characterization of numerous semiconductor devices. Through Metrics ICS control of the 370A, measurements can be performed without the need to interact with the instruments front panel. Every aspect of instrument control and data analysis is available through a set of interactive dialog boxes that are configured in a graphics-oriented Microsoft Windows environment.

TEST FIXTURING

A test fixture is a standard accessory that provides safe device enclosure to ensure operator protection during measurements. The test fixture accommodates standard A1001 through A1005 adapters with Kelvin sensing, 3-Pin adapters without Kelvin sensing and the A1023 and A1024 surface mount adapters.

370A Programmable Curve Tracer

The 370A, the world standard for high resolution curve tracers is used in a wide variety of applications. The 370A performs DC parametric characterization of transistors, thyristors, diodes,

SCRs, MOSFETs, optoelectronic components, solar cells, solid state displays and other semiconductor devices.

In the R&D lab, the 370A and 371A are used for characterization of new designs, extraction of SPICE parameters, failure analysis and data sheet generation.

In manufacturing test, the 370A and 371A are used to verify device quality and process monitoring.

The 370A and 371A are used for incoming inspection to verify device performance, perform failure analysis and to match components.

371A High Power Programmable Curve Tracer

The 371A, the industry leader in high power curve tracers is used for testing a wide variety of power semiconductors. It performs DC parametric characterization of thyristors, SCRs and power MOSFETs.

The high voltage collector mode permits testing the Off-Characteristics of a device up to 3,000 volts. The pulsed high current collector mode provides output current pulses greater than 400 amps peak for testing On-Characteristics. It also permits high power testing up to 3,000 watts.

AUTOMATED CURSOR MEASUREMENTS

The 371A provides three cursor measurement modes. The Dot cursor provides direct screen readout of voltage, current, gm or DC beta at any point. The Window cursor can be positioned between two curves to measure small signal beta or gm, and can also be used for visual go/no-go tests. The Function Line cursor provides screen readout of a slope or intercept value.

SWEEP MEASUREMENT MODE

In the sweep measurement mode, the 371A will automatically construct a family of curves while stimulating the device with low duty-cycle pulses. With this capability, power curves can be displayed without excessive heating of the device.

Characteristics

370A

Modes- AC, ±DC, ±Leakage, ±Rectified Sine.

Range	Max Peak Current (±)	Peak Current Pulsed (±)*1
16 V	10 A	20 A
80 V	2 A	4 A
400 V	.4 A	.8 A
2000 V	.05 A	.1 A

*1 *Collector supply is not pulsed; assumes a pulsed step generator supply.*

STEP GENERATOR

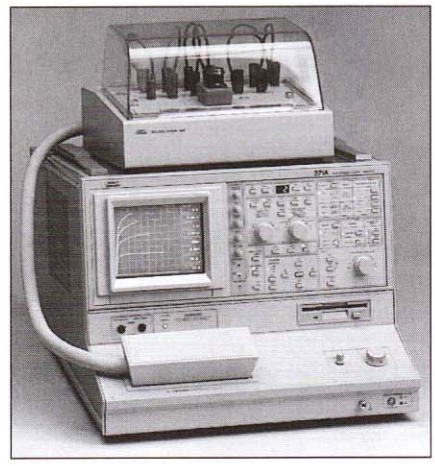
Modes – Stair step: DC, 80 µsec pulse, 300 µsec pulse.
Step Range – Current: 50 nA to 200 mA in 1-2-5 sequence. Voltage: 50 mV to 2 V in 1-2-5 sequence.
Offset – Up to ±10X step amplitude.
No. of steps – 0 to 10.

MEASUREMENT CHARACTERISTICS

Collector Current –
Measurement range: 100 nA/div (1 nA resolution) to 2 A/div.
Accuracy: 1.5% of cursor readout +0.05 div of setting (with dot cursor).

Emitter Current –
Measurement range: 1 nA/div (10 pA resolution) to 2 mA/div.
Accuracy: 1.5% of cursor readout + 0.05 div of setting + 1 nA.

Safety – UL1244, CSA231, HD401 S1.



371A

371A

COLLECTOR SUPPLY

Modes –
High Current: 250 µsec pulses with max. peak of 30 volts.
High Voltage: Full rectified sine with max. peak of 3000 volts (positive and negative polarities for both modes).

Range	Peak Current	Peak Power
High Current		
30 V	400 A	3 kW(pulsed)
30 V	40 A	300 W
High Voltage		
3 kV	40 mA ±20%	30 W
3 kV	4 mA ±20%	3 W
300 V	4 mA ±20%	300 mW
300 V	0.4 mA ±20%	30 mW

MEASUREMENT CHARACTERISTICS

Collector Current –

Maximum Power Setting	Vertical Range (in 1-2-5 increments)
3 kW	1 A/div to 50 A/div
300 W	500 mA/div to 5 A/div
30 W	100 µA/div to 5 mA/div
3 W, 300 mW	10 µA/div to 500 µA/div
30 mW	1 µA/div to 50 µA/div

Accuracy: within 0.1 vertical division.

Test Fixture – Designed to allow easy connection to a variety of devices. It has a safety enclosure to assure operator protection. Special patch cords are provided for connecting large devices.

STEP GENERATOR

Modes –
Current (stair step): DC, 500 µsec ±10% of pulse.
Voltage (stair step): DC.

Step Range –
Current: 1 mA/step to 2 A/step pulsed (hi current mode). 1 µA/step to 2 mA/step DC (hi voltage mode).
Voltage: 200 mV/step to 5 V/step.
Offset: ±10X step amplitude (5X in 5 V/step and 2 V/step settings).

Safety –
UL1244, CSA231, HD401 S1.

ACCESSORIES

K475 INSTRUMENT CART

- Ergonomic design
- Simple height, angle and shelf adjustments
- Durable steel and aluminum construction
- Large diameter smooth rolling casters
- Nylon safety straps included

For complete selection information on all Accessory products, see page 495.

ORDERING INFORMATION

For price information: Outside the U.S. contact your local Tektronix representative, inside the U.S. see the price list in the back of this catalog.

371A

High Power Curve Tracer.

Includes: In-line Transistor A1002; TO3/TO66 Adapter A1003; Power Cord (070-6839-00); Operator's Manual (070-8043-00); Pocket Reference Guide (070-6841-00), and Test Fixture (016-0908-02).

ADDITIONAL ACCESSORIES

Also see page 495.

Field Wiring Cable – Order 198-5628-00.

Service Manual – Order 070-8044-02.

370A

Curve Tracer.

Includes: Blank Adapter A1001; In-line Transistor A1002, Axial Diode Lead Adapter A1005; 4 and 6 Lead Transistor/FET Adapter A1007; Floppy Diskette (119-3446-00); Protective Cover (337-3344-00); Spare Fuses 125 V/4 A (159-0259-00); Slow Blow 250 V/2 A Fuse(159-0160-00); Power Cord (161-0066-00); Operator's Manual (070-7779-00).

Opt. 1R – Rack Mounting.

MEASUREMENT SERVICE OPTIONS

Opt. C3 – Three years of Calibration Services.

Opt. D1 – Cal Data Report.

Opt. D3 – Test Data (requires Opt. C3).

Opt. R3 – Repair warranty extended to cover three years.

ADDITIONAL ACCESSORIES

Also see page 495.

Service Manual – Order 070-7780-00.

Calibration Fixture – Order 067-0187-00.

Rackmount Kit – Order 016-0930-00.

Socket Adapters – See adapters on page 494.

SOFTWARE

METRICS ICS Software – Requires 063-1650-00 drivers. Order 063-1649-00.

METRICS Software Drivers – Tektronix 37x Curve Tracer Drivers. Order 063-1650-00.

Cart – Order K475.

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

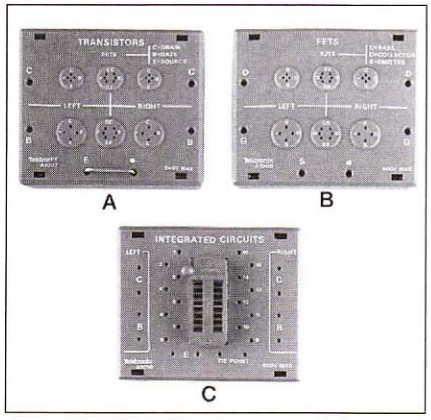
CE

GPIB IEEE-488

Product(s) complies with IEEE Standard 488.1-1987, and with Tektronix Standard Codes and Formats.

SONY Tektronix

ISO9002 Certified
JMI-0113



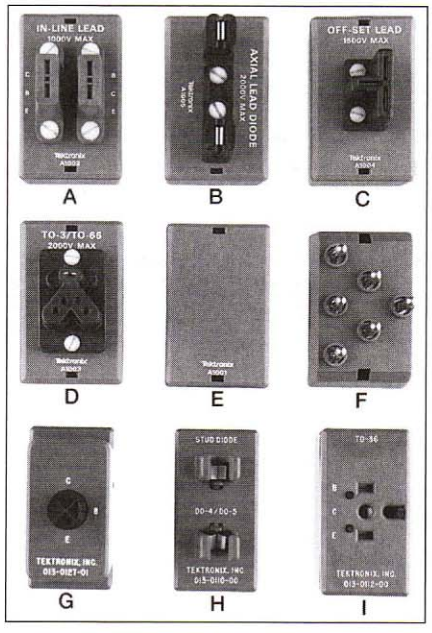
DUAL WIDTH ADAPTERS

Adapters A1007, A1009 and A1010 fit the side-by-side terminals on test fixtures of the 370A Curve Tracer. These adapters allow either 1 or 2 devices mounted in the adapter which is useful for alternating comparisons of two devices.

A. Transistor Adapters for Bipolar Transistors and some MOSFETs – Order A1007.

B. FET Adapter for most FETs – Order A1009.

C. Integrated Circuit Adapter for Multi-pin Dual-in-line Device Packages – The pins are connected to the collector, base or emitter terminals with patch cords. A tie point is also provided for an external power supply or signal source connection to the IC pins. Includes one each lead for connecting auxiliary supply to the tie points (196-3067-00); six each 4-inch test leads (012-0310-00). Order A1010.



KELVIN SENSING ADAPTERS

These adapters fit the test fixtures of the 370A and 371A Curve Tracer.

A. In-Line Adapter – Accepts large and small TO-220 transistors with in-line leads. Spacing between leads is 0.06 inch to 0.18 inch. The adapter is wired for both B-C-E and C-B-E lead configurations. Order A1002.

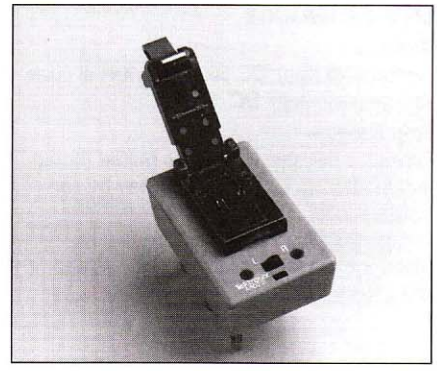
B. Axial Lead Diode Adapter – Order A1005.

C. Offset Lead Adapter for Power Transistor – Order A1004.

D. TO-3/TO-66 Adapter for Power Transistors – Order A1003.

E. Blank Adapter for Mounting Custom Sockets – Order A1001.

F. Shows Adapter Bottom 6th Pin for Base/Gate Kelvin Sensing Adapters.



A1023 SOT-23 Adapter.

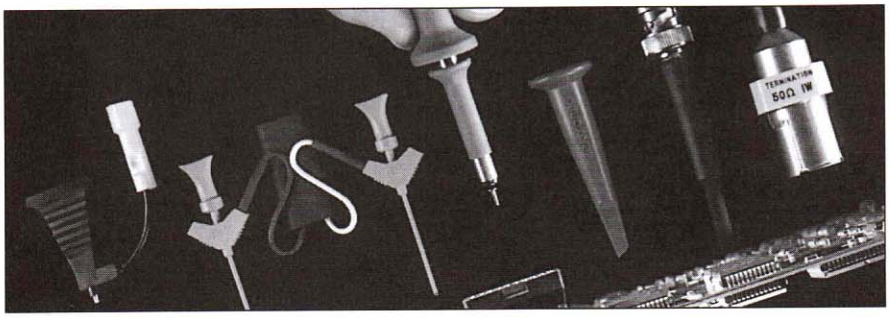
SMT DEVICE ADAPTERS

SOT-23 Adapter for Surface Mount Devices – Order A1023.

TO 252/SMT DPack Adapter for Surface Mount Devices – Order A1024.

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

ACCESSORIES



WITH TEKTRONIX, THE DIFFERENCE IS MEASURABLE

Whether you're using a scope from our revolutionary TDS 200/3000/400/500/600/700/800 or 11000 Series, our portable 2400 or 2200 Series, or our TLS Series, you've invested in the finest line of measurement instruments available. That's why it doesn't pay to compromise performance with unreliable accessories.

A dependable probe is essential to completing your test system because even the most advanced scope can only be as precise as the data that goes into it. Off-the-shelf general-purpose probes are frequently unreliable and are not expressly designed for your scope. They can cost you in ways you never bargained for: greatly impaired measurement results, embarrassing errors, and expensive delays.

PLUG IN PEACE OF MIND

Only genuine Tektronix probes measure up to your Tektronix scope, with designed-in compatibility and identical standards for quality, for performance you can always depend on.

Of course, choosing the right kind of probe is equally important, which is why we offer the world's largest and most respected line: passive and active voltage probes, current probes, high voltage probes, opto-electrical converters, specialty probes, and SMD probes designed for dense circuitry. All are built with the kind of ruggedness, reliability and long life that add up to the best probe value on the market. And they're complemented by an amazingly wide array of probe accessories for virtually every need.

DOCUMENTATION, CARTS AND WORKSTATIONS

We also provide products for documenting your measurement results, a step that's become almost as essential as testing itself. As with our probes, only Tektronix software and printers are precision-matched to your instrument and applications. They're exceptional values, too, as are Tektronix SCOPE-MOBILE® carts and workstations which free up bench space and make equipment easy to share and move around.

SUPPORT IN EVERY SENSE OF THE WORD

Tektronix products come with all the back-up you could ever need: generous warranties, optional extended service plans, and parts and service that are always readily available. Plus we offer the convenience of Tektronix' worldwide field office network for in-person product demos, service, and other assistance.

Even more than that, expert personal guidance is as close as your phone any time you need help in choosing and using Tektronix products. And we're always ready to assist you with the widest choice of training materials in the industry.

An extra measure of performance, compatibility, quality, and support – added value that increases your productivity without raising your costs. That's the competitive advantage you get with every Tektronix product.

ORDER ONLINE

Selected products will be available to order from our web site. For availability of this service see our web site at www.tektronix.com/Measurement/ebusiness

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A probe can be any conductor used to establish a connection between the circuit under test and the measuring instrument. This conductor could be a piece of bare wire, a multimeter lead or a piece of unterminated coaxial cable.

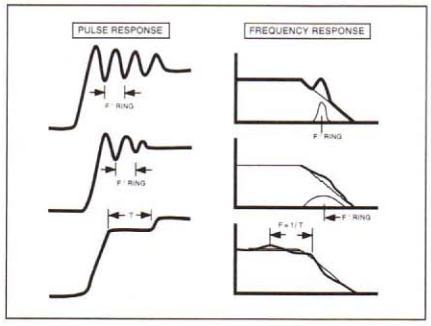
These "simple probes," however, do not fulfill the essential purpose of a probe; that is, "to extract minimal energy from the circuit under test and transfer it to a measuring instrument with maximum fidelity." The bare wire can load the input amplifier with its high capacitance and inductance or even cause a short circuit; multimeter leads are unshielded and are often susceptible to stray pickup, and the unterminated coax will severely capacitively load the circuit under test (100 pF per meter typically). Also, the unterminated coax is usually resonant at certain frequencies and does not allow faithful transfer of the signal to the test instrument due to reflections.

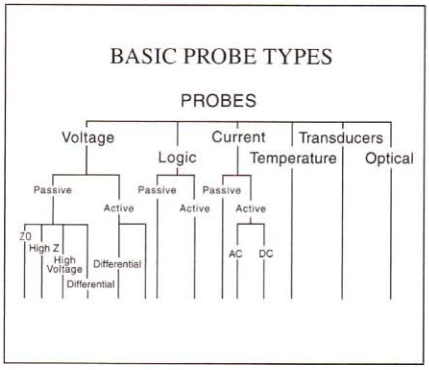
Tektronix has been designing and manufacturing instrument probes for more than 40 years, placing a constant effort on minimizing the reflections and other effects associated with unterminated coaxial probe cables and to reduce the effect of coaxial probe cables' capacitance in today's high-speed probing products.

This brief tutorial will quickly review the basic probe types and look at some of the more common issues around probe selection.

TYPES OF PROBES

Tektronix probe products include General Purpose Passive Voltage Probes, Active (FET) Voltage Probes, SMD Passive Voltage Probes, Active and Passive Current Probes, High Voltage Passive Probes, 50 Ω Divider Passive Voltage Probes (Zo, low impedance/high frequency) and Differential Voltage Probes, to name a few.





GENERAL PURPOSE PASSIVE

Attenuating Passive Voltage Probes are the most commonly used probes today. They provide a convenient and extremely rugged, yet inexpensive, way to acquire signals from your device under test. They maintain the accuracy of the oscilloscope to which they are connected over a wide dynamic range (±400 V). The 10X passive voltage probe presents a high impedance to the circuit under test at low frequencies (approximately 5 MHz and lower). Their main disadvantage is a decreasing impedance level with increasing frequency (i.e., high input capacitance).

ACTIVE FET PROBES

FET probes include active components (field effect transistors or other active devices) rather than passive components. The FET input results in a higher input impedance without loss of signal, i.e., low input capacitance (typically <0.4 pF to <2 pF) and high input resistance values (typically >100 kΩ). Some FET probes include an offset control that allows a substantial increase in the active probe's linear dynamic range. Since FET probes have a 50 Ω output impedance, they can drive a 50 Ω cable. This capability allows the distance from the probe tip to the instrument to be increased within the practical limits of the probe amplifier system and the limitations of the coaxial cable.

HIGH VOLTAGE PASSIVE

Several high voltage probes are available from Tektronix that provide 100X or 1000X compensated dividers. Because of the larger attenuation factors required for high voltage applications, the input capacitance is reduced to approximately 3 pF.

CURRENT PROBES

Current probes provide a method to measure the current flowing in a circuit. Two types of current probes are available, the traditional AC only probes and the "Hall Effect" semiconductor type. AC only current probes use a transformer to convert current flux into AC signals and have a frequency response from a few hundred Hz to GHz. Combining a "Hall Effect" device with an AC transformer provides a frequency response from DC to 50 MHz. Because of its "non-invasive" nature, a current probe typically imposes less loading than other probes.

50 Ω DIVIDER PROBES (Z0)

50 Ω Divider Probes provide the lowest input capacitance (typically <1 pF for high frequency signals) and are used with high frequency, 50 Ω input scopes. 50 Ω Divider Probes provide the most consistent probe loading because they exhibit a frequency response that is essentially flat throughout their designed frequency range.

DIFFERENTIAL PROBES

Tektronix differential probes are available with high common mode rejection ratio. The normal 10X probe has a typical accuracy of ±1% and gives a differential measurement accuracy of two parts per 100. Using this 10X probe, the common mode rejection ratio of a scope and probe combination would be no better than 50:1. A true differential probe allows the user to adjust the probe's attenuation for compatibility with a variety of Tektronix amplifiers to provide common mode rejection ratios of 10,000:1 and higher. This attenuation adjustment includes probe compensation so the probes match at high frequency as well as low frequencies.

PROBING CONSIDERATIONS AND RULES OF THUMB

A prime consideration in selecting the proper probe is the circuit loading effect of the oscilloscope/probe combination. The probe with the highest input impedance (lowest input capacitance and highest input resistance) will provide the least circuit loading. As circuit frequency increases and/or rise time decreases, the capacitive loading becomes most important. At DC and low frequencies the resistive loading is the most important.

Capacitive loading of voltage probes is the most important consideration when measuring fast rise time pulses. The time required to charge the input capacitance of the probe from the 10 to 90% level is

$t_r = 2.2 \times R_{source} \times C_{probe}$

Probe only rise time is the rise time of the probe driven from a terminated 50 Ω source. From this formula the rise time of the probe/oscilloscope system may be calculated for non passive probes that terminate in 50 Ω.

t_r^2 system = t_r^2 probe + t_r^2 scope

Bandwidth (3 dB down) of the probe/oscilloscope system may be calculated, knowing the system rise time and using the formula

BW approximately $0.35 / t_{rise}$

As you can see, these formulas are all dependent upon the input capacitance of the probe/oscilloscope system. **Since input capacitance plays such an important role, carefully consider the value of the probe's input capacitance when selecting your probe.**

Probe attenuation ratio is also an important consideration. The oscilloscope must have enough gain to allow viewing of the attenuated signal when using probes with larger attenuation ratios.

When an attenuating probe is used with an oscilloscope, the input resistance and input capacitance of the oscilloscope are represented by R_2C_2 and the probe resistance and capacitance are represented by R_1C_1 (see the figure below).

$R_2C_2 = R_1C_1$ = Optimum Signal Transfer

When the probe is first connected to the oscilloscope, compensate it by applying a low frequency square wave (1 to 10 kHz normally) to achieve the equalization of time constants. Improper compensation will result in either overshoot, roll-off or incorrect signal amplitudes.

The charts on page 498 give you information on specifications, oscilloscope compatibility and obsolete probe replacements to help you select the right probe for your application.

CONSIDER THE FOLLOWING FACTORS IN MAKING YOUR PROBE SELECTION:

- **Match Probe to Scope Input Resistance and Input Capacitance –** Be sure the desired probe will match the input resistance and capacitance of the oscilloscope being used. Fifty Ω scope inputs will require 50 Ω probes.
- **Match to Scope Bandwidth and Rise Times –** Select a probe with adequate rise time and bandwidth for the oscilloscope and application.
- **Probe Loading Effects –** Minimize probe loading effects by selecting low-impedance test points. Although the input impedance of a probe is made as high as possible, it still will always have some finite effect on the circuit under test. Usually cathodes, emitters and sources are preferred over plates, collectors or drains. Inputs to high-impedance dividers should be used rather than the midpoints.

Be aware of the fact that the input impedance of a probe varies inversely with frequency. Example: A probe having a bandwidth of 50 MHz and an input resistance of 10 MΩ at DC would have an input resistance of approximately 1.5 Kilohm at 50 MHz. Choose the probe with the lowest possible input capacitance and highest input resistance for best overall signal fidelity.

- **Time Delay Effects –** Time delay differences must be considered, particularly in phase and time coincidence measurements and in differential measurement applications. Always use two probes of the same model and cable length when making skew or time difference measurements.
- **Grounding Effects –** Grounding practices should always be kept in mind, particularly in high-impedance probe applications. Using as short a ground path as possible (preferably a coaxial adapter or short ground connector) will minimize the effect of series inductance to the probe input.

RECOMMENDED PROBE CROSS REFERENCE

Scope	Passive 1X	10X	1X/10X	100X	1000X	SMD	50 Ω (Zo)	Active CMOS/TTL	All Technologies	Logic
11800, CSA 800 Series Plug-ins										
SD-20							P6150	P6245 w/1103	P6249 w/1003	
SD-22							P6150	P6245 w/1103	P6249 w/1103	
SD-24							P6150	P6245 w/1103	P6249 w/1103	
SD-26							P6150	P6245 w/1103	P6249 w/1103	
SD-30							P6150	P6245 w/1103	P6249 w/1103	
SD-32							P6150	P6245 w/1103	P6249 w/1103	
TDS 200/3000/400/500/600/700/800 and TLS200 Series										
TDS 210	P6101B	P6112	P6119B	P5100	P6015A	P6561A		P6243S	P6243S	P6408
TDS 220	P6101B	P6112	P6119B	P5100	P6015A	P6561A		P6243S	P6243S	P6408
TDS 224	P6101B	P6112	P6119B	P5100	P6015A	P6561A		P6243S	P6243S	P6408
TDS 3012/3014	P6101B	P3010	P6129B	P5100	P6015A		P6158	P6243	P6243	P6408
TDS 3032/3034	P6101B	P6139A	P6129B	P5100	P6015A		P6158	P6243	P6243	P6408
TDS 3052/3054	P6101B	P6139A	P6129B	P5100	P6015A		P6158	P6243	P6243	P6408
TDS 420A	P6101B	P6138A	P6129B	P5100	P6015A	P6562A	P6158	P6205	P6243	P6408
TDS 430A	P6101B	P6138A	P6129B	P5100	P6015A	P6562A	P6158	P6205	P6243	P6408
TDS 460A	P6101B	P6138A	P6129B	P5100	P6015A	P6562A	P6158	P6205	P6243	P6408
TDS 510A	P6101B	P6139A		P5100	P6015A	P6563A	P6158	P6243	P6245, P6249	P6408
TDS 520D	P6101B	P6139A		P5100	P6015A	P6563A	P6158	P6243	P6245, P6249	P6408
TDS 540C	P6101B	P6139A		P5100	P6015A	P6563A	P6158	P6243	P6245, P6249	P6408
TDS 540D	P6101B	P6139A		P5100	P6015A	P6563A	P6158	P6243	P6245, P6249	P6408
TDS 580D	P6101B	P6139A		P5100	P6015A	P6563A	P6158	P6245	P6245, P6249	P6408
TDS654C	P6101B	P6139A		P5100	P6115A	P6563A	P6158	P6243	P6245	P6408
TDS680C	P6101B	P6139A		P5100	P6115A	P6563A	P6158	P6245	P6249	P6408
TDS684C	P6101B	P6139A		P5100	P6115A	P6563A	P6158	P6245	P6249	P6408
TDS694C		P6339A*[1]					P6158	P6245	P6249	
TDS 724D	P6101B	P6139A		P5100	P6015A	P6563A	P6158	P6243	P6245, P6249	P6408
TDS 754D	P6101B	P6139A		P5100	P6015A	P6563A	P6158	P6243	P6245, P6249	P6408
TDS 784D	P6101B	P6139A		P5100	P6015A	P6563A	P6158	P6243	P6245, P6249	P6408
TDS 794D		P6339A*[1]					P6158	P6245	P6245, P6249	
TDS 820							P6150	P6207	P6207	
TLS 216								P6240	P6240	
THS700 Series										
THS710A	P6101B	P6117	P6129B	P5102*[2]						P6408
THS720A	P6101B	P6117	P6129B	P5102*[2]						P6408
THS720P	P6101B	P6117	P6129B	P5102*[2]						P6408
THS730A	P6101B	P6117	P6129B	P5102*[2]						P6408
TLA700 Series (Plug-ins)										
TLA7D1	P6101B	P6139A		P5100	P6015A	P6563A	P6158	P6243	P6245	P6408
TLA7D2	P6101B	P6139A		P5100	P6015A	P6563A	P6158	P6243	P6245	P6408
TLA7E1	P6101B	P6139A		P5100	P6015A	P6563A	P6158	P6245	P6249	P6408
TLA7E2	P6101B	P6139A		P5100	P6015A	P6563A	P6158	P6245	P6249	P6408
TVS Series (VXI Plug-ins)										
TVS621A	P6101B	P6139A		P5100	P6015A	P6563A	P6158	P6243	P6245	P6408
TVS625A	P6101B	P6139A		P5100	P6015A	P6563A	P6158	P6243	P6245	P6408
TVS641A	P6101B	P6139A		P5100	P6015A	P6563A	P6158	P6245	P6249	P6408
TVS645A	P6101B	P6139A		P5100	P6015A	P6563A	P6158	P6245	P6249	P6408

*[1] *Buffered Passive Probe.*

*[2] *10X High Voltage.*

RECOMMENDED PROBE CROSS REFERENCE

Scope	Differential Digital/Telecom	MicroVolt	High Voltage	Current AC Only	AC/DC	Electro-optical Converter	Documentation Software	Cart
11800, CSA 800 Series Plug-ins								
SD 20								
SD 22								
SD 24								
SD 26								
SD 30								
SD 32								
TDS 200/3000/400/500/600/700/800 and TLS200 Series								
TDS 210		ADA400A w/1103	P5200	P6021	AM503S		WSTRO, WSTR31	
TDS 220		ADA400A w/1103	P5200	P6021	AM503S		WSTRO, WSTR31	
TDS 224		ADA400A w/1103	P5200	P6021	AM503S		WSTRO, WSTR31	
TDS 3012/3014		ADA400A	P5205/P5210		TCP202, AM503S		WSTRO	K420
TDS 3032/3034		ADA400A	P5205/P5210		TCP202, AM503S		WSTRO	K420
TDS 3052/3054		ADA400A	P5205/P5210		TCP202, AM503S		WSTRO	K420
TDS 420A	P6246	ADA400A	P5205, P5210	P6021	AM503S, TCP202	P6701B, P6703B	WSTRO, WSTR31	K420
TDS 430A	P6246	ADA400A	P5205, P5210	P6021	AM503S, TCP202	P6701B, P6703B	WSTRO, WSTR31	K420
TDS 460A	P6246	ADA400A	P5205, P5210	P6021	AM503S, TCP202	P6701B, P6703B	WSTRO, WSTR31	K420
TDS 510A	P6247, P6246	ADA400A	P5205, P5210	P6021	TCP202, AM503S	P6701B, P6703B	WSTRO, WSTR31	K420
TDS 520D	P6246, P6247	ADA400A	P5205, P5210	P6021	TCP202, AM503S	P6701B, P6703B	WSTRO, WSTR31	K420
TDS 540D	P6246, P6247	ADA400A	P5205, P5210	P6021	TCP202, AM503S	P6701B, P6703B	WSTRO, WSTR31	K420
TDS 580D	P6247, P6248	ADA400A	P5205, P5210	P6021	TCP202, AM503S	P6701B, P6703B	WSTRO, WSTR31	K420
TDS 654C	P6247, P6246	ADA400A	P5205, P5210	P6021	TCP202, AM503S	P6701B, P6703B	WSTRO	K420
TDS 680C	P6248, P6247	ADA400A	P5205, P5210	P6021	TCP202, AM503S	P6701B, P6703B	WSTRO	K420
TDS 684C	P6248, P6247	ADA400A	P5205, P5210	P6021	TCP202, AM503S	P6701B, P6703B	WSTRO	K420
TDS 694C	P6247, P6248				TCP202, AM503S	P6701B, P6703B	WSTRO	K420
TDS 724D	P6247, P6246	ADA400A	P5205, P5210	P6021	TCP202, AM503S	P6701B, P6703B	WSTRO, WSTR31	K420
TDS 754D	P6247, P6246	ADA400A	P5205, P5210	P6021	TCP202, AM503S	P6701B, P6703B	WSTRO, WSTR31	K420
TDS 784D	P6247, P6248	ADA400A	P5205, P5210	P6021	TCP202, AM503S	P6701B, P6703B	WSTRO, WSTR31	K420
TDS 794D	P6247, P6248		P5205, P5210		TCP202, AM503S	P6701B, P6703B	WSTRO, WSTR31	K420
TDS 820	P6247, P6248 w/1103				AM503S w/adapters		WSTRO, WSTR31	K420
TLS 216								K420
THS700 Series								
THS710A				A621	A622		WSTRO, WSTR31	
THS720A				A621	A622		WSTRO, WSTR31	
THS720P				A621	A622		WSTRO, WSTR31	
THS730A				A621	A622		WSTRO, WSTR31	
TLA7D1	P6247, P6246	ADA400A	P5205, P5210	P6021	TCP202, AM503S	P6701B, P6703B		
TLA7D2	P6247, P6246	ADA400A	P5205, P5210	P6021	TCP202, AM503S	P6701B, P6703B		
TLA7E1	P6247, P6246	ADA400A	P5205, P5210	P6021	TCP202, AM503S	P6701B, P6703B		
TLA7E2	P6247, P6246	ADA400A	P5205, P5210	P6021	TCP202, AM503S	P6701B, P6703B		
TVS Series (VXI Plug-ins)								
TVS621A	P6247, P6246	ADA400A	P5205, P5210	P6021	TCP202, AM503S	P6701B, P6703B		
TVS625A	P6247, P6246	ADA400A	P5205, P5210	P6021	TCP202, AM503S	P6701B, P6703B		
TVS641A	P6247, P6246	ADA400A	P5205, P5210	P6021	TCP202, AM503S	P6701B, P6703B		
TVS645A	P6247, P6246	ADA400A	P5205, P5210	P6021	TCP202, AM503S	P6701B, P6703B		

**Buffered Passive Probe.*

SUGGESTED REPLACEMENT

Scope	Passive 1X	10X	1X/10X	100X	1000X	SMD	50 Ω (Zo)	Active CMOS/TTL	All Technologies	Logic
11000 Series										
11201/A	P6101B	P6134C		P5100	P6015A	P6562A		P6243;P6205	P6245	
11A16										
11A32/34	P6101B	P6134C		P5100	P6015A	P6562A	P6158	P6243	P6245	P6408
11A33	P6101B	P6135A		P5100	P6015A	P6562A	P6158	P6243	P6245	P6408
11A34V	P6101B	P6134C		P5100	P6015A	P6562A				P6408
11A52							P6158	P6245	P6249	
11A71/72/81							P6158	P6245	P6249	
2200 and 2300 Series										
2201/05/10/14	P6101B	P6103B	P6119B	P5100	P6015A	P6561A				P6408
2211/12	P6101B	P6109B	P6129B	P5100	P6015A	P6561A				P6408
2213/13A/15/15A	P6101B	P6122	P6119B	P5100	P6015A	P6561A				P6408
2216/20/21/21A/24	P6101B	P6109B	P6129B	P5100	P6015A	P6561A				P6408
2225	P6101B	P6103B	P6119B	P5100	P6015A	P6561A				P6408
2230/32	P6101B	P6109B	P6129B	P5100	P6015A	P6561A				P6408
2235/35A	P6101B	P6109B	P6119B	P5100	P6015A					P6408
2235L	P6101B	P6122	P6119B	P5100	P6015A					P6408
2236/36A	P6101B	P6109B	P6129B	P5100	P6015A					P6408
2245/45A/46/46A	P6101B	P6109B	P6129B	P5100	P6015A	P6561A		P6205;w/1103	P6243S	P6408
2247/47A/52	P6101B	P6109B	P6129B	P5100	P6015A	P6561A		P6205;w/1103	P6243S	P6408
2300 Series										
2335/36/36YA/37	P6101B	P6109B	P6119B	P5100	P6015A					
2400 Series										
2430/30A/30M/31L	P6101B	P6133 25	P6129B	P5100	P6015A	P6562A	P6158		P6202A	
2432/32A/32M	P6101B	P6137	P6129B	P5100	P6015A	P6562A	P6158		P6201	
2439	P6101B	P6136 25	P6129B	P5100	P6015A	P6562A	P6158		P6202A	
2440/40M	P6101B	P6137	P6129B	P5100	P6015A	P6562A	P6158		P6201	
2445	P6101B	P6131	P6129B	P5100	P6015A	P6562A	P6158		P6202A	
2445A	P6101B	P6133 25	P6129B	P5100	P6015A	P6562A	P6158		P6202A	
2445B	P6101B	P6137	P6129B	P5100	P6015A	P6562A	P6158		P6202A	
2455A/55B	P6101B	P6136 25	P6129B	P5100	P6015A	P6562A	P6158		P6202A	
2465	P6101B	P6131	P6129B	P5100	P6015A	P6562A	P6158	P6202A	P6201	
2465A	P6101B	P6136 25	P6129B	P5100	P6015A	P6562A	P6158	P6202A	P6201	
2465B	P6101B	P6137	P6129B	P5100	P6015A	P6562A	P6158	P6202A	P6201	
2467	P6101B	P6136 25	P6129B	P5100	P6015A	P6562A	P6158		P6201	
2467B/67HD	P6101B	P6137	P6129B	P5100	P6015A	P6562A	P6158	P6202A	P6201	
200 Series										
222A/222PS/224		P850								
300 Series										
305/314/335/336/336A	P6101B									
390AD	P6101B	P6105A	P6129B	P5100	P6015A					
400 Series										
434/455/464/464M	P6101B	P6105A	P6129B	P5100	P6015A	P6561A			P6202A	P6408
465/465B/465M	P6101B	P6105A	P6129B	P5100	P6015A	P6561A			P6202A	P6408
466/468	P6101B	P6105A	P6129B	P5100	P6015A	P6561A			P6202A	P6408
475/475A/485	P6101B	P6106A	P6129B	P5100	P6015A	P6561A	P6158		P6201	P6408
5000 Series										
5A14N	P6101B				P6015A	P6561A				
5A15N5A18N	P6101B					P6561A				
5A21N/5A22N/5A26	P6101B									
5A38N	P6101B	P6105A	P6129B	P5100		P6561A				
5A45/5A48/5D10	P6101B	P6105A	P6129B	P5100	P6015A	P6561A				

SUGGESTED REPLACEMENT

Scope	Differential Gen	MicroVolt	High Voltage	Current AC Only	AC/DC	Electro-optical - Converter	Software	Cart
11000 Series								
11201/A	P6246; P6247	ADA400A	P5205; P5210		TCP202	P6701B; P6703B		K475
11A16					A6302; A6303			
11A32/34	P6246	ADA400A	P5205; P5210		TCP202	P6701B; P6703B		
11A33	P6135A		P5205; P5210		TCP202	P6701B; P6703B		
11A34V								
11A52	P6246				TCP202	P6701B; P6703B		
11A71/72/81	P6246; P6247				TCP202	P6701B; P6703B		
2200 and 2300 Series								
2201/05/10/14		ADA400A; w/1103	P5200	P6021; P6022	AM503S			K212
2211/12		ADA400A; w/1103	P5200	P6021; P6022	AM503S		WSTRO; WSTR31	K212
2213/13A/15/15A		ADA400A; w/1103	P5200	P6021; P6022	AM503S			K212
2216/20/21/21A/24		ADA400A; w/1103	P5200	P6021; P6022	AM503S		WSTRO; WSTR31	K212
2225		ADA400A; w/1103	P5200	P6021; P6022	AM503S			K212
2230/32		ADA400A; w/1103	P5200	P6021; P6022	AM503S		WSTRO; WSTR31	K212
2235/35A		ADA400A; w/1103	P5200					K212
2235L		ADA400A; w/1103	P5200					K212
2236/36A		ADA400A; w/1103	P5200					
2245/45A/46/46A	P6246; w/1103	ADA400A; w/1103	P5200	P6021; P6022	AM503S			K212
2247/47A/52	P6246; w/1103	ADA400A; w/1103	P5200	P6021; P6022	AM503S			K212
2300 Series								
2335/36/36YA/37		ADA400A; w/1103	P5200	P6021; P6022	AM503S			K212
2400 Series								
2430/30A/30M/31L		ADA400A; w/1103	P5200				WSTRO; WSTR31	K212
2432/32A/32M		ADA400A; w/1103	P5200				WSTRO; WSTR31	K212
2439		ADA400A; w/1103	P5200					K212
2440/40M		ADA400A; w/1103	P5200				WSTRO; WSTR31	K212
2445		ADA400A; w/1103	P5200					K212
2445A		ADA400A; w/1103	P5200					K212
2445B		ADA400A; w/1103	P5200					K212
2455A/55B		ADA400A; w/1103	P5200					K212
2465	P6246; P6247; P6248 w/1103	ADA400A; w/1103	P5200	P6021; P6022	AM503S			K212
2465A	P6246; P6247; P6248 w/1103	ADA400A; w/1103	P5200	P6021; P6022	AM503S			K212
2465B	P6246; P6247; P6248 w/1103	ADA400A; w/1103	P5200	P6021; P6022	AM503S			K212
2467	P6246; P6247; P6248 w/1103	ADA400A; w/1103	P5200					K212
2467B/67HD	P6246; P6247; P6248 w/1103	ADA400A; w/1103	P5200	P6021; P6022	AM503S			K212
200 Series								
222A/222PS/224								
300 Series								
305/314/335/336/336A								
390AD			P5200		AM503S			
400 Series								
434/455/464/464M		ADA400A; w/1103	P5200					K212
465/465B/465M		ADA400A; w/1103	P5200					K212
466/468		ADA400A; w/1103	P5200					K212
475/475A/485		ADA400A; w/1103	P5200					K212
5000 Series								
5A14N								
5A15N5A18N								
5A21N/5A22N/5A26	P6135A							
5A38N								
5A45/5A48/5D10								

SUGGESTED REPLACEMENT

Scope	Passive 1X	10X	1X/10X	100X	1000X	SMD	50 Ω (Zo)	Active CMOS/TTL	All Technologies	Logic
7000 Series										
7A13	P6101B	P6135A		P5100	P6015A					
7A15A/7A18/7A18A	P6101B	P6105A	P6129B	P5100	P6015A	P6561A			P6202A	
7A16A	P6101B	P6106A	P6129B	P5100	P6015A	P6561A			P6202A	
7A19/7A24							P6158		P6201	
7A22	P6101B	P6135A							P6202A	
7A26	P6101B	P6106A	P6129B	P5100	P6015A	P6561A			P6202A	
7A29/7A29P							P6158		P6201	
7A42		P6131	P6129B	P5100		P6561A	P6158		P6202A	
7D15/7D20		P6106A	P6129B		P6015A	P6561A				
TM500/5000 Mainframe Plug-Ins / OTHER										
AM502	P6101B	P6135A								
DC503A/504A/5004		P6106A								
DC505/505A		P6122								
DC508/508A		P6106A								
DC509/5009/510/5010		P6106A								
SC501/502/503	P6101B				P6015A					
SC504	P6101B	P6105A	P6129B	P5100	P6015A					
SI5010							P6158		P6202A	
TAS 200/400 Series										
TAS220/250	P6101B	P6103B	P6129B	P5100	P6015A	P6561A				P6408
TAS455/465/475	P6101B	P6109B	P6129B	P5100	P6015A	P6561A				P6408
TAS485	P6101B	P6111B	P6129B	P5100	P6015A	P6561A				P6408
TDS 200/300/400/500/600/700/800 Series and TLS200 Series										
TD1301	P6101B	P6109B	P6129B	P5100	P6015A	P6561A		P6205;w/1103	P6243S	
TDS310/320/340	P6101B	P6109B	P6129B	P5100	P6015A	P6561A		P6205;w/1103	P6243S	P6408
TDS340A	P6101B	P6109B	P6129B	P5100	P6015A	P6562A		P6205 w/1103	P6243S	P6408
TDS360	P6101B	P6111B	P6129B	P5100	P6015A	P6562A		P6205 w/1103	P6243S	P6408
TDS350	P6101B	P6111B	P6129B	P5100	P6015A	P6561A		P6205;w/1103	P6243S	P6408
TDS380	P6101B	P6114B	P6129B	P5100	P6015A	P6562A		P6205 w/1103	P6243S	P6408
TDS410/410A/420/460	P6101B	P6138A	P6129B	P5100	P6015A	P6562A	P6158	P6205/P6243	P6204/P6245	P6408
TDS520/520A/520B/520C	P6101B	P6139A	P6129B	P5100	P6015A	P6563A	P6158	P6205/P6243	P6204/P6245	P6408
TDS524A	P6101B	P6139A	P6129B	P5100	P6015A	P6563A	P6158	P6205/P6243	P6204/P6245	P6408
TDS540/540A/540B/540C	P6101B	P6139A	P6129B	P5100	P6015A	P6563A	P6158	P6205/P6243	P6204/P6245	P6408
TDS544A	P6101B	P6139A	P6129B	P5100	P6015A	P6563A	P6158	P6205/P6243	P6204/P6245	P6408
TDS620/620A/620B	P6101B	P6139A	P6129B	P5100	P6015A	P6563A	P6158	P6205/P6243	P6204/P6245	P6408
TDS640/644A/640A/644B	P6101B	P6139A	P6129B	P5100	P6015A	P6563A	P6158	P6205/P6243	P6204/P6245	P6408
TDS654B	P6101B	P6139A		P5100	P6015A	P6563A	P6158	P6243	P6245, P6249	P6408
TDS680B	P6101B	P6139A		P5100	P6015A	P6563A	P6158	P6243	P6245, P6249	P6408
TDS684B	P6101B	P6139A		P5100	P6015A	P6563A	P6158	P6243	P6245, P6249	P6408
TDS654A/680B/684B	P6101B	P6139A		P5100	P6015A	P6563A	P6158	P6205/P6243	P6204/P6245	P6408
TDS724A	P6101B	P6139A	P6129B	P5100	P6015A	P6563A	P6158	P6205/P6243	P6204/P6245	P6408
TDS724C	P6101B	P6139A		P5100	P6015A	P6563A	P6158	P6243	P6245; P6249	P6408
TDS744/744A	P6101B	P6139A	P6129B	P5100	P6015A	P6563A	P6158	P6205/P6243	P6245; P6249	P6408
TDS754/754A	P6101B	P6139A		P5100	P6015A	P6563A	P6158	P6243	P6245; P6249	P6408
TDS782A/784A	P6101B	P6139A	P6129B	P5100	P6015A	P6563A	P6158	P6205/P6243	P6245/6249	P6408
TDS784C	P6101B	P6139A		P5100	P6015A	P6563A	P6158	P6243	P6245; P6249	P6408

SUGGESTED REPLACEMENT

Scope	Differential Gen	MicroVolt	High Voltage	Current AC Only	AC/DC	Electro-optical - Converter	Software	Cart
7000 Series								
7A13	P6246; w/1103	ADA400A; w/1103	P5200					
7A15A/7A18/7A18A		ADA400A; w/1103	P5200					
7A16A		ADA400A; w/1103	P5200					
7A19/7A24								
7A22		ADA400A; w/1103	P5200					
7A26		ADA400A; w/1103	P5200					
7A29/7A29P		ADA400A; w/1103						
7A42		ADA400A; w/1103						
7D15/7D20								
TM500/5000 Mainframe Plug-ins / OTHER								
AM502								
DC503A/504A/5004								
DC505/505A								
DC508/508A								
DC509/5009/510/5010								
SC501/502/503			P5205; P5210					
SC504			P5205; P5210					
SI5010								
TAS 200/400 Series								
TAS220/250	P6246; w/1103	ADA400A; w/1103	P5200	P6021; P6022	AM503S			K212
TAS455/465/475	P6246; w/1103	ADA400A; w/1103	P5200	P6021; P6022	AM503S			K212
TAS485	P6246; w/1103	ADA400A; w/1103	P5200	P6021; P6022	AM503S			K212
TDS 200/300/400/500/600/700/800 Series and TLS200 Series								
TD1301								
TDS310/320/340		ADA400A; w/1103	P5200	P6021; P6022	AM503S		WSTRO; WSTR31	K212
TDS340A	P6246 w/1103	ADA400A; w/1103	P5200	P6021	AM503S		WSTRO, WSTR31	K212
TDS350		ADA400A; w/1103	P5200	P6021; P6022	AM503S		WSTRO; WSTR31	K212
TDS360	P6246 w/1103	ADA400A; w/1103	P5200	P6021	AM503S		WSTRO, WSTR31	K212
TDS380	P6246 w/1103	ADA400A; w/1103	P5200	P6021	AM503S		WSTRO, WSTR31	K212
TDS410/410A/420/460	P6246	ADA400A	P5205; P5210	P6021; P6022	AM503S; TCP202	P6701B; P6703B	WSTRO; WSTR31	K220
TDS520/520A/520B/520C	P6246; P6247	ADA400A	P5205; P5210	P6021; P6022	TCP202; AM503S		WSTRO; WSTR31	K420
TDS524A	P6246	ADA400A	P5205; P5210	P6021; P6022	AM503S; TCP202	P6701B; P6703B	WSTRO; WSTR31	K420
TDS540/540A/540B/540C	P6246; P6247	ADA400A	P5205; P5210	P6021; P6022	TCP202; AM503S		WSTRO; WSTR31	K420
TDS544A	P6246; P6247	ADA400A	P5205; P5210	P6021; P6022	AM503S; TCP202		WSTRO; WSTR31	K420
TDS620/620A/620B	P6246	ADA400A	P5205; P5210	P6021; P6022	AM503S; TCP202	P6701B; P6703B	WSTRO; WSTR31	K420
TDS640/644A/640A/644B	P6246	ADA400A	P5205; P5210	P6021; P6022	AM503S; TCP202	P6701B; P6703B	WSTRO; WSTR31	K420
TDS 654B	P6246, P6247	ADA400A	P5205, P5210	P6021	AM503S, TCP202	P6701B, P6703B	WSTRO, WSTR31	K420
TDS 680B	P6247, P6248	ADA400A	P5205, P5210	P6021	AM503S, TCP202	P6701B, P6703B	WSTRO, WSTR31	K420
TDS 684A/TDS 684B	P6247, P6248	ADA400A	P5205, P5210	P6021	AM503S, TCP202	P6701B, P6703B	WSTRO, WSTR31	K420
TDS724A	P6247; P6246	ADA400A	P5205; P5210	P6021; P6022	TCP202; AM503S	P6701B; P6703B	WSTRO; WSTR31	K420
TDS724C	P6247; P6246	ADA400A	P5205; P5210	P6021	TCP202; AM503S	P6701B; P6703B	WSTRO; WSTR31	K420
TDS744/744A	P6246	ADA400A	P5205; P5210	P6021; P6022	AM503S; TCP202	P6701B; P6703B	WSTRO; WSTR31	K420
TDS754A/754C	P6247; P6246	ADA400A	P5205; P5210	P6021	TCP202; AM503S	P6701B; P6703B	WSTRO; WSTR31	K420
TDS782A/784A	P6247; P6246	ADA400A	P5205; P5210	P6021; P6022	TCP202; AM503S	P6701B; P6703B	WSTRO; WSTR31	K420
TDS784C	P6247; P6246	ADA400A	P5205; P5210	P6021	TCP202; AM503S	P6701B; P6703B	WSTRO; WSTR31	K420

Scope	Passive 1X	10X	1X/10X	100X	1000X	SMD	50 Ω (Zo)	Active CMOS/TTL	All Technologies	Logic
THM 400/500 AND THS 700 Series										
THM420	ATLDX1									
THM550/560/565	TXMDXPB									
THS710/720	P6101B	P6117	P6129B	P5102						
TVS Series										
TVS621/625/641/645	P6101B	P6139A	P6129B	P5100	P6015A	P6563A	P6158	P6243	P6245	P6408
DIGITIZERS										
RTD710A	P6101B	P6109B	P6129B	P5100	P6015A					
RTD720A							P6158		P6245	
SCD1000							P6158		P6245	
SCD5000							P6158		P6245; w/1103	

Scope	Differential Gen	MicroVolt	High Voltage	Current AC Only	AC/DC	Electro-optical - Converter	Software	Cart
THM 400/500 AND THS 700 Series								
THM420				A605	A622			
THM550/560/565				A605	A622			
THS710/720				A621	A622		WSTRO; WSTR31	
TVS Series								
TVS621/625/641/645	P6246	ADA400A	P5205; P5210	P6021; P6022	TCP202; AM503S	P6701B; P6703B		
DIGITIZERS								
RTD710A		ADA400A; w/1103			AM503S			
RTD720A		ADA400A			TCP202; AM503S	P6701B; P6703B		
SCD1000								
SCD5000					TCP202; AM503S	P6701B; P6703B		

PASSIVE PROBES

Type	Cable Length	Attenuation	Bandwidth at –3 dB	System Input Resistance	Typical Input C	Max Voltage DC + Peak AC	Compensation Range	Read Out	ID/ Gnd Ref.	Tip/Head Style	Page
1X Passive Probe											
P6101B	2 m	1	15 MHz	1 MΩ	100 pF	420 V	NA			5 mm (Min.)	524
10X Passive Probes											
P3010	2 m	10	100 MHz	10 MΩ	13 pF	420 V RMS	15 to 35 pF	X		5 mm (Min.)	524
P5102	3.1 m	10	100 MHz	5 MΩ	11.2 pF	1000 V RMS	24 to 28 pF			mono.	527
P6103B	2 m	10	60 MHz	10 MΩ	13 pF	420 V	15 to 35 pF			5 mm (Min.)	524
P6105A	2 m	10	100 MHz	10 MΩ	11 pF	500 V	15 to 35 pF	X	X	5 mm (Min.)	526
Opt. 01	1 m	10	100 MHz	10 MΩ	9 pF	500 V	15 to 35 pF			5 mm (Min.)	
P6106A	2 m	10	250 MHz	10 MΩ	11 pF	500 V	15 to 35 pF	X	X	5 mm (Min.)	526
Opt. 01	1 m	10	250 MHz	10 MΩ	9 pF	500 V	15 to 35 pF			5 mm (Min.)	
P6109B	2 m	10	100 MHz	10 MΩ	13 pF	420 V	15 to 35 pF	X		5 mm (Min.)	524
P6111B	2 m	10	200 MHz	10 MΩ	14 pF	420 V	15 to 35 pF	X		5 mm (Min.)	524
P6112	2 m	10	100 MHz	10 MΩ	13.3 pF	300 V RMS	15 to 35 pF			5 mm (Min.)	524
P6114B	2 m	10	400 MHz	10 MΩ	14.1 pF	300 V RMS	10 to 35 pF	X		5 mm (Min.)	524
P6117	2 m	10	200 MHz	10 MΩ	13.3 pF	300 V RMS	15 to 35 pF			5 mm (Min.)	524
P6122	1.5 m	10	100 MHz	10 MΩ	11 pF	500 V	15 to 35 pF			5 mm (Min.)	526
P6131	1.3 m	10	300 MHz	10 MΩ	10.8 pF	500 V	14 to 18 pF	X		2.5 mm (Sub.)	529
Opt. 02	2 m	10	250 MHz	10 MΩ	13.5 pF	500 V	14 to 18 pF			2.5 mm (Sub.)	
Opt. 03	3 m	10	150 MHz	10 MΩ	14.5 pF	500 V	14 to 18 pF			2.5 mm (Sub.)	
P6133	2 m	10	150 MHz	10 MΩ	12.7 pF	500 V	10 to 25 pF	X		2.5 mm (Sub.)	529
Opt. 01	1.3 m	10	150 MHz	10 MΩ	11.4 pF	500 V	10 to 25 pF			2.5 mm (Sub.)	
Opt. 03	3 m	10	120 MHz	10 MΩ	14.5 pF	500 V	10 to 25 pF			2.5 mm (Sub.)	
Opt. 25	1.3 m	10	150 MHz	10 MΩ	10.8 pF	500 V	10 to 25 pF			3.5 mm (Comp.)	
P6134C	1.5 m	10	400 MHz	10 MΩ	11.3 pF	500 V	12 to 18 pF	X	X	3.5 mm (Comp.)	529
P6136	1.3 m	10	350 MHz	10 MΩ	10.8 pF	500 V	12 to 18 pF	X		2.5 mm (Sub.)	529
Opt. 25	1.3 m	10	350 MHz	10 MΩ	10.8 pF	500 V	12 to 18 pF			3.5 mm (Comp.)	
P6137	1.5 m	10	400 MHz	10 MΩ	10.8 pF	500 V	12 to 18 pF	X	X	3.5 mm (Comp.)	529
P6138A	1.3 m	10	350 MHz	10 MΩ	10 pF	300 V RMS	12 to 18 pF	X		3.5 mm (Comp.)	529
P6139A	1.3 m	10	500 MHz	10 MΩ	8 pF	500 V	8 to 12 pF	X		3.5 mm (Comp.)	529
P6339A	1.3 m	10	500 MHz	10 MΩ	8 pF	300 V RMS	TDS 794D TDS 694C	X		3.5 mm (Comp.)	531
P6561A	1.3 m	10	200 MHz	10 MΩ	<11 pF	42 V	15 to 35 pF	X		SMD	533
P6562A	1.3 m	10	350 MHz	10 MΩ	<11 pF	42 V	12 to 35 pF	X		SMD	533
P6563A	1.3 m	20	500 MHz	9.5 MΩ	<5 pF	42 V	7 to 30 pF	X		SMD	533

PASSIVE PROBES

Type	Cable Length	Attenuation	Bandwidth at –3 dB	System Input Resistance	Typical Input C	Max Voltage DC + Peak AC	Compensation Range	Read Out	ID/ Gnd Ref.	Tip/ Head Style	Page
1X/10X Switchable											
P6119B	2 m	1/10	10/100 MHz	1/10 MΩ	100/18 pF	420 V	15 to 35 pF			5 mm (Min.)	524
P6129B	2 m	1/10	10/100 MHz	1/10 MΩ	100/18 pF	420 V	15 to 35 pF	X		5 mm (Min.)	524
Y5060	1.5 m	1/10	50/60 MHz	1/10 MΩ	110/16.6 pF	500 V	20 to 45 pF			5 mm (Min.)	528
100X/1000X High Voltage											
P5100	3.1 m	100	250 MHz	10 MΩ	2.75 pF	2,500 V	7 to 30 pF	X		mono.	553
P6015A	3.0 m	1000	75 MHz	100 MΩ	3.0 pF	20,000 V	7 to 49 pF			HVP	553
Opt. 1R	3.0 m	1000	75 MHz	100 MΩ	3.0 pF	20,000 V	7 to 49 pF	X		HVP	
Opt. 25	7.6 m	1000	25 MHz	100 MΩ	3.0 pF	20,000 V	7 to 49 pF			HVP	
Opt. 2R	7.6 m	1000	25 MHz	100 MΩ	3.0 pF	20,000 V	7 to 49 pF	X		HVP	

m = meters, V = volts, MHz = Megahertz, mono. = monolithic, HVP = high voltage probe, pF = picofarads, mm = millimeters.

ACTIVE PROBES

Type	Cable Length	Attenuation	Bandwidth at –3 dB	System Input Resistance	Typical Input C	Max Voltage DC + Peak AC	Linear Range	DC Offset Range	ID/ Gnd Ref.	Tip/ Head Style	Page
P6201	1.8 m	1	900 MHz	100 kΩ	3.0 pF	±56 V	±0.6 V	±5.6 V		mono	518
		10	900 MHz	1 MΩ	1.5 pF	±200 V	±6.0 V	±56 V		mono	
		100	900 MHz	1 MΩ	1.5 pF	±200 V	±60 V#	±200 V		v	
P6202A	2.0 m	10	500 MHz	10 MΩ	2.0 pF	±200 V	±6.0 V	±55 V		mono	518
		100	500 MHz	10 MΩ	2.0 pF	±200 V	±60 V	±200 V		mono	
P6204	1.5 m	10	1000 MHz	10 MΩ	1.9 pF	±40 V	±10 V	±15 V	X	5 mm (Min.)	516
P6205	1.5 m	10	750 MHz	1 MΩ	2.0 pF	±40 V	±10 V	N/A		5 mm (Min.)	516
P6207	1.6 m	10	4000 MHz	100 kΩ	0.4 pF	±40 V	±4.0 V	±5 V		4 mm	N/A
P6243	1.3 m	10	1000 MHz	1 MΩ	1.0 pF	±40 V	±8.0 V	N/A		SMD Active	514
P6245	1.3 m	10	1500 MHz	1 MΩ	1.0 pF	±40 V	±8.0 V	±10 V		SMD Active	512
P6249	1.3 m	5x	4000 MHz	20 kΩ	1.0 pF	±30 V	±1.75 V	±3.5 V		SMD Active	512

50 Ω DIVIDER PROBES

Type	Cable Length	Attenuation	Bandwidth at –3 dB	System Input Resistance	Typical Input C	Max Voltage DC + Peak AC	Instrument Input	Read Out	ID/ Gnd Ref.	Tip/ Head Style	Page
P6150	1 m	10	9 GHz	500 Ω	<0.15 pF	12.5 V RMS	50 Ω			Comp.	520
		1	≥3 GHz	50 Ω	N/A	*1	50 Ω				
P6158	1.2 m	20	≥3.0 GHz		1.5 pF	22 V RMS	50 Ω	X		3.5 mm (Comp.)	521

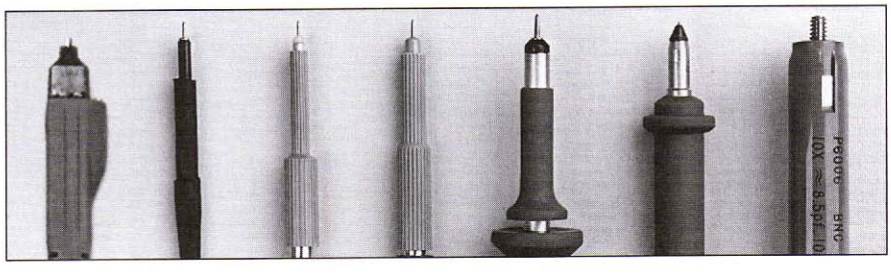
DIFFERENTIAL PROBES/SIGNAL CONDITIONERS

Type		Type	
ADA 400A	For Specifications see page 558	P6246/P6247/P6248	For Specifications see page 555
P5200/P5205/P5210	For Specifications see page 560	P6135A	For Specifications see page 559
Kit for P5100	Order 040-1487-00		

m = meters, V = volts, MHz = Megahertz, mono. = monolithic, HVP = high voltage probe, pF = picofarads, mm = millimeters.

**1 Limited by scope input or 42 V RMS.*

**2 Limited by scope input or 50 V RMS.*



Tip/Head Styles.

PASSIVE PROBES

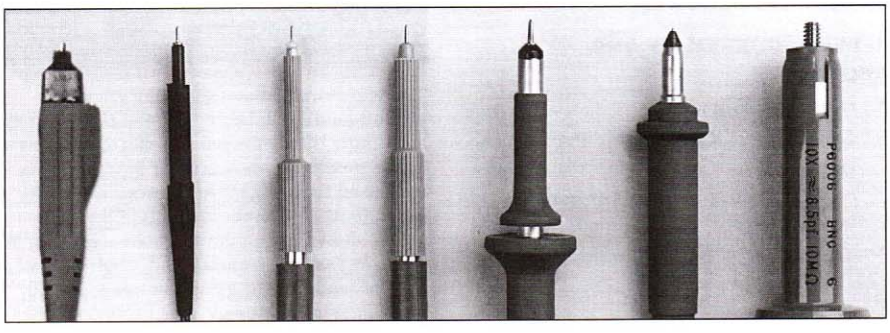
Type Opt.	Cable Lenth Meter	Cable Length Feet	Atten	B/W at –3 dB (MHz)	Input Impedance resist (MΩ)	Input Impedance Cap (pF)	Max V (DC + pk AC)	Comp Range Min (pF)	Comp Range Max (pF)	R/O	ID	Tip/Head Style	Suggested Replacement
P400	1.1	3.5	1	20	1	30	400	N/A	N/A	No	No	5 mm (Min.)	P850
P6006	1.8	6	10	25	10	11	600	15	55	No	No	Mono	P6129B
P6006 03	2.7	9	10	25	10	11	600	15	55	No	No	Mono	P6129B
P6006 04	3.7	12	10	12	10	15	600	15	55	No	No	Mono	P6129B
P6007	1.8	6	100	20	10	2.2	1500	8	55	No	No	Mono	P5100
P6007 01	1.1	3.5	100	25	10	2	1500	8	55	No	No	Mono	P5100
P6007 03	2.7	9	100	15	10	2.4	1500	8	55	No	No	Mono	P5100
P6007 04	3.7	12	100	13	10	2.6	1500	8	55	No	No	Mono	P5100
P6008	1.8	6	10	100	10	7.5	600	12	47	No	No	Mono	None
P6009	2.7	9	100	120	10	2.5	1500	8	55	Yes	No	Mono	P5100
P6009 14	3.7	12	100	120	10	2.5	1500	8	55	Yes	No	Mono	P5100
P6015	3.1	10	1000	75	100	3	40000	12	47	Yes	No	HVP	P6015A
P6015 10	3.1	10	1000	75	100	3	13000	12	47	Yes	No	HVP	P6015A
P6015 25	7.6	25	1000	8	100	4	40000	12	47	Yes	No	HVP	P6015A 2R
P6015 26	7.6	25	1000	8	100	4	13000	12	47	Yes	No	HVP	P6015A 2R
P6053	1.8	6	10	200	10	12.5	500	15	35	Yes	Yes	5 mm (Min.)	P6106A
P6053B	1.8	6	10	200	10	12.5	500	15	35	Yes	Yes	5 mm (Min.)	P6106A
P6053C	2	6.6	10	250	10	12.5	500	15	35	Yes	Yes	3.5 mm (Comp.)	P6106A
P6053C 01	1.5	4.9	10	250	10	9.5	500	15	35	Yes	Yes	3.5 mm (Comp.)	P6106A 01
P6053C 03	3	9.8	10	250	10	13.5	500	15	35	Yes	Yes	3.5 mm (Comp.)	P6106A 03
P6056	1.8	6	10	3500	0.0005	1	9	N/A	N/A	Yes	Yes	5 mm (Min.)	P6158
P6056 03	2.7	9	10	3500	0.0005	1	9	N/A	N/A	Yes	Yes	5 mm (Min.)	P6158
P6057	1.8	6	100	1400	0.005	1	21	N/A	N/A	Yes	Yes	5 mm (Min.)	None
P6057 03	2.7	9	100	1400	0.005	1	21	N/A	N/A	Yes	Yes	5 mm (Min.)	None
P6062B	2	6.6	1/10	6.5/100	1/10	105/14	500	15	47	Yes	Yes	5 mm (Min.)	P6129B
P6062B 01	1.5	4.9	1/10	8/100	1/10	100/13	500	15	47	Yes	Yes	5 mm (Min.)	P6129B
P6062B 03	3	9.8	1/10	4.5/100	1/10	135/17	500	15	47	Yes	Yes	5 mm (Min.)	P6129B
P6063B	2	6.6	1/10	6/200	1/10	105/14	500	15	24	Yes	Yes	5 mm (Min.)	None
P6063B 01	1.5	4.9	1/10	12/200	1/10	80/11	500	15	24	Yes	Yes	5 mm (Min.)	None
P6101A	2	6.6	1	15	1	54	500	N/A	N/A	No	No	5 mm (Min.)	P6101B
P6101A 01	1	3.3	1	34	1	32	500	N/A	N/A	No	No	5 mm (Min.)	P6101B
P6101A 03	3	9.8	1	8	1	78	500	N/A	N/A	No	No	5 mm (Min.)	P6101B
P6102A	2	6.6	10	60	10	13	500	15	35	Yes	Yes	5 mm (Min.)	P6129B
P6103	2	6.6	10	50	10	13.2	500	15	35	No	No	5 mm (Min.)	P6103B
P6103 01	1	3.3	10	50	10	10.9	500	15	35	No	No	5 mm (Min.)	P6103B
P6103 03	3	9.8	10	50	10	15.5	500	15	35	No	No	5 mm (Min.)	P6103B
P6105A 03	3	9.8	10	90	10	13	500	15	30	No	No	5 mm (Min.)	None
P6106A 03	3	9.8	10	150	10	13	500	15	30	No	No	5 mm (Min.)	None
P6107A	2	6.6	10	100	10	13	500	20	51	Yes	No	5 mm (Min.)	P6129B
P6108A	2	6.6	10	200	10	11	500	15	35	No	No	5 mm (Min.)	P6105A
P6108A 01	1	3.3	10	100	10	9	500	15	35	No	No	5 mm (Min.)	None
P6108A 03	3	9.8	10	90	10	13	500	15	35	No	No	5 mm (Min.)	None
P6109	2	6.6	10	150	10	13.2	500	15	35	Yes	No	5 mm (Min.)	P6109B
P6109 01	1.5	4.9	10	150	10	11.8	500	15	35	Yes	No	5 mm (Min.)	P6109B
P6109 03	3	9.8	10	100	10	15.5	500	15	35	Yes	No	5 mm (Min.)	P6109B
P6113B	2	6.6	10	100	10	13.3	300 V RMS	15	35	No	No	Mono.	P6117
P6115	1.5	4.9	1	5	1	64	42	N/A	N/A	No	No	5 mm (Min.)	P6101B
P6119	2	6.6	1/10	8/100	1/10	120/15.3	350/500	15	35	No	No	5 mm (Min.)	P6119B
P6119 03	3	9.8	1/10	6.7/100	1/10	145/17.5	350/500	15	35	No	No	5 mm (Min.)	P6119B
P6121	1.5	4.9	10	100	10	11	500	20	26	No	No	5 mm (Min.)	P6109B
P6122 02	2	6.6	10	100	10	12	500	15	35	No	No	5 mm (Min.)	None
P6122 03	3	9.8	10	90	10	14	500	15	35	No	No	5 mm (Min.)	None

Discontinued Probes
Replacement Guide

Type Opt.	Cable Lenth Meter	Cable Length Feet	Atten	B/W at –3 dB (MHz)	Input Impedance resist (MΩ)	Input Impedance Cap (pF)	Max V (DC + pk AC)	Comp Range Min (pF)	Comp Range Max (pF)	R/O	ID	Tip/Head Style	Suggested Replacement
P6125	1.5	4.9	5	200	5	20	250	15	33	No	No	5 mm (Min.)	None
P6127	1.5	4.9	1/10	8/300	1/10	100/12.7	350/500	12	18	Yes	No	5 mm (Min.)	None
P6129	2	6.6	1/10	8/100	1/10	124/16	350/500	15	35	Yes	No	5 mm (Min.)	P6129B
P6130	2	6.6	10	250	10	13.2	500	15	35	Yes	No	2.5 mm (Sub.)	P6106A
P6130 01	1.5	4.9	10	250	10	12.7	500	15	35	Yes	No	2.5 mm (Sub.)	None
P6130 03	3	9.8	10	150	10	14.5	500	15	30	Yes	No	2.5 mm (Sub.)	P6106A 03
P6134	1.5	4.9	10	300	10	11.3	500	12	18	Yes	Yes	2.5 mm (Sub.)	P6134C
P6138	1.3	4.3	10	350	10	10	500	12	18	Yes	No	3.5 mm (Comp.)	P6138A
P6148A	2	6.6	10	50	10	13	500	20	51	Yes	No	5 mm (Min.)	None
P6149A	2	6.6	10	50	10	13	500	20	51	No	No	5 mm (Min.)	None
P6156	1.5	4.9	10	3500	500 Ω	1	15 V RMS	N/A	N/A	Yes	Yes	3.5 mm (Comp.)	P6158
P6156 25	1.5	4.9	100	3000	5 kΩ	1.1	50 V RMS	N/A	N/A	Yes	Yes	3.5 mm (Comp.)	None
P6156 26	1.5	4.9	20	35000	1 kΩ	1	22 V RMS	N/A	N/A	Yes	Yes	3.5 mm (Comp.)	P6158
P6156 27	1.5	4.9	1	1500	50 Ω	N/A	50 V RMS	N/A	N/A	Yes	Yes	3.5 mm (Comp.)	None
P6561AS	1.3	4.3	10	200	10	11	42	15	35	Yes	No	SMD	P6561A
P6562	1.5	4.9	10	350	10	10.3	42	15	30	Yes	No	SMD	P6562A
P6562AS	1.3	4.3	10	350	10	11	42	12	35	Yes	No	SMD	P6562A
P6563AS	1.3	4.3	20	500	9.5	5	42	7	30	Yes	No	SMD	P6563A
Y5100	1.5	4.9	1/10	5/100	1/10	110/16.6	500	20	45	No	No	5 mm (Min.)	P6129B

Active/Differential Probes

Characteristics								Changes in Characteristics							
Discontinued Probe	Attn	B/W MHz	Linear Range	DC Offset	Vin	Cin pF	Rin	Suggested Replacement	Attn	B/W MHz	Linear Range	DC Offset	Max Vin	Cin pF	Rin
P6203	10	1000	±10 V	±10 V	40	2	10 K	P6204 w/1103 or	10	1000	±10 V	±10 V	40	1.9	10 M
								P6205 w/1103	10	750	±10 V	N/A	40	2	1M
P6206	10	1000	±10 V	N/A	40	2	1 M	P6204 w/1103 or	10	1000	±10 V	±10 V	40	1.9	10 M
								P6205 w/1103	10	750	±10 V	N/A	40	2	1M
P6230	10	1500	±5 V	±5 V	30	1.3	450	P6231 w/1103	10	1500	±5 V	±5 V	30	1.6	450
P6231	10	1500	±5 V	±5 V	30	1.6	450	P6245	10	1500	±8 V	±10 V	40	1	1 M
P6046	1/10	100	5/50 V		25	10	1 M	P6246	1	400	±7 V		25	2	200 K
								P6247 w/1103	10	1000					
P6217	10	4000	±400 V	±5 V		0.4	100 K	P6249	5	4000	±1.75 V	±3.5 V	±30	1	20 K



Tip/Head Styles.

DESIGNED FOR:

- Digital design and debug of logic families such as:
  - ECL
  - GaAs
  - MOS: CMOS; FastCMOS; BiCMOS
  - TTL
- Component characterization/measurement of high-speed analog circuitry relative to:
  - Amplitude levels
  - Aberrations
  - Propagation delay and timing
  - Bandwidths and rise times

CHOOSING AN ACTIVE PROBE

Today active probes achieve higher performance than their predecessors and their high impedance passive counterparts. They provide:

EASY USE

- **Integral Probe Power** from compatible instrumentation.
- **Scope AutoCal*1** which compensates for probe offsets and drift.
- **Readout Encoding** accounts for probe attenuation factor and reduces measurement reading errors.
- **Auto Termination** eliminates the need to manually terminate the system (TEKPROBE® models).
- **Wide Linear Dynamic Range** allows access to today's logic voltage levels.
- **Variable DC Offset** allows correction for DC levels, to bring the signal into the probe's linear dynamic range. Probe Offset is controlled by a compatible instrument or externally by the probe itself.

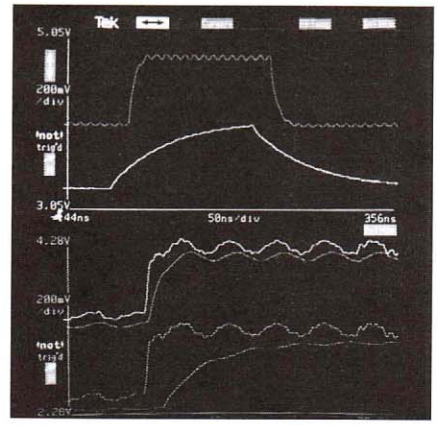
TRUER SIGNAL REPRODUCTION AND FIDELITY

- **Ultra-low Input Capacitances and High Input Resistances** allow making measurements at unknown impedance test points by maintaining higher probe input impedance across a wider bandpass and reduce ground lead loop effects allowing the use of longer ground leads than a standard passive probe.
- **DC up to 4 GHz Bandwidths** allow improved AC and DC signal characterization and testing.

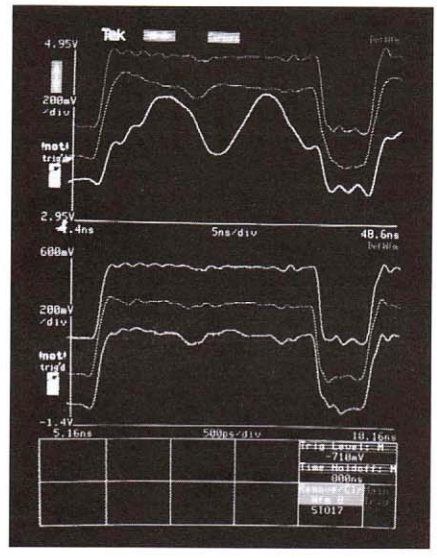
SERVICE, DURABILITY AND RELIABILITY

- **One-year Warranty**
- **Gold-Plated Replaceable Probe Tips** improve electrical connections and reliability and they lower maintenance costs.

*1 *11000; TDS 400/500/600/700 Series.*



The waveforms above show impedance test points of 50 Ω and 1 KΩ as probed with:
- **A 1X Passive probe [trace T1 (50 Ω), trace T2 (1 KΩ)]**
- **A 10X Active FET probe [trace T3 (50 Ω), trace T4 (1 KΩ)]**



The waveforms above show the effects of ground lead inductance. The top three traces show how the displayed waveform changes as the passive probe's ground lead length is increased from 1/2 in. (top trace) to 6 in. to 12 in. (bottom trace). The bottom three traces show how an active probe's waveform remains relatively unchanged, regardless of ground lead length, using the same ground lead sequence as the passive probe in the top three traces.

GUIDE TO CHOOSING AN ACTIVE PROBE

WHEN YOU HAVE	WHAT YOU NEED	WHY
Source impedance; >100 Ω and/or low power circuits	Any active probe with greater than 20 kΩ and <2 pF depends on the instrumentation interface, the frequency range and the sensitivity required.	Active probes maintain a higher input impedance throughout their frequency range. The low input C and high input R combination allows the acquisition of the fastest rise times and accurate amplitude measurements and provides less signal drian than a conventional passive probe.
Small signal circuit analysis	P6201 with its 1X sensitivity or P6249, P6245, P6243, P6204 and P6205 with 11 K high resolution mode.	Unity gain (1X) allows full sensitivity without bandwidth loss and maintains signal amplitude of small signals.
Characterization of circuits >350 MHz	The use of active probes or low capacitance probes is recommended. The specific model depends upon the frequency and measurement response required.	Low input C, low capacitance probes provide excellent rise time and propagation delay measurements; however, active probes provide better overall circuit analysis capabilities (amplitudes, rise times, propagation delay, aberrations, etc.).
Tuned circuits: Oscillators, tank circuits, etc.	P6249, P6245, P6243, P6201, P6204 dependent upon the frequency and measurement response required.	Low input C and high input R minimize circuit disturbance by reducing any additional impedance to the circuit.
General purpose circuit characterization and trouble shooting where the circuit under test impedance is unknown or not easily calculated, and/or access to circuit ground is several inches away.	The P6243, P6245 and P6249 active probes provide low input C, high input R, durability.	Low input C and the high input R provide truer signal fidelity for unknown or uncalculated impedance points. Lower input Cs also provide a higher ring frequency than passive probes, allowing the use of longer grounds.

Probe Type	Cable Length in Meters	Attenuation	Bandwidth at -3dB in MHz	Input C in ≤pF	Input R in Ω	Linear Dynamic Range in Volts	DC Offset Range in Volts	Maximum Voltage in Volts (DC + pk AC)	Interface/ Readout Identify*2	Recommended Instrument
P6201	1.8	1X	900	3	100 k	±6.0	±5.6	±56	BNC/Y/N	400/2400/7000 Series*3
		10X	900	1.5	1 M	±6.0	±56	±200	BNC/Y/N	
		100X	900	1.5	1 M	±6.0	±200	±200	BNC/Y/N	
P6202A	2	10X	500	2	10 M	±6.0	±55	±200	BNC/Y/N	400/2400/7000 Series*3
		100X*1	500	2	10 M	±60	±200	±200	BNC/N/N	
P6204	1.5	10X	1000	1.9	10 M	±10	±15	±40	TPB/Y/Y	11000*4; TDS 400*5/ 500/600/700
P6205	1.5	10X	750	2	1 M	±10	NA	±40	TPB/Y/N	11000*4; TDS 400*5/ 500/600/700
P6243	1.3	10X	1000	≤1	1 M	±8.0	N/A	±40	TPB/Y/N	11000*4; TDS 400*5/ 500/600/700
P6245	1.3	10X	1500	≤1	1 M	±8.0	±10.0	±40	TPB/Y/N	11000*4; TDS 400*5/ 500/600/700
P6249	1.3	5X	4000	≤1	20 K	±1.75	±3.5	±30	TPB/Y/N	11000*4, TDS 600/700

*1 *Optional Accessory. Order 010-0384-00.*

*2 *Interface/Readout/Identify-AutoProbe Code: (TPB=TEKPROBE BNC)/(TPS=TEKPROBE SMA)/(BNC=Conventional BNC)/(Y=Yes)/(N=No).*

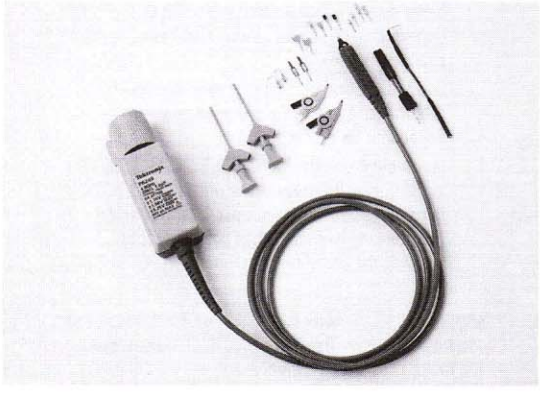
*3 *Requires Probe Power connector on the scope or recommended power supply.*

*4 *11000 Series = 11A32/11A34/11A52/11A71/11A81 in a compatible mainframe, i.e., DSA 600/CSA 400/11400, etc.*

*5 *DC Offset Functions are not incorporated into the older TDS 400 Series.*

Active Probe for SMDs

New P6249 and P6245



Features – Benefits

New P6249

>4.0 GHz (Typical Probe Only)

Direct Access to SMDs as Small as .010 in. Pitch

Measures 3.0 V Logic, RAMBUS DATA LINES, RISETIME on Gigabit Ethernet, Fibre Channel, IEEE 1394

P6245

≥1.5 GHz Bandwidth (Typical Probe Only)

1 MΩ Input Resistance

Direct Access to SMDs as Small as 0.5 mm Pitch

Measures CMOS, BiCMOS, ECL, GaAs and TTL logic

Applications

High-speed Digital Systems Design

Component Design/Characterization

Manufacturing Engineering and Test

Educational Research

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

CE

ISO 9001

Tektronix measurement products are manufactured in ISO registered facilities.

P6245 and P6249 Active Probe for TEKPROBE® BNC Interfaces

The P6245 and P6249 Active probes provide the electrical and mechanical performance required for today's digital systems designs. No additional power supplies or cables are required with TEKPROBE BNC interface. Both the P6245 and P6249 achieve high-speed signal acquisition by solving today's problems faced by designers.

Direct and easy access to SMDs (Small compact probe head and versatile attachment accessories allow direct connection to the DUT.)

Access DUT signals at scope bandwidth (P6245 and P6249 Active Probes provide scope bandwidth at the probe tip for the TDS 500/600 and TDS 700 Series).

CHARACTERISTICS

Bandwidth –
P6249: DC to 4.0 GHz (typical probe only).
P6245: DC to 1.5 GHz (typical probe only).

Risetime – <120 ps (P6249), <250 ps (P6245) guaranteed.

Dynamic Range – ±1.75 V (P6249), ± 8.0 V (P6245).

Attenuation – 5X (P6249), 10X (P6245).

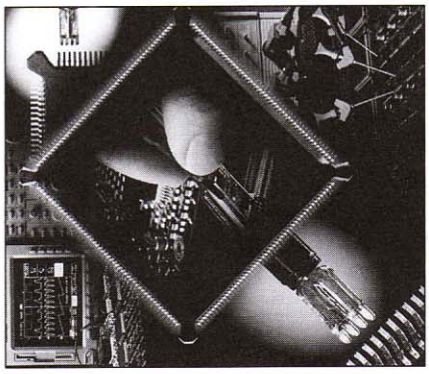
Input Resistance – 20 kΩ (P6249), 1 MΩ (P6245).

DC Offset Range – 3.5 V (P6249), 10 V (P6245).

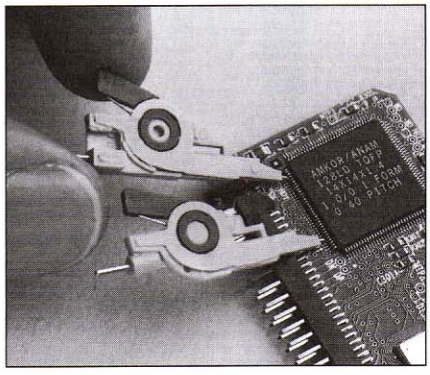
Input Capacitance – < 1 pF (P6249 and P6245).

Destructive Voltage –
40 V (DC + peak AC) (P6245).
30 V (DC + peak AC) (P6249).

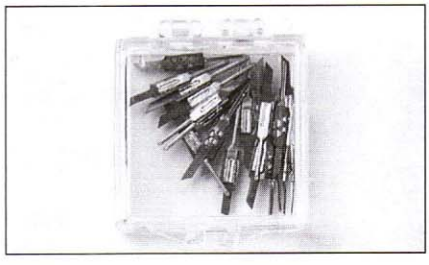
Cable Length – 1.3 m (P6249 and P6245).



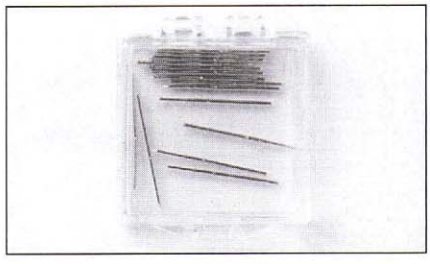
SF500 Series.



SMK4.



SureToe.



Pogo Pin Grd.

ORDERING INFORMATION

For price information: Outside the U.S. contact your local Tektronix representative, inside the U.S. see the price list in the back of this catalog.

P6249
Active Probe.

P6245
Active Probe.

RECOMMENDED ACCESSORIES
See page 548.

POWER SUPPLY
TEKPROBE® Power Supply Order 1103.
See page 516 for complete selection information.

MEASUREMENT SERVICE OPTIONS
Opt. D1 – Calibration Data Report.
Opt. C3 – Three Years of Calibration Service.
Opt. D3 – Test Data; Requires C3.
Opt. R3 – Repair Warranty Extended to Cover 3 Years.
Please see the Customer Information page 615 for additional information.

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

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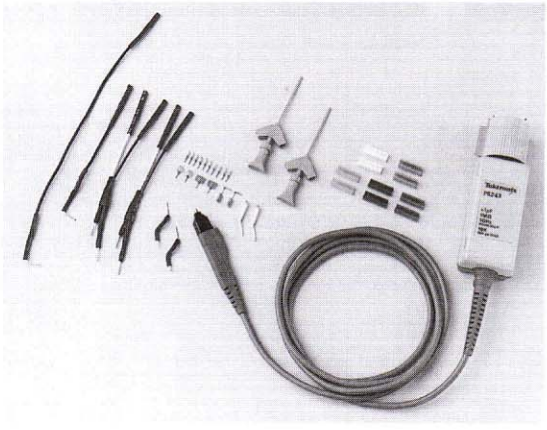
INCLUDED ACCESSORIES

P6245	P6249	Description	Order
2 Each	12 Each	50 mil SureFoot®	(SF501)
2 Each	12 Each	25 mil SureFoot®	(SF502)
2 Each	12 Each	0.5 mm SureFoot®	(SF503)
None	12 Each	0.010 in. SureToe	(ST501)
10 Each	30 Each	Solderable Probe Tips	131-5638-00
2 Each	None	6 in. Ground Lead	N/A
2 Each	3 Each	3 in. Ground Lead	196-3456-00
2 Each	2 Each	Y Lead Adapters	196-3456-00
4 Each	2 Each	SMT KlipChip™	206-0364-00
None	4 Each	SMK4	(SMK4)
1 Each	1 Each	5 colors, Cable Markers	016-1315-00
None	15 Each	Pogo Ground Pin	016-1772-00
None	15 Each	Ground Pin Length Adapter	016-1773-00
2 Each	10 Each	Right Angle Square Pin Adapter	016-1774-00
None	1 Each	Probe Buddy Actuator Arm	(PPM007)

Active Probe for SMDs

P6243 • P6243S



Features – Benefits

- ≤1 pF Input Capacitance
- 1 GHz Bandwidth (probe only)
- 1 MΩ Input Resistance
- Direct Access to SMDs as Small as 0.5 mm Pitch
- Measures CMOS, BiCMOS, ECL, GaAs and TTL Logic
- Low Mass Probe Head/Cable
- No Additional Power Supplies or Cables Are Required with TEKPROBE® BNC Interface

Applications

- High-speed Digital Systems Design
- Component Design/Characterization
- Educational Research
- Manufacturing Engineering and Test

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

CE

ISO 9001

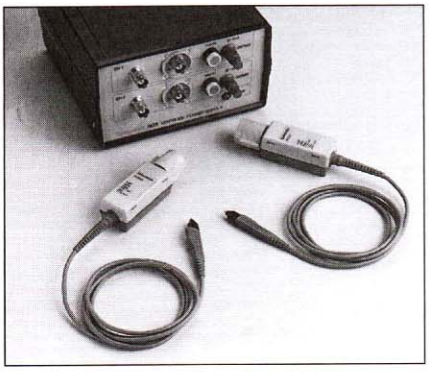
Tektronix measurement products are manufactured in ISO registered facilities.

1 GHz Active Probe for SMDs for TEKPROBE BNC Interfaces

P6243

The P6243 Active FET probe is the high performance probing solution for 500 MHz oscilloscopes. The P6243 has a probe only bandwidth of 1 GHz and will provide a 500 MHz system bandwidth when used with Tektronix' full line of 500 MHz oscilloscopes. In addition, the P6243 is powered by the TEKPROBE BNC interface, eliminating the need for additional power supplies and cables when used with TEKPROBE BNC oscilloscopes.

The P6243 offers superior signal acquisition on surface mount devices compared to the much higher capacitive loading of passive probes. The P6243 has ≤1 pF capacitive loading which allows it to measure high speed signals without affecting the signal or device under test. Furthermore, the included accessories and adapters allow for easy attachment to SMDs.



P6243S.

P6243S

The P6243S is the ideal package for using the P6243 on non-TEKPROBE BNC oscilloscopes. The P6243S consists of 2 P6243 probes and the 1103 TEKPROBE Power Supply. This provides the full performance of the P6243 (except automatic scale factor readout) on any oscilloscope, including Tektronix' TDS300 Series and 2400 Series oscilloscopes.

CHARACTERISTICS

Probe Type	P6243
Cable Length	1.3
Attenuation	10X
Bandwidth in GHz (Probe Only)	1
Rise Time	350 ps
Input C in pF	<1 pF
Input R in Ω	1 M
Linear Dynamic Range	±8 V
DC Offset Range	N/A
Max Voltage (Non-destruct)	±40
Propagation Delay	5.3 ns ±200 ps

ORDERING INFORMATION

For price information: Outside the U.S. contact your local Tektronix representative, inside the U.S. see the price list in the back of this catalog.

P6243S
Active Probe System.
Includes: Two each P6243 Active Probe, 1 each 1103 TEKPROBE® Power Supply.

P6243
Active Probe.
Includes: Two each: 50 mil, 25 mil (0.65 mm), and 0.5 mm SureFoot® Adapters; 10 each Solderable Probe Tips; 2 each 1 in., 1 each 3 in. and 6 in. Ground Leads; 1 each Y Lead Adapters; 4 each SMT KlipChip™; 2 each of 5 colors, Cable Markers; 2 each Spring Adapter: Right Angle; and Instruction Manual.

RECOMMENDED ACCESSORIES
See page 548.

POWER SUPPLY
TEKPROBE Power Supply – Order 1103.
See page 516 for complete selection information.

MEASUREMENT SERVICE OPTIONS
Please see the Customer Information pages.

SMD PROBING ADAPTERS*1
SureFoot® Adapters – 50 mil pitch. Order SF501.
25 mil and 0.65 mm pitch. Order SF502.
0.5 mm pitch. Order SF503.
SMK4 Micro KlipChip™ Adapter – 0.5 mm pitch. Order SMK4.

*1 *See page 507 for complete SMD Adapters information.*

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

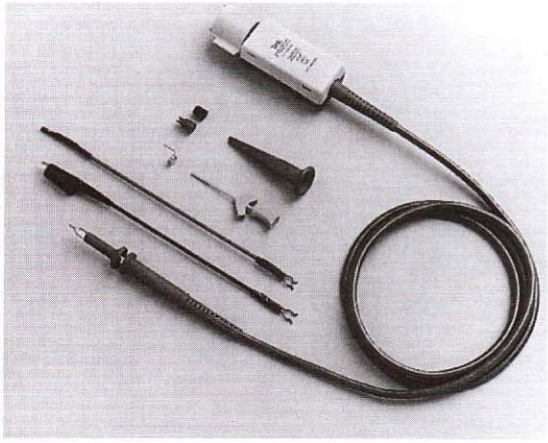
CE

ISO 9001

Tektronix measurement products are manufactured in ISO registered facilities.

Active FET Probes

P6205 • P6204 • 1103



Features – Benefits

P6205
DC to 750 MHz
2 pF Input C
1 Megaohm Input R
Low Price
Integral Probe Power
TEKPROBE BNC

P6204
DC to 1 GHz
1.9 pF Input C
10 Megaohm Input R
DC Offset
Identify Button
Integral Probe Power
TEKPROBE BNC

1103
Powers up to Two Probes
For Use with P6203, P6204, P6205, P6217, P6231, P6243, P6245, P6701B, P6703B, P6711, P6713, P6723, P6246, P6247, P5205, P5210, ADA 400A on Non-TEKPROBE Tektronix Interfaced Scopes*[1]
Overload Protected

Applications

High-speed Digital Systems Design
- ECL
- GaAs
- MOS: CMOS; FastCMOS; BiCMOS; TTL

Component Design/Characterization
- Amplitude levels
- Aberrations
- Propagation delay and timing
- Bandwidths and rise times

Educational Research

Manufacturing Engineering and Test

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

CE (1103 only)

ISO 9001

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Active FET Probes for TEKPROBE® BNC Interface

The P6204 and P6205 Probes are part of Tektronix' line of Low Circuit Loading Signal Acquisition probes for CSA (Communications Signal Analyzers), DSA (Digitizing Signal Analyzers), 11000 Series and the TDS Family of Oscilloscopes.

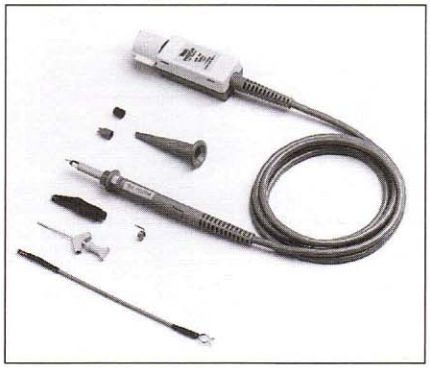
The P6204 and P6205 are designed with FET devices for their inputs, which allows very high input resistance values and low input capacitances.

The P6204 provides wide bandwidth, with low input capacitance and the highest input resistance available. At the same time the P6204 is the only active FET probe available which provides remote control capabilities.

The P6205 provides low input capacitance and high input resistance performance at a budget price.

Both Active FET probes provide a wide linear dynamic input range for accessing most digital device families using today's logic voltage levels.

Power for the P6204 and P6205 is supplied by the CSA, DSA, TDS and 11000 Series main-



P6204 with Accessories.



1103 TEKPROBE Power Supply.

frames through the TEKPROBE BNC Interface, eliminating the need for extra cabling and/or external power supplies.*2

A variable DC Offset function, which is controlled through the mainframe (CSA, DSA and 11000 Series) to bring signals (those within the offset control range) into the dynamic range of the probe, is available for the P6204.

Probe information such as type, serial number, attenuation factor, offset scale factor, input resistance and termination resistance required is communicated through the TEKPROBE Interface between the Active Probe and the CSA, DSA and 11000 Series mainframes. This information is used by these oscilloscope mainframes during the scope initialization sequence and measurement analysis.

Remote Control of several 11000 Series Programmable Functions/Actions is possible using the "Identify Button" on the P6204 probe head. These functions include Autoset, recall the next in a series of stored setups, invoke Automatic-Measurement, issue an SRQ (service action request) or activate the trace identification function.

These Active Probes may also be use with 50 0hm or 1 MΩ oscilloscope systems, with conventional BNC interfaces, via the Tektronix 1103 TEKPROBE® Power Supply. The 1103 has dual TEKPROBE Power Supply inputs, dual BNC signal outputs and dual voltage offset on/off switches and potentiometers.

**1 The characteristics for TEKPROBE Interface probes are subject to change when used with the 1103 Tek Probe Power Supply. Bandwidth, Risetime, Propagation Delays will generally differ from the advertised specification of the Probe Only.*

**2 To use these TEKPROBE BNC Interface Probes on the 11800 or CSA 800 Series requires an 1103 TEKPROBE Power Supply, an SMA Male to BNC Female adapter and a 50 Ω BNC cable.*

CHARACTERISTICS

Probe Type	Nominal Cable Length in Meters	Attenuation	Bandwidth at -3dB in MHz	Input C in pF	Input R in Ω	Linear Dynamic Range in Volts	DC Offset Range in Volts	Maximum Voltage in Volts (DC + pk AC)	Interface/ Readout Identify*2	Recommended Instrument
P6204	1.5	10X	1000	1.9	10 M	±10	±15	±40	TPB/Y/Y	11000*3
P6205	1.5	10X	750	2	1 M	±10 TDS 700	NA	±40	TPB/Y/N	11000*3, TDS400*4,

**3 Interface/Readout/Identify Code: (TPB=TEKPROBE BNC)/(TPS=TEKPROBE SMA)/(BNC=CONVENTIONAL BNC)/(Y=Yes)/(N=No).*

**4 11000 SERIES = 11A32/11A34/11A52/11A71/11A72/11A81.*

**5 P6204, P6217 and P6245 DC Offset functions are not incorporated into the TDS 400 Family.*

ORDERING INFORMATION

For price information: Outside the U.S. contact your local Tektronix representative, inside the U.S. see the price list in the back of this catalog.

P6204
10X, 1 GHz Active FET Probe.
Includes: Retractable Hook Tip (013-0107-07); 6 in. Ground Lead with Alligator (196-3120-01); 6 in. Ground Lead with Square-pin Receptacle (196-3198-01); Ground Contact, Spring (214-4125-00) SMT KlipChip™ (206-0364-00); Insulating Ground Cover (166-0404-01); IC Test Tip; Carrying Case; Instruction Manual (070-6949-03).

P6205
10X, 750 MHz Active FET Probe.
Includes: Same as P6204 except Instruction Manual (070-8202-01).

1103
TEKPROBE Power Supply.
For P6203, P6204, P6205, P6245, P6231 and P6700 Series. Powers two Probes.

INTERNATIONAL POWER PLUGS
Opt. A1 – Opt. A5 – Available.
See page 619 for description.

ADDITIONAL ACCESSORIES (FOR 1103)
36 in. Precision 50 Ω BNC Cable – Order 012-0482-00.
50 Ω Feedthrough Termination – Order 011-0049-01.

RECOMMENDED ACCESSORIES FOR P6204, P6205
Please see page 516.
Please see page 548.

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

CE
(1103 only)
ISO 9001
Tektronix measurement products are manufactured in ISO registered facilities.

Active FET Probes

P6201 • P6202A • 1101A



For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

CE
(1101A only)

ISO 9001
Tektronix measurement products are manufactured in ISO registered facilities.

Features – Benefits

FOR 50Ω AND 1 MΩ INTERFACES

P6201
True Signal Fidelity, DC up to 900 MHz

1.5 pF Input C*[1]

1 MΩ Input R*[1]

1X/10X/100X

AC-DC Coupling

Variable DC Offset, up to ±200 V

Selectable 50 Ω, Termination for Use with 50 Ω or 1 MΩ Inputs*[1]

*[1] *See Specifications page 507.*

P6202A
DC to 3500 MHz

2 pF Input C

10 MΩ Input R

10X/Optional 100X

AC-DC Coupling

Variable DC Offset, up to ±200 V

Selectable 50 Ω, Termination for Use with 50 Ω or 1 MΩ Inputs

1101A
Powers up to Two Probes

For Probe Use with Oscilloscopes That Do Not Have Probe Power

Compatible with the P6201, P6202A and P6230

Overload Protected

Variable DC Offset, up to ±200 V

Selectable 50 Ω, Termination for Use with 50 Ω or 1 MΩ Inputs

Applications

Digital Design and Debug of Logic Families

Component Characterization/Measurement of High-speed Analog Circuitry

Digital Design and Debug of Logic Families such as:
- ECL
- GaAs
- MOS: CMOS; FastCMOS; BiCMOS
- TTL

Component Characterization/Measurement of High-speed Analog Circuitry Relative to:
- Amplitude Levels
- Aberrations
- Propagation Delay and Timing
- Bandwidths and Rise Times

The P6201 and P6202A are Low Circuit Loading Active Signal Acquisition probes for Tektronix 400 Series, 2400 Series and 7000 Series Families of Oscilloscopes.

The P6201 and P6202A with Active FET devices in their inputs provide very high input impedances.

Both the P6201 and P6202A probes provide a wide linear dynamic input range for accessing

most digital device families using today's logic voltage levels.

The P6201 provides unity gain (1X) and is the best general purpose FET probe within its voltage range. Plug-on attenuator heads provide wider dynamic ranges (10X and 100X), while maintaining the oscilloscope readout factor.

Wider dynamic input range for the P6202A is achieved by an optional 10X attenuator head which provides 100X attenuation.

Both the P6201 and P6202A probes provide a variable DC Offset function which is set via the offset controls on the probe's compensation box to bring signals (those within the offset control range) into the dynamic range of the probe.

AC or DC coupling selection is available on the P6201 and P6202A FET Probes. When AC coupled, the DC voltage component is blocked, allowing viewing of superimposed signals.

A self-contained selectable 50 Ω termination switch allows the P6201 or P6202A to be terminated into a 50 Ω or 1 MΩ oscilloscope inputs.

Power for the P6201 and P6202A is supplied by the 400 Series, 2400 Series and 7000 Series mainframes through the optional Probe Power Jack or the 1101A Power Supply.

The P6201 or P6202A may also be used with other 50 Ω and 1 MΩ input real-time oscilloscopes, sampling systems, spectrum analyzers and counters via the 1101A and appropriate interface adapters (SMA to BNC, GR to BNC, etc.).

The 1101A power supply provides external power to probes when the oscilloscope used does not have the capability to supply probe power.

The 1101A has two power receptacles that will power up to two independent probes, such as the P6201, P6202A and P6230.

CHARACTERISTICS

Probe Type	Nominal Cable Length in Meters	Attenuation	Bandwidth at -3dB in MHz	Input C in pF	Input R in Ω	Linear Dynamic Range in Volts	DC Offset Range in Volts	Maximum Voltage in Volts (DC + pk AC)	Interface/ Readout Identify*1	Recommended Instrument
P6201	1.8	1X	900	3	100k	±0.6	±5.6	±50	BNC/Y/N	400/2400/
		10X	900	1.5	1M	±6.0	±56	±200	BNC/Y/N	7000 Series*2
		100X	900	1.5	1M	±60.0	±200	±200	BNC/Y/N	
P6202A	2	10X	500	2	10M	±6.0	±5.5	±200	BNC/Y/N	400/2400/
		100X*3	500	2	10M	±60.0	±200	±200	BNC/Y/N	7000 Series*2

*1 *Interface/Readout/Identify-AutoProbe Code: (TPB=TEKPROBE® BNC) / (TPS=TEKPROBE SMA) / (BNC=Conventional BNC) / (Y=Yes) / (N=No).*

*2 *Requires Probe Power connector on mainframe or 1101A Power Supply.*

*3 *Optional Accessory. Order 010-0384-00.*

ORDERING INFORMATION

For price information: Outside the U.S. contact your local Tektronix representative, inside the U.S. see the price list in the back of this catalog.

P6201
1X, 900 MHz FET Probe.

Includes: Retractable Probe Tip (013-0135-00); 10X Attenuator Head (010-0376-00); 100X Attenuator Head (010-0377-00); 3 Probe Tips (206-0200-00); Miniature Probe Tip Adapter (103-0164-00); 12 in. Ground Lead (175-0848-02); Ground Contact (131-1302-00); Alligator Clip (344-0046-01); Electrical Insulating Sleeve; Ground Contact Insulator (342-0180-00); Probe Holder (352-0351-00); Carrying Case; Instruction Manual (070-1306-03).

P6202A
10X, 500 MHz FET Probe.

Includes: Retractable Probe Tip (013-0097-01); 2 Alligator Clips (344-0046-01); Probe Holder (352-0351-00); 3 in. Ground Lead (175-0849-00); Probe Adjustment Tool; 6 in. Ground Lead (175-1017-00); 2 Replaceable Probe Tips (206-0230-01); Electrical Insulating Sleeve (166-0404-01); Carrying Case; Instruction Manual (070-3642-00).

ADDITIONAL ACCESSORIES
Also see page 548 and 550.

1101A POWER SUPPLY
For P6201, P6202A. Powers 2 Probes.

INTERNATIONAL POWER PLUGS (FOR 1101A)
Opt. A1 – Universal Euro, 220 V 50 Hz.
Opt. A2 – United Kingdom, 240 V 50 Hz.
Opt. A3 – Australian, 240 V 50 Hz.
Opt. A4 – North American, 240 V 60 Hz.
Opt. A5 – Switzerland, 220 V 50 Hz.

See page 619 for description.

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

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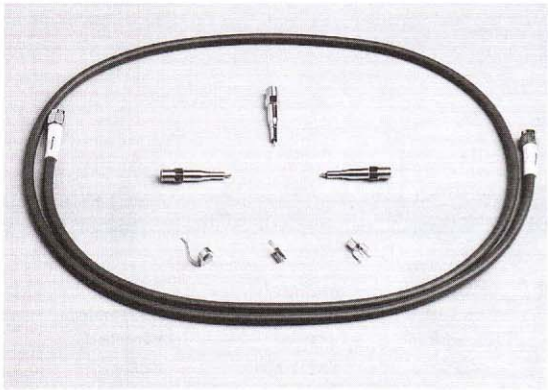
50 Ω Divider (Zo) Low Capacitance

P6150



Features – Benefits

Low Capacitive Loading to Extremely High Frequencies

Interchangeable Attenuator Tip Assemblies: 1X, 10X (P6150)

Applications

High-speed Device Characterization in Microwave Communication, Signal Processing, and Logic Applications

Propagation Delays for ECL, GaAs and Other Logic Circuitry and Devices

Circuit Board Impedance Testing (TDR)

High-speed Sampling Systems

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

ISO 9001

Tektronix measurement products are manufactured in ISO registered facilities.

P6150 DC to 9 GHz

The P6150 is a very high bandwidth, 10X attenuation, low impedance probe designed for use with the SD2X family of Sampling/TDR plug-ins. The probe consists of interchangeable, screw-in attenuator tip assemblies (1X and 10X) and an SMA-to-SMA probe cable. An assortment of circuit and grounding attachments is included to optimize attachment to the device under test while maintaining high signal integrity.

Characteristics

Nominal Length – 1 m.
Attenuation – 10X: ±2%, 1X: ±2%.
Bandwidth – 9 GHz, ≥3 GHz.
Rise Time – <38.8 ps, ≤170 ps.
Lading Input R/C – 500 Ω/<0.15 pF, 50 Ω/N/A.
Max V in – 12.5 V RMS*1.
Propagation Delay – 4.40 ns ±0.1 ns, 4.40 ns ±0.1 ns.
Interface/Readout/Identify –
Interface: B=BNC; S=SMA.
Readout/Identify: Y=Yes; N=No.
*1 *Limited by scope input or 42 V RMS.*

Ordering Information

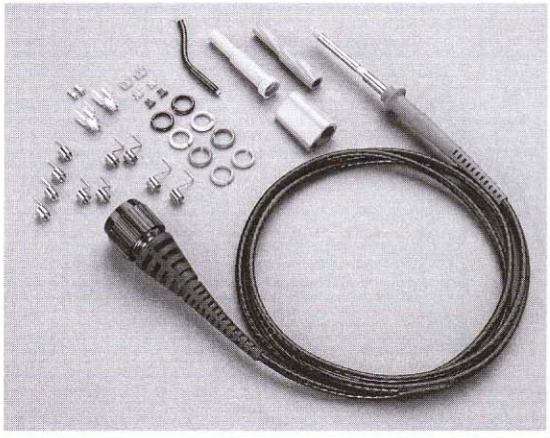
For price information:
Outside the U.S. contact your local Tektronix representative, inside the U.S. see the price list in the back of this catalog.

P6150
10X, 9 GHz, 1.0 m, Low Impedance Probe.
Includes: One 1X Attenuator Head (206-0398-00); Two 10X Attenuator Heads (206-0399-03); 1.0 m Cable Assembly (174-1341-00); Instruction Sheet (070-7173-00); and 1 Accessory Kit consisting of: 20 each Ground Clip, 3 each Adjustable Ground Lead, 10 each Electrical Contact, and 2 each Probe to Circuit Board Ground Connectors (020-1708-00).

ADDITIONAL ACCESSORIES
See pages 542, 546.
SMA Male to BNC Female – Order 015-0554-00.
SMA Female to BNC Male – Order 015-0572-00.

20X Low Capacitance Probe

P6158



Features – Benefits

- 3 GHz Bandwidth
- 1.5 pF Input Capacitance
- 1 kΩ Input Resistance
- 22 V_{rms} Max. Input Voltage
- Activates 20X Readout in TEKPROBE® Interface Instruments
- Compact Probe Tip Compatible with a Wide Range of Tektronix Accessories and Adapters

Applications

- High-speed Device Characterization
- Propagation Delays for ECL, CMOS, and Other Logic Circuitry and Devices
- Circuit Board Impedance Testing (TDR)
- High-speed Sampling Systems

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

ISO 9001

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The P6158 is a 3 GHz, 20X, low-capacitance probe. The P6158 is ideal for high-speed applications because of its ability to extend high-frequency response to 3 GHz. The BNC connector incorporates encoding to correct scale factors for 20X attenuation in oscilloscopes with TEKPROBE power supply interface. To facilitate SMD probing, the P6158 comes standard with SureFoot adapters. Additionally, the probe comes standard with an array of short ground leads that insert minimal inductance into the signal path of the measured waveform. The compact probe head/tip assembly is compatible with the full line of 3.5 mm probe accessories. Although designed for the TDS 500/600/700 series oscilloscopes, the P6158 probe may be used with 11000 Series plug-ins, and the 11800 Series SD2X Sampling/TDR plug-ins.

Characteristics

Bandwidth (Probe Only) – DC to 3 GHz, –3 dB.
Rise Time – >100 ps.
Attenuation – ÷20 (–26 dB).
Attenuation Accuracy – ±3%.
Input C – 1.5 pF.
Input R – 1 kΩ.
Output Termination – Terminate into 50 Ω.
Signal Delay – 5 ns.

PHYSICAL CHARACTERISTICS

Probe Tip/Head Style – 3.5 mm/Compact.
Output Cable Length – 1.2 m.

ENVIRONMENTAL CHARACTERISTICS

Temperature –
Operating: –15°C to +55°C (+5°F to +131°F).
Humidity –
High Operating: 55°C @ 95 to 97% RH.
Low Operating: 30°C @ 95 to 97% RH.

RECOMMENDED INSTRUMENTS

TDS 500/600/700 Series.
11000 Series.
11800 SD2X Sampling/TDR plug-ins.

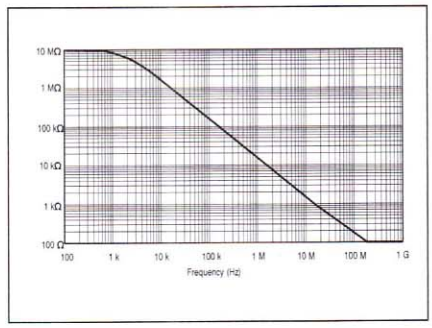

Figure 1. P6158 Attenuation vs. frequency.

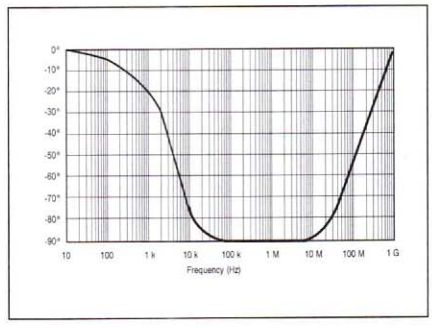

Figure 2. P6158 Input impedance and phase.

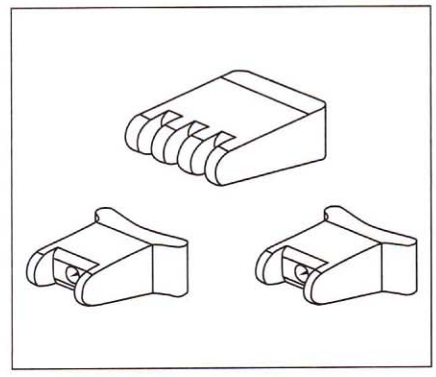

Figure 3. SF200A Series SureFoot® adapters.

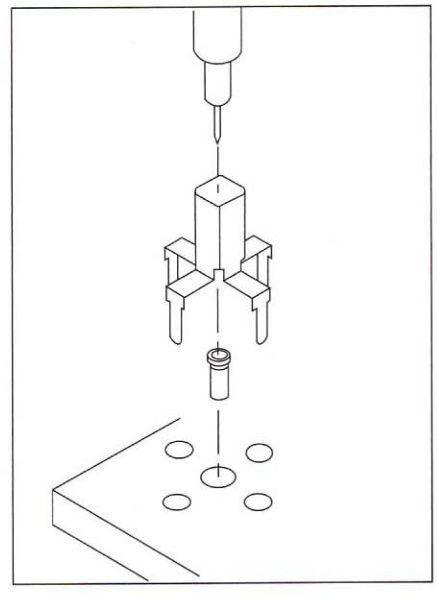

Figure 4. Compact probe tip circuit board test points.

Ordering Information

For price information: Outside the U.S. contact your local Tektronix representative, inside the U.S. see the price list in the back of this catalog.

P6158
3 GHz Low Capacitance Probe.
Includes: P6158 Probe Tip Accessory Kit (020-2232-00) with: Attenuator Tip Cover (204-1049-00); 2 ea. 50 mil, 25 mil (0.65 mm), and 0.5 mm SureFoot Adapters; 2-in. Ground Lead (195-4240-00); Ground Collar (343-1003-01); 2 ea. Ground Tip Contact, 5 lengths w/ Cover Shell (016-1077-00); 2 ea. Compact Probe Tip Circuit Board Test Points; 2 ea. Marker Set, Various Colors (016-0633-00); Instruction Manual (071-0123-00).

RECOMMENDED REPLACEMENT ACCESSORIES

SureFoot Adapter, Orange, 50 mil (12 ea.) – Order SF201A.
SureFoot Adapter, Blue, 0.65 mm/25 mil (12 ea.) – Order SF202A.
SureFoot Adapter, Red, 0.50 mm/20 mil (12 ea.) – Order SF203A.
Compact Probe Tip Circuit Board Test Points (25 ea.) – Order 131-5031-00.
Compact Probe Tip Circuit Board Test Points (100 ea.) – Order 131-4244-00.

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ISO 9001

Tektronix measurement products are manufactured in ISO registered facilities.

TIPS ON SELECTING PROBES

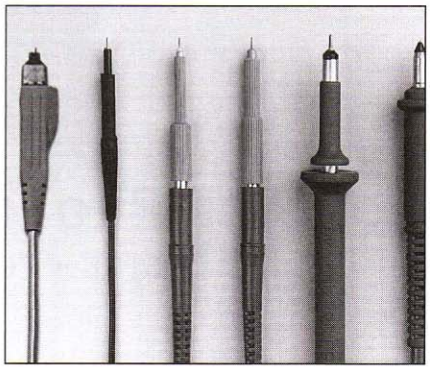
Nearly all general purpose and laboratory oscilloscopes use probes to make a direct, flexible and convenient connection to a device-under-test (DUT). Of all the different types of measurements, voltage measurements top the list by a wide margin. The ideal probe/oscilloscope combination should acquire the signal and truly represent it on the display without changing the signal source.

CONSIDER YOUR SCOPE'S . . .

- **Bandwidth** – Select a probe with equal or better bandwidth.
- **Input capacitance** – Select a probe with a compensation range covering the scope's nominal input capacitance.
- **Readout feature support** – Select a probe that provides automatic coding for scale factor.
- **Input loading** – Standard passive probes support 1 MΩ inputs. 50 Ω probes are also available in passive and active (FET) styles.

CONSIDER YOUR APPLICATION...

- **Engineering and design** – High frequency, specialty, non-absolute measurements.
- **Service** – Mixture of high and low frequency, specialty and general purpose, absolute and relative measurements.
- **Manufacturing** – Low frequency, general purpose, relative measurements.



CONSIDER YOUR MEASUREMENTS ...

- **How will probe loading affect your measurements?** High resistance probes (10 MΩ) give minimum amplitude error; however, any significant tip capacitance will degrade the leading edge.
- **What is the waveform rise time?** Passive probes work in conjunction with the scope's input circuitry to provide a system bandwidth.
- **What is the peak voltage?** Passive probes typically have 420 V peaks. High voltage probes can handle 1.5 kV to 40 kV.
- **What is the waveform amplitude?** Maximum input voltage for a passive probe is stated as DC plus peak AC. This is also the maximum safe input before electrical damage occurs.

CONSIDER YOUR MECHANICAL REQUIREMENTS . . .

- **Probe size** – Small probes are easier to handle and attach to test points. Larger probes are more durable.
- **Tip type** – Probe tip durability is affected by materials and design. Tektronix' most durable configuration for passive voltage probes is the miniature type which is supported by a wide variety of tip accessories for test point connection. The compact probe configuration offers improved electrical performance. Subminiature probe types are useful for probing high density circuitry where several probes have to be attached in close proximity.
- **Environmental conditions** – Probes are expected to be exposed to harsh conditions in the field, but often overlooked are the rigors of daily use and abuse that general purpose probes are most likely to experience.

Passive voltage probes are the most commonly used oscilloscope probe. Other specialty probes expand the range and functionality of an oscilloscope as a measurement system, but a general purpose, passive voltage probe is the working end of the oscilloscope, a tool used and abused every day without concern by engineers and technicians. The probe's utility is often taken for granted... that is, until it doesn't work. Then it's a scramble just to complete the simplest task.

Passive Voltage Probes

P6101B • P6103B • P6109B • P6111B • P6112 • P6114B • P6117 • P6119B • P6129B • New P3010



Features – Benefits

- Molded Passive Voltage Probes
- Single Piece, Molded Rubber Body
- Lightweight Ergonomic Design
- 10 Times Improvement in Durability
- HYBRID/SMT Circuitry on Multi-layer Circuit Board for Improved Performance and Reliability
- New Stronger Replaceable Probe Tip
- Safety Certification
- 1 Year Unconditional Guarantee
- Miniature Probe Tip Compatible With a Wide Range of Tektronix Accessories and Adapters

Applications

- Mixture of High, Medium and Low Frequency General Purpose Relative Measurements
  - Engineering and Design
  - Service
  - Manufacturing

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

CE
(except P6119B • P6129B)

ISO 9001

Tektronix measurement products are manufactured in ISO registered facilities.

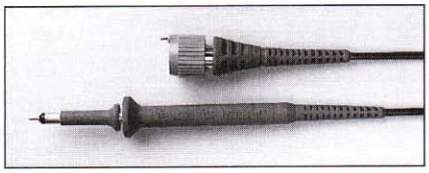
Two years of customer research, design innovation and an exhaustive test program resulted in a most remarkable family of oscilloscope probes. This family of passive voltage probes is specifically designed for Tektronix' analog and digital portable oscilloscopes. The 1X, 10X and 1X/10X switchable probes combine the same high quality electrical performance that customers expect from Tektronix with a new rugged mechanical design.

These probes are encased in a resilient, molded rubber body that is virtually indestructible. They are lighter in weight, more comfortable to hold and more reliable than modular probe styles. The probes' replaceable tips are designed to withstand up to 20 pounds of force. Patented integral strain relief allows complete freedom of movement while providing superior cable flex. Each probe has received UL safety certification and meets MIL-T-28800, Class 3, environment specifications – something portable scope users will appreciate.

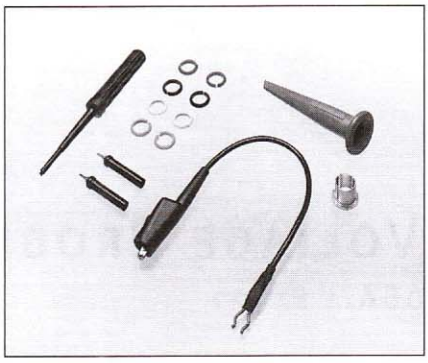
The P6101B, P6103B, P6109B, P6111B, P6112, P6114B, P6117, P6119B, P6129B and P3010 probes are designed to complement Tektronix' family of portable DSO and ART instruments. The core of each probe's performance is supplied by a Tektronix HYBRID/SMT device.

Tektronix' instrumentation experience provides an extra margin of quality and reliability to the molded probes that is not commonly available to probe manufacturers. These molded probes have been designed and tested to support the overall system performance and measurement quality that Tektronix oscilloscopes guarantee.

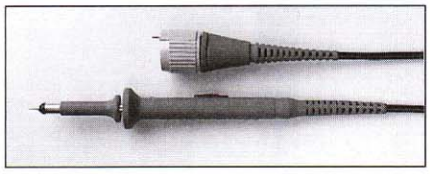
Through the introduction of the molded probes, Tektronix has set a new standard for passive voltage probe styling, performance and durability.



P6109B/P3010.



Standard Accessories.



P6129B.

Characteristics

Type	Attenuation	Bandwidth Megahertz (MHz)	Comp. Range Picofarads (pF)	System Input Resistance (Megaohm)	Typical Input C Picofarads (pF)	Maximum Voltage DC+pk AC (volts)	Readout	Scope/Product
P6101B	1X	15	NA	1	100	300 V RMS		All Scopes
P6103B	10X	60	15 to 35	10	13	300 V RMS		2201, 2205, 2212, 2214, 2225, TAS 220, TAS 250
P6109B	10X	100	15 to 35	10	13	300 V RMS	X	2211, 2221, 2224, 2230, 2232, 2235A, 2236A, 2245A, 2246A, 2247A, 2252, TAS 455, TAS 465, TAS 475, TDS 310, TDS 320, TDS 340, TDS 340A
P6111B	10X	200	15 to 35	10	14	300 V RMS	X	TAS 485, TDS 350, TDS 360
P6112	10X	100	15 to 35	10	13.3	300 V RMS		TDS 200
P6114B	10X	400	10 to 35	10	14.1	300 V RMS	X	TDS 380
P6117	10X	200	15 to 35	10	13.3	300 V RMS		THS 700
P6119B	1X/10X	10/100	15 to 35	10	100/18	420		2201, 2205, 2212, 2214, 2225, TAS 220, TAS 250
P6129B	1X/10X	10/100	15 to 35	10	100/18	420	X	2211, 2221, 2224, 2230, 2232, 2235, 2236A, 2245A, 2246A, 2247A, 2225, TAS 455, TAS 465, TAS 475, TDS 310, TDS 320, TDS 350, TDS 360, TDS380
P3010	10X	100	15 to 35	10	13	300 V RMS	X	TDS 3012, TDS 3014

Ordering Information

For price information: Outside the U.S. contact your local Tektronix representative, inside the U.S. see the price list in the back of this catalog.

P6101B

1X, 15 MHz Passive Voltage Probe.

Includes: 4 Pairs of Colored Cable Markers; Retractable Hook Tip; 6 in. Ground Lead; 2 Replacement Probe Tips; BNC to Probe Tip Adapter; Adjustment Tool; Storage Pouch; Instruction Manual (070-7819-07).

P6103B

10X, 60 MHz Passive Voltage Probe.

Includes: Same as P6101B except Instruction Manual (070-7847-06).

P6109B

10X, 100 MHz Passive Voltage Probe with Readout.

Includes: Same as P6101B except Instruction Manual (070-7849-06).

P6111B

10X, 200 MHz Passive Voltage Probe.

Includes: Same as P6101B except Instruction Manual (070-8543-05).

P6112

10X, 100 MHz Passive Voltage Probe.

Includes: 4 Pairs of Colored Cable Markers; Retractable Hook Tip; 6 in. Ground Lead; BNC to Probe Tip Adapter; Adjustment Tool; Instruction Manual (070-9694-00).

P6114B

10X, 400 MHz Passive Voltage Probe.

Includes: Same as P6112 except Instruction Manual (070-9491-02).

P6117

10X, 200 MHz Passive Voltage Probe.

Includes: Same as P6112 except Instruction Manual (070-9729-00).

P3010

10X, 100 MHz Passive Voltage Probe.

Includes: Same as P6101B except Instruction Manual (071-0466-00).

P6119B

1X/10X, 10/100 MHz Passive Voltage Probe.

Includes: 4 Pairs of Colored Cable Markers; Retractable Hook Tip; 6 in. Ground Lead; 2 Replacement Probe Tips; BNC to Probe Tip Adapter; Adjustment Tool; Storage Pouch; Instruction Manual (070-8000-05).

P6129B

1X/10X, 10/100 MHz Passive Voltage Probe with Readout.

Includes: 4 Pairs of Colored Cable Markers; Retractable Hook Tip; 6 in. Ground Lead; 2 Replacement Probe Tips; BNC to Probe Tip Adapter; Adjustment Tool; Storage Pouch; Instruction Manual (070-8547-05).

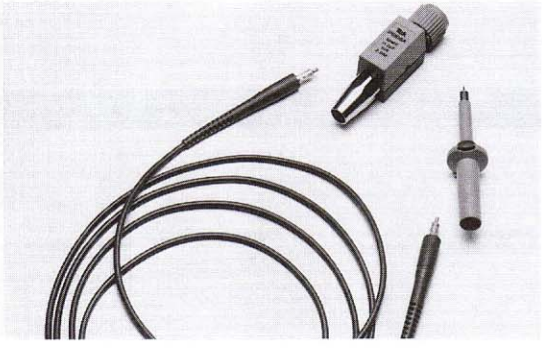
RECOMMENDED ACCESSORIES

See page 548.

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

Passive Voltage Probes

P6105A • P6106A • P6122



Features – Benefits

100 MHz (P6105A)

250 MHz (P6106A)

100 MHz (P6122)

Modularity Readout/Ground Reference

Rugged Construction

Applications

Mixture of High Medium and Low Frequency General Purpose Measurement
- Engineering
- Service
- Manufacturing

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

CE

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Tektronix measurement products are manufactured in ISO registered facilities.

Modular Probes

Technological gains have allowed performance improvements over time, but the basic look and feel established by Tektronix remains. Because of this, Tektronix scopes 10 and even 20 years old are still being used. We call these the Classics. Some of these older instruments have special probe requirements.

Tektronix modular probes are designed to save you money in repair and maintenance over the life of the probe. The three modules, probe head, cable and connector quickly snap or screw together, eliminating the need for soldering. Spare modules can be ordered and stocked, reducing downtime and eliminating the need to send a probe in for repairs. Modularity, rugged construction and highly reliable hybrid circuitry make these Tektronix probes a cost-effective probing solution.

Type	Length Meters	Atten.	Bandwidth	Comp. Range pF	System Input Resistance MΩ	Typical Input C pF	Ground Reference	Readout	Scope/Product Compatibility
P6105A	2	10X	100	15 to 35	10	11	X	X	434, 455, 464, 464M, 465, 466, 468, 475, 485, 7A16, SC504
Opt. 01	1		100			9			
P6106A	2	10X	250	15 to 35	10	11	X	X	475, 485, DC 503A, DC 5009, DC 5010
Opt. 01	1		250			9			
P6122	1.5	10X	100	15 to 35	10	11			2201, 2205, 2212, 2214, 2225

Note: Maximum voltage DC + peak AC ≤500.

Ordering Information

For price information:
Outside the U.S. contact your local Tektronix representative, inside the U.S. see the price list in the back of this catalog.

P6105A 10X, 100 MHz Modular Probe.
Includes: Retractable Hook Tip; Probe Tip Ground Cover; 5 in. Ground Lead, 12 in. Ground Lead; Alligator Clip; 4 Pairs of Colored Cable Markers; Adjustment Tool; Instruction Sheet (070-5516-02).

P6106A 10X, 250 MHz Modular Probe.
Includes: Same as P6105A except 3 in. Ground Lead instead of 12 in. Ground Lead; Instruction Sheet (070-5517-02).

P6122 10X, 100 MHz Modular Probe.
Includes: Same as P6105A; Instruction Sheet (070-5512-00).

OPTIONAL CABLE LENGTHS (P6105A, P6106A)
Opt. 01 – 1 Meter Cable.

RECOMMENDED ACCESSORIES
Also see page 548.

Passive High Voltage Probes

P5102



Features – Benefits

100 MHz Bandwidth

Up to 1,000 V_{rms}

10X Attenuation

UL3111-1, CSA1010.1, EN61010-2-031

Applications

Power Supply Design

Motor Drive Design

Electronic Ballast

Power Semiconductors

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

CE

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IsolatedChannel™ Applications

In many applications, it is important to be able to isolate the measurement from earth ground and also to isolate the common voltage between channels. With the P5102 and the THS 700 Series handheld digital storage oscilloscopes you have not only the isolation for the measurement from earth ground, but you also have full isolation between the two channels.

The P5102 was designed to give you this isolated channel performance for up to 1000 V AC RMS on the 100 MHz probe. A variety of screw-on accessories provides easy connection to the device under test.

Characteristics

Nominal Length – 2 m.
Attenuation – 10X.
Bandwidth – 100 MHz.
Rise Time – ≤3.5 ns.
Loading – 5 MΩ/11.2 pF.
Max Input V – 1000 V AC RMS.
Max Float – 600 V AC RMS.
Compensation Range – 24 to 28 pF.

Ordering Information

For price information:
Outside the U.S. contact your local Tektronix representative, inside the U.S. see the price list in the back of this catalog.

P5102
10X, High Voltage Probe for THS 700 Series.
Includes: Large Retractable Hook Tip, Small Retractable Hook Tip, 6 in. Common Lead, 18 in. Common Lead, Large Crocodile Clip, Colored Cable Markers, Adjustment Tool, Instruction Manual (070-9294-01).

RECOMMENDED ACCESSORIES
Also see page 551.

Passive Voltage Probes

YT5060



Features – Benefits

- 1X/10X Attenuation
- 60 MHz Bandwidth
- 1.5 Meter Length
- UL3111-1, CSA1010.1, EN61010-2-031

Applications

- Relative Low Frequency Measurements
- Power Supplies
- Low Frequency Amplifiers

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

NOT AVAILABLE IN EUROPE.

YT5060 Passive Voltage Probe

The YT5060 60 MHz Passive Voltage Probe permits selection of 1X or 10X attenuation, using a switch located on the probe head.

This probe is compatible with general purpose oscilloscopes having an input capacitance between 20 and 40 pF.

Characteristics

X10 POSITION

Bandwidth – DC: 60 MHz (YT5060).
Probe Length – 1.5 m.
Attenuation Ratio – 10:1.
Compensation Range – 20 to 45 pF.
Input Capacitance – 16.6 pF.
Input Resistance – 10 MΩ.
Maximum Input Voltage – 300 V CAT II.

X1 POSITION

Bandwidth – DC: 4 MHz (YT5060).
Probe Length – 1.5 m.
Attenuation Ratio – 1:1.
Compensation Range – All scopes with 1 MΩ input.
Input Capacitance – 110 pF.
Input Resistance – 1 MΩ.
Maximum Input Voltage – 150 V RMS.

Ordering Information

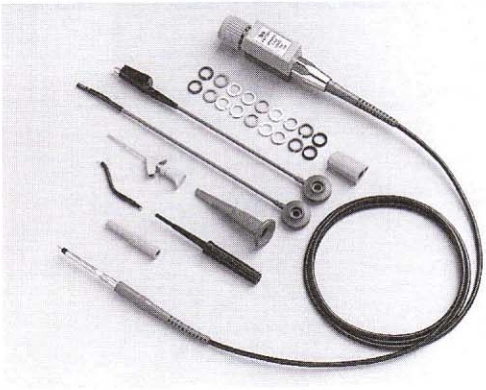
For price information:
Outside the U.S. contact your local Tektronix representative, inside the U.S. see the price list in the back of this catalog.

YT5060
1X/10X, 60 MHz Passive Voltage Probe.
Includes: Retractable Hook Tip (013-0107-07), 6 in. Ground Lead (196-3120-01), Instruction Manual (070-9323-00).

RECOMMENDED ACCESSORIES
See page 548.

Passive Voltage Probes

P6131 • P6133 • P6134C • P6136 • P6137 • P6138A • P6139A



Features – Benefits

Small Geometry Tips – Easier Circuit Access

Readout for 10X Attenuation Factor – Reduces Confusion and Errors in Measurement Readings

Flexible Lightweight Cable – Easier to Use and Reduces Mechanical Stress to Device Under Test

HYBRID/SMT Circuitry – Provides Improved Performance and Reliability

Modularity – Provides Lower Cost of Ownership

Compact Size Accessories – Provides Compatibility with Existing Adapters

UL1244, CSA231, (except P6138A: UL3111-1, CSA1010.1, EN61010-2-031)

Applications

High and Low Frequency Relative Measurements for:

- Design
- Service
- Manufacturing

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

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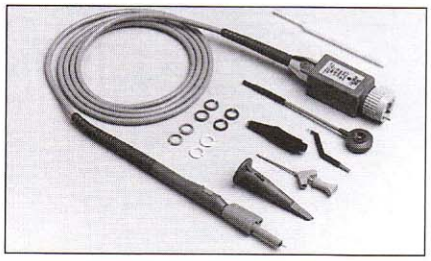
The P613X family of oscilloscope probes sets the standard for high performance passive voltage probes. Continued growth of the family paces Tektronix' new series of high performance bench top oscilloscopes, the TDS 500/600/700/3000 Series and high performance portable oscilloscopes and the TDS 400 Series.

These probes feature modular construction, HYBRID/SMT circuitry, a smaller probe head/cable assembly than traditional passive probes, 10X attenuation readout encoding and a full complement of attachment accessories. Smaller probe tips and lightweight cable assemblies allow easy negotiation of dense circuitry or tight spaces.

The compact probe head/tip assembly is compatible with the full line of compact accessories. When the Subminiature/Compact-to-Miniature probe tip adapter (013-0202-03) is installed over the probe head/tip, the P6138A and P6139A probes are fully compatible with all miniature tip accessories.

The P6139A probe has been specifically designed for the TDS 500/600/700/3000 Series of oscilloscopes to provide 500 MHz bandwidth at the probe tip, while presenting an 8 pF/10 MΩ input impedance to the circuit under test. Similarly, the P6138A's design meets the TDS 400 Series signal path requirements, helping to ensure the highest accuracy ever in a general purpose oscilloscope.



P6137.

CHARACTERISTICS

Type	Cable Length in Meters	Bandwidth MHz	Atten.	Comp. Range pF	Input C pF	System Input Resistance MΩ	Readout	ID/ Ground Ref.	Scope/Product Compatibility
P6131	1.3	300	10X	14 to 18	10.8	10	X		2400 Series (2445, 2465)
Opt. 02	2	250			13.5				
Opt. 03	3	150			14.5				
P6133	2	150	10X	10 to 25	12.7	10	X		2400 Series (2430/A/M, 2445A, 2445B)
Opt. 01	1.3	150			11.4				
Opt. 03	3	120			14.5				
Opt. 25	1.3	150			10.8				
P6134C	1.5	400	10X	12 to 18	11.3	10	X	X	11000 Series (11A32, 11A34)
P6136	1.3	350	10X	12 to 18	10.8	10			2400 Series (2431L, 2439, 2455 A/B, 2465A, 2467)
Opt. 25	1.3	350			10.8				
P6137	1.5	400	10X	12 to 18	10.8	10	X		X 2400 Series (2432/A/M, 2440/MU, 2445B, 2465B, 2467B/HD)
P6138A	1.3	400	10X	12 to 18	10	10	X	X	TDS 400 Series
P6139A	1.3	500	10X	8 to 12	8	10	X	X	TDS 500, 600, 700 and 3000 Series

Note: Maximum voltage DC + peak AC ≤ 500: Opt. 25 substitutes Compact for Subminiature tip.

ORDERING INFORMATION

For price information: Outside the U.S. contact your local Tektronix representative, inside the U.S. see the price list in the back of this catalog.

P6131
10X, 300 MHz Modular Subminiature Probe.
Includes: Rectractable Hook Tip; Adjustment Tool; 8 in. Ground Lead; 6 in. Ground Lead; 2 in. Ground Lead with Alligator Clip; Probe Holder; 4 Pairs of Colored Cable Markers; Instruction Sheet (070-5514-02).
Opt. 02 – 2 meter cable.
Opt. 03 – 3 meter cable.

P6133
10X, 150 MHz Modular Subminiature Probe.
Includes: Same as P6131 except Instruction Sheet (070-5795-03).
Opt. 01 – 1.3 meter cable.
Opt. 03 – 3 meter cable.
Opt. 25 – 1.3 meter cable and compact tip.
Includes: Same as P6137 except Instruction Sheet (070-5795-03).

P6134C
10X, 400 MHz Modular Compact Probe.
Includes: Adjustment Tool; Retractable Hook Tip; 2 in. Ground Lead; 6 in. Ground Lead; Miniature Alligator Clip; SMT KlipChip™; 4 Pairs of Colored Cable Markers; Instruction Sheet (070-7676-01).

P6136
10X, 350 MHz Modular Subminiature Probe.
Includes: Same as P6131 except Instruction Sheet (070-5795-03).
Opt. 25 – 1.3 meter cable and compact tip.
Includes: Same as P6137 except Instruction Sheet (070-6025-03).

P6137
10X, 400 MHz Modular Compact Probe.
Includes: Adjustment Tool; Retractable Hook Tip; 2 in. Ground Lead; 6 in. Ground Lead with 0.025 in. Square-pin Receptacle; 6 in. Ground Lead with Alligator Clip; SMT KlipChip™; Low Inductance Lead Ground Collar; 4 Pairs of Colored Cable Market; Instruction Sheet (070-6432-02).

P6138A
10X, 400 MHz Modular Compact Probe.
Includes: Adjustment Tool; Retractable HookTip; 2 in. Ground Lead; 6 in. 2 each of SureFoot® Tip Guides Ground Lead with 0.025 in. Square-pin Receptacle; 6 in. Ground Lead with Alligator Clip; SMT KlipChip™; Low Inductance Lead Ground Collar; 2 in. Low Inductance Ground Lead; 4 Pairs of Colored Cable Markers; Accessory Pouch; Instruction Sheet (063-0835-00).

P6139A
10X, 500 MHz Modular Compact Probe.
Includes: Same as P6138A except Instruction Sheet (063-0870-02).

OPTIONAL ACCESSORIES

Conversion Kit – Subminiature tip to compact tip.
P6131. Order 040-1251-02.
P6133. Opt. 01. Order 040-1250-02.
P6136. Order 040-1253-02.

RECOMMENDED ACCESSORIES

See pages 544-549.

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

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Buffered Passive Probe

P6339A



Features – Benefits

- 300 VRMS Maximum Input Voltage
- 8 pF Input Capacitance
- 10 MΩ Input Resistance
- Scope Controlled Parameters
- Connects to TEKPROBE III Interface Instruments
- Compact Probe Tip Compatible with a Wide Range of Tektronix Accessories and Adapters
- TEKPROBE III Interface Allows Control of Key Probe Parameters
  - Input Gain
  - AC/DC Coupling
  - Bandwidth Limiting
  - DC Offset

Applications

- General Purpose
- Digital Design
- Power Device Characterization
- Mixed Signal

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

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DESIGNED FOR TEKPROBE® III AND TDS 794D

The P6339A 500 MHz Buffered Passive Probe is a revolutionary leap in probe technology. The P6339A's wide dynamic range makes it ideal for general purpose measurement applications.

To facilitate SMD probing, the P6339A comes standard with a set of SureFoot® adapters. The compact probe head/tip assembly is compatible with the full line of 3.5 mm (compact) accessories. The P6339A probe is designed exclusively for the TDS 794D and TEKPROBE III instruments.

Characteristics

WARRANTED SPECIFICATIONS

Maximum Input Voltage – 300 Vrms.

Voltage Sensitivity – 10 mV/div to 100 V/div in a 1, 2, 5 sequence.

DC Attenuation Accuracy – ±4%.

Output Offset – ≤±5 mV.

TYPICAL SPECIFICATIONS

Bandwidth – DC to 500 MHz.

Rise Time – 700 ps.

Input C – 8 pF.

Input R – 10 MΩ.

Bandwidth Limit – Selectable 20 MHz and 150 MHz.

Coupling – AC/DC, <10 Hz Cutoff.

Output Termination – TEKPROBE III interface/50 Ω termination.

PHYSICAL CHARACTERISTICS

Probe Tip/Head Style – 3.5 mm/Compact.

Output Cable Length – 1.3 m.

ENVIRONMENTAL CHARACTERISTICS

Temperature –
Operating: +10°C to +40°C (+50°F to +104°F).

Safety – UL3111-1, CSA1010.1, EN61010-1, EN61010-2-031.

RECOMMENDED INSTRUMENTS

TDS 794D, TDS694C and other TEKPROBE III products.

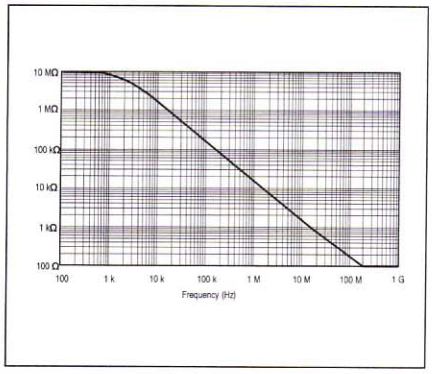

Figure 1. P6339A input impedance.

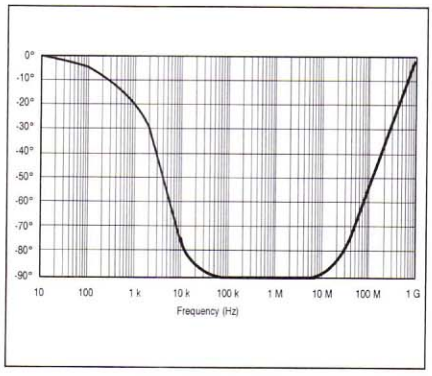

Figure 2. P6339A input phase.

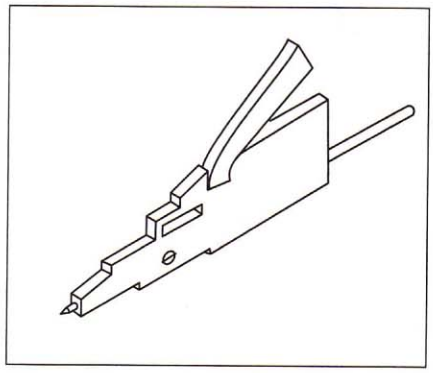

Figure 3. SMK4 Micro KlipChip™ adapter.

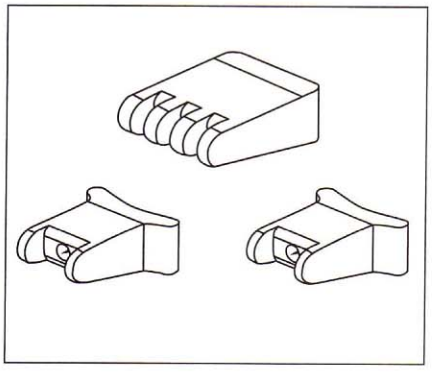

Figure 4. SF200A Series SureFoot® adapters.

ORDERING INFORMATION

For price information: Outside the U.S. contact your local Tektronix representative, inside the U.S. see the price list in the back of this catalog.

P6339A
500 MHz Buffered Passive Probe.
Includes: Adjustment Tool (003-1433-00); Attenuator Tip Cover (204-1049-00); Retractable Hook Tip (013-0107-07); 2 ea. 50 mil, 25 mil (0.65 mm), and 0.5 mm SureFoot Adapters; 2-in. Ground Lead (195-4240-00); 6-in. Ground Lead with 0.025 in. Square-pin Receptacle (196-3113-02); 6-in. Ground Lead with Alligator Clip (196-3305-00); SMT KlipChip (206-0364-00); Low Inductance Lead Ground Collar (343-1003-01); 2-in. Low Inductance Ground Lead (195-4240-00); 2 ea. Pairs of Colored Cable Markers (016-0633-00); Accessory Pouch; Instruction Sheet (071-0178-00).

RECOMMENDED/REPLACEMENT ACCESSORIES

SureFoot Adapter, Orange, 50 mil (12 ea.) – Order SF201A.

SureFoot Adapter, Blue, 0.65 mm/25 mil (12 ea.) – Order SF202A.

SureFoot Adapter, Red, 0.50 mm/20 mil (12 ea.) – Order SF203A.

KlipChip Adapter (20 ea.) – Order SMG50.

Micro KlipChip Adapter (4 ea.) – Order SMK4.

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

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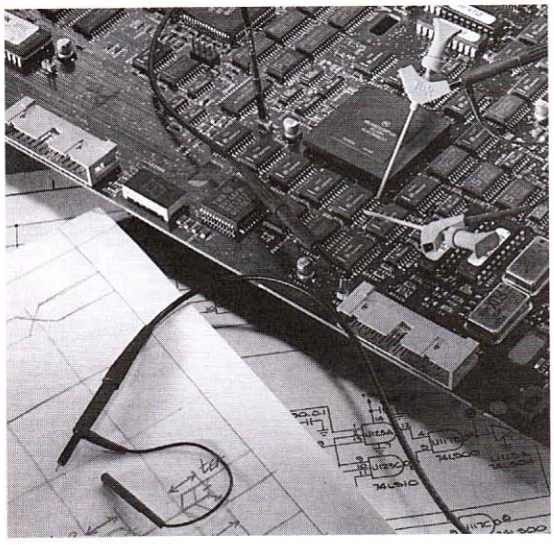
Small Geometry Probes

P6561A • P6562A • P6563A



Features – Benefits

CIRCUIT COMPATIBILITY

CMOS, BiCMOS, FastCMOS, TTL, ECL

SCOPE COMPATIBILITY

TDS Series, TAS Series, 2400 Series, 11000 Series

FOR SURFACE MOUNT DEVICES

SMD PACKAGE SUPPORT

50 mil SO/SOIC

50 mil QUAD

25 mil JEDEC

0.5 mm EIAJ

0.65 mm EIAJ

Applications

Easy Access

General Purpose Relative Measurements

Digital Design

Device Characterization

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

ISO 9001

Tektronix measurement products are manufactured in ISO registered facilities.

The P6561A, P6562A, and P6563A are scaled for surface mounted IC packages.

Their low-mass probe body is only 1.5 inches long and 100 mils wide.

Designed to match the oscilloscope's performance, these probes provide solutions for the most popular EIAJ and JEDEC surface mount packages.

SURFACE MOUNT DEVICE PROBING

While instrumentation improvements have provided a steady stream of digital troubleshooting tools, the physical challenges associated with probing small geometry ICs have gone unaddressed until now. SMD probes from Tektronix provide circuit designers the first complete, off-the-shelf solution for probing small geometry IC packages.

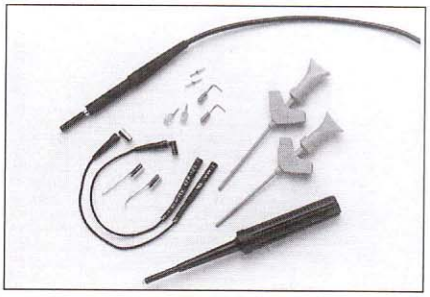
UNIQUE UTILITY

The basic contact of the SMD probe family is a 25 mil socket that accepts square or round pins. A variety of tip adapters permits convenient, non-destructive, temporary connection to the most popular EIAJ and JEDEC surface mount packages.

EXCEPTIONAL PERFORMANCE

Each SMD probe is designed to minimize capacitive loading on TTL, ECL, CMOS, FastCMOS and BiCMOS circuits. The probe and oscilloscope form a measurement system optimized for circuit designers by providing fast transient response, high system bandwidth and low capacitive circuit loading.

Figure 1 presents a sample conversion of the SMD probe family's capacitive circuit loading to an equivalent number of typical CMOS gates. Being aware of the potential effects of probe loading on the circuit under test can eliminate chasing false indicators, reduce test times and lead to more accurate and repeatable measurements.

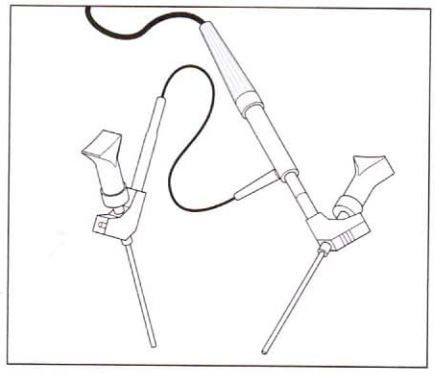


SMD Standard Accessories.

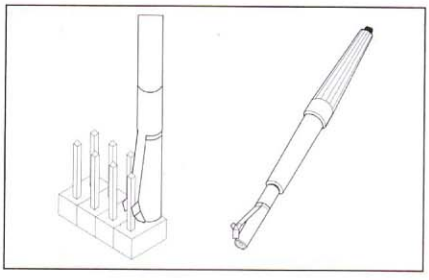
Scope Series	Probe	Equivalent Loading*
TAS 400 & TDS 300	P6561AS	
TDS 400, 2400 & 1100	P6562AS	
TDS 500/600	P6563AS	

*CMOS Load = 3.0 pF per Gate
Drive = 25 pF per Gate

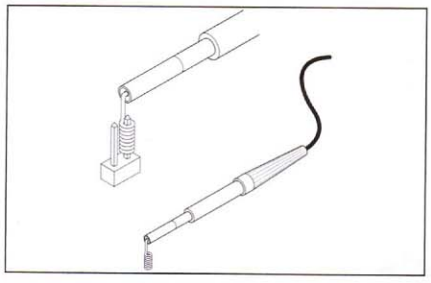
Figure 1.



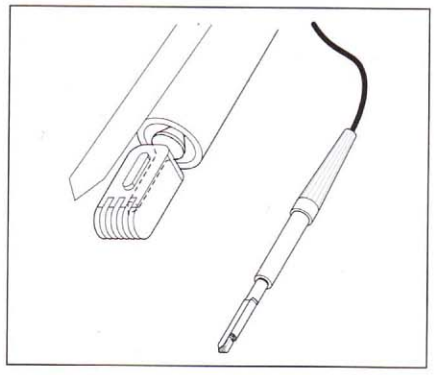
SOIC/SOP Small Outline Packages – 50 mil center lead spacing.



Signal-ground Pair – 25 mil Square-pin headers on 100 mil centers.



Circuit Boards in System Enclosures – 25 mil Square-pin headers on 100 mil centers.



PQFP and Quad Packages – JEDEC 25 mil center lead spacing. EIAJ 0.5 and 0.65 mm center lead spacing.

Characteristics

Probe Set	P6561A	P6562A	P6563A
Digitizing Oscilloscopes	TDS 300	TDS 400, 2400, 11000	TDS 500/600/700 Series
Analog Oscilloscopes	TAS 400	2400	
Scope Plug-ins		11A32, 11A34/V	
Bandwidth (–3 dB)	200 MHz	350 MHz	500 MHz
Rise Time (typical)	<1.85 ns	<1.1 ns	<800 ps
Uniform Signal Delay	±150 ps	±125 ps	±100 ps
Attenuation	10X	10X	20X
Device Loading Capacitance (typical)	<11 pF	<11 pF	<5 pF
Device Loading Resistance	10 MΩ	10 MΩ	9.5 MΩ
Maximum Non-destructive Input Voltage	42 V (DC + peak AC)	42 V (DC + peak AC)	42 V (DC + peak AC)
Compensation Range	15 pF – 35 pF	12 pF – 35 pF	7 pF – 30 pF
Length	1.3 m	1.3 m	1.3 m

Ordering Information

For price information: Outside the U.S. contact your local Tektronix representative, inside the U.S. see the price list in the back of this catalog.

P6561A
200 MHz, 10X SMD Probe.
Includes: 2 ea. of 3 Pitches SureFoot® Tip Guides, 4 in. Ground Leads, Signal-ground Adapters, Blade-ground Adapters, and 1 ea. Adjustment Tool and Instruction Sheet.

P6562A
350 MHz, 10X SMD Probe.
Includes: 2 ea. of 3 Pitches SureFoot Tip Guides, 4 in. Ground Leads, Signal-ground Adapters, Blade-ground Adapters, and 1 ea. Adjustment Tool and Instruction Sheet.

P6563A
500 MHz, 20X SMD Probe.
Includes: 2 ea. of 3 Pitches SureFoot Tip Guides, 4 in. Ground Leads, Signal-ground Adapters, Blade-ground Adapters, and 1 ea. Adjustment Tool and Instruction Sheet.

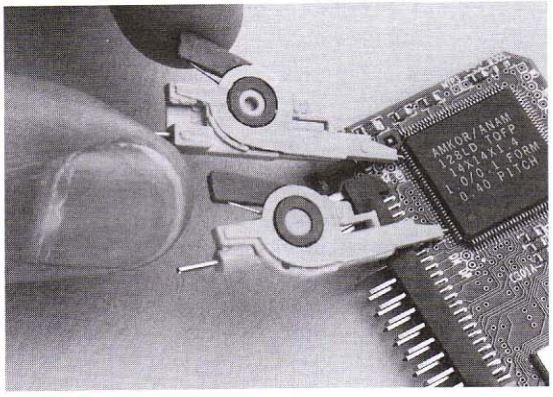
MEASUREMENT SERVICE OPTIONS
Please see the Customer Information pages 615.

RECOMMENDED ACCESSORIES
See page 542.

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

SMD Interconnects, Articulated Arms

SMK4 • SMG50 • SMCK1/QK1 • SureFoot® • ST501 • PPM203B/007



Features – Benefits

MICRO KLIPCHIP™ ADAPTER SMK4
Hand Probe Fine Pitch SMD Package
- 25 mil JEDEC, 0.65 mm EIAJ, 0.5 mm EIAJ

Thin Clip Body Width Allows Many PQFP Clips to Be Mounted Side by Side and Simultaneously tested

SureFoot ADAPTERS SF200A AND SF500 SERIES
Hand Probe Fine Pitch SMD Packages
- 25 mil JEDEC, 0.65 mm EIAJ, 0.5 mm EIAJ

SMT KLIPCHIP ADAPTER SMG50
Access to 0.050 in. Centers PLCC, SOIC and Other Packages

PLCC/SOIC ADAPTER KITS SMCK1 AND SMQK1
Assortment of SOIC or PLCC Clips

Leads and SMT KlipChip Included

Signal Insertion and Temporary Lead Jumpers Without Soldering

Mechanically Assisted Probing
- Three-axis Articulated Arm with Hi-mass Base

Applications

Research and Design
Manufacturing Test of SMD Circuitry
Servicing of SMD Circuitry
Prototype Debug and Design

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

ISO 9001

Tektronix measurement products are manufactured in ISO registered facilities.

Surface Mount Device Probing and Interconnects

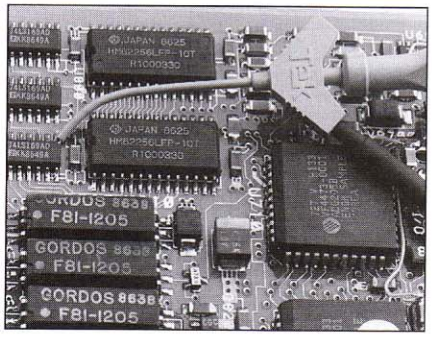
The increasing use of surface mount technology (SMT) brings many benefits to electronic circuit board (ECB) design and manufacture. Among these are increased circuit density, increased product reliability and lower assembly costs.

Troubleshooting and device interconnection, however, have become more difficult due to decreased device size, tighter lead spacing and increased ECB densities. Tektronix' offering of the following SMT probing and interconnect devices meets these demanding requirements.

SMK4 Micro KlipChip Adapter

The SMK4 is an interface device which can attach to fine-pitch IC leads similar to the SMG50. The difference between the SMK4 and the SMG50 is the size. The SMK4 can be used to attach to PQFP packages up to a pitch of 0.5 mm which is five times smaller than the SMG50.

The kit of four 0.5 mm SMK4 Micro KlipChip Adapters are for use as probe tip accessory replacements with the P6247/P6246 and as a recommended accessory for the probes listed below, which can attach to the SMK4 0.025 in. lead.

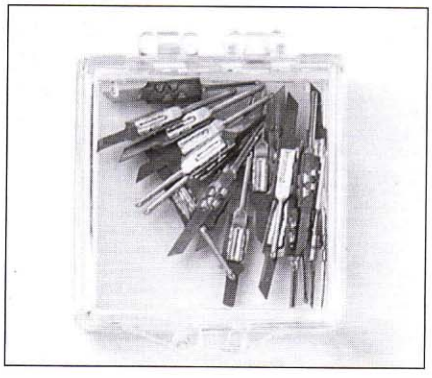


SMT KlipChip Adapter.

SMG50 KLIPCHIP™ ADAPTER

The SMT KlipChip adapter is an interface device for attachment of logic and analog probes to today's SMDs, DIPs, and discrete components. The SMT KlipChip adapter is capable of attaching to components with maximum lead diameters of 0.095 inches and stackable on lead centers of 0.050 inches. Dual sided 0.025 inch lead contacts allow this grabber to be used in multiple signal insertion/acquisition.

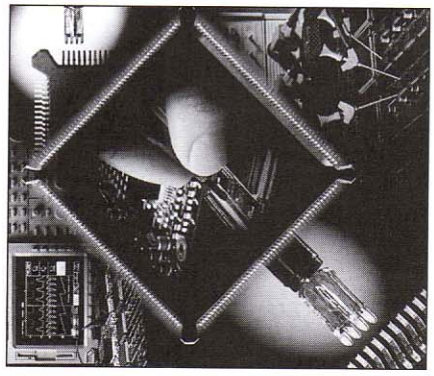
Available as package of 20 (SMG50), or singularly (206-0364-00).



ST501 SURETOE

FOR 0.010 IN. SPACING

Insulated Suretoe protects adjacent legs. Allowing signal acquisition of its neighbor.



Surefoot SF Series.

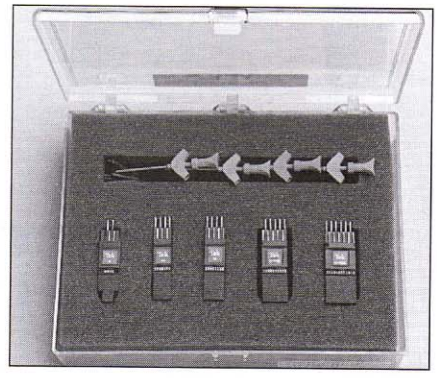
SUREFOOT ADAPTER

PROBING 25 MIL JEDEC, 0.65 AND 0.5 MM EIAJ PACKAGES

SureFoot is an integral probe tip and miniature guide that enables fault-free "hands-on" probing of fine-pitch SMD packages. Guided by the IC's leads, SureFoot's miniature plastic tines align the probe before electrical contact is made. The tines also form a shield between IC leads, preventing the probe tip from shorting adjacent pins.

SureFoot conforms to EIAJ (Electronic Industry Association of Japan) or JEDEC (Joint Electron Device Engineering Council) packaging standards, assuring quick and reliable probe contact with fine-pitch IC leads.

Several color coded versions of SureFoot are available, addressing the most common SMD packages. The yellow version fits the 50 mil (JEDEC) center packages. The blue version fits both the 25 mil (JEDEC) and the .65 mm (EIAJ) center packages. Finally, the red versions fits the tighter, 0.5 mm (EIAJ) center packages.



SMCK1/SOIC Kit.

SOIC CLIPS

Simplify connection to Small Outline Integrated Circuits (SOIC). The spring design provides a strong and accurate fit. Compatible with gullwing or "J" leads on 0.050 inch centers. Gold-plated contacts for low contact resistances; 0.025 inch upper square pins provide access for probe or flying lead connection.



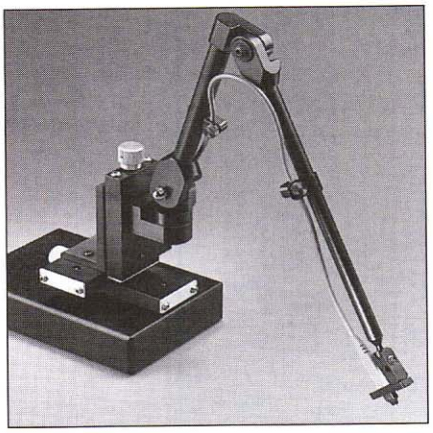
SMQK1/PLCC Kit.

PLCC QUAD CLIPS

For easy connection to Plastic Leaded Chip Carriers (PLCC) with "J" leads on 0.050 inch centers. Gold-plated contacts maintain low contact resistance. 0.025 inch square pins provide contact for probes, flying leads, etc.

SUREFOOT ADAPTER SELECTION GUIDE

Package Lead Spacing	Package Standard	Color Code	3.5 mm (Compact) (P613X)	Active SMD Probes SMD Probes P6243/P6245/P6249	P6561A/2A/3A
50 mil	JEDEC	Yellow	SF201A	SF501	SF501
25 mil	JEDEC	Blue	SF202A	SF502	SF502
0.65 mm	EIAJ	Blue	SF202A	SF502	SF502
0.5 mm	EIAJ	Red	SF203A	SF503	SF503
0.010 in.	JEDEC/EIAT			ST501	



SMKA4 SELECTION GUIDE

SMK4 Direct Connection	Used with Probe
Direct Connection to Probe Head	P6561A, P6562A, P6563A, P6243, P6245, P6249
196-3268-01 Ground Lead with 0.025 in. Receptacle	P6561A, P6562A, P6563A
196-3302-00 6 in. Receptacle Ground Lead	P6131, P6133, P6133 Opt. 25, P6136, 6136 Opt. 25, P6138A, P6139A
196-3305-00 6 in. Receptacle Ground Lead	P6131, P6133, P6133 Opt. 25, P6134, P6134C
196-3382-00 3 in. Receptacle Ground Lead	P6131, P6133, P6133 Opt. 25, P6134, P6134C
103-0177-01 Flexible Tip	P61XXB, P6202A, P6204, P6205
206-0193-00 Flex Tip for 0.025 in. Square Pin	P61XXB, P6202A, P6204, P6205
015-0325-00 Dual Lead Adapter	P61XXB, P6202A, P6204, P6205
020-2008-00 Y-lead Adapter	P6240
196-3410-00 Y-lead Adapter	P6246, P6247, P6248
020-2203-00 Y-lead Adapter	P6246, P6247, P6248

PROBING FINE PITCH DEVICES

Probing today's designs with their delicate fine pitch devices is safer and more convenient with the Tektronix PPM articulating arm.

The PPM articulating arm provides high accuracy and resolution by mechanically assisted probe positioning, helping designers meet the physical demands of probing the constantly shrinking geometry of devices.

PPM203B

The PPM203B has a three axis arm system. It is a general purpose benchtop probing aid designed to be used when probing PC Boards, Hybrids and MCMs that employ fine pitch devices and interconnects.

The PPM203B incorporates a weighted base that makes it well suited to probing fine pitches in benchtop applications.

CHARACTERISTICS

PPM203B

Number of Manipulator Axes – PPM203B, 3 Axis (X, Y and Z).

Manipulator Travel – PPMS203B, 1 in. min.

Manipulator Lead Screw Pitch – PPM203B, 10 threads per inch.

Probe Mounting – Accepts most Tektronix probes including SMD, 2.5 mm, 3.5 mm, 4 mm, 5 mm and P6245 probe styles.

Attachment Method to Work Surface – PPM203B, manually positioned with weighted base.

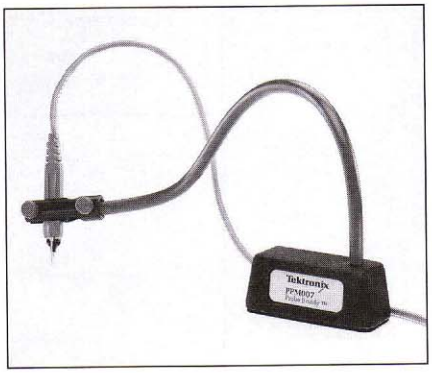
Articulated Arm Reach – X,Y: 14 in., Theta: 180°.

Ground Lead Positioners –
For Tektronix SMD probes and Tektronix 2.5 mm subminiature, 3.5 mm compact, and 4 mm active probes.
Reach: (signal lead to ground lead) 40°, >1 in.
Travel: (spring loaded ground pin) >0.1 in.

PPM007 – PROBE BUDDY

The probe buddy is a hands free actuator arm that is your "buddy" in probing situations. The Probe Buddy has a 12 oz. Base and moveable 8" articulator arm that gives flexibility in probing situations.

Designed for P6243, P6245 and P6249.




Tektronix
SF502
SureFoot® BLUE
25mil SET OF 12
PAT. 5,387,872
Tektronix
ST501
SureToe™
SET OF 12
Tektronix
016-1773-00
SOCKET, SQ PIN
SET OF 15
Tektronix
SF501
SureFoot® ORANGE
50mil SET OF 12
PAT. 5,387,872
Tektronix
SF503
SureFoot® RED
0.5 mm SET OF 12
PAT. 5,387,872
Tektronix
016-1772-00
POGO PIN GND
SET OF 15
Tektronix
131-5638-30
PROBE TIP
SET OF 30
Tektronix
016-1774-00
SPRING ADAPTER
SET OF 10
016-1315-00
Coding Color Clips
206-0364-00
Quantity 1 SMT Klip Chip
SMK4

ORDERING INFORMATION

For price information: Outside the U.S. contact your local Tektronix representative, inside the U.S. see the price list in the back of this catalog.

SMK4
Micro KlipChip™ Adapter.
Includes: 4 each Adapters.

SMG50
SMT KlipChip Adapter.
Includes: 20 SMT KlipChip.

SMCK1
SOIC Engineering Kit.
Includes: 1 each of 8, 14, 16, 20, 24-Pin SOIC Clips plus 4 SMT KlipChip Adapter; 8 Electrical Leads with (0.025 in.) Square-pin Connectors.

SMQK1
PLCC Engineering Kit.
Includes: 1 each of 20, 28, 44, 52, 68, 84-Pin PLCC Clips plus 4 SMT KlipChip Adapter; 8 Electrical Leads with (0.025 in.) Square-pin Connectors.

SF201A (50 MIL PITCH)
SureFoot Adapter for P613X (3.5 mm) Passive Probes.
Includes: 12 Yellow 50 mil/0.65 mm SureFoot Adapter Tip Guide.

SF202A (25 MIL PITCH/0.65 MM PITCH)
SureFoot Adapter for P613X (3.5 mm) Passive Probes.
Includes: 12 Blue 25 mil/0.65 mm SureFoot Adapter Tip Guides.

SF203A (0.5 MM PITCH)
SureFoot Adapter for P613X (3.5 mm) Passive Probes.
Includes: 12 Red 0.5 mm SureFoot Adapter Tip Guides.

SF501 (50 MIL)
SureFoot Adapter for P6561A, P6562A, P6563A, P6243, P6245, P6249 SMD Probes.
Includes: 12 Yellow 50 mil (25 mil-Pin) SureFoot Adapter Tip Guides.

SF502 (25 MIL/0.65 MM PITCH)
SureFoot Adapter for P6561A, P6562A, P6563A, P6243, P6245, P6249 SMD Probes.
Includes: 12 Blue 25 mil/0.65 mm (25 mil-Pin) SureFoot Adapter Tip Guides .25 mil/0.65 mm.

SF503 (0.5 MM PITCH)
SureFoot Adapter for P6561A, P6562A, P6563A, P6243, P6245, P6249 SMD Probes.
Includes: 12 Red 0.5 mm (25 mil-Pin) SureFoot Adapter Tip Guides.

ST501 (0.010 IN. PITCH)
SureFoot Adapter for P6243, P6245, P6249, P646XA series SMD Probes.

Electrical Leads – or SMQK1 and SMCK1 Package of 10 each with 0.025 in. Square-pin Receptacles.
4 in. length. Order 198-5817-00.
8 in. length. Order 198-5819-00.

PPM203B
Articulated Arm, 3 Axis with Hi-mass Base.
Includes: Articulated Arm; Hi-mass Base; 6 probe adapters to attach various probe styles.

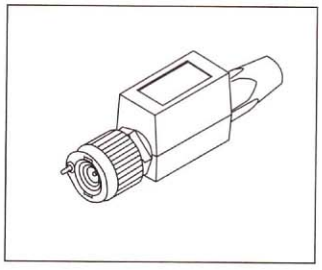
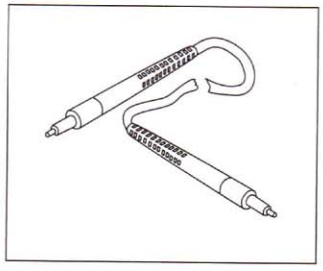
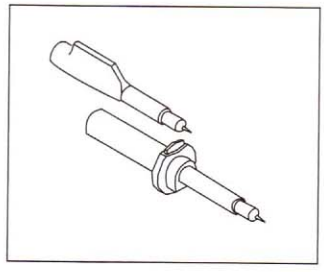
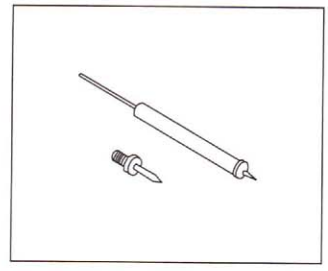
Probe Adapters (PPM 203B) – Additional probe adapters can be ordered by the following part numbers:
SMD Probes. Order 407-4365-00.
P6245. Order 407-4368-00.
4 mm, Active Probes. Order 407-4370-00.
2.5 mm, Subminiature Probes. Order 407-4366-00.
3.5 mm, Compact Probes. Order 407-4367-00.
5 mm, Miniature Probes. Order 407-4369-00.

PPM007
Probe Buddy.
Includes: Low mass articulated arm.

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

ISO 9001
Tektronix measurement products are manufactured in ISO registered facilities.
Except PPM203B.

PASSIVE AND ACTIVE PROBE GENERAL REPLACEMENT PARTS

Probe	Length (m)	Connector/Comp. Box	Probe Cable	Probe Head	Probe Tip/Hybrid Tip
P6101B	2	N/A	N/A	N/A	131-4997-01*2
P6102A	2	206-0352-00	174-0976-00	206-0302-00	N/A
P6103B	2	N/A	N/A	N/A	131-4997-01*2
P6105A	1	206-0331-00	174-0975-00	206-0328-00	206-0336-01*2
	2	206-0334-00	174-0976-00	206-0301-00	206-0337-01*2
	3	206-0320-02	174-0977-00	206-0302-00	N/A
P6106A	1	206-0313-01	174-0975-00	206-0328-00	206-0336-01*2
	2	206-0319-01	174-0976-00	206-0301-00	206-0337-01*2
	3	206-0320-01	174-0977-00	206-0302-00	N/A
P6107A	2	206-0247-02	174-0976-00	206-0217-02	206-0339-04*2
P6108A	1	206-0332-01	174-0975-00	206-0303-00	206-0336-01*2
	2	206-0318-02	174-0976-00	206-0304-00	206-0337-01*2
	3	206-0333-00	174-0977-00	206-0305-00	N/A
P6109B	2	N/A	N/A	N/A	131-4997-01*2
P6111B	2	N/A	N/A	N/A	131-4997-01*2
P6112	2	N/A	N/A	N/A	131-4997-01*2
P6113B	2	N/A	N/A	N/A	131-4997-01*2
P6117	2	N/A	N/A	N/A	131-4997-01*2
P6119B	2	N/A	N/A	N/A	131-4997-01*2
P6121	1.5	206-0311-00	174-0967-00	206-0323-01	206-0341-01*2
P6122	1.5	206-0312-00	174-0967-00	206-0324-01	206-0342-01*2
	2	206-0318-00	174-0968-00	206-0325-01	N/A
	3	206-0318-01	174-0969-00	206-0326-01	206-0338-01*2
P6129B	2	N/A	N/A	N/A	131-4997-01*2
P6148A	2	206-0255-02	174-0976-00	206-0217-02	206-0339-04*2
P6149A	2	206-0255-02	174-0976-00	206-0217-02	206-0339-04*2
P6201	1.8	N/A	N/A	N/A	206-0200-00*3
P6202A	2	N/A	N/A	N/A	206-0230-03*1
P6203*4	1.5	N/A	N/A	N/A	131-4280-00*3
P6204*4	1.5	N/A	N/A	206-0390-00	131-4280-00*3
P6205*4	1.5	N/A	N/A	N/A	131-4280-00*3
P6206*4	1.7	N/A	N/A	N/A	131-4280-00*3
P6243*4	1.3	N/A	N/A	N/A	131-5638-11*1
P6245*4	1.3	N/A	N/A	N/A	131-5638-11*1
P3010	2	N/A	N/A	N/A	131-4997-01*2
P6420	1	N/A	174-0975-00	206-0236-01	206-0230-03*1
	2	N/A	174-0976-00	206-0236-01	206-0230-03*1
	3	N/A	174-0977-00	206-0236-01	206-0230-03*1
P6561A	1.3	N/A	206-0417-10	N/A	131-5638-11*1
P6562A	1.3	N/A	206-0417-10	N/A	131-5638-11*1
P6563A	1.3	N/A	206-0459-00	N/A	131-5638-11*1

*1 *Probe tips in package of ten.*

*2 *Probe hybrid tip assemblies in packages two each.*

*3 *Probe hybrid tip assembly in quantities of one.*

*4 *131-1685-01 contact for readout and power (P6205, P6217, P6245, P6243, P6231).*

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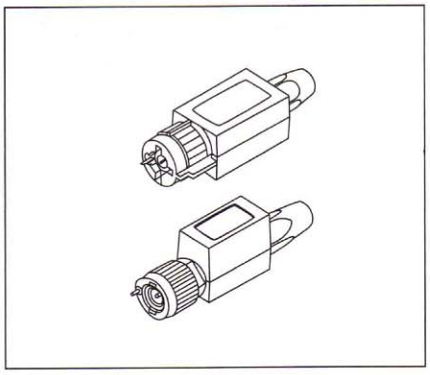

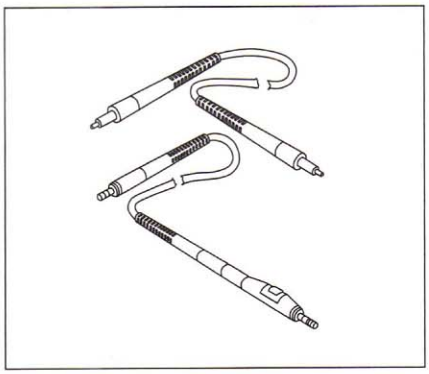

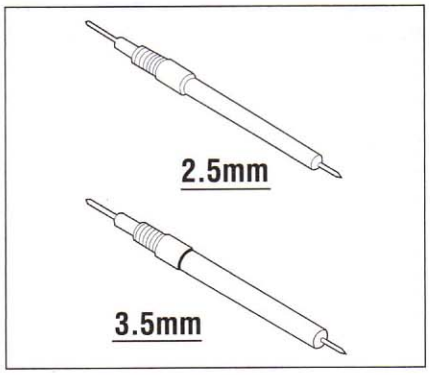

Probe	Length (m)	Connector/Comp. Box	Probe Cable	Probe Tip/Hybrid Tip	Probe Tip/Hybrid Tip Color
P6053C	6	206-0421-00	174-2132-01	206-0422-01	tip-gray/tail-red
Opt. 01	3.5	N/A	174-2133-01	206-0392-00	tip-gray/tail-blue
Opt. 03	9	N/A	174-2134-01	206-0422-02	tip-blue/tail-red
P6130	2	206-0319-00	174-0971-00	206-0270-12*2	tip-brown/tail-yellow
Opt. 01	1.5	206-0313-00	174-0970-00	206-0270-10*2	tip-brown/tail-blue
Opt. 03	3	206-0320-00	174-0972-00	206-0270-11*2	tip-brown/tail-red
P6131	1.3	206-0314-00	174-0973-00	206-0265-10*2	tip-clear/tail-blue
Opt. 02	2	206-0321-00	174-0971-00	206-0265-12*2	tip-clear/tail-yellow
Opt. 03	3	206-0322-00	174-0972-00	206-0265-11*2	tip-clear/tail-red
P6133	2	206-0350-00	174-0971-00	206-0265-12*2	tip-clear/tail-yellow
Opt. 01	1.3	206-0349-00	174-0973-00	206-0265-13*2	tip-clear/tail-clear
Opt. 03	3	206-0351-00	174-0972-00	206-0265-11*2	tip-clear/tail-red
Opt. 25	1.3	206-0349-00	174-0973-00	206-0393-00*2	tip-clear/tail-natural
P6134C	1.5	206-0420-00	174-1081-04	206-0418-00*2	tip-black/tail-red
P6135A (13 to 17pF)*4	1.5	N/A	N/A	206-0416-00*3	tip-red/tail-natural
(18 to 22pF)*4	1.5	N/A	N/A	206-0419-00*3	tip-black/tail-yellow
(45 to 49pF)*4	1.5	N/A	N/A	206-0415-00*3	tip-blue/tail-natural
P6136	1.3	206-0359-00	174-0978-00	206-0265-10*2	tip-clear/tail-blue
Opt. 25	1.3	206-0359-00	174-0978-00	206-0392-00*2	tip-gray/tail-blue
P6137	1.5	206-0389-01	174-1081-04	206-0378-00*2	tip-black/tail-natural
P6138	1.3	206-0439-00	174-0978-00	206-0392-00*2	tip-gray/tail-blue
P6138A	1.3	N/A	174-3649-00	206-0392-00*2	tip-gray/tail-blue
P6139A	1.3	206-0440-00	174-0978-00	206-0441-00*2	tip-blue/tail-yellow
P6150*1 (10X)	1	N/A	174-1341-00	206-0399-03*2	N/A
(1X)	1	N/A	174-1341-00	206-0398-00*2	N/A
P6156 (10X)	1.5	N/A	174-1127-00	206-0380-00*2	tip-blue/tail-black
Opt. 25 adds 100X tip		N/A	N/A	206-0382-00*2	tip-red/tail-black
20X tip		N/A	N/A	206-0381-00*2	tip-gray/tail-black
P6158	1.2	N/A	174-3889-00	206-0381-00*2	tip-gray/tail-black
P6230	1.6	N/A	N/A	206-0279-10*2	tip-yellow/tail-blue
P6231*5	1.5	N/A	N/A	206-0279-10*2	tip-yellow/tail-blue
P6339A	1.3	206-0485-00	174-0978-00	206-0441-00*2	tip-blue/tail-yellow

*1 *Not pictured above.*

*2 *Probe hybrid tip assembly in quantities of one.*

*3 *Consists of a matched pair.*

*4 *Scope Input Capacitance Range.*

*5 *131-1685-01 contact for readout and power (P6205, P6205, P6217, P6245, P6243, P6231).*

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ORDERING INFORMATION

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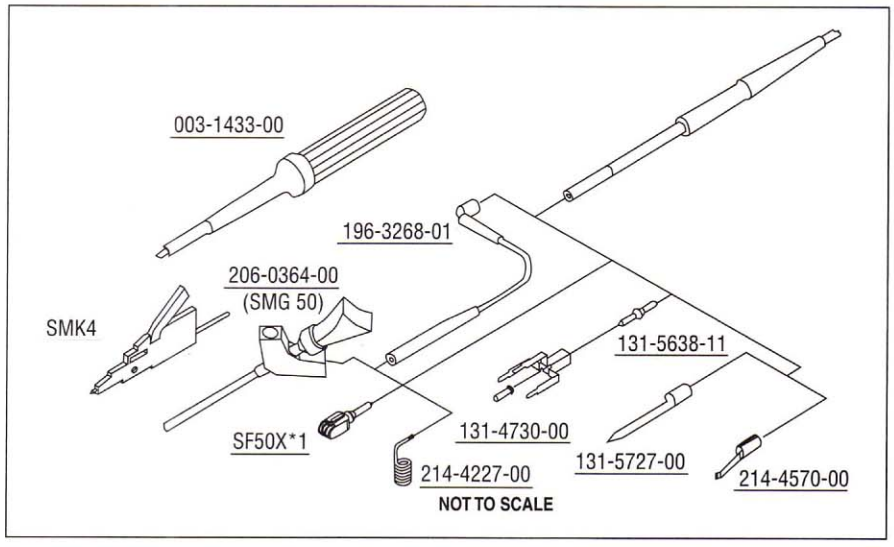
P6561A/P6562A/P6563A*2

Part Number	Description
003-1433-00	Adjustment Tool pkg. of 1.
131-5727-00	Low Inductance Ground Lead.
131-4730-00	SMT Probe Tip Circuit Board Test Points, pkg. of 5.
131-5638-11	Receptacle Tip for P656X/AS, pkg. of 10.
196-3268-01	Ground Lead with 0.025 in. Receptacle, pkg. of 5.
206-0364-00	SMT KlipChip™ Adapter, 1 each.
214-4227-00	Right Angle Square-pin Adapter.
214-4570-00	100 mil Square-pin Ground Adapter.
SMK4	Micro KlipChip Adapter, 4 each.
SMG50	SMT KlipChip, 20 each.
SF501	SureFoot® Probe Tip Adapter, pkg. of 12, Yellow, 50 mil Pitch.
SF502	SureFoot Probe Tip Adapter, pkg. of 12, Blue, 25 mil/0.65 mm Pitch.
SF503	SureFoot Probe Tip Adapter, pkg. of 12, Red, 0.5 mm Pitch.

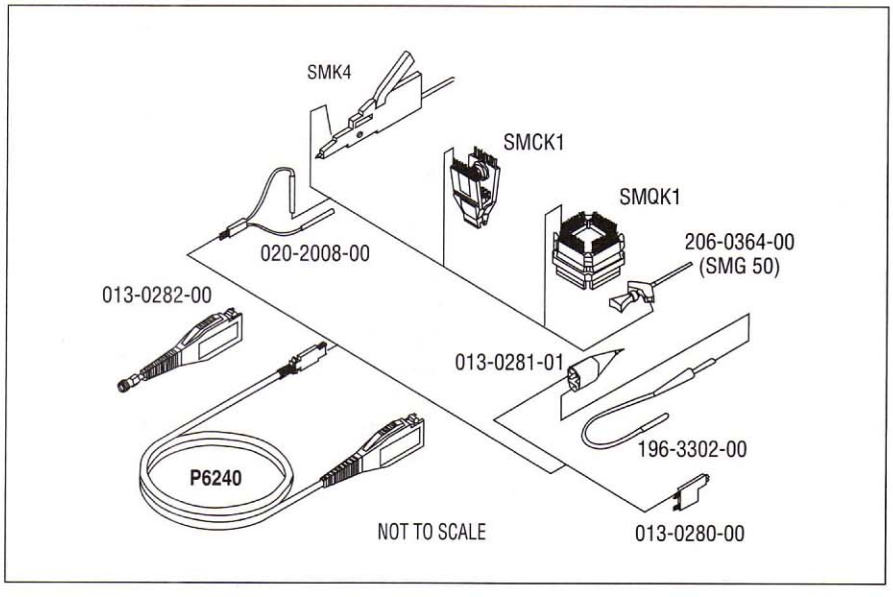
**1 See SF501/SF502/SF503 or page 535 for complete selection information.*

**2 Potential last time buy.*



P6240 PROBE SYSTEM FOR TLS216

Part Number	Description
013-0280-00	One to Two Adapter.
013-0281-01	Handheld Probe Tip Adapter w/ Tips.
013-0282-00	50 to 75 Ω Converter.
196-3302-00	6 in. Ground Lead.
020-2008-00	Y Lead Adapter, pkg. of 10.
206-0364-00	SMT KlipChip Adapter, 1 each.
352-1039-01	Probe Cable Loom, pkg. of 6.
SMK4	Micro KlipChip Adapter, 4 each.
SMG50	SMT KlipChip Adapter, 20 each.
SMCK1	SOIC Engineering Kit. (Please see page 535 for included items.)
SMQK1	PLCC Engineering Kit. (Please see page 535 for included items.)



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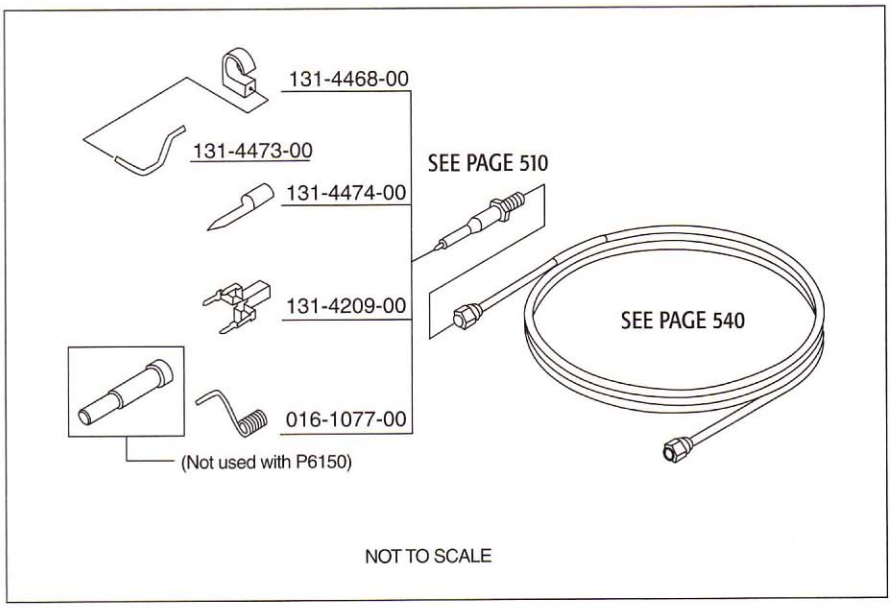
POTENTIAL LAST TIME BUY

P6150

Part Number	Description
016-1077-00*1	Spring Ground Contact, 2 each of 5 Lengths.
131-4209-00	Probe Tip to CKT BD Adapter.
131-4468-00	Ground Collar.
131-4473-00	1/4 in. Ground Lead.
131-4474-00	1 Leg Ground Contact.

1 Potential last time buy.

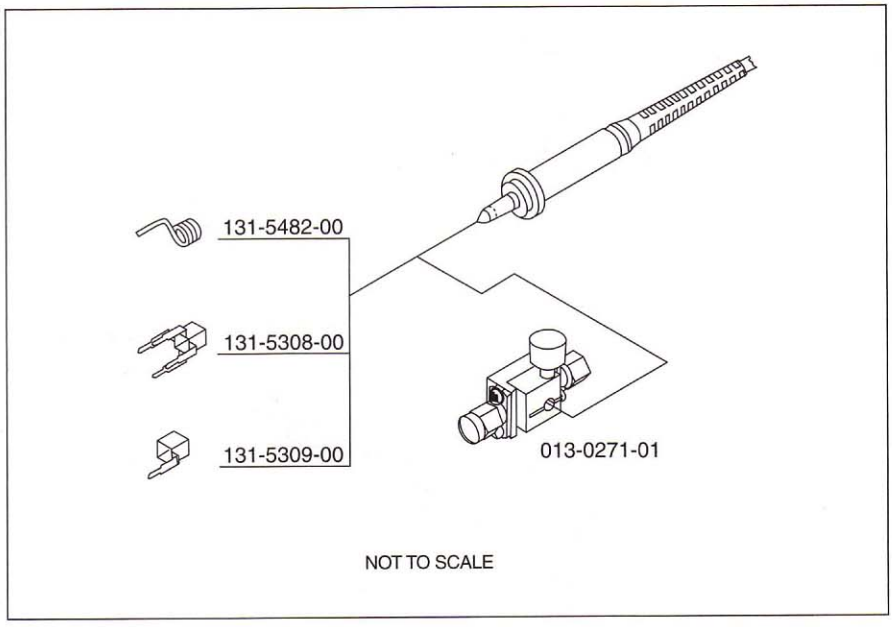


P6150

SD-14 (4 MM)

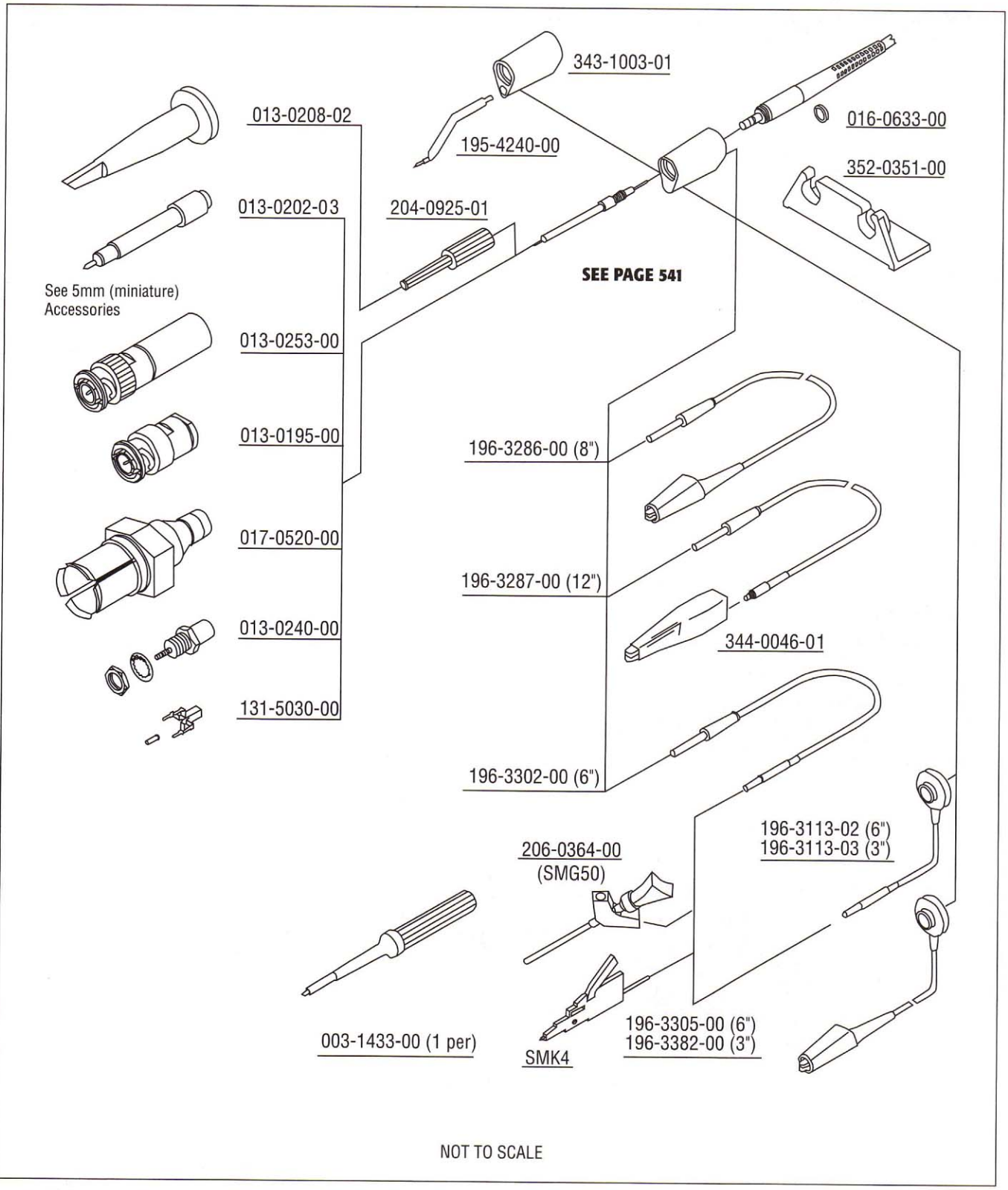
Part Number	Description
013-0271-01*1	SMA Adapter to SD-14.
131-5308-00	4 Leg Ground Contact.
131-5309-00	1 Leg Ground Contact.
131-5482-00	Spring Ground Contact 2 each of 5 Lengths.

1 Potential last time buy.

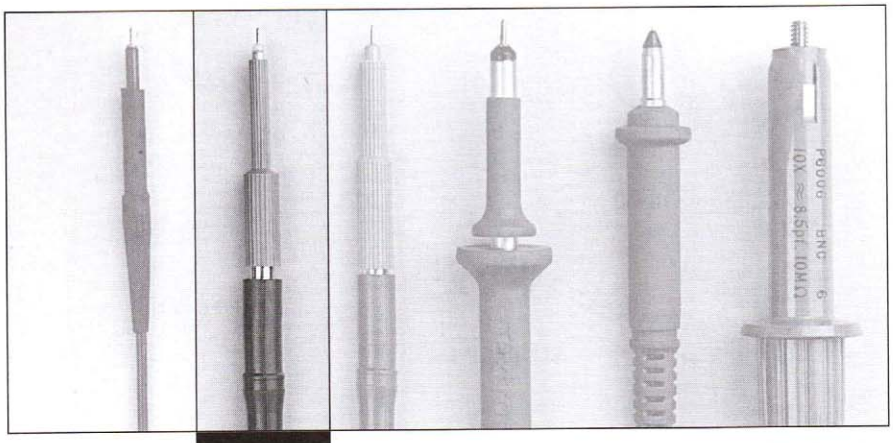


4mm Accessories for P6207, P6217, SD-14.

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.



2.5 mm (Subminiature) Probe Accessories for P6130, P6131, P6133, P6134, P6135, P6136, P6230, P6231.



Tip/Head Style:	SMD	2.5 mm Subminiature	3.5 mm Compact	5 mm Miniature	4 mm	6/32 Thread Monolithic

ORDERING INFORMATION

For price information: Outside the U.S. contact your local Tektronix representative, inside the U.S. see the price list in the back of this catalog.

Part Number	Description
003-1433-00	Adjustment Tool.
013-0195-00	Subminiature Probe Tip to BNC Adapter.
013-0202-03	Subminiature/Compact-to-miniature Probe to Adapter (Allows Use of Miniature Probe Tip Accessories). See page 548.
013-0208-02	Retractable Hook Tip for Subminiature Tip Probes.
013-0240-00	Subminiature Probe Tip Chassis Mount Test Jack.
013-0253-00	Subminiature Probe Tip to BNC Adapter Thread Locking (Non-terminated).
016-0633-00	Cable Marker Set for all Modular Cables (P610X/A/B, P612X, P613X/A, P62X, (Except P6201, P6202A)).

Part Number	Description
017-0520-00	Subminiature Probe Tip to GR 50 Ω Termination Adapter.
131-5030-00	Subminiature Probe Tip Circuit Board Test Points (Package of 25).
195-4240-00	Low Impedance Ground Contact.
196-3113-02	6 in. Slip-on Ground Lead.
196-3113-03	3 in. Slip-on Ground Lead.
196-3286-00	8 in. Alligator Ground Lead.
196-3287-00	12 in. Slip-on Ground Lead.
196-3302-00	6 in. Alligator Ground Lead (Not Compatible with P6137, P6134C, P6053C or P6156).
196-3305-00	6 in. Alligator Ground Lead.
196-3382-00	3 in. Alligator Ground Lead.
204-0925-01	Subminiature Probe Tip Attenuator Tip Cover.
206-0364-00	SMT KlipChip™ Adapter.
343-1003-01	Ground Collar.

Part Number	Description
344-0046-01	#6-32 Thread Alligator Ground Clip.
352-0351-00	Probe Holder, Self-adhesive Back, Black.
352-0670-00	Tip Holder (Not Shown).

SMD ATTACHMENT TOOLS

Part Number	Description
SMG50	SMT KlipChip Adapter, Package of 20.
SMK4	Micro KlipChip Adapter, (4 Each).

See pages 533 to 538 for complete selection of SMD Tools.

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

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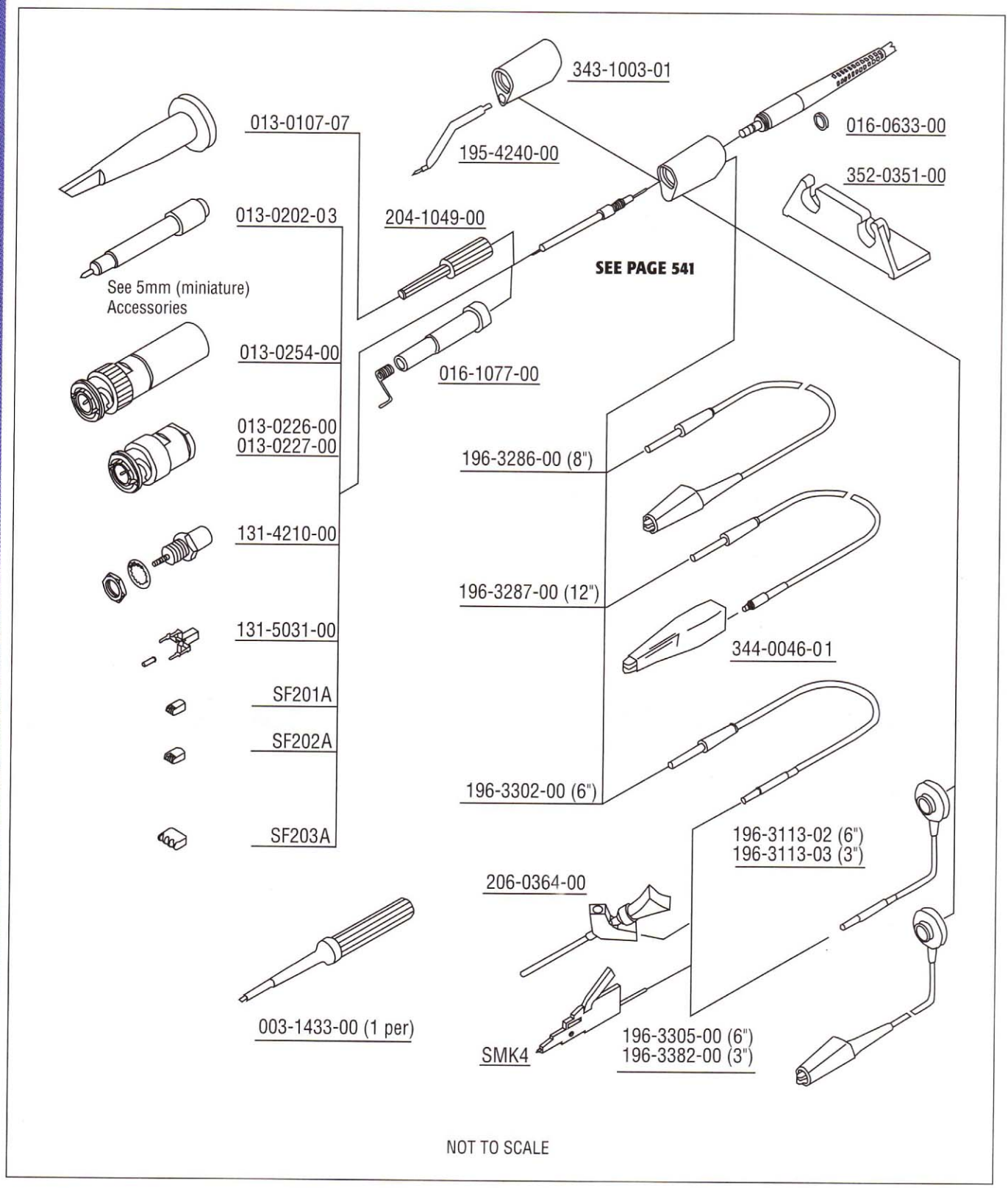
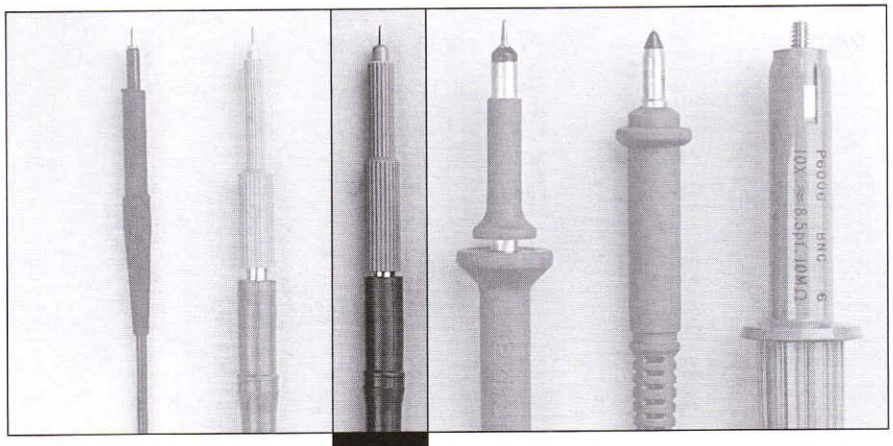


3.5 mm (Compact) Probe Accessories for P6053C, P6133 Opt. 25, P6134C, P6135A, P6136 Opt. 25, P6137, P6138, P6138A, P6139A, P6156, P6158.



Tip/Head Style:	SMD	2.5 mm Subminiature	3.5 mm Compact	5 mm Miniature	4 mm	6/32 Thread Monolithic

ORDERING INFORMATION

For price information: Outside the U.S. contact your local Tektronix representative, inside the U.S. see the price list in the back of this catalog.

Part Number	Description
003-1433-00	Adjustment Tool.
013-0107-07	Retractable Hook Tip for Compact Tip Probes.
013-0202-03	Subminiature/Compact-to-Miniature Probe to Adapter (Allows Use of Miniature Probe Tip Accessories). See page 548.
013-0226-00	Compact Probe Tip to BNC Adapter (Non-terminated).
013-0227-00	50 Ω Compact Probe Tip to BNC Termination Adapter.
013-0254-00	Compact Probe Tip to BNC Adapter Thread Locking (Non-terminated).
016-0633-00	Cable Marker Set For All Modular Cables (P610X/A/B, P612X, P613X/A, P623X, P62XX) (Except P6201, P6202A).
016-1077-00	Ground Tip Contact for Compact Tip Probes. 2 ea. Five Different Probe Tip to Ground Contact Spacings.

Part Number	Description
131-4210-00	Compact Probe Tip Chassis Mount Test Jack.
131-5031-00	Compact Probe Tip Circuit Board Test Points (Package of 25).
195-4240-00	Low Impedance Ground Contact.
196-3113-02	6 in. Slip-on Ground Lead.
196-3113-03	3 in. Slip-on Ground Lead.
196-3286-00	8 in. Alligator Ground Lead.
196-3287-00	12 in. Slip-on Ground Lead.
196-3302-00	6 in. Alligator Ground Lead (Not Compatible With P6137, P6134C, P6053C or P6156).
196-3305-00	6 in. Alligator Ground Lead.
196-3382-00	3 in. Alligator Ground Lead.
204-1049-00	Compact Probe Tip Attenuator Tip Cover.
206-0364-00	SMT KlipChip™ Adapter.
343-1003-01	Ground Collar.
344-0046-01	#6-32 Thread Alligator Ground Clip.
352-0351-00	Probe Holder, Self-adhesive Back, Black.

SMD ATTACHMENT TOOLS

Part Number	Description
SMG50	SMT KlipChip Adapter, Package of 20.
SMK4	Micro KlipChip Adapter, 4 each.
SF201A	SureFoot® Probe Tip Adapter, Package of 12, Yellow, 50 mil Pitch.
SF202A	SureFoot Probe Tip Adapter, Package of 12, Blue, 25 mil/0.65 mm Pitch.
SF203A	SureFoot Probe Tip Adapter, Package of 12, Red, 0.5 mm Pitch.

See pages 533 to 538 for complete selection of SMD Tools.

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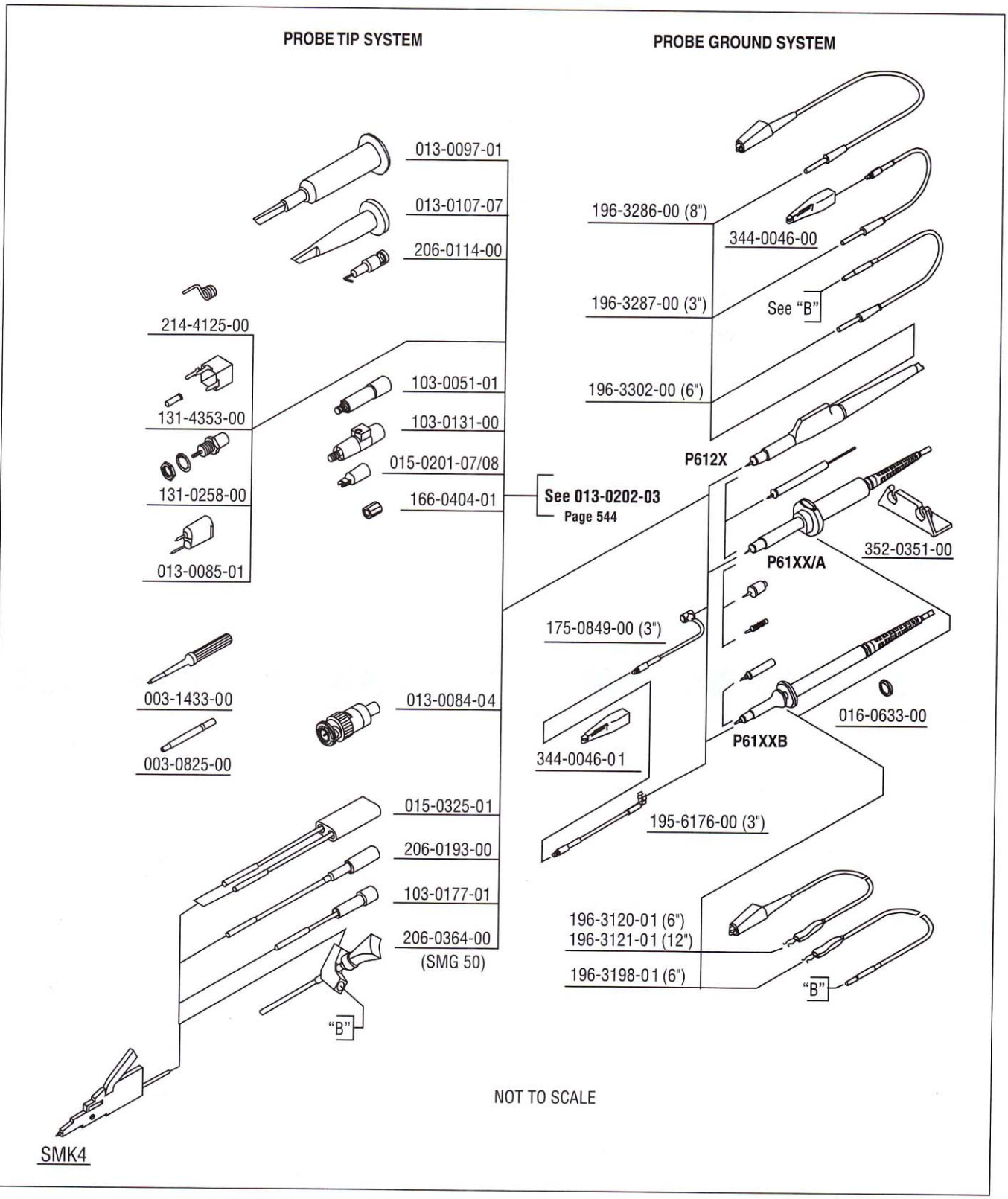
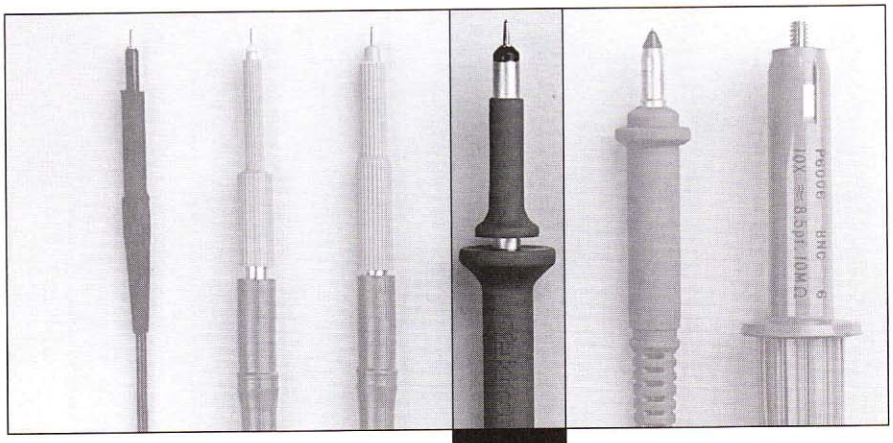


5 mm (Miniature) Probe Accessories for P3010, P6048, P6053, P6053B, P6055, P6056, P6057, P6062B, P6063B, P61XX/A Family, P612X Family, P61XXB Family, P6202A with Adapter, P6203, P6204, P6205 and P6206.



Tip/Head Style:	SMD	2.5 mm Subminiature	3.5 mm Compact	**5 mm Miniature**	4 mm	6/32 Thread Monolithic

ORDERING INFORMATION

For price information: Outside the U.S. contact your local Tektronix representative, inside the U.S. see the price list in the back of this catalog.

MINIATURE PROBE ACCESSORIES

Part Number	Description
003-0825-00	Tip Extractor For Miniature Probes (Except For P610X/"A" Version and P612X Family Probes).
003-1433-00	Adjustment Tool.
013-0084-04	Miniature Probe Tip To BNC Adapter (Non-terminated).
013-0085-00	Bayonet Ground Assembly.
013-0097-01	Retractable Hook Tip For P6202A and P6420.
013-0107-07	Retractable Hook Tip (For All Except P6202A and P6420).
015-0201-07	IC Test Ground Cover, Gray (100 Mil Spacing), Package of 10.
015-0201-08	IC Test Ground Cover, Gray (100 Mil Spacing), Package of 100.
015-0325-01	Dual Lead Adapter.
016-0633-00	Cable Marker Set For All Modular Cables (P610X/A/B, P612X, P613X/A, P623X, P62XX Except P6201, P6202A).
103-0051-01	Screw Tip (#6-32).
103-0131-00	Screw Tip With Ground Connection (#6-32).
103-0177-01	Flexible Tip.
131-0258-00	Chassis Mount Test Jack.
131-4353-00	Circuit Board Test Point, Package of 25.
166-0404-01	Insulating Ground Cover.
175-0849-00	3 in. Probe Tip Cap Lead for All Miniature Size Probe Tips.
195-6176-01	3 in. Probe Tip Clip-on Lead For All Miniature Size Probe Tips.
196-3120-01	6 in. Clip-on Ground Lead.
196-3121-01	12 in. Clip-on Ground Lead.
196-3198-01	6 in. Clip-on Ground Lead (With 0.025 In. Pin Receptacle).
196-3286-00	8 in. Ground Lead.
196-3287-00	#6-32 Thread Ground Lead.
196-3302-00	6 in. Slip-on Ground Lead (With 0.025 In. Pin Receptacle).
206-0114-00	Hook Tip.
206-0193-00	Flex Tip For 0.025 In. Square Pin.
214-4125-00	Electrical Contact Ground.
344-0046-01	#6-32 Thread Alligator Ground Clip.
352-0351-00	Probe Holder, Self-adhesive Back, Black.

SMD ATTACHMENT TOOLS

Part Number	Description
206-0364-00	SMT KlipChip™ Adapter (Used with 0.025-Pin Receptacles).
SMG 50	Package of 20 each SMT KlipChip Adapters.
SMK4	Micro KlipChip Adapter (4 each).

See pages 533-538 for complete selection of SMD Tools.

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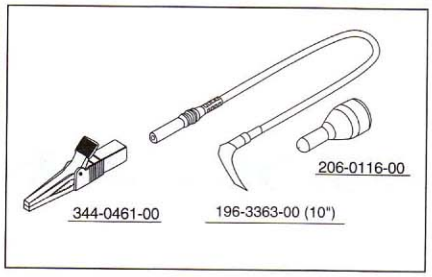
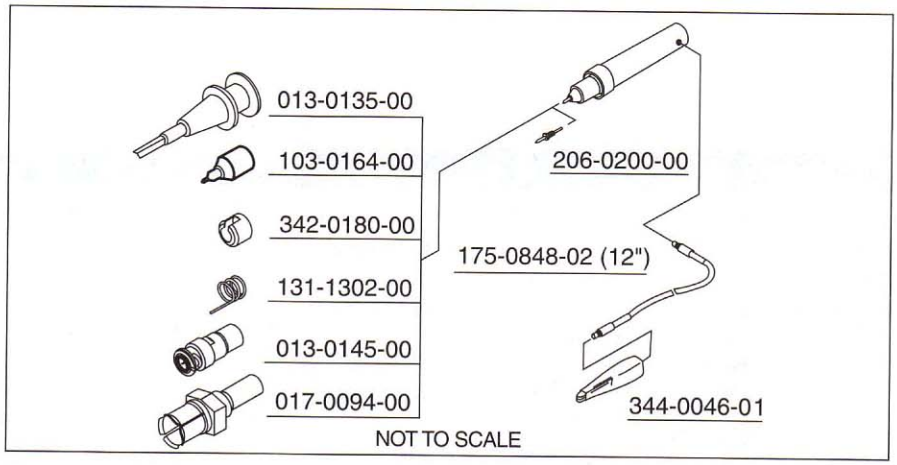


P6015A.

P6015A

Part Number	Description
344-0461-00	Crocodile Clip, 4 mm Socket.
196-3363-00	10 in. Clip-on Ground Lead for P6015A.
206-0116-00	Banana tip (P6015 only) #10-32.



P6201 PROBE

Part Number	Description
013-0135-00	Retractable Hook Tip.
013-0145-00	Probe Tip to BNC Adapter.
017-0094-00	Probe Tip to GR 50 Ω Termination Adapter.
103-0164-00	Probe Tip to Miniature Probe Tip Adapter. (See page 548 for compatible accessories.)
131-1302-00	Ground Contact.
175-0848-02	12 in. Ground Lead.
206-0200-00	Replaceable Probe Tip.
342-0180-00	Ground Contact Insulator.
344-0046-01	#6-32 Thread Alligator Ground Clip.

CABLE MARKER SETS

Part Number	Description
016-0127-00	For 3/16 in. dia. Cable.

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

ISO 9001

Tektronix measurement products are manufactured in ISO registered facilities.

ORDERING INFORMATION

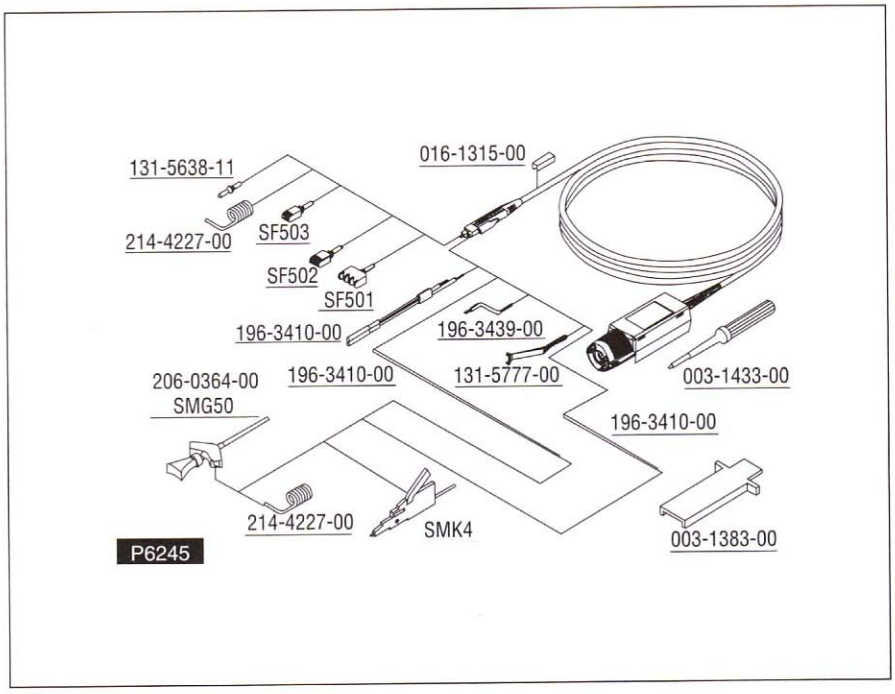
For price information: Outside the U.S. contact your local Tektronix representative, inside the U.S. see the price list in the back of this catalog.

P6245/P6243

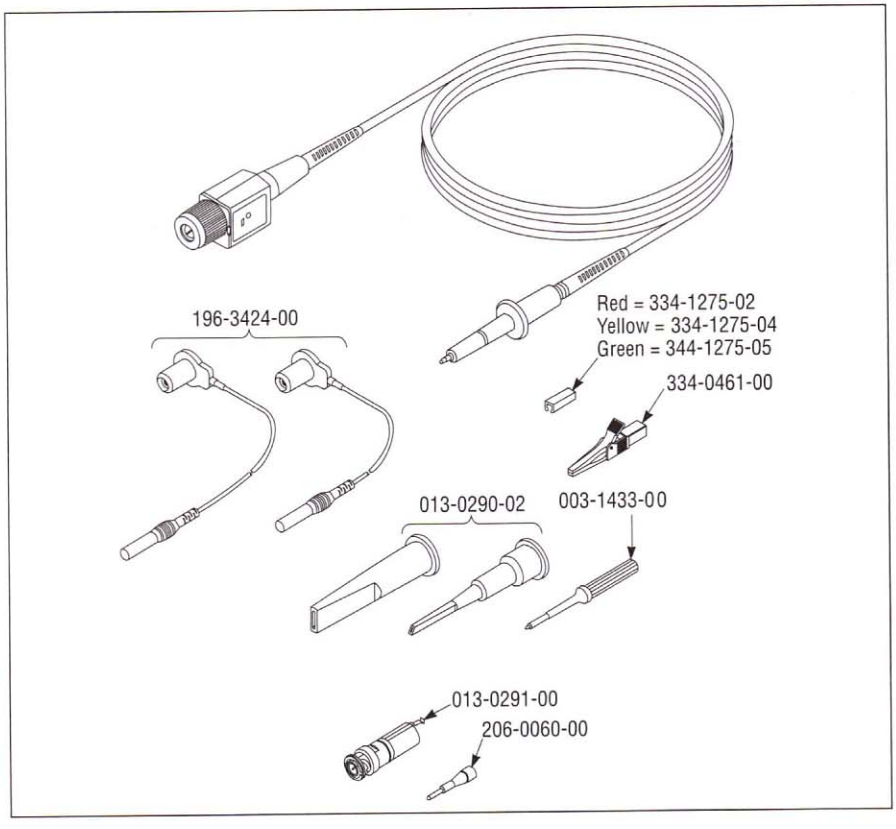
Part Number	Description
003-1383-00	Compensation Box Cover Removal Tool.
003-1433-00	Adjustment Tool.
016-1315-00	Two each – Five Colors of Cable Markers.
131-5638-11	10 each – Solderable Probe Tips.
131-5777-00	100 mil Square Pin Ground Adapter.
196-3410-00	Ground Lead Set Includes: 2 each – 1 in., 3 in., 6 in. Ground Leads w/Square Pin Receptacle; 2 each – Y Lead Adapters.
196-3439-00	1 in. Ground Lead.
206-0364-00	SMT KlipChip™, 1 each.
214-4227-00	Right Angle Square Pin Adapter.
SF501	SureFoot® Probe Tip Adapter, pkg. of 12, Yellow, 50 mil Pitch.
SF502	SureFoot Probe Tip Adapter, pkg. of 12, Blue, 25 mil/0.65 mm Pitch.
SF503	SureFoot Probe Tip Adapter, pkg. of 12, Red, 0.5 mm pitch.
SMG50	SMT KlipChip, 20 each.
SMK4	Micro KlipChip Adapter, 4 each.

P5100/P5102

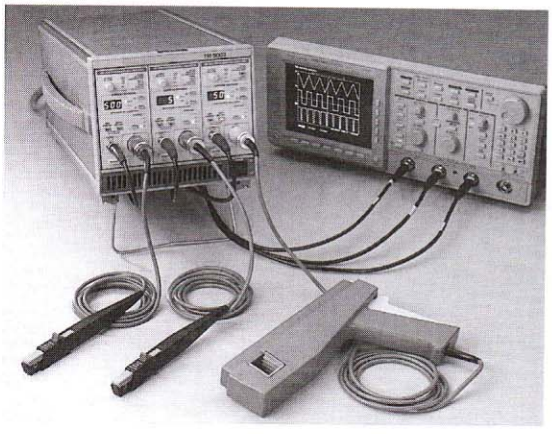
Part Number	Description
020-2137-01	P5100/P5102 Accessory Kit Includes: Regular Retractable Hook Tip, Large Retractable Hook Tip, 6 in. Ground Lead w/Alligator Clip, 18 in. Ground Lead w/4 mm Shielded Banana Plug, Large Crocodile Clip.
196-3424-00	Common Lead Set. 6 in. and 18 in.
003-1433-01	Package of 5 each of 003-1433-00, above.
013-0290-02	Hooktip Set, Large and Small.
013-0291-00	P5100 Probe Tip to BNC Adapter.
016-0127-00	Cable Marker Set.
206-0060-00	Spring Tip (0.08 in. dia.).
334-1275-XX	Cable Markers.
344-0461-00	Large Crocodile Clip.



P6243/P6245.



Power Electronics Measurements



Features – Benefits	Applications
High Voltage Isolation	Power Supplies
Differential Current	Motor Drives
	Electronic Ballast
	Power Converters
	Power Device Evaluation
	Switch Mode Control
	UPS Systems

Power Electronics Measurements

Oscilloscopes measure voltages, presented at their inputs, to provide amplitude versus time displays and offer a wide range of analysis capabilities. These voltage signals are typically referenced to ground and less than 600 V. While providing valuable information about what is occurring in your device, it is clear that knowledge of currents, high voltages and floating voltages may all be required to completely understand what is happening with your application.

In the following sections we describe a selection of probes and devices which enable you to safely and accurately capture current, high voltage and floating signals – all converted to voltage inputs acceptable to your oscilloscope or other measurement instrument.

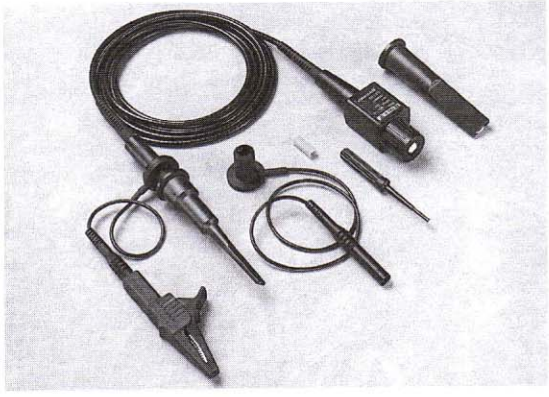
While current and differential voltage measurements are important to most electrical and electronic applications, higher current and voltage and isolated floating measurements are especially critical in power conversion applications. These applications include devices characterized by high currents and differential voltages which change rapidly as the devices switch on and off. In these applications, safety as well as accuracy is of critical importance. The special needs of these applications are addressed by the group of products we refer to as power measurement products.

In the following pages we describe each category of measurement products: current probes, high voltage probes, monolithic isolators, fiber optic isolation systems and differential probes.

In each section, we describe product features and applications. We also provide information to help you select the right device to safely and accurately make your measurement. We will also provide valuable Data Sheets on how to make measurements specific to your application.

Passive High Voltage Probes

P5100 • P5102 • P6015A



Features – Benefits

P5100
DC to 250 MHz P5100
2500 V DC + Peak AC P5100
100X with Readout P5100
UL 3111-1, CSA1010.2.031, EN61010-2-031
7-30 pF Compensation Range

P5102
100 MHz Bandwidth
Up to 1,000 Vrms
10X Attenuation
UL 3111-1, EN61010-2-031, CSA1010.2.031

P6015A
High Voltage – 20 kV DC/40 kV Peak (100 ms Pulse Width)
High Bandwidth – 75 MHz
Silicone Dielectric
Optional 1,000X Coding
Wide Compensation Range (7-49 pF)
Heavy Duty Versatile Ground Lead and Clip

Applications

Power Supply Design
Motor Drive Design
Electronic Ballast
Power Semiconductors

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

CE (P5100/P5102 only)

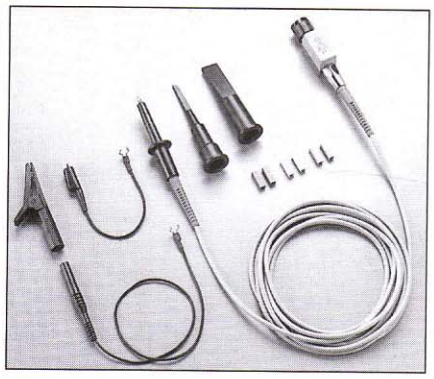
ISO 9001

Tektronix measurement products are manufactured in ISO registered facilities.

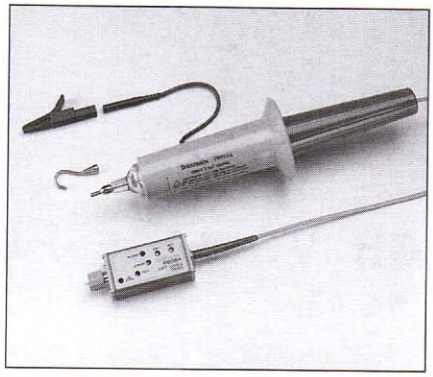
P5102 IsolatedChannel™ Applications

In many applications, it is important to be able to isolate the measurement from earth ground and also to isolate the common voltage between channels. With the P5102 and the THS 700 Series handheld digital storage oscilloscopes you have not only the isolation for the measurement from earth ground, but you also have full isolation between the two channels.

The P5102 was designed to give you this isolated channel performance for up to 1000 V AC RMS on the 100 MHz probe. A variety of screw-on accessories provides easy connection to the device under test.



P5100.



P6015A.

P5100 High Voltage Probe

The P5100 is a low-input capacitance High Voltage (2.5 kV) Probe designed for higher frequency applications. The probe can be compensated to match plug-ins and oscilloscopes with nominal input capacitances of 7-30 pF. A variety of screw-on accessories provide easy connection to the device under test. For additional information on P5100, request Data Sheet 56W-10262-1.

P6015A High Voltage Probe

For heavy-duty high-performance measurements of voltages over 2.5 kV, the P6015A is the industry standard. You can measure DC voltages up to 20 kV and pulses up to 40 kV. The 75 MHz bandwidth enables you to capture fast, high-voltage signals.

The P6015A uses an environmentally safe silicone compound for a dielectric and never needs refilling. Other features include: a 7-49 pF compensation range, small compensation boxes which fit on adjacent amplifier inputs and a readout option for use with Tektronix digital scopes. With the readout option, displayed voltage amplitude values will be the actual signal value rather than understated by a factor of 1,000. Using the readout version with other than Tektronix digital scopes may result in an erroneous readout display. For additional information on the P6015A, request P6015A Data Sheet 51W-8217-1.

Characteristics

P6015A/P5100/P5102

Probe	Nominal Length	Attenuation	Bandwidth	Risetime	Loading	Max Input V	in pF DC or RMS	Readout
P6015A	10 ft.	1000X	75 MHz	4.0 ns	100 MΩ/3 pF	20 kV	7 to 49	No
P6015A Opt. 1R	10 ft.	1000X	75 MHz	4.0 ns	100 MΩ/3 pF	20 kV	7 to 49	Yes
P6015A Opt. 25	25 ft.	1000X	25 MHz	14 ns	100 MΩ/4 pF	20 kV	7 to 49	No
P6015A Opt. 2R	25 ft.	1000X	25 MHz	14 ns	100 MΩ/4 pF	20 kV	7 to 49	Yes
P5100	10 ft.	100x	250 MHz	1.75 ns	10 MΩ/2.75 pF	2.5 kV	7 to 30	Yes
P5102	2 m	10X	100 MHz	3.5 ns	5 MΩ/11.2 pF	1000 VRMS	24 to 28	No

Ordering Information

For price information: Outside the U.S. contact your local Tektronix representative, inside the U.S. see the price list in the back of this catalog.

P5100

100X, 10 ft. High Voltage Probe.
Includes: 2 ea. three colors Cable Markers, 1 ea. Crocodile Clip, 1 ea. Adjustment Tool, 1 ea. Hooktip (Small), 1 ea. Hooktip (large), 1 ea. 18 inch Ground Lead, 1 ea. 6 in. Ground Lead, Instruction Manual (070-8151-03).

RECOMMENDED ACCESSORIES

Probe Tip to BNC Adapter – Order 013-0291-00.

0.080 in. Diameter Spring Tip – Order 206-0060-00.

Differential Probe Pair Kit – 2 Differential Ground Leads; 1 Long and 1 Short (either connects the probe grounds together at the tips). 12 "S" Clips (clips hold the ends of the probes together). Instruction Sheet (includes a procedure for twisting the probe leads together and adjusting the probes to maximize CMRR). Order 040-1487-00.

P5102

10X, High Voltage Probe for THS 700 Series.
See page 551 for complete information.

P6015A

1,000X, 10 ft. High Voltage Probe.
Includes: Hook Probe Tip (206-0463-00); Banana Plug Tip (134-0016-00); Crocodile Clip – plugs onto Ground Lead (344-0461-00); Ground Lead (196-3363-00); Carrying Case (016-1147-00); Instruction Manual (070-8223-03).

Opt. 1R – 10 ft. with Readout.

Opt. 25 – 25 ft. without Readout.

Opt. 2R – 25 ft. with Readout.

MEASUREMENT SERVICE OPTIONS

Opt. R3 – Repair warranty extended to cover three years (P6015A only).

Opt. R5 – Repair warranty extended to cover five years (P6015A only).

RECOMMENDED ACCESSORIES:

See page 551.

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

CE (P5100/5102 only)

ISO 9001

Tektronix measurement products are manufactured in ISO registered facilities.

Differential Probes

New P6248 • P6247 • P6246



Features – Benefits

P6248

1.7 GHz (Typical Probe Only ≤27°C) 1X Mode

1.5 GHz Bandwidth (Guaranteed)

1.85 GHz (Typical Probe Only ≤27°C) 10X Mode

P6247 and P6246

P6247: > 1.0 GHz Bandwidth (Guaranteed)

P6246: 400 MHz Bandwidth (Guaranteed)

Family Features & Benefits

Low Input Capacitance: <1 pF Differential

Probe Input Connector: Two Standard 0.025 in./0.63 mm (0.1 in. center) Square Pin Receptacle (Female)

Electrostatic Discharge Tolerant (IEC 801-2)

Connects to TEKPROBE® Interface on TDS Series Scope, or Other Instruments Using 1103 TEKPROBE Power Supply

For Use with Oscilloscopes, Spectrum or Network Analyzers

>60 dB (1000:1) Common Mode Rejection Ratio (CMRR)

Small Probe Head Allows Easy Probing of SMDs

Applications

Communications (Gigabit Ethernet, IEEE 1394, Fibre Channel)

Semiconductor Characterization (RAMBUS)

Disk Drive Read Channel Design

Communication Pulse Shape Compliance

Jitter, Cross-Talk, BERT Measurements

Location of Ground Bounce

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

CE

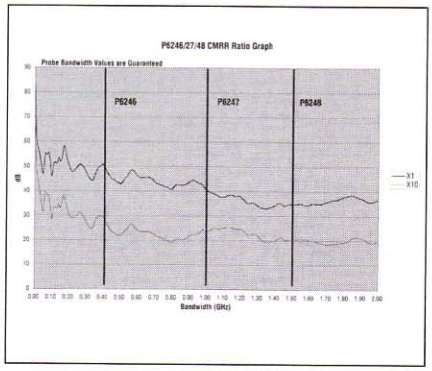
ISO 9001

Tektronix measurement products are manufactured in ISO registered facilities.

The P6246, P6247 and New P6248 Differential Probes

The P6248, P6247 and P6246 enable users to make time domain or frequency domain measurements on high bandwidth signals commonly found in disk drive, digital IC design (RAMBUS), and communication applications (Gigabit Ethernet, IEEE 1394 Firewire and Fibre Channel). The P6248 includes accessories that allow RAMBUS via probing and IEEE 1394 interconnect access. The small probe head geometry and assorted probe tip accessories allow these probes to easily accommodate manual probing of surface mount devices while maintaining high CMRR.

The P6246, P6247 and P6248 are ideal for design verification of disk drive read channel electronics and timing analysis for troubleshooting ground bounce problems associated with high speed logic. They can also be used for pulse shape or cross talk compliance testing of high speed communication signals.



CHARACTERISTICS

Bandwidth (Guaranteed) –
P6248: DC to 1.5 GHz.
P6247: DC to 1.0 GHz.
P6246: DC to 400 MHz.

Rise Time (specified) –
<265 ps (P6248), <350 ps (P6247), <875 ps (P6246).

Common Mode Rejection Ratio (CMRR) –
Switchable: 1X, 10X.
10X Attenuation: (1.85 GHz – typical probe only ≤ 27°C)
<45 dB at ≤1 MHz.
<25 dB at ≤100 MHz.
<20 dB at ≤500 MHz.
<18 dB at ≤1 GHz.
<18 dB at ≤1.5 GHz typical.
1X Attenuation: (1.7 GHz – typical probe only ≤ 27°C)
<60 dB at ≤1 MHz.
<38 dB at ≤100 MHz.
<35 dB at ≤500 MHz.
<30 dB at ≤1 GHz.
<25 dB at ≤1.5 GHz typical. (P6248)

DC Attenuation Accuracy – ±2%.

Common Input Voltage Range –
±7.0 V, 1X; ±7.0 V, 10X.

Differential Input Voltage Range –
±850 mV, 1X; ±8.5 V, 10X.

Max. Non-Destruct Input Voltage –
±25 V (DC + peak AC).

Electrostatic Immunity – >15 kV.

TEKPROBE® Interface – Probe power, auto-scaling, auto-termination with TDS scopes.

Bandwidth Limit – Switchable, 200 MHz (P6246 & P6247).

DC Reject – 0.4 Hz, 1X; 4.0 Hz, 10X (P6246 & P6247).

TYPICAL SPECIFICATIONS

Common Mode Rejection Ratio (CMRR) –
<60 dB at ≤1 MHz (P6246 & P6247).
<50 dB at ≤100 MHz.
<30 dB at ≤500 MHz.
<30 dB at ≤1 GHz.

Input C –
<1 pF (differential mode),
<2 pF (common mode).

Input R –
200 kΩ (differential mode),
100 kΩ (common mode).

Linearity – ±2%.

Noise – <50 nV/ Hz.

Harmonic Distortion – ≤1.5% @ 100 MHz.

Passband Ripple – <±0.25 dB.
P6248: DC to 1.5 GHz.
P6247: DC to 850 MHz.
P6246: DC to 400 MHz.

Output Termination –
Terminate into 50 Ω.

PHYSICAL CHARACTERISTICS

Weight (probe only) – 160 g (0.36 lb.).

Probe Head Volume – 6 cm^3 (0.3 $in.^3$).

Probe Head Input Connection – 0.63 mm (0.025 in.) square pins on 2.54 mm (0.1 in.) centers.

Output Cable Length – 1.2 m (4.0 ft.).

ENVIRONMENTAL CHARACTERISTICS

Temperature –
Operating 0 to 50° C.
Nonoperating –55 to +75° C.

Humidity (0 to 90% RH) –
Operating 30 to 50° C.
Nonoperating 30 to 60° C.

ORDERING INFORMATION

For price information: Outside the U.S. contact your local Tektronix representative, inside the U.S. see the price list in the back of this catalog.

P6248
1.7 GHz Differential Probe (Typical ≤ 27°C).
1.5 GHz Differential Probe (Guaranteed).

P6247
1.0 GHz Differential Probe (Guaranteed).

P6246
400 MHz Differential Probe (Guaranteed).

Hard Case –
P6248, P6247 Order 006-7340-00.
P6246 Order 016-0156-03.

Certificate of Traceable Calibration

P6246 and P6247 User Manual Set –
English, German, French, and Japanese:
Order 070-9898-02.
Service: 071-9899-01.

P6248 Instruction Manual – English: Order 071-0566-00.

INCLUDED ACCESSORIES

Product Name/Description	P6246 & P6247 Quantity	P6248 Quantity	Order
Y Lead Adapter	2 Each	2 Each	196-3462-00
3 in. Ground Lead	2 Each	4 Each	196-3462-00
6 in. Ground Lead	2 Each	2 Each	196-3462-00
SMK4	2 Each	4 Each	SMK4 (1 package of 4)
SMT KlipChip™	3 Each	4 Each	206-0364-00 (1 per package)
BNC to Probe Tip Adapter	1 Each	1 Each	013-0304-00
TwinFoot™- Package 4 each	2 Each	4 Each	016-1785-00 (1 package of 4)
TwinTip™ Adapter- Package 4 each	2 Each	4 Each	016-1786-00 (1 package of 4)
Short Ground Contact	2 Each	10 Each	016-1783-00
Spring Loaded Grounds	2 Each	6 Each	016-1782-00
New Products			
Probe Tip Connector Saver	2 Each	2 Each	016-1781-00 (2 per package)
IEEE 1394 Breakout Connector	None	Order Separately	679-5027-00
RAMBUS "Longhorn" Via Probe	None	5 Each	016-1780-00 (5 per package)

ORDERING INFORMATION

For price information: Outside the U.S. contact your local Tektronix representative, inside the U.S. see the price list in the back of this catalog.



P6246/47.

Service Manual – English: Order 071-0573-00.

MEASUREMENT SERVICE OPTIONS

Opt. D1 – Calibration Data.

Opt. R3 – 3 Years Extended Warranty.

Opt. C3 – 3 Years Calibration Services.

RECOMMENDED/REPLACEMENT ACCESSORIES

50 Ω, BNC (M) to BNC (M) Coaxial Cable – 18 in. Order 012-0076-00.

50 Ω, BNC Coaxial Terminator – Order 011-0049-01.

50 Ω, SMA (F) to BNC (M) Adapter – Order 015-0572-00.

RELATED PRODUCTS

1103 – TEKPROBE® Power Supply w/ standard North America/Japan Power Cord.
(Please see page 516.)

INTERNATIONAL POWER PLUGS

Opt. A1 – Europe Power Cord.

Opt. A2 – UK Power Cord.

Opt. A3 – Australia Power Cord.

Opt. A4 – Switzerland Power Cord.

Opt. A6 – Japanese Power Cord.

See page 619 for description.

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

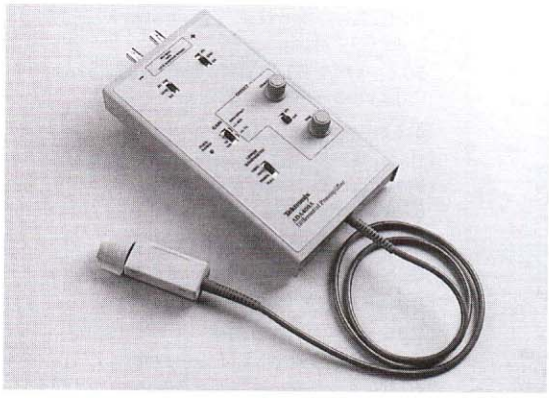
CE

ISO 9001

Tektronix measurement products are manufactured in ISO registered facilities.

Differential Preamplifier

ADA400A



Features – Benefits

- Active Differential Preamplifier
- 10 µV/div Sensitivity
- Typically 100 dB CMRR DC to 10 kHz
- Integral Probe Power with TEKPROBE® BNC

Applications

- Biomedical Research
- Medical Equipment
- Mechanical Analysis
- Audio Design

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

CE

ISO 9001

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The ADA400A Differential Preamplifier allows direct oscilloscope measurements of very low amplitude voltages and signals which are not ground referenced. The high impedance of both inputs eliminates the need to add additional ground points in the DUT, thereby avoiding circulating currents which disturb the measurement or the circuit.

The high gain and extremely high common mode rejection provide usable measurements of voltages as low as 5 µV, even in high noise environments. Selectable bandwidth limiting reduces normal mode noise from digital logic, switch mode power supplies and line frequency sources. Adjustable differential offset allows the user to null out transducer bridge bias and galvanic potential from the test setup. An "infinite impedance" mode can be selected in the two highest gain ranges allowing accurate measurements of signals with high source impedance.

The ADA400A is powered directly from TDS 400, TDS 500 TDS 600 and TDS 700 Series oscilloscopes. It may also be powered by a 1103 Probe Power Supply.

Characteristics

CMRR – ≥100,000:1 DC – 10 kHz.

Gain	CM Range	Differential Range*1	MAX Offset
100	±10 V	0.1 V	±1.0 V
10	±10 V	1 V	±1.0 V
1	±40 V	10 V	±40 V
0.1	±40 V	80 V	±40 V

**1 For higher voltages, attenuating probes may be used, but CMRR performance will be degraded.*

Bandwidth Limits – 100 Hz, 3 kHz, 100 kHz, Full (≥1 MHz).

Input Impedance – 1 MΩ || ~ 50 pF (infinity Ω Selectable in 100X and 10X gains).

Noise – Typically ≤30 µV RMS @ X100 Gain (Referred to Input).

Ordering Information

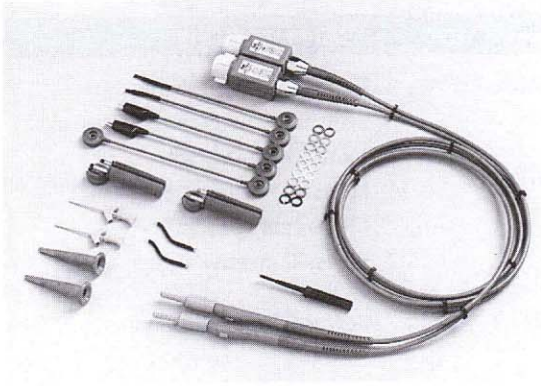
For price information:
Outside the U.S. contact your local Tektronix representative, inside the U.S. see the price list in the back of this catalog.

ADA400A
Differential Preamplifier.
Includes: Instruction Manual (Order 070-9164-00), 2 Spare Input Fuses (Order 159-0024-00).

RECOMMENDED ACCESSORIES
P6101B 1X Passive Probe (2 recommended).

Differential Passive Voltage Probe Pair

P6135A



Features – Benefits

- Attenuation Adjustable to 10X
- 10,000: 1 CMRR on 11A33 Differential Comparator; 20,000: 1 on 7A13 Differential Amplifier
- ±500 V Maximum Common Mode Voltage
- Matched Pair

Applications

- Power Supplies
- Disk Drives
- Electronic Ballast
- Intelligent Motion
- Adjustable Speed Drives

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

CE

ISO 9001

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P6135A Differential Probe Pair

The P6135A differential probe pair is very carefully matched to minimize differences in impedance and signal delay. With differential amplifiers the P6135A provides CMRR ratios up to 20,000:1. Since a single 10X probe with accuracy of 1% or less gives a scope-to-probe CMRR of no better than 50:1, the P6135A is essential to obtain accurate results from your differential amplifier. Three pairs of carefully matched, precision-engineered hybrid tips enable the P6135A to be specifically matched with all Tektronix 11000, 7000 and 5000 Series differential amplifiers and comparators. It also provides excellent performance when used with plug-in amplifiers or oscilloscopes having input impedances of 1 MΩ/13-15 pF, 1 MΩ/18-22 pF and 1 megohm/45-49 pF.

Characteristics

CMRR – On 11A33: 10,000:1 from DC to 1 kHz, derating to 100:1 at 20 MHz. On 7000 Series: 20,000:1 from DC to 1 kHz derating to 100:1 at 20 MHz.

Attenuation – Adjustable to 10X.

Input Resistance – 1 MΩ.

Input Capacitance – 10.5 pF on instrument with 15 pF input capacitance; 11.0 pF when used with instrument that has 20 pF input capacitance; 13.7 pF when used with instrument that has 47 pF input capacitance.

Maximum Useful Bandwidth – On 11A33: DC to 150 MHz; On 7A13: DC >90 MHz.

Typical Probe Rise Time – On 11A33: <2.33 ns; On 7A13: <3.89 ns.

Maximum Common Mode Voltage – 500 V (DC + pk AC) from DC to 1.3 MHz, derated to 50 V (DC + pk AC) at 100 MHz.

For more information about the P6135A and differential measurements, request Data Sheet 63W-8103.

Safety – UL 1244.

Ordering Information

For price information:
Outside the U.S. contact your local Tektronix representative, inside the U.S. see the price list in the back of this catalog.

P6135A

Pair of 10X, 150 MHz Differential Probes.

Includes: Adjustment Tool (003-1433-00); Two Retractable Hook Tips (013-0107-07); 6 in. Dual-ring Ground Lead (196-3295-00); Accessory Pouch (016-0708-00); Two 6 in. Ground Leads (196-3113-02); Two 6 in. Ground Leads with Alligator Clips (196-3305-00); Two SMT KlipChip™ (206-0364-00); Two Low Inductance GND Collars (343-1003-01); Two Probe Tip Holders (352-0670-00); 2 in. Ground Leads (195-4240-00); Cable Marker Rings; Instruction Manual (070-7675-01).

RECOMMENDED ACCESSORIES

Also see page 546.

High Voltage Differential Probes

P5200 • P5205 • P5210



Features – Benefits

- Bandwidths up to 100 MHz
- Up to 5,600 V Differential (DC + pk AC)
- Up to 2,200 V Common (RMS)
- Overrange Indicator
- Safety Certified
- Switchable Attenuation
- Switchable Bandwidth Limit

Applications

- Floating Measurements
- Switching Power Supply Design
- Motor Drive Design
- Electronic Ballast Design
- CRT Display Design
- Power Converter Design and Service
- Power Device Evaluation

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

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Tektronix measurement products are manufactured in ISO registered facilities.

The P5200 can be used with any oscilloscope and enables users to **safely** make measurements of floating circuits with their oscilloscope grounded. The P5200 Active Differential Probe converts floating signals to low voltage ground referenced signals that can be displayed safely and easily on any ground referenced oscilloscope.

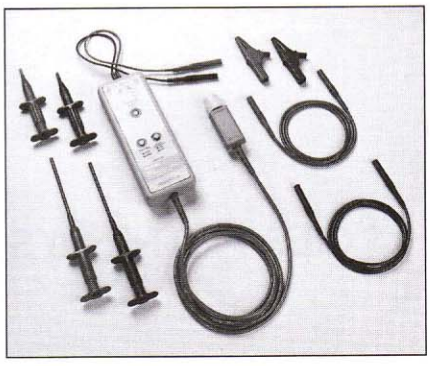
The P5210 is a Differential Probe that is capable of measuring floating voltages up to 5,600 V (DC + pk AC) **safely** and has a bandwidth up to 50 MHz. It is supplied with two sizes of hook tips and has an overrange visual and oral indicator which warns the user when they are exceeding the linear range of the probe. It can be used with Tektronix TEKPROBE® interface oscilloscopes directly or with any oscilloscope with the use of the 1103 TEKPROBE Power Supply.

The P5205 is a 100 MHz Active Differential Probe capable of measuring fast rise times of signals in floating circuits. This 1300 V differential probe can measure **safely** voltages in IGBT circuits such as motor drives or power converters. It is specifically designed to operate on Tektronix oscilloscopes with TEKPROBE interface.

Specifications	P5200	P5205	P5210
Differential Voltage DC + pk AC	1300 V	1300 V	5600 V
Bandwidth (–3 dB)	25 MHz	100 MHz	50 MHz
Common Mode Voltage DC + pk AC	1300 V	1300 V	5600 V
Common Mode Voltage RMS CAT II	1000 V	1000 V	2200 V
Common Mode Voltage RMS CAT III	600 V	600 V	1000 V
Attenuation (switchable)	50X/500X	50X/500X	100X/1000X
CMRR @ 60 Hz/1 MHz (typical)	80 dB/50 dB	80 dB/50 dB	80 dB/50 dB
Input R (each input)	4 MΩ	4 MΩ	8 MΩ
Input C (each input)	7 pF	7 pF	7 pF
Power Source	AC wall adapter	TEKPROBE®	TEKPROBE®
Safety (all)	UL3111-1/CSA1010.2.031	UL3111-1/EN61010-2-031	UL3111-1/IEC61010-2-031
Compatible Products	ALL	TDS 400/500/600/700 and 11000 Series	TDS 400/500/600/700 and 11000 Series



P5200.



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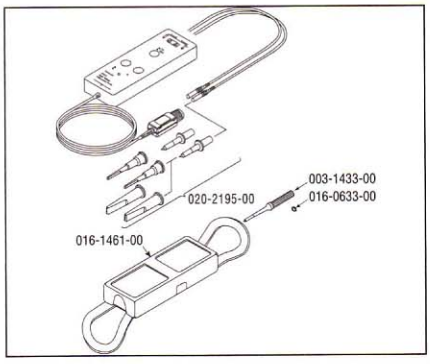

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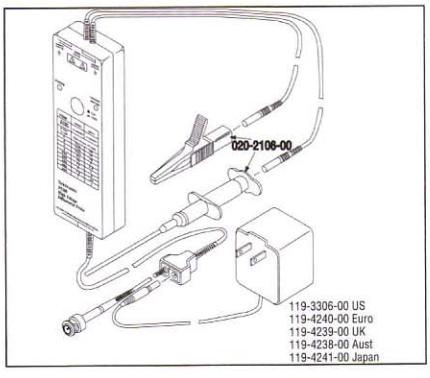

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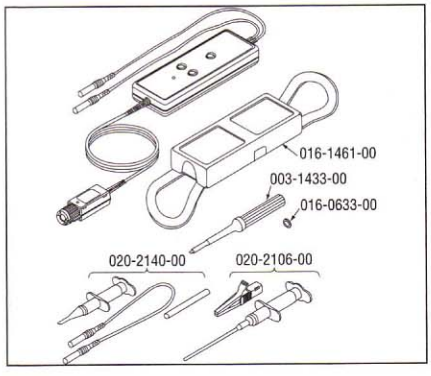

P5205.

Ordering Information

For price information: Outside the U.S. contact your local Tektronix representative, inside the U.S. see the price list in the back of this catalog.

P5200
Active Differential Probe.
Includes: 2 Crocodile Clips; 2 Plunger Clips; 9 V DC Power Supply; Manual (070-9018-01).

INTERNATIONAL POWER PLUGS (P5200 ONLY)
Opt. A1 – Universal Euro 220 V, 50 Hz.
Opt. A2 – United Kingdom 240 V, 50 Hz.
Opt. A3 – Australian 240 V, 50 Hz
Opt. A5 – Switzerland 220 V, 50 Hz.
Opt. A6 – Japan 100 V, 50 Hz.
See page 619 for description.

P5205
Active Differential Probe.
Includes: 2 each Plunger Clamps; 2 each Crocodile Clips; 2 each Extender Leads; 2 each Lead Adapters; 2 each Plunger Hook Clips; Soft Case; Manual (070-9472-00).

P5210
Active Differential Probe.
Includes: 2 each Large Hook clips; 2 each Small Hook Clips; 2 each Probe Heads; Soft Case; Manual (070-9841-00).

MEASUREMENT SERVICE OPTIONS
Please see the Customer Information pages.
Opt. C3 (P6205 only) – Three years of calibration services.

ACCESSORY PACK (P5200, P5205)
Order 020-2106-00.
Includes: 2 each Plunger Clamps; 2 each Crocodile Clips.

ACCESSORY PACK (P5200, P5205)
Order 020-2140-00.
Includes: 2 each Extender Leads; 2 each Lead Adapters; 2 each Plunger Hook Clips.

ACCESSORY PACK (P5210)
Order 020-2195-00.
Includes: 2 each Large Hook Clips; 2 each Small Hook Clips; 2 each Probe Heads.

SOFT CASE
Order 016-1461-00.

POWER SUPPLY (P5205, P5210 ONLY)
TEKPROBE® Power Supply. Order 1103.

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

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Voltage Isolation Systems

A6907 • A6909



Features – Benefits	Applications
For Floating Signals to ±850 V	Motor Drives
60 MHz	Power Supplies
Monolithic	Electronic Ballast
4 Channels (2 Channels A6909)	UPS Systems
CMRR: 60dB @ 1 MHz	Switch Mode Control
GPIB (Optional A6909)	Power Semiconductors
Push-button Self-calibration of Offset and Gain	
Each Channel Can Be Individually Set for Coupling and Attenuation	

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

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ISO9002 Certified
JMI-0113

A6907/A6909 Voltage Isolators

The A6907/A6909 monolithic voltage isolators are essential tools for power conversion design. Accurate floating measurements are required to design and verify high-performance switch mode circuits. The A6907 and A6909 offer safety, performance, multiple isolated channels (A6907-four/A6909-two), direct connection to the measurement instrument and simplified controls in a single box. The A6907/A6909 offer high performance and safety for the lowest cost per channel.

The A6907/A6909 isolators feature a bandwidth of 60 MHz, slew rate of 20,000 V/µs and CMRR of 60 dB (1,000:1) at 1 MHz and GPIB control (standard on the A6907; available as Opt. 10 for the A6909) in a package the size of a Tektronix TDS Oscilloscope. The ±850 V probes plug directly into the isolator and are specifically designed for safe connection to floating circuits and enhanced CMRR.

CHARACTERISTICS

ELECTRICAL

Attenuation Settings – 2,000X to 1X (100 mV/div to 200 V/div with oscilloscope set to 100 mV/div) in 1-2-5 steps.
Full Range Measurements – ±2 mV to ±850 V.
Frequency Response Bandwidth – 60 MHz (–3 dB).
Transient Response – Rise Time: <7.0 ns 100 mV/div and 200 mV/div. <5.8 ns 500 mV/div to 200 V/div.
Maximum Working Voltage – 600 V RMS, 850 V (DC + peak AC).
Input Impedance – Resistance: 10 MΩ. Capacitance: 4.5 pF, ±0.5 pF.
Output Impedance – 50 Ω.
Output Drive – ±500 mV into 50 Ω load.
Maximum Common to Ground Slew Rate – 20,000 V/µs.
Offset Accuracy – ±20 mV.
Delay – ≈ 30 ns with 1.5 m probe cable.
Safety – UL1244, EN61010-1.

CMRR

60 Hz	>105 dB (100 mV/div), >100 dB (1 V/div).
1 MHz	>60 dB (100 mV/div), >45 dB (1 V/div).
10 MHz	>50 dB (100 mV/div), >40 dB (1 V/div)

POWER REQUIREMENTS

Line Voltage Ranges – 90-250 V AC.
Line Frequency Range – 47-66 Hz.
Maximum Power Consumption –
A6907: 48 W.
A6909: 28 W.

ORDERING INFORMATION

For price information: Outside the U.S. contact your local Tektronix representative, inside the U.S. see the price list in the back of this catalog.

A6907
60 MHz Monolithic 4-CH Isolator (850 V Maximum).
Includes: Four 850 V Floating Probes (010-0576-00); 43 in. 50 Ω Cable Set (4); A6907/A6909 User Operator Instruction Manual (070-9094-05).

A6909
60 MHz Monolithic 2-CH Isolator (850 V Maximum).
Includes: Two 850 V Floating Probes (010-0576-00); 43 in. 50 Ω Cable Set (2); A6907/A6909 User Operator Instruction Manual (070-9094-05).
Opt. 10 – Add GPIB.

INTERNATIONAL POWER PLUGS
Opt. A1 – Universal Euro 220 V, 50 Hz.
Opt. A2 – United Kingdom 240 V, 50 Hz.
Opt. A3 – Australian 240 V, 50 Hz.
Opt. A5 – Switzerland 220 V, 50 Hz.
See page 619 for description.

MEASUREMENT SERVICE OPTIONS
Opt. C3 – Three years of calibration services.
Opt. D3 – Test data (requires Opt. C3).
Opt. R3 – Repair warranty extended to cover three years.

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

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Power Electronics

Current Measurements



Features – Benefits	Applications
AC/DC Current	Motor Drives
DC to 2 GHz	Switching Power Supplies
1 mA to 20,000 A	Disk Drive
Split Core and Solid Core	Electronic Ballasts
	Inverters
	Avionics
	Data Storage Read Channel Design
	Silicon Characterization
	High-frequency Analog Design
	ESD Testing
	Signal Injection
	Differential Current Measurements
	Single Shot Low Rep-rate Pulse Measurements
	Propagation Delay Measurement

CURRENT MEASUREMENTS

Tektronix offers the widest selection of high performance current probes available. Tektronix current measurement systems provide programmable and manual simultaneous AC/DC measurements, bandwidth coverage from DC to 1 GHz and amplitude measurements from mAs to 20,000 A.

Current probes measure the flux field generated by the movement of electrons through a conductor. Within the range specifications of the current probe, the flux field surrounding a conductor is converted to a linear voltage output that can be displayed and analyzed on an oscilloscope or other measurement instrument.

Tektronix provides current probes for AC only and AC/DC current measurements. The AC only probes are available in solid and split core configurations.

AC AND DC CURRENT MEASUREMENTS

AC currents induce voltage in a transformer resulting from the buildup and collapse of flux fields as the current changes direction. AC current probes are passive in that they do not require external power. A steady state DC current, however, will not induce a current in a transformer. By taking advantage of the Hall Effect, a current biased semiconductor device will produce a voltage output in response to a DC generated flux field. Consequently, a DC current probe is an active device in that it requires external power.

Each type of current sensing device will roll off or produce a non-linear output at a certain point. A given AC probe will roll off at a certain maximum current amplitude and frequency, as well as at a minimum amplitude and low-end frequency. DC current probes will be linear from DC to a maximum frequency and will have a minimum and maximum sensitivity level as well. Since we often encounter signals which contain both AC and DC components, it is important to be able to measure both simultaneously with a single probe. In addition, signals which may look like AC, such as a square wave switching on and off, but never fall below zero amps, actually have a significant DC component and cannot be accurately captured with a transformer only AC probe. The unique Tektronix solution is to combine both a Hall Effect device and a transformer to provide broadband current measurement capabilities within one system.

SPLIT VERSUS SOLID CORE

To accurately measure the flux field, we need to completely surround the conductor with the probe core. Tektronix offers two mechanical probe configurations: split core and solid core. Split core probes offer convenience. Precisely engineered and manufactured, the split core probes can be clipped onto a conductor without having to break the connection.

Solid core current transformers (CT) offer small size and very high frequency response for measuring very fast, low amplitude current pulses and AC signals. They are designed to be permanently or semi-permanently installed and have cables which are easily connected and disconnected to the CT.

In this Current Probe section we will describe the features and characteristics of each of the Tektronix Current Probes, as well as mention some of the primary applications of each.

AMP*SECOND PRODUCT

As mentioned in the current probe introduction, transformer core materials saturate and become nonlinear when they are subjected to too much current. "Too much current" is a function of both the amplitude of the current and the time it is applied. The product of the average amplitude times the pulse width is called the amp*second product. Each probe has an amp*second product specification (see the Current Probe Selection Guide). If the signal does not exceed this specification, the voltage output will be linear and the measurement accurate.

A special feature of the AM 503S Current Probe Systems utilizes the phenomenon that opposing currents are subtractive. The AM 503S senses the current level in the conductor under test and feeds an equal but opposite current through the probe. This "bucking current" nulls out the current in the transformer and eliminates any core saturation. The bucking current limit is 20 A in the A6312 and A6302XL, 100 A in the A6303XL and 500 A in the A6304XL. Up to these amplitudes you need not be concerned about the amp*second product.



AM50xx series Current Measurement Family (Left to Right) A6303, AM503S, A6302, A6303XL, A6304XL, A6302XL, AM5030S with two additional AM5030 plug-ins.

CURRENT PROBE SELECTION GUIDE

Type AM 503B or AM 5030 Amplifiers with:

	Bandwidth Hz to MHz	Peak Pulse	Max AC p-p	Derate Below	Derate Above	Max DC	Amp*S Product	Current/Div Display Range	Rise Time	Insertion Impedance @ 1 MHz	Max Barewire Voltage	Max Conductor Diameter	Cable Length
A6312	DC to 100	50 A	40 A	N/A	20 kHz	20 A	100 x10^{-6}	1 mA to 5 A*1	≤3.5 ns	0.1 Ω	300 V	0.15 in.	2 m
A6312 w/CT-4	0.5 to 20	20 kA*2	2 kA*3	50 Hz	1.2 kHz	20 A	0.1	20 mA to 5 kA*1	≤17.5 ns	30 mΩ	3 kV	1.5 in.	2 m
A6302	DC to 50	50 A	40 A	N/A	20 kHz	20 A	100 x10^{-6}	1 mA to 5 A*1	≤7.0 ns	0.1 Ω	300 V	0.15 in.	2 m
A6302 w/ CT-4	0.5 to 20	20 kA*2	2 kA*3	50 Hz	1.2 kHz	20 A	0.1	20 mA to 5 kA*1	≤17.5 ns	30 mΩ	3 kV	1.5 in.	2 m
A6302XL	DC to 17	50 A	40 A	N/A	20 kHz	20 A	100 x10^{-6}	1 mA to5 A*1	≤20 ns	0.1 Ω	300 V	0.15 in.	8 m
A6302XL w/ CT-4	0.5 to 13	20 kA*2	2 kA*3	50 Hz	1.2 kHz	20 A	0.1	20 mA to 5 kA*1	≤20 ns	30 mΩ	3 kV	1.5 in.	8 m
A6303	DC to 15	500 A	200 A	N/A	20 kHz	100 A	10,000 x10^{-6}	5 mA to 50 A*1	≤23 ns	0.02 Ω	700 V	0.83 in.	2 m
A6303XL	DC to 10	500 A	200 A	N/A	1.8 kHz	100 A	10,000 x10^{-6}	5 mA to 50 A*1	≤35 ns	0.02 Ω	700 V	0.83 in.	8 m
A6304XL	DC to 2	700 A	700 A	N/A	1.8 kHz	500 A	0.4	500 mA to 200 A*1	≤175 ns	0.2 Ω	700 V	0.83 in.	8 m
P6021	120 to 60	250 A	15 A	300 Hz	0.5 MHz	0.5 A	500 x10^{-6}	20 mA or 100 mA*1	≤5.8 ns	0.03 Ω	600 V	0.15 in.	1.5 m/ 2.75 m*5
P6021 w/ CT-4	120 to 20	20 kA*2	2 kA*3	300 Hz	1.2 MHz	20 A	0.5	400 mA or 100 A*1	≤17.5 ns	0.03 Ω	3 kV	1.5 in.	1.5 m/ 2.75 m*5
P6022	935 to 120	100 A	6 A	3 kHz	10 MHz	0.2 A	9x10^{-6}	10 mA or 100 mA*1	≤2.2 ns	0.03 Ω	600 V	0.10 in.	2.75 m
CT-1	25 K to 1000	12 A	1.4 A			0.3 A	1 x10^{-6}	2 mA*1 (5 mV/mA)	≤0.35 ns	1 Ω	175 V_{rms}	0.070 in.	1.07 m
CT-2	1.2 K0 to 20	36 A	7 A			0.3 A	50 x10^{-6}	10 mA*1 (1mV/mA)	≤0.5 ns	0.1 Ω	175 V_{rms}	0.052 in.	1.07 m
CT-6	250 K to 2000	6 A	.7 A				−0.25 x10^{-6}	2 mA (5mV/mA)	≤200 ps	1.1 Ω	30 V_{rms}		
TEKPROBE® (TDS 400/500/600/700 and 11000 Series)													
TCP202	DC to 50	50 A	40 A	N/A	20 kHz	15 A	500 x10^{-6}	*4	≤7.0 ns	0.07 Ω	300 V	0.15 in.	2.2 m
TCP202 w/ CT-4	0.5 to 20	20 kA*2	2 kA*3	50 Hz	1.2 kHz	15 A	0.1	*4	≤17.5 ns	30 mΩ	3 kV	1.5 in.	2.2 m

*1 Scope set at 10 mV/Div.

*2 Based on voltage breakdown.

*3 Based on thermal heating limits in CT-4.

*4 Depends on instrument used.

*5 Opt. 03 is 2.75 meters long.

DC Coupled Current Probe

TCP202



Features – Benefits

- Easy Current Measurements
- Probe Connects Directly to TDS Scope through TEKPROBE® Interface
- Split Core Construction for Easy Circuit Connection
- DC to 50 MHz Bandwidth
- 15 Amps DC + Peak AC Current
- 50 Amps Peak Pulse Current
- Safety Certified

Applications

- Motor Drives
- Switching Power Supplies
- Disk Drive
- Electronic Ballasts
- Inverters
- Avionics

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

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When combined with a Tektronix TDS oscilloscope, the TCP202 enables users to make direct readout DC and AC current measurements, resulting in accurate displayed and recorded measurements.

The TCP202 is a general-purpose probe for displaying and measuring current in electronic circuits. It's ideal for power supply and motor drive design, and for device testing.

Characteristics

Bandwidth – DC to 50 MHz.
Max DC + Peak AC Current – 15 A.
Max Peak Pulse Current – 50 A.
Minimum Sensitivity – 10 mA/div.
DC Accuracy – ±1% (with probe calibrator). ±3% (without probe calibrator).
Max Bare Wire Voltage – 300 V (Cat I).

TYPICAL CHARACTERISTICS

Insertion Impedance – 0.002 Ω at 1 kHz. 0.1 Ω at 5 MHz.
Propagation Delay – 17 ns.
Max Conductor Diameter – 3.8 mm (0.15 in.).
Electrostatic Immunity – (per IEC 801-2) > 8 kV.
Amp*Sec Product – 500 x 10^{-6} Amp*Sec.
Rise Time – ≤ 7.0 ns.

PHYSICAL CHARACTERISTICS

Weight – 0.19 kg (0.44 lbs.).
Cable Length – 2.2 m (7.2 ft.).

POWER REQUIREMENTS

TCP202 is powered by the TDS oscilloscope via the TEKPROBE interface.

SAFETY

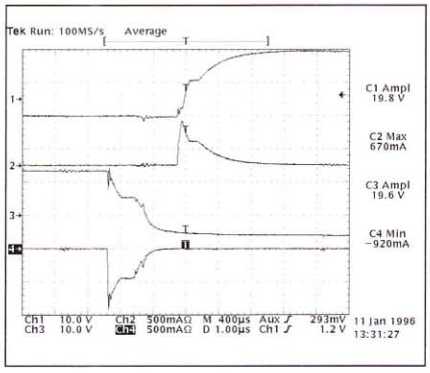
UL 3111-1, CSA1010.1, EN61010-1, IEC61010-1, EN61010-2-032, IEC61010-2-032.

RECOMMENDED OSCILLOSCOPES

TDS 520B; TDS 520C; TDS 520D; TDS 540B; TDS 540C; TDS 540D; TDS 580C; TDS 580D; TDS 654C, TDS 680C, TDS 684C, TDS 694C, TDS 724A; TDS 724C; TDS 724D; TDS 744A (S/N B040100 or higher); TDS 754A; TDS 754C; TDS 754D; TDS 784A (S/N B040100 or higher); TDS 784C; TDS 784D; TDS 794D.
TDS 744A and TDS 784A with S/N B030XXX or lower can be upgraded to the latest version using the TDS 7U01 Upgrade Kit.
For TCP202 operation with other TDS 400, TDS 500, TDS 600, and TDS 700 series oscilloscopes; the scale factor will be correct, but measurement will be indicated as V instead of A.

INCREASE THE ACCURACY OF YOUR CURRENT MEASUREMENTS

The accuracy of the TCP202 AC/DC current probe is normally 3%. However, the accuracy may be improved to 1% when the probe is calibrated on the TDS oscilloscope using the optional Calibrator P/N 015-0672-50. This improved accuracy is available on the above Recommended Oscilloscopes list.



ORDERING INFORMATION

For price information: Outside the U.S. contact your local Tektronix representative, inside the U.S. see the price list in the back of this catalog.

TCP202 DC COUPLED CURRENT PROBE

Includes: Instruction manual (070-9542-00), reference manual (070-9543-02).

RECOMMENDED ACCESSORIES

Probe Calibrator – (015-0672-50) Use with TDS 510A, TDS 520B, TDS 520C, TDS 520D, TDS 540B, TDS 540C, TDS 540D, TDS 580D, TDS 654C, TDS 680C, TDS 684C, TDS 694C, TDS 724A, TDS 724C, TDS 724D, TDS 754A, TDS 754C, TDS 754D, TDS 784A, TDS 784C, TDS 784D, TDS 794D for improved accuracy.

TDS 7U01 Upgrade Kit – For TDS 744A and TDS 784A. Please check with your local Tektronix Service Center.

RELATED PRODUCTS

1103 – TEKPROBE® Power Supply (for use with non-TEKPROBE BNC scopes).

ADA400A – Differential Preamplifier.

P5205 – High Voltage Differential Probe.

P5210 – High Voltage Differential Probe.

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

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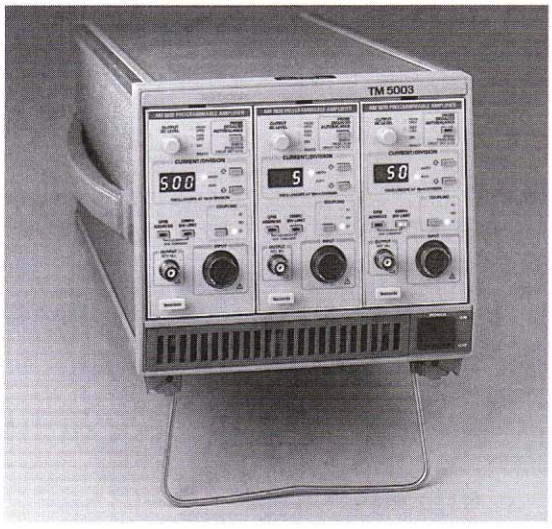
Current Measurement Systems

AM 503S • AM 503B • AM 5030S • AM 5030



Features – Benefits	Applications
AM 503S/AM 503B	Switching Power Supplies/Inverters
Manual Current Probe Amplifier	Disk Drives
Push Button Auto Balance/Degauss	Electronic Ballasts
Bright LED Current/Division Display	Motor Drives
Eliminates Need to Calibrate Amplifier with Specific Probes	
Plugs into TM 500/5000 Power Modules	
AC/DC Measurements	
AM 5030S/AM 5030	
GPIB Programmable Current Probe Amplifier	
Plugs into TM 5000 Power Modules	
Operated with External Controller or Manually from Front Panel	

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

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Tektronix measurement products are manufactured in ISO registered facilities.

AM 503 Current Measurement Family

The AM 503 Current Measurement system family is the most sophisticated current measurement solution available. The split core probes incorporate both a transformer for AC and a Hall Effect device for DC measurements to provide broadband current measurements from DC to 100 MHz. The AM 5030 Programmable Current Probe Amplifier automates time consuming manual measurements via a GPIB command set. The industry standard AM 503S Current Probe System provides a complete current measurement system in a single package.

The XL Series of probes features eight-meter cables for convenient access to test points. The A6304XL enables measurements of 500 A at DC, 700 A Peak.

AM 5030 PROGRAMMABLE CURRENT PROBE AMPLIFIER

The AM 5030 Current Probe Amplifier with General Purpose Interface Bus (GPIB) adds programmability to the versatile AM 503B. The AM 5030 enables you to use automated techniques to make wide bandwidth AC/DC current measurements. The AM 5030 is a TM 5000 single-wide module that plugs into a 3-slot TM 5003 power module mainframe. While the non-programmable AM 503B will operate in either a TM 500 or TM 5000 power module mainframe, the AM 5030 works only in a TM 5000 mainframe. The AM 5030 uses A6312, A6302, A6303 and the XL Series of current probes and connects to any scope or analyzer via a BNC cable.

Like the AM 503B, the AM 5030 does not have to be calibrated with specific current probes. This is a tremendous operational improvement over the older AM 503. The AM 5030 and AM 503B also provide several improvements over the AM 503A, including a faster Degauss/self-calibration cycle and more responsive, reliable front-panel controls.

The AM 5030 uses the IEEE 488.1 bus standard. Using a simple command set, you can configure and confirm the settings of the amplifier or read the instrument's serial number. You can determine

whether the current probe is open or closed, use bus commands to initiate a self-test or force a probe Degauss and DC balance operation. The AM 5030 bus address is set through the front panel and the address is retained when power is removed. The AM 5030 does not require an external controller to operate. It can be completely controlled using the front panel; however, when used with a controller, the front panel can be disabled to prevent manual operator adjustments.

For more information about the AM 5030, request the AM 5030 Programmable Current Probe Amplifier Data Sheet 51W-8941-0.

AM 5030S

The AM 5030S consists of an AM 5030 and a TM 5003. If you already own a power module, order only an AM 5030. If you need a power module, order an AM 5030S. Order the appropriate probes separately.

AM 503S CURRENT PROBE SYSTEM

The AM 503S Current Probe System is the most versatile current measurement system available. Since the probes incorporate both a transformer and a Hall Effect device, broadband AC/DC current can be measured simultaneously. Depending on the probe used, current from DC to 100 MHz and up to 700 A can be measured by clipping the split-core probes around the conductor. The AM 503S is truly a system, consisting of an AM 503B Current Probe Amplifier, a TM 502A two-wide Power Module, and an A6302 Current Probe. Options enable you to add or substitute an A6312 Current Probe, A6303 Current Probe or delete the A6302 Current Probe. If you require any of the XL current probes (longer length), then use Option 09, which deletes the A6302.

Order AM 503S Current Measurement System Data Sheet 51W-10226-1 for more information.

AM 503B CURRENT PROBE AMPLIFIER

The AM 503B Current Probe Amplifier is the heart of the AM 503S System. The AM 503B amplifies and sums the voltage outputs from the transformer and Hall Effect device and outputs it to the measurement instrument. It also provides the Hall Effect Device bias voltage and a reverse "bucking" current that resists saturation of the A6312/A6302/A6303 Current Probe core.

The AM 503B Current Probe Amplifier replaces the AM 503A. All functions are microprocessor controlled, providing a significant improvement in ease of use and functionality. The AM 503B uses bright, easy-to-read LEDs to display current/Division settings which are controlled with up/down push buttons. A single push button provides both Degauss and auto-balance functions. An additional significant improvement with the AM 503B is that individual



AM 503S with A6312 and A6303 probes.

A6312/A6302/A6303 probes no longer need to be calibrated with a specific amplifier but can be interchanged between AM 503Bs and AM 5030s. The AM 503B and the AM 5030 both support the new XL Series of current probes. The AM 503 and the AM 503A do not support the XL Series. The AM 503B operates in any TM 500/TM 5000 power module. The 50 Ω output of the AM 503B can be displayed on any oscilloscope or measurement instrument that has a sensitivity setting of 10 mV/Div. A 50 Ω output cable and termination is included with the AM 503B. The scope or measurement instrument requires at least a 400 MHz bandwidth to display the full bandwidth of the A6312 (100 MHz) and 50 MHz for the A6303. You can select either AC only mode or a DC mode which allows you to display a combined AC/DC current signal.

ORDERING INFORMATION

For price information: Outside the U.S. contact your local Tektronix representative, inside the U.S. see the price list in the back of this catalog.

AM 5030
Programmable Current Probe Amplifier.
Includes: 50 Ω BNC Cable (012-0057-01); Instruction Manual (070-8766-05); Reference Card (070-8770-01). The AM 5030 requires an A6312, A6302, A6303 or XL Series Current Probe and a TM 5003 or AM 5030S Power Module Mainframe.

AM 5030S
Programmable Current Probe Amplifier and Power Module.
Includes: AM 5030 Programmable Current Probe Amplifier and TM 5003 3-wide Power Module Mainframe. Order probes separately.

AM 503B
Current Probe Amplifier.
Includes: Same as AM 5030. The AM 503B requires one of the TM 500/5000 Series Power Modules, and an A6312, A6302, A6303 or XL Series Current Probe.

AM 503S
Current Probe System.
Includes: AM 503B Current Probe Amplifier; TM 502A Power Module; A6302 Current Probe; AM 503S Instruction Manual (070-8766-05); A6302 Instruction Manual (070-3905-04).
Opt. 01 – Adds A6303 Current Probe.
Opt. 03 – Substitutes A6303 Current Probe.
Opt. 05 – Substitutes A6312 Current Probe.
Opt. 09 – Deletes A6302 Current Probe.

INTERNATIONAL POWER PLUGS
Opt. A1 – Universal Euro 220 V, 50 Hz.
Opt. A2 – UK 240 V, 50 Hz.
Opt. A3 – Australian 240 V, 50 Hz.
Opt. A4 – North American 240 V, 60 Hz.
Opt. A5 – Switzerland 220 V, 50 Hz.
See page 619 for description.

MEASUREMENT SERVICE OPTIONS
Please see the Customer Information pages.

AM5030/AM503S
Opt. C3 – Three years of Calibration Services.
Opt. R3 – Repair warranty extended to cover three years.

AM503B
Opt. C3 – Three years of Calibration Services.
Opt. R3 – Repair warranty extended to cover three years.
See page 615 for further information.

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

Current Measurement Systems Probes

A6312 • A6302 • A6302XL • A6303 • A6303XL • A6304XL



For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

CE

ISO 9001

Tektronix measurement products are manufactured in ISO registered facilities.

Features – Benefits

A6312
20 Amps Continuous/50 Amps Peak
DC to 100 MHz
2 Meter Cable
Up to 0.15 in. Conductor Diameter

A6302
20 Amps Continuous/50 Amps Peak
DC to 50 MHz
2 Meter Cable
Up to 0.15 in. Conductor Diameter

A6302XL
8 Meter Cable
20 Amps Continuous/50 Amps Peak
DC to 17 MHz

A6303
100 Amps Continuous/500 Amps Peak
DC to 15 MHz
2 Meter Cable
Up to 0.83 in. Conductor Diameter

A6303XL
8 Meter Cable
100 Amps Continuous/500 Amps Peak
DC to 10 MHz

A6304XL
8 Meter Cable
500 Amps Continuous/700 Amps Peak
DC to 2 MHz

Applications

Motor Drives
Satellite Systems
Inverters
Transportation Systems
Power Supplies
Avionics

AM 503 Family Current Probes

A total of six current probes are available for use with the AM 503B and AM 5030 Current Probe Amplifiers. Since all six probes are of the split-core mechanical design, they easily clip on and off of a conductor. All the probes provide simultaneous DC and AC current measurements with a wide range of current amplitude and bandwidth capabilities.

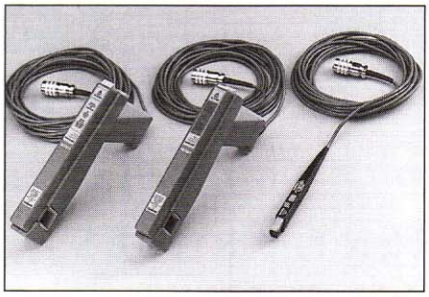
The AM 503 Current Probes convert the DC and AC flux field of a conductor to a voltage signal which is sent to an AM 503B or AM 5030

Amplifier. The probes include both a Hall Effect device, which senses the DC current, and a ferrite transformer which senses the AC current. The probes also utilize a bucking current from the Amplifier, which eliminates core saturation. The bucking current for the A6302XL is 20 A, 100 A for the A6303XL and 500 A for the A6304XL.

A6312, A6302 AND A6303 CURRENT PROBES

The A6312, A6302 and A6303 offer a wide range of current measurement capability for the lab and bench environment. The A6312 covers frequencies from DC to 100 MHz while the A6302 covers DC to 50 MHz. Both clip onto conductors up to 3.81 mm (0.15 in.) and measure continuous currents up to 20 A and peak currents up to 50 A as long as they do not exceed the amp*second product of 100 A*µs. The larger A6303 measures higher amplitude, lower frequency currents.

It clips onto conductors up to 21.1 mm (0.83 in.) in diameter. Its frequency range is DC to 15 MHz. It will measure continuous currents up to 100 A and peak currents up to 500 A, as long as the Amp*second product of 10,000 A*µs is not exceeded.



A6303XL,A6304XL and A6302XL. The eight-meter XL Series Current Probes.

The A6312, A6302 and A6303 are also compatible with the 11A16 2-CH Current Probe Amplifier for the 11000 and DSA Series oscilloscopes. With the 11A16, the A6312 and A6302 are rated for 10.5 A, and the A6303 for 52.5 A.

XL SERIES CURRENT PROBES

The three XL current probes add both convenience and expanded current measurement capability. The XL probes are designed to operate with the AM 503B and AM 5030 Current Probe Amplifiers. They are incompatible with the older AM 503 and AM 503A amplifiers. The XL (for extra long) probes have eight-meter cables, which allow you to reach test points on large devices such as heavy duty motors or automobiles. In addition, connecting to test points on transportation platforms such as trains, ships, or aircraft is much easier with the XL probes.

The A6302XL and A6303XL are modified versions of the A6302 and A6303 probes. The A6302XL can measure 20 A continuous (50 A peak) signals from DC to 17 MHz. The A6303XL can measure 100 A continuous (500 A peak) signals from DC to 10 MHz.

The A6304XL is rated for 500 A continuous (700 A peak) and is the same size as the A6303XL. The A6304XL has a bandwidth of DC to 2 MHz and is especially well suited for measurements on high-performance inverters, motor drives, and other high current switch-mode control devices. The eight meter cable makes it very easy to access test points on devices physically separated from your measurement instrument.

SAFETY (ALL)

UL3111-1, CSA1010.2.032, EN61010-2-032, IEC61010-2-032.

ORDERING INFORMATION

For price information: Outside the U.S. contact your local Tektronix representative, inside the U.S. see the price list in the back of this catalog.

A6312
100 MHz, 2 m, 20 A Current Probe.
Includes: 6 in. (152 mm) Ground Lead (196-3120-01) and A6312 Instruction Manual (070-9603-00).

A6302
50 MHz, 2 m, 20 A Current Probe.
Includes: 6 in. (152 mm) Ground Lead (196-3120-01), A6302 and A6302/XL Instruction Manual (070-9605-04).

A6303
15 MHz, 2 m, 100 A Current Probe.
Includes: Carrying Case (202-0318-00); A6303 and A6303/XL Instruction Manual (070-3905-04).
Note: A6302/A6303 probes must be used with an AM 503, AM 503A, AM 503B or AM 5030 Current Probe Amplifier.

A6302XL
17 MHz, 8 m, 20 A Current Probe.
Includes: Same as A6302 Current Probe.

A6303XL
10 MHz, 8 m, 100 A Current Probe.
Includes: Same as A6303 Current Probe.

A6304XL
2 MHz, 8 m, 500 A Current Probe.
Includes: Carrying Case (202-0318-00); A6304XL Instructions (070-8939-01).
Note: XL Probes work only with AM 503B or AM 5030 Current Probe Amplifiers.

MEASUREMENT SERVICE OPTION A6303/A6302XL/A6303XL/A6304XL
Opt. R3 – Repair warranty extended to cover three years.
See page 615 for further information.

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

CE

ISO 9001

Tektronix measurement products are manufactured in ISO registered facilities.

AC Current Probes

CT-1 • CT-2 • New CT-6



Features – Benefits	Applications
High Bandwidth	Data Storage Read Channel Design
Ultra-low Inductance	Silicon Characterization
Very Small Form Factor	High-frequency Analog Design
Characterize Current Waveforms up to <200 pSec Rise Times	ESD Testing
Very Low Loading of Circuit Under Test	Signal Injection
Fits Into Dense, Closely-spaced Circuit Designs	Differential Current Measurements
	Single Shot Low Rep-rate Pulse Measurements
	Propagation Delay Measurement

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

CE
(CT-6 is exempt)

ISO 9001

Tektronix measurement products are manufactured in ISO registered facilities.

CT-6 Current Probe – New

The CT-6 is the newest addition to the Tektronix portfolio of high-frequency current probes. It is designed to meet the needs of high-speed circuit design and test applications which require ultra high bandwidth, low inductance and extremely small form factor. The CT-6 provides up to 2 GHz bandwidth when used with high-bandwidth oscilloscopes such as the Tektronix TDS 794D oscilloscope or with other compatible 50 Ω input measuring instruments. Low inductance (<3 nH) assures that the loading effect of the CT-6 on the circuit-under-test will be negligible, which is especially important for today's low-amplitude, high-speed circuit designs such as disk drive read/write preamplifiers. The probe is a closed-circuit design which will accept uninsulated wire sized up to 20 gauge. This product is exempt from CE mark by virtue of its 30 V voltage limit.

CT-1/CT-2 Current Probes

The CT-1 and CT-2 Current Probes are designed for permanent or semi-permanent in-circuit installation. Each probe consists of a current transformer and an interconnecting cable. The current transformers have a small hole through which a current carrying conductor is passed during circuit assembly.

The P6041 Probe Cable provides the connection between the CT-1 and CT-2 Current Transformers and a BNC oscilloscope input. A 50 Ω termination is required to terminate the cable when connected to a high impedance (1 MΩ) oscilloscope input. One probe cable can be used to monitor several current transformers that have been wired into a circuit.

MINIATURE CONSTRUCTION

The CT-1 and CT-2 detachable cable design enables one or more probes to be located on circuit boards or in other limited space areas.

The CT-6 offers the smallest form factor available, for measurement on ever-shrinking circuit boards and components. It is designed for temporary installation and does not incorporate removable cables, as the CT-1 and CT-2 do.

HIGH SENSITIVITY

The CT-1 and CT-6 provide an output of 5 mV for each milliamp of input current when terminated in 50 Ω.

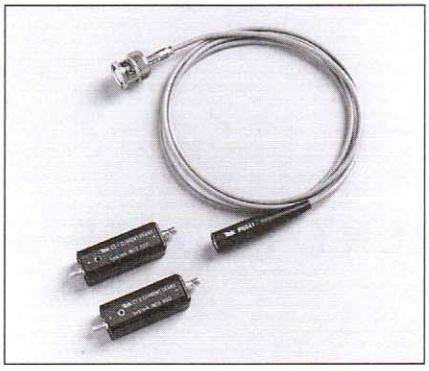
The CT-2 provides 1 mV per milliamp when terminated in 50 Ω.

TYPICAL SYSTEMS

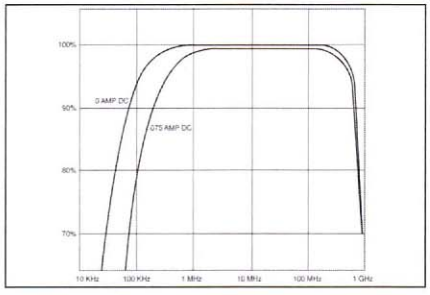
The CT-1, CT-2 and CT-6 high frequency current transformers are dynamic (i.e., non-DC) current measuring devices. They are typically used in conjunction with compatible high bandwidth oscilloscopes and other instruments to observe and/or record high frequency current waveforms. The CT-1, CT-2 and CT-6 normally operate directly into 50 Ω scopes and other measuring device inputs.

The CT-1 or CT-2 can be used with 1 MΩ input systems; use the P6041 probe cable and terminate the output with a 50 Ω feed-through termination (see Optional Accessories).

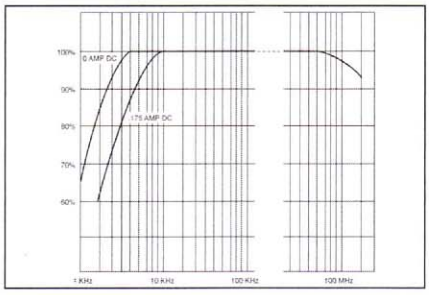
In all cases, the CT-1, CT-2 and CT-6 must work into 50 Ωs to obtain specified performance and sensitivity.



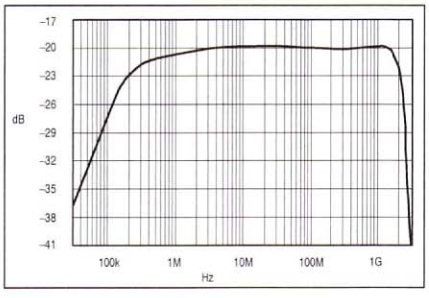
CT-1/CT-2 Current Probes with P6041 BNC Probe Cable.



CT-1 Typical Frequency Response.



CT-2 Typical Frequency Response.



CT-6 Typical Frequency Response.

CT-1, CT-2, & CT-6 CHARACTERISTICS

Parameter		CT-1	CT-2	CT-6
Bandwidth (typical)		25 kHz to 1 GHz	1.2 kHz to 200 MHz	250 kHz to 2 GHz
Risetime		350 p Sec	500 p Sec	200 p Sec
Sensitivity (into 50 Ωs)		5 mV/mA	1 mV/mA	5 mV/mA
Accuracy		± 3%	± 3%	± 3%
Magnetizing Inductance		6 microHenries	7 microHenries	1 microHenry
Leakage Inductance		2.4 nH	1 nH	1.5 nH
Insertion Impedance:	@ 10 MHz	< 1 Ω	0.1 Ω	1.1 Ω
	@ 100 MHz	2 Ω	0.5 Ω	1.3 Ω
	@ 1 GHz			11.9 Ω
Max. Bare Wire Size		#14 wire 1.78 mm (0.070 in.)	#16 wire 1.32 mm (0.052 in.)	#20 wire 0.8 mm (0.032 in.)
Max. Bare Wire Voltage:	RMS	175 V RMS CAT 1	175 V RMS CAT 1	30 V RMS CAT 1
* (< 3.25% duty factor)	Peak	1000 V *	1000 V *	30 V
	DC	175 V	175 V	30 V
Max. Peak Pulse Current		12 A	36 A	6 A
Max. Continuous Current (RMS)		450 mA	2.5 A	120 mA
Amp –Second Product		1 x 10^{-6} A*Sec	50 x 10^{-6} A*Sec	0.25 x 10^{-6} A*Sec
L/R Time Constant (droop)		> 6.35 µsec	> 160 µsec	0.4 µsec
Propagation Delay		3.25 nSec	6.1 nSec	5.2 nSec
Safety		UL3111-1, CSA1010.1, EN61010-1	UL3111-1, CSA1010.1, EN61010-1	

ORDERING INFORMATION

For price information: Outside the U.S. contact your local Tektronix representative, inside the U.S. see the price list in the back of this catalog.

CT-1 – High Frequency Current Probe.

CT-2 – High Frequency Current Probe.

CT-6 – High Frequency Current Probe.

CT-1 OR CT-2 RECOMMENDED ACCESSORIES

Feed-through 50 Ω Termination – Order 011-0049-01.

CT-6 OPTIONS

Opt. C3 – Three years calibration service.

Opt. D1 – Calibration data report.

Opt. D3 – Three years calibration data reports.

Opt. R3 – Three years repair service.

CT-6 STANDARD ACCESSORIES

SMA to BNC Adapter – Order 015-0572-00.

User Manual – Order 071-0453-00.

Color Cable Marker Bands

Probe Holder – Order 015-0682-00.

Certificate of Traceable Calibration

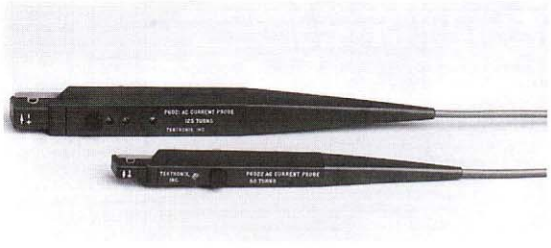
WARRANTY

One Year.

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

AC Current Probes

P6021 • P6022



Features – Benefits

P6021
120 Hz to 60 MHz
15 A Peak
For 1 MΩ Inputs
Shielded Probe Heads
AC Only
Split Core

P6022
935 Hz to 120 MHz
6 A Peak
For 1 MΩ Inputs
Shielded Probe Heads
AC Only
Split Core

Applications

Motor Drives
Inverters
Power Supply
Avionics

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

CE

ISO 9001

Tektronix measurement products are manufactured in ISO registered facilities.

P6021 AND P6022 CURRENT PROBES

The P6021 and P6022 Current Probes provide versatile AC current measurements. Both probes provide accurate current measurements over a wide range of frequencies. The P6021 and P6022 allow current measurements without breaking the circuit by clipping onto the current carrying conductor. Shielded probe heads are not grounded when the slides are in their open positions, eliminating accidental grounding of the circuit under test.

P6021 CURRENT PROBE

For general purpose applications, the P6021 provides wide-band performance with excellent low-frequency characteristics. Bandwidth is 120 Hz to 60 MHz. The passive termination is switchable from 2 mA/mV to 10 mA/mV.

P6022 CURRENT PROBE

With a head size of 0.47 in. x 0.25 in. (10 mm x 6 mm, about half the size of the P6021) and a bandwidth of 935 Hz to 120 MHz, the P6022 is ideal for measuring currents in compact, high-performance circuits. Passive termination output is switchable between 1 mA/mV or 10 mA/mV.

SAFETY

UL3111-1, CSA1010.2.032, EN61010-2-032, IEC61010-2-032.

Ordering Information

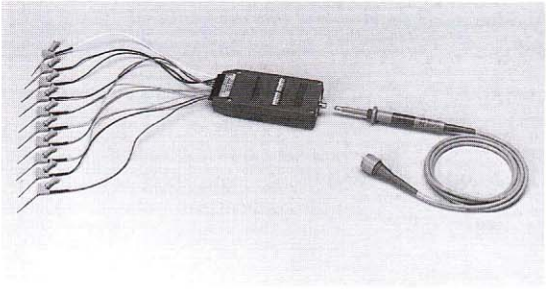
For price information:
Outside the U.S. contact your local Tektronix representative, inside the U.S. see the price list in the back of this catalog.

P6021
5 ft. Current Probe with Termination.
Includes: 6 in. Ground Lead (196-3120-01); Instruction Manual (070-0947-04).
Opt. 03 – 9 ft. with Termination.

P6022
5 ft. Current Probe with Termination.
Includes: Same as the P6021; Instruction Manual (070-0948-03).
Opt. 03 – 9 ft. with Termination.
Passive Termination only – (P6021) – Order 011-0105-00.

Word Recognizer Trigger Probe

P6408



Features – Benefits

- For TTL and TTL-compatible Logic
- 17-Bits (16 Data Bits Plus Qualifier)
- Synchronous and Asynchronous Operation
- Easy to Use
- Simplifies Digital Troubleshooting and Debug

Applications

Use with Any Oscilloscope

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

ISO 9001

Tektronix measurement products are manufactured in ISO registered facilities.

The P6408 is a 16-Bit word recognizer trigger probe for use with analog and digital storage oscilloscopes. It allows the oscilloscope to trigger on user defined logic states (rather than on analog levels), thus extending the utility of the oscilloscope into digital troubleshooting and debug applications.

The P6408 may also be used on oscilloscopes with 15 to 35 pF inputs, when used with the P6109B probe or other probes which have a miniature size probe tip. The P6408 trigger word is manually programmed via miniature DIP switches on the probe pod. The P6408 derives its operating power from the device under test +5 V bus.

Characteristics

Input Channels – Data (Clock/Qualifier)/Power (Ground): 16 (1)/1 (2).

Input Logic Level – HI (ONE)/LO (ZERO): ≥ 2.0 V/≤ 0.7 V.

Input Loading Current –
HI (ONE): 20 µA max @ 2.7 V;
LO (ZERO): –600 µA max @ 0.5 V.

Maximum Input Voltage Swing – 0 V to ≤ V cc.

Maximum Non-destructive Input Voltage – 1 V (LO) to +15 V (HI).

Word Recognizer Output Level –
HI (ONE)/LO (ZERO): ≥ 200 mV/≤ 70 mV.

ASYNCHRONOUS MODE

Maximum Trigger Frequency – 20 MHz.

Minimum Coincidence Between Data Inputs Resulting in a Trigger – 40 ns.

Maximum Coincidence Between Any Two Data Inputs Without Producing a Trigger – 40 ns.

Delay of Input Word Coincidence to Word Out – 20 ns.

SYNCHRONOUS MODE

Power Requirements – +5 V ±0.25 V, 100 mA max.

Recommended Instrument – Any instrumentation with 8 to 35 pF inputs.

Ordering Information

For price information:
Outside the U.S. contact your local Tektronix representative, inside the U.S. see the price list in the back of this catalog.

P6408

Word Recognizer/Trigger Probe.

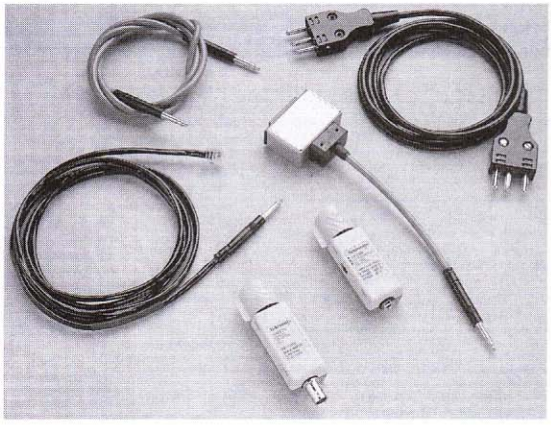
Includes: Two (10-wide) Lead Headers (012-0747-01); Pkg. of 20 SMT KlipChip™ Adapters (SMG50); P6109B Probe (complete package); Instruction Sheet (070-6938-00).

ADDITIONAL ACCESSORY

Probe Power Cable – Order 174-1342-00. Used with 1101A Power Supply.

Electrical Communication Adapters

AFTDS • AMT75



Features – Benefits

AFTDS Differential Signal Adapter for Electrical Communication

Complies with ANSI T1.102 and ITU-T G.703 Standards

120 MHz Bandwidth

Low VSWR (Return Loss) (≥ 26 dB)

Connects Directly to TDS Series Scope (TEKPROBE® Interface) or Other 50 Ω Terminated Instruments

CE Certified

AMT75 75Ω Adapter for Electrical Communication and Video Signals

Complies with ANSI T1.102, ITU-T G.957, ITU-T G.703 Standards and Bellcore GR-253-CORE

1.0 GHz Bandwidth

Low VSWR (Return Loss) ≤ 1.1:1, (≥ 26 dB)

Connects Directly to TDS Series Scope (TEKPROBE Interface) or Other 50 Ω Terminated Instruments

CE Exempt

Applications

Communication Pulse Shape or Eye Pattern Testing

Electrical Communication and Video Signal Interface for 50 Ω Terminated Instruments

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

CE (AFTDS only)

ISO 9001

Tektronix measurement products are manufactured in ISO registered facilities.

The AFTDS Differential Signal Adapter and the AMT75 75 Ω Adapter provide an effective means for 50 Ω terminated instruments to connect to and analyze differential and high speed electrical communication signals as well as video signals.

Both adapters are rugged and have the TEKPROBE interface, which provides convenient auto-scaling of waveforms on Tektronix TDS series oscilloscopes. Also the low VSWR (Return Loss) performance minimizes measurement errors commonly associated with interfacing with complex electrical signals.

Ideal for use in pulse shape compliance testing of high speed electrical communication signals.

Characteristics

AFTDS DIFFERENTIAL SIGNAL ADAPTER

Electrical Standards –
DS-1: (1.544 Mb/s)
DS-1A: (2.048 Mb/s)
DS-1C: (3.152 Mb/s)
DS-2: (6.312 Mb/s)
E-1: (2.048 Mb/s).

Standards of Compliance – ANSI T1.102, ITU-T G7.03.

Bandwidth (–3 dB) – 7 kHz to 120 MHz.

Rise Time – < 3.0 ns.

Attenuation – 5x, (–14dB) ±5.0% (valid over 50 kHz to 30 MHz).

Droop – ≤ 2.0% per 700 ns.

VSWR (Return Loss) – ≤ 1.1:1 (≥ 26 dB), typical (valid over 50 kHz to 30 MHz).

AMT75 75Ω ADAPTER

Electrical Standards –
DS-3: (44.736 Mb/s).
DS-4: (139.264 Mb/s).
STS-1: (51.84 Mb/s).
STS-3: (155.51 Mb/s).
STM-1: (155.51 Mb/s).
E-2: (8.448 Mb/s).
E-3: (34.368 Mb/s).
E-4: (139.264 Mb/s).
D-1: (270 Mb/s).
D-2: (143 Mb/s).

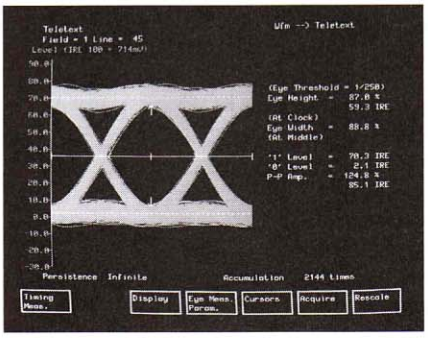
Standards of Compliance – ANSI T1.102, ITU-T G.957, ITU-T G7.03, Bellcore GR-253-CORE.

Bandwidth (–3dB) – DC to 1.0 GHz (typical).

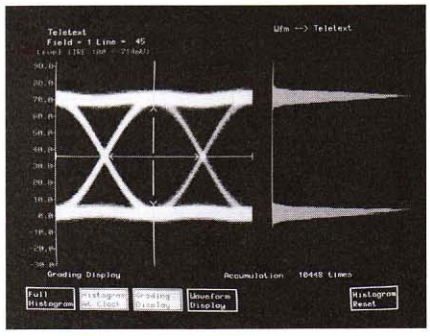
Rise Time – < 350 ps (typical).

Attenuation – 5X, (–14 dB) ± 2.0%.

VSWR (Return Loss) – ≤ 1.1:1 (≥ 26 dB), up to 1 GHz (typical).



AFTDS VSWR/Return Loss.



AMT75 VSWR/Return Loss.

AFTDS FEATURES

TEKPROBE® Interface – Auto-scaling and auto-termination with Tektronix TDS scopes.
Input Impedance –
100 Ω, 110 Ω or 120 Ω ± 3.0% (Selectable). (Valid over 50 kHz to 30 MHz).
Load Impedance – 50 Ω ± 3.0%.
Safety – UL3111-1, CSA1010.1, EN61010-1, IEC61010-1 (AFTDS only).

AMT75 FEATURES

TEKPROBE® Interface – Auto-scaling and auto-termination with Tektronix TDS scopes.
Input Impedance – 75 Ω ± 1.5%.
Output Impedance – 50 Ω ± 1.5%.

ORDERING INFORMATION

For price information: Outside the U.S. contact your local Tektronix representative, inside the U.S. see the price list in the back of this catalog.

AFTDS

Differential Signal Adapter.

Includes: Bantam (M) to Siemens (F) Cable, 5 in. (012-1520-00), Users Manuals (English) (070-9483-00), Certificate of Traceable Calibration.

RECOMMENDED ACCESSORIES

Siemens (M) to Siemens (M) Cable – 2 m (6.5 ft.), 120 Ω. Order 012-1469-00.

Bantam (M) to Bantam (M) Cable – 0.9 m (3 ft.). Order 012-1522-00.

Bantam (M) to RJ11 (M) Cable – 1.8 m (6 ft.). Order 012-1521-00.

RJ45/RJ11 (F) to RJ45 (F) Adapter – Order 103-0409-00.

Opt. D1 – Calibration Data.

AMT75

75 Ω Signal Adapter.

Includes: User's Manuals (English) (070-9479-00), Certificate of Traceable Calibration.

RECOMMENDED ACCESSORIES

75 Ω, BNC (M) to BNC (M) Coaxial Cable – 2 ft. Order 012-1339-00.

50 Ω, BNC (F) to BNC (F) Feed-through Adapter – Order 103-0028-00.

Opt. D1 – Calibration Data.

OPTIONAL ACCESSORIES FOR INSTRUMENT CONNECTIONS

50 Ω, BNC (M) to BNC (F) Coaxial Cable – 18 in. Order 012-0104-00.

50 Ω, BNC Coaxial Terminator Adapter – Order 011-0049-01.

50 Ω, BNC (F) to SMA (M) Adapter – Order 015-0554-00.

RECOMMENDED OSCILLOSCOPES

TDS 500 Series Digitizing Oscilloscopes.
TDS 600 Series Digitizing Oscilloscopes.
TDS 700 Series Digitizing Oscilloscopes.
TDS 800 Series Digitizing Oscilloscopes.
11800 Series Digital Sampling Oscilloscopes.
CSA 803 Series Communications Signal Analyzer.

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

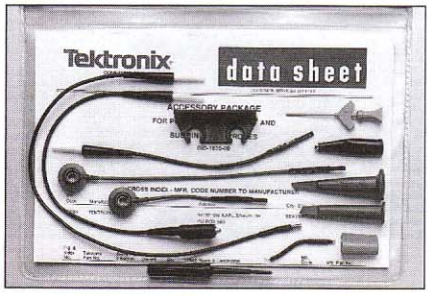
CE (AFTDS only)

ISO 9001

Tektronix measurement products are manufactured in ISO registered facilities.

ORDERING INFORMATION

For price information: Outside the U.S. contact your local Tektronix representative, inside the U.S. see the price list in the back of this catalog.



PROBE ACCESSORY BONUS PACKS

020-1386-01 Accessory Kit; Package of 12 206-0364-00.

020-1708-00 Accessory Pack; Standard Accessories to P6150.

020-1908-00 Accessory Pack; P400 and P850.

020-2106-00 Accessory Kit with 1 ea. Crocodile Clips, Red and Black.

020-2137-01 Accessory Kit; Leads, Adapters and Marker Strips, for P5102.

020-2140-00 Accessory Pack for P5205. **Includes:** 2 ea. 18 in. Extender Leads, Lead Adapters and Plunger Hook Clips.

040-1487-00 Differential Mod Kit for P5100.

131-4244-00 Probe Connector Pack of 100 ea. Order 131-4209-00 and 136-0962-00.

020-2134-01 Accessory Kit; Test, P6113B.

PROBE TIP GROUNDING HARDWARE

013-0085-00 Probe Tip Ground Collar.

131-1302-00 Ground Contact.

166-0557-00 0.381 ID x 0.43 OD x 0.385 Long Ground Cover.

175-1017-01 5 in. Grounding Strap.

196-3295-00 6 in. Ground Lead with Double Ground Collar.

196-3337-00 12 in. Ground Lead.

344-0046-01 Mini-gator Clip, Steel Jaws.

344-0465-00 Electrical Jaw-grip Clip, 20 mm Wide (Open), Black.

CRT SCREEN IMPLOSION SHIELDS

337-2775-00 CRT Implosion Shield/Filter, Blue.

337-2775-01 CRT Implosion Shield.

PROBE TIPS AND ACCESSORIES

131-3685-01 Electrical Contact Spring Tip, Gold Plated.

131-4280-00 Probe Tip Contact.

131-4997-01 2 ea. Probe Tip Insulator Assemblies.

206-0153-04 Probe Tip Relay Switch Assembly for P6046.

206-0463-00 Probe Hook Tip for P6015A.

013-0290-02 Probe Hook Tip Set (Large and Small) for P5100.

134-0016-00 Banana Plug Tip to 10-32 Thread.

013-0107-08 Probe Tip for Miniature/Compact Probes, Black.

PROBE REPLACEMENT HEAD

206-0438-00 Probe Head Assembly with Cable 1.5 m Long for P6205.

ADDITIONAL TEST LEADS AND CLIPS FOR HANDHELD METERS AND OSCILLOSCOPES

012-1482-00 Test Lead Set with One Red and One Black.

IC TEST CLIPS

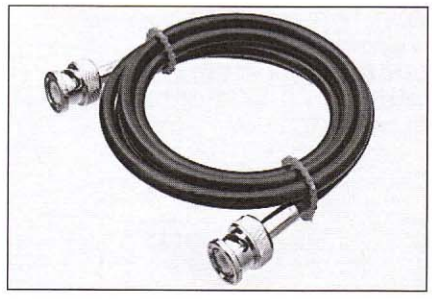
344-0422-00 PQFP100 Test Clip Assembly.

OTHER ACCESSORIES

062-1675-00 Probe Card; P6062A/P6060A, DP.

067-0563-00 Fixture, CAL; Shield.

067-0681-01 Fixture, CAL; Tunnel Diode Pulser.



CABLES

COAXIAL BNC CABLES

50 Ω

012-0057-01 42 in., Male-to-male.

012-0076-00 18 in., Male-to-male.

012-0208-00 10 in., Male-to-male.

012-0482-00 36 in., Precision (1%) Male-to-male.

012-1341-00 36 in., Male-to-male.

012-1342-00 24 in., Male-to-male.

75 Ω

012-1339-00 24 in., Male-to-male.

COAXIAL SMA (3 MM) 50 Ω CABLES

GENERAL PURPOSE FLEXIBLE CABLES

174-1364-00 12 in., Male-to-male.

174-1427-00 20 in., Male-to-male.

174-1428-00 60 in., Male-to-male.

174-0679-00 2 m, SMA Male-to-male.

174-1120-00 8.5 in., SMA Male-to-male.

174-1341-00 1 m, SMA Male-to-male.

PRECISION, FLEXIBLE DELAY CABLES

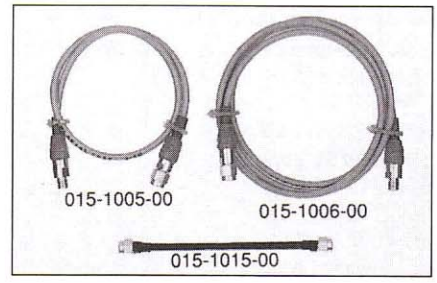
015-0560-00 2 ns, Male-to-male.

015-0561-00 5 ns, Male-to-male.

015-1005-00 2 ns, Male-to-female.

015-1006-00 5 ns, Male-to-female.

015-1019-00 1 ns, Male-to-female.



FIBER OPTIC CABLE

174-2324-00 2 m, Fiber Optic Cable, 62.5 Micron, FC. PC to SMA 906.

174-2323-00 2 m, Fiber Optic Cable, 62.5 Micron, FC/PC to BICONIC.

SEMI-RIGID DELAY CABLES

015-1015-00 500 ps, 4.5, Male-to-male.

015-1017-00 750 ps, Male-to-male.

BNC TO BANANA PLUG-JACK, 18 IN.

012-0090-00 Black.

BANANA PLUG-JACK TO BANANA PLUG-JACK, 18 IN.

012-0031-00 Red.

012-0039-00 Black.

PIN-JACK TO PIN-JACK, 0.08 IN. DIA-PIN

012-0180-00 Red, 18 in.

012-0182-00 Black, 18 in.

INTERFACE CABLES (NOT SHOWN)

GPIB

012-0991-00 2 m, Double-shielded.

012-0991-01 1 m, Double-shielded.

012-1282-00 0.5 m GPIB.

CENTRONICS

012-1233-00 3 m, 4693 to Terminal.

012-1214-00 8 ft. Male Centronics to PC 25-Pin D.

RS-232C

012-0911-00 10 ft. DB25 Male – DB25 Female, Straight Through.

131-4923-00 DB25 Male – DB25 Male gender changer.

174-1453-00 For 222/224.

012-1241-00 RS-232C, 9-Pin Female to 25-Pin Male.

012-1379-00 RS-232C, 9-Pin Female to 9-Pin Male.

TELEPHONE EXTENSION CABLE

012-1364-00 84 in. RJ45 8-Position to RJ45 8-Position.

EXTENDER HEAD FOR USE WITH SA-42, SA-46, SD-42 OPTICAL TO ELECTRICAL CONVERTERS

012-1220-00 1 m, Sampling Head Extends Cables for 11801B.

012-1221-00 2 m, Sampling Head Extends Cables for 11801B.

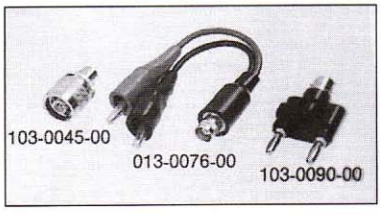
ORDERING INFORMATION (CONTINUED)

For price information: Outside the U.S. contact your local Tektronix representative, inside the U.S. see the price list in the back of this catalog.



ADAPTERS

017-0064-00 BNC Male to GR.
103-0032-00 BNC Male to UHF Female.
103-0033-00 BNC Male to Binding Post.
103-0035-00 BNC Male to Dual Binding Post.
103-0058-00 BNC Male to N Female.
103-0126-00 BNC Male to F type Female.



011-0112-00 BNC Male 75 to 50 Ω min. loss.
103-0045-00 BNC Female to N Male.
103-0090-00 BNC Female to Dual Banana Plug.
131-4199-00 BNC Female 75 to 50 Ω Type N Min. Loss.
103-0076-00 BNC Female to Alligator Clips.
103-0261-00 BNC Female to Alligator Clips.
103-0076-01 BNC Female to Retractable Hook Tip.
131-0112-00 BNC Female 75 to 50 Ω Type N Min. Loss.
011-0128-00 BNC Insertion Tee.



SMA ADAPTERS

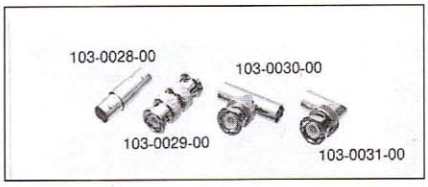
015-0554-00 SMA Male to BNC Female.
015-0549-00 SMA Male to SMA Female.
020-1693-00 SMA Kit.
015-0572-00 SMA Female to BNC Male.
015-0553-00 SMA Female to SMA Slide On Male.
015-1006-00 SMA Female to GR.

3.5 MM ADAPTERS

015-0551-00 SMA Male to SMA Male.

N STYLE ADAPTERS

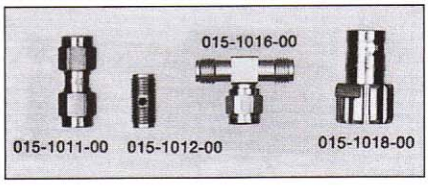
103-0058-00 N Female to BNC Male.
103-0045-00 N Male to BNC Female.



CONNECTORS

BNC CONNECTORS

103-0028-00 BNC Female to BNC Male.
103-0029-00 BNC Male to BNC Male.
103-0030-00 BNC "T".
103-0031-00 BNC Elbow Male to Female.



SMA CONNECTORS

015-1011-00 SMA Male to SMA Male.
015-1016-00 SMA "T".
015-1018-00 SMA Male to BNC Female.
015-1012-00 SMA Female to SMA Female.
020-1885-00 Fiber Optic Connector Kit w/ FC, ST, DIN and SC Connectors Specialty Connector Adapters.
103-0403-00 RJ45 Phone Jack to 9-Pin D-Sub Female.
119-5116-00 ASC-108 Optical connector.
134-0016-01 Banana-jack to Binding Post 50 Ω Current Loops.
015-0672-50 50 Turn Current Loop.
015-0601-50 1 Turn Current Loop.



MISCELLANEOUS CONNECTORS

103-0158-00 "F" Male to BNC Female.

INSTRUMENT POWER CORDS

161-0230-01 92 in. Power Cord, 125 V, 6 A, 3-pole.
161-0104-00 98 in. Power Cord, 125 V, 10 A, 3-pole.

AC POWER ADAPTER MODULES

	Order Part No.
TSG90/95/601, WFM 90, SDA601	
US 120 V	119-4538-00
Universal Euro 230 V A1	119-4540-00
UK 240 V A2	119-4541-00
Australian 240 V A3	119-4542-00
Japan 100 V A6	119-4539-00

MISC. INTERCONNECT CABLES

	Order Part No.
1910 to RCU, 6 ft.	012-0108-00
1910 to RCU, 22 ft.	012-0251-00
1720 to 1730, 18 in.	012-1422-01
LVDS (Parallel) Interface (For use with MTS200/ MTG200/MTD200/DDS200)	174-3562-00

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

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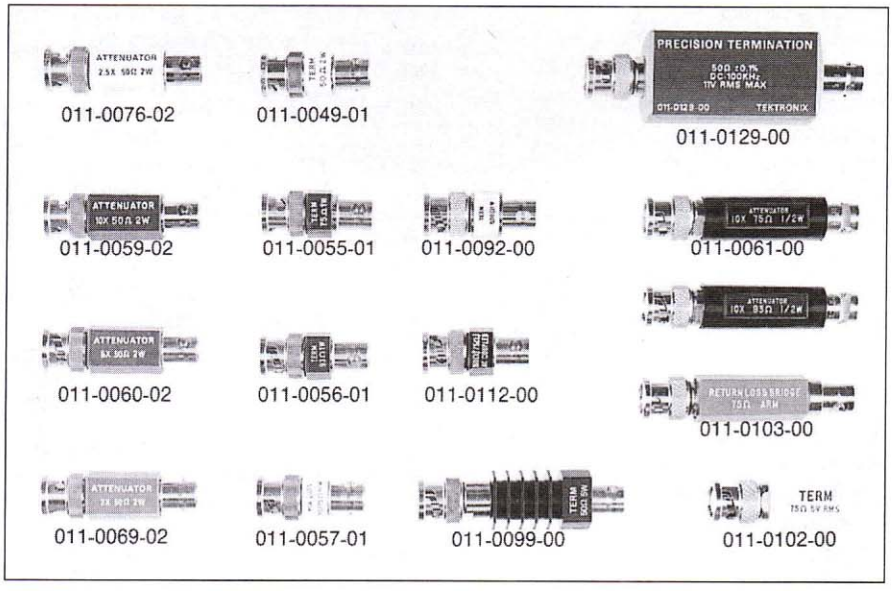
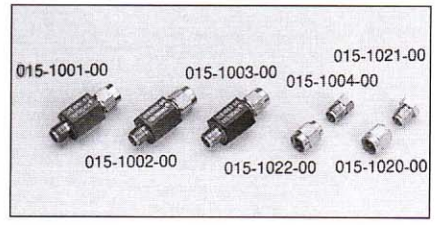


BNC (See table next page).



SMA (see table next page).

IMPEDANCE MATCHING TRANSFORMERS

120-1883-00 75 Ω to 50 Ω matching, 50 kHz to 300 MHz.

120-1884-00 75 Ω to 50 Ω matching, 50 MHz to 1 GHz.

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

3.5 MM TERMINATIONS (NOT SHOWN)

011-0150-00 Female short-circuit.

011-0148-00 Male 50 Ω.

011-0151-00 Male short-circuit.

011-0155-00 Male 50 Ω Precision DC to 26.5 GHz.

ATTENUATORS (NOT SHOWN)

011-0118-00 75 Ω to 50 Ωmatching, dBm to dBV.

PROBE ATTENUATORS (NOT SHOWN)

010-0376-00 10X Attenuator P6201.

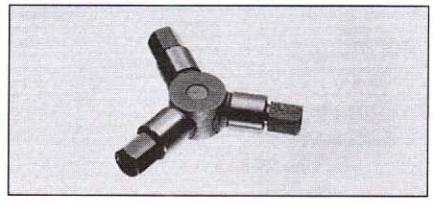
010-0377-00 100X Attenuator P6201.

010-0384-00 10X Attenuator P6202A.

PROBE TERMINATIONS (NOT SHOWN)

011-0105-00 BNC to P6021.

011-0106-00 BNC to P6022.



50 Ω POWER DIVIDER

015-0565-00 SMA female connector.

Designed for use in broadband 50 Ω systems where the mismatch introduced by ordinary "Tee" connectors is undesirable. Load isolation is nominally 6 dB while the voltage attenuation ratio is nominally 2X (input to either load arm, other load arm terminated in a standard 50 Ω termination).

ATTENUATORS/TERMINATIONS SELECTION GUIDE

BNC 50, 75 and 93 Ω (see photo on previous page)

	Type	Impedance (Ω)	Z-Tol (Ω)	Atten.	Atten. (dB)	Tol. (dB)	Freq. (DC to Watts)	Avg. Power (Watts)	Peak Power	Max. VSWR
011-0049-01	Feed-through	50	±1	NA	NA	NA	1 GHz	2	300	1.2 DC to 1 GHz
011-0059-02	Attenuator	50	±1	10X	20	±0.4 to 1 GHz ±0.6 1-2 GHz	2 GHz	2	500	1.1 DC to 1 GHz 1.2-1 to 2 GHz
011-0060-02	Attenuator	50	±1	5X	14	±0.4 to 1 GHz ±0.6 1-2 GHz	2 GHz	2	500	1.1 DC to 1 GHz 1.2-1 to 2 GHz
011-0069-02	Attenuator	50	±1	2X	6	±0.3 to 1 GHz ±0.5 1-2 GHz	2 GHz	2	500	1.1 DC to 1 GHz 1.2-1 to 2 GHz
011-0076-02	Attenuator	50	±1	2.5X	8	±0.3 to 1 GHz ±0.5 1-2 GHz	2 GHz	2	500	1.1 DC to 1 GHz 1.2-1 to 2 GHz
011-0099-00	Feed-through Termination	50	±0.5	NA	NA	NA	200 MHz	5		1.1 DC to 100 MHz 1.2-1 to 2 GHz
011-0055-01	Feed-through Termination	75	±1	NA	NA	NA	100 MHz	1	300	1.1 DC to 100 MHz
011-0056-01	Feed-through Termination	93	±1	NA	NA	NA	100 MHz	1	300	1.1 DC to 100 MHz
011-0057-01	Min. Loss Attenuator	50 to 75		2.3X	7.2	±0.5	100 MHz	0.5		1.1 DC to 100 MHz
011-0092-00	Feed-through Termination	600	±6	NA	NA	NA	1 MHz	1		
011-0112-00	Min. Loss Attenuator	75 to 50						2		(AC coupled)
011-0129-00	Feed-through Termination	50	±0.05	NA	NA	NA	100 kHz			
011-0102-01	Coax Termination	75	±0.5	NA	NA	NA		0.5		
011-0103-02	Return Loss Bridge	75	±0.5	NA	NA	NA				
011-0118-00	Matching dBm to dBV	50 to 75								
011-0155-00	Coax Termination	50	±2%	0.5	1.09	DC to 26.5 GHz				

SMA (3MM) 50 Ω (SEE PHOTO ON PREVIOUS PAGE)

	Type	Impedance (Ω)	Z-Tol (Ω)	Atten.	Atten. (dB)	Tol. (dB)	Freq. (DC to Watts)	Avg. Power (Watts)	Peak Power	Max. VSWR
015-1001-00	Attenuator	50	±1.0	2X	6	±0.3	18 GHz	1	500	1.15 DC to 4 GHz 1.25-4 to 12.4 GHz 1.35-12.4 to 18 GHz
015-1002-00	Attenuator	50	±10	5X	14	±0.5	18 GHz	1	500	1.15 DC to 4 GHz 1.20-4 to 8 GHz 1.25-8 to 12.4 GHz 1.35-12.4 to 18 GHz
015-1003-00	Attenuator	50	±1.0	10X	20	±0.5	18 GHz	2	500	1.15 DC to 4 GHz 1.20-4 to 8 GHz 1.25-8 to 12.4 GHz 1.35-12.4 to 18 GHz
015-1004-00	Termination (Female)	50	±0.5	NA	NA	NA	18 GHz	0.5	200	1.05 DC to 4 GHz 1.10-4 to 12.4 GHz 1.15-12.4 to 18 GHz
015-1020-00	Short-circuit Termination (Male)	0		NA	NA	NA	18 GHz	NA	NA	
015-1021-00	Short-circuit Termination (Female)	0		NA	NA	NA	18 GHz	NA	NA	
015-1022-00	Termination (Male)	50	±0.5	NA	NA	NA	18 GHz	0.5	100	

Instrument Carts/Workstation

Contents

K420 Bench-Height Cart 583
K465 Storage Tower 583
K415 Transport Cart 584
K475 Workstation Tower 584
K212 Portable Instrument Cart . . 585
Test Station (016-1239-00) 585

Tektronix can free up your valuable work space, make sharing and moving equipment easy and get you closer to the device under test.

Our ergonomically designed instrument carts and workstations bring a higher level of functionality to the end user, while safeguarding your instrument investment.

All new instrument carts and workstations can be customized to meet your specific requirements. The carts are shipped ready to assemble, allowing maximum configuration flexibility. The shelf height of the carts can be quickly and easily adjusted.

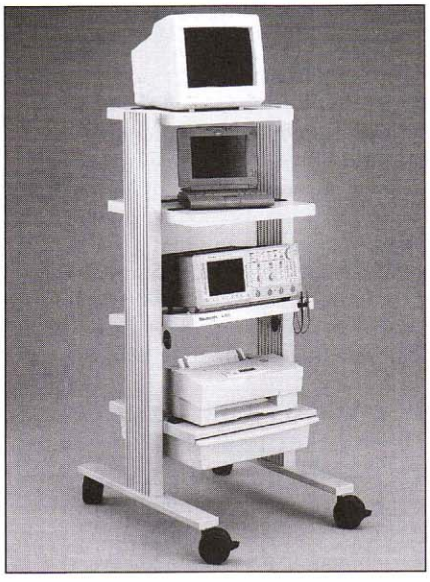
Instrument Compatibility Chart

	K212	K415	K420	K465	K475	TEST STATION (016-1239-00)
Oscilloscopes/Digitizers						
11000 Series, CSA 803A/404		*		X	*	*
DSA 600 Series					X	*
2200/2400 Series	X	*	*			
305/314/336	X	*				
5000/7000 Cabinet			X			
5000/7000 Rackmount		*	X	*	*	
TDS 3000			X			
TDS 300/400 Series	X		*	*		
TDS 500, 600, 700, 800 Series		*	X	*	*	*
TAS Series	X	*				
2500/2600		*	X	*		
TLS 216		*	X	*		
Television/Spectrum Analyzers						
1480 Series Cabinet	X		*			
1480 Rackmount		X	*		*	
17XX Cabinet	X					
17XX Rackmount		*		*		
1910		X	*		*	
2710 Series	X					
2750 Series		*		*	*	
2780/2790 Series	X		*			
490 Series	X	*				
Logic Analyzers						
1230		*	X	*		
DAS 9200		*			X	*
LV500				*	X	*
Prism 3000		*	*	*	X	*
TLA 500/900*[1]		*	*	*		
DAS® NT		*	X	*		
DAS® XP		*	X	*		
Curve Tracers						
370A/371/372					X	*
577		*				

X – Recommended.

** – Compatible.*

**1 LACart is the K420 Cart equipped with a mouse pad and skyhook.*





RACK-WIDTH PORTABILITY

The K465 Instrument Tower is specifically designed for Tektronix' larger oscilloscopes like the 11000 Series and the CSA Series. These sturdy carts provide stable and safe instrument mobility with large smooth-rolling four-inch dual durometer twin wheel casters. The tiltable shelf has infinite positive locking positions between horizontal and 26 degrees. The three-quarter shelf is intended to hold a printer or other small device. In addition, the spacious accessory drawer provides convenient storage for power cords, probes, manuals and small parts.

DURABLE WORK BENCH

These sturdy, portable carts are specifically designed for the Tektronix TDS Series Oscilloscopes used in digital design, telecommunications service and installation and manufacturing environments. The tiltable shelf is rack-width to accommodate your instruments. The cart handle can serve double duty as a probe drape.

In addition, the spacious accessory drawer provides convenient storage for power cords, probes, manuals and small parts.

K465

- Four Rack-width Shelves
- Designed for Use with 11K Series and CSA Series Oscilloscopes
- Tiltable Shelf with Positive Locking
- Three-quarter Shelf for Printer
- Bottom Shelf with Drawer
- Tough Steel and Aluminum Construction Means a Secure Platform for All Your Instruments
- Shipped Ready to Assemble to Give Maximum Configurability

K420

- Stable/Mobile Platform
- Tiltable Shelf for Optimum Viewing
- Work-bench Height
- Heavy-duty Nylon Instrument Straps
- Surge and Noise Suppression
- Surge-protected Four Outlet Power Strip Accessory
- Shipped Ready to Assemble

PHYSICAL CHARACTERISTICS

Dimensions	K465	mm	in.	K420	mm	in.
Width	Overall Cart	635	25	Overall Cart	635	25
	Tilt Shelf	502	19.75	Top Shelf	502	19.75
	All Other Shelves and Drawer	508	20	Bottom Shelf	508	20
Height	Overall Cart	1415	55.7		780	30.7
Depth	Overall Cart	533.4	21	Overall Cart	620	24.4
	Top Shelf	419	16.5	Top Shelf	533	21
	Middle and Bottom Shelves	533.4	21	Bottom Shelf	533	21
Weight	**K465**	**kg**	**lb.**	**K420**	**kg**	**lb.**
Net		35	78		26	57

CHARACTERISTICS

K465

Shelf Tilt – 0° to 26°.

Shelf Loading – Top Shelf: 35 lb. (16 kg). Middle Shelves: 82 lb. (37 kg). Basket: 50 lb. (23 kg).

K420

Shelf Tilt – 0° to 26°.

Shelf Loading – 82 lb. (37 kg) per shelf.

Drawer Dimensions – 18 in. x 19.5 in. x 4 in. (645 x 495 x 102 mm).

ORDERING INFORMATION

For price information: Outside the U.S. contact your local Tektronix representative, inside the U.S. see the price list in the back of this catalog.

K420
Work Bench Cart.

Includes: Probe Holders, Two Heavy Duty Nylon Instrument Straps, Instrument Manual, Retainer Bar, Hex Wrench, Level.

K465
Instrument Tower.

Includes: Two Probe Holders, Four Nylon Instrument Straps, Instrument Manual, Level, Hex Wrench, Retainer Bar.

RECOMMENDED ACCESSORIES

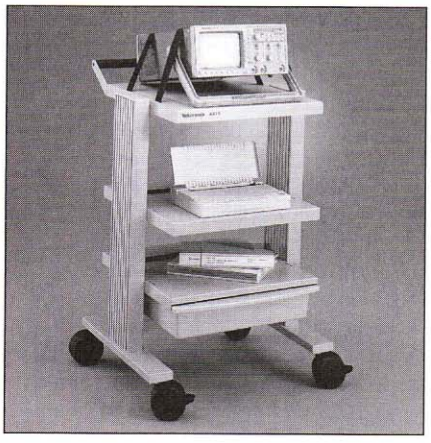
U.S. Power Strip – UL Listed Four Outlet, 15 ft., Noise/Surge Suppression. Order 131-5342-01.

Skyhook – Order 384-1800-00.

Mouse Pad – Order 436-0317-00.

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

Products are manufactured in ISO 9002 registered facilities.





K415

- Constructed of Extruded Aircraft Aluminum
- Tactile Fit and Hold Soft Form Handle
- Stable/Sturdy Platform
- Easy Assembly
- Height Adjustable Shelves

K475

- Rugged Workstation Tower Offering Sturdy, Mobile Instrument Platform
- Oversized Shelf for Larger Oscilloscopes or Fixed Keyboard Platform
- 4 Instrument Restraining Straps
- Steel and Aluminum Design Ensures Solid Support
- Shipped Ready to Assemble to Give Maximum Configurability

UNMATCHED VALUE IN PORTABILITY

The K415 Transport Cart, one of two mid-height carts, is constructed of nearly indestructible high-strength aluminum. These sturdy carts are ideal general purpose utility carts for holding Tektronix portable oscilloscopes, 1230 Logic Analyzers and other general purpose service instrumentation like the Tektronix TM 5000 and 7000 Series. The K415 consists of two rack-width shelves, plus a drawer for storage.

PORTABILITY FOR LARGER OSCILLOSCOPES

The rugged K475 Workstation Tower is designed for rackmount applications required in digital design, research and development and manufacturing environments. This cart holds Tektronix' larger oscilloscopes, like the DSA Series, providing stable transportation. It includes an extra long shelf (26.6 inches) with ample work space in front of the scope and three three-quarter shelves with loading capacity of 75 lb. per shelf.

CHARACTERISTICS

PHYSICAL CHARACTERISTICS

Dimensions	K415	mm	in.	K475	mm	in.
Width	Overall Cart	635	25	Overall Cart	635	25
	Top Shelf	508	20	All Shelves	508	20
	Bottom Shelf	508	20			
Height	Overall Cart	907	35.7	Overall Cart	1418	55.7
Depth	Overall Cart	533	21	Middle Shelf	676	26.6
	Shelves	533	21	All Other Shelves	370	16.5
Weight	**K415**	**kg**	**lb.**	**K475**	**kg**	**lb.**
Net		30	65		38	83

ORDERING INFORMATION

For price information: Outside the U.S. contact your local Tektronix representative, inside the U.S. see the price list in the back of this catalog.

K415
Transport Cart.
Includes: Two Probe Holders, Two Heavy Duty Nylon Safety Straps, Hex Wrench, Instruction Manual, Level.

K475
Workstation Tower.
Includes: Two Probe Holders, Four Nylon Instrument Straps, Hex Wrench, Level, Instrument Manual.

RECOMMENDED ACCESSORIES
U.S. Power Strip – UL Listed Four Outlet, 15 ft., Noise/Surge Suppression. Order 131-5342-01.
Skyhook – Order 384-1800-00.
Mouse Pad – Order 436-0317-00.

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

Products are manufactured in ISO 9002 registered facilities.





LOW COST PORTABILITY

The K212 column and trays are made from high strength aluminum; the base is thermoset polyester.

SYSTEM MOBILITY AND WORK SPACE FUNCTIONALITY

The Test Station is perfect for use with systems requiring multiple pieces of equipment. It can be used as a stand-alone work space with enough room for a scope and accessories, as well as an additional work area. The Test Station consists of the main desk top, two shelves, a slide out keyboard, manual holders and power cord channel. Both the shelves and base are height adjustable.

K212

- For Most Portable Instruments
- Sturdy and Mobile Platform
- Enhances Sharing and Work Space
- Tiltable Top Tray
- Locking Front Casters
- Four Outlet Power Strip Option

TEST STATION (016-1239-00)

- Organizes System Hardware
- Provides Additional Work Area
- Slide Out Keyboard
- Height Adjustability
- Practical and Sturdy
- Shipped Ready to Assemble

CHARACTERISTICS

Shelf Loading – 75 lb. per shelf; 100 lb. on main desktop.

PHYSICAL CHARACTERISTICS

Dimensions	Test Station (016-1239-00)	mm	in.	K212	mm	in.
Width	Overall Cart	1442	56	Overall Cart	435	17
Height	Overall Cart	1295	51	Overall Cart	840	33
Depth	Overall Cart	762	30	Overall Cart	550	21.6
Weight		**kg**	**lb.**		**kg**	**lb.**
Net		*1	*1		9	20

*1 *Contact your local Tektronix representative.*

ORDERING INFORMATION

For price information: Outside the U.S. contact your local Tektronix representative, inside the U.S. see the price list in the back of this catalog.

K212
Portable Instrument Cart.
Includes: Two 1 in. x 5 ft. Securing Straps, Retaining Bar, Instruction Sheet and Probe Holders.
Opt. 10 – Add Four Outlet Power Strip.
Opt. 12 – Add Second Tray.
Opt. 22 – Combines Opt. 10/12.

TEST STATION
Order 016-1239-00.
Includes: Slide Out Keyboard Tray, Cable Management Channel, Manual Holders.

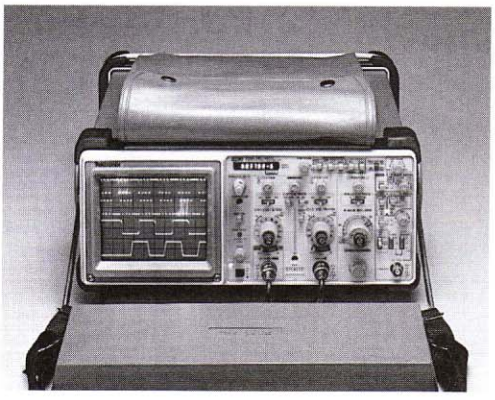
RECOMMENDED ACCESSORIES
U.S. Power Strip – UL Listed Four Outlet, 15 ft., Noise/Surge Suppression.
Order 131-5342-01.
Skyhook – Order 384-1800-00.
Mouse Pad – Order 436-0317-00.

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

Products are manufactured in ISO 9002 registered facilities.

Additional Accessories

Travel Accessories



Features – Benefits	Applications
Portable Instrument Transit/Carrying Cases High Strength Foam Padding Custom Fit	Portability Storage Protection
Portable Instument Protective Covers Custom Fit Waterproof Vinyl for Complete Enclosure of High-impact Plastic for Front Panel Enclosure	
Front Covers Snap-on Front Cover High-impact Plastic	
Power Supplies Wall Mount Power Supply	
Rechargeable Battery Pack Battery Packs Cigarette Lighter Plug-ins	
Instrument Foot Switch Foot Operated Start, Switch Measurement	

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

PORTABLE INSTRUMENT TRANSIT/CARRYING CASES

Rugged transit cases molded of high strength glass-epoxy protect your instruments from hostile environments, shock, vibration, moisture and impact. Recommended for shipping or transporting your instruments. Adjustments can be made to the internal padding of the 016-0792-01 to accommodate a wide variety of portable instruments and accessories.

PORTABLE INSTRUMENT PROTECTIVE COVERS

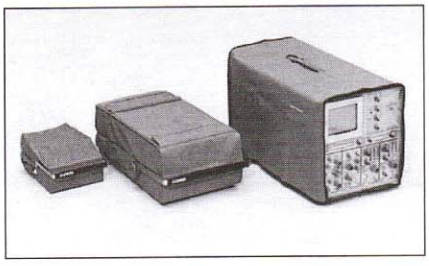
The covers provide protection for the instruments during transport or storage. Made of waterproof vinyl, the covers are available for both laboratory and portable instruments. The covers for 5000/7000 Series have clear vinyl frontal areas.

FRONT COVERS

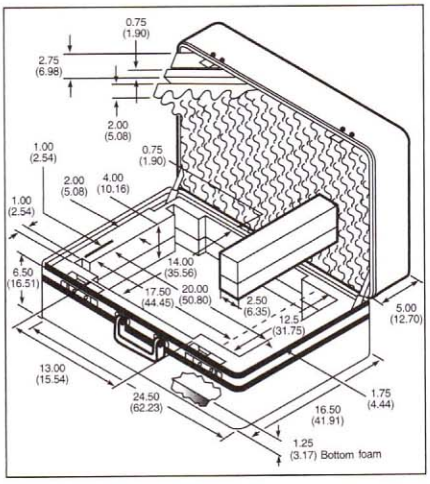
Front covers are available for most portable oscilloscopes, spectrum analyzers and TM 500/5000 mainframes.

ORDERING INFORMATION

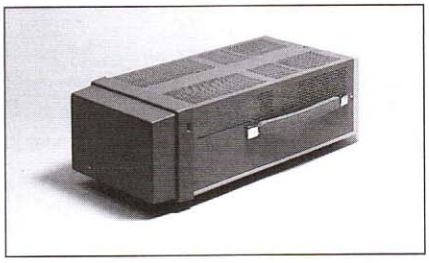
For price information: Outside the U.S. contact your local Tektronix representative, inside the U.S. see the price list in the back of this catalog.



Complete Covers.



016-0792-01 (Shown).



Front Covers Only.

PORTABLE INSTRUMENT TRANSIT/CARRYING CASES

Hard Sided Case –
271X Family. Order 016-0792-02.
278X, 279X Family, OF150, OF235. Order 016-0658-00.
TM 504. Order 016-0608-00.
TM 515. Order 016-0643-00.

Soft Sided Case –
271X Family. Order 016-1158-01.
278X, 279X Family, OF150, OF235. Order 016-0659-00.

Carrying Strap –
2200/2300 Series, 271X Family. Order 346-0199-00.

PORTABLE INSTRUMENT PROTECTIVE COVERS

7300/7400/7600 Series. Order 016-0192-01.
5000 Series. Order 016-0544-00.
434/464/466. Order 016-0365-00.
TM 504. Order 016-0621-00.
TM 503. Order 016-0620-00.

FRONT COVERS

2400 Series. Order 200-3199-01.
2245A, 2246A, 2247A. Order 200-3232-01.**2235A, 2236A/271X Family.** Order 200-2520-00.
2201, 2205, 2211, 2225. Order 200-3397-00.
TM 506. Order 200-1728-00.
TM 504. Order 200-1727-00.
TM 503A. Order 200-3554-00.

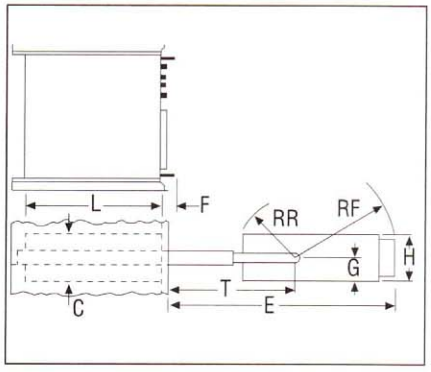
POWER SUPPLY

Rechargeable Battery Pack – 2 x 4 V, 224. Order 146-0075-00.
Wall Mount Power Supply – 120 V AC, 224. Order 120-1807-00.
Cigarette Lighter Plug Power Cable Adapter – 224. Order 174-1734-00.
Battery Pack, 6 V, 12 A, Lead-acid Battery – A6906S. Order 650-3022-00.
Probe Power Supply with Amplifier – P6046. Order 015-0106-00.
Wall Mount Power Supply, 120 V AC in, 12 V 100 mA-1.2 W Out – J7, J8. Order 119-5032-00.
Power Supply – 1.2 W; 12 V 100 mA, unregulated, 120 V AC 60 Hz, 183 cm CABL. Order 119-4488-00.
Alkaline Battery – 9.0 V, 500 mAH at 510 Ω to 4.8 V, 1604 Case. Order 146-0017-00.
Storage Battery – 6 V, 0.75 AH, with 3 A fuse. Order 146-0033-02.
Power Supply Amplifier – Order 015-0114-00.
Wall Mount Power Supply – 110 V AC, –50/60 Hz, to 9.5 V DC-1.5A. Order 119-1847-00.
Wall Mount Power Supply – 115 V AC, to 9 V DC-1A. Order 119-4242-00.

ACCESSORIES

Instrument Foot Switch – SPDT, 7 A, 125 VAC with micro phone plug. Order 260-1189-02.

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.



Dimensions – Exclusive of Plug-in Units and Probes.

Symbol	Definition
H	Height of front panel
L	Rack front to rearmost permanent fixture excluding cables
F	Back of front panel to foremost protrusion
E	Maximum forward clearance with instrument out and horizontal
D Min.	Minimum mounting depth from front mounting rail to rear mounting rail
D Max.	Maximum mounting depth from front mounting rail to rear mounting rail

RACKMOUNT KIT SELECTION GUIDE

		H		L		F		E		D Min		D Max	
Instrument	**Part Number**	**in.**	**cm**	**in.**	**cm**	**in.**	**cm**	**in.**	**cm**	**in.**	**cm**	**in.**	**cm**
DSA 601, DSA 602	040-1279-02	12.25	31.1	24.3	61.7	2.4	6.1	31.7	80.5	14.63	37.2	27.75	70.49
11201/A, 11301/A, 11302/A, 11401, 11402/A, 11403/A, 11801, 11802, CSA 803A, SM11	040-1214-03	8.75	22.3	21.6	55					14.63	37.2	27.75	70.49
7704A, 7104, 7934, 7854, 7904A	040-0611-01	15.75	40	21.63	54.9	1.25	3.18	30.48	77.4				
7704A, 7104, 7934, 7854, 7904A	040-0560-00*[1]	22	55.9	21.9	55.6	1.98	5						
5100, 5400 Series	040-0583-03	5.25	13.3	19	48.3	1.1	2.8	24.6	62.5				
279X Family	016-0844-02	8.75	22.3	17.8	45.2								
278X Family	016-1019-01	8.75	22.3	17.8	45.2								
271X Family	016-0901-01	5.25	13.3	16.3	41.4	1.84	4.67						
2400 Series (with DV or DMM Opt.)	016-0805-00	8.75	22.3	18.3	46.5	1.8	4.5	24.8	62.9	12.8	32.5	26.8	68.1
2400 Series (w/o DV or DMM Opt.)	016-0825-01	7	17.8	18.3	46.5	1.8	4.5	24.8	62.9	12.8	32.5	26.8	68.1
2402 TekMate™	016-0971-00	3.5	8.9	18	45.7	1.8	4.5	24.5	62.2	11	27.9	23	58.4
2335	016-0468-00	5.25	13.3	16.3	41.4	1.8	4.5			7.5	19.1	24.5	62.2
2220, 2221, 2224, 2230, 2232		5.25	13.3	16.3	41.4	1.8	4.5			7.5	19.1	24.5	62.2
1240, 1241	016-0789-00	8.75	22.3	17.75	45.1	1.13	2.9						
TAS 200/400 TDS 300/400	016-1166-00	7	17.8	18.3	46.5	2.2	5.6	24.8	62.9	12.8	32.5	24.5	62.2
TDS 200 Series	RM200	6.94	17.7	4.03	10.2	1.75	4.45						
TDS 3000 Series	RM3000	6.95	17.7	4.16	10.6	1.78	4.51						
TDS 500/600/700	016-1236-00	7	17.8	22	55.9	16.3	41.4						
TM 5003	040-1257-02	7	17.8	18	45.7								
Two TM 503s side by side	040-0616-02	5.3	13.5	16.5	41.9	1.1	2.8	24.6	62.5				
TM 503 with 1/2 Rackwidth Adapter	040-0617-02	5.3	13.5	16.5	41.9	1.1	2.8	24.6	62.5				

ORDERING INFORMATION

For price information: Outside the U.S. contact your local Tektronix representative, inside the U.S. see the price list in the back of this catalog.

CATHODE-RAY TUBE LIGHT FILTERS

Instrument*1	Color	Part Number
200 Series	Blue	378-0691-00
324/335	Blue	378-2016-01
490	Amber	378-0115-01
	Gray	378-0115-02
	Blue	378-0115-00
465/465B	Blue	337-1674-00
576	Blue*2	378-0616-00
605/606/607	Blue	337-1674-00
Graticule (Clear)	337-1674-10	Clear Shield
Gray*2	337-1674-06	
2200 Series	Blue*2	337-2775-00
	Clear	337-2775-01
2300 Series	Blue Implosion Shield*2	337-2760-00
2400 Series	Blue*2	378-0199-03
	Clear Implosion Shield*2	378-0208-00
271X Series	Smoke Gray	337-2775-02
7603	Blue	378-0684-00
	Amber	378-0684-01
	Gray	378-0684-02
	Green	378-0684-03
	Spectrum Analyzer Graticule	337-1439-01
	Blue Implosion Shield*2	337-1700-01
	Clear Implosion Shield	337-1700-04
7613/7623/	Spectrum Analyzer	
7623A/7633	Graticule	378-0625-07
	Green (UV)	378-0625-03
7844/7313	Blue*2	378-0625-00
7700 Series/	Gray	378-0625-02
7613/7623/	Green	378-0625-03
7100 Series/	Spectrum Analyzer	
7900	Graticule	337-1159-02

CRT MESH/EMC FILTERS

Instrument*1	Color	Part Number
465/465B/ 475/464/ 466/434	N/A	378-0726-01
7400/7603	N/A	378-0696-00
7100/7500/ 7700/7800/ 7900 Series/ 7613/7623/A/ 7633	N/A	378-0603-00

The mesh filter improves display contrast for instrument viewing under high ambient light conditions. A fine metal screen with a matte black surface is utilized to reduce light reflections. Although light transmission from the CRT is reduced to approximately 28%, the high attenuation of external reflections allows viewing low intensity displays in room light or other bright surroundings.

The mesh filter also serves as an EMC filter. Installed on the instrument, the metal frame of the filter is grounded, providing effective filtering of the EMC spectrum.

*1 *For cabinet and rackmount instruments unless otherwise noted.*

*2 *Standard filter supplied with instrument.*

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

Television Test Products

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Picture Quality Analysis System
PQA200 591

MPEG Test System
MTS 200 592

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WFM 300A 597
WFM601 SERIES 597
WFM 1125 597
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1740, 1750, 1760 Series 599

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Video Networking
M2T 610

As new video technologies emerge and proliferate, one name above all others identifies the products that help make it all work. And keep working...Tektronix.

Tektronix delivers the test and measurement tools to help create and distribute television throughout the world. We've been a part of the committees that define industry standards. And, our developments and contributions to television technologies have earned Tektronix five Emmy awards, one Oscar and over 130 video patents.

Solutions for design, manufacturing, maintenance and calibration—you'll find them all in the broad range of Tektronix video and audio test products.

Picture Quality Analysis System

PQA200



Features – Benefits

Provides Fast, Accurate and Repeatable Objective Measurements of Picture Quality Against a Reference

Delivers Invaluable Information for the Evaluation and Optimization of Digital Video Compression Systems

Task-specific Hardware Reduces Analysis Time From Hours Into Seconds

Applications

MPEG Compression Equipment Design

MPEG Compression Equipment Evaluation

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

CE

ISO 9001

Tektronix measurement products are manufactured in ISO registered facilities.

For product detail, request a TV catalog by completing the business reply card in the back of this catalog.

Introducing the PQA200...the industry's only objective picture quality measurement tool that actually looks at video.

The PQA200 delivers analysis of picture quality with repeatable objective measurements that directly replicate subjective human visual assessments. This provides invaluable information to enable optimum video compression without compromising picture quality.

Based on a Windows NT workstation, the PQA200 is both a generator and analyzer of reference test material for testing compressed video systems. Standard inputs and outputs are 270 MB/s serial component (Rec. 601). Option 01 provides analog composite NTSC/PAL inputs and outputs.

Ordering Information

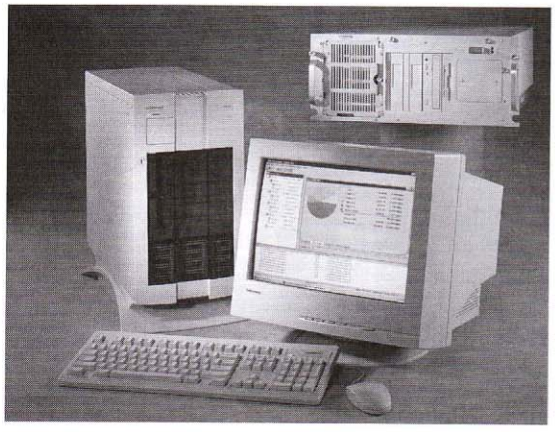
For price information:
Outside the U.S. contact your local Tektronix representative, inside the U.S. see the price list in the back of this catalog.

PQA200
Picture Quality Analysis System.

OPTIONS
Opt. 01 – Analog Video Inputs/Outputs for PQA200.
Opt. A1 – Universal Europe power cord.
Opt. A2 – United Kingdom power cord.
Opt. A3 – Australia power cord.
Opt. A5 – Switzerland power cord.

MPEG Test Systems

MTS200 Series



Features – Benefits

- Data Rates to 60 MBits/second
- Real-Time Analysis of Transport Streams
- On-line Storage of Captured Transport Streams
- Create and Generate Custom MPEG and DVB-compliant Transport Streams
- Intuitive Interface Based on Windows NT
- Modular Concept – Purchase Only Performance Required Today
- Rackmount Configuration Available

Applications

- MPEG and DVB Compliance Testing
- Component and Equipment Design Evaluation

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

CE

ISO 9001

Tektronix measurement products are manufactured in ISO registered facilities.

SARNOFF Corporation

DOLBY DIGITAL

DVB Digital Video Broadcasting

THOMCAST

The MTS200 Series MPEG Test Systems provide innovative solutions to meet the challenges of designing and testing MPEG transport systems. The MTS200 Series products are based on an industry-standard computing platform that provides flexible and expandable test capabilities. The MTS200 Series provides three primary capabilities: real-time analysis, deferred-time analysis, and custom transport stream generation.

Ordering Information

For price information:
Outside the U.S. contact your local Tektronix representative, inside the U.S. see the price list in the back of this catalog.

MTS205
Real-Time Analyzer.

MTS210
Deferred-Time Analysis System and Transport Stream Generator.

MTS210 OPTIONS (ONE REQUIRED)
Opt. 1A – Deferred-Time Analysis System only.
Opt. 1G – Custom MPEG Transport Stream Generation only.
Opt. AG – Deferred-Time Analysis System with Custom MPEG Transport Stream Generation.

MTS215
MPEG Test System.

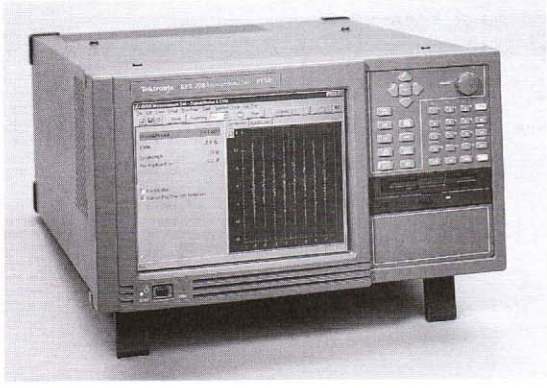
INTERNATIONAL POWER PLUGS
Opt. A1 – Universal Euro 220 V, 50 Hz.
Opt. A2 – UK 240 V, 50 Hz.
Opt. A3 – Australian 240 V, 50 Hz.
Opt. A5 – Switzerland 220 V, 50 Hz.
See page 619 for description.

MTS200 SERIES UPGRADE KITS
MTS1F05 – Updates existing MTS100 to MTS215 features and functionality.
MTS1F03 – Updates existing MTS100 to MTS210 Opt. AG features and functionality.
MTS2F01 – Updates MTS205 to MTS215 features and functionality.
MTS2F04 – Updates MTS210 to MTS215 features and functionality.
MTS2F06 – Updates MTS210 Opt. 1G or MTS210 Opt. 1A to MTS210 Opt. AG features and functionality.
MTS2F1R – Adds rackmount capability (Proliant only).

MEASUREMENT SERVICE OPTIONS
Opt. C5 – Adds five years of calibration services.
Opt. R2 – Two years repair protection.

Measurement Set

RFA300



Features – Benefits	Applications
Simple Operation	Install, Operate, Maintain 8VSB Transmitter
Automated Measurements	

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

CE

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Tektronix measurement products are manufactured in ISO registered facilities.

For product detail, request a TV catalog by completing the business reply card in the back of this catalog.

RFA300

The Tektronix RFA300 sets a high level of performance and flexibility, providing fast, easy and efficient solutions for 8VSB RF measurements. The RFA300 provides the measurement accuracy and ease of use you've come to expect from Tektronix.

The range of capabilities offered by the RFA300 include all the measurement functions required to install operate and maintain an 8VSB transmitter.

- Auto mode
  - Unattended monitoring of 8VSB signals
  - User-specified limits (2 Levels)
  - Notification when Limits Exceeded
  - Notification to Control Point or Local (Dry Contact Closure)
- Remote control operation
  - PC-Anywhere

Characteristics

Measurements	Graphic Display
Signal-to Noise Ratio Error Vector Magnitude Modulation Error Ratio Pilot Offset	Constellation
Out-of-Channel Emissions	Selected and Adjacent Channel Spectrum
Linear Distortions	Frequency Response Group Delay Waveform
Non-Linear Distortions	Actual Signal Magnitude Error vs Ideal Actual Signal Phase vs Ideal
Phase Noise	Pilot Phase Noise
Peak vs. Average Power	Peak to Average Power - Cumulative Distribution
Signal to Pilot Ratio	

Ordering Information

For price information:
Outside the U.S. contact your local Tektronix representative, inside the U.S. see the price list in the back of this catalog.

RFA300
8VSB Measurement Set.
Includes: User's Manual, Power Cord.

Measurement Sets

VM700T/VM100 Series/1780R Series



Features – Benefits	Applications
VM700T Many Capabilities in One Instrument **VM100 Series** Automatically Measures 13 Key Video Parameters **1780R Series** Full Bandwidth Analog Video Processing	Automated Manufacturing Testing Quality Control/Acceptance Testing Transmission Link Testing Equipment Evaluation

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

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VM700T VIDEO MEASUREMENT SET

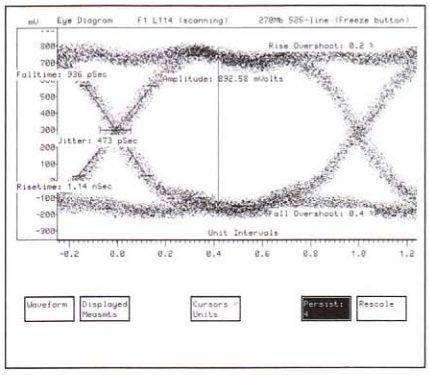
- Many Capabilities in One Instrument
- Auto Mode
- Measure Mode Provides Graphic Display of Measurements
- Award-winning User Interface
- State-of-the-art Architecture
- Extremely Fast Update Rate
- Parallel and Serial Printer Ports
- Three Input Channels
- Channel Difference Modes
- External VGA Display Port
- Fully Documented Remote Control Operation
- Hardcopy for Analysis and Documentation

VM700T OPTION 1S/SERIAL DIGITAL MEASUREMENTS

- Automatic Analysis of 270 Mbit Component, and 143 Mbit Composite and 360 Mbit Component Serial Digital Video Signals
- Continuous Real-Time Format Analyzer with Event Logging and Frame Capture
- Eye Diagram Display with Automatic Limit Violation Detection
- Jitter Measurements with Wide Band Spectral Analysis
- Ancillary Data Analyzer with Full Frame Data Distribution Display
- Conformance Testing to SMPTE 259M
- AES and Embedded Digital Audio Measurements
- Parade, Stacked and Overlay Displays with Interpolated Waveforms
- SMPTE RP-165 Digital Error Detection and Reporting
- Audio-to-Video Delay Measurements on AES or Embedded Audio
- Picture Mode with Relative to Reference Capability
- Relative to Reference Modes
- Longitudinal Time Code Input for Time Stamping Error Events
- Video Wander Measurement

VM 700T OPTION 20 TELETEXT MEASUREMENTS

- Adds Teletext Measurement to the VM700T Measurement Mode
- Measures and Monitors teletext Signals for either NTSC or PAL Systems
- Provides the following Measurements:
  - Eye Height
  - Eye Width
  - Data Level
  - Start-of-Code
  - Number of Run-in Bits



Opt. 1S SDI Eye Diagram.

VM 700T OPTION 21 CAMERA MEASUREMENTS

- Significantly simplifies key measurements of camera performance
- Compatible with NTSC or PAL cameras
- Automates pre-purchase evaluation and comparison of cameras
- Uses industry standard charts

VM 700T OPTION 30 COMPONENT MEASUREMENTS

- Provides Numerical Results For:
  - Relative Timing of B-Y and R-Y
  - Relative Amplitude of B-Y and R-Y
  - Peak to Peak Amplitude for B-Y and R-Y
  - Peak White Amplitude
- Configurable for Y/R-Y/B-Y or GBR Formats
- Full Complement of Component Analog Video Measurements and Displays

VM 700T OPTION 40/41 AUDIO MEASUREMENTS

- Incorporates both Automated and Manual Audio Measurements
- Audio Spectral Analysis
- Multitone Analysis
- Stereo Audio Monitoring

VM 700T OPTION 42/AVTIME

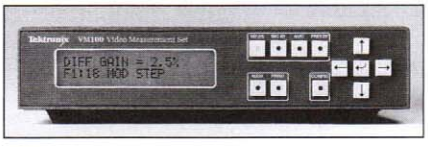
- Measures timing difference between audio and video portions from different transmission paths
- Supports both NTSC and PAL

VM 700T OPTION 48 GPIB INTERFACE

- Enhances VM 700T Remote Control Capability
- Allows Access to GPIB Environments and Development Software

AUTOMATIC & VIDEO MEASUREMENT SETS

VM100 • VM101 • 1780R SERIES



VM100/VM101/VM140/VM141

- Automatically Measures 13 Key Video Parameters
- Verifies Compliance with Industry Standard TV Regulations
- Automatic "Signal ID"
- Fast, Accurate Measurements at a Touch of a Button



1780R/1781R

- Full Bandwidth Analog Video Processing
- Precision Waveform and Vector Measurements
- Component and Composite Waveform Display
- Polar SCH Presentation, with Calibration
- Four Loop-through Video Input Channels
- Front Panel Probe Input
- Component or Composite Waveform Evaluation
- Measurement-grade Time and Voltage Cursors
- Electronic K Factor and ICPM Graticules
- Precision Differential Phase/Differential Gain Measurements Even with Noisy Signals
- Stereo Audio Phase and Amplitude Display
- Digital Control of All Functions
- Touch Screen User Interface
- User-definable Semiautomatic Setups
- Available for Either NTSC or PAL Standards

ORDERING INFORMATION

For price information: Outside the U.S. contact your local Tektronix representative, inside the U.S. see the price list in the back of this catalog.

VM700T
Video Measurement Set.
Includes: Instruction manual; 75 Ω terminators (3) 011-0102-00; power cord.
Opt. 01 – NTSC Measurements
Opt. 11 – PAL Measurements.
Opt. 01/11 – Dual Standard Measurements.
Opt. 1S – Serial Digital Measurements.
Opt. 20 – Teletext Measurements.
Opt. 21 – Camera Measurements.
Opt. 30 – Component Measurements.
Opt. 40 – Audio Measurement Module.
Opt. 41 – 6 Channel Audio Measurement Module.
Opt. 42 – Audio to Video Delay Measurement.
Opt. 48 – GPIB Interface.
Opt. 1C – Cabinet Version.
Opt. 1G – Echo/Rounding Measurements.
Opt. 1P – Printer.
Opt. 1T – Calibration – NIST/MIL Traceable.
Opt. 1Z – Probe Adapter (067-1429-00).
Opt. 3Z – Probe Adapter (3 each of 067-1429-00).

VM700T SOFTWARE UTILITIES
VMBKUP – VM700T Backup Utility.
VMREMGR – Remote Graphics Software for the VM700T.
VMT – VM700T Remote Control Software.

OPTIONAL ACCESSORIES
VM7FC1 – Field-installable conversion kit to convert rackmount unit to cabinet.
VM7FR1 – Field-installable conversion kit to convert cabinet to rackmount unit.

MEASUREMENT SERVICE OPTIONS
Opt. C3 – Three years of Calibration Services.
Opt. C5 – Five years of Calibration Services.
Opt. R3 (VM700T/VM100/VM101 only) – Repair warranty extended to cover three years.
Opt. R5 (VM700T only) – Repair warranty extended to cover five years.
Opt. S1 – One year upgrade to "On-site" Service.
Opt. S3 – Three year upgrade to "On-site" Service.
Opt. S5 – Five year upgrade to "On-site" Service.
Opt. IN – Product Installation Service.

MEASUREMENT SERVICE OPTIONS
Opt. C3 – Three years of Calibration Services.
Opt. C5 – Five years of Calibration Services.
Opt. R3 (VM 700T/VM100/VM101 only) – Repair warranty extended to cover three years.
Opt. R5 (VM 700T only) – Repair warranty extended to cover five years.
Opt. S1 – One year upgrade to "On-site" Service.
Opt. S3 – Three year upgrade to "On-site" Service.
Opt. S5 – Five year upgrade to "On-site" Service.
Opt. IN – Product Installation Service.

VM100
Video Measurement Set.
Includes: User Manual (070-9522-XX), Power Cable (161-0216-00), Replacement Cushion Pad (348-0844-00).

VM101
Video Measurement Set.
Includes: User Manual (070-9522-XX), Power Cable (161-0216-00), Replacement Cushion Pad (348-0844-00).
WINWARE – Software.
CSS50 – Software.

MEASUREMENT SERVICE OPTIONS
Opt. C3 – Three years of Calibration Services.
Opt. C5 – Five years of Calibration Services.
Opt. R3 (VM700T/VM100/VM101 only) – Repair warranty extended to cover three years.
Opt. R5 (VM700T only) – Repair warranty extended to cover five years.

1780R
NTSC Video Measurement Set 525/60.

1781R
PAL Video Measurement Set 625/50.
Includes: Power Cable Assembly, Spare Fuse, Replacement Air Filter, Rackmountable Metal Case.

INTERNATIONAL POWER
Opt. A1 – 220 V Euro Plug.
Opt. A2 – 240 V UK Plug.
Opt. A3 – 240 V Aust Plug.
Opt. M2 – Remedial Service Support.
Opt. M8 – Calibration Service.
Opt. 74 – White Phospher.

OPTIONAL ACCESSORIES
1780F02 – Portable Cabinet, including Handle, Feet, Front and Rear Covers.
1780F05 – Zero Clearance Mounting Shelf.
P6109B – 10x 2m Probe.

MEASUREMENT SERVICE OPTIONS
Opt. C3 – Three years of Calibration Services.
Opt. C5 – Five years of Calibration Services.
Opt. R3 (VM700T/VM100/VM101 only) – Repair warranty extended to cover three years.
Opt. R5 (VM700T only) – Repair warranty extended to cover five years.

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

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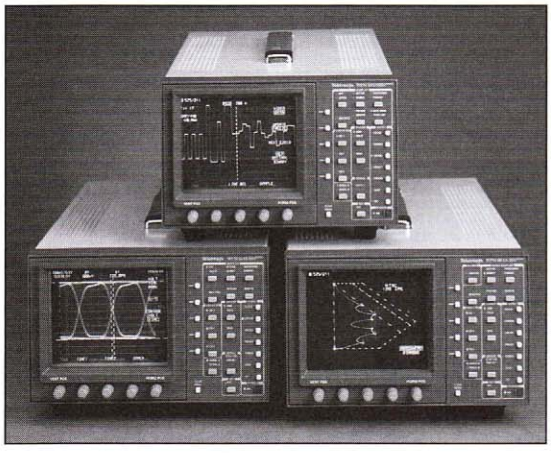
Tektronix measurement products are manufactured in ISO registered facilities.

For product detail, request a TV catalog by completing the business reply card in the back of this catalog.

Waveform Monitor/Vectorscope

WFM 90 • WFM 91 • WFM 300A • WFM601A • WFM601E • WFM601M • WFM 1125



Features – Benefits	Applications
WFM 90 Series Battery or AC Powered	Field Production Studio Monitoring Camera Setup Technical Monitoring Troubleshooting
WFM 300A Component and Composite Waveform Display	
WFM601 Series Real Time CRT Display Suitable for Live Monitoring	
WFM 1125 Waveform/Vector Monitor for DTV Baseband Video	
WVR 500 Rasterizes NTSC or PAL Video Signal for Picture Monitor Display	

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

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Tektronix

SONY Tektronix

Features

WFM 90/91

- Battery or AC Powered
- Truly Portable
- Four-inch/102 mm Color LCD Display
- Picture Monitor
- Waveform Monitor
- Vectorscope
- Line Select Display
- Audio Monitor
- Waveform-in-picture Mode
- Video Output for Routing to External Display
- NTSC (WFM 90) or PAL (WFM 91) Models

WFM 300A

- Component and Composite Waveform Display
- Lightning Display for Equipment Setup and Monitoring
- Bowtie Display for System Timing
- Menu Selectable Component Format Options

WFM601A/601E/601M ALL MODELS SHARE THE BASIC ATTRIBUTES OF THE WFM601A:

- Two 270 MB Serial Component Loop-through Inputs
- Real Time CRT Display Suitable for Live Monitoring
- Waveform Parade and Overlay Displays
- Waveform Display in RGB or Y-PB-PR Levels
- Bright Line Select Display
- Component Vector Display
- Tektronix Lightning, Bowtie and Diamond Displays
- Picture Display of Y Channel
- Identification of Embedded Audio Channels
- RGB or Y-PB-PR Analog Picture Monitor Outputs



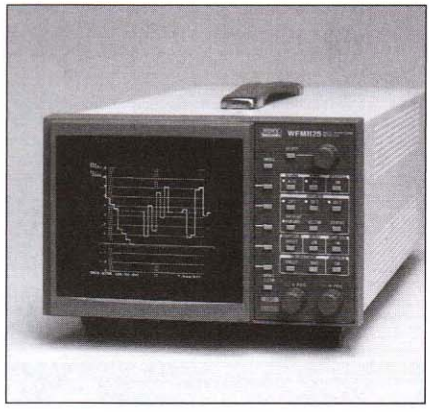
WFM 90.

WFM 1125

- Waveform/Vector Monitor for HDTV Baseband Video
- Two SMPTE 292M, 1.485 Gb Serial Component Inputs
- Interlaced Video and Progressive Formats
- Parade and Overlay Waveform Display
- Waveform Save Mode for Signal Comparison
- Gamut, Status, and Line-by-Line CRC Monitoring
- VGA Display and Screen Output
- Analog Picture Monitor
- Extracts AES/GBU Audio Embedded in SMPTE 274M Video

WVR 500 Waveform/Vector Rasterizer

- Rasterizes NTSC or PAL Video Signal for Picture Monitor Display
- High Quality Display of Live or Test Waveforms
- Full Field or Cut-in Waveform and Vector Displays



WFM 1125 Digital Waveform Monitor in accessory 1700F02 case.

- 4:3 or 16:9 Display Formats
- No Processing of Picture, Even in Cut-in Modes
- Line Select for VITS Observation
- Ideal for Dual Standard Applications
- 1U, Half Rack Width Package

ORDERING INFORMATION

For price information: Outside the U.S. contact your local Tektronix representative, inside the U.S. see the price list in the back of this catalog.

WFM601A
Serial Component Monitor

WFM601E
Serial Component Monitor with Eye Pattern

WFM601M
Serial Component Measurement Set
All Includes: WFM601 series instruments are supplied with an instruction manual, power cable, spare graticule lamps, spare fuse, and spare air filters. White (P4) phosphor is standard. To meet safety and EMI listing requirements order a cabinet or rack mount from the Optional Accessories list.
Note: Portable cabinet optional.

OPTIONS
Opt. A1 – Universal Europe locking power cord.
Opt. A2 – United Kingdom power cord.
Opt. A3 – Australia power cord.
Opt. A5 – Switzerland power cord.

MEASUREMENT SERVICE OPTIONS
Call your local Tektronix representative for a full list of service options.

WFM 1125
Digital Television Waveform Monitor
Includes: U.S. Power Cord, User's Manual.
Opt. 0A – 1080i/60 Format.
Opt. 0B – 720p/60 Format.
Opt. 0C – 1080i/720p/60 Dual Format.
Opt. 0D – Multi-format 1080i/60, 720p/60, 1080p/24, 1080/24sF.

WFM 90
Handheld Waveform/Vector/Picture/Audio Monitor (NTSC).

WFM 91
Handheld Waveform/Vector/Picture/Audio Monitor (PAL).
Note: WFM 90 Series monitors are self-contained instruments.
All include: User Manual, Carrying Pouch with Shoulder Strap, AC Adapter
Opt. 01 – NiCad Battery.
Opt. 33 – Travel line package.
Includes: Carrying Case, NiCad Battery Pack, Desk Stand, and Viewing Hood.

MEASUREMENT SERVICE OPTIONS
Call your local Tektronix representative for a full list of service options.

WFM 300A
Component/Composite Waveform Monitor. 625/50 line/field rate. PAL mV CRT graticule. SMPTE/ EBU N10 (Betacam or MII as used in PAL countries) transcoder installed. Wired for 110 V power, with U.S. power cord. Select Option A1, A2, or A3 for 220 V/240 V AC mains operation.
Includes: Instruction Manual; Power Cable Assembly; Spare Fuse; Spare Graticule Lamps.
Opt. 10 – 525/60 line field rate. NTSC IRE CRT graticule. Betacam 60 Hz transcoder (Betacam as used in NTSC countries) installed. Wired for 110 V power, with U.S. power cord.
Opt. 14 – 525/60 line field rate. NTSC IRE CRT graticule. SMPTE/EBU N10 transcoder (MII as used in NTSC countries) installed. Wired for 110 V power, with U.S. power cord.
Opt. A1 – Wired for 220 V power, with European power cord and two fuses.
Opt. A2 – Wired for 240 V power, with United Kingdom power cord and two fuses.
Opt. A3 – Wired for 240 V power, with Australian power cord and two fuses.

WVR 500
Waveform/Vector Rasterizer. Order appropriate mounting hardware if rack mounting is desired.
Opt. A1 – Universal European 220 V Power Cord.
Opt. A2 – United Kingdom 240 V Power Cord.
Opt. A3 – 240 V Australian Power Cord.

ACCESSORIES
TVGF13 – Hardware to mount two WVR 500s side-by-side in a 19 in. rack space.
TVGF14 – Hardware to mount one WVR 500 and one half-rack width generator in a 1700F05 dual half-rack cabinet or 1700F02 portable case.

MEASUREMENT SERVICE OPTIONS
Opt. C3 – Three years of Calibration Services.
Opt. C5 – Five years of Calibration Services.

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

Waveform/Vector/Spectrum Monitors

1710J • 1720 /1730 Series • 1730 D • 1735 HD • 1740A/1750A/1760 Series • 1705A



Features – Benefits	Applications
1710J	**1710J**
Cost-effective Signal Monitoring	Basic Signal Monitoring
1720/1730 Series	**1720/1730 Series**
Economical Full Frame Line Select	Composite Waveform/Vector Monitoring
1740A/1750A/1760 Series	**1740A/1750A/1760 Series**
Composite or Component Waveform Monitoring	Advanced Monitoring for Component Signals
1705A	**1705A**
Full 850 MHz Span for International Satellites	SNG Link Setup

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

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ISO 9001

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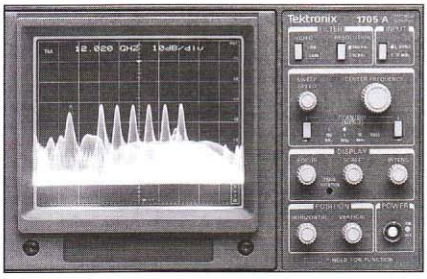
1710J
- Cost-effective Monitoring
- Fast, Standardized Operation
- Dual-signal and Dual-filter Displays
- RGB/YRGB Camera Monitoring
- Flat, Low-Pass, and Chroma Filters
- Light Weight
- Low Power Consumption
- Bright, Internal Graticule CRT
- Models Available for NTSC or PAL
- CE

1720/1730 Series
- Performance and Economy
- Full Frame Line Select
- Simultaneous Channel A & B Display
- Dual Filter Display
- One-button Front Panel Recall
- RGB/YRGB Display Capability
- 1730 Series Displays D-2 Servo Waveforms
- SCH Monitoring Available with 1720 SCH Series Vectorscopes

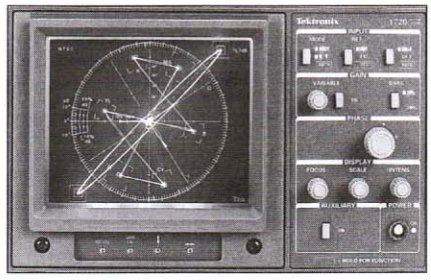
1730 D
- Two Analog, Two Serial Digital and One Parallel Digital Composite Inputs
- Passive Loop-through for Serial Inputs
- Precision Analog Display of Digital Input
- Full Time DAC Output
- Error Detection and Handling Display Mode (EDH)

1735 HD
- HDTV Sweep Speeds
- Full 30 MHz Bandwidth
- Six Video Input Channels
- Parade and Overlay Displays
- Complete Line Select
- Accepts Tri-level Sync
- On-screen Readouts

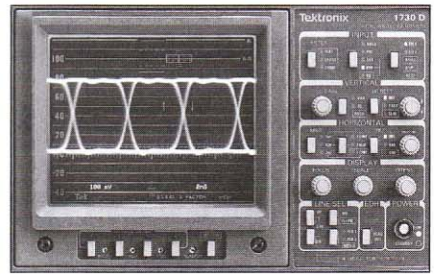
1740A/1750A/1760 Series
- Composite or Component Waveform Monitoring
- Composite Vector Display
- Picture Display
- Stereo Audio Display(1750A series)
- Time Code Phasing and Amplitude
- SCH and Color Framing Display
- Component Vector, Lightning, Diamond and Bowtie



L-Band modulated RF input, offset frequency display.



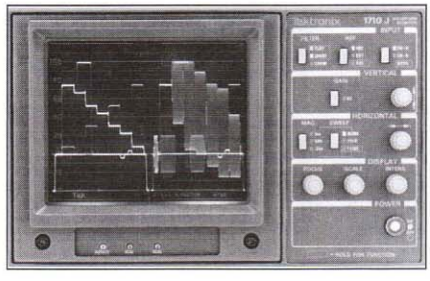
1720 Vectorscope - Vector and Stereo Audio Dual display mode.



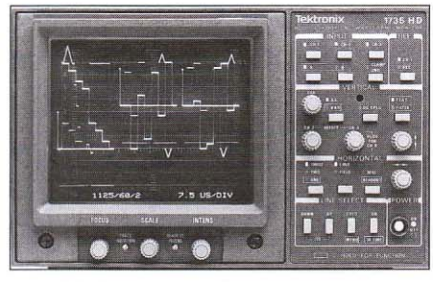
1730 D Digital Composite Waveform Monitor with EYE Pattern display.

1705A

- Full 850 MHz Span for International Satellites
- L-band and 70 MHz IF Inputs
- Designed for Satellite News Gathering
- On-screen Ku– or C-Band Frequency Readout



1710J Waveform Monitor, dual-filter display.



1735 HD Front Panel, 3-Channel display.

ORDERING INFORMATION

For price information: Outside the U.S. contact your local Tektronix representative, inside the U.S. see the price list in the back of this catalog.

1705A
Spectrum Monitor.
Includes: Instruction Manual; Adapter, F-type Male Connector to BNC Female Connector; Power Cord (with correct plug for the selected power plug option).
Opt. 74 – White CRT Phosphor.
Opt. A1 – Universal Europe locking Power Cord, 220 V AC.
Opt. A2 – United Kingdom Power Cord, 240 V AC.
Opt. A3 – Australia Power Cord, 240 V AC.

1710J
Waveform Monitor for NTSC 525/60 System Applications.
Includes: Instruction Manual, Power Cable Assembly.

1711J
Waveform Monitor for PAL 625/50 System Applications.
Includes: Instruction Manual, Power Cable Assembly.
NOTE: 1700 Series instruments are shipped without a case or handle. Order the appropriate enclosure from the optional accessories list.

1710J/1711J OPTIONS
Opt. 74 – White (P4) CRT phosphor.
Opt. A5 – Switzerland 220 V, 50 Hz.

1720
Vectorscope (for NTSC System Applications).

1720 SCH
Vectorscope with SCH (NTSC).

1721
Vectorscope (for PAL System Applications).

1721 SCH
Vectorscope with SCH (PAL).

1725
Vectorscope (for PAL/NTSC Dual Standard Applications).

1730
Waveform Monitor (for NTSC System Applications).

1731
Waveform Monitor (for PAL System Applications).

1735
Waveform Monitor (for PAL/NTSC Dual Standard Applications). PAL-M instruments are available as a modified product.
All Include: Instruction Manual, Power Cable Assembly, Spare Fuse, Auxiliary Control Cable 012-1422-01 (1720 Series only).
Opt. 74 – Substitute P4 (white) phosphor on CRT.

1730 D
NTSC Digital Waveform Monitor.

1735 HD
High Definition Television Waveform Monitor.

1740A
NTSC Waveform/Vector Monitor.

1741A
PAL Waveform/Vector Monitor.

1745A
NTSC/PAL Waveform/Vector Monitor.

1750A
NTSC Waveform/Vector/SCH Monitor.

1751A
PAL Waveform/Vector/SCH Monitor.

1755A
NTSC/PAL Waveform/Vector/SCH Monitor.

1760
NTSC/Component Waveform/Vector Monitor.

1761
PAL/Component Waveform/Vector Monitor.

1765
NTSC/PAL/Component Waveform/Vector Monitor.

All Include: User Manual, Spare Fuse, and Air Filter.
To meet safety listing requirements, order a Cabinet or Rack Mount from Optional Accessories list.
Opt. 74 – White CRT Phosphor for most models.
Opt. SC – SCH/Color Framing option for 1760/1761/1765.

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

CE

ISO 9001

Tektronix measurement products are manufactured in ISO registered facilities.

For product detail, request a TV catalog by completing the business reply card in the back of this catalog.

GENERATORS



FEATURES – BENEFITS

Precision Test Signals for Characterization of Circuit Designs, Products and Systems

Programmable Units for Generation of User-defined Test Signals

Multi-format Generators and Format Specific Units Available

Bench, Rack-mount and Handheld Units Available

Calibration Services

APPLICATIONS

A Source of Reference Signals for TV Operations

Service and Maintenance of TV Equipment and Systems

Design Engineering

Manufacturing Test and Quality Control

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1933, inside the U.S. call: 1-800-426-2200.

Products manufactured in ISO 9001 facilities. (TPG20 in ISO 9002 facility).

CE
(except TSG100, TSG200)

Tektronix provides a comprehensive selection of test signal generators, synchronizing generators and electronic changeover units to meet the wide range of applications required by broadcast operations, post-production facilities and manufactureres of TV equipment.

Test signal formats include:

- Analog composite and component, 525, 625 standards
- Digital test signals for 525, 625 standards
- High-definition digital test signals for current standards
- Special Service Series, Sony PVW, Panasonic MII, Panasonic DVCPro

See TV catalog and selection guide in this catalog for details

GENERATOR SELECTION GUIDE

	SPG170A	SPG271	SPG422	SPG1000	TPG20	TSG95	TSG100	TSG111	TSG130A	TSG131A	TG2000
FORMATS											
NTSC	X		Blkbrst		X	X	X		X		X*9
PAL		X	Blkbrst		X	X		X	X		X*9
PAL-M					Opt.						X*9
PAL-N					Opt.						X*9
SECAM					X						X*9
Y/C 525/60					X				X		X*9
Y/C 625/50					X					X	X*9
Analog Component 525/60					X				X*1, 2		X*9
Analog Component 625/50					X					X*1, 2	X*9
Composite Digital					X						X*10,16(NTSC)
Component Digital (4:2:2)			X*6		X						X*10
HDTV				X*3							X*19
FUNCTIONS											
Sync Signals	X	X		Sync/clk							
Black	X	X	X						Opt.	Opt.	X
Color Bars	Opt.	X	X*7								
Test Signals			Opt.*7	X	X	X	X	X	X	X	X
Cable TV Test Signals						X					
VITS Insertion											
Character ID	Opt.	Opt.	X			X					X
Analog Audio Tone (# channels)	Opt. (1)	Opt. (1)				X (2)	X (1)	X (2)	X (2)	X (2)	
AES/EBU Digital Audio			X								
Genlock	X	X	X	X	X						X*12
Tape Leader Countdown	Opt.	Opt.									
VM 700A Source ID											
GCR Signals											
Zone Plates					X*8						X*11
ARCHITECTURE											
8-Bit	X					X	X				
10-Bit			X	X	X			X	X	X	
12-Bit		X									X*13
CONTROLS											
Programmable											X
Ground Closure	X	X	X	X	X						X
RS-232			X	X	X						X
GPIB											X
MISCELLANEOUS											
DC Power						X	X				
Handheld						X					
Height*12 (in./mm)	1U	1U	1U	1U	1U	7.5/190.5	1U	1U	1U	1U	3U
Width*13 (in./mm) (Rackwidth)	Full	Full	Full	Full	Full	3.6/91.44	Half	Half	Half	Half	Full
Depth (in./mm)	22.1/561	22.1/561	22.1/561	21/533.4	18/457	2.2/55.8	12/305	15/381	15/381	15/381	23/584
Net Weight (lbs./kg)	13.5/6.14	13.5/6.14	13.5/6.14	12/5.44	15.75/7.2	3.31/1.5	3.25/1.47	3.25/1.47	3.25/1.47	3.25/1.47	38/17.3

**1 Y/color-difference output.*
**2 RGB output.*
**3 Multi-format.*
**4 1U = 1 rack unit (1.75 in./44 mm); 2U = 2 rack units (3.5 in./88 mm).*
**5 Full = Full rack width (19.0 in./483 mm); Half = Half rack width (8.1 in./206 mm).*
**6 Serial Digital only.*
**7 Serial component digital only.*
**8 Zone plate part of S & W 2 test pattern.*
**9 With AVG1 installed.*
**10 With DVG1 installed.*
**11 With AWVG1 installed.*
**12 With AGL1 installed.*
**13 AVG1, AWVG1.*
**14 Parallel; Serial optional.*
**15 Parallel only.*
**16 NTSC only.*
**17 Embedded in video.*
**19 With HDVG1 installed.*

GENERATOR SELECTION GUIDE

	TSG170A	TSG170D	TSG200	TSG271	TSG422	TSG601	VITS100	VITS200	VITS201
FORMATS									
NTSC	X	X	X				X	X	
PAL				X					X
PAL-M									
PAL-N									
SECAM									
Y/C 525/60									
Y/C 625/50									
Analog Component 525/60									
Analog Component 625/50									
Composite Digital		X*14							
Component Digital (4:2:2)					X*14	X*6			
HDTV									
FUNCTIONS									
Sync Signals	X			X					Sync
Black	X	X	X	X	X*3			X	
Color Bars	Opt.								
Test Signals	X	X	X	X	X	X		X	
Cable TV Test Signals							Opt.	X	
VITS Insertion							X	X	X
Character ID	Opt.	X	X	Opt.		X		X	X
Analog Audio Tone (# channels)	Opt. (1)	X (1)	X (2)	Opt. (1)					
AES/EBU Digital Audio		X			X*17	X*17			
Genlock	X	X		X	X		X	X	X
Tape Leader Countdown	Opt.	X	X	Opt.					
VM 700A Source ID			X				X	X	X
GCR Signals								X	X
Zone Plates									
ARCHITECTURE									
8-Bit									
10-Bit	X	X	X		X	X			
12-Bit				X	X		X	X	X
CONTROLS									
Programmable									
Ground Closure	X	X	X	X	X		X	X	X
RS-232								X	
GPIB									
MISCELLANEOUS									
DC Power			X			X			
Handheld						X			
Height*10 (in./mm)	1U	1U	1U	1U	1U	7.5/190.5	1U	1U	1U
Width*11 (in./mm) (Rackwidth)	Full	Full	Half	Full	Full	3.6/91.44	Half	Full	Full
Depth (in./mm)	22.1/561	22.1/561	15/381	22.1/561	22.1/561	2.2/55.8	17.3/440	17.3/440	18.4/467
Net Weight (lbs./kg)	13.5/6.14	18.9/8.6	3.25/1.47	13.5/6.14	13.5/6.14	3.31/1.5	4.75/2.2	10.25/4.7	10.5/4.8

**1 Y/color-difference output.*

**2 RGB output.*

**3 Multi-format.*

**4 1U = 1 rack unit (1.75 in./44 mm); 2U = 2 rack units (3.5 in./88 mm).*

**5 Full = Full rack width (19.0 in./483 mm); Half = Half rack width (8.1 in./206 mm).*

**6 Serial Digital only.*

**7 Serial component digital only.*

**8 Zone plate part of S & W 2 test pattern.*

**9 With AVG1 installed.*

**10 With DVG1 installed.*

**11 With AWVG1 installed.*

**12 With AGL1 installed.*

**13 AVG1, AWVG1.*

**14 Parallel; Serial optional.*

**15 Parallel only.*

**16 NTSC only.*

**17 Embedded in video.*

**19 With HDVG1 installed.*

Audio

Monitors/Generators/Analyzers

764 • 760A • ASG 100 • ASG 140 • AM70



Features – Benefits	Applications
764 Digital Audio Monitor Adjustable Clip/Mute Indicators Audio Phase Display Unique Session Statistics Compilation **760A Stereo Audio Monitor** Graphic CRT Display of Stereo Audio Signal **ASG 100** Balanced, Loop-through Operation with Programmable Output Impedance **ASG 140** Four Balanced XLR Signals and Fixed 10 Ω Output Impedance **AM70 Digital Audio Analyzer/Generator** Balanced/Unbalanced Digital Inputs and Outputs and Balanced Analog Outputs	**764 Digital Audio Monitor** Digital Audio Post-production **760A Stereo Audio Monitor** Audio Post-production **ASG 100 and ASG 140** Audio Link Testing Multichannel Audio Testing **AM70 Digital Audio Analyzer/Generator** Digital Audio Troubleshooting

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For product detail, request a TV catalog by completing the business reply card in the back of this catalog.

764 DIGITAL AUDIO MONITOR

- Two balanced or unbalanced AES/EBU or SPDIF loop-through inputs drive four-channel level meters
- Adjustable clip/ mute indicators
- Audio phase display
- Phase correlation meter
- Unique session statistics compilation
- VITC and LTC time code inputs
- Channel status and user data decoding
- AES-3 DARS input
- Optional serial digital video (embedded audio) input
- Optional balanced analog line outputs

760A STEREO AUDIO MONITOR

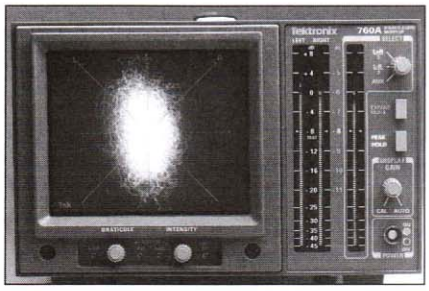
- Graphic CRT display of stereo audio signal
- AGC for continuously viewable pattern
- Bar graph for quick setups and accurate peak indication
- Third bar indicates mono compatibility when set to L+R
- Suitable for phase and amplitude measurements
- Scale and dynamics conform to proposed IEEE ppm standard
- EXPAND SCALE feature increases resolution at –8 dB level for accurate line-ups
- White phosphor CRT option available

ASG 100/ASG 140 AUDIO SIGNAL GENERATORS

- 20 Hz to 20 kHz
- 24 dBu to –90 dBu
- 4 Second Voice ID
- Balanced XLR Signal Paths
- RS-232 Remote Control
- Front Panel Lockout
- Contact Closure
- Special Measurement Signals
  - Multitone Test Signals
  - Audio/Video Delay Signals
  - CCITT 0.33 Signals
  - Tektronix Autosequences

AM70 DIGITAL AUDIO ANALYZER/GENERATOR

- Balanced Analog Outputs
- Balanced/Unbalanced Digital Inputs and Outputs
- Optical Inputs and Outputs
- Internal Speaker/Headphone Jack
- Battery Powered



760A Stereo Audio Monitor.



ASG 100/ASG 140.



AM70

ORDERING INFORMATION

For price information: Outside the U.S. contact your local Tektronix representative, inside the U.S. see the price list in the back of this catalog.

764 DIGITAL AUDIO MONITOR
Includes instruction manual and power cord.

764 OPTIONS
Opt. 01 – Embedded Audio Input.
Opt. 02 – Analog Line Output.

760A
Stereo Audio Monitor.
Include: Instruction Manual, X-Y Graticule, Power Cable Assembly.
Opt. 74 – Substitutes white phosphor CRT.

ASG 100
Audio Signal Generator.

ASG 140
Audio Signal Generator.

AM70
Digital Audio Analyzer/Generator.

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

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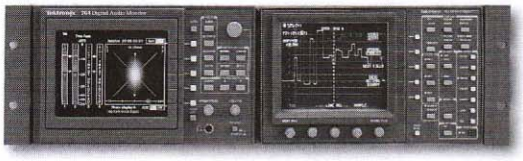
Digital Audio/Video Monitoring Systems

AV601A/AV601E/AV601M



Features – Benefits

270 MB SERIAL COMPONENT VIDEO MONITORING

Waveform, Vector, Gamut, Data Error Displays:
- Select AV601A for Operational Monitoring
- Select AV601E for Transmission Applications
- Select AV601M for Video Data Testing

AES/EBU DIGITAL AUDIO MONITORING

Audio Level, Phase, and Time Code Displays
- Option 01 for Audio Embedded in Video
- Option 02 Provides Analog Line Outputs

Complete Monitoring System in a Single Cabinet

Economical Price/Feature Set for the Application

Applications

Advanced Monitoring for Baseband Digital Audio & Video Systems

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

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Products registered in ISO 9002 facilities.

For product detail, request a TV catalog by completing the business reply card in the back of this catalog.

The AV601 system is a comprehensive system for setup and operation of digital video and audio production and transmission systems. It provides a combination of monitoring capabilities to assure both sound and picture quality.

By combining the two most-specified Tektronix monitors – the 764 Digital Audio Monitor and a member of the WFM601 family of Digital Video Waveform Monitors – the AV601 Monitoring System offers the convenience of seamless integration into the all-digital facility. Offering a selection of models and options, the AV601 system provides the exact feature set required for a particular application, at a most economical price.

AV601 systems include a choice of serial component video monitor, the WFM601A, WFM601E, or WFM601M (see configuration table); a 764 AS/EBU digital audio monitor with options for audio-embedded-in-video and/or analog line monitoring outputs; and a Tektronix 1700F05 rack mounting cabinet.

The AV601A is appropriate for operational monitoring positions, such as studio control rooms or video recording centers. The AV601E adds video transport layer monitoring features needed in transmission centers or master control rooms. The AV601M includes all features of the AV601A and AV601E, and provides data layer signal analysis tools for design, installation, maintenance, and testing of digital plants.

AV601 series options include Option 01, which allows monitoring of digital audio embedded in the digital video signal, and Option 02,

which provides stereo analog line driver outputs for monitoring selected audio channels.

Operating as a system, one of two digital audio/video program channels is selected on the WFM601 series digital video monitor, and up to four of a possible sixteen digital audio channels are selected on the 764 digital audio monitor. As a configured system, the AV601 series provides exactly the tools needed for a digital program application.

For a complete description of instruments supplied as part of the AV601 system, please see data sheets on the WFM601 Series Serial Component Monitors and the 764 Digital Audio Monitor.

ORDERING INFORMATION

For price information: Outside the U.S. contact your local Tektronix representative, inside the U.S. see the price list in the back of this catalog.

AV601A
Digital Audio/Video Monitoring System.
Includes: WFM601A Digital Video Monitor, 764 Digital Audio Monitor, 1700F05 Dual Rack Mount Adapter.

AV601E
Digital Audio/Video Monitoring System.
Includes:
WFM601E Digital Video Monitor, 764 Digital Audio Monitor, 1700F05 Dual Rack Mount Adapter.

AV601M
Digital Audio/Video Monitoring System.
Includes: WFM601M Digital Video Monitor, 764 Digital Audio Monitor, 1700F05 Dual Rack Mount Adapter.

AV601 OPTIONS
Options (for all configurations).
Opt. 01 – Embedded Audio Input for 764.
Opt. 02 – Analog Line Output for 764.

RECOMMENDED ACCESSORIES
070-8810-00 – 764 Service Manual.
070-9836-00 – WFM601 Series Service Manual.

MEASUREMENT SERVICE OPTIONS
Contact your local Tektronix representative.

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

Product(s) available through your local Tektronix Distributor listed in the back of this catalog.

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Products registered in ISO 9002 facilities.

For product detail, request a TV catalog by completing the business reply card in the back of this catalog.

Television Demodulators

DS 1001/2/3 • DS1201/2/3/4/5 • TV1340/50



Features – Benefits	Applications
DS1000 SERIES Standards Supported: M/N (DS 1001), B/G (DS 1002), I (DS1003)	Broadcast Demodulation Cable TV Demodulation
DS1200 SERIES Low Cost, 47 MHz to 860 MHz Frequency Range Demodulator System	
TV1300 SERIES Continuously Tunable Over All TV Bands and CATV Channels (HRC & IRC) to 880 MHz (channels 2-99) with Synthesizer Precision for HRC and IRC	

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916 inside the U.S. call: 1-800-426-2200.

CE (DS1001/2/3, TV1350 only)

Product manufactured in ISO 9001 facilities (DS1201/2/3/4/5, TV1340/50).

For product detail, request a TV catalog by completing the business reply card in the back of this catalog.

DS 1001/ DS 1002/ DS 1003

- Standards supported: M/N (DS 1001), B/G (DS 1002), I (DS1003)
- Tuning range:
  - 55.25 to 801.25 MHz (M/N)
  - 48.25 to 860.25 MHz (B/G, I)
- Stereo sound: BTSC, dual tone, NICAM (system dependent)
- Zero carrier pulse for depth of modulation measurements
- Standard and user-defined channel tables
- 20 user-defined programs
- RS-232/RS485 I/O port for remote control

DS1200

- Low cost
- Measurement quality performance
- 47 MHz to 860 MHz frequency range
- Cable TV standard, HRC and VHF/UHF channel tables
- RS-232C or RS-485 control of TDC5 Tunable Down Converter
- Synchronous detection
- Gain control system optimizes signal-to-noise ratio and intermodulation distortion
- Zero carrier pulse for depth of modulation measurement
- Wide dynamic range
- Four RF inputs on TDC5
- Quadrature out for ICPM measurements
- Aural intercarrier out for interface to a BTSC decoder

TV1350 • TV1340

- User-friendly Operation
- Channel Selection by Digital Entry of Channel Number, Manual or Remote Modes, Plus Search
- Automatic Compensation for Carrier Offsets to ±100 kHz
- Switch Selectable Sound Trap
- Switchable IF Gain for Improved S/N Ratio
- Selectable Envelope or Synchronous Detection
- Synchronous Detector Quadrature Output for Convenient Adjustment of Modulation Balance and ICPM Measurements
- Stable Zero Carrier Reference for Video Level Adjustments and Residual Carrier Measurements
- Available in Standards M, D/K, B/G, I, and K1
- Worldwide Audio Standards Available: Dual Sound, NICAM Prepared, Wideband Audio Out for BTSC Stereo Decoders
- Built-in Loudspeaker, Headphone Jack and Deviation Meter
- Parallel Remote Control Standard; IEEE-488 (GPIB) Bus Interface Optional

ORDERING INFORMATION

For price information: Outside the U.S. contact your local Tektronix representative, inside the U.S. see the price list in the back of this catalog.

DS 1001
M/N Television Demodulator.
Includes: User's Manual, Power Cord.

DS 1002
B/G Television Demodulator.
Includes: User's Manual, Power Cord.

DS 1003
Television Demodulator.
Includes: User's Manual, Power Cord.

DS1201
Demodulator System.

DS1202
Demodulator System.

DS1203
Demodulator System.

DS1204
Demodulator System.

DS1205
Demodulator System.

TV1350
Test Receiver and Demodulator.

TV1340
Test Demodulator.

For your local Tektronix representative see the list in the back of this catalog or outside the U.S. call: 1-503-627-1916, inside the U.S. call: 1-800-426-2200.

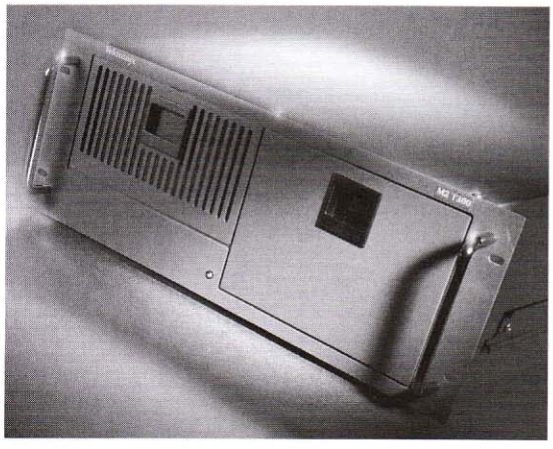
CE (DS1001/2/3, TV1350 only)

Product manufactured in ISO 9001 facilities (DS1201/2/3/4/5, TV1340/50).

For product detail, request a TV catalog by completing the business reply card in the back of this catalog.

Trunking Video Edge Device

M2T300



Features – Benefits

- Supports Full Range of MPEG-2 MP@ML and 4:2:2P@ML (1.5-50 Mbps)
- Audio Processing: Uncompressed and MPEG-1 Layer II
- Output to DVB/ASI or ATM AAL5 with SVC or PVC on OC-3c/STM-1
- DS-3/E-3 PDH Interface Available for Point-to-point Connections
- Flexible Analog or Digital I/O (SMPTE 259M, NTSC/PAL)
- Intuitive, Graphical, Web-based User Interface
- Also Available: M2 Series Video Edge Device for Broadcast Quality Collaboration

Applications

- Video Trunking
- Post Production
- Event Coverage
- Studio/Transmitter Links
- Satellite Operations
- Terrestrial Switched Applications
- Point-to-Point Applications

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The Tektronix M2T300 Video Edge Device delivers high quality real-time MPEG-2 digital video for a variety of video trunking applications. The applications served by the M2T300 range from post-production to event coverage to studio/transmitter links.

The M2T300 is based on well-accepted video and networking standards. The M2T300 incorporates a flexible architecture to support multiple input or output channels. Video bit rates range from MPEG-2 MP@ML (up to 15Mbps) to MPEG-2 4:2:2P@ML (up to 50 Mbps).

Video inputs and outputs can be either SMPTE 259M or NTSC/PAL composite.

An embedded Web server controls and manages the M2T300 via an intuitive Web-based graphical user interface, enabling administration of the video edge device from any location on the network.

Transport interfaces to the M2T300 are via DVB/ASI for satellite operations, OC-3c/STM-1/DS-3 ATM for terrestrial switched applications, or DS-3/E-3 PDH for point-to-point applications. The ATM OC-3c/STM-1/DS-3 interface includes the capability of SVC channels to lower network management and administration.

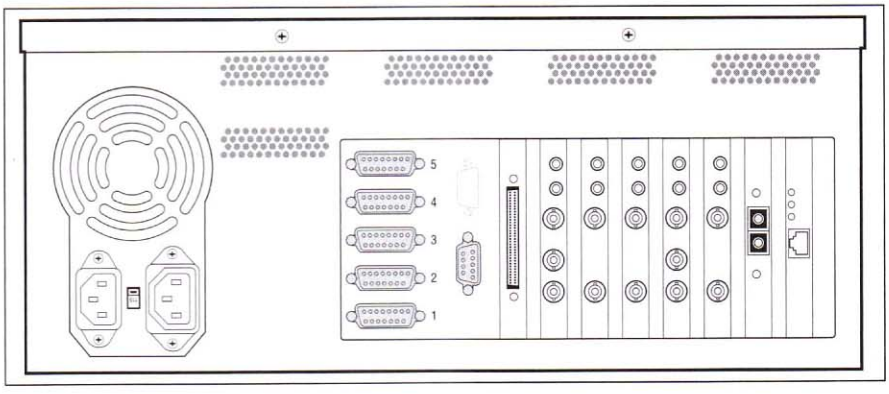
The combination of high quality video delivery, our adherence to industry standards, and the easy-to-use graphical user interface make the M2T300 the ideal device for a multitude of video trunking applications.

POST PRODUCTION INTERCONNECTION

The M2T300 Video Edge Device is optimized to maintain video and audio quality through the compression/decompression process. In the past, the transfer of video content from post houses to studios necessitated creating a tape and physically delivering it to the client facility. Now, with the M2T300, post houses can transmit previews or completed materials to their clients electronically – without sacrificing quality, and in the process, save considerable time and money. By using the MPEG-2 4:2:2P@ML, multiple generations of video can still be used as source material. The audio can remain uncompressed, preserving integrity until final transmission.

EVENT COVERAGE

Events happen at many different locations at different times. A video edge device needs to be easy to setup and access remotely for troubleshooting. The M2T300 video edge device transmits video using ATM (AAL5 with SVC). SVC capability reduces the setup of the transmission channel to the equivalent of dialing a "telephone number." The SVC circuit remains active until the user ends the transmission. Transmission costs are minimized because the public carrier is paid only for the actual transmission time. Furthermore, identifying the destination and the specification of configuration parameters can all be accomplished via a Web browser located anywhere on your network.



STUDIO/TRANSMITTER LINK

The migration to compressed digital transmission is occurring now. Broadcasters, however, must maintain revenue streams while looking toward the future. The M2T300 includes DVB/ASI outputs for satellite operations as broadcaster's transition to newer transmission methods. The M2T300 also transmits all of the VBI data to preserve transmission of existing material.

ORDERING INFORMATION

For price information: Outside the U.S. contact your local Tektronix representative, inside the U.S. see the price list in the back of this catalog.

M2T300
MPEG-2 Trunking Video Edge Device.
Includes: chassis, power supply, 10/100BaseT I/F, 5 available slots Maximum of 3 encoders or 5 decoders per chassis.

ENCODER OPTIONS
Opt. E1 – 4:2:0 MPEG-2 Encoder – Analog Video/Analog Audio Input.
Opt. E3 – 4:2:0 MPEG-2 Encoder – Digital Video/Analog Audio Input.
Opt. E4 – 4:2:0 MPEG-2 Encoder – Digital Video/Digital Audio Input.
Opt. E5 – Precision 4:2:0 MPEG-2 Encoder (Analog Video/Audio).
Opt. EA – 4:2:2 MPEG-2 Encoder – Analog Video/Analog Audio Input.
Opt. EB – 4:2:2 MPEG-2 Encoder – Analog Video/Digital Audio Input.
Opt. EC – 4:2:2 MPEG-2 Encoder – Digital Video/Analog Audio Input.
Opt. ED – 4:2:2 MPEG-2 Encoder – Digital Video/Digital Audio Input.
Opt. EE – Precision 4:2:2 MPEG-2 Encoder (Analog Video/Audio).

DECODER OPTIONS
Opt. D1 – 4:2:0 MPEG-2 Decoder – Analog Video/Analog Audio Output.
Opt. D3 – 4:2:0 MPEG-2 Decoder – Digital Video/Analog Audio Output.
Opt. D4 – 4:2:0 MPEG-2 Decoder – Digital Video/Digital Audio Output.
Opt. DA – 4:2:2 MPEG-2 Decoder – Analog Video/Analog Audio Output.
Opt. DB – 4:2:2 MPEG-2 Decoder – Analog Video/Digital Audio Output.
Opt. DC – 4:2:2 MPEG-2 Decoder – Digital Video/Analog Audio Output.
Opt. DD – 4:2:2 MPEG-2 Decoder – Digital Video/Digital Audio Output.

OTHER OPTIONS
Opt. N1 – Multimode OC-3c/STM-1 ATM UNI 3.0/3.1.
Opt. N2 – Single mode/Intermediate reach OC-3c/STM-1 ATM UNI 3.0/3.1.
Opt. N3 – DS-3 PDH.
Opt. N4 – E3 PDH.
Opt. N5 – DS-3 ATM UNI 3.0/3.1.

SERVICE OPTIONS
Opt. B2 – 1 Year Support Pack Basic.
Opt. B3 – 2 Year Support Pack Basic.
Opt. B4 – 3 Year Support Pack Basic.

INTERNATIONAL POWER PLUGS
Opt. A0 – USA Power Cord; 115 V.
Opt. A1 – 220V Euro Plug; 50 Hz, 15 A.
Opt. A2 – 240V UK Plug; 50 Hz, 13 A.
Opt. A3 – 240V Australian Plug; 50 Hz, 10 A.
See page 619 for description.

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Authorized Tektronix Distributors and Manufacturers Representatives offer selected products in geographic areas. They will provide you with fast, convenient service and support. Ask your electronics distributor or representative if they carry Tektronix products. Take advantage of their support and purchase Tektronix products from them.

As you use this catalog, note the products that are available through our distributors and representatives. To find the distributor or representative nearest you, see the list in the back of this catalog. Questions? Call 1-800-479-4490 in the U.S.

LEASE AND RENTAL PROGRAMS

Tektronix measurement products are available under a variety of lease and rental programs offered by Tektronix Authorized Rental Companies. For lease and rental program details and a list of our Authorized Rental Companies, see pages 613, 632.

WARRANTY

Products offered by Tektronix are manufactured to provide the highest level of reliability and performance. Tektronix warrants these products against defects in materials and workmanship in accordance with the warranty statement applicable to each product. If any product fails during the warranty period, Tektronix will provide the remedy set forth in the applicable warranty. A copy of the warranty applicable to a particular product offered by Tektronix may be obtained from your nearest Tektronix office or from our website – http://www.tektronix.com/Measurement/Service/library/warranty/welcome.html.

GENERAL TERMS

Prices – The prices listed in this catalog were current US MSRP at the time of publication. Tektronix reserves the right to change prices without notice. Shipping to a foreign country? Export pricing and information is available from your nearest Tektronix Office.

Payment – Net 30 from date of invoice, subject to approved credit. Other terms are available.

Credit Cards – Tektronix currently accepts the following credit cards: VISA, MasterCard and American Express.

Shipment – FOB Tektronix plant unless otherwise specified.

Electronic Data Interchange – Tektronix encourages the use of EDI/EC to communicate quotations, orders, invoices and payment. If you are capable of this medium, please contact your nearest Tektronix Office and let us know.

- U.S. GOVERNMENT CUSTOMERS
  - Federal Order Management Office
  - GSA Contract Information
  - Logistics Data Information
- AUTHORIZED RENTAL/LEASING COMPANIES

U.S. Government Customers

FEDERAL ORDER MANAGEMENT OFFICE

U.S. Government agencies should obtain price, delivery and place orders directly with Tektronix at:

Tektronix, Inc.
Federal Order Management
M/S 50-290
P.O. Box 4600
Beaverton, OR 97076

FAX: (503) 629-5388
Phone: (800) 682-1210

GSA CONTRACT INFORMATION

Tektronix General Service Administration Multiple Award Schedule Contract makes available many of the products listed in this catalog. This contract is:

- Instruments and Laboratory Equipment; FSC Group 66, Class 6625, Part II, *Section J*, GS-24F-0819A.

An Authorized GSA Price List for the above contracts is available at http://www.tektronix.com/Measurement/Products/GS, from your nearest Tektronix office or by calling (800) 682-1210.

Selected Tektronix products are available through GSA MAS contracts held by Tektronix Authorized Distributors. For information on MBD products available through this channel, call (800) 682-1210.

For information on Tektronix Color Printing and Imaging Division products available under GSA MAS contracts, call (800) 835-6100.

LOGISTICS DATA INFORMATION

Logistics data information on products, accessories and parts sold by Tektronix is available from Tektronix Federal Order Management at (800) 682-1210. This data includes National and NATO Stock Numbers, military nomenclature, products provisioned by the military, Balcort numbers, ECCN/HTS numbers and other related data.

Authorized Rental/Leasing Companies

Tektronix' Authorized Rental Companies provide the widest selection of well-maintained Tektronix products, with flexible and attractive terms. For short term rentals, leases and lease purchase options, Tektronix' Authorized Rental Companies provide the right terms, the right instruments, the right options so you can make the right choice.

Our Authorized Rental Companies can provide you a solution when you want to try out new equipment before you purchase or when you need equipment for short-term projects or for an immediate requirement. They will provide you the best answers for managing your test equipment inventory, whether you rent it for a month or lease it for a year.

When you need to rent or lease Tektronix products, look to our Authorized Rental Companies. Call:

Continental Resources, Inc.

1-800-937-4688

Electro Rent Corporation

1-800-688-1111

McGrath RenTelco (General Purpose Test Instruments)

1-800-352-2900

McGrath RenTelco (Telecommunications Test Instruments)

1-800-233-5807

Newcourt Financial – Technology Rentals & Services

1-800-874-7123

Telogy, Inc.

1-800-835-6494

TestEquity Inc.

1-800-732-3457

SERVICE PROGRAMS

- Calibration Services
- Product Updates
- On-site and Mobile Service
- Product Upgrades
- Repair Services
- Customer-site Installations
- Discontinued Product Support Program
- Training and Assistance
- Product and Technical Seminars
- Operational and Applications Workshops
- Module Exchange Services
- Replacement and Exchange Parts
- Technical Support

Customer support programs may vary according to country. For information on programs available in your location, contact your Tektronix representative (listed in the back of this catalog).

TOTAL SOLUTIONS FOR YOUR SUCCESS

There is more in the box than a quality product when you purchase your product from Tektronix. You'll find an array of services that provides total-solution coverage – coverage that begins with your first call to Tektronix and continues after the sale through our support for discontinued products program. Our sales and service personnel work together to help you make the best selections for your applications. Then we help you maximize your investment by ensuring optimum product performance. All this is accomplished through customer support programs ranging from training to product installations and a variety of service plans.

Contact your nearest Tektronix office. Our U.S. and international office locations are listed at the back of this catalog. We will give you information on products and the names of Account Managers assigned to serve your product interests.

SERVICE OFFERINGS

Advancing technology has brought incredible change to the power of measurement products. Manufacturing methods and calibration techniques have been revolutionized, making the service challenge tougher than ever. With Calibration requiring dedicated ATE test systems, and repair using factory prepared modules, only the original manufacturer can fully support most of today's products.

Put simply, nobody can service your Tektronix product better than Tektronix.

CUSTOMER-SITE INSTALLATIONS

Tektronix provides on-site installations for most Tektronix-configured systems, setting up your product to meet all operating specifications. Contact your nearest Tektronix office for more information.

DISCONTINUED PRODUCT SUPPORT PROGRAM

Tektronix has a long-standing policy to provide service coverage after a product has been removed from the catalog, subject to parts availability. Contact your Tektronix service center for service quotes and information.

TRAINING AND ASSISTANCE

Your product is most useful to you when you are thoroughly familiar with it. Formal training classes and self-study aids can help you get up to speed faster. Contact your Tektronix office for details about customer training.

OPERATION, APPLICATIONS, AND SERVICE WORKSHOPS

Achieve optimum utilization of your equipment. Let Tektronix provide fast-paced courses with classroom lectures and supervised hands-on laboratory sessions. Participants receive manuals and workbooks containing detailed course notes and lab exercises. For added convenience, Tektronix also offers private workshops conducted at your company.

MODULE EXCHANGE SERVICES

Easily exchangeable modular components facilitate rapid troubleshooting and repair of many products offered by Tektronix. You may choose to diagnose a problem and specify the module to exchange, or a Tektronix customer service technician can provide assistance. Typically your module order will ship from our plant within 24 hours, and overnight delivery can be arranged for most U.S. locations. To place an order, call Tektronix at (800) 833-9200.

REPLACEMENT PARTS

Replacement parts and supplies can be ordered by calling toll free between 5:30 AM and 5:00 PM, Pacific Time. Call Tektronix at (800) 833-9200.

TECHNICAL SUPPORT

Tektronix provides high quality Technical Support on applications, operation, measurement specifications, hardware, and software by expert application engineers.

For Applications Support call:
1-800-833-9200, Opt. 3.
Outside the U.S., call:
1-503-627-2400
E-mail Address:
"tm_app_supp@tek.com"
Hours: 6:00 AM to 5:00 PM
Pacific Time



TEKTRONIX HARDWARE SERVICE

In today's complex technological world, buying your measurement equipment from Tektronix is a smart business decision. Buying Service Options from Tektronix is a smart decision, too. That's because, as the original manufacturer, only Tektronix can offer you genuine service on Tektronix products.

Measurement instrument technology has changed rapidly in recent years, bringing you more speed, more power, and more capabilities. Manufacturing methods and calibration techniques have been revolutionized, too.

STATE-OF-THE-ART CALIBRATION AND SERVICE

Calibration requiring dedicated Automated Test Equipment (ATE) systems — and repair using factory-prepared modules — means that only the original manufacturer can give you the service you need. You can rely on Tektronix quality in Service, too, with full ISO9000 approval and Calibration Laboratories accredited by key National Standards bodies.

Tektronix makes it easy for you to purchase the services you require with the Service Options described below. Simply ask your Account Manager to add these options to your new equipment purchase.

WHAT ARE THE IMPLICATIONS OF ISO9000?

ISO9000/EN29000 is a Quality standard with wide ranging implications for approved companies and its clause 4.11 sets high standards for the control and calibration of measurement instruments. The standard requires that instruments whose usage affects quality should be within relevant specification and traceable to a recognized National Standard.

Most significantly it also requires the ability to assess appropriate remedial action should an instrument be found out of specifications.

EXCEEDING ISO9000 DEMANDS

This means that the calibration service must fully verify performance, and record the measured values of any parameters found out of tolerance, before any adjustments are made. Only these measured values enable an informed decision. A statement such as "time base out of specifications" is not adequate.

Tektronix performs all calibrations to the highest standards and ensures that documentation meets or exceeds the demands of ISO9000.

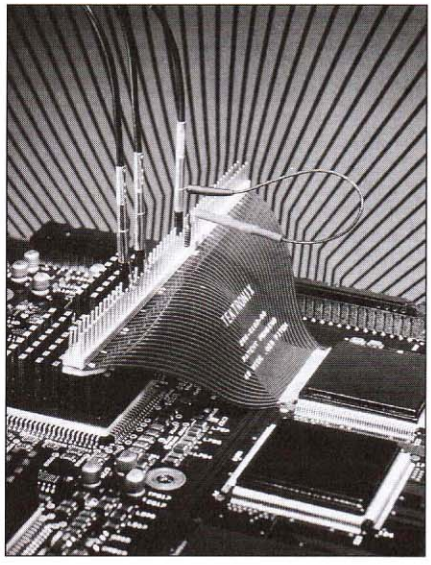
TEKTRONIX SERVICE OPTIONS

WHY BUY SERVICE OPTIONS WITH YOUR INSTRUMENT?

- You can be secure that Tektronix delivers original manufacturer expertise and technical excellence
- You can eliminate the annual hassle of initiating internal paperwork
- There is no need to seek approval for services when they are required
- You get official product updates installed free of charge when Tektronix repairs or calibrates your instrument
- You get priority turnaround from Tektronix Service Centers
- You maximize productive uptime for your instruments

NO ONE CAN SERVICE YOUR TEKTRONIX PRODUCT BETTER THAN TEKTRONIX

Your Requirements	Period of Coverage	
	1 Year	3 Year
Installation An installation specialist to install and configure your instruments and provide initial user training.	For complex or system-oriented products	
Calibration Coverage Calibration at the Recommended Calibration Interval to keep your instruments in peak working condition	Initial Calibration free with instrument	C3
Test Data Recorded values of measurements made during calibration to detail your instrument's performance on receipt and after any adjustment	D1	D3
On-site Service The convenience and security of having services performed at your own site.	S1	S3
Extended Repair Warranty The security of getting your instrument back to work with minimum fuss and downtime in the unlikely event of a failure	Initial Warranty free with instrument	R3



EXTENDED REPAIR WARRANTY

OPTION R3

It's always reassuring to be protected by the original manufacturer, if the unexpected happens!

- Option R3 extends your repair warranty to a total of three years
- Extending repair warranty fixes long-term maintenance costs and eliminates unplanned expenditure
- Get your instruments back to work with minimum hassle and downtime.

CALIBRATION

OPTION C3

Tektronix Calibration is specifically designed to the requirements of standards including ISO9000 and ANSI/NCSL Z-540, in terms of both the technical services performed and the documentation supplied.

- The C3 Option provides 3 years of calibration coverage
- With your instrument you will receive the factory calibration certification
- Throughout your coverage period your instrument will be calibrated according to its Recommended Calibration Interval

TEST DATA

OPTION D1/D3

Test data is the recorded values of measurements made to test an instrument's performance during Calibration, as required by many Quality Systems.

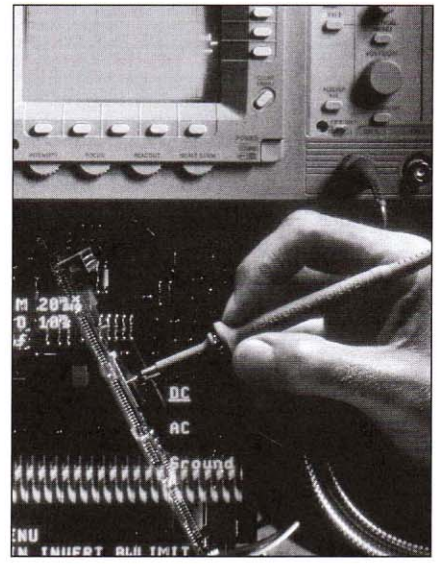
- Option D1 provides an initial Test Data report from manufacturing
- Option D3 provides initial Test Data plus a Test Data Report for every calibration performed during three years of coverage (requires Option C3)

PRODUCT INSTALLATION

OPTION IN

For complex modular or system oriented products, it is more time efficient and cost effective to have a trained specialist configure and install your new instrument.

- Saves you valuable engineering time, keeps your staff focused on their real project tasks and brings you productive results faster
- Provides configuration, either at your site or at a Tektronix location
- A Tektronix specialist completes installation, after delivery, ensuring that your product is fully functional and ready to use
- Start-up training session provides front panel and product familiarization, enabling you to begin working quickly and effectively



ON-SITE SERVICE

OPTION S1/S3

Nothing beats the convenience and security of having services performed at your own site. Now it's easy to order the expertise of the Tektronix mobile team as a Service Option with your new instruments:

- Option S1/S3 upgrades a standard 1-year/3-year return-to-depot warranty to an On-site warranty
- When option S3 is ordered with a calibration and/or extended repair option, delivery of these services is upgraded to On-site
- Calibration is arranged in advance to suit your schedules. Repair is provided on a priority basis, further increasing your uptime

For more information about Tektronix Service, or ISO9000, visit us at our Website:
http://www.tektronix.com/Measurement/Service

MEASUREMENT CUSTOMER TRAINING OFFERINGS

- Measurement Product Service Training
- Measurement User and Measurement Applications Training

Instructor-led training is available at the MBD Worldwide Training Center in Beaverton, Oregon. On-site classes are also available upon request.

For more information on training opportunities contact:

Tektronix, Inc.

MBD Worldwide Training

Howard Vollum Park

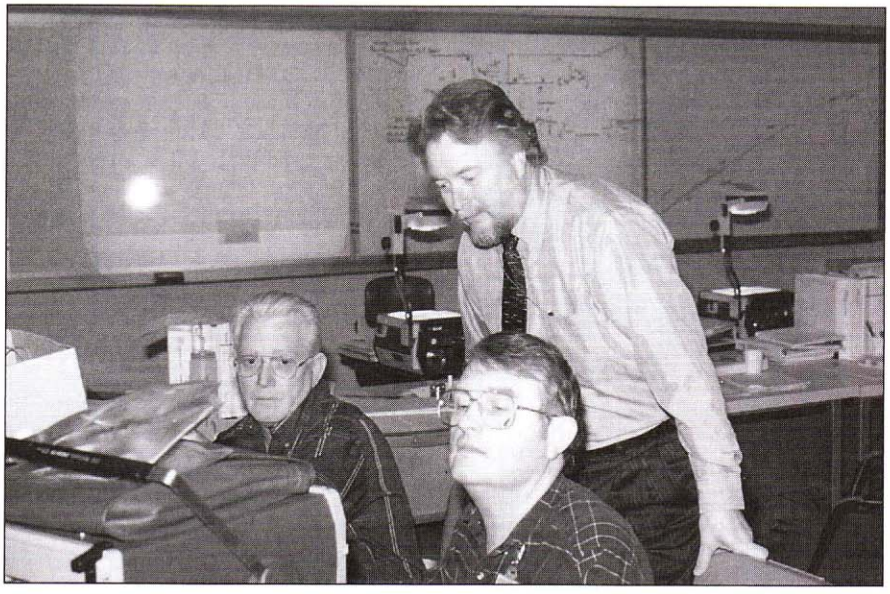
PO Box 500, M/S 13-100

Beaverton, Oregon 97077-0001

(800) 835-9433 (x-77510), (503) 627-7510

Or visit our website at:

http://www.tektronix.com/Measurement/Products/catalog/Support/Seminars





Another satisfied TekSelect product customer.

"TekSelect"

That's the Tektronix program name for our reconditioned inventory. It's our second chance at making another happy customer with these products. We have a huge selection of inventory that spans our entire product portfolio. Logic Analyzers, Spectrum Analyzers, General Purpose Scopes ... you name it and we've probably got it in the TekSelect program inventory.

The TekSelect program inventory consists mostly of instruments from the latest product showcase such as NAB, Comdex, IBC or other smaller regional technology shows. In the past, this inventory has been a "best kept secret" for those smart buyers who found out where to get them. Now, Tektronix is making sure that everyone has the chance to get in on these excellent purchase opportunities!

OUTSTANDING PERFORMANCE

All products in the TekSelect program are serviced, calibrated and tested to meet the same high standards of quality that you've come to expect from Tektronix. That's our way of making sure that you don't have to sacrifice performance when purchasing a product from Tektronix.

ATTRACTIVE PRICES

Nowhere else can you buy direct from the factory at these savings. It's not uncommon for customers who purchase from the TekSelect program to comment on what an excellent deal they've made. This is our chance to help those customers whose budget constraints limit their ability to buy new. We take great pleasure in finding them a product that will do the job, at a price that won't break their budget. Contact your Account Manager, CSR or one of our TekSelect product reseller partners (listed below) for the latest price and availability on TekSelect product inventory.

"UNHEARD-OF" NEW PRODUCT WARRANTY

While all TekSelect products are reconditioned, the warranty isn't! We provide each TekSelect product with a new product warranty. That's right! New Product Warranty!

This is one of the greatest features of the TekSelect program. All TekSelect products have the same warranty as new products. Extended service options are also available on most products. That's our commitment to ensure that you're not short-changed on one of the most important aspects of buying reconditioned inventory, the product's warranty!

TekSelect APPEARANCE AND CONDITION

Because these are used products, you'll probably notice normal wear and tear on them. However, what you sacrifice in aesthetics, you make up for in price and functionality. Remember that while TekSelect products may have a few dings and scratches, they come with a full product warranty at substantial savings from the list price. We stand behind TekSelect products.

AVAILABILITY/DELIVERY

When you have a special project with tight deadlines, waiting for an instrument simply won't do. The TekSelect program can help you! In some cases, products have been reconditioned in advance and are available immediately. For those products not reconditioned in advance, or for products requiring reconfiguration, some lead-time is required for us to properly recondition your TekSelect product or install the added options you've purchased. Your CSR will help you understand the required lead-time for delivery.

TekSelect products are offered on a "first come, first serve" basis. So hurry and call your Account Manager, CSR or one of our TekSelect product reseller partners today for availability and delivery information.

OPTION UPGRADES

Many TekSelect products can be ordered with option upgrades. The upgrades are priced at list price, but can be installed on your new TekSelect product for free. Please consult your CSR for option upgrade availability when ordering your TekSelect product.

All products are reconditioned to the configuration they were in when originally manufactured. Tektronix does not represent that TekSelect inventory will match the current option configuration offered in new products. Please contact your sales representative or CSR for questions regarding the configuration of existing TekSelect inventory.

Authorized TekSelect Resellers:

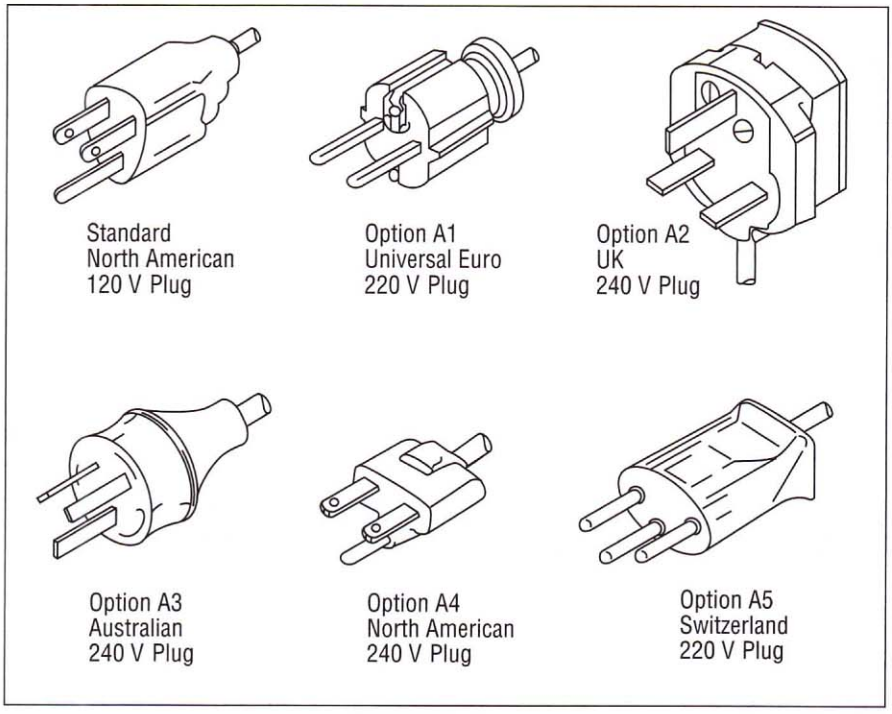
Reseller	HQ	Phone Number
Beta Lambda Instruments	New Jersey	1 800 282-5632
Exphil Calibration Labs	New York	1 800 539-7445
Metric	California	1 800 432-3424
Newcourt Financial	Texas	1 800 874-7123
NW Test & Measurement	Oregon	1 800 320-9001
Telogy	California	1 800 835-6494
TestEquity	California	1 800 732-3457
Tucker Electronics	Texas	1 800 527-4642

Many products offered by Tektronix*[1] provide wide-range regulated supplies, or quick change line-voltage selectors for convenient selection of line-voltage operating ranges. In a few products transformer taps can be changed to accommodate specific line-voltage operating ranges or, if specified on the purchase order, can be factory wired for a specific range.

Most Tektronix products are designed to operate from a power source that will not apply more than 250 Volts RMS between the supply conductors or between either supply conductor and ground.

For power cord/plug options not specified, contact your local Tektronix representative for information. Products specifying Opt. A1, A2, A3, A5, A6 and AC are subject to export pricing.

*[1] *These options are not available for Rohde & Schwarz or ADVANTEST products sold in North America.*



Except for some double-insulated products, most Tektronix products are equipped with either a three-conductor attached power cord or a three-terminal power cord receptacle. The third wire or terminal is connected directly to the product's chassis to protect operating personnel.

Power cord coding follows one of the two following schemes:

	Scheme 1	Scheme 2
Line	Black	Brown
Neutral	White	Light blue
Ground (safety earth)	Green-yellow	Green-yellow

Many Tektronix products can be fitted with one of the power cord/plug options listed and wired for the voltage as indicated, if specified on the purchase order.

Standard	North American	120 V
Opt. A1	Universal Euro	220 V
Opt. A2	United Kingdom	240 V
Opt. A3	Australian	240 V
Opt. A4	North American	240 V
Opt. A5	Switzerland	220 V
Opt. A6	Japan	100 V
Opt. AC	China	240 V

YOU NOW HAVE A FAST, CONVENIENT WAY TO OBTAIN APPLICATION/ TECHNICAL INFORMATION FROM TEKTRONIX:

TEKFAX

- The TekFAX™ Instant Information System. Perfect for Information You Need Immediately
- Tektronix Has a Full Library of Information to Support Your Needs

TECHNICAL INFORMATION AVAILABLE VIA FAX

Tektronix is pleased to provide 24 hour automated information service on over 600 of our fine measurement products.

Through your touch tone telephone, follow our voice-prompted selection process and immediately receive application information or specification data directly from your office or home fax machine.

This service reflects our commitment to deliver top value to you in all our products and services.

CALL TekFAX AT: 1-800-835-7732 U.S./CANADA

To Receive:
Call TekFAX and then

SELECT "1"
IF YOU KNOW THE DOCUMENT NUMBER YOU WISH TO RECEIVE

OR

SELECT "2"
FOR DOCUMENT INDEXES AND ENTER YOUR CHOICE FROM THE LIST TO THE RIGHT

Indexes with Technical Information available through TekFAX:

1. Oscilloscope Solutions
2. Basic Instrumentation
3. Electronic Measurement Instruments
4. VXI Instruments
5. Digital Systems Development
6. Video and Audio Test
7. Communications Test
8. Customer Services and Company Information
9. Accessories and Other Products (Including Probes)

TO ACCESS TEKFAX:

1. Call 1-800-835-7732 (from anywhere in the US or Canada).
2. Select "1" if you are familiar with TekFAX system, "2" for an overview of how TekFAX system works.
3. Select "1" if you know the document number you wish to receive.
4. Select "2" if you are calling to request a document index of choice (see list above).
5. After selecting the information you would like, you will be prompted to enter the fax machine number to which you want information sent.
6. Another prompt will allow you to indicate a phone extension number or name to ensure delivery of information if you have a multiple user fax machine.
7. TekFAX system will process your request.

If you prefer personal service, call 1-800-426-2200. At the auto prompt press 1 and a representative will be available to assist you.

Worldwide Sales and Service Offices

FOR COUNTRIES NOT LISTED :

Customers in South America, Central America and The Caribbean should contact Tektronix Export Sales

Tektronix, Inc.
Export Sales
P.O. Box 500, M/S 50-235
Beaverton, OR 97077
USA
Phone 1 (503) 627-6905
Fax 1 (503) 627-6611

AFRICA

Customers in Benin, Burkina Faso, Cameroon, Central African Republic, Chad, Congo, Djibouti, Equatorial Guinea, Gabon, Guinea, Ivory Coast, Malagasy, Mali, Mauritius, Monaco, Niger, Senegal, Togo, Zaire should contact Tektronix SA., Orsay, France.

Tektronix S.A., France
Orsay
Courtaboeuf 1
Parc Technopolis- Bât. Oméga B.P.13
3, avenue du Canada
Les Ulis Cedex, 91941
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Phone +33 1 69 86 81 81
Fax +33 1 69 86 81 19
E-mail measurement.france@tektronix.com

ALBANIA

Austria, Central Eastern Europe, Greece, Malta, Cyprus

Tektronix Ges.m.b.H.
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E-mail measurement.austria@tektronix.com

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E-mail:
ricardo.baez@tek.com

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Tektronix Australia Pty. Limited
Sydney
80 Waterloo Road
North Ryde, NSW 2113
Australia
Phone 61 (2) 9888-0100
Fax 61 (2) 9888-0125

Control Dynamics (Tektronix Australia Representative)
Perth
5 Bookham St
Morley
WA, 6062
Australia
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Fax 61 (8) 9275-9717

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131 Afkhalifa Ave.
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Fax +973 727 228
E-mail
rajeshbh@batelco.com.bh

THE BALTICS

Customers for Armenia, Azerbaijan, Belarus, Georgia, and Ukraine should contact Tektronix Oy, Finland

Tektronix Oy
Sales Office/Export
Piispantilankuja 2
Espoo, FIN-02240
Finland
Phone +3589 4783 4211
Fax +3589 4783 4200
E-mail measurement.finland@tektronix.com

BANGLADESH

Customers in Bangladesh should contact the Tektronix office in Bangalore, India.

Tektronix (India) Limited
Bangalore Office (Corporate Office)
Tek Tower, Hayes Road
Bangalore, 560 025
India
Phone (91) 80-2275577
Fax (91) 80-2275588

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Fax +375 17231 2545
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bisri@ceibo.entelnet.bo

BRAZIL

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Centro Empresarial de São Paulo
Av. Maria Coelho Aguiar, 215 - Bloco D - 1o Andar
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Fax (Sales)
55 (11) 3741-7358
Phone (Service)
55 (11) 7266-2364
Fax (Service)
55 (11) 7291-7640
E-mail: MBD-sales-brasil@tek.com

Tektronix Industria e Comercio Ltda
Rio de Janeiro Office
Praia do Flamengo
66 Bl B - Sala 1406 - 14º andar
22228-900 - Rio de Janeiro
RJ
Brasil
Phone 55 (21) 541-9755
Fax 55 (21) 542-3589

BRUNEI

Customers in Brunei should contact the Tektronix office in Singapore.

Tektronix Southeast Asia Pte Ltd
101 Thomson Road
#02-02 United Square
Singapore 307591
Phone (65) 356-3900
Fax (65) 356-4483

BULGARIA

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E-mail
bjanntek@vmei.acad.bg

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Fax (613) 599-4513

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3280 Langstaff Road Unit 1
Concord
ON L4K 5B6
Canada
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015022200 ..... $3.00
015032501 ..... $27.00
015033000 ..... $54.00
015054900 ..... $105.00
015055400 ..... $50.00
015056000 ..... $625.00
015056200 ..... $541.00
015056500 ..... $468.00
015057200 ..... $32.00
015060150 ..... $158.00
015067250 ..... $168.00
015100100 ..... $237.00
015100200 ..... $221.00
015100400 ..... $69.00
015101100 ..... $35.00
015101200 ..... $16.00
015101400 ..... $394.00
015101600 ..... $63.00
015101800 ..... $16.00
015102000 ..... $33.00
015102100 ..... $37.00
015102200 ..... $53.00
016019505 ..... $74.00
016036202 ..... $121.00
016056600 ..... $48.00
016059200 ..... $27.00
016062202 ..... $58.00
016063300 ..... $7.00
016067702 ..... $57.00
016079201 ..... $525.00
016081301 ..... $280.00
016087600 ..... $32.00
016087700 ..... $17.00
016087800 ..... $17.00
016087900 ..... $17.00
016089700 ..... $788.00
016090901 ..... $252.00
016093900 ..... $21.00
016094000 ..... $21.00
016094100 ..... $17.00
016107700 ..... $21.00
016113500 ..... $840.00
016114500 ..... $210.00
016115400 ..... $231.00
016115700 ..... $735.00
016115801 ..... $158.00
016115900 ..... $57.00
016116600 ..... $525.00
016121000 ..... $275.00
016123600 ..... $475.00
016123900 ..... $2,079.00
016126800 ..... $116.00
016131500 ..... $14.00
016138500 ..... $21.00
016139901 ..... $96.00
016144200 ..... $250.00
016144300 ..... $650.00
016144700 ..... $650.00
016146100 ..... $31.00
016146202 ..... $250.00
016146302 ..... $250.00
016149400 ..... $650.00
016160900 ..... $552.00
016167400 ..... $184.00
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020169300 ..... $3,082.00
020170800 ..... $252.00
020188500 ..... $510.00
020190800 ..... $27.00
020199301 ..... $56.00
020200800 ..... $163.00
020210600 ..... $48.00
020213401 ..... $21.00
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020214000 ..... $58.00
020220900 ..... $113.00
040127601 ..... $305.00
040148700 ..... $105.00
040152401 ..... $100.00
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067056300 ..... $263.00
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068021907 ..... $70.00
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068025103 ..... $60.00
068025104 ..... $60.00
068025106 ..... $70.00
068025107 ..... $70.00
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068025203 ..... $60.00
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068026804 ..... $115.00
068034401 ..... $60.00
068034402 ..... $60.00
068034403 ..... $60.00
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070627004 ..... $30.00
070667401 ..... $35.00
070673603 ..... $25.00
070673802 ..... $30.00
070674003 ..... $15.00
070716704 ..... $25.00
070763701 ..... $25.00
070789604 ..... $140.00
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070794203 ..... $10.00
070803502 ..... $5.00
070803602 ..... $145.00
070804600 ..... $8.00
070806900 ..... $35.00
070809702 ..... $25.00
070831805 ..... $48.00
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070835503 ..... $25.00
070836203 ..... $15.00
070840400 ..... $25.00
070840502 ..... $140.00
070847601 ..... $25.00
070847902 ..... $25.00
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070855903 ..... $35.00
070856804 ..... $130.00
070856903 ..... $5.75
070857005 ..... $285.00
070858002 ..... $29.00
070868805 ..... $140.00
070870907 ..... $50.00
070871804 ..... $125.00
070872101 ..... $29.00
070884002 ..... $15.00
070894003 ..... $25.00
070894303 ..... $10.00
070896500 ..... $5.00

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070902603 ..... $150.00
070902706 ..... $45.00
070909405 ..... $79.00
070918601 ..... $15.00
070918602 ..... $15.00
070919600 ..... $30.00
070919700 ..... $35.00
070921800 ..... $29.00
070922000 ..... $5.00
070923200 ..... $15.00
070923501 ..... $10.00
070923602 ..... $10.00
070924402 ..... $10.00
070924500 ..... $75.00
070924603 ..... $30.00
070924702 ..... $20.00
070925700 ..... $10.00
070930900 ..... $5.00
070937201 ..... $47.00
070938301 ..... $75.00
070938401 ..... $25.00
070938901 ..... $100.00
070939802 ..... $100.00
070940400 ..... $315.00
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070943301 ..... $50.00
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070957103 ..... $15.00
070957303 ..... $15.00
070957504 ..... $15.00
070957602 ..... $30.00
070958301 ..... $10.00
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070964200 ..... $50.00
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070967200 ..... $25.00
070969200 ..... $5.00
070969301 ..... $25.00
070969304 ..... $25.00
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070970304 ..... $145.00
070973105 ..... $20.00
070973205 ..... $21.00
070974101 ..... $15.50
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070975201 ..... $37.00
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071040600 ..... $25.00
071040700 ..... $25.00
071040800 ..... $25.00
071040900 ..... $15.00
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071048400 ..... $12.00
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071048700 ..... $12.00
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071048900 ..... $12.00
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071049100 ..... $12.00
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071049300 ..... $30.00
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103003100 ..... $11.00
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103003500 ..... $16.00
103004500 ..... $25.00
103009000 ..... $18.00
103015800 ..... $18.00
103016400 ..... $37.00
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103032400 ..... $52.00
103033400 ..... $18.00
103036500 ..... $25.00
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103036700 ..... $25.00
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1101A $1,077.00
1101A A1 ..... $0.00
1101A A2 ..... $0.00
1101A A3 ..... $0.00
1101A A4 ..... $0.00
1101A A5 ..... $0.00
1101A R3 ..... $105.00
1101A R5 ..... $210.00
1103 ..... $1,095.00
1103 A1 ..... $0.00
1103 A2 ..... $0.00
1103 A3 ..... $0.00
1103 A5 ..... $0.00
1180IC $22,240.00
1180IC 1M $3,995.00
1180IC 1R $280.00
1180IC A1 ..... $0.00
1180IC A2 ..... $0.00
1180IC A3 ..... $0.00
1180IC A4 ..... $0.00
1180IC A5 ..... $0.00
1180IC C3 ..... $660.00
1180IC C5 ..... $1,315.00
1180IC D1 ..... $145.00
1180IC D3 ..... $270.00
1180IC D5 ..... $535.00
1180IC R3 ..... $1,330.00
1180IC R5 ..... $2,660.00
118668700 ..... $39.00
118940200 ..... $125.00
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119451300 ..... $170.00
119451400 ..... $275.00
119451500 ..... $275.00
119451600 ..... $170.00
119451700 ..... $275.00
119451800 ..... $170.00
119454600 ..... $170.00
119455600 ..... $275.00
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119511800 ..... $252.00
119514400 ..... $100.00
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119514600 ..... $100.00
119515400 ..... $275.00
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119516700 ..... $100.00
119516800 ..... $100.00
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119517000 ..... $100.00
119517100 ..... $100.00
119517200 ..... $100.00
119561000 ..... $250.00
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119591600 ..... $893.00
119592900 ..... $683.00
119593600 ..... $683.00
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131130200 ..... $3.00
131276601 ..... $53.00
131276603 ..... $11.00
131368501 ..... $6.00
131419900 ..... $132.00
131421000 ..... $10.00
131424400 ..... $130.00
131428000 ..... $3.00
131435300 ..... $75.00
131446800 ..... $17.00
131447300 ..... $2.00
131447400 ..... $2.00
131472800 ..... $60.00
131499701 ..... $8.00
131499702 ..... $189.00
131503000 ..... $75.00
131503100 ..... $75.00
131507200 ..... $60.00
131507300 ..... $60.00
131507800 ..... $60.00
131508000 ..... $60.00
131518100 ..... $60.00
131530800 ..... $3.00
131530900 ..... $3.00
131534201 ..... $95.00
131548200 ..... $33.00
131572700 ..... $2.00
131573500 ..... $100.00
131577700 ..... $3.00
131636100 ..... $30.00
131645700 ..... $75.00
134001300 ..... $2.00
134001600 ..... $3.00
1350F01 ..... $3,400.00
1350F05 ..... $355.00
1405 ..... $9,650.00
1405 01 ..... $250.00
1405 03 ..... $0.00
1405 A1 ..... $0.00
1405 A2 ..... $0.00
1405 A3 ..... $0.00
1405 A4 ..... $0.00
1405 A5 ..... $0.00
1405 R3 ..... $315.00
1405 R5 ..... $630.00
146003302 ..... $137.00
1502C $8,070.00
1502C 04 ..... $1,100.00
1502C 05 ..... $0.00
1502C A1 ..... $0.00
1502C A2 ..... $0.00
1502C A3 ..... $0.00
1502C A4 ..... $0.00
1502C A5 ..... $0.00
1502C C3 ..... $545.00
1502C C5 ..... $1,085.00
1502C CS $760.00
1502C D1 ..... $125.00
1502C D3 ..... $240.00
1502C D5 ..... $475.00
1502C DE $0.00
1502C R3 ..... $515.00
1502C R5 ..... $1,030.00
1503C $5,945.00
1503C 04 ..... $1,100.00
1503C 05 ..... $0.00
1503C 06 ..... $395.00
1503C 08 ..... $395.00
1503C 09 ..... $395.00
1503C 10 ..... $395.00
1503C A1 ..... $0.00
1503C A2 ..... $0.00
1503C A3 ..... $0.00
1503C A4 ..... $0.00
1503C A5 ..... $0.00
1503C C3 ..... $515.00

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1503C C5 ..... $1,030.00
1503C D1 ..... $125.00
1503C D3 ..... $230.00
1503C D5 ..... $460.00
1503C DE $0.00
1503C R3 ..... $460.00
1503C R5 ..... $915.00
152101600 ..... $330.00
159002900 ..... $7.75
159005400 ..... $1.30
159028700 ..... $25.00
159029700 ..... $2.40
159033700 ..... $10.00
159035500 ..... $2.84
159035500 ..... $2.84
159035700 ..... $6.00
161010400 ..... $15.00
161023001 ..... $12.00
166040401 ..... $3.00
166055700 ..... $3.00
1700F00 ..... $95.00
1700F02 ..... $175.00
1700F05 ..... $295.00
1700F06 ..... $85.00
1700F07 ..... $265.00
1705A $4,995.00
1705A 74 ..... $150.00
1705A A1 ..... $0.00
1705A A2 ..... $0.00
1705A A3 ..... $0.00
1705A A5 ..... $0.00
1705A R5 ..... $220.00
1710J $2,395.00
1710J 74 ..... $150.00
1710J A1 ..... $0.00
1710J A2 ..... $0.00
1710J A3 ..... $0.00
1710J A5 ..... $0.00
1710J R5 ..... $135.00
1711J $2,395.00
1711J 74 ..... $150.00
1711J A1 ..... $0.00
1711J A2 ..... $0.00
1711J A3 ..... $0.00
1711J A5 ..... $0.00
1711J R5 ..... $135.00
1720 ..... $2,850.00
1720 74 ..... $150.00
1720 A1 ..... $0.00
1720 A2 ..... $0.00
1720 R5 ..... $165.00
1720SCH $4,350.00
1720SCH74 ..... $150.00
1720SCHA1 ..... $0.00
1720SCHA2 ..... $0.00
1720SCHA3 ..... $0.00
1720SCHR5 ..... $190.00
1721 ..... $2,850.00
1721 74 ..... $150.00
1721 A1 ..... $0.00
1721 A2 ..... $0.00
1721 A3 ..... $0.00
1721 A5 ..... $0.00
1721 PM $500.00
1721 PN $500.00
1721 R5 ..... $165.00
1721SCH $4,350.00
1721SCH74 ..... $150.00
1721SCHA1 ..... $0.00
1721SCHA2 ..... $0.00
1721SCHA3 ..... $0.00
1721SCHA5 ..... $0.00
1721SCHR5 ..... $190.00
1725 ..... $3,995.00
1725 74 ..... $150.00
1725 A1 ..... $0.00
1725 A2 ..... $0.00
1725 A3 ..... $0.00
1725 A5 ..... $0.00
1725 R5 ..... $190.00
1730 ..... $2,850.00
1730 74 ..... $150.00
1730 A1 ..... $0.00
1730 A2 ..... $0.00
1730 R5 ..... $250.00
1730D $4,995.00
1730D A1 ..... $0.00
1730D A2 ..... $0.00
1730D A3 ..... $0.00
1730D R5 ..... $210.00
1731 ..... $2,850.00
1731 74 ..... $150.00
1731 A1 ..... $0.00
1731 A2 ..... $0.00
1731 A3 ..... $0.00
1731 A5 ..... $0.00
1731 PM $500.00
1731 PN $500.00
1731 R5 ..... $165.00
1735 ..... $3,250.00
1735 74 ..... $150.00
1735 A1 ..... $0.00
1735 A2 ..... $0.00
1735 A3 ..... $0.00
1735 A5 ..... $0.00
1735 R5 ..... $175.00
1735HD $6,595.00
1735HD 74 ..... $150.00
1735HD A1 ..... $0.00
1735HD A2 ..... $0.00
1735HD A3 ..... $0.00
1735HD A4 ..... $0.00
1735HD A5 ..... $0.00
1735HD R5 ..... $270.00
1740A $5,165.00
1740A 02 ..... $175.00
1740A 74 ..... $150.00
1740A A1 ..... $0.00
1740A A2 ..... $0.00
1740A A3 ..... $0.00
1740A R5 ..... $280.00
174112000 ..... $32.00
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174138600 ..... $810.00
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174138800 ..... $580.00
174142700 ..... $79.00
174142800 ..... $90.00
174149700 ..... $610.00
174173401 ..... $23.00
174191000 ..... $158.00
1741A $4,995.00
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1741A A1 ..... $0.00
1741A A2 ..... $0.00
1741A A3 ..... $0.00
1741A R5 ..... $220.00
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174232400 ..... $137.00
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174382800 ..... $63.00
174391900 ..... $35.00
174392000 ..... $130.00
174392100 ..... $45.00
174392200 ..... $40.00
174392600 ..... $12.00
1745A $5,395.00
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1745A A2 ..... $0.00
1745A A3 ..... $0.00
1745A R5 ..... $240.00
175084802 ..... $15.00
1750A $6,495.00
1750A 74 ..... $150.00
1750A A1 ..... $0.00
1750A A2 ..... $0.00
1750A A3 ..... $0.00
1750A R5 ..... $270.00
175101701 ..... $14.00
1751A $6,495.00
1751A 74 ..... $150.00
1751A A1 ..... $0.00
1751A A2 ..... $0.00
1751A A3 ..... $0.00
1751A R5 ..... $270.00
1755A $6,895.00
1755A 74 ..... $150.00
1755A A1 ..... $0.00
1755A A2 ..... $0.00
1755A A3 ..... $0.00
1755A R5 ..... $280.00
1760 ..... $5,595.00
1760 74 ..... $0.00
1760 A1 ..... $0.00
1760 A2 ..... $0.00
1760 A3 ..... $0.00
1760 R5 ..... $240.00
1760 SC $1,500.00
1761 ..... $5,595.00
1761 74 ..... $0.00
1761 A1 ..... $0.00
1761 A2 ..... $0.00
1761 A3 ..... $0.00
1761 A5 ..... $0.00
1761 R5 ..... $240.00
1761 SC $1,500.00
1765 ..... $5,995.00
1765 74 ..... $0.00
1765 A1 ..... $0.00
1765 A2 ..... $0.00
1765 A3 ..... $0.00
1765 R5 ..... $250.00
1765 SC $1,500.00
1780F02 ..... $595.00
1780F05 ..... $215.00
1780R $12,995.00
1780R 74 ..... $300.00
1780R A1 ..... $0.00
1780R A2 ..... $0.00
1780R C3 ..... $1,000.00
1780R C5 ..... $1,995.00
1780R D1 ..... $200.00
1780R D3 ..... $355.00
1780R D5 ..... $705.00
1780R R5 ..... $420.00
1781R $12,995.00
1781R A1 ..... $0.00
1781R A2 ..... $0.00
1781R A3 ..... $0.00
1781R C3 ..... $1,000.00
1781R C5 ..... $1,995.00
1781R D1 ..... $200.00
1781R D3 ..... $355.00
1781R D5 ..... $705.00
1781R R5 ..... $420.00
1910F00 ..... $400.00
195424000 ..... $5.00
195617600 ..... $11.00
196311302 ..... $15.00
196311303 ..... $12.00
196312001 ..... $5.00
196312101 ..... $5.00
196319801 ..... $5.00
196320100 ..... $21.00
196328600 ..... $12.00
196328700 ..... $15.00
196329500 ..... $10.00
196330200 ..... $20.00
196330500 ..... $18.00
196332100 ..... $25.00
196333700 ..... $18.00
196336300 ..... $28.00
196338200 ..... $20.00
196340801 ..... $9.00
196341000 ..... $46.00
196342401 ..... $12.00
196343900 ..... $40.00
198581900 ..... $39.00
200252000 ..... $32.00
200323201 ..... $13.00
200369601 ..... $32.00
200389701 ..... $23.00
204092501 ..... $2.00
204104900 ..... $2.00
206001500 ..... $11.00
206006000 ..... $11.00
206010500 ..... $5.00
206011400 ..... $11.00
206015304 ..... $205.00
206019300 ..... $53.00
206020000 ..... $3.00
206023003 ..... $48.00
206023004 ..... $189.00
206023301 ..... $37.00
206026510 ..... $27.00
206026511 ..... $27.00

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206026512 ..... $27.00
206026513 ..... $27.00
206033601 ..... $74.00
206033701 ..... $63.00
206033801 ..... $95.00
206034201 ..... $74.00
206036400 ..... $7.00
206037800 ..... $26.00
206038000 ..... $94.00
206038100 ..... $94.00
206039200 ..... $27.00
206039300 ..... $27.00
206039800 ..... $268.00
206042600 ..... $95.00
206042700 ..... $77.00
206043800 ..... $336.00
206046300 ..... $24.00
214028300 ..... $11.00
214412500 ..... $3.00
214422700 ..... $8.00
26N50 ..... $1,275.00
2704 ..... $1,370.00
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2704 A2 ..... $0.00
2704 A3 ..... $0.00
2704 A4 ..... $0.00
2704 A5 ..... $0.00
2704 R3 ..... $175.00
2704 R5 ..... $345.00
2705 ..... $450.00
2706 ..... $5,795.00
2706 A1 ..... $0.00
2706 A2 ..... $0.00
2706 A3 ..... $0.00
2706 A4 ..... $0.00
2706 A5 ..... $0.00
2706 D1 ..... $110.00
2706 R3 ..... $390.00
2706 R5 ..... $780.00
2707 ..... $5,110.00
2707 01 ..... $0.00
2707 A1 ..... $0.00
2707 A2 ..... $0.00
2707 A3 ..... $0.00
2707 A4 ..... $0.00
2707 A5 ..... $0.00
2707 C3 ..... $380.00
2707 C5 ..... $760.00
2707 D1 ..... $105.00
2707 D3 ..... $190.00
2707 D5 ..... $380.00
2707 R3 ..... $375.00
2707 R5 ..... $745.00
2711 ..... $10,935.00
2711 02 ..... $990.00
2711 03 ..... $930.00
2711 04 ..... $3,680.00
2711 05 ..... $4,900.00
2711 07 ..... $1,825.00
2711 08 ..... $900.00
2711 10 ..... $745.00
2711 15 ..... $320.00
2711 21 ..... $5,575.00
2711 30 ..... $295.00
2711 33 ..... $125.00
2711 34 ..... $680.00
2711 A1 ..... $0.00
2711 A2 ..... $0.00
2711 A3 ..... $0.00
2711 A4 ..... $0.00
2711 A5 ..... $0.00
2711 C3 ..... $695.00
2711 C5 ..... $1,390.00
2711 D1 ..... $145.00
2711 D3 ..... $280.00
2711 D5 ..... $555.00
2711 R3 ..... $495.00
2711 R5 ..... $990.00
2712 ..... $14,200.00
2712 04 ..... $3,615.00
2712 05 ..... $4,900.00
2712 07 ..... $1,820.00
2712 08 ..... $0.00
2712 10 ..... $740.00
2712 12 ..... $1,705.00
2712 14 ..... $695.00
2712 15 ..... $315.00
2712 20 ..... $3,705.00
2712 21 ..... $5,515.00
2712 30 ..... $290.00
2712 33 ..... $125.00
2712 34 ..... $670.00
2712 A1 ..... $0.00
2712 A2 ..... $0.00
2712 A3 ..... $0.00
2712 A4 ..... $0.00
2712 A5 ..... $0.00
2712 C3 ..... $875.00
2712 C5 ..... $1,750.00
2712 D1 ..... $170.00
2712 D3 ..... $315.00
2712 D5 ..... $630.00
2712 R3 ..... $570.00
2712 R5 ..... $1,140.00
27120B $16,125.00
27120B 05 ..... $3,507.00
27120B 10 ..... $714.00
27120B 11 ..... $3,400.00
27120B 16 ..... $2,800.00
27120B 17 ..... $5,625.00
27120B A1 ..... $0.00
27120B A2 ..... $0.00
27120B A3 ..... $0.00
27120B A4 ..... $0.00
27120B A5 ..... $0.00
2715 ..... $16,695.00
2715 03 ..... $0.00
2715 05 ..... $3,507.00
2715 07 ..... $1,764.00
2715 08 ..... $0.00
2715 15 ..... $304.50
2715 30 ..... $279.00
2715 33 ..... $120.00
2715 34 ..... $651.00
2715 50 ..... $1,600.00
2715 75 ..... $1,600.00
2715 A1 ..... $0.00
2715 A2 ..... $0.00
2715 A3 ..... $0.00
2715 A4 ..... $0.00
2715 A5 ..... $0.00
2715 AC $1,319.00
2715 C3 ..... $980.00
2715 C5 ..... $1,960.00
2715 D1 ..... $185.00
2715 D3 ..... $345.00
2715 D5 ..... $685.00
2715 R3 ..... $620.00
2715 R5 ..... $1,235.00
3026 ..... $22,750.00
3026 A1 ..... $0.00
3026 A2 ..... $0.00
3026 A3 ..... $0.00
3026 A4 ..... $0.00
3026 A5 ..... $0.00
3026 C3 ..... $1,085.00
3026 C5 ..... $2,095.00
3026 D1 ..... $165.00
3026 D3 ..... $600.00
3026 D5 ..... $965.00
3026 R3 ..... $1,210.00
3026 R5 ..... $2,330.00
3066 ..... $43,500.00
3066 10 ..... $915.00
3066 1R $910.00
3066 1S $1,950.00
3066 A1 ..... $0.00
3066 A2 ..... $0.00
3066 A3 ..... $0.00
3066 A4 ..... $0.00
3066 A5 ..... $0.00
3066 C3 ..... $1,985.00
3066 D1 ..... $165.00
3066 D3 ..... $990.00
3066 R3 ..... $1,330.00
3066 R5 ..... $2,660.00
3086 ..... $61,950.00
3086 10 ..... $915.00
3086 1R $1,040.00
3086 1S $1,950.00
3086 A1 ..... $0.00
3086 A2 ..... $0.00
3086 A3 ..... $0.00
3086 A4 ..... $0.00
3086 A5 ..... $0.00
3086 C3 ..... $2,845.00
3086 C5 ..... $5,495.00
3086 D1 ..... $165.00
3086 D3 ..... $1,360.00
3086 D5 ..... $2,190.00
3086 R3 ..... $2,615.00
3086 R5 ..... $5,050.00
315068000 ..... $0.65
334609001 ..... $0.60
337277500 ..... $9.00
342103710 ..... $60.00
342103810 ..... $60.00
342103910 ..... $60.00
343100301 ..... $5.00
344004601 ..... $4.00
344046100 ..... $15.00
346026100 ..... $27.00
348148000 ..... $47.00
352035100 ..... $3.00
370A $30,970.00
370A 1R $595.00
370A A1 ..... $0.00
370A A2 ..... $0.00
370A A3 ..... $0.00
370A A4 ..... $0.00
370A A5 ..... $0.00
370A C3 ..... $1,940.00
370A C5 ..... $3,880.00
370A D1 ..... $235.00
370A D3 ..... $580.00
370A D5 ..... $1,160.00
370A R3 ..... $1,010.00
370A R5 ..... $2,015.00
371A $34,500.00
371A A1 ..... $0.00
371A A2 ..... $0.00
371A A3 ..... $0.00
371A A4 ..... $0.00
371A A5 ..... $0.00
371A C3 ..... $1,625.00
371A C5 ..... $3,250.00
371A D1 ..... $265.00
371A D3 ..... $505.00
371A D5 ..... $1,010.00
371A R3 ..... $1,065.00
371A R5 ..... $2,130.00
384180000 ..... $247.00
436031700 ..... $147.00
6502 ..... $6,285.00
6502 D1 ..... $155.00
73A270 ..... $4,305.00
73A270 C3 ..... $240.00
73A270 C5 ..... $475.00
73A270 D1 ..... $85.00
73A270 D3 ..... $165.00
73A270 D5 ..... $325.00
73A270 R3 ..... $305.00
73A270 R5 ..... $610.00
73A308 ..... $2,130.00
73A451 ..... $1,840.00
73A451 01 ..... $84.00
73A451 02 ..... $84.00
73A451 20 ..... $395.00
73A452 ..... $1,210.00
73A452 01 ..... $84.00
73A452 02 ..... $84.00
73A455 ..... $8,610.00
73A734 ..... $200.00
73A850 ..... $840.00
73A851A $1,680.00
73A851A01 ..... $155.00
73A851A02 ..... $160.00
760A $2,995.00
760A 74 ..... $150.00
760A A1 ..... $0.00
760A A2 ..... $0.00
760A A3 ..... $0.00
760A A4 ..... $0.00
760A A5 ..... $0.00
760A R3 ..... $165.00
760A R5 ..... $325.00
764 ..... $4,995.00
764 01 ..... $1,000.00
764 02 ..... $450.00
764 A1 ..... $0.00

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764 A2 ..... $0.00
764 A3 ..... $0.00
764 A4 ..... $0.00
764 A5 ..... $0.00
764 C3 ..... $515.00
764 C5 ..... $1,030.00
764 D1 ..... $150.00
764 D3 ..... $230.00
764 D5 ..... $460.00
764 R3 ..... $220.00
764 R5 ..... $440.00
764F01 ..... $1,200.00
764F01 D1 ..... $200.00
7KB9400-8AK $260.00
7KK1103-2AW00 ... $13,440.00
7KK1103-2AW01 ... $13,440.00
7KK1103-2CW00 ... $11,485.00
7KK1103-2CW01 ... $11,485.00
7KK1103-2WW00 ... $3,310.00
7KK1103-4CC11 ..... $695.00
7KK1103-4CE11 ..... $360.00
7KK1103-4SC11 ..... $3,425.00
7KK1103-4SM10 ..... $407.00
7KK1103-5AA00 ..... $2,710.00
7KK1103-5AB00 .... $2,030.00
7KK1103-5AC00 ..... $1,552.00
7KK1103-5AD00 ..... $776.00
7KK1103-5AE00 ..... $1,290.00
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7KK1103-6AA41 ..... $1,025.00
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7KK1103-6AA43 ..... $1,025.00
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7KK1103-6BA20 .... $2,245.00
7KK1103-6BA21 ..... $2,245.00
7KK1103-6BA40 .... $2,245.00
7KK1103-6BA41 ..... $2,245.00
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7KK1103-6BA51 ..... $2,245.00
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7KK1103-6BC11 ..... $2,370.00
7KK1103-6BC21 ..... $1,365.00
7KK1103-6BC41 ..... $1,365.00
7KK1103-6BD11 .... $3,390.00
7KK1103-6BD21 ..... $1,365.00
7KK1103-6BD41 ..... $1,365.00
7KK1103-6BE11 ..... $2,370.00
7KK1103-6BE21 ..... $825.00
7KK1103-6BE41 ..... $825.00
7KK1103-6BF11 ..... $2,370.00
7KK1103-6BF21 ..... $825.00
7KK1103-6BF41 ..... $825.00
7KK1103-6BG11 .... $3,390.00
7KK1103-6BG21 ..... $1,365.00
7KK1103-6BG41 ..... $1,365.00
7KK1103-6CA11 ..... $2,305.00
7KK1103-6CA21 ..... $825.00
7KK1103-6CA41 ..... $825.00
7KK1103-6DA10 .... $3,290.00
7KK1103-6DA11 .... $3,290.00
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7KK1103-6DA40 .... $1,365.00
7KK1103-6DA41 ..... $1,365.00
7KK1103-6DB10 .... $3,290.00
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7KK1103-6DB21 ..... $1,365.00
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7KK1103-6DC40 .... $1,365.00
7KK1103-6DC41 ..... $1,365.00
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7KK1103-6DD41 .... $2,245.00
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7KK1103-6DE40 ..... $1,365.00
7KK1103-6DE41 ..... $1,365.00
7KK1103-6DF11 ..... $6,560.00
7KK1103-6DF41 ..... $2,245.00
7KK1103-6EA11 ..... $2,305.00
7KK1103-6EA21 ..... $825.00
7KK1103-6EA41 ..... $825.00
7KK1103-6EB11 ..... $3,390.00
7KK1103-6EB21 ..... $1,365.00
7KK1103-6EB51 ..... $1,365.00
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7KK1103-6EC21 ..... $1,365.00
7KK1103-6EC41 ..... $1,365.00
7KK1103-6GA10 ..... $1,705.00
7KK1103-6GA11 ..... $1,705.00
7KK1103-6GA20 ..... $825.00
7KK1103-6GA21 ..... $825.00
7KK1103-6GA41 ..... $825.00
7KK1103-6GB10 .... $5,350.00
7KK1103-6GB11 .... $5,350.00
7KK1103-6GB20 .... $1,365.00
7KK1103-6GB21 ..... $1,365.00
7KK1103-6HA11 ..... $1,705.00
7KK1103-6HA21 ..... $825.00
7KK1103-6HA41 ..... $825.00
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7KK1103-6JA21 ..... $2,235.00
7KK1103-6JA41 ..... $2,235.00
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7KK1103-6KA11 ..... $6,560.00
7KK1103-6KA20 .... $2,245.00
7KK1103-6KA21 ..... $2,245.00
7KK1103-6KA40 .... $2,245.00
7KK1103-6KA41 ..... $2,245.00
7KK1103-6KA50 .... $3,375.00
7KK1103-6KA51 ..... $3,390.00
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7KK1103-6KB11 ..... $6,785.00
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7KK1103-6KB41 ..... $2,320.00
7KK1103-6KB50 .... $3,500.00
7KK1103-6KB51 ..... $3,500.00
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7KK1103-6LA11 ..... $6,560.00
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7KK1103-6LA21 ..... $2,245.00
7KK1103-6LA40 ..... $2,245.00
7KK1103-6LA41 ..... $2,245.00
7KK1103-6LA50 ..... $3,375.00
7KK1103-6LA51 ..... $3,375.00
7KK1103-6LB10 ..... $6,545.00
7KK1103-6LB11 ..... $6,545.00
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7KK1103-6LB41 ..... $2,235.00
7KK1103-6LB50 ..... $3,390.00
7KK1103-6LB51 ..... $3,390.00
7KK1103-7AA10 ..... $1,290.00
7KK1103-7AA20 ..... $300.00
7KK1103-7AA40 ..... $345.00
7KK1103-7AV10 ..... $870.00
7KK1103-7BA11 ..... $630.00
7KK1103-7BA21 ..... $345.00
7KK1103-7BA41 ..... $345.00
7KK1103-7DA11 ..... $1,290.00
7KK1103-7DA21 ..... $345.00
7KK1103-7DA41 ..... $345.00
7KK1103-7FA11 ..... $11,815.00
7KK1103-7FB11 .... $11,550.00
7KK1103-7FC11 .... $11,550.00
7KK1103-
7XY11-8YY2 ..... $21,865.00
7KK1103-
7XY11-8YY3 ..... $64,120.00
7KK1103-8AA $1,705.00
7KK1103-8AB $475.00
7KK1103-8BA $2,716.00
7KK1197-4CM10 ..... $313.00
7KK1197-4CP10 ..... $625.00
7KK1197-4HK10 ..... $5,625.00
7KK1197-4HV10 ..... $1,875.00
7KK1197-4HV20 ..... $3,125.00
7KK1197-4SC11 ..... $4,065.00
7KK1197-4SM10 ..... $125.00
7KK1197-4SP10 ..... $250.00
7KK1197-6AW11 .... $9,465.00
7KK1197-6AW21 ..... $960.00
7KK1197-6AW41 .... $2,845.00
7KK1197-6CW11 ... $10,420.00
7KK1197-6CW21 .... $1,045.00
7KK1197-6CW41 ..... $3,135.00
7KK1197-6GW11 .... $6,080.00
7KK1197-6GW21 ..... $620.00
7KK1197-6GW41 .... $1,830.00
7KK1197-6HW11 .... $13,175.00
7KK1197-6HW21 .... $1,325.00
7KK1197-6HW41 .... $3,955.00
7KK1197-6KW11 .... $10,010.00
7KK1197-6KW21 ..... $1,010.00
7KK1197-6LW11 .... $12,190.00
7KK1197-6LW21 ..... $1,220.00
7KK1197-6NW11 .... $4,630.00
7KK1197-6NW21 ..... $470.00
7KK1197-6PW11 .... $4,405.00
7KK1197-6PW21 ..... $445.00
7KK1197-6QW11 .... $8,120.00
7KK1197-6QW21 ..... $835.00
7KK1197-6SW11 .... $6,960.00
7KK1197-6SW21 ..... $695.00
7KK1197-6TW11 ..... $8,120.00
7KK1197-6TW21 ..... $835.00
7KK1197-6UW11 .... $5,010.00
7KK1197-6UW21 ..... $505.00
7KK1197-6VW11 ... $10,685.00
7KK1197-6VW21 .... $1,085.00
7KK1197-6WA11 .... $5,755.00
7KK1197-6WA21 ..... $600.00
7KK1197-6WB11 .... $5,090.00
7KK1197-6WB21 ..... $520.00
7KK1197-6WE11 .... $3,745.00
7KK1197-6WE21 ..... $395.00
7KK1197-6WE41 ..... $1,135.00
7KK1197-6WF11 ..... $4,074.00
7KK1197-6WH11 .... $3,525.00
7KK1197-6WH21 ..... $370.00
7KK1197-6WK11 ..... $8,120.00
7KK1197-6WK21 ..... $835.00
7KK1197-6WK41 .... $2,460.00
7KK1197-6WL11 ..... $6,775.00
7KK1197-6WL21 ..... $695.00
7KK1197-7AW11 ... $13,525.00
7KK1197-7AW21 .... $1,375.00
7KK1197-7AW41 .... $4,065.00
7KK1197-7CW11 ... $15,350.00
7KK1197-7CW21 .... $1,550.00
7KK1197-7CW41 .... $4,625.00
7KK1197-7GW11 .... $8,120.00
7KK1197-7GW21 ..... $835.00
7KK1197-7GW41 .... $2,460.00
7KK1197-7HW11 ... $16,895.00
7KK1197-7HW21 .... $1,705.00
7KK1197-7HW41 .... $5,090.00
7KK1197-7KW11 ... $14,380.00
7KK1197-7KW21 .... $1,440.00
7KK1197-7LW11 .... $15,630.00
7KK1197-7LW21 ..... $1,570.00
7KK1197-7NW11 .... $5,510.00
7KK1197-7NW21 ..... $560.00
7KK1197-7PW11 .... $5,425.00
7KK1197-7PW21 ..... $560.00
7KK1197-7QW11 .... $9,465.00
7KK1197-7QW21 ..... $960.00
7KK1197-7SW11 .... $14,195.00
7KK1197-7SW21 .... $1,440.00
7KK1197-7TW11 .... $9,465.00
7KK1197-7TW21 ..... $960.00
7KK1197-7UW11 .... $5,950.00
7KK1197-7UW21 ..... $610.00
7KK1197-7VW11 ... $12,850.00
7KK1197-7VW21 .... $1,300.00
7KK1197-7WA11 .... $6,775.00
7KK1197-7WA21 ..... $695.00
7KK1197-7WB11 ..... $6,105.00
7KK1197-7WB21 ..... $630.00
7KK1197-7WH11 .... $6,775.00
7KK1197-7WH21 ..... $695.00
7KK1197-7WK11 .... $10,140.00
7KK1197-7WK21 .... $1,025.00
7KK1197-7WK41 .... $3,050.00
7KK1197-7WL11 ..... $8,120.00
7KK1197-7WL21 ..... $835.00
7KK1197-8AA11 ..... $6,290.00

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7KK1197-8AA21 . . . . . $650.00
7KK1197-8AA41 . . . . . $1,905.00
7KK1197-8AB11 . . . . . $6,290.00
7KK1197-8AB21 . . . . . $650.00
7KK1197-8AE11 . . . . . $6,290.00
7KK1197-8AE21 . . . . . $650.00
7KK1197-8AF11 . . . . . $6,290.00
7KK1197-8AF21 . . . . . $650.00
7KK1197-8AH11 . . . . . $6,290.00
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7KK1197-8VJ11 . . . . . $33,110.00
7KK1197-8XA11 . . . . . $4,735.00
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7KK1297-5AD11 .... $13,085.00
7KK1297-5AM11 .... $2,055.00
7KK1297-5BB11 ..... $1,540.00
7KK1297-5BC11 ..... $6,735.00
7KK1297-5BX11 ..... $685.00
7KK1297-5CA01 .... $4,605.00
7KK1297-5CA11 ..... $8,455.00
7KK1297-5MM11 ..... $360.00
7KK1297-5SC11 ..... $360.00
7KK1297-6AW11 .... $5,950.00
7KK1297-6AW21 ..... $610.00
7KK1297-6AW41 .... $1,790.00
7KK1297-6BW11 .... $5,950.00
7KK1297-6BW21 ..... $610.00
7KK1297-6BW41 .... $1,790.00
7KK1297-6CW11 .... $5,950.00
7KK1297-6CW41 .... $1,790.00
7KK1297-6DL11 ..... $5,285.00
7KK1297-6DW11 .... $5,950.00
7KK1297-6DW41 .... $1,790.00
7KK1297-6EW11 .... $5,950.00
7KK1297-6EW41 .... $1,790.00
7KK1297-6FW11 .... $5,950.00
7KK1297-6FW21 ..... $610.00
7KK1297-6FW41 .... $1,790.00
7KK1297-6GW11 .... $5,950.00
7KK1297-6GW51 .... $2,645.00
7KK1297-6HW11 .... $5,950.00
7KK1297-6HW51 .... $2,645.00
7KK1297-6JW11 ..... $5,285.00
7KK1297-6JW41 ..... $2,120.00
7KK1297-6KW11 .... $6,610.00
7KK1297-6KW41 .... $1,995.00
7KK1297-6KW51 .... $2,645.00
7KK1297-6LW11 .... $6,545.00
7KK1297-6QW11 .... $5,950.00
7KK1297-6WA11 .... $5,285.00
7KK1297-6WA41 .... $1,590.00
7KK1297-6WC11 .... $5,285.00
7KK1297-6WC41 .... $1,590.00
7KK1297-6WD11 .... $5,285.00
7KK1297-6WD41 .... $1,510.00
7KK1297-6WG11 .... $3,965.00
7KK1297-6WG41 .... $1,200.00
7KK1297-6WH11 .... $3,515.00
7KK1297-6WH41 .... $1,065.00
7KK1297-6WJ11 ..... $3,515.00
7KK1297-6WJ41 ..... $1,065.00
7KK1297-6WM11 .... $6,610.00
7KK1297-6WN11 .... $6,610.00
7KK1297-6WW11 ... $3,955.00
7KK1297-6WW41 .... $1,190.00
7KK1297-6ZA11 .... $28,380.00
7KK1297-6ZB11 .... $23,650.00
7KK1297-6ZC11 .... $22,530.00
7KK1297-6ZE11 ..... $5,670.00
7KK1297-6ZF11 ..... $5,670.00
7KK1297-6ZM11 ... $28,380.00
7KK1297-6ZN11 .... $28,380.00
7KK1297-6ZP11 .... $27,030.00
7KK1297-6ZQ11 .... $27,030.00
7KK1297-6ZR11 .... $27,030.00
7KK1297-7AW11 .... $9,250.00
7KK1297-7AW21 ..... $940.00
7KK1297-7AW41 .... $2,785.00
7KK1297-7BW11 ... $14,330.00
7KK1297-7BW21 .... $1,450.00
7KK1297-7BW41 .... $4,305.00
7KK1297-7CW11 .... $17,100.00
7KK1297-7CW41 .... $5,150.00
7KK1297-7DW11 ... $12,365.00
7KK1297-7DW41 .... $3,725.00
7KK1297-7EW11 .... $20,155.00
7KK1297-7EW41 .... $6,055.00

Prices and Specifications Subject to Change. All prices, specifications and characteristics set forth in this catalog are subject to change without notice. Prices current at the time an order is accepted by Tektronix will apply. Check with your local Tektronix representative for current price and specification information. If CFQ is listed in place of a price, please call your local Tektronix Sales Office for a quote.

7KK1297-7FW11 . . . $15,200.00
7KK1297-7FW21 . . . . $1,530.00
7KK1297-7FW41 . . . . $4,570.00
7KK1297-7GW11 . . . $20,155.00
7KK1297-7GW51 . . . . $6,055.00
7KK1297-7HW11 . . . $20,155.00
7KK1297-7HW51 . . . . $6,055.00
7KK1297-7JW11 . . . . $11,630.00
7KK1297-7JW21 . . . . . $1,200.00
7KK1297-7JW41 . . . . . $3,705.00
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7KK1297-7MW11 . . . $20,280.00
7KK1297-7MW41 . . . . $3,390.00
7KK1297-7NV11 . . . . $6,450.00
7KK1297-7NW11 . . . $40,540.00
7KK1297-7NW41 . . . . $6,775.00
7KK1297-7PW11 . . . $20,280.00
7KK1297-7PW41 . . . . $3,390.00
7KK1297-7QW11 . . . $20,155.00
7KK1297-7QW41 . . . . $6,055.00
7KK1297-7RW11 . . . $16,895.00
7KK1297-7RW41 . . . . $3,390.00
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7KK1297-7VW11 . . . $37,510.00
7KK1297-7WA11 . . . . $9,250.00
7KK1297-7WA41 . . . . $2,785.00
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7KK1297-7WB41 . . . . $1,995.00
7KK1297-7WC11 . . . . $9,250.00
7KK1297-7WC41 . . . . $2,785.00
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7KK1297-8AB41 . . . . . $1,690.00
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7KK1297-8AC41 . . . . . $1,690.00
7KK1297-8AD11 . . . . . $4,735.00
7KK1297-8AD41 . . . . . $1,425.00
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7KK1297-8AK11 . . . . . $6,485.00
7KK1297-8AK41 . . . . . $1,955.00
7KK1297-8AL11 . . . . . $6,485.00
7KK1297-8AL41 . . . . . $1,955.00
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7KK1297-8AM41 . . . . $1,955.00
7KK1297-8AP11 . . . . . $6,110.00
7KK1297-8AQ11 . . . . $6,485.00
7KK1297-8AR11 . . . . . $9,660.00
7KK1297-8AR41 . . . . . $6,450.00
7KK1297-8DA11 . . . $27,035.00
7KK1297-8DB11 . . . . $6,485.00
7KK1297-8DB21 . . . . . $660.00
7KK1297-8DB41 . . . . . $1,955.00
7KK1297-8DC11 . . . . $2,520.00
7KK1297-8DD11 . . . . $5,285.00
7KK1297-8DE11 . . . . $12,155.00
7KK1297-8DJ11 . . . . . $6,080.00
7KK1297-8DJ41 . . . . . $1,830.00
7KK1297-8DP11 . . . . $10,140.00
7KK1297-8DR11 . . . . $18,630.00
7KK1297-8DT11 . . . . $23,650.00
7KK1297-8DT41 . . . . . $7,100.00
7KK1297-8DU11 . . . $15,630.00
7KK1297-
8GB11-8YY1 . . . . . $8,240.00
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7KK1297-8JB21 . . . . . $940.00
7KK1297-8JB41 . . . . . $2,645.00
7KK1297-8JC11 . . . . $10,570.00
7KK1297-8JC21 . . . . . $940.00
7KK1297-8JC41 . . . . . $2,645.00
7KK1297-8JD11 . . . . $10,570.00
7KK1297-8JD21 . . . . . $1,065.00
7KK1297-8JD41 . . . . . $2,645.00
7KK1297-8JE11 . . . . $17,840.00
7KK1297-8JE21 . . . . . $1,730.00
7KK1297-8JE41 . . . . . $4,105.00
7KK1297-8JE51 . . . . . $5,285.00
7KK1297-8JF11 . . . . $17,840.00
7KK1297-8JF21 . . . . . $1,730.00
7KK1297-8JF41 . . . . . $4,105.00
7KK1297-8JF51 . . . . . $4,635.00
7KK1297-8JG11 . . . . $12,030.00
7KK1297-8JG21 . . . . . $1,200.00
7KK1297-8JG41 . . . . . $1,730.00
7KK1297-8JG51 . . . . . $1,995.00
7KK1297-8PA11 . . . . $23,650.00
7KK1297-8PA21 . . . . . $2,370.00
7KK1297-8PA41 . . . . . $7,100.00
7KK1297-8PC11 . . . . $13,475.00
7KK1297-8PC21 . . . . . $1,365.00
7KK1297-8PC41 . . . . . $4,025.00
7KK1297-8PD11 . . . . $11,235.00
7KK1297-8PD41 . . . . . $3,375.00
7KK1297-8PE11 . . . . $30,380.00
7KK1297-8PE21 . . . . . $3,050.00
7KK1297-8PE41 . . . . . $9,125.00
7KK1297-8PF11 . . . . $40,560.00
7KK1297-8PF21 . . . . . $4,065.00
7KK1297-8PF41 . . . . $12,180.00
7KK1297-8PG11 . . . . $20,155.00
7KK1297-8PH11 . . . . $16,785.00
7KK1297-8QA11 . . . $12,820.00
7KK1297-8QB11 . . . . $12,820.00
7KK1297-8QC11 . . . . $9,250.00
7KK1297-8QC21 . . . . . $940.00
7KK1297-8QD11 . . . . $9,250.00
7KK1297-8TA11 . . . . $14,755.00
7KK1297-8TB11 . . . . . $7,510.00
7KK1297-8TC11 . . . . $22,305.00
7KK1297-8TD11 . . . . $22,305.00
7KK1297-8TE11 . . . . $25,690.00
7KK1297-8TF11 . . . . $13,525.00
7KK1297-8TG11 . . . . $10,140.00
7KK1297-8TH11 . . . . $16,770.00
7KK1297-8TJ11 . . . . $23,650.00
7KK1297-8TK11 . . . . $16,895.00
7KK1297-8TL11 . . . . . $6,260.00
7KK1297-8TM11 . . . $16,895.00
7KK1297-8TN11 . . . . $10,140.00
7KK1297-8UA11 . . . . $11,235.00
7KK1297-8UA41 . . . . . $3,375.00
7KK1297-8UB11 . . . . $11,235.00
7KK1297-8UB41 . . . . . $3,375.00
7KK1297-8UC11 . . . . $12,560.00
7KK1297-8UC41 . . . . . $3,775.00
7KK1297-8UC51 . . . . $5,650.00
7KK1297-8UD11 . . . $12,560.00
7KK1297-8UD41 . . . . $3,775.00
7KK1297-8UD51 . . . . $5,650.00
7KK1297-8UE11 . . . . $13,210.00
7KK1297-8UE41 . . . . . $3,965.00
7KK1297-8UF11 . . . . $13,210.00
7KK1297-8UF41 . . . . . $3,965.00
7KK1297-8UG11 . . . . $6,220.00
7KK1297-8UG41 . . . . $1,855.00
7KK1297-8UH11 . . . . $9,250.00
7KK1297-8UJ11 . . . . $11,235.00
7KK1297-8UJ41 . . . . . $3,375.00
7KK1297-8UK11 . . . . $10,570.00
7KK1297-8UK51 . . . . . $4,760.00
7KK1297-8UL11 . . . . $10,570.00
7KK1297-8UM11 . . . . $7,275.00
7KK1297-8UM41 . . . . $2,195.00
7KK1297-8UN11 . . . . $7,275.00
7KK1297-8UN41 . . . . . $2,195.00
7KK1297-8UP11 . . . . $13,875.00
7KK1297-8UP41 . . . . . $4,170.00
7KK1297-8UQ11 . . . $13,875.00
7KK1297-8UQ41 . . . . . $4,170.00
7KK1297-8UR11 . . . . $15,850.00
7KK1297-8US11 . . . . $15,850.00
7KK1297-8UT11 . . . . $23,450.00
7KK1297-8UT21 . . . . . $2,360.00
7KK1297-8UU11 . . . $33,950.00
7KK1297-8UV11 . . . . $27,675.00
7KK1297-8UW11 . . . $15,530.00
7KK1297-8UW51 . . . . $7,015.00
7KK1297-8UX51 . . . . . $7,015.00
7KK1297-8UY11 . . . . $10,045.00
7KK1297-8VA11 . . . . $13,875.00
7KK1297-8VB11 . . . . . $8,455.00
7KK1297-8VC11 . . . . . $8,455.00
7KK1297-8VD11 . . . . . $9,590.00
7KK1297-8VE11 . . . . . $7,800.00
7KK1297-8VE51 . . . . . $3,515.00
7KK1297-8VF11 . . . . $17,050.00
7KK1297-8VG11 . . . . $21,800.00
7KK1297-8XA11 . . . . $22,130.00
7KK1297-8XA51 . . . . . $6,950.00
7KK1297-8XB11 . . . . $15,200.00
7KK1297-8XB51 . . . . . $7,925.00
7KK1297-8XC11 . . . . . $7,275.00
7KK1297-8ZA11 . . . . $62,900.00
7KK1298-0AT01 . . . $126,050.00
7KK1298-0HC11 . . $130,260.00
7KK1298-0HS11 . . . $130,260.00
7KK1298-0JU01 . . . . $28,130.00
7KK1298-0PA11 . . . . $62,900.00
7KK1298-0PA41 . . . . $12,580.00
7KK1298-4AB11 . . . . $18,925.00
7KK1298-
4AB11-8YY1 . . . . . $515,655.00
7KK1298-4AJ11 . . . $121,575.00
7KK1298-
4AJ11-8YY1 . . . . . $688,780.00
7KK1298-
4AJ11-8YY2 . . . . . $11,825.00
7KK1298-5FA01 . . . . . $3,260.00
7KK1298-5NB11 . . . . $3,390.00
7KK1298-8BA11 . . . . $8,455.00
7KK1298-8DA11 . . . $49,635.00
7KK1298-8YY02 . . . . $19,100.00
7KK1298-8YY11 . . . . $35,125.00
7KK1400-5CA11 . . . . . $80.00
7KK1400-5CB11 . . . . . $270.00
7KK1400-5DA10 . . . . . $80.00
7KK1400-5PA11 . . . . . $185.00
7KK1400-5PB11 . . . . . $205.00
7KK1403-
0AA02-1B $36,495.00
7KK1403-
0AA02-2B $36,495.00
7KK1403-
0AC12-1B $61,760.00
7KK1403-
0AC22-2B $69,780.00
7KK1403-
0AC32-1B $80,860.00
7KK1403-
0AC32-2B $80,860.00
7KK1403-
0BA02-1B $36,495.00
7KK1403-
0BA02-2B $36,495.00
7KK1403-
0BA12-1B. $47,525.00
7KK1403-
0BA22-1B $55,525.00
7KK1403-
0BA22-2B $55,525.00
7KK1403-
0BA32-1B. $66,615.00
7KK1403-
0BA32-2B. $66,615.00

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7KK1403-
0BC02-1B $50,745.00
7KK1403-
0BC02-2B $50,745.00
7KK1403-
0BC12-1B $61,760.00
7KK1403-
0BC12-2B $58,830.00
7KK1403-
0BC22-1B $69,780.00
7KK1403-
0BC22-2B $69,780.00
7KK1403-
0BC32-1B $80,860.00
7KK1403-
0BC32-2B $80,860.00
7KK1403-2AA40 ... $14,650.00
7KK1403-2AB00 .... $11,425.00
7KK1403-2AC10 .... $11,565.00
7KK1403-2AE00 ... $20,095.00
7KK1403-6AB11 .... $5,390.00
7KK1403-6AB21 ..... $345.00
7KK1403-6AD10 .... $14,710.00
7KK1403-6AD11 .... $14,710.00
7KK1403-6AD20 .... $10,180.00
7KK1403-6AD21 .... $10,180.00
7KK1403-6AE00 .... $6,055.00
7KK1403-6AF00 .... $6,055.00
7KK1403-6BA10 .... $7,955.00
7KK1403-6BA11 .... $7,955.00
7KK1403-6BA40 .... $1,855.00
7KK1403-6BA41 ..... $1,855.00
7KK1403-8AA04 .... $4,080.00
7KK1403-8AA05 .... $5,855.00
7KK1403-8AB01 .... $5,650.00
7KK1403-8AB02 .... $4,345.00
7KK1403-8AD $6,775.00
7KK1403-8AE $2,445.00
7KK1403-8AF $5,390.00
7KK1403-8AG $4,530.00
7KK1403-8BA00 ..... $345.00
7KK1403-8BA01 ..... $345.00
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7KK1404-
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7KK1404-6AA10 ..... $6,115.00
7KK1404-6AA11 ..... $6,115.00
7KK1404-6AA40 .... $2,040.00
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7KK1404-6AC10 .... $12,610.00
7KK1404-6AC11 .... $12,610.00
7KK1404-6BA11 .... $5,325.00
7KK1404-6BB11 ..... $5,325.00
7KK1404-6BB41 ..... $345.00
7KK1404-8AA01 .... $5,650.00
7KK1404-8AA02 .... $4,345.00
7KK1404-8AA04 .... $4,080.00
7KK1404-8AA05 .... $5,855.00
7KK1404-8AB $2,180.00
7KK1404-8AC $2,445.00
7KK1404-8BA00 ..... $310.00
7KK1404-8BA01 ..... $310.00
7KK1405-8AA $31,375.00
7KK1405-8AB $31,375.00
7KK1405-8BA01 ..... $270.00
7KK3000-1CA00 .... $2,040.00
7KK3000-1CB00 .... $2,470.00
7KK3000-1CC00 .... $2,470.00
7KK3000-1CC10 .... $2,470.00
7KK3000-1CD00 .... $2,470.00
7KK3000-1DA00 .... $2,040.00
7KK3000-1DB00 .... $2,470.00
7KK3000-1DD00 .... $2,470.00
7KK3000-1EA00 .... $2,040.00
7KK3000-1EB00 .... $2,470.00
7KK3000-1EB10 ..... $2,470.00
7KK3000-1ED00 .... $2,470.00
7KK3000-1GB00 .... $2,470.00
7KK3000-1JB10 ..... $2,470.00
7KK3000-1KF00 .... $2,970.00
7KK3000-1LF00 ..... $2,970.00
7KK3000-4AA00 .... $1,000.00
7KK3000-6KA10 ..... $470.00
7KK3000-6KA30 ..... $130.00
7KK3000-6KA31 ..... $140.00
7KK3000-6KA40 ..... $180.00
7KK3000-6KB10 ..... $600.00
7KK3000-6WB10 .... $1,000.00
7KK3000-6WB30 .... $1,850.00
7KK3000-6WC10 ..... $540.00
7KK3000-6WD10 .... $1,250.00
7KK3000-8AA01 ..... $2,160.00
7KK4304-5AC $3,440.00
7KK4305-5AC $5,620.00
7KK4315-5AB $7,830.00
7KK4315-5AC $7,220.00
7KK4900-5AD $250.00
7KK4900-5AE $60.00
7KK4900-5AG $90.00
7KK4900-5AJ $110.00
7KK4900-5AK $100.00
7KK4900-5AO $100.00
7KK4900-5BC $110.00
7KK4900-5CB $1,440.00
7KK5302-1SA01 .... $4,835.00
7KK5302-1SB01 .... $4,835.00
7KK5302-1SC01 .... $4,835.00
7KK5302-2RA01 .... $3,805.00
7KK5302-2RA03 .... $3,805.00
7KK5302-2RA05 .... $3,805.00
7KK5302-2RB01 .... $3,805.00
7KK5302-5AA01 ..... $570.00
7KK5302-5AB01 ..... $600.00
7KK5302-5AC01 ..... $695.00
7KK5302-5BA01 ..... $570.00
7KK5302-5BB01 ..... $600.00
7KK5302-5BC01 ..... $695.00
7KK5302-5DA01 ..... $220.00
7KK5302-8AA $0.00
7KK5302-8BA11 .... $1,995.00
7KM366-BS $24,570.00
7KM366-BS-SW-R50 ... $7,540.00
7KM366-BS-SW-U50 ... $1,855.00
7KM366-BS-SW-U60 ... $1,630.00
7KM366-CONTRL ... $2,120.00
7KM366-
CPU-CONTRL $2,785.00
7KM366-DCR $940.00
7KM366-DSP $4,895.00
7KM366-FP $70.00
7KM366-GPS $2,645.00
7KM366-MI-RT-R41 ... $1,325.00
7KM366-MR-900 .... $6,345.00
7KM366-MR-SAG ... $5,690.00
7KM366-MS-900 ... $25,505.00
7KM366-
MS-SW-R50 ..... $15,065.00
7KM366-
MS-SW-U50 ..... $5,690.00
7KM366-
MS-SW-U60 ..... $4,880.00
7KM366-MT $4,105.00
7KM366-PC $9,385.00
7KM366-
PP-CSW-R50 ..... $5,950.00
7KM366-
PP-SSW-R50 ..... $20,220.00
7KM366-
PP-SW-R50 ..... $26,290.00
7KM366-PP-SW-U50 .. $4,500.00
7KM366-
SERVICE-UNIT $670.00
7KM366-TRAINING .. $2,040.00
7KM366-VGPS $2,645.00
7KM366-VMR $2,520.00
7KM366-VMS $21,275.00
7KM366-
VMS-SW-R50 ..... $21,010.00
7KM366-VOT35-D ... $2,645.00
7KM366-VOT35-D-A ... $270.00
7KM366-VOT35-G ... $2,645.00
7KM366-VOT35-G-A ... $270.00
7KM366-VOT35-M-A ... $270.00
7KM366-VOT35-P ... $2,645.00
7KM366-VOT35-P-A ... $270.00
7KM366-VOT75-M ... $3,775.00
7KM366-VOT75-M-A ... $250.00
7KM366S-
ACDC-NC $1,325.00
7KM366S-AK-NC $405.00
7KM366S-ALI-1 ..... $2,380.00
7KM366S-
ANT-DCS-NC $155.00
7KM366S-
ANT-GPS-NC $270.00
7KM366S-
ANT-GSM-NC $155.00
7KM366S-BBU-RV ... $2,120.00
7KM366S-BS-1 ..... $9,780.00
7KM366S-CK-AL-RV ... $145.00
7KM366S-CK-PC $205.00
7KM366S-J2 ..... $115.00
7KM366S-MPC $2,645.00
7KM366S-MS-1 ..... $9,780.00
7KM366S-MS-1-VXI ... $9,780.00
7KM366S-OT-XX-X-A ... $390.00
7KM366S-OTXX-X-AS ... $405.00
7KM403-DMU-HW ... $11,890.00
7KM403-SW-R21 ... $24,975.00
7KM403-SW-R21A ... $13,970.00
7KM403-SW-R21B ... $20,510.00
7KM403-TDMU $7,540.00
7KM403-TRAINING ... $640.00
7KM410-ACCESS $270.00
7KM410-ACDC $2,380.00
7KM410-BASE $11,580.00
7KM410-BRAN-12 ... $4,230.00
7KM410-BRAN-T $2,380.00
7KM410-CABINET ... $3,965.00
7KM410-CONTRL $2,120.00
7KM410-
CPU-CONTRL $2,785.00
7KM410-FP $0.00
7KM410-KIT $1,325.00
7KM410-LPC $4,635.00
7KM410-OT35-D $2,645.00

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7KM410-OT35-G $2,645.00
7KM410-OT35-P $2,645.00
7KM410-OT75-M $3,775.00
7KM410-OTXX-X-A $390.00
7KM410-OTXX-X-UPG. . . $390.00
7KM410-PC $9,385.00
7KM410-RACK-19 . . . $5,025.00
7KM410-SH888-DB. . . $1,465.00
7KM410-SIM $3,900.00
7KM410-SPLITTER-2. . . . . $1,200.00
7KM410-SPLITTER-4. . . . . $1,465.00
7KM410-SW-B-B-R10 . . . . . $6,870.00
7KM410-SW-S-B-R10 . . . . . $13,740.00
7KM410-SW-SIM-B-R10 . . . . . $11,310.00
7KM410-SW-V-12-R10 . . . . . $1,855.00
7KM410-SW-V-24-R10 . . . . . $1,465.00
7KM410-SW-V-B-8-R10 . . . . . $15,065.00
7KM410-SW-V-B-M-R10. . . . . $5,950.00
7KM410-SW-V-B-R10. . . . . $29,995.00
7KM410-SW-V-M-R10. . . . . $535.00
7KM410-TRANS-6 . . . . . $15,065.00
7KM410S-ACDC-MOD $1,200.00
7KM410S-ANT-DB. $270.00
7KM410S-HDSET $270.00
7KM410S-LAN-KIT $270.00
7KM410S-OTXX-X-AS $390.00
7KM410S-RACK-FAN. $1,325.00
7KM410S-RACK-PWS $2,520.00
7KM410S-TRANS-ACDC. $1,325.00
7KM410S-TRANS-PWS $2,380.00
9617A3 . . . . . $2,660.00
9617F3. . . . . $2,895.00
9617K3 . . . . . $2,100.00
9617R3. . . . . $3,500.00
9617S3 . . . . . $3,100.00
A01019 . . . . . $270.00
A01224 . . . . . $150.00
A01241 . . . . . $65.00
A01242 . . . . . $150.00
A01247 . . . . . $85.00
A01274 . . . . . $40.00
A01413 . . . . . $25.00
A01434 . . . . . $110.00
A02433. . . . . $300.00
A02452. . . . . $300.00
A02455. . . . . $330.00
A02459. . . . . $330.00
A02463. . . . . $145.00
A02464. . . . . $150.00
A02467. . . . . $330.00
A02468. . . . . $350.00
A02642. . . . . $106.00
A02706. . . . . $290.00
A02708. . . . . $330.00
A02710 . . . . . $305.00
A02712 . . . . . $415.00
A02714 . . . . . $375.00
A02716 . . . . . $120.00
A02718 . . . . . $140.00
A02804. . . . . $220.00
A02806. . . . . $165.00
A02807. . . . . $150.00
A08012 . . . . . $330.00
A08013 . . . . . $440.00
A08017 . . . . . $20.00
A08018 . . . . . $110.00
A08019 . . . . . $20.00
A08020. . . . . $440.00
A08021 . . . . . $165.00
A08024 . . . . . $715.00
A08025. . . . . $400.00
A08028. . . . . $400.00
A08029. . . . . $400.00
A08032. . . . . $470.00
A08035. . . . . $65.00
A08081 . . . . . $250.00
A08082. . . . . $300.00
A08083. . . . . $300.00
A08084. . . . . $300.00
A08087. . . . . $300.00
A08090. . . . . $440.00
A08095. . . . . $400.00
A08096. . . . . $440.00
A08161 . . . . . $105.00
A08163 . . . . . $130.00
A08338. . . . . $100.00
A09505. . . . . $550.00
A09506 . . . . . $1,400.00
A09507. . . . . $140.00
A09508. . . . . $170.00
A1001 . . . . . $189.00
A1002. . . . . $325.00
A1003. . . . . $325.00
A1004. . . . . $325.00
A1005. . . . . $335.00
A1007. . . . . $489.00
A1009. . . . . $479.00
A1010 . . . . . $690.00
A1023. . . . . $455.00
A1024. . . . . $455.00
A605. . . . . $105.00
A621 . . . . . $450.00
A621 C3 . . . . . $155.00
A621 D1. . . . . $75.00
A621 R3 . . . . . $80.00
A622 . . . . . $470.00
A622 C3 . . . . . $155.00
A622 D1. . . . . $75.00
A622 R3 . . . . . $90.00
A6302 . . . . . $959.00
A6302 C3 . . . . . $185.00
A6302 D1 . . . . . $80.00
A6302 D3 . . . . . $145.00
A6302 R3. . . . . $145.00
A6302XL. $1,495.00
A6302XLC3. . . . . $200.00
A6302XLC5. . . . . $400.00
A6302XLD1 . . . . . $80.00
A6302XLD3. . . . . $155.00
A6302XLD5 . . . . . $305.00
A6302XLR3. . . . . $165.00
A6302XLR5. . . . . $325.00
A6303. . . . . $1,950.00
A6303 C3 . . . . . $200.00
A6303 C5 . . . . . $400.00
A6303 D1 . . . . . $80.00
A6303 D3 . . . . . $155.00
A6303 D5 . . . . . $305.00
A6303 R3. . . . . $190.00
A6303 R5 . . . . . $380.00
A6303XL. $2,395.00
A6303XLC3. . . . . $240.00
A6303XLC5. . . . . $475.00
A6303XLD1 . . . . . $85.00
A6303XLD3. . . . . $165.00
A6303XLD5 . . . . . $325.00
A6303XLR3. . . . . $210.00
A6303XLR5. . . . . $420.00
A6304XL. $2,495.00
A6304XLC3. . . . . $240.00
A6304XLC5. . . . . $475.00
A6304XLD1 . . . . . $85.00
A6304XLD3. . . . . $165.00
A6304XLD5 . . . . . $325.00
A6304XLR3. . . . . $210.00
A6304XLR5. . . . . $420.00
A6312 . . . . . $1,095.00
A6312 C3. . . . . $200.00
A6312 C5. . . . . $400.00
A6312 D1 . . . . . $80.00
A6312 D3. . . . . $155.00
A6312 D5 . . . . . $305.00
A6312 R3. . . . . $155.00
A6312 R5. . . . . $305.00
A6907. . . . . $9,995.00
A6907 A1 . . . . . $0.00
A6907 A2 . . . . . $0.00
A6907 A3 . . . . . $0.00
A6907 A5 . . . . . $0.00
A6907 C3 . . . . . $545.00
A6907 C5 . . . . . $1,085.00
A6907 D1 . . . . . $125.00
A6907 D3 . . . . . $240.00
A6907 D5 . . . . . $475.00
A6907 R3. . . . . $470.00
A6909 . . . . . $5,595.00
A6909 10 . . . . . $310.00
A6909 A1 . . . . . $0.00
A6909 A2 . . . . . $0.00
A6909 A3 . . . . . $0.00
A6909 A5 . . . . . $0.00
A6909 C3 . . . . . $905.00
A6909 C5 . . . . . $1,805.00
A6909 D1 . . . . . $100.00
A6909 D3 . . . . . $325.00
A6909 D5 . . . . . $650.00
A6909 R3. . . . . $190.00
AC11. . . . . $35.00
AC12. . . . . $39.00
AC13. . . . . $30.00
AC220 . . . . . $69.00
AC3000. . . . . $160.00
ACL21 . . . . . $15.00
ACL22 . . . . . $24.00
ACL23 . . . . . $23.00
ACL24 . . . . . $28.00
AD007. . . . . $995.00
AD007 A0 . . . . . $0.00
AD007 A1 . . . . . $0.00
AD007 A2 . . . . . $0.00
AD007 A3 . . . . . $0.00
AD007 A5 . . . . . $0.00
AD007 A6 . . . . . $0.00
ADA400A $1,095.00
ADA400AC3 . . . . . $420.00
ADA400AC5 . . . . . $840.00
ADA400AD1 . . . . . $75.00
ADA400AD3 . . . . . $200.00
ADA400AD5 . . . . . $400.00
ADA400AR5 . . . . . $145.00
ADS-B1 . . . . . $1,705.00
ADSRS $20,950.00
ADSRS 01 . . . . . $1,500.00
ADSRS C3. . . . . $1,220.00
ADSRS C5. . . . . $2,435.00
ADSRS D1 . . . . . $295.00
ADSRS D3 . . . . . $400.00
ADSRS D5 . . . . . $800.00
ADSRS R3 . . . . . $705.00
ADSRS R5 . . . . . $1,410.00
ADSRSZ2 . . . . . $865.00
AFG310 . . . . . $1,895.00
AFG310 A1 . . . . . $0.00
AFG310 A2 . . . . . $0.00
AFG310 A3 . . . . . $0.00
AFG310 A4 . . . . . $0.00
AFG310 A5 . . . . . $0.00
AFG310 D1 . . . . . $150.00
AFG320 . . . . . $2,695.00
AFG320 A1. . . . . $0.00
AFG320 A2. . . . . $0.00
AFG320 A3. . . . . $0.00
AFG320 A4. . . . . $0.00
AFG320 A5. . . . . $0.00
AFG320 D1. . . . . $150.00
AFTDS. $525.00
AFTDS C3 . . . . . $115.00
AFTDS D1 . . . . . $75.00
AFTDS D3 . . . . . $185.00
AFTDS R3 . . . . . $190.00
AGL1 . . . . . $1,695.00
AGL1 C3. . . . . $380.00
AGL1 C5. . . . . $760.00
AGL1 D1. . . . . $155.00
AGL1 D3. . . . . $190.00
AGL1 D5 . . . . . $380.00
AGL1 R3 . . . . . $175.00
AGL1 R5. . . . . $345.00
AM5030 . . . . . $2,595.00
AM5030 C3 . . . . . $260.00
AM5030 C5. . . . . $515.00
AM5030 D1 . . . . . $85.00

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AM5030 D3 ..... $165.00
AM5030 D5 ..... $325.00
AM5030 R3 ..... $200.00
AM5030 R5 ..... $400.00
AM5030S $4,795.00
AM5030S02 ..... $415.00
AM5030SA1 ..... $0.00
AM5030SA2 ..... $0.00
AM5030SA3 ..... $0.00
AM5030SA5 ..... $0.00
AM5030SC3 ..... $355.00
AM5030SC5 ..... $705.00
AM5030SD1 ..... $100.00
AM5030SD3 ..... $190.00
AM5030SD5 ..... $380.00
AM5030SR3 ..... $285.00
AM5030SR5 ..... $570.00
AM503B $1,995.00
AM503B C3 ..... $240.00
AM503B C5 ..... $475.00
AM503B D1 ..... $85.00
AM503B D3 ..... $165.00
AM503B D5 ..... $325.00
AM503B R3 ..... $190.00
AM503B R5 ..... $380.00
AM503S $3,550.00
AM503S 01 ..... $1,595.00
AM503S 03 ..... $820.00
AM503S 05 ..... $155.00
AM503S 52 ..... $0.00
AM503S A1 ..... $0.00
AM503S A2 ..... $0.00
AM503S A3 ..... $0.00
AM503S A5 ..... $0.00
AM503S C3 ..... $295.00
AM503S C5 ..... $590.00
AM503S D1 ..... $90.00
AM503S D3 ..... $175.00
AM503S D5 ..... $345.00
AM503S R3 ..... $240.00
AM503S R5 ..... $475.00
AM524 ..... $43,350.00
AM524 D1 ..... $155.00
AM70 ..... $2,195.00
AM70 01 ..... $75.00
AM70 A1 ..... $0.00
AM70 A2 ..... $0.00
AM70 A3 ..... $0.00
AM70 A6 ..... $0.00
AM70 C3 ..... $335.00
AM70 C5 ..... $665.00
AM70 D1 ..... $150.00
AM70 D3 ..... $185.00
AM70 D5 ..... $365.00
AM70 R3 ..... $145.00
AM70 R5 ..... $285.00
AM7FR1 ..... $295.00
AMIQ $15,750.00
AMIQ 1R $250.00
AMIQ B1 ..... $1,250.00
AMIQ B19 ..... $195.00
AMIQ B2 ..... $1,250.00
AMIQ D1 ..... $250.00
AMIQ K11 ..... $0.00
AMIQ R3 ..... $620.00
AMIQ R5 ..... $1,235.00
AMIQ-B1 ..... $1,250.00
AMIQ-K11 ..... $0.00
AMT75 ..... $249.00
AMT75 C3 ..... $155.00
AMT75 D1 ..... $75.00
AMT75 D3 ..... $135.00
AMT75 R3 ..... $70.00
ASG100 ..... $2,295.00
ASG100 A1 ..... $0.00
ASG100 A2 ..... $0.00
ASG100 A3 ..... $0.00
ASG100 A4 ..... $0.00
ASG100 A5 ..... $0.00
ASG100 C3 ..... $380.00
ASG100 C5 ..... $760.00
ASG100 D1 ..... $125.00
ASG100 D3 ..... $190.00
ASG100 D5 ..... $380.00
ASG100 R3 ..... $190.00
ASG100 R5 ..... $380.00
ASG140 ..... $2,395.00
ASG140 A1 ..... $0.00
ASG140 A2 ..... $0.00
ASG140 A3 ..... $0.00
ASG140 A4 ..... $0.00
ASG140 A5 ..... $0.00
ASG140 C3 ..... $380.00
ASG140 C5 ..... $760.00
ASG140 D1 ..... $125.00
ASG140 D3 ..... $190.00
ASG140 D5 ..... $380.00
ASG140 R3 ..... $190.00
ASG140 R5 ..... $380.00
ASW100F $2,195.00
ASW100FA1 ..... $0.00
ASW100FA2 ..... $0.00
ASW100FA3 ..... $0.00
ASW100FA5 ..... $0.00
ASW100FR3 ..... $190.00
ASW100FR5 ..... $380.00
ASW100M $2,195.00
ASW100MA1 ..... $0.00
ASW100MA2 ..... $0.00
ASW100MA3 ..... $0.00
ASW100MA5 ..... $0.00
ASW100MR3 ..... $190.00
ASW100MR5 ..... $380.00
ATK01 ..... $19.00
ATL01 ..... $14.00
ATL21 ..... $19.00
ATL22 ..... $9.00
ATL23 ..... $14.00
ATL25 ..... $25.00
ATLDX1 ..... $75.00
ATP01 ..... $14.00
ATS-GUI-S1 ..... $30,880.00
ATS-GUI-UPD $12,510.00
ATS-PROT-1276X-2 .. $12,510.00
ATS-PROT-1293X-2 .. $12,510.00
ATS-PROT-A40-1 .... $12,510.00
ATS-PROT-AN1-1 ... $13,010.00
ATS-PROT-I2761-1 .. $13,010.00
ATS-PROT-UNI-1 .... $19,510.00
ATS-PROT-UNI-2UPG $10,940.00
ATS-SCN-S1 ..... $9,760.00
ATS-SU-B2 ..... $26,010.00
ATS-SU-Q33-X1 .... $31,260.00
ATS-SU-Q33-X1UPG . $21,130.00
ATS-SU-Q4 ..... $21,140.00
ATS-SU-Q5-X1 ..... $12,360.00
ATS-SU-Q5-X101 ... $14,960.00
ATS-SU-Q6-X1 ..... $11,380.00
ATS-SU-Q7-X1 ..... $13,650.00
ATS-SU-Q7-X101 ... $13,650.00
ATS-SU-Q9-X $26,250.00
ATS-TRAINING $7,130.00
AV601A $10,995.00
AV601A 01 ..... $1,000.00
AV601A 02 ..... $450.00
AV601A A1 ..... $0.00
AV601A A2 ..... $0.00
AV601A A3 ..... $0.00
AV601A A5 ..... $0.00
AV601A R5 ..... $1,010.00
AV601E $12,595.00
AV601E 01 ..... $1,000.00
AV601E 02 ..... $450.00
AV601E A1 ..... $0.00
AV601E A2 ..... $0.00
AV601E A3 ..... $0.00
AV601E A5 ..... $0.00
AV601E R5 ..... $1,105.00
AV601M $14,295.00
AV601M 01 ..... $1,000.00
AV601M 02 ..... $450.00
AV601M A1 ..... $0.00
AV601M A2 ..... $0.00
AV601M A3 ..... $0.00
AV601M A5 ..... $0.00
AV601M R5 ..... $1,200.00
AVG1 ..... $3,295.00
AVG1 C3 ..... $420.00
AVG1 C5 ..... $840.00
AVG1 D1 ..... $115.00
AVG1 D3 ..... $200.00
AVG1 D5 ..... $400.00
AVG1 R3 ..... $230.00
AVG1 R5 ..... $460.00
AVTIME $1.00
AVTIME 01 ..... $36,725.00
AVTIME 02 ..... $36,625.00
AVTIME 11 ..... $35,700.00
AVTIME 12 ..... $35,600.00
AWDK1 ..... $3,065.00
AWG2005 ..... $8,495.00
AWG200502 ..... $4,495.00
AWG200504 ..... $1,895.00
AWG200505 ..... $1,895.00
AWG200509 ..... $2,495.00
AWG20051R $595.00
AWG20051S $695.00
AWG2005A1 ..... $0.00
AWG2005A2 ..... $0.00
AWG2005A3 ..... $0.00
AWG2005A4 ..... $0.00
AWG2005A5 ..... $0.00
AWG2005B1 ..... $150.00
AWG2005C3 ..... $355.00
AWG2005C5 ..... $705.00
AWG2005D1 ..... $100.00
AWG2005D3 ..... $190.00
AWG2005D5 ..... $380.00
AWG2005R3 ..... $420.00
AWG2005R5 ..... $840.00
AWG2021 ..... $12,595.00
AWG202102 ..... $4,395.00
AWG202103 ..... $1,895.00
AWG202104 ..... $1,895.00
AWG202109 ..... $2,495.00
AWG20211R $595.00
AWG20211S $695.00
AWG2021A1 ..... $0.00
AWG2021A2 ..... $0.00
AWG2021A3 ..... $0.00
AWG2021A4 ..... $0.00
AWG2021A5 ..... $0.00
AWG2021B1 ..... $150.00
AWG2021C3 ..... $430.00
AWG2021C5 ..... $855.00
AWG2021D1 ..... $115.00
AWG2021D3 ..... $210.00
AWG2021D5 ..... $420.00
AWG2021R3 ..... $535.00
AWG2021R5 ..... $1,065.00
AWG510 ..... $21,995.00
AWG510 03 ..... $5,500.00
AWG510 1R $395.00
AWG510 1S $695.00
AWG510 A1 ..... $0.00
AWG510 A2 ..... $0.00
AWG510 A3 ..... $0.00
AWG510 A4 ..... $0.00
AWG510 A5 ..... $0.00
AWG510 C3 ..... $640.00
AWG510 D1 ..... $180.00
AWG510 D3 ..... $260.00
AWG510 R3 ..... $810.00
AWG520 ..... $30,445.00
AWG520 03 ..... $3,250.00
AWG520 1R $395.00
AWG520 1S $695.00
AWG520 A1 ..... $0.00
AWG520 A2 ..... $0.00
AWG520 A3 ..... $0.00
AWG520 A4 ..... $0.00
AWG520 A5 ..... $0.00
AWG520 C3 ..... $760.00
AWG520 D1 ..... $205.00
AWG520 D3 ..... $285.00
AWG520 R3 ..... $990.00
AWG610 ..... $34,995.00
AWG610 10 ..... $3,000.00
AWG610 1R $395.00
AWG610 1S $695.00
AWG610 A1 ..... $0.00
AWG610 A2 ..... $0.00
AWG610 A3 ..... $0.00
AWG610 A4 ..... $0.00
AWG610 A5 ..... $0.00
AWG610 C3 ..... $890.00
AWG610 D1 ..... $170.00
AWG610 D3 ..... $515.00
AWG610 R3 ..... $2,800.00
AWVG1 ..... $3,295.00

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AWVG1 C3 ..... $420.00
AWVG1 C5 ..... $840.00
AWVG1 D1 ..... $225.00
AWVG1 D3 ..... $200.00
AWVG1 D5 ..... $400.00
AWVG1 R3 ..... $230.00
AWVG1 R5 ..... $460.00
BG020 ..... $1,300.00
BG020 D1 ..... $155.00
BG1 ..... $1,200.00
BPAK $4,095.00
BPAK 01 ..... $3,200.00
C28P2F1 ..... $4,260.00
C28P2SC $4,050.00
C2DUOSC $930.00
C2P2-SC $2,760.00
C2P2F1 ..... $2,655.00
C2P2PSC $2,420.00
C48P2F1 ..... $2,860.00
C48P2SC $2,970.00
C49P2SC $2,605.00
C73000-W6000-C19 .... $70.00
C73165-A67-A11 ..... $520.00
C73165-A67-A12 ..... $510.00
C73249-A12-B150-1 .... $70.00
C73249-A12-B151-1 .... $60.00
C73249-A12-B152-1 ... $130.00
C73249-A12-B153-1 ... $130.00
C73249-A12-B154-1 ... $190.00
C73249-A2-B29-1 ... $3,320.00
C73249-A2-D13-2 .. $11,880.00
C73249-A41-B13 ..... $20.00
C73249-A41-B14-2 ..... $70.00
C73249-A41-B15 ..... $20.00
C73249-A41-B46-2 ..... $50.00
C73249-A41-B7 ..... $160.00
C73249-A41-C200-1 ... $150.00
C73249-A41-C201 ..... $40.00
C73249-A41-D125-2 ... $630.00
C73249-A41-D126-2 ... $630.00
C73249-A41-D127-2 ... $630.00
C73249-A41-D140-1 ... $470.00
C73249-A44-D1-2 ... $3,830.00
C73249-A97-B29-1 .... $240.00
C73249-A97-C150-1 ... $320.00
C73365-Z1213-A2 ..... $440.00
C73365-Z1213-A3 ..... $500.00
C73458-A396-C6 ..... $10.00
CAL4100 ..... $65.00
CAL4200 ..... $75.00
CAL4300 ..... $115.00
CAL4400 ..... $175.00
CAL4500 ..... $245.00
CAL4600 ..... $285.00
CAL4700 ..... $545.00
CAL4800 ..... $1,025.00
CATV $36,660.00
CATVK1 ..... $1,980.00
CDM250 ..... $399.00
CEGSMU1 ..... $1,210.00
CFG253 ..... $420.00
CFG280 ..... $1,030.00
CMC251 ..... $620.00
CMD-B1 ..... $1,065.00
CMD-B104 ..... $1,035.00
CMD-B14 ..... $2,500.00
CMD-B17 ..... $5,000.00
CMD-B17IQ $1,210.00
CMD-B19 ..... $3,425.00
CMD-B2 ..... $1,575.00
CMD-B3 ..... $250.00
CMD-B30 ..... $1,260.00
CMD-B4 ..... $3,105.00
CMD-B41 ..... $1,375.00
CMD-B42 ..... $1,495.00
CMD-B43 ..... $1,625.00
CMD-B44 ..... $546.00
CMD-B51 ..... $905.00
CMD-B6 ..... $725.00
CMD-B60 ..... $730.00
CMD-B61 ..... $370.00
CMD-B62 ..... $490.00
CMD-B82 ..... $5,000.00
CMD-B84 ..... $10,000.00
CMD-K10 ..... $3,500.00
CMD-K11 ..... $4,375.00
CMD-K13 ..... $2,975.00
CMD-K14 ..... $2,950.00
CMD-K43 ..... $630.00
CMD-K51 ..... $525.00
CMD-U10 ..... $895.00
CMD-U10D1 ..... $155.00
CMD-U11 ..... $1,715.00
CMD-U12 ..... $1,015.00
CMD-U13 ..... $2,585.00
CMD-U17 ..... $1,950.00
CMD-U18 ..... $2,358.00
CMD-U20 ..... $1,865.00
CMD-U3 ..... $2,500.00
CMD-U5 ..... $400.00
CMD-U56 ..... $10,525.00
CMD-U8 ..... $6,125.00
CMD-U9 ..... $2,485.00
CMD-UK1 ..... $8,005.00
CMD-UK2 ..... $8,005.00
CMD-Z1 ..... $270.00
CMD-Z10 ..... $1,160.00
CMD-Z20 ..... $195.00
CMD-Z21 ..... $960.00
CMD-Z22 ..... $1,150.00
CMD-Z23 ..... $960.00
CMD-Z24 ..... $960.00
CMD-Z25 ..... $960.00
CMD-Z40 ..... $540.00
CMD-Z50 ..... $175.00
CMD-Z8 ..... $3,900.00
CMD50 ..... $20,250.00
CMD50 1R $185.00
CMD50 B1 ..... $1,065.00
CMD50 B3 ..... $250.00
CMD50 B30 ..... $1,260.00
CMD50 B4 ..... $3,105.00
CMD50 B41 ..... $1,330.00
CMD50 B42 ..... $1,385.00
CMD50 B6 ..... $725.00
CMD50 B62 ..... $490.00
CMD50 C3 ..... $1,200.00
CMD50 C5 ..... $2,395.00
CMD50 D1 ..... $215.00
CMD50 D3 ..... $400.00
CMD50 D5 ..... $800.00
CMD50 R3 ..... $725.00
CMD50 R5 ..... $1,445.00
CMD50 U5 ..... $400.00
CMD52 ..... $30,400.00
CMD52 1R $185.00
CMD52 B1 ..... $1,065.00
CMD52 B3 ..... $250.00
CMD52 B4 ..... $3,150.00
CMD52 B41 ..... $1,375.00
CMD52 B42 ..... $1,495.00
CMD52 B6 ..... $725.00
CMD52 B61 ..... $370.00
CMD52 B62 ..... $490.00
CMD52 C3 ..... $1,760.00
CMD52 C5 ..... $3,515.00
CMD52 D1 ..... $280.00
CMD52 D3 ..... $545.00
CMD52 D5 ..... $1,085.00
CMD52 R3 ..... $950.00
CMD52 R5 ..... $1,900.00
CMD52 Z2 ..... $215.00
CMD53 ..... $22,465.00
CMD53 1R $200.00
CMD53 B1 ..... $1,135.00
CMD53 B17IQ $1,320.00
CMD53 B19 ..... $3,570.00
CMD53 B20 ..... $690.00
CMD53 B3 ..... $250.00
CMD53 B30 ..... $1,350.00
CMD53 B4 ..... $2,540.00
CMD53 B41 ..... $1,470.00
CMD53 B42 ..... $1,595.00
CMD53 B43 ..... $1,055.00
CMD53 B44 ..... $615.00
CMD53 B51 ..... $905.00
CMD53 B6 ..... $0.00
CMD53 B62 ..... $0.00
CMD53 C3 ..... $1,420.00
CMD53 C5 ..... $2,835.00
CMD53 D1 ..... $310.00
CMD53 D3 ..... $460.00
CMD53 D5 ..... $915.00
CMD53 K43 ..... $655.00
CMD53 R3 ..... $830.00
CMD53 R5 ..... $1,655.00
CMD53 U18 ..... $2,355.00
CMD53 U5 ..... $425.00
CMD53 U56 ..... $10,595.00
CMD55 ..... $31,350.00
CMD55 1R $200.00
CMD55 B1 ..... $1,135.00
CMD55 B17IQ $1,330.00
CMD55 B19 ..... $3,570.00
CMD55 B2 ..... $1,645.00
CMD55 B3 ..... $255.00
CMD55 B4 ..... $2,545.00
CMD55 B41 ..... $1,470.00
CMD55 B42 ..... $1,595.00
CMD55 B43 ..... $1,670.00
CMD55 B44 ..... $615.00
CMD55 B51 ..... $905.00
CMD55 B6 ..... $0.00
CMD55 B61 ..... $390.00
CMD55 B62 ..... $0.00
CMD55 C3 ..... $1,920.00
CMD55 C5 ..... $3,840.00
CMD55 D1 ..... $310.00
CMD55 D3 ..... $580.00
CMD55 D5 ..... $1,160.00
CMD55 K43 ..... $655.00
CMD55 R3 ..... $1,045.00
CMD55 R5 ..... $2,090.00
CMD55 U18 ..... $2,655.00
CMD55 U5 ..... $425.00
CMD55 U56 ..... $10,595.00
CMD55 Z2 ..... $120.00
CMD57 ..... $37,965.00
CMD57 1R $185.00
CMD57 43 ..... $630.00
CMD57 B1 ..... $1,065.00
CMD57 B17IQ $1,210.00
CMD57 B19 ..... $3,425.00
CMD57 B2 ..... $1,575.00
CMD57 B3 ..... $250.00
CMD57 B41 ..... $1,375.00
CMD57 B51 ..... $905.00
CMD57 B6 ..... $0.00
CMD57 B61 ..... $370.00
CMD57 B62 ..... $0.00
CMD57 B7 ..... $7,500.00
CMD57 B8 ..... $4,500.00
CMD57 BE $13,580.00
CMD57 C3 ..... $2,120.00
CMD57 C5 ..... $4,240.00
CMD57 D1 ..... $345.00
CMD57 D3 ..... $630.00
CMD57 D5 ..... $1,255.00
CMD57 K10 ..... $3,500.00
CMD57 K11 ..... $4,375.00
CMD57 K13 ..... $2,975.00
CMD57 K14 ..... $2,950.00
CMD57 K51 ..... $525.00
CMD57 R3 ..... $1,135.00
CMD57 R5 ..... $2,265.00
CMD57 U13 ..... $2,585.00
CMD57 U3 ..... $2,500.00
CMD57 U5 ..... $400.00
CMD57 U8 ..... $6,125.00
CMD57 U9 ..... $2,485.00
CMD80 ..... $42,165.00
CMD80 1R $185.00
CMD80 B1 ..... $1,035.00
CMD80 B14 ..... $2,500.00
CMD80 B17 ..... $1,210.00
CMD80 B3 ..... $250.00
CMD80 B61 ..... $345.00
CMD80 B81 ..... $2,500.00
CMD80 B82 ..... $5,000.00
CMD80 B84 ..... $10,000.00
CMD80 C3 ..... $2,825.00
CMD80 C5 ..... $5,645.00
CMD80 D1 ..... $425.00
CMD80 D3 ..... $810.00
CMD80 D5 ..... $1,615.00
CMD80 K2 ..... $8,005.00
CMD80 R3 ..... $1,570.00
CMD80 R5 ..... $3,135.00
CMDAZ1 ..... $1,950.00
CMDAZ1 D1 ..... $155.00

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CMDAZ1 R3 ..... $175.00
CMDAZ1 R5 ..... $345.00
CMM150 ..... $45.00
CMS-Z37 ..... $320.00
CMS-Z40 ..... $635.00
CMS-Z41 ..... $1,240.00
CMS54 ..... $17,845.00
CMS54 01 ..... $950.00
CMS54 02 ..... $1,770.00
CMS54 03 ..... $1,215.00
CMS54 06 ..... $1,630.00
CMS54 07 ..... $0.00
CMS54 08 ..... $195.00
CMS54 09 ..... $1,295.00
CMS54 10 ..... $315.00
CMS54 11 ..... $610.00
CMS54 12 ..... $610.00
CMS54 13 ..... $780.00
CMS54 14 ..... $500.00
CMS54 15 ..... $595.00
CMS54 16 ..... $285.00
CMS54 17 ..... $1,315.00
CMS54 18 ..... $2,200.00
CMS54 19 ..... $120.00
CMS54 20 ..... $1,855.00
CMS54 22 ..... $530.00
CMS54 23 ..... $0.00
CMS54 27 ..... $1,855.00
CMS54 C3 ..... $1,200.00
CMS54 C5 ..... $2,395.00
CMS54 D1 ..... $215.00
CMS54 D3 ..... $400.00
CMS54 D5 ..... $800.00
CMS54 R3 ..... $705.00
CMS54 R5 ..... $1,410.00
CMS57 ..... $22,735.00
CMS57 01 ..... $950.00
CMS57 02 ..... $1,780.00
CMS57 03 ..... $1,215.00
CMS57 04 ..... $2,035.00
CMS57 06 ..... $1,630.00
CMS57 07 ..... $0.00
CMS57 08 ..... $195.00
CMS57 09 ..... $1,295.00
CMS57 10 ..... $315.00
CMS57 11 ..... $610.00
CMS57 12 ..... $610.00
CMS57 13 ..... $780.00
CMS57 14 ..... $500.00
CMS57 15 ..... $595.00
CMS57 16 ..... $285.00
CMS57 17 ..... $1,315.00
CMS57 18 ..... $2,200.00
CMS57 19 ..... $120.00
CMS57 22 ..... $530.00
CMS57 23 ..... $0.00
CMS57 24 ..... $1,215.00
CMS57 27 ..... $1,855.00
CMS57 C3 ..... $1,505.00
CMS57 C5 ..... $3,005.00
CMS57 D1 ..... $255.00
CMS57 D3 ..... $475.00
CMS57 D5 ..... $950.00
CMS57 R3 ..... $840.00
CMS57 R5 ..... $1,675.00
CMSZ1 ..... $180.00
CMSZ2 ..... $430.00
CMSZ5 ..... $105.00
CPK52F1 ..... $2,205.00
CPK52SC $2,290.00
CPK53F1 ..... $2,205.00
CPK53SC $2,290.00
CPK54F1 ..... $2,205.00
CPK54SC $2,290.00
CPK55SC $3,135.00
CPK56F1 ..... $1,420.00
CPK56SC $1,445.00
CPK58F1 ..... $2,450.00
CPK58SC $2,545.00
CPK59F1 ..... $1,225.00
CPK59SC $1,280.00
CPK5AF1 ..... $1,300.00
CPK5ASC $1,405.00
CPK5BF1 ..... $3,300.00
CPK5BSC $3,465.00
CPK62F1 ..... $2,205.00
CPK62SC $2,290.00
CPK63F1 ..... $2,205.00
CPK63SC $2,290.00
CPK64F1 ..... $2,205.00
CPK64SC $2,290.00
CPK65F1 ..... $3,020.00
CPK65SC $3,135.00
CPK66F1 ..... $1,420.00
CPK66SC $1,445.00
CPK68F1 ..... $2,450.00
CPK68SC $2,545.00
CPK69F1 ..... $1,225.00
CPK69SC $1,280.00
CPK6AF1 ..... $1,300.00
CPK6ASC $1,405.00
CPK6BF1 ..... $3,300.00
CPK6BSC $3,465.00
CPK72F1 ..... $2,205.00
CPK72SC $2,290.00
CPK73F1 ..... $2,205.00
CPK73SC $2,290.00
CPK74F1 ..... $2,205.00
CPK74SC $2,290.00
CPK75F1 ..... $2,750.00
CPK75SC $3,135.00
CPK76F1 ..... $1,420.00
CPK76SC $1,450.00
CPK78F1 ..... $2,450.00
CPK78SC $2,545.00
CPK79F1 ..... $1,225.00
CPK79SC $1,280.00
CPK7ASC $1,405.00
CPK7BSC $3,465.00
CPS250 ..... $495.00
CR02DUO $7,755.00
CR02P2P $20,165.00
CR02PH2 ..... $22,945.00
CR28PH2 ..... $35,535.00
CR48PH2 ..... $24,715.00
CR49P2P $21,715.00
CRAUDSC $1,145.00
CRB19SC $10,090.00
CRB31SC $10,090.00
CREGSSC $1,505.00
CRMB1SC $2,025.00
CRNASC $10,090.00
CRNATA $84,105.00
CRT-1T $6,940.00
CRT-2T $18,915.00
CRT-B4 ..... $3,225.00
CRT-K3 ..... $5,655.00
CRT-K5 ..... $5,650.00
CRT-K7 ..... $5,650.00
CRT-K8 ..... $5,650.00
CRT-K9 ..... $5,430.00
CRT-U2 ..... $420.00
CRT-U5 ..... $13,335.00
CRT-U9 ..... $0.00
CRTBR19 ..... $84,105.00
CRTBR31 ..... $84,105.00
CRTC02 ..... $229,450.00
CRTC02 1T $6,940.00
CRTC02 B1 ..... $4,885.00
CRTC02 B7 ..... $1,770.00
CRTC02 B9 ..... $4,500.00
CRTC02 D1 ..... $1,155.00
CRTC02 U5 ..... $13,335.00
CRTC02 Z2 ..... $120.00
CRTKAUD $9,525.00
CRTKEGS $12,505.00
CRTKMB1 ..... $16,865.00
CRTP-B7 ..... $3,540.00
CRTP-B9 ..... $4,500.00
CRTP-K56 ..... $12,010.00
CRTP-K66 ..... $12,010.00
CRTPK22 ..... $32,735.00
CRTPK23 ..... $29,460.00
CRTPK24 ..... $32,735.00
CRTPK26 ..... $4,915.00
CRTPK52 ..... $19,065.00
CRTPK53 ..... $19,065.00
CRTPK54 ..... $19,065.00
CRTPK55 ..... $26,120.00
CRTPK58 ..... $21,190.00
CRTPK59 ..... $10,595.00
CRTPK5A $11,785.00
CRTPK5B $28,850.00
CRTPK62 ..... $19,065.00
CRTPK63 ..... $19,065.00
CRTPK64 ..... $19,065.00
CRTPK65 ..... $26,120.00
CRTPK66 ..... $12,550.00
CRTPK68 ..... $21,190.00
CRTPK69 ..... $10,595.00
CRTPK6A $11,785.00
CRTPK6B $28,850.00
CRTPK72 ..... $19,065.00
CRTPK73 ..... $19,065.00
CRTPK74 ..... $19,065.00
CRTPK75 ..... $26,120.00
CRTPK76 ..... $12,010.00
CRTPK78 ..... $21,190.00
CRTPK79 ..... $10,595.00
CRTPK7A $11,785.00
CRTPK7B $28,850.00
CRTS-B2 ..... $805.00
CRTS-B5 ..... $2,975.00
CRTSK1 ..... $5,780.00
CRTSK2 ..... $5,615.00
CRTSK22 ..... $22,465.00
CRTSK23 ..... $20,070.00
CRTSK24 ..... $28,090.00
CRTSK26 ..... $4,135.00
CRTSK28 ..... $53,970.00
CRTSK38 ..... $22,030.00
CRTSK48 ..... $28,090.00
CRTU1 ..... $3,075.00
CRTZ2 ..... $120.00
CSA803C $20,225.00
CSA803C1R $280.00
CSA803CA1 ..... $0.00
CSA803CA2 ..... $0.00
CSA803CA3 ..... $0.00
CSA803CA4 ..... $0.00
CSA803CA5 ..... $0.00
CSA803CC3 ..... $1,085.00
CSA803CC5 ..... $2,170.00
CSA803CD1 ..... $195.00
CSA803CD3 ..... $375.00
CSA803CD5 ..... $745.00
CSA803CR3 ..... $1,030.00
CSA803CR5 ..... $2,055.00
CSS50 ..... $550.00
CSS500 ..... $2,050.00
CT1 ..... $395.00
CT100 ..... $1,995.00
CT100 1B $495.00
CT100 2A $495.00
CT100 3B $495.00
CT100 46 ..... $50.00
CT11BF $695.00
CT12AF $495.00
CT12BF $895.00
CT13BF $495.00
CT2 ..... $389.00
CT4 ..... $2,595.00
CT4 R3 ..... $190.00
CT4 R5 ..... $380.00
CT6 ..... $470.00
CT6 C3 ..... $200.00
CT6 D1 ..... $70.00
CT6 D3 ..... $155.00
CT6 R3 ..... $60.00
CT6 TF $580.00
CTD-B5 ..... $595.00
CTD-Z10 ..... $675.00
CTS-K6 ..... $589.00
CTS-K7 ..... $1,090.00
CTS-U7 ..... $305.00
CTS55 ..... $11,250.00
CTS55 B1 ..... $825.00
CTS55 C3 ..... $725.00
CTS55 C5 ..... $1,445.00
CTS55 D1 ..... $150.00
CTS55 D3 ..... $280.00
CTS55 D5 ..... $555.00
CTS55 K6 ..... $589.00
CTS55 K7 ..... $1,090.00
CTS55 R3 ..... $685.00
CTS55 R5 ..... $1,370.00
CTS710 ..... $16,290.00
CTS710 03 ..... $7,790.00
CTS710 04 ..... $10,500.00
CTS710 05 ..... $10,500.00

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CTS710 06 ..... $21,000.00
CTS710 22 ..... $5,990.00
CTS710 A1 ..... $0.00
CTS710 A2 ..... $0.00
CTS710 A3 ..... $0.00
CTS710 A4 ..... $0.00
CTS710 A5 ..... $0.00
CTS710 C3 ..... $1,020.00
CTS710 C5 ..... $2,035.00
CTS710 D1 ..... $230.00
CTS710 D3 ..... $355.00
CTS710 D5 ..... $705.00
CTS710 R5 ..... $610.00
CTS7F03 ..... $8,290.00
CTS7F04 ..... $11,000.00
CTS850 ..... $16,800.00
CTS850 01 ..... $305.00
CTS850 03 ..... $8,180.00
CTS850 04 ..... $11,025.00
CTS850 05 ..... $11,025.00
CTS850 06 ..... $22,050.00
CTS850 08 ..... $3,150.00
CTS850 12 ..... $1,050.00
CTS850 14 ..... $9,975.00
CTS850 31 ..... $0.00
CTS850 32 ..... $0.00
CTS850 33 ..... $0.00
CTS850 34 ..... $0.00
CTS850 38 ..... $9,755.00
CTS850 55 ..... $5,245.00
CTS850 A1 ..... $0.00
CTS850 A2 ..... $0.00
CTS850 A3 ..... $0.00
CTS850 A4 ..... $0.00
CTS850 A5 ..... $0.00
CTS850 C3 ..... $1,900.00
CTS850 C5 ..... $3,800.00
CTS850 D1 ..... $315.00
CTS850 R5 ..... $1,010.00
CTS8F01 ..... $995.00
CTS8F03 ..... $8,705.00
CTS8F04 ..... $11,550.00
CTS8F0433 ..... $0.00
CTS8F05 ..... $11,550.00
CTS8F08 ..... $3,250.00
CTS8F55 ..... $5,295.00
CTS8U14 ..... $13,120.00
CTS8U14D1 ..... $155.00
CTS8U38 ..... $12,595.00
CTS8U38D1 ..... $155.00
CTS8U55 ..... $7,350.00
D3186 ..... $145,000.00
D3186 10 ..... $45,750.00
D3186 11 ..... $32,525.00
D3186 12 ..... $0.00
D3186 70 ..... $13,950.00
D3186 C3 ..... $2,315.00
D3186 C5 ..... $4,475.00
D3186 D1 ..... $380.00
D3186 D3 ..... $1,130.00
D3186 D5 ..... $1,820.00
D3186 R3 ..... $3,345.00
D3186 R5 ..... $6,700.00
D3286 ..... $129,500.00
D3286 70 ..... $13,950.00
D3286 C3 ..... $2,315.00
D3286 C5 ..... $4,475.00
D3286 D1 ..... $380.00
D3286 D3 ..... $1,130.00
D3286 D5 ..... $1,820.00
D3286 R3 ..... $3,100.00
D3286 R5 ..... $6,200.00
DASMTIF $2,100.00
DG2020A $10,495.00
DG2020A01 ..... $2,995.00
DG2020A02 ..... $4,995.00
DG2020A1R $595.00
DG2020AA1 ..... $0.00
DG2020AA2 ..... $0.00
DG2020AA3 ..... $0.00
DG2020AA4 ..... $0.00
DG2020AA5 ..... $0.00
DG2020AC3 ..... $420.00
DG2020AD1 ..... $155.00
DG2020AD3 ..... $200.00
DG2020AR3 ..... $745.00
DG2030 ..... $14,995.00
DG2030 01 ..... $4,995.00
DG2030 1R $595.00
DG2030 A1 ..... $0.00
DG2030 A2 ..... $0.00
DG2030 A3 ..... $0.00
DG2030 A4 ..... $0.00
DG2030 A5 ..... $0.00
DG2030 C3 ..... $640.00
DG2030 D1 ..... $110.00
DG2030 D3 ..... $260.00
DG2030 R3 ..... $1,095.00
DG2040 ..... $13,495.00
DG2040 1R $595.00
DG2040 A1 ..... $0.00
DG2040 A2 ..... $0.00
DG2040 A3 ..... $0.00
DG2040 A4 ..... $0.00
DG2040 A5 ..... $0.00
DG2040 C3 ..... $4,305.00
DG2040 D1 ..... $150.00
DG2040 D3 ..... $1,180.00
DG2040 R3 ..... $105.00
DL11 ..... $5,500.00
DL11 R3 ..... $135.00
DL11 R5 ..... $270.00
DMA120 ..... $3,995.00
DMA120 C3 ..... $355.00
DMA120 C5 ..... $705.00
DMA120 D1 ..... $95.00
DMA120 D3 ..... $190.00
DMA120 D5 ..... $380.00
DMA120 L1 ..... $0.00
DMA120 L2 ..... $0.00
DMA120 R3 ..... $400.00
DMA120 R5 ..... $800.00
DMA121 ..... $3,995.00
DMA121 C3 ..... $355.00
DMA121 C5 ..... $705.00
DMA121 D1 ..... $95.00
DMA121 D3 ..... $190.00
DMA121 D5 ..... $380.00
DMA121 L1 ..... $0.00
DMA121 L2 ..... $0.00
DMA121 R3 ..... $400.00
DMA121 R5 ..... $800.00
DMABAT $80.00
DMACHG $145.00
DMACHG A2 ..... $0.00
DMACHG A3 ..... $0.00
DMAPRN $350.00
DMAPRN A0 ..... $0.00
DMAPRN A1 ..... $0.00
DMM150 ..... $75.00
DMM157 ..... $109.00
DMM249 ..... $169.00
DMM254 ..... $219.00
DMM912 ..... $219.00
DMM912 00 ..... $0.00
DMM912 1L $0.00
DMM914 ..... $269.00
DMM914 00 ..... $0.00
DMM914 1L $0.00
DMM916 ..... $315.00
DMM916 00 ..... $0.00
DMM916 1L $0.00
DNF $425.00
DNF D1 ..... $155.00
DNF-10 ..... $425.00
DNF-20 ..... $425.00
DNF-3 ..... $425.00
DNF-30 ..... $425.00
DNF-6 ..... $425.00
DQOS-DMU-HW ... $11,070.00
DQOS-SW-R10 ..... $18,070.00
DQOS-SW-R10A $11,750.00
DQOS-SW-R10B $14,880.00
DQOS-SW-R20 ..... $23,130.00
DQOS-SW-R20A ... $13,630.00
DQOS-SW-R20B ... $19,940.00
DQOS-TDMU $11,880.00
DQOS-TRAINING $630.00
DS1001 ..... $4,815.00
DS1001 R3 ..... $410.00
DS1002 ..... $4,815.00
DS1003 ..... $4,815.00
DS1201 ..... $13,915.00
DS1201 D1 ..... $165.00
DS1201 KS $500.00
DS1201 R3 ..... $590.00
DS1202 ..... $14,469.00
DS1202 D1 ..... $170.00
DS1202 R3 ..... $610.00
DS1203 ..... $13,915.00
DS1203 D1 ..... $165.00
DS1203 R3 ..... $590.00
DS1204 ..... $13,915.00
DS1204 CG $0.00
DS1204 D1 ..... $165.00
DS1204 R3 ..... $590.00
DS1205 ..... $13,915.00
DS1205 D1 ..... $165.00
DS1205 R3 ..... $590.00
DVBPI $4,600.00
DVBPI A0 ..... $0.00
DVBPI A2 ..... $0.00
DVBPI A4 ..... $0.00
DVBPI A5 ..... $0.00
DVBPI R3 ..... $410.00
DVBPI R5 ..... $795.00
DVG1 ..... $2,295.00
DVG1 C3 ..... $320.00
DVG1 C5 ..... $615.00
DVG1 D1 ..... $125.00
DVG1 D3 ..... $255.00
DVG1 D5 ..... $410.00
DVG1 R3 ..... $345.00
DVG1 R5 ..... $570.00
DVG1 S1 ..... $825.00
ECO170A $3,295.00
ECO170AA1 ..... $0.00
ECO170AA2 ..... $0.00
ECO170AA3 ..... $0.00
ECO170AR3 ..... $175.00
ECO170AR5 ..... $345.00
ECO422 ..... $2,795.00
ECO422 A1 ..... $0.00
ECO422 A2 ..... $0.00
ECO422 A3 ..... $0.00
ECO422 A5 ..... $0.00
ECO422 R3 ..... $165.00
ECO422 R5 ..... $325.00
EMC120 ..... $2,450.00
EMC120U $950.00
ENC1 ..... $795.00
ESBI $83,950.00
ESBI 01 ..... $5,095.00
ESBI C3 ..... $4,505.00
ESBI C5 ..... $9,010.00
ESBI D1 ..... $325.00
ESBI D3 ..... $1,230.00
ESBI D5 ..... $2,455.00
ESBI R3 ..... $2,465.00
ESBI R5 ..... $4,925.00
ESCS-B2 ..... $300.00
ESCS-B4 ..... $2,600.00
ESCS30 ..... $46,250.00
ESCS30 1R $220.00
ESCS30 B1 ..... $1,200.00
ESCS30 B2 ..... $325.00
ESCS30 B4 ..... $2,600.00
ESCS30 B5 ..... $3,200.00
ESCS30 B6 ..... $800.00
ESCS30 B9 ..... $1,150.00
ESCS30 C3 ..... $2,680.00
ESCS30 C5 ..... $5,360.00
ESCS30 D1 ..... $325.00
ESCS30 D3 ..... $770.00
ESCS30 D5 ..... $1,540.00
ESCS30 R3 ..... $1,330.00
ESCS30 R5 ..... $2,660.00
ESH2Z1 ..... $1,325.00
ESH2Z1 D1 ..... $80.00
ESH2Z1 R3 ..... $135.00
ESH2Z1 R5 ..... $270.00
ESH2Z11 ..... $705.00
ESH2Z11D1 ..... $285.00
ESH2Z11R3 ..... $95.00
ESH2Z2 ..... $1,550.00
ESH2Z2 D1 ..... $285.00
ESH2Z2 R3 ..... $145.00
ESH2Z2 R5 ..... $285.00
ESH2Z3 ..... $1,390.00
ESH2Z3 C3 ..... $400.00

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ESH2Z3 C5 ..... $800.00
ESH2Z3 D1 ..... $285.00
ESH2Z3 D3 ..... $200.00
ESH2Z3 D5 ..... $400.00
ESH2Z3 R3 ..... $135.00
ESH2Z3 R5 ..... $270.00
ESH2Z31 ..... $270.00
ESH2Z31D1 ..... $280.00
ESH2Z5 ..... $7,950.00
ESH2Z5 D1 ..... $280.00
ESH2Z5 R3 ..... $470.00
ESH2Z5 R5 ..... $935.00
ESH3Z2 ..... $495.00
ESH3Z2 D1 ..... $285.00
ESH3Z2 R3 ..... $90.00
ESH3Z3 ..... $1,750.00
ESH3Z3 D1 ..... $285.00
ESH3Z3 R3 ..... $155.00
ESH3Z3 R5 ..... $305.00
ESH3Z4 ..... $1,220.00
ESH3Z4 D1 ..... $285.00
ESH3Z4 R3 ..... $125.00
ESH3Z4 R5 ..... $250.00
ESH3Z5 ..... $2,590.00
ESH3Z5 D1 ..... $285.00
ESH3Z5 R3 ..... $190.00
ESH3Z5 R5 ..... $380.00
ESH3Z6 ..... $1,950.00
ESH3Z6 C3 ..... $1,540.00
ESH3Z6 C5 ..... $3,080.00
ESH3Z6 D1 ..... $285.00
ESH3Z6 D3 ..... $485.00
ESH3Z6 D5 ..... $970.00
ESHS10 ..... $25,750.00
ESHS10 1R $220.00
ESHS10 C3 ..... $1,665.00
ESHS10 C5 ..... $3,325.00
ESHS10 D1 ..... $325.00
ESHS10 D3 ..... $515.00
ESHS10 D5 ..... $1,030.00
ESHS10 R3 ..... $935.00
ESHS10 R5 ..... $1,865.00
ESHS30 ..... $35,950.00
ESHS30 1R $220.00
ESHS30 C3 ..... $2,005.00
ESHS30 C5 ..... $4,010.00
ESHS30 D1 ..... $325.00
ESHS30 D3 ..... $600.00
ESHS30 D5 ..... $1,200.00
ESHS30 R3 ..... $1,140.00
ESHS30 R5 ..... $2,280.00
ESI26 ..... $95,000.00
ESI26 B10 ..... $12,950.00
ESI26 B11 ..... $16,195.00
ESI26 B12 ..... $2,750.00
ESI26 B1602 ..... $1,375.00
ESI26 B1603 ..... $1,375.00
ESI26 B17 ..... $1,375.00
ESI26 B21 ..... $3,500.00
ESI26 B3 ..... $1,500.00
ESI26 B7 ..... $17,600.00
ESI26 C3 ..... $4,250.00
ESI26 C5 ..... $8,215.00
ESI26 D1 ..... $4,435.00
ESI26 D3 ..... $8,570.00
ESI26 D5 ..... $655.00
ESI26 R3 ..... $1,965.00
ESI26 R5 ..... $3,165.00
ESI40 ..... $115,000.00
ESI40 B10 ..... $12,950.00
ESI40 B11 ..... $16,195.00
ESI40 B12 ..... $2,750.00
ESI40 B1602 ..... $1,375.00
ESI40 B1603 ..... $1,375.00
ESI40 B17 ..... $1,375.00
ESI40 B21 ..... $3,500.00
ESI40 B3 ..... $1,500.00
ESI40 B7 ..... $17,600.00
ESI40 C3 ..... $5,130.00
ESI40 C5 ..... $9,915.00
ESI40 D1 ..... $5,315.00
ESI40 D3 ..... $10,270.00
ESI40 D5 ..... $785.00
ESI40 R3 ..... $2,345.00
ESI40 R5 ..... $3,775.00
ESI7 ..... $69,500.00
ESI7 B10 ..... $12,950.00
ESI7 B11 ..... $16,195.00
ESI7 B12 ..... $2,750.00
ESI7 B1602 ..... $1,375.00
ESI7 B1603 ..... $1,375.00
ESI7 B17 ..... $1,375.00
ESI7 B3 ..... $1,500.00
ESI7 B7 ..... $17,600.00
ESI7 C3 ..... $3,130.00
ESI7 C5 ..... $6,045.00
ESI7 D1 ..... $3,315.00
ESI7 D3 ..... $6,405.00
ESI7 D5 ..... $495.00
ESI7 R3 ..... $1,485.00
ESI7 R5 ..... $2,385.00
ESK1 ..... $4,150.00
ESK10 ..... $5,090.00
ESK100 ..... $5,890.00
ESK100 03 ..... $500.00
ESK1003 ..... $500.00
ESK11 ..... $5,090.00
ESK12 ..... $5,090.00
ESK13 ..... $5,090.00
ESK14 ..... $5,090.00
ESK15 ..... $5,090.00
ESK16 ..... $5,005.00
ESK1F $0.00
ESK2 ..... $5,090.00
ESK30 ..... $5,090.00
ESK31 ..... $5,090.00
ESK32 ..... $5,090.00
ESK33 ..... $5,090.00
ESK34 ..... $5,090.00
ESK35 ..... $3,400.00
ESK36 ..... $3,400.00
ESK50 ..... $1,700.00
ESK80 ..... $1,900.00
ESMI $116,950.00
ESMI C3 ..... $3,795.00
ESMI C5 ..... $7,585.00
ESMI D1 ..... $325.00
ESMI D3 ..... $1,045.00
ESMI D5 ..... $2,090.00
ESMI R3 ..... $4,180.00
ESMI R5 ..... $8,360.00
ESMI-B1 ..... $29,950.00
ESMI-B1D1 ..... $325.00
ESMI-Z7 ..... $2,800.00
ESMI-Z7D1 ..... $255.00
ESN $84,950.00
ESN 01 ..... $9,950.00
ESN 1R $210.00
ESN C3 ..... $4,430.00
ESN C5 ..... $8,855.00
ESN D1 ..... $325.00
ESN D3 ..... $1,210.00
ESN D5 ..... $2,415.00
ESN R3 ..... $2,435.00
ESN R5 ..... $4,865.00
ESPC $24,500.00
ESPC 1R $220.00
ESPC B1 ..... $380.00
ESPC B2 ..... $1,500.00
ESPC B3 ..... $3,500.00
ESPC C3 ..... $1,625.00
ESPC C5 ..... $3,250.00
ESPC D1 ..... $325.00
ESPC D3 ..... $505.00
ESPC D5 ..... $1,010.00
ESPC R3 ..... $875.00
ESPC R5 ..... $1,750.00
ESS $87,950.00
ESS 01 ..... $3,500.00
ESS C3 ..... $4,875.00
ESS C5 ..... $9,750.00
ESS D1 ..... $325.00
ESS D3 ..... $1,325.00
ESS D5 ..... $2,645.00
ESS R3 ..... $2,265.00
ESS R5 ..... $4,525.00
ESVB $55,950.00
ESVB 01 ..... $4,250.00
ESVB 02 ..... $5,950.00
ESVB C3 ..... $2,930.00
ESVB C5 ..... $5,855.00
ESVB D1 ..... $325.00
ESVB D3 ..... $830.00
ESVB D5 ..... $1,655.00
ESVB R3 ..... $1,645.00
ESVB R5 ..... $3,290.00
ESVD $48,950.00
ESVD 01 ..... $4,250.00
ESVD 02 ..... $5,950.00
ESVD C3 ..... $2,710.00
ESVD C5 ..... $5,415.00
ESVD D1 ..... $325.00
ESVD D3 ..... $780.00
ESVD D5 ..... $1,560.00
ESVD R3 ..... $1,425.00
ESVD R5 ..... $2,850.00
ESVD-B1 ..... $4,250.00
ESVD-B1D1 ..... $325.00
ESVD-B2 ..... $5,950.00
ESVD-B2D1 ..... $325.00
ESVN20 ..... $49,950.00
ESVN20 01 ..... $3,350.00
ESVN20 C3 ..... $2,750.00
ESVN20 C5 ..... $5,495.00
ESVN20 D1 ..... $325.00
ESVN20 D3 ..... $790.00
ESVN20 D5 ..... $1,580.00
ESVN20 R3 ..... $1,445.00
ESVN20 R5 ..... $2,890.00
ESVN30 ..... $56,750.00
ESVN30 01 ..... $3,350.00
ESVN30 C3 ..... $3,090.00
ESVN30 C5 ..... $6,175.00
ESVN30 D1 ..... $325.00
ESVN30 D3 ..... $875.00
ESVN30 D5 ..... $1,750.00
ESVN30 R3 ..... $1,590.00
ESVN30 R5 ..... $3,175.00
ESVS10 ..... $31,600.00
ESVS10 01 ..... $1,550.00
ESVS10 C3 ..... $1,720.00
ESVS10 C5 ..... $3,440.00
ESVS10 D1 ..... $325.00
ESVS10 D3 ..... $535.00
ESVS10 D5 ..... $1,065.00
ESVS10 R3 ..... $790.00
ESVS10 R5 ..... $1,580.00
ESVS30 ..... $43,750.00
ESVS30 01 ..... $1,550.00
ESVS30 C3 ..... $2,645.00
ESVS30 C5 ..... $5,285.00
ESVS30 D1 ..... $325.00
ESVS30 D3 ..... $760.00
ESVS30 D5 ..... $1,520.00
ESVS30 R3 ..... $1,330.00
ESVS30 R5 ..... $2,660.00
ESVZ1 ..... $1,750.00
ESVZ1 C3 ..... $800.00
ESVZ1 C5 ..... $1,600.00
ESVZ1 D1 ..... $285.00
ESVZ1 D3 ..... $295.00
ESVZ1 D5 ..... $590.00
ESVZ1 R3 ..... $155.00
ESVZ1 R5 ..... $305.00
ESVZ3 ..... $2,250.00
ESVZ3 D1 ..... $285.00
ESXSK1 ..... $1,950.00
EZ1002 ..... $2,550.00
EZ1002 D1 ..... $285.00
EZ1003 ..... $2,250.00
EZ1003 D1 ..... $285.00
EZ11 ..... $120.00
EZ12 ..... $2,205.00
EZ1203 ..... $2,320.00
EZ13 ..... $335.00
EZ14 ..... $335.00
EZ15 ..... $95.00
EZ1702 ..... $1,670.00
EZ1702 D1 ..... $285.00
EZ1702 R3 ..... $155.00
EZ1702 R5 ..... $305.00
EZ1703 ..... $1,670.00
EZ1703 D1 ..... $285.00
EZ1703 R3 ..... $155.00
EZ1703 R5 ..... $305.00
EZ18 ..... $3,600.00
EZ18 D1 ..... $285.00
EZ19 ..... $85.00
EZ4 ..... $380.00
EZ402 ..... $320.00

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EZ5 ..... $380.00
EZ502 ..... $350.00
EZ6 ..... $380.00
EZ8 ..... $1,350.00
FG1315 ..... $11,200.00
FG1315 30 ..... $0.00
FG1315 31 ..... $0.00
FG1315 32 ..... $0.00
FG1315 33 ..... $0.00
FG1315 34 ..... $0.00
FG1315 35 ..... $0.00
FG1315 36 ..... $0.00
FG1315 37 ..... $0.00
FG1315 38 ..... $0.00
FG1315 39 ..... $0.00
FG1315 C3 ..... $780.00
FG1315 C5 ..... $1,560.00
FG1315 D1 ..... $155.00
FG1315 D3 ..... $295.00
FG1315 D5 ..... $590.00
FG1315 R3 ..... $1,030.00
FG1315 R5 ..... $2,055.00
FL1315. ..... $18,400.00
FL1315 30 ..... $0.00
FL1315 31 ..... $0.00
FL1315 32 ..... $0.00
FL1315 33 ..... $0.00
FL1315 34 ..... $0.00
FL1315 35 ..... $0.00
FL1315 36 ..... $0.00
FL1315 37 ..... $0.00
FL1315 38 ..... $0.00
FL1315 39 ..... $0.00
FL1315 AU $0.00
FL1315 HL $735.00
FL1315 R3 ..... $970.00
FL1315 R5 ..... $1,940.00
FL1315 SL $0.00
FM8513 ..... $13,200.00
FM8513 20 ..... $0.00
FM8513 21 ..... $0.00
FM8513 22 ..... $0.00
FM8513 23 ..... $0.00
FM8513 24 ..... $0.00
FM8513 25 ..... $0.00
FM8513 26 ..... $0.00
FM8513 27 ..... $0.00
FM8513 28 ..... $0.00
FM8513 29 ..... $0.00
FM8513 C3 ..... $895.00
FM8513 C5 ..... $1,790.00
FM8513 D1 ..... $170.00
FM8513 D3 ..... $325.00
FM8513 D5 ..... $650.00
FM8513 NF $200.00
FM8513 PF $735.00
FM8513 PG $735.00
FM8513 R3 ..... $800.00
FM8513 R5 ..... $1,600.00
FM8513 SL $0.00
FMA $28,150.00
FMA 01 ..... $2,190.00
FMA 02 ..... $2,785.00
FMA 03 ..... $3,400.00
FMA 05 ..... $3,830.00
FMA 07 ..... $3,755.00
FMA 08 ..... $13,600.00
FMA 09 ..... $1,835.00
FMA 10 ..... $10,125.00
FMA 1R $195.00
FMA C3 ..... $1,505.00
FMA C5 ..... $3,005.00
FMA D1 ..... $280.00
FMA D3 ..... $475.00
FMA D5 ..... $950.00
FMA R3 ..... $970.00
FMA R5 ..... $1,940.00
FMAB $35,700.00
FMAB 05 ..... $3,830.00
FMAB 07 ..... $4,385.00
FMAB 08 ..... $13,600.00
FMAB 09 ..... $1,835.00
FMAB 10 ..... $10,125.00
FMAB 1R $195.00
FMAB C3 ..... $1,760.00
FMAB C5 ..... $3,515.00
FMAB D1 ..... $330.00
FMAB D3 ..... $545.00
FMAB D5 ..... $1,085.00
FMAB R3 ..... $1,150.00
FMAB R5 ..... $2,300.00
FMAS $58,435.00
FMAS C3 ..... $2,480.00
FMAS C5 ..... $4,960.00
FMAS D1 ..... $255.00
FMAS D3 ..... $725.00
FMAS D5 ..... $1,445.00
FMAS R3 ..... $1,665.00
FMAS R5 ..... $3,325.00
FMAV $34,925.00
FMAV 01 ..... $2,190.00
FMAV 02 ..... $2,785.00
FMAV 03 ..... $3,415.00
FMAV 05 ..... $3,835.00
FMAV 08 ..... $13,600.00
FMAV C3 ..... $1,990.00
FMAV C5 ..... $3,975.00
FMAV D1 ..... $325.00
FMAV D3 ..... $600.00
FMAV D5 ..... $1,200.00
FMAV R3 ..... $1,085.00
FMAV R5 ..... $2,170.00
FMAZ1 ..... $3,255.00
FMB $35,700.00
FMB 01 ..... $2,190.00
FMB 02 ..... $2,785.00
FMB 03 ..... $3,415.00
FMB 05 ..... $3,835.00
FMB 07 ..... $4,385.00
FMB 08 ..... $13,600.00
FMB 09 ..... $1,835.00
FMB 10 ..... $10,125.00
FMB 1R $195.00
FMB C3 ..... $1,760.00
FMB C5 ..... $3,515.00
FMB D1 ..... $330.00
FMB D3 ..... $545.00
FMB D5 ..... $1,085.00
FMB R3 ..... $1,150.00
FMB R5 ..... $2,300.00
FMTAP $1,295.00
FMTAP SL $9,970.00
FS-K3 ..... $4,495.00
FS-Z15 ..... $1,450.00
FS1315. ..... $18,400.00
FS1315 30 ..... $0.00
FS1315 31 ..... $0.00
FS1315 32 ..... $0.00
FS1315 33 ..... $0.00
FS1315 34 ..... $0.00
FS1315 35 ..... $0.00
FS1315 36 ..... $0.00
FS1315 37 ..... $0.00
FS1315 38 ..... $0.00
FS1315 39 ..... $0.00
FS1315 41 ..... $0.00
FS1315 42 ..... $0.00
FS1315 AU $0.00
FS1315 C3 ..... $1,125.00
FS1315 C5 ..... $2,245.00
FS1315 D1 ..... $210.00
FS1315 D3 ..... $380.00
FS1315 D5 ..... $760.00
FS1315 HL $895.00
FS1315 R3 ..... $1,390.00
FS1315 R5 ..... $2,775.00
FS1315 SL $0.00
FS1315 WT $9,970.00
FSE-B10 ..... $12,950.00
FSE-B11 ..... $16,195.00
FSE-B12 ..... $2,750.00
FSE-B15 ..... $2,740.00
FSE-B16 ..... $1,375.00
FSE-B1603 ..... $1,375.00
FSE-B17 ..... $1,375.00
FSE-B18 ..... $1,995.00
FSE-B19 ..... $1,290.00
FSE-B2 ..... $14,000.00
FSE-B21 ..... $3,500.00
FSE-B4 ..... $4,465.00
FSE-B5 ..... $3,165.00
FSE-B7 ..... $17,600.00
FSE-B8 ..... $10,250.00
FSE-B9 ..... $13,500.00
FSE-K10 ..... $3,950.00
FSE-K11 ..... $3,950.00
FSE-K4 ..... $2,950.00
FSE-Z1 ..... $900.00
FSE-Z2 ..... $65.00
FSE-Z3 ..... $300.00
FSE-Z4 ..... $475.00
FSEA20 ..... $29,995.00
FSEA20 02 ..... $14,000.00
FSEA20 04 ..... $4,465.00
FSEA20 07 ..... $17,600.00
FSEA20 15 ..... $2,740.00
FSEA20 16 ..... $1,375.00
FSEA20 17 ..... $1,375.00
FSEA20 1R $200.00
FSEA20 49 ..... $1,375.00
FSEA20 B12 ..... $2,750.00
FSEA20 B18 ..... $1,995.00
FSEA20 B22 ..... $1,250.00
FSEA20 B23 ..... $510.00
FSEA20 B5 ..... $3,165.00
FSEA20 B8 ..... $10,250.00
FSEA20 B9 ..... $13,500.00
FSEA20 C3 ..... $1,740.00
FSEA20 C5 ..... $3,480.00
FSEA20 D1 ..... $290.00
FSEA20 D3 ..... $535.00
FSEA20 D5 ..... $1,065.00
FSEA20 K10 ..... $3,950.00
FSEA20 K11 ..... $3,950.00
FSEA20 K3 ..... $4,495.00
FSEA20 K4 ..... $2,950.00
FSEA20 R3 ..... $1,370.00
FSEA20 R5 ..... $2,740.00
FSEA30 ..... $47,855.00
FSEA30 02 ..... $14,000.00
FSEA30 07 ..... $17,600.00
FSEA30 15 ..... $2,740.00
FSEA30 16 ..... $1,375.00
FSEA30 17 ..... $1,375.00
FSEA30 1R $200.00
FSEA30 49 ..... $1,375.00
FSEA30 B12 ..... $2,750.00
FSEA30 B18 ..... $1,995.00
FSEA30 B22 ..... $1,250.00
FSEA30 B23 ..... $510.00
FSEA30 B8 ..... $10,250.00
FSEA30 B9 ..... $13,500.00
FSEA30 C3 ..... $2,585.00
FSEA30 C5 ..... $5,170.00
FSEA30 D1 ..... $405.00
FSEA30 D3 ..... $745.00
FSEA30 D5 ..... $1,485.00
FSEA30 K10 ..... $3,950.00
FSEA30 K11 ..... $3,950.00
FSEA30 K3 ..... $4,495.00
FSEA30 K4 ..... $2,950.00
FSEA30 R3 ..... $1,895.00
FSEA30 R5 ..... $3,785.00
FSEB20 ..... $36,745.00
FSEB20 04 ..... $4,465.00
FSEB20 07 ..... $17,600.00
FSEB20 15 ..... $2,740.00
FSEB20 16 ..... $1,375.00
FSEB20 17 ..... $1,375.00
FSEB20 1R $200.00
FSEB20 49 ..... $1,375.00
FSEB20 B10 ..... $12,950.00
FSEB20 B11 ..... $16,195.00
FSEB20 B12 ..... $2,750.00
FSEB20 B18 ..... $1,995.00
FSEB20 B22 ..... $1,250.00
FSEB20 B23 ..... $510.00
FSEB20 B5 ..... $3,165.00
FSEB20 C3 ..... $2,005.00
FSEB20 C5 ..... $4,010.00
FSEB20 D1 ..... $360.00
FSEB20 D3 ..... $600.00
FSEB20 D5 ..... $1,200.00
FSEB20 K10 ..... $3,950.00
FSEB20 K11 ..... $3,950.00
FSEB20 K3 ..... $4,495.00
FSEB20 K4 ..... $2,950.00
FSEB20 R3 ..... $1,540.00
FSEB20 R5 ..... $3,080.00
FSEB30 ..... $52,495.00

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FSEB30 07 ..... $17,600.00
FSEB30 15 ..... $2,740.00
FSEB30 16 ..... $1,375.00
FSEB30 17 ..... $1,375.00
FSEB30 1R $200.00
FSEB30 49 ..... $1,375.00
FSEB30 B10 ..... $12,950.00
FSEB30 B11 ..... $16,195.00
FSEB30 B12 ..... $2,750.00
FSEB30 B18 ..... $1,995.00
FSEB30 B22 ..... $1,250.00
FSEB30 B23 ..... $510.00
FSEB30 C3 ..... $2,825.00
FSEB30 C5 ..... $5,645.00
FSEB30 D1 ..... $435.00
FSEB30 D3 ..... $810.00
FSEB30 D5 ..... $1,615.00
FSEB30 K10 ..... $3,950.00
FSEB30 K11 ..... $3,950.00
FSEB30 K3 ..... $4,495.00
FSEB30 K4 ..... $2,950.00
FSEB30 R3 ..... $2,035.00
FSEB30 R5 ..... $4,070.00
FSEK20 ..... $55,950.00
FSEK20 1R $200.00
FSEK20 49 ..... $1,375.00
FSEK20 B15 ..... $2,740.00
FSEK20 B16 ..... $1,375.00
FSEK20 B17 ..... $1,375.00
FSEK20 B18 ..... $1,995.00
FSEK20 B21 ..... $3,500.00
FSEK20 B22 ..... $1,250.00
FSEK20 B23 ..... $510.00
FSEK20 B4 ..... $4,465.00
FSEK20 B5 ..... $3,165.00
FSEK20 B7 ..... $17,600.00
FSEK20 C3 ..... $3,385.00
FSEK20 C5 ..... $6,765.00
FSEK20 D1 ..... $505.00
FSEK20 D3 ..... $945.00
FSEK20 D5 ..... $1,885.00
FSEK20 K10 ..... $3,950.00
FSEK20 K11 ..... $3,950.00
FSEK20 K3 ..... $4,495.00
FSEK20 K4 ..... $2,950.00
FSEK20 R3 ..... $1,875.00
FSEK20 R5 ..... $3,745.00
FSEK30 ..... $74,250.00
FSEK30 1R $200.00
FSEK30 49 ..... $1,375.00
FSEK30 B10 ..... $12,950.00
FSEK30 B11 ..... $16,195.00
FSEK30 B12 ..... $2,750.00
FSEK30 B15 ..... $2,740.00
FSEK30 B16 ..... $1,375.00
FSEK30 B17 ..... $1,375.00
FSEK30 B18 ..... $1,995.00
FSEK30 B21 ..... $3,500.00
FSEK30 B22 ..... $1,250.00
FSEK30 B23 ..... $510.00
FSEK30 B7 ..... $17,600.00
FSEK30 C3 ..... $4,155.00
FSEK30 C5 ..... $8,305.00
FSEK30 D1 ..... $655.00
FSEK30 D3 ..... $1,140.00
FSEK30 D5 ..... $2,280.00
FSEK30 K10 ..... $3,950.00
FSEK30 K11 ..... $3,950.00
FSEK30 K3 ..... $4,495.00
FSEK30 K4 ..... $2,950.00
FSEK30 R3 ..... $2,280.00
FSEK30 R5 ..... $4,560.00
FSEM20 ..... $41,400.00
FSEM20 1R $200.00
FSEM20 49 ..... $1,375.00
FSEM20 B15 ..... $2,740.00
FSEM20 B16 ..... $1,375.00
FSEM20 B17 ..... $1,375.00
FSEM20 B18 ..... $1,995.00
FSEM20 B21 ..... $3,500.00
FSEM20 B22 ..... $1,250.00
FSEM20 B23 ..... $510.00
FSEM20 B4 ..... $4,465.00
FSEM20 B5 ..... $3,165.00
FSEM20 B7 ..... $17,600.00
FSEM20 C3 ..... $2,350.00
FSEM20 C5 ..... $4,695.00
FSEM20 D1 ..... $370.00
FSEM20 D3 ..... $685.00
FSEM20 D5 ..... $1,370.00
FSEM20 K10 ..... $3,950.00
FSEM20 K11 ..... $3,950.00
FSEM20 K3 ..... $4,495.00
FSEM20 K4 ..... $2,950.00
FSEM20 R3 ..... $1,750.00
FSEM20 R5 ..... $3,500.00
FSEM30 ..... $57,750.00
FSEM30 1R $200.00
FSEM30 49 ..... $1,375.00
FSEM30 B10 ..... $12,950.00
FSEM30 B11 ..... $16,195.00
FSEM30 B12 ..... $2,750.00
FSEM30 B15 ..... $2,740.00
FSEM30 B16 ..... $1,375.00
FSEM30 B17 ..... $1,375.00
FSEM30 B18 ..... $1,995.00
FSEM30 B21 ..... $3,500.00
FSEM30 B22 ..... $1,250.00
FSEM30 B23 ..... $510.00
FSEM30 B7 ..... $17,600.00
FSEM30 C3 ..... $3,090.00
FSEM30 C5 ..... $6,175.00
FSEM30 D1 ..... $470.00
FSEM30 D3 ..... $875.00
FSEM30 D5 ..... $1,750.00
FSEM30 K10 ..... $3,950.00
FSEM30 K11 ..... $3,950.00
FSEM30 K3 ..... $4,495.00
FSEM30 K4 ..... $2,950.00
FSEM30 R3 ..... $2,530.00
FSEM30 R5 ..... $5,055.00
FSIQ26 ..... $88,000.00
FSIQ26 1R $200.00
FSIQ26 49 ..... $1,375.00
FSIQ26 B10 ..... $12,950.00
FSIQ26 B11 ..... $16,195.00
FSIQ26 B12 ..... $2,750.00
FSIQ26 B16 ..... $1,375.00
FSIQ26 B17 ..... $1,375.00
FSIQ26 B21 ..... $3,500.00
FSIQ26 B22 ..... $1,250.00
FSIQ26 B23 ..... $510.00
FSIQ26 C3 ..... $4,100.00
FSIQ26 C5 ..... $7,915.00
FSIQ26 D1 ..... $600.00
FSIQ26 D3 ..... $1,800.00
FSIQ26 D5 ..... $3,060.00
FSIQ26 K10 ..... $3,950.00
FSIQ26 K11 ..... $3,950.00
FSIQ26 K3 ..... $4,495.00
FSIQ26 K4 ..... $2,950.00
FSIQ26 R3 ..... $4,285.00
FSIQ26 R5 ..... $8,275.00
FSIQ3 ..... $68,000.00
FSIQ3 1R $200.00
FSIQ3 49 ..... $1,375.00
FSIQ3 B12 ..... $2,750.00
FSIQ3 B16 ..... $1,375.00
FSIQ3 B17 ..... $1,375.00
FSIQ3 B2 ..... $14,000.00
FSIQ3 B22 ..... $1,250.00
FSIQ3 B23 ..... $510.00
FSIQ3 B8 ..... $10,250.00
FSIQ3 B9 ..... $13,500.00
FSIQ3 C3 ..... $3,220.00
FSIQ3 C5 ..... $6,215.00
FSIQ3 D1 ..... $510.00
FSIQ3 D3 ..... $1,520.00
FSIQ3 D5 ..... $2,445.00
FSIQ3 K10 ..... $3,950.00
FSIQ3 K11 ..... $3,950.00
FSIQ3 K3 ..... $4,495.00
FSIQ3 K4 ..... $2,950.00
FSIQ3 R3 ..... $3,405.00
FSIQ3 R5 ..... $6,575.00
FSIQ7 ..... $75,000.00
FSIQ7 1R $200.00
FSIQ7 49 ..... $1,375.00
FSIQ7 B10 ..... $12,950.00
FSIQ7 B11 ..... $16,195.00
FSIQ7 B12 ..... $2,750.00
FSIQ7 B16 ..... $1,375.00
FSIQ7 B17 ..... $1,375.00
FSIQ7 B22 ..... $1,250.00
FSIQ7 B23 ..... $510.00
FSIQ7 C3 ..... $3,550.00
FSIQ7 C5 ..... $6,855.00
FSIQ7 D1 ..... $555.00
FSIQ7 D3 ..... $1,665.00
FSIQ7 D5 ..... $2,675.00
FSIQ7 K10 ..... $3,950.00
FSIQ7 K11 ..... $3,950.00
FSIQ7 K3 ..... $4,495.00
FSIQ7 K4 ..... $2,950.00
FSIQ7 R3 ..... $3,735.00
FSIQ7 R5 ..... $7,210.00
FSTIP $125.00
GB1400 ..... $56,175.00
GB1400 02 ..... $1,995.00
GB1400 05 ..... $4,000.00
GB1400 07 ..... $2,000.00
GB1400 08 ..... $9,500.00
GB1400 2M $400.00
GB1400 A3 ..... $0.00
GB1400 C3 ..... $3,025.00
GB1400 D1 ..... $765.00
GB1400 D3 ..... $855.00
GB1400 R3 ..... $1,560.00
GB1400R $27,975.00
GB1400R02 ..... $800.00
GB1400R05 ..... $2,200.00
GB1400R08 ..... $5,000.00
GB1400R1M $200.00
GB1400RA3 ..... $0.00
GB1400RC3 ..... $1,740.00
GB1400RD1 ..... $415.00
GB1400RD3 ..... $535.00
GB1400RR3 ..... $970.00
GB1400T $29,750.00
GB1400T02 ..... $800.00
GB1400T05 ..... $2,200.00
GB1400T07 ..... $2,200.00
GB1400T08 ..... $5,000.00
GB1400T1M $200.00
GB1400TA3 ..... $0.00
GB1400TC3 ..... $1,740.00
GB1400TD1 ..... $415.00
GB1400TD3 ..... $535.00
GB1400TR3 ..... $1,010.00
GB140U8 ..... $12,500.00
GB14RU8 ..... $6,500.00
GB14TU5 ..... $3,000.00
GB14TU8 ..... $6,500.00
GB14U02 ..... $3,600.00
GB14U07 ..... $2,300.00
GB700 ..... $43,500.00
GB700 02 ..... $2,000.00
GB700 2M $400.00
GB700 A1 ..... $0.00
GB700 A2 ..... $0.00
GB700 A3 ..... $0.00
GB700 A4 ..... $0.00
GB700 A5 ..... $0.00
GB700 C3 ..... $2,120.00
GB700 D1 ..... $365.00
GB700 D3 ..... $630.00
GB700 R3 ..... $755.00
GB700R $21,850.00
GB700R 02 ..... $1,100.00
GB700R 1M $200.00
GB700R A1 ..... $0.00
GB700R A2 ..... $0.00
GB700R A3 ..... $0.00
GB700R A5 ..... $0.00
GB700R C3 ..... $1,085.00
GB700R D1 ..... $195.00
GB700R D3 ..... $375.00
GB700R R3 ..... $810.00
GB700T $21,850.00
GB700T 02 ..... $1,100.00
GB700T 1M $200.00
GB700T A1 ..... $0.00
GB700T A2 ..... $0.00
GB700T A3 ..... $0.00
GB700T A5 ..... $0.00
GB700T C3 ..... $1,040.00
GB700T D1 ..... $195.00
GB700T D3 ..... $365.00
GB700T R3 ..... $810.00
GCRF00 ..... $595.00

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GP1 ..... $895.00
GP1 R3 ..... $210.00
GP1 R5 ..... $405.00
GTS1250 ..... CFQ
GTS125001 ..... CFQ
GTS1250A1 ..... CFQ
GTS1250A2 ..... CFQ
GTS1250A3 ..... CFQ
GTS1250A5 ..... CFQ
GTS1250AC ..... CFQ
GTS1250C3 ..... CFQ
GTS1250D1 ..... CFQ
GTS1250D3 ..... CFQ
GTS1250R3 ..... CFQ
HCC $8,325.00
HCMB1 ..... $1,590.00
HCMB2 ..... $3,100.00
HCMB3 ..... $790.00
HCMF04 ..... $17,250.00
HCMF06 ..... $18,100.00
HCMM04 ..... $19,350.00
HCMM06 ..... $20,250.00
HCT1202 ..... $15,500.00
HCT1203 ..... $12,500.00
HDVG1 ..... $7,495.00
HDVG1 C3 ..... $650.00
HDVG1 D1 ..... $200.00
HDVG1 D3 ..... $324.00
HDVG1 R3 ..... $390.00
HFH2Z1 ..... $7,100.00
HFH2Z1 D1 ..... $285.00
HFH2Z2 ..... $6,825.00
HFH2Z2 D1 ..... $285.00
HFH2Z4 ..... $725.00
HFH2Z6 ..... $3,300.00
HFH2Z6 D1 ..... $285.00
HFS9003 ..... $17,250.00
HFS900301 ..... $995.00
HFS90031R $300.00
HFS9003A1 ..... $0.00
HFS9003A2 ..... $0.00
HFS9003A3 ..... $0.00
HFS9003A5 ..... $0.00
HFS9003C3 ..... $640.00
HFS9003C5 ..... $1,275.00
HFS9003D1 ..... $140.00
HFS9003D3 ..... $260.00
HFS9003D5 ..... $515.00
HFS9003R3 ..... $1,370.00
HFS9003R5 ..... $2,740.00
HFS9009 ..... $26,250.00
HFS900901 ..... $995.00
HFS9009A1 ..... $0.00
HFS9009A2 ..... $0.00
HFS9009A3 ..... $0.00
HFS9009A5 ..... $0.00
HFS9009C3 ..... $945.00
HFS9009C5 ..... $1,885.00
HFS9009D1 ..... $180.00
HFS9009D3 ..... $335.00
HFS9009D5 ..... $665.00
HFS9009R3 ..... $1,970.00
HFS9009R5 ..... $3,935.00
HFS9DG1 ..... $13,400.00
HFS9DG1C3 ..... $515.00
HFS9DG1C5 ..... $1,030.00
HFS9DG1D1 ..... $120.00
HFS9DG1D3 ..... $230.00
HFS9DG1D5 ..... $460.00
HFS9DG1R3 ..... $1,095.00
HFS9DG1R5 ..... $2,185.00
HFS9DG2 ..... $9,650.00
HFS9DG2C3 ..... $400.00
HFS9DG2C5 ..... $800.00
HFS9DG2D1 ..... $105.00
HFS9DG2D3 ..... $200.00
HFS9DG2D5 ..... $400.00
HFS9DG2R3 ..... $850.00
HFS9DG2R5 ..... $1,695.00
HFU2Z4 ..... $860.00
HFU2Z4 D1 ..... $285.00
HFU2Z5 ..... $680.00
HFUMZ02 ..... $8,750.00
HFUMZ02D1 ..... $285.00
HFUTZ02 ..... $2,650.00
HFVZ $335.00
HK116 ..... $2,675.00
HK116 D1 ..... $285.00
HL023A1 ..... $4,325.00
HL023A1D1 ..... $285.00
HL223 ..... $2,990.00
HL223 D1 ..... $285.00
HL223Z1 ..... $740.00
HL223Z1D1 ..... $285.00
HM525 ..... $16,850.00
HM525 D1 ..... $285.00
HM525Z1 ..... $450.00
HPT-C3916A-ABD. ... $1,870.00
HUFZ1 ..... $2,885.00
HUFZ1 D1 ..... $285.00
HUFZ4 ..... $3,400.00
HUFZ4 D1 ..... $285.00
HZ1 ..... $860.00
HZ1102 ..... $1,490.00
HZ12 ..... $5,350.00
HZ12 D1 ..... $285.00
HZ13 ..... $5,100.00
HZ13 D1 ..... $285.00
HZ14 ..... $5,400.00
HZ18 ..... $245.00
HZ19 ..... $270.00
HZ3 ..... $335.00
HZ4 ..... $360.00
HZ9 ..... $1,950.00
IQSIMK $950.00
IST-ISTS2 ..... $155,735.00
J17 ..... $1,295.00
J17 D1 ..... $150.00
J18 ..... $2,295.00
J18 D1 ..... $150.00
J1803 ..... $655.00
J1803 D1 ..... $150.00
J1810 ..... $1,645.00
J1810 D1 ..... $150.00
J1811 ..... $765.00
J1811 D1 ..... $150.00
J1820 ..... $1,645.00
J1820 D1 ..... $150.00
K212 ..... $479.00
K212 10 ..... $80.00
K212 12 ..... $100.00
K212 22 ..... $170.00
K415 ..... $839.00
K420 ..... $860.00
K465 ..... $935.00
K475 ..... $1,095.00
KNW242 ..... $4,600.00
KNW403D $2,800.00
KNW407 ..... $2,700.00
KT10 ..... $6,200.00
KT20 ..... $6,200.00
LACART $925.00
LPB1100 ..... $24,050.00
LPB11001C $3,570.00
LPB11001L $450.00
LPB11001M $3,570.00
LPB11001S $3,570.00
LPB11001W $0.00
LPB1100A1 ..... $0.00
LPB1100A2 ..... $0.00
LPB1100A3 ..... $0.00
LPB1100C3 ..... $740.00
LPB1100D1 ..... $0.00
LPB1100D3 ..... $450.00
LPB1100P6 ..... $5,410.00
LPB1100R3 ..... $1,525.00
LPB1300 ..... $51,700.00
LPB13001L $450.00
LPB13001M $3,540.00
LPB13001W $0.00
LPB1300A1 ..... $0.00
LPB1300A2 ..... $0.00
LPB1300A3 ..... $0.00
LPB1300C3 ..... $1,375.00
LPB1300D1 ..... $0.00
LPB1300D3 ..... $725.00
LPB1300R3 ..... $3,410.00
LPB1550 ..... $40,600.00
LPB15501L $450.00
LPB15501M $3,470.00
LPB15501W $5,600.00
LPB15502W $11,100.00
LPB15503W $0.00
LPB1550A1 ..... $0.00
LPB1550A2 ..... $0.00
LPB1550A3 ..... $0.00
LPB1550C3 ..... $1,250.00
LPB1550D1 ..... $0.00
LPB1550D3 ..... $675.00
LPB1550P6 ..... $5,260.00
LPB1550PX $10,510.00
LPB1550R3 ..... $3,040.00
LPM5000 ..... $6,100.00
LPM5000A1 ..... $0.00
LPM5000A2 ..... $0.00
LPM5000A3 ..... $0.00
LPM5000C3 ..... $415.00
LPM5000D3 ..... $310.00
LPM5000R3 ..... $540.00
LPM5200 ..... $17,500.00
LPM52001M $3,450.00
LPM52001S $3,450.00
LPM52001W $0.00
LPM52002W $0.00
LPM5200C3 ..... $905.00
LPM5200D3 ..... $520.00
LPM5200P6 ..... $3,450.00
LPM5200PX $6,900.00
LPM5200R3 ..... $920.00
LPM5500 ..... $9,800.00
LPM550001 ..... $0.00
LPM550002 ..... $0.00
LPM550003 ..... $0.00
LPM550004 ..... $0.00
LPM550005 ..... $0.00
LPM550006 ..... $0.00
LPM550007 ..... $0.00
LPM550008 ..... $0.00
LPM550009 ..... $0.00
LPM550010 ..... $0.00
LPM550011 ..... $0.00
LPM550012 ..... $0.00
LPM550013 ..... $0.00
LPM550014 ..... $0.00
LPM550015 ..... $0.00
LPM550016 ..... $0.00
LPM550017 ..... $0.00
LPM550018 ..... $0.00
LPM550019 ..... $0.00
LPM550020 ..... $0.00
LPM550021 ..... $0.00
LPM550022 ..... $0.00
LPM550023 ..... $0.00
LPM550024 ..... $0.00
LPM550025 ..... $0.00
LPM550026 ..... $0.00
LPM550027 ..... $0.00
LPM550028 ..... $0.00
LPM550029 ..... $0.00
LPM550030 ..... $0.00
LPM550031 ..... $0.00
LPM550032 ..... $0.00
LPM550033 ..... $0.00
LPM550034 ..... $0.00
LPM550035 ..... $0.00
LPM550036 ..... $0.00
LPM5500C3 ..... $460.00
LPM5500D3 ..... $330.00
LPM5500R3 ..... $585.00
LPM5700 ..... $16,600.00
LPM5700C3 ..... $700.00
LPM5700D3 ..... $435.00
LPM5700R3 ..... $765.00
LVWIN95 ..... $2,175.00
LVWIN9510 ..... $0.00
LVWIN9511 ..... $0.00
LVWIN9521 ..... $435.00
LVWINNT $2,175.00
LVWINNT10 ..... $0.00
LVWINNT21 ..... $435.00
LVWINTE $570.00
LWCVI95 ..... $2,175.00
LWCVI9510 ..... $0.00
LWCVI9511 ..... $0.00
LWCVI9521 ..... $435.00
LWCVINT $2,175.00
LWCVINT10 ..... $0.00
LWCVINT21 ..... $435.00
LWCVITE $570.00
M2T300 ..... $7,995.00

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M2T300 A0 ..... $0.00
M2T300 A1 ..... $0.00
M2T300 A2 ..... $0.00
M2T300 A3 ..... $0.00
M2T300 B2 ..... $1,600.00
M2T300 B3 ..... $3,000.00
M2T300 B4 ..... $4,300.00
M2T300 D1 ..... $2,000.00
M2T300 D3 ..... $2,000.00
M2T300 D4 ..... $2,000.00
M2T300 DA $3,000.00
M2T300 DC $3,000.00
M2T300 DD $3,000.00
M2T300 E1 ..... $17,000.00
M2T300 E3 ..... $17,000.00
M2T300 E4 ..... $17,000.00
M2T300 E5 ..... $20,000.00
M2T300 EA $22,000.00
M2T300 EC $22,000.00
M2T300 ED $22,000.00
M2T300 EE $25,000.00
M2T300 N1 ..... $3,000.00
M2T300 N2 ..... $5,000.00
M2T300 N3 ..... $3,500.00
M2T300 N4 ..... $3,500.00
M2T300 N5 ..... $4,000.00
M366-BS..... $20,760.00
M366-BS-SW-R30 ... $3,500.00
M366-BS-SW-R31 ... $3,500.00
M366-DSP..... $6,260.00
M366-FP..... $50.00
M366-GPS..... $3,500.00
M366-MI-RT-R41 .... $1,260.00
M366-MI-SW-R10... $17,760.00
M366-MI-SW-R31... $17,760.00
M366-MR-900 ..... $11,130.00
M366-MS-900..... $28,260.00
M366-MS-DFQ-R31 .. $5,380.00
M366-MS-SW-R30... $6,320.00
M366-MS-SW-R31 ... $6,320.00
M366-MT..... $3,500.00
M366-RP-SW-R10 ... $3,820.00
M366-RP-SW-R31 ... $3,820.00
M366-TRAINING $1,260.00
MC61 ..... $60.00
MCTAP..... $95.00
MDS21 ..... $4,145.00
MDS21 D1..... $285.00
MDS22..... $4,325.00
MDS22 D1 ..... $285.00
MI09..... $170.00
MM18..... $900.00
MP612A $200.00
MP613A50 ..... $300.00
MP613A75 ..... $300.00
MSS170A..... $12,575.00
MSS170AC3..... $715.00
MSS170AC5..... $1,425.00
MSS170AD1 ..... $155.00
MSS170AD3 ..... $280.00
MSS170AD5 ..... $555.00
MSS170AR3..... $715.00
MSS170AR5 ..... $1,190.00
MTS1F03..... $10,000.00
MTS1F05..... $18,000.00
MTS205 ..... $35,000.00
MTS205 1R $1,800.00
MTS205 A1 ..... $0.00
MTS205 A2 ..... $0.00
MTS205 A3 ..... $0.00
MTS205 A5 ..... $0.00
MTS205 R3 ..... $1,030.00
MTS205 R5 ..... $2,055.00
MTS205 SS $1,500.00
MTS210..... $0.00
MTS210 1A $36,000.00
MTS210 1G $36,000.00
MTS210 1R..... $1,800.00
MTS210 A1..... $0.00
MTS210 A2..... $0.00
MTS210 A3..... $0.00
MTS210 A5..... $0.00
MTS210 AC $5,000.00
MTS210 AG $47,000.00
MTS210 CA $3,000.00
MTS210 ES..... $10,000.00
MTS210 OM..... $9,000.00
MTS210 PS $9,000.00
MTS210 SS..... $1,500.00
MTS215..... $57,750.00
MTS215 1R..... $1,800.00
MTS215 A1..... $0.00
MTS215 A2..... $0.00
MTS215 A3..... $0.00
MTS215 A5..... $0.00
MTS215 AC $5,000.00
MTS215 CA $3,000.00
MTS215 ES..... $10,000.00
MTS215 OM..... $9,000.00
MTS215 PS $9,000.00
MTS215 R3..... $1,095.00
MTS215 R5..... $2,185.00
MTS215 SS..... $1,500.00
MTS2AC3 ..... $5,000.00
MTS2AN..... $10,000.00
MTS2AN AC $5,000.00
MTS2AN CA $3,000.00
MTS2AN ES..... $10,000.00
MTS2CR $15,000.00
MTS2CR CA..... $3,000.00
MTS2CR ES $10,000.00
MTS2ES..... $10,000.00
MTS2F01 ..... $25,000.00
MTS2F04..... $22,000.00
MTS2F06..... $12,000.00
MTS2F07..... $10,000.00
MTS2F08..... $3,000.00
MTS2F1R..... $1,800.00
MTS2F25..... $5,000.00
MTS2F30 ..... $0.00
MTS2FPS..... $9,000.00
MTS2TS $25,000.00
MTS2TS AC..... $5,000.00
MTS2TS CA..... $3,000.00
MTS2TS ES $10,000.00
MTS2WIZ..... $0.00
MTSFAC3..... $5,000.00
MTSFOMX..... $9,000.00
MTSFSSI $1,500.00
MXI2PCI $4,900.00
MXI2PCI01 ..... $110.00
MXI2PCI02..... $330.00
MXI2PCI03..... $0.00
MXI2PCI04 ..... $210.00
NAP-B4..... $930.00
NAP02 ..... $2,525.00
NAP02 C3 ..... $715.00
NAP02 C5..... $1,425.00
NAP02 D1..... $205.00
NAP02 R3 ..... $190.00
NAP02 R5 ..... $380.00
NAP04 ..... $3,275.00
NAP04 C3 ..... $715.00
NAP04 C5..... $1,425.00
NAP04 D1..... $205.00
NAP04 R3 ..... $230.00
NAP04 R5 ..... $460.00
NAPZ2..... $390.00
NAPZ2 D1 ..... $155.00
NAPZ3 ..... $1,585.00
NAPZ3 C3 ..... $715.00
NAPZ3 C5..... $1,425.00
NAPZ3 D1 ..... $100.00
NAPZ3 D3..... $280.00
NAPZ3 D5..... $555.00
NAPZ3 R3 ..... $155.00
NAPZ3 R5 ..... $305.00
NAPZ4 ..... $1,975.00
NAPZ4 D1 ..... $155.00
NAPZ4 R3 ..... $175.00
NAPZ4 R5 ..... $345.00
NAPZ42 ..... $2,550.00
NAPZ42 C3 ..... $1,200.00
NAPZ42 C5 ..... $2,395.00
NAPZ42 D1..... $100.00
NAPZ42 D3 ..... $400.00
NAPZ42 D5 ..... $800.00
NAPZ42 R3..... $190.00
NAPZ42 R5..... $380.00
NAPZ5 ..... $2,195.00
NAPZ5 C3 ..... $905.00
NAPZ5 C5..... $1,805.00
NAPZ5 D1 ..... $100.00
NAPZ5 D3..... $325.00
NAPZ5 D5..... $650.00
NAPZ5 R3 ..... $175.00
NAPZ5 R5 ..... $345.00
NAPZ6 ..... $2,295.00
NAPZ6 C3..... $1,200.00
NAPZ6 C5..... $2,395.00
NAPZ6 D1 ..... $100.00
NAPZ6 D3..... $400.00
NAPZ6 D5..... $800.00
NAPZ6 R3 ..... $175.00
NAPZ6 R5 ..... $345.00
NAPZ7 ..... $2,595.00
NAPZ7 C3..... $1,200.00
NAPZ7 C5..... $2,395.00
NAPZ7 D1 ..... $100.00
NAPZ7 D3..... $400.00
NAPZ7 D5..... $800.00
NAPZ7 R3 ..... $200.00
NAPZ7 R5 ..... $400.00
NAPZ8 ..... $2,595.00
NAPZ8 C3..... $1,200.00
NAPZ8 C5..... $2,395.00
NAPZ8 D1 ..... $100.00
NAPZ8 D3..... $400.00
NAPZ8 D5..... $800.00
NAPZ8 R3 ..... $200.00
NAPZ8 R5 ..... $400.00
NAPZ9 ..... $1,975.00
NAPZ9 D1 ..... $100.00
NAPZ9 R3 ..... $175.00
NAPZ9 R5 ..... $345.00
NAS $1,200.00
NAS D1 ..... $100.00
NAS-Z30..... $325.00
NAS-Z7..... $1,365.00
NAS-Z7 D1 ..... $155.00
NAS-Z7 R3 ..... $235.00
NAS-Z7 R5 ..... $455.00
NASZ1..... $950.00
NASZ1 C3 ..... $495.00
NASZ1 D1 ..... $155.00
NASZ1 D3..... $220.00
NASZ1 R3 ..... $115.00
NASZ10..... $165.00
NASZ2..... $1,175.00
NASZ2 C3 ..... $715.00
NASZ2 D1 ..... $155.00
NASZ2 D3..... $280.00
NASZ2 D5..... $555.00
NASZ2 R3 ..... $125.00
NASZ2 R5 ..... $250.00
NASZ3..... $975.00
NASZ3 C3 ..... $220.00
NASZ3 D1 ..... $155.00
NASZ3 D3..... $155.00
NASZ3 R3 ..... $115.00
NASZ5..... $950.00
NASZ5 D1 ..... $155.00
NASZ6 ..... $1,275.00
NASZ6 D1 ..... $155.00
NASZ9 ..... $65.00
NAZ10..... $150.00
NAZ10 D1 ..... $155.00
NAZ30..... $360.00
NAZ30 D1 ..... $155.00
NRT $2,795.00
NRT 1R $295.00
NRT B1 ..... $595.00
NRT B2 ..... $345.00
NRT B3 ..... $495.00
NRT D1..... $95.00
NRT-B1 ..... $595.00
NRT-B1 D1..... $95.00
NRT-B3..... $495.00
NRT-Z1 ..... $195.00
NRT-Z210 ..... $350.00
NRT-Z230..... $595.00
NRT-Z3..... $595.00
NRT-Z4..... $695.00
NRT-Z43..... $2,295.00
NRT-Z43D1..... $95.00
NRT-Z44..... $2,295.00
NRT-Z44D1..... $95.00
NRV-Z15 ..... $2,395.00
NRV-Z32..... $2,195.00
NRV-Z3205..... $1,810.00

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NRV-Z32D1 ..... $100.00
NRV-Z32R3 ..... $165.00
NRV-Z32R5 ..... $325.00
NRV-Z51D1 ..... $100.00
NRV-Z53 ..... $2,195.00
NRV-Z53D1 ..... $100.00
NRV-Z53R3 ..... $145.00
NRV-Z53R5 ..... $285.00
NRV-Z54 ..... $2,375.00
NRV-Z54D1 ..... $100.00
NRV-Z54R3 ..... $190.00
NRV-Z54R5 ..... $380.00
NRV-Z55 ..... $2,075.00
NRVD $5,295.00
NRVD 01 ..... $675.00
NRVD 1R $340.00
NRVD C5 ..... $515.00
NRVD D1 ..... $205.00
NRVD D3 ..... $115.00
NRVD D5 ..... $230.00
NRVD R3 ..... $305.00
NRVD R5 ..... $610.00
NRVD-B2 ..... $655.00
NRVD-S1 ..... $785.00
NRVS $2,695.00
NRVS 1R $340.00
NRVS B1 ..... $450.00
NRVS C5 ..... $1,140.00
NRVS D1 ..... $205.00
NRVS D3 ..... $190.00
NRVS D5 ..... $380.00
NRVS R3 ..... $200.00
NRVS R5 ..... $400.00
NRVS-B1 ..... $450.00
NRVZ102 ..... $1,565.00
NRVZ102C3 ..... $260.00
NRVZ102C5 ..... $515.00
NRVZ102D1 ..... $100.00
NRVZ102D3 ..... $165.00
NRVZ102D5 ..... $325.00
NRVZ102R3 ..... $145.00
NRVZ102R5 ..... $285.00
NRVZ103 ..... $1,595.00
NRVZ103C3 ..... $260.00
NRVZ103C5 ..... $515.00
NRVZ103D1 ..... $100.00
NRVZ103D3 ..... $165.00
NRVZ103D5 ..... $325.00
NRVZ103R3 ..... $145.00
NRVZ103R5 ..... $285.00
NRVZ202 ..... $1,695.00
NRVZ202C3 ..... $260.00
NRVZ202C5 ..... $515.00
NRVZ202D1 ..... $100.00
NRVZ202D3 ..... $165.00
NRVZ202D5 ..... $325.00
NRVZ202R3 ..... $145.00
NRVZ202R5 ..... $285.00
NRVZ203 ..... $1,875.00
NRVZ203C3 ..... $260.00
NRVZ203C5 ..... $515.00
NRVZ203D1 ..... $100.00
NRVZ203D3 ..... $165.00
NRVZ203D5 ..... $325.00
NRVZ203R3 ..... $145.00
NRVZ203R5 ..... $285.00
NRVZ302 ..... $1,495.00
NRVZ302C3 ..... $260.00
NRVZ302C5 ..... $515.00
NRVZ302D1 ..... $100.00
NRVZ302D3 ..... $165.00
NRVZ302D5 ..... $325.00
NRVZ302R3 ..... $145.00
NRVZ302R5 ..... $285.00
NRVZ303 ..... $1,595.00
NRVZ303D1 ..... $100.00
NRVZ303R3 ..... $145.00
NRVZ303R5 ..... $285.00
NRVZ312 ..... $1,895.00
NRVZ312D1 ..... $100.00
NRVZ312R3 ..... $145.00
NRVZ312R5 ..... $285.00
NRVZ313 ..... $1,895.00
NRVZ313C3 ..... $905.00
NRVZ313C5 ..... $1,805.00
NRVZ313D1 ..... $100.00
NRVZ313R3 ..... $145.00
NRVZ313R5 ..... $285.00
NRVZ314 ..... $1,895.00
NRVZ314D1 ..... $155.00
NRVZ314R3 ..... $145.00
NRVZ314R5 ..... $285.00
NRVZ402 ..... $1,395.00
NRVZ402C3 ..... $800.00
NRVZ402C5 ..... $1,600.00
NRVZ402D1 ..... $100.00
NRVZ402D3 ..... $295.00
NRVZ402D5 ..... $590.00
NRVZ402R3 ..... $145.00
NRVZ402R5 ..... $285.00
NRVZ403 ..... $1,495.00
NRVZ403C3 ..... $800.00
NRVZ403C5 ..... $1,600.00
NRVZ403D1 ..... $100.00
NRVZ403D3 ..... $295.00
NRVZ403D5 ..... $590.00
NRVZ403R3 ..... $145.00
NRVZ403R5 ..... $285.00
NRVZ502 ..... $1,750.00
NRVZ502C3 ..... $800.00
NRVZ502C5 ..... $1,600.00
NRVZ502D1 ..... $100.00
NRVZ502D3 ..... $295.00
NRVZ502D5 ..... $590.00
NRVZ502R3 ..... $145.00
NRVZ502R5 ..... $285.00
NRVZ503 ..... $1,975.00
NRVZ503C3 ..... $800.00
NRVZ503C5 ..... $1,600.00
NRVZ503D1 ..... $100.00
NRVZ503D3 ..... $295.00
NRVZ503D5 ..... $590.00
NRVZ503R3 ..... $145.00
NRVZ503R5 ..... $285.00
NRVZ51 ..... $885.00
NRVZ51 C3 ..... $905.00
NRVZ51 D1 ..... $100.00
NRVZ51 D3 ..... $325.00
NRVZ51 R3 ..... $115.00
NRVZ52 ..... $1,695.00
NRVZ52 C3 ..... $260.00
NRVZ52 C5 ..... $515.00
NRVZ52 D1 ..... $100.00
NRVZ52 D3 ..... $165.00
NRVZ52 D5 ..... $325.00
NRVZ52 R3 ..... $145.00
NRVZ52 R5 ..... $285.00
NRVZ6 ..... $1,895.00
NRVZ6 C3 ..... $260.00
NRVZ6 C5 ..... $515.00
NRVZ6 D1 ..... $100.00
NRVZ6 D3 ..... $165.00
NRVZ6 D5 ..... $325.00
NRVZ6 R3 ..... $145.00
NRVZ6 R5 ..... $285.00
NRVZ8 ..... $1,295.00
NRVZ8 C3 ..... $260.00
NRVZ8 C5 ..... $515.00
NRVZ8 D1 ..... $100.00
NRVZ8 D3 ..... $165.00
NRVZ8 D5 ..... $325.00
NRVZ8 R3 ..... $145.00
NRVZ8 R5 ..... $285.00
OA5002 ..... $7,395.00
OA5002 A1 ..... $0.00
OA5002 A2 ..... $0.00
OA5002 A3 ..... $0.00
OA5002 A4 ..... $0.00
OA5002 A5 ..... $0.00
OA5002 C3 ..... $1,805.00
OA5002 C5 ..... $3,610.00
OA5002 D1 ..... $120.00
OA5002 D3 ..... $555.00
OA5002 D5 ..... $1,105.00
OA5002 R3 ..... $420.00
OA5002 R5 ..... $840.00
OA5012 ..... $7,195.00
OA5012 A1 ..... $0.00
OA5012 A2 ..... $0.00
OA5012 A3 ..... $0.00
OA5012 A4 ..... $0.00
OA5012 A5 ..... $0.00
OA5012 C3 ..... $1,790.00
OA5012 C5 ..... $3,575.00
OA5012 D1 ..... $115.00
OA5012 D3 ..... $545.00
OA5012 D5 ..... $1,085.00
OA5012 R3 ..... $375.00
OA5012 R5 ..... $745.00
OA5022 ..... $7,195.00
OA5022 A1 ..... $0.00
OA5022 A2 ..... $0.00
OA5022 A3 ..... $0.00
OA5022 A4 ..... $0.00
OA5022 A5 ..... $0.00
OA5022 C3 ..... $1,790.00
OA5022 C5 ..... $3,575.00
OA5022 D1 ..... $115.00
OA5022 D3 ..... $545.00
OA5022 D5 ..... $1,085.00
OA5022 R3 ..... $375.00
OA5022 R5 ..... $745.00
OA5032 ..... $7,195.00
OA5032 A1 ..... $0.00
OA5032 A2 ..... $0.00
OA5032 A3 ..... $0.00
OA5032 A4 ..... $0.00
OA5032 A5 ..... $0.00
OA5032 C3 ..... $1,790.00
OA5032 C5 ..... $3,575.00
OA5032 D1 ..... $115.00
OA5032 D3 ..... $545.00
OA5032 D5 ..... $1,085.00
OA5032 R3 ..... $375.00
OA5032 R5 ..... $745.00
OIG501 ..... $13,995.00
OIG501 C3 ..... $620.00
OIG501 D1 ..... $150.00
OIG501 D3 ..... $260.00
OIG501 R3 ..... $515.00
OIG502 ..... $13,995.00
OIG502 C3 ..... $620.00
OIG502 D1 ..... $150.00
OIG502 D3 ..... $260.00
OIG502 R3 ..... $515.00
ORR24 ..... $11,995.00
ORR24 C3 ..... $620.00
ORR24 D1 ..... $135.00
ORR24 D3 ..... $260.00
ORR24 R3 ..... $505.00
ORS20 ..... $14,995.00
ORS20 01 ..... $0.00
ORS20 A1 ..... $0.00
ORS20 A2 ..... $0.00
ORS20 A3 ..... $0.00
ORS20 A4 ..... $0.00
ORS20 A5 ..... $0.00
ORS20 C3 ..... $780.00
ORS20 D1 ..... $150.00
ORS20 D3 ..... $295.00
ORS20 FR $350.00
ORS20 R3 ..... $580.00
P3010 ..... $95.00
P3410 ..... $1,245.00
P3410 D1 ..... $80.00
P3410 R3 ..... $135.00
P3410 R5 ..... $270.00
P3420 ..... $2,495.00
P3420 D1 ..... $90.00
P3420 R3 ..... $190.00
P3420 R5 ..... $380.00
P5100 ..... $229.00
P5102 ..... $225.00
P5200 ..... $479.00
P5200 A1 ..... $0.00
P5200 A2 ..... $0.00
P5200 A3 ..... $0.00
P5200 A5 ..... $0.00
P5200 A6 ..... $0.00
P5200 C3 ..... $155.00
P5200 D1 ..... $75.00
P5200 D3 ..... $135.00
P5205 ..... $995.00
P5205 C3 ..... $185.00
P5205 D1 ..... $75.00
P5205 D3 ..... $145.00
P5205 R3 ..... $135.00
P5210 ..... $1,995.00
P5210 C3 ..... $200.00
P5210 C5 ..... $400.00

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P5210 D1 ..... $85.00
P5210 D3 ..... $155.00
P5210 D5 ..... $305.00
P5210 R3 ..... $210.00
P5210 R5 ..... $420.00
P6015A $1,195.00
P6015A 1R $70.00
P6015A 25 ..... $155.00
P6015A 2R $200.00
P6015A C3 ..... $200.00
P6015A C5 ..... $400.00
P6015A D1 ..... $80.00
P6015A D3 ..... $155.00
P6015A D5 ..... $305.00
P6015A R3 ..... $125.00
P6015A R5 ..... $250.00
P6021 ..... $729.00
P6021 03 ..... $65.00
P6022 ..... $749.00
P6041 ..... $160.00
P6101B $75.00
P6103B $100.00
P6105A $239.00
P6105A 01 ..... $60.00
P6106A $279.00
P6106A 01 ..... $60.00
P6109B $120.00
P6111B $165.00
P6112 ..... $85.00
P6114B $229.00
P6117 ..... $110.00
P6119B $119.00
P6122 ..... $170.00
P6129B $155.00
P6131 ..... $285.00
P6131 02 ..... $60.00
P6133 ..... $239.00
P6133 01 ..... $60.00
P6133 25 ..... $55.00
P6134C $319.00
P6135A $1,095.00
P6136 ..... $260.00
P6136 25 ..... $55.00
P6137 ..... $299.00
P6138A $249.00
P6139A $295.00
P6150 ..... $1,250.00
P6156 ..... $359.00
P6158 ..... $329.00
P6201 ..... $2,095.00
P6201 C3 ..... $460.00
P6201 C5 ..... $915.00
P6201 D1 ..... $75.00
P6201 D3 ..... $210.00
P6201 D5 ..... $420.00
P6201 R3 ..... $230.00
P6201 R5 ..... $460.00
P6202A $1,450.00
P6202A C3 ..... $200.00
P6202A C5 ..... $400.00
P6202A D1 ..... $80.00
P6202A D3 ..... $155.00
P6202A D5 ..... $305.00
P6202A R3 ..... $95.00
P6202A R5 ..... $190.00
P6204 ..... $1,950.00
P6204 C3 ..... $220.00
P6204 C5 ..... $440.00
P6204 D1 ..... $80.00
P6204 D3 ..... $155.00
P6204 D5 ..... $305.00
P6204 R3 ..... $175.00
P6204 R5 ..... $345.00
P6205 ..... $725.00
P6205 C3 ..... $185.00
P6205 D1 ..... $75.00
P6205 D3 ..... $145.00
P6205 R3 ..... $80.00
P6207 ..... $3,995.00
P6207 C3 ..... $315.00
P6207 C5 ..... $630.00
P6207 D1 ..... $95.00
P6207 D3 ..... $185.00
P6207 D5 ..... $365.00
P6207 R3 ..... $260.00
P6207 R5 ..... $515.00
P6240 ..... $250.00
P6240 R3 ..... $80.00
P6243 ..... $449.00
P6243 C3 ..... $155.00
P6243 D1 ..... $75.00
P6243 D3 ..... $135.00
P6243 R3 ..... $80.00
P6243S $1,695.00
P6243S A1 ..... $0.00
P6243S A2 ..... $0.00
P6243S A3 ..... $0.00
P6243S A5 ..... $0.00
P6245 ..... $1,695.00
P6245 C3 ..... $220.00
P6245 C5 ..... $440.00
P6245 D1 ..... $80.00
P6245 D3 ..... $155.00
P6245 D5 ..... $305.00
P6245 R3 ..... $95.00
P6245 R5 ..... $190.00
P6246 ..... $2,495.00
P6246 C3 ..... $260.00
P6246 C5 ..... $515.00
P6246 D1 ..... $85.00
P6246 D3 ..... $165.00
P6246 D5 ..... $325.00
P6246 R3 ..... $175.00
P6246 R5 ..... $345.00
P6247 ..... $3,395.00
P6247 C3 ..... $315.00
P6247 C5 ..... $630.00
P6247 D1 ..... $95.00
P6247 D3 ..... $185.00
P6247 D5 ..... $365.00
P6247 R3 ..... $220.00
P6247 R5 ..... $440.00
P6248 ..... $4,295.00
P6248 C3 ..... $230.00
P6248 D1 ..... $90.00
P6248 D3 ..... $235.00
P6248 R3 ..... $370.00
P6249 ..... $3,395.00
P6249 C3 ..... $205.00
P6249 D1 ..... $95.00
P6249 D3 ..... $220.00
P6249 R3 ..... $335.00
P6339A $995.00
P6339A D1 ..... $155.00
P6408 ..... $795.00
P6417 ..... $750.00
P6418 ..... $525.00
P6434 ..... $1,050.00
P6434 01 ..... $325.00
P6561A $275.00
P6562A $295.00
P6563A $339.00
P6701B $3,495.00
P6701B C3 ..... $295.00
P6701B C5 ..... $590.00
P6701B D1 ..... $90.00
P6701B D3 ..... $175.00
P6701B FR $350.00
P6701B R3 ..... $145.00
P6703B $3,495.00
P6703B C3 ..... $315.00
P6703B C5 ..... $630.00
P6703B D1 ..... $95.00
P6703B D3 ..... $185.00
P6703B FR $350.00
P6703B R3 ..... $155.00
P6711 ..... $2,395.00
P6711 01 ..... $0.00
P6711 02 ..... $0.00
P6711 03 ..... $0.00
P6711 04 ..... $0.00
P6711 C3 ..... $240.00
P6711 C5 ..... $475.00
P6711 D1 ..... $85.00
P6711 D3 ..... $165.00
P6711 D5 ..... $325.00
P6711 R3 ..... $115.00
P6711 R5 ..... $230.00
P6713 ..... $2,795.00
P6713 01 ..... $0.00
P6713 02 ..... $0.00
P6713 03 ..... $0.00
P6713 04 ..... $0.00
P6713 C3 ..... $260.00
P6713 C5 ..... $515.00
P6713 D1 ..... $85.00
P6713 D3 ..... $165.00
P6713 D5 ..... $325.00
P6713 R3 ..... $135.00
P6713 R5 ..... $270.00
P6723 ..... $2,695.00
P6723 C3 ..... $260.00
P6723 C5 ..... $515.00
P6723 D1 ..... $85.00
P6723 D3 ..... $165.00
P6723 D5 ..... $325.00
P6723 R3 ..... $125.00
P6723 R5 ..... $250.00
P850 ..... $229.00
PB200 ..... $36,995.00
PB200 1M $200.00
PB200 A1 ..... $0.00
PB200 A2 ..... $0.00
PB200 A3 ..... $0.00
PB200 A4 ..... $0.00
PB200 A5 ..... $0.00
PB200 C3 ..... $1,665.00
PB200 D1 ..... $275.00
PB200 D3 ..... $515.00
PB200 R3 ..... $1,180.00
PPM007 ..... $90.00
PPM203B $1,495.00
PQA200 ..... $52,395.00
PQA200 01 ..... $7,600.00
PQA200 A1 ..... $0.00
PQA200 A2 ..... $0.00
PQA200 A3 ..... $0.00
PQA200 A5 ..... $0.00
PQA200 R3 ..... $1,275.00
PR494501-FI $498.00
PS2520G $1,395.00
PS2521G $1,395.00
PS280 ..... $725.00
PSA200 ..... $9,000.00
PSA200 AC $5,000.00
PSA200 ES $10,000.00
PSAZ1 ..... $1,265.00
Q32605 ..... $13,210.00
Q32605 D1 ..... $150.00
Q7606A $79,995.00
Q7606A 10 ..... $0.00
Q7606A C3 ..... $2,930.00
Q7606A C5 ..... $5,665.00
Q7606A D1 ..... $470.00
Q7606A D3 ..... $1,400.00
Q7606A D5 ..... $2,250.00
Q7606B $59,995.00
Q7606B 10 ..... $0.00
Q7606B C3 ..... $2,230.00
Q7606B C5 ..... $4,305.00
Q7606B D1 ..... $365.00
Q7606B D3 ..... $1,095.00
Q7606B D5 ..... $1,760.00
Q7750 ..... $219,000.00
Q7750 10 ..... $9,400.00
Q81201 ..... $1,270.00
Q81201 C3 ..... $240.00
Q81201 C5 ..... $475.00
Q81201 D1 ..... $85.00
Q81201 D3 ..... $165.00
Q81201 D5 ..... $325.00
Q81201 R3 ..... $305.00
Q81201 R5 ..... $610.00
Q81202 ..... $2,070.00
Q81202 C3 ..... $280.00
Q81202 C5 ..... $555.00
Q81202 D1 ..... $90.00
Q81202 D3 ..... $175.00
Q81202 D5 ..... $345.00
Q81202 R3 ..... $325.00
Q81202 R5 ..... $650.00
Q81203 ..... $3,230.00
Q81203 C3 ..... $315.00
Q81203 C5 ..... $630.00
Q81203 D1 ..... $95.00
Q81203 D3 ..... $185.00
Q81203 D5 ..... $365.00
Q81203 R3 ..... $345.00
Q81203 R5 ..... $685.00
Q81204 ..... $2,995.00

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Q81204 C3 ..... $315.00
Q81204 C5 ..... $630.00
Q81204 D1 ..... $95.00
Q81204 D3 ..... $185.00
Q81204 D5 ..... $365.00
Q81204 R3 ..... $345.00
Q81204 R5 ..... $685.00
Q81205 ..... $4,045.00
Q81205 C3 ..... $355.00
Q81205 C5 ..... $705.00
Q81205 D1 ..... $100.00
Q81205 D3 ..... $190.00
Q81205 D5 ..... $380.00
Q81205 R3 ..... $365.00
Q81205 R5 ..... $725.00
Q81206 ..... $5,775.00
Q81206 C3 ..... $420.00
Q81206 C5 ..... $840.00
Q81206 D1 ..... $110.00
Q81206 D3 ..... $200.00
Q81206 D5 ..... $400.00
Q81206 R3 ..... $400.00
Q81206 R5 ..... $800.00
Q81207 ..... $6,355.00
Q81207 C3 ..... $460.00
Q81207 C5 ..... $915.00
Q81207 D1 ..... $110.00
Q81207 D3 ..... $210.00
Q81207 D5 ..... $420.00
Q81207 R3 ..... $420.00
Q81207 R5 ..... $840.00
Q81211 ..... $5,775.00
Q81211 C3 ..... $420.00
Q81211 C5 ..... $840.00
Q81211 D1 ..... $110.00
Q81211 D3 ..... $200.00
Q81211 D5 ..... $400.00
Q81211 R3 ..... $400.00
Q81211 R5 ..... $800.00
Q81212 ..... $8,665.00
Q81212 C3 ..... $545.00
Q81212 C5 ..... $1,085.00
Q81212 D1 ..... $125.00
Q81212 D3 ..... $240.00
Q81212 D5 ..... $475.00
Q81212 R3 ..... $470.00
Q81212 R5 ..... $935.00
Q8134 ..... $1,920.00
Q81345 ..... $3,750.00
Q81345 C3 ..... $355.00
Q81345 C5 ..... $705.00
Q81345 D1 ..... $95.00
Q81345 D3 ..... $190.00
Q81345 D5 ..... $380.00
Q81345 R3 ..... $355.00
Q81345 R5 ..... $705.00
Q8163 ..... $18,500.00
Q8163 13 ..... $0.00
Q82018A $1,845.00
Q82018AC3 ..... $295.00
Q82018AC5 ..... $590.00
Q82018AD1 ..... $85.00
Q82018AR3 ..... $165.00
Q82018AR5 ..... $325.00
Q82039 ..... $4,495.00
Q82039 D1 ..... $100.00
Q82039 R3 ..... $280.00
Q82039 R5 ..... $555.00
Q82202 ..... $1,155.00
Q82202 D1 ..... $80.00
Q82202 R3 ..... $230.00
Q82202 R5 ..... $460.00
Q82203 ..... $1,680.00
Q82203 D1 ..... $85.00
Q82208 ..... $5,545.00
Q82208 C3 ..... $420.00
Q82208 C5 ..... $840.00
Q82208 D1 ..... $110.00
Q82208 D3 ..... $200.00
Q82208 D5 ..... $400.00
Q82208 R3 ..... $495.00
Q82208 R5 ..... $990.00
Q8221 ..... $2,295.00
Q8221 1R $318.00
Q8221 2R $155.00
Q8221 C3 ..... $440.00
Q8221 C5 ..... $875.00
Q8221 D1 ..... $115.00
Q8221 R3 ..... $210.00
Q8221 R5 ..... $420.00
Q82214 ..... $940.00
Q82214 C3 ..... $200.00
Q82214 D1 ..... $80.00
Q82214 D3 ..... $155.00
Q82214 R3 ..... $220.00
Q82215 ..... $1,415.00
Q82215 D1 ..... $85.00
Q82215 R3 ..... $135.00
Q82215 R5 ..... $270.00
Q82216 ..... $4,040.00
Q82216 C3 ..... $355.00
Q82216 C5 ..... $705.00
Q82216 D1 ..... $100.00
Q82216 D3 ..... $190.00
Q82216 D5 ..... $380.00
Q82216 R3 ..... $460.00
Q82216 R5 ..... $915.00
Q82227 ..... $4,515.00
Q82227 D1 ..... $100.00
Q82227 R3 ..... $280.00
Q82227 R5 ..... $555.00
Q82232 ..... $4,650.00
Q8344A $38,850.00
Q8344A 01 ..... $2,310.00
Q8344A 10 ..... $1,155.00
Q8344A 1R $596.00
Q8344A 40 ..... $0.00
Q8344A C3 ..... $1,265.00
Q8344A C5 ..... $2,530.00
Q8344A D1 ..... $220.00
Q8344A D3 ..... $420.00
Q8344A D5 ..... $840.00
Q8344A R3 ..... $1,435.00
Q8344A R5 ..... $2,870.00
Q8347 ..... $83,995.00
Q8347 1R $311.00
Q8347 D1 ..... $355.00
Q8347 R3 ..... $2,185.00
Q8347 R5 ..... $4,370.00
Q8381A $37,795.00
Q8381A 1R $596.00
Q8381A C3 ..... $1,825.00
Q8381A C5 ..... $3,650.00
Q8381A D1 ..... $215.00
Q8381A R3 ..... $1,200.00
Q8381A R5 ..... $2,395.00
Q8383 ..... $43,900.00
Q8383 D1 ..... $235.00
Q8383 R3 ..... $1,340.00
Q8383 R5 ..... $2,680.00
Q84601 ..... $19,895.00
Q84601 D1 ..... $190.00
Q84601 R3 ..... $760.00
Q84601 R5 ..... $1,520.00
Q84605 ..... $12,135.00
Q84605 D1 ..... $145.00
Q84605 R3 ..... $535.00
Q84605 R5 ..... $1,065.00
Q84605P $12,135.00
Q84605PD1 ..... $145.00
Q84605PR3 ..... $535.00
Q84605PR5 ..... $1,065.00
Q84606 ..... $17,340.00
Q84606 D1 ..... $175.00
Q84606 R3 ..... $685.00
Q84606 R5 ..... $1,370.00
Q8460A $9,245.00
Q8460A 80 ..... $1,155.00
Q8460A D1 ..... $135.00
Q8460A R3 ..... $450.00
Q8460A R5 ..... $895.00
Q84621A $24,675.00
Q84621AD1 ..... $220.00
Q84621AR3 ..... $885.00
Q84621AR5 ..... $1,770.00
R13002B $1,420.00
R13220 ..... $220.00
R14601 ..... $1,150.00
R14601 C3 ..... $220.00
R14601 C5 ..... $440.00
R14601 D1 ..... $75.00
R14601 D3 ..... $155.00
R14601 D5 ..... $305.00
R14601 R3 ..... $125.00
R14601 R5 ..... $250.00
R16056A $1,100.00
R16059 ..... $1,100.00
R16072 ..... $1,320.00
R16074 ..... $765.00
R16080 ..... $700.00
R16211 ..... $530.00
R16216A $495.00
R16219 ..... $685.00
R16601 ..... $85.00
R16905 ..... $430.00
R2465A $57,000.00
R2465A C3 ..... $3,205.00
R2465A C5 ..... $6,405.00
R2465A D1 ..... $485.00
R2465A D3 ..... $905.00
R2465A D5 ..... $1,805.00
R2465A R3 ..... $1,625.00
R2465A R5 ..... $3,250.00
R2465B $66,500.00
R2465B 1R $353.00
R2465B C3 ..... $3,725.00
R2465B C5 ..... $7,450.00
R2465B D1 ..... $555.00
R2465B D3 ..... $1,030.00
R2465B D5 ..... $2,055.00
R2465B R3 ..... $1,825.00
R2465B R5 ..... $3,650.00
R3131 ..... $7,495.00
R3131 1R $350.00
R3131 74 ..... $2,950.00
R3131 C3 ..... $535.00
R3131 C5 ..... $1,065.00
R3131 D1 ..... $105.00
R3131 D3 ..... $230.00
R3131 D5 ..... $460.00
R3131 R3 ..... $430.00
R3131 R5 ..... $855.00
R3131+74 RETRO $2,950.00
R3261C $13,950.00
R3261C 12 ..... $1,095.00
R3261C 15 ..... $2,195.00
R3261C 1K $2,000.00
R3261C 1R $353.00
R3261C C3 ..... $875.00
R3261C C5 ..... $1,750.00
R3261C D1 ..... $170.00
R3261C D3 ..... $315.00
R3261C D5 ..... $630.00
R3261C R3 ..... $590.00
R3261C R5 ..... $1,180.00
R3261CN $13,950.00
R3261CN12 ..... $1,095.00
R3261CN15 ..... $2,195.00
R3261CNC3 ..... $945.00
R3261CNC5 ..... $1,885.00
R3261CND1 ..... $170.00
R3261CND3 ..... $335.00
R3261CND5 ..... $665.00
R3261CNR3 ..... $590.00
R3261CNR5 ..... $1,180.00
R3261D $19,865.00
R3261D 12 ..... $1,095.00
R3261D 15 ..... $2,195.00
R3261D 1K $2,000.00
R3261D C3 ..... $1,200.00
R3261D C5 ..... $2,395.00
R3261D D1 ..... $210.00
R3261D D3 ..... $400.00
R3261D D5 ..... $800.00
R3261D R3 ..... $715.00
R3261D R5 ..... $1,425.00
R3263 ..... $21,950.00
R3263 15 ..... $750.00
R3263 1R $330.00
R3263 55 ..... $6,000.00
R3263 77 ..... $2,000.00
R3263 C3 ..... $1,265.00
R3263 C5 ..... $2,530.00
R3263 D1 ..... $225.00
R3263 D3 ..... $420.00
R3263 D5 ..... $840.00
R3263 R3 ..... $735.00
R3263 R5 ..... $1,465.00
R3265A $32,250.00
R3265A 07 ..... $750.00

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R3265A 1R $353.00
R3265A 21 ..... $660.00
R3265A C3 ..... $1,865.00
R3265A C5 ..... $3,725.00
R3265A D1 ..... $305.00
R3265A D3 ..... $565.00
R3265A D5 ..... $1,125.00
R3265A R3 ..... $990.00
R3265A R5 ..... $1,980.00
R3267 ..... $30,995.00
R3267 01 ..... $5,495.00
R3267 02 ..... $450.00
R3267 05 ..... $750.00
R3267 10 ..... $995.00
R3267 1R $330.00
R3267 21 ..... $550.00
R3267 61 ..... $1,995.00
R3267 62 ..... $4,495.00
R3267 63 ..... $1,995.00
R3267 64 ..... $1,995.00
R3267 73 ..... $1,495.00
R3267 74 ..... $5,995.00
R3267 79 ..... $3,195.00
R3267 C3 ..... $1,350.00
R3267 C5 ..... $2,605.00
R3267 D1 ..... $240.00
R3267 D3 ..... $715.00
R3267 D5 ..... $1,150.00
R3267 R3 ..... $1,420.00
R3267 R5 ..... $2,740.00
R3271A $31,995.00
R3271A 06 ..... $3,340.00
R3271A 07 ..... $750.00
R3271A 1R $353.00
R3271A 21 ..... $660.00
R3271A C3 ..... $2,085.00
R3271A C5 ..... $4,165.00
R3271A D1 ..... $305.00
R3271A D3 ..... $620.00
R3271A D5 ..... $1,235.00
R3271A R3 ..... $935.00
R3271A R5 ..... $1,865.00
R3272 ..... $25,495.00
R3272 15 ..... $750.00
R3272 1R $219.00
R3272 C3 ..... $1,685.00
R3272 C5 ..... $3,365.00
R3272 D1 ..... $280.00
R3272 D3 ..... $525.00
R3272 D5 ..... $1,045.00
R3272 R3 ..... $905.00
R3272 R5 ..... $1,805.00

R3273 ..... $35,995.00
R3273 01 ..... $5,495.00
R3273 02 ..... $450.00
R3273 05 ..... $750.00
R3273 10 ..... $995.00
R3273 16 ..... $5,495.00
R3273 17 ..... $7,995.00
R3273 1R $330.00
R3273 21 ..... $550.00
R3273 61 ..... $1,995.00
R3273 62 ..... $4,495.00
R3273 63 ..... $1,995.00
R3273 64 ..... $1,995.00
R3273 73 ..... $1,495.00
R3273 74 ..... $5,995.00
R3273 79 ..... $3,195.00
R3273 C3 ..... $1,610.00
R3273 C5 ..... $3,115.00
R3273 D1 ..... $280.00
R3273 D3 ..... $830.00
R3273 D5 ..... $1,335.00
R3273 R3 ..... $1,630.00
R3273 R5 ..... $3,145.00
R3361C $19,980.00
R3361C 12 ..... $1,095.00
R3361C 15 ..... $2,195.00
R3361C 1K $2,000.00
R3361C 1R $353.00
R3361C C3 ..... $1,200.00
R3361C C5 ..... $2,395.00
R3361C D1 ..... $210.00
R3361C D3 ..... $400.00
R3361C D5 ..... $800.00
R3361C R3 ..... $725.00
R3361C R5 ..... $1,445.00
R3361CN $19,980.00
R3361CN12 ..... $1,095.00
R3361CN15 ..... $2,195.00
R3361CN1R $353.00
R3361CNC3 ..... $1,200.00
R3361CNC5 ..... $2,395.00
R3361CND1 ..... $210.00
R3361CND3 ..... $400.00
R3361CND5 ..... $800.00
R3361CNR3 ..... $715.00
R3361CNR5 ..... $1,425.00
R3361D $25,795.00
R3361D 12 ..... $1,095.00
R3361D 15 ..... $2,195.00
R3361D 1K $2,000.00
R3361D 1R $353.00
R3361D C3 ..... $1,505.00

R3361D C5 ..... $3,005.00
R3361D D1 ..... $255.00
R3361D D3 ..... $475.00
R3361D D5 ..... $950.00
R3361D R3 ..... $850.00
R3361D R5 ..... $1,695.00
R3365A $43,750.00
R3365A 07 ..... $750.00
R3365A 1R $353.00
R3365A 21 ..... $660.00
R3365A C3 ..... $2,480.00
R3365A C5 ..... $4,960.00
R3365A D1 ..... $390.00
R3365A D3 ..... $725.00
R3365A D5 ..... $1,445.00
R3365A R3 ..... $1,255.00
R3365A R5 ..... $2,510.00
R3371A $51,500.00
R3371A 07 ..... $750.00
R3371A 1R $353.00
R3371A 21 ..... $660.00
R3371A C3 ..... $2,910.00
R3371A C5 ..... $5,815.00
R3371A D1 ..... $445.00
R3371A D3 ..... $830.00
R3371A D5 ..... $1,655.00
R3371A R3 ..... $1,425.00
R3371A R5 ..... $2,850.00
R34-AR $995.00
R3463 ..... $27,500.00
R3463 09 ..... $1,950.00
R3463 15 ..... $750.00
R3463 1H $0.00
R3463 1R $330.00
R3463 61 ..... $8,500.00
R3463 73 ..... $2,150.00
R3463 75 ..... $2,000.00
R3463 76 ..... $5,000.00
R3463 C3 ..... $1,600.00
R3463 C5 ..... $3,195.00
R3463 D1 ..... $270.00
R3463 D3 ..... $495.00
R3463 D5 ..... $990.00
R3463 R3 ..... $885.00
R3463 R5 ..... $1,770.00
R3465 ..... $32,995.00
R3465 08 ..... $2,125.00
R3465 09 ..... $1,950.00
R3465 15 ..... $750.00
R3465 1H $0.00
R3465 1R $330.00
R3465 21 ..... $600.00

R3465 51 ..... $6,000.00
R3465 56 ..... $0.00
R3465 61 ..... $8,500.00
R3465 73 ..... $2,150.00
R3465 75 ..... $2,000.00
R3465 76 ..... $5,000.00
R3465 77 ..... $2,000.00
R3465 C3 ..... $1,900.00
R3465 C5 ..... $3,800.00
R3465 D1 ..... $310.00
R3465 D3 ..... $570.00
R3465 D5 ..... $1,140.00
R3465 R3 ..... $1,010.00
R3465 R5 ..... $2,015.00
R3560 1R $330.00
R3561 ..... $18,995.00
R3561 C3 ..... $910.00
R3561 C5 ..... $1,755.00
R3561 D1 ..... $175.00
R3561 D3 ..... $525.00
R3561 D5 ..... $845.00
R3561 R3 ..... $1,065.00
R3561 R5 ..... $2,060.00
R3561L $10,925.00
R3561L 1R $595.00
R3561L C3 ..... $715.00
R3561L C5 ..... $1,425.00
R3561L D1 ..... $150.00
R3561L D3 ..... $280.00
R3561L D5 ..... $555.00
R3561L R3 ..... $495.00
R3561L R5 ..... $990.00
R3753A R3 ..... $1,130.00
R3753A R5 ..... $2,175.00
R3753AH $26,300.00
R3753AH1R $155.00
R3753AHC3 ..... $1,540.00
R3753AHC5 ..... $3,080.00
R3753AHD1 ..... $265.00
R3753AHD3 ..... $485.00
R3753AHD5 ..... $970.00
R3753AHR3 ..... $855.00
R3753AHR5 ..... $1,710.00
R3753B $24,300.00
R3753B C3 ..... $1,360.00
R3753B C5 ..... $2,720.00
R3753B D1 ..... $245.00
R3753B D3 ..... $440.00
R3753B D5 ..... $875.00
R3753B R3 ..... $830.00
R3753B R5 ..... $1,655.00
R3754-70 ..... $1,950.00

R3754A $8,300.00
R3754A 01 ..... $475.00
R3754A 02 ..... $475.00
R3754A 03 ..... $975.00
R3754A 10 ..... $975.00
R3754A 11 ..... $1,950.00
R3754A 1R $350.00
R3754A 20 ..... $1,225.00
R3754A 70 ..... $1,950.00
R3754A 71 ..... $975.00
R3754A 91 ..... $0.00
R3754A C3 ..... $800.00
R3754A C5 ..... $1,600.00
R3754A D1 ..... $225.00
R3754A D3 ..... $295.00
R3754A D5 ..... $590.00
R3754A R3 ..... $555.00
R3754A R5 ..... $1,105.00
R3754B $9,975.00
R3754B 01 ..... $475.00
R3754B 02 ..... $475.00
R3754B 03 ..... $975.00
R3754B 10 ..... $975.00
R3754B 11 ..... $1,950.00
R3754B 1R $350.00
R3754B 20 ..... $1,225.00
R3754B 70 ..... $1,950.00
R3754B 71 ..... $975.00
R3754B 91 ..... $0.00
R3754B C3 ..... $905.00
R3754B C5 ..... $1,805.00
R3754B D1 ..... $225.00
R3754B D3 ..... $325.00
R3754B D5 ..... $650.00
R3754B R3 ..... $600.00
R3754B R5 ..... $1,200.00
R3765AH $22,500.00
R3765AH1R $225.00
R3765AH70 ..... $1,950.00
R3765AHC3 ..... $1,285.00
R3765AHC5 ..... $2,565.00
R3765AHD1 ..... $230.00
R3765AHD3 ..... $420.00
R3765AHD5 ..... $840.00
R3765AHR3 ..... $780.00
R3765AHR5 ..... $1,560.00
R3765BH $23,500.00
R3765BH1R $225.00
R3765BH70 ..... $1,950.00
R3765BHC3 ..... $1,325.00
R3765BHC5 ..... $2,645.00
R3765BHD1 ..... $235.00

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R3765BHD3 ..... $430.00
R3765BHD5 ..... $855.00
R3765BHR3 ..... $810.00
R3765BHR5 ..... $1,615.00
R3765CH $31,500.00
R3765CH1R $225.00
R3765CH70 ..... $1,950.00
R3765CHC3 ..... $1,960.00
R3765CHC5 ..... $3,915.00
R3765CHD1 ..... $320.00
R3765CHD3 ..... $590.00
R3765CHD5 ..... $1,180.00
R3765CHR3 ..... $1,040.00
R3765CHR5 ..... $2,075.00
R3767AH $29,000.00
R3767AH1R $225.00
R3767AH70 ..... $1,950.00
R3767AHC3 ..... $1,685.00
R3767AHC5 ..... $3,365.00
R3767AHD1 ..... $280.00
R3767AHD3 ..... $525.00
R3767AHD5 ..... $1,045.00
R3767AHR3 ..... $925.00
R3767AHR5 ..... $1,845.00
R3767BH $30,500.00
R3767BH1R $225.00
R3767BH70 ..... $1,950.00
R3767BHC3 ..... $1,760.00
R3767BHC5 ..... $3,515.00
R3767BHD1 ..... $295.00
R3767BHD3 ..... $545.00
R3767BHD5 ..... $1,085.00
R3767BHR3 ..... $950.00
R3767BHR5 ..... $1,900.00
R3767CH $37,500.00
R3767CH1R $225.00
R3767CH70 ..... $1,950.00
R3767CHC3 ..... $2,265.00
R3767CHC5 ..... $4,525.00
R3767CHD1 ..... $360.00
R3767CHD3 ..... $665.00
R3767CHD5 ..... $1,330.00
R3767CHR3 ..... $1,160.00
R3767CHR5 ..... $2,320.00
R3961B $11,560.00
R3961B C3 ..... $745.00
R3961B C5 ..... $1,485.00
R3961B D1 ..... $155.00
R3961B D3 ..... $285.00
R3961B D5 ..... $570.00
R3961B R3 ..... $515.00
R3961B R5 ..... $1,030.00
R3961BN $11,560.00
R3961BNC3 ..... $745.00
R3961BNC5 ..... $1,485.00
R3961BND1 ..... $150.00
R3961BND3 ..... $285.00
R3961BND5 ..... $570.00
R3961BNR3 ..... $515.00
R3961BNR5 ..... $1,030.00
R3962A $12,000.00
R3962A 1R $100.00
R3962A C3 ..... $780.00
R3962A C5 ..... $1,560.00
R3962A D1 ..... $155.00
R3962A D3 ..... $295.00
R3962A D5 ..... $590.00
R3962A R3 ..... $535.00
R3962A R5 ..... $1,065.00
R3963A $16,000.00
R3963A 1R $100.00
R3963A C3 ..... $1,000.00
R3963A C5 ..... $1,995.00
R3963A D1 ..... $185.00
R3963A D3 ..... $355.00
R3963A D5 ..... $705.00
R3963A R3 ..... $620.00
R3963A R5 ..... $1,235.00
R3964A $4,500.00
R3964A 1R $100.00
R3964A C3 ..... $365.00
R3964A C5 ..... $725.00
R3964A D1 ..... $100.00
R3964A D3 ..... $190.00
R3964A D5 ..... $380.00
R3964A R3 ..... $365.00
R3964A R5 ..... $725.00
R3965A $14,500.00
R3965A C3 ..... $710.00
R3965A C5 ..... $1,370.00
R3965A D1 ..... $150.00
R3965A D3 ..... $440.00
R3965A D5 ..... $705.00
R3965A R3 ..... $910.00
R3965A R5 ..... $1,755.00
R4131D $9,995.00
R4131D 1R $300.00
R4131D C3 ..... $675.00
R4131D C5 ..... $1,350.00
R4131D D1 ..... $140.00
R4131D D3 ..... $270.00
R4131D D5 ..... $535.00
R4131D R3 ..... $475.00
R4131D R5 ..... $950.00
R4945A $2,350.00
RAD $235.00
RAD D1 ..... $155.00
RAD50 ..... $210.00
RAD50 D1 ..... $155.00
RAD600 ..... $210.00
RAD600 D1 ..... $155.00
RAM $575.00
RAM D1 ..... $155.00
RAU $1,340.00
RAU D1 ..... $155.00
RAZ $575.00
RAZ D1 ..... $155.00
RBS1000 ..... $5,180.00
RBS1000D1 ..... $155.00
RBS1000R3 ..... $305.00
RBS1000R5 ..... $610.00
RBU100-10 ..... $1,695.00
RBU100-20 ..... $1,695.00
RBU100-3 ..... $1,695.00
RBU100-30 ..... $1,700.00
RBU100-6 ..... $1,695.00
RBU50-10 ..... $1,085.00
RBU50-20 ..... $1,085.00
RBU50-3 ..... $1,085.00
RBU50-30 ..... $1,085.00
RBU50-6 ..... $1,085.00
REP4100 ..... $35.00
REP4200 ..... $60.00
REP4300 ..... $95.00
REP4400 ..... $150.00
REP4500 ..... $230.00
REP4600 ..... $340.00
REP4700 ..... $650.00
REP4800 ..... $1,225.00
REP5100 ..... $150.00
REP5200 ..... $170.00
REP5300 ..... $200.00
REP5400 ..... $250.00
REP5500 ..... $320.00
REP5600 ..... $415.00
REP5700 ..... $685.00
REP5800 ..... $1,185.00
RFA300 ..... $51,975.00
RFA300 1R $350.00
RFA300 A1 ..... $0.00
RFA300 A2 ..... $0.00
RFA300 A4 ..... $0.00
RFA300 R3 ..... $1,045.00
RFM151 ..... $2,540.00
RFM151 A1 ..... $0.00
RFM151 A2 ..... $0.00
RFM151 A3 ..... $0.00
RFM151 A6 ..... $0.00
RFM151 C3 ..... $280.00
RFM151 C5 ..... $555.00
RFM151 D1 ..... $90.00
RFM151 D3 ..... $175.00
RFM151 D5 ..... $345.00
RFM151 R5 ..... $315.00
RFM90 ..... $995.00
RFM90 01 ..... $0.00
RFM90 A1 ..... $0.00
RFM90 A2 ..... $0.00
RFM90 A3 ..... $0.00
RFM90 A6 ..... $0.00
RFMANT $45.00
RFMBAT $95.00
RFMCHG $195.00
RFMCHG A1 ..... $0.00
RFMCHG A2 ..... $0.00
RFMCHG A3 ..... $0.00
RFMCHG A6 ..... $0.00
RFMSHA $40.00
RM200 ..... $200.00
RM3000 ..... $295.00
RNB $130.00
RNB D1 ..... $155.00
RSG $8,490.00
RSG C3 ..... $565.00
RSG C5 ..... $1,125.00
RSG D1 ..... $320.00
RSG D3 ..... $240.00
RSG D5 ..... $475.00
RSG R3 ..... $420.00
RSG R5 ..... $840.00
RSM $11,280.00
RSM C3 ..... $715.00
RSM C5 ..... $1,425.00
RSM D1 ..... $320.00
RSM D3 ..... $280.00
RSM D5 ..... $555.00
RSM R3 ..... $515.00
RSM R5 ..... $1,030.00
RSP $14,730.00
RSP C3 ..... $905.00
RSP C5 ..... $1,805.00
RSP D1 ..... $320.00
RSP D3 ..... $325.00
RSP D5 ..... $650.00
RSP R3 ..... $580.00
RSP R5 ..... $1,160.00
RVZ $950.00
RVZ D1 ..... $155.00
S3FG220 ..... $540.00
S3FT100 ..... $625.00
S3FT110 ..... $835.00
S3FT200 ..... $520.00
S3FT300 ..... $520.00
S3FT400 ..... $945.00
S44035-Z6003-C150 ..... $80.00
S44035-Z6008-C100 ..... $120.00
S44035-Z6038-A701 ..... $240.00
S85HFS1 ..... $1,025.00
SA42 C3 ..... $365.00
SAF-Z D1 ..... $155.00
SAFZ1 D1 ..... $155.00
SC100A $4,750.00
SC100A A1 ..... $0.00
SC100A A2 ..... $0.00
SC100A A3 ..... $0.00
SC100A A4 ..... $0.00
SC100A A5 ..... $0.00
SC100A R3 ..... $240.00
SC100A R5 ..... $475.00
SD14 ..... $7,700.00
SD14 01 ..... $275.00
SD14 C3 ..... $460.00
SD14 C5 ..... $915.00
SD14 D1 ..... $105.00
SD14 D3 ..... $210.00
SD14 D5 ..... $420.00
SD14 R3 ..... $355.00
SD14 R5 ..... $705.00
SD20 ..... $6,450.00
SD20 C3 ..... $420.00
SD20 C5 ..... $840.00
SD20 D1 ..... $100.00
SD20 D3 ..... $200.00
SD20 D5 ..... $400.00
SD20 R3 ..... $315.00
SD20 R5 ..... $630.00
SD22 ..... $9,000.00
SD22 C3 ..... $515.00
SD22 C5 ..... $1,030.00
SD22 D1 ..... $95.00
SD22 D3 ..... $230.00
SD22 D5 ..... $460.00
SD22 R3 ..... $400.00
SD22 R5 ..... $800.00
SD24 ..... $13,000.00
SD24 C3 ..... $640.00
SD24 C5 ..... $1,275.00
SD24 D1 ..... $115.00
SD24 D3 ..... $260.00
SD24 D5 ..... $515.00

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SD24 R3 ..... $505.00
SD24 R5 ..... $1,010.00
SD26 ..... $9,000.00
SD26 C3 ..... $515.00
SD26 C5 ..... $1,030.00
SD26 D1 ..... $95.00
SD26 D3 ..... $230.00
SD26 D5 ..... $460.00
SD26 R3 ..... $400.00
SD26 R5 ..... $800.00
SD32 ..... $8,800.00
SD32 C3 ..... $515.00
SD32 C5 ..... $1,030.00
SD32 D1 ..... $110.00
SD32 D3 ..... $230.00
SD32 D5 ..... $460.00
SD32 R3 ..... $390.00
SD32 R5 ..... $780.00
SD42 ..... $4,295.00
SD42 C3 ..... $335.00
SD42 C5 ..... $665.00
SD42 D1 ..... $100.00
SD42 D3 ..... $185.00
SD42 D5 ..... $365.00
SD42 R3 ..... $240.00
SD42 R5 ..... $475.00
SD43 ..... $7,495.00
SD43 C3 ..... $460.00
SD43 D1 ..... $150.00
SD43 D3 ..... $210.00
SD43 R3 ..... $355.00
SD44 ..... $6,795.00
SD44 C3 ..... $420.00
SD44 D1 ..... $115.00
SD44 R3 ..... $325.00
SD48 ..... $10,495.00
SD48 C3 ..... $565.00
SD48 D1 ..... $135.00
SD48 D3 ..... $240.00
SD48 R3 ..... $440.00
SD48 RR $3,000.00
SD51 ..... $6,600.00
SD51 R3 ..... $325.00
SD51 R5 ..... $650.00
SDA601 ..... $3,195.00
SDA601 01 ..... $75.00
SDA601 A1 ..... $0.00
SDA601 A2 ..... $0.00
SDA601 A3 ..... $0.00
SDA601 A6 ..... $0.00
SDA601 R3 ..... $350.00
SDA601 R5 ..... $665.00

SDP300 ..... $995.00
SF201A $65.00
SF202A $65.00
SF203A $65.00
SF501 ..... $65.00
SF502 ..... $65.00
SF503 ..... $65.00
SIU800 ..... $2,150.00
SIU800 A1 ..... $0.00
SIU800 A2 ..... $0.00
SIU800 A3 ..... $0.00
SIU800 A5 ..... $0.00
SIU800 A6 ..... $0.00
SJ300E $31,500.00
SJ300E 04 ..... $6,125.00
SJ300E 06 ..... $8,250.00
SJ300E 09 ..... $3,750.00
SJ300E 1M $200.00
SJ300E 3C $0.00
SJ300E 4C $0.00
SJ300E 4S $2,250.00
SJ300E 7C $0.00
SJ300E A1 ..... $0.00
SJ300E A2 ..... $0.00
SJ300E A3 ..... $0.00
SJ300E A4 ..... $0.00
SJ300E A5 ..... $0.00
SJ300E C3 ..... $2,280.00
SJ300E C5 ..... $4,560.00
SJ300E D1 ..... $465.00
SJ300E D3 ..... $665.00
SJ300E D5 ..... $1,330.00
SJ300E R3 ..... $905.00
SJ300E R5 ..... $1,805.00
SJ30F04 ..... $7,995.00
SJ30F06 ..... $10,500.00
SJ30F07 ..... $750.00
SJ30FA6 ..... $5,250.00
SJ30FE4 ..... $11,995.00
SJ30U08 ..... $8,000.00
SJ30U12 ..... $2,000.00
SJ30U7C $1,600.00
SL7PC66 ..... $1,950.00
SL7PC86 ..... $1,950.00
SM-B1 ..... $1,150.00
SM-B2 ..... $995.00
SM-B3 ..... $2,525.00
SM-B4 ..... $1,195.00
SM-B5 ..... $1,950.00
SM-B6 ..... $2,695.00
SM-B8 ..... $2,600.00
SM-B9 ..... $3,790.00

SM-U50 ..... $3,900.00
SM-Z3 ..... $1,100.00
SM11 ..... $38,500.00
SM11 1R $295.00
SM11 A1 ..... $0.00
SM11 A2 ..... $0.00
SM11 A3 ..... $0.00
SM11 A4 ..... $0.00
SM11 A5 ..... $0.00
SM11 D1 ..... $270.00
SM11 IN $380.00
SM11 R3 ..... $1,425.00
SM11 R5 ..... $2,850.00
SMCK1 ..... $140.00
SME-B11 ..... $1,550.00
SME-B12 ..... $1,085.00
SME-B19 ..... $260.00
SME-B41 ..... $1,600.00
SME-B42 ..... $1,395.00
SME-K2 ..... $0.00
SME02 ..... $17,350.00
SME02 01 ..... $1,150.00
SME02 02 ..... $995.00
SME02 03 ..... $2,525.00
SME02 04 ..... $1,195.00
SME02 05 ..... $1,950.00
SME02 06 ..... $2,695.00
SME02 11 ..... $1,550.00
SME02 12 ..... $1,085.00
SME02 19 ..... $260.00
SME02 1R $195.00
SME02 41 ..... $1,600.00
SME02 42 ..... $1,450.00
SME02 B50 ..... $3,000.00
SME02 C5 ..... $1,040.00
SME02 D1 ..... $195.00
SME02 D5 ..... $365.00
SME02 R3 ..... $830.00
SME02 R5 ..... $1,655.00
SME03 ..... $21,750.00
SME03 01 ..... $1,150.00
SME03 02 ..... $995.00
SME03 04 ..... $1,195.00
SME03 05 ..... $1,950.00
SME03 06 ..... $2,695.00
SME03 08 ..... $2,600.00
SME03 11 ..... $1,550.00
SME03 12 ..... $1,085.00
SME03 19 ..... $260.00
SME03 1R $195.00
SME03 41 ..... $1,600.00
SME03 42 ..... $1,450.00

SME03 B50 ..... $3,000.00
SME03 C5 ..... $1,265.00
SME03 D1 ..... $225.00
SME03 D5 ..... $420.00
SME03 R3 ..... $950.00
SME03 R5 ..... $1,900.00
SME03E $19,400.00
SME03E 01 ..... $1,150.00
SME03E 02 ..... $995.00
SME03E 04 ..... $1,150.00
SME03E 05 ..... $1,950.00
SME03E 06 ..... $2,695.00
SME03E 08 ..... $2,600.00
SME03E 12 ..... $1,085.00
SME03E 19 ..... $260.00
SME03E 1R $195.00
SME03E 41 ..... $1,600.00
SME03E 42 ..... $1,450.00
SME03E B50 ..... $3,000.00
SME03E C5 ..... $1,180.00
SME03E D1 ..... $210.00
SME03E D5 ..... $390.00
SME03E R3 ..... $885.00
SME03E R5 ..... $1,770.00
SME06 ..... $35,450.00
SME06 01 ..... $1,150.00
SME06 02 ..... $995.00
SME06 04 ..... $1,150.00
SME06 05 ..... $1,950.00
SME06 06 ..... $2,695.00
SME06 09 ..... $3,790.00
SME06 11 ..... $1,550.00
SME06 12 ..... $1,085.00
SME06 19 ..... $260.00
SME06 1R $195.00
SME06 41 ..... $1,600.00
SME06 42 ..... $1,450.00
SME06 B50 ..... $3,000.00
SME06 C5 ..... $1,920.00
SME06 D1 ..... $325.00
SME06 D5 ..... $580.00
SME06 R3 ..... $1,325.00
SME06 R5 ..... $2,645.00
SMG $15,555.00
SMG 01 ..... $1,800.30
SMG 02 ..... $1,595.00
SMG 03 ..... $665.00
SMG 10 ..... $335.00
SMG 1R $195.00
SMG D1 ..... $255.00
SMG R3 ..... $410.00
SMG R5 ..... $820.00

SMG-B1 ..... $1,745.00
SMG-B3 ..... $665.00
SMG43 ..... $19,945.00
SMG50 ..... $105.00
SMGL $22,350.00
SMGL 01 ..... $1,800.30
SMGL 02 ..... $1,695.00
SMGL 03 ..... $665.00
SMGL 10 ..... $335.00
SMGL C5 ..... $1,285.00
SMGL D1 ..... $230.00
SMGL D3 ..... $210.00
SMGL D5 ..... $420.00
SMGL R3 ..... $820.00
SMGL R5 ..... $1,635.00
SMGLZ10 ..... $335.00
SMGU $34,250.00
SMGU 10 ..... $335.00
SMGU 1R $195.00
SMGU C5 ..... $1,980.00
SMGU D1 ..... $320.00
SMGU D3 ..... $295.00
SMGU D5 ..... $590.00
SMGU R3 ..... $1,125.00
SMGU R5 ..... $2,245.00
SMGU-B9 ..... $260.10
SMGU-Z9 ..... $275.00
SMGUZ2 ..... $2,395.00
SMGZ2 ..... $950.00
SMH $20,350.00
SMH 01 ..... $1,600.00
SMH 02 ..... $1,509.60
SMH 03 ..... $585.00
SMH 10 ..... $285.00
SMH 1R $195.00
SMH C5 ..... $1,220.00
SMH D1 ..... $215.00
SMH D3 ..... $200.00
SMH D5 ..... $400.00
SMH R3 ..... $770.00
SMH R5 ..... $1,540.00
SMHU-B2 ..... $2,800.00
SMHU-B3 ..... $2,800.00
SMHU-B4 ..... $2,800.00
SMHU-B5 ..... $3,520.00
SMHU-B6 ..... $6,910.00
SMHU-B7 ..... $3,675.00
SMHU52 ..... $42,550.00
SMHU52 10 ..... $325.00
SMHU52 C5 ..... $2,340.00
SMHU52 D1 ..... $215.00
SMHU52 D3 ..... $345.00

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SMHU52 D5 ..... $685.00
SMHU52 R3 ..... $1,190.00
SMHU52 R5 ..... $2,375.00
SMHU58 ..... $48,725.00
SMHU58 01 ..... $2,925.00
SMHU58 02 ..... $2,925.00
SMHU58 03 ..... $2,925.00
SMHU58 04 ..... $3,675.00
SMHU58 06 ..... $6,975.00
SMHU58 07 ..... $3,675.00
SMHU58 10 ..... $275.00
SMHU58 C5 ..... $2,660.00
SMHU58 D1 ..... $410.00
SMHU58 D3 ..... $380.00
SMHU58 D5 ..... $760.00
SMHU58 R3 ..... $1,325.00
SMHU58 R5 ..... $2,645.00
SMIQ-B10 ..... $3,495.00
SMIQ-B11 ..... $1,195.00
SMIQ-B12 ..... $700.00
SMIQ-B13 ..... $700.00
SMIQ-B14 ..... $11,950.00
SMIQ-B15 ..... $11,950.00
SMIQ-B17 ..... $5,295.00
SMIQ-B19 ..... $200.00
SMIQ-B42 ..... $1,550.00
SMIQ-B43 ..... $2,295.00
SMIQ-U47 ..... $2,950.00
SMIQ02B $17,950.00
SMIQ02B1R $185.00
SMIQ02BB1 ..... $1,395.00
SMIQ02BB10 ..... $3,350.00
SMIQ02BB11 ..... $1,150.00
SMIQ02BB12 ..... $700.00
SMIQ02BB13 ..... $700.00
SMIQ02BB14 ..... $11,950.00
SMIQ02BB15 ..... $11,950.00
SMIQ02BB17 ..... $5,695.00
SMIQ02BB19 ..... $295.00
SMIQ02BB42 ..... $1,550.00
SMIQ02BB43 ..... $2,295.00
SMIQ02BB47 ..... $2,195.00
SMIQ02BB5 ..... $2,095.00
SMIQ02BB50 ..... $4,795.00
SMIQ02BC5 ..... $1,662.00
SMIQ02BD1 ..... $191.00
SMIQ02BD5 ..... $810.00
SMIQ02BR3 ..... $1,028.00
SMIQ02BR5 ..... $1,985.00
SMIQ02EC5 ..... $1,000.00
SMIQ02ED1 ..... $235.00
SMIQ02ED5 ..... $355.00
SMIQ02ER3 ..... $620.00
SMIQ02ER5 ..... $1,235.00
SMIQ03B $19,450.00
SMIQ03B1R $185.00
SMIQ03BB1 ..... $1,385.00
SMIQ03BB10 ..... $3,350.00
SMIQ03BB11 ..... $1,150.00
SMIQ03BB12 ..... $700.00
SMIQ03BB13 ..... $700.00
SMIQ03BB14 ..... $11,950.00
SMIQ03BB15 ..... $11,950.00
SMIQ03BB17 ..... $5,695.00
SMIQ03BB19 ..... $295.00
SMIQ03BB42 ..... $1,550.00
SMIQ03BB43 ..... $2,295.00
SMIQ03BB47 ..... $2,195.00
SMIQ03BB5 ..... $2,095.00
SMIQ03BB50 ..... $4,795.00
SMIQ03BC5 ..... $1,789.00
SMIQ03BD1 ..... $201.00
SMIQ03BD5 ..... $856.00
SMIQ03BR3 ..... $1,081.00
SMIQ03BR5 ..... $2,090.00
SMIQ03ED1 ..... $230.00
SMIQ03ER3 ..... $660.00
SMIQ03ER5 ..... $1,315.00
SMK4 ..... $90.00
SMP-B11 ..... $3,795.00
SMP-B12 ..... $2,695.00
SMP-B15 ..... $5,695.00
SMP-B17 ..... $1,225.00
SMP-B20 ..... $1,160.00
SMP02 ..... $28,950.00
SMP02 01 ..... $1,375.00
SMP02 02 ..... $1,050.00
SMP02 05 ..... $2,095.00
SMP02 11 ..... $3,495.00
SMP02 12 ..... $3,795.00
SMP02 13 ..... $1,150.00
SMP02 14 ..... $950.00
SMP02 15 ..... $2,695.00
SMP02 18 ..... $995.00
SMP02 19 ..... $1,125.00
SMP02 C5 ..... $1,920.00
SMP02 D1 ..... $315.00
SMP02 D5 ..... $580.00
SMP02 R3 ..... $990.00
SMP02 R5 ..... $1,980.00
SMP03 ..... $39,950.00
SMP03 01 ..... $1,375.00
SMP03 02 ..... $1,050.00
SMP03 05 ..... $2,095.00
SMP03 11 ..... $3,495.00
SMP03 12 ..... $3,795.00
SMP03 13 ..... $1,150.00
SMP03 14 ..... $950.00
SMP03 15 ..... $2,695.00
SMP03 18 ..... $995.00
SMP03 19 ..... $1,125.00
SMP03 C5 ..... $2,385.00
SMP03 D1 ..... $315.00
SMP03 D5 ..... $695.00
SMP03 R3 ..... $1,255.00
SMP03 R5 ..... $2,510.00
SMP04 ..... $45,950.00
SMP04 01 ..... $1,375.00
SMP04 02 ..... $1,050.00
SMP04 05 ..... $2,095.00
SMP04 11 ..... $3,495.00
SMP04 12 ..... $3,795.00
SMP04 13 ..... $1,150.00
SMP04 14 ..... $950.00
SMP04 15 ..... $2,495.00
SMP04 17 ..... $5,695.00
SMP04 18 ..... $995.00
SMP04 19 ..... $1,275.00
SMP04 B20 ..... $1,225.00
SMP04 C5 ..... $2,765.00
SMP04 D1 ..... $315.00
SMP04 D5 ..... $790.00
SMP04 R3 ..... $1,390.00
SMP04 R5 ..... $2,775.00
SMP22 ..... $44,950.00
SMP22 01 ..... $1,375.00
SMP22 02 ..... $950.00
SMP22 05 ..... $2,095.00
SMP22 11 ..... $3,495.00
SMP22 12 ..... $3,795.00
SMP22 13 ..... $1,150.00
SMP22 14 ..... $950.00
SMP22 15 ..... $2,695.00
SMP22 18 ..... $995.00
SMP22 19 ..... $1,275.00
SMP22 C5 ..... $2,520.00
SMP22 D1 ..... $315.00
SMP22 D5 ..... $735.00
SMP22 R3 ..... $1,370.00
SMP22 R5 ..... $2,740.00
SMQK1 ..... $350.00
SMT-B19 ..... $225.00
SMT02 ..... $10,600.00
SMT02 01 ..... $1,395.00
SMT02 02 ..... $1,050.00
SMT02 03 ..... $2,595.00
SMT02 04 ..... $1,295.00
SMT02 06 ..... $2,875.00
SMT02 1R $185.00
SMT02 20 ..... $225.00
SMT02 C5 ..... $695.00
SMT02 D1 ..... $225.00
SMT02 D5 ..... $280.00
SMT02 R3 ..... $495.00
SMT02 R5 ..... $990.00
SMT03 ..... $13,300.00
SMT03 01 ..... $1,395.00
SMT03 02 ..... $1,050.00
SMT03 04 ..... $1,295.00
SMT03 06 ..... $2,875.00
SMT03 08 ..... $2,795.00
SMT03 1R $185.00
SMT03 20 ..... $225.00
SMT03 C5 ..... $840.00
SMT03 D1 ..... $225.00
SMT03 D5 ..... $305.00
SMT03 R3 ..... $570.00
SMT03 R5 ..... $1,140.00
SMT06 ..... $22,450.00
SMT06 01 ..... $1,395.00
SMT06 02 ..... $1,050.00
SMT06 04 ..... $1,295.00
SMT06 06 ..... $2,875.00
SMT06 09 ..... $2,795.00
SMT06 1R $185.00
SMT06 20 ..... $225.00
SMT06 C5 ..... $1,285.00
SMT06 D1 ..... $225.00
SMT06 D5 ..... $420.00
SMT06 R3 ..... $1,255.00
SMT06 R5 ..... $2,510.00
SMY-B1 ..... $1,050.00
SMY-B10 ..... $245.00
SMY01 ..... $5,995.00
SMY01 01 ..... $1,050.00
SMY01 10 ..... $244.00
SMY01 1R $180.00
SMY01 B40 ..... $1,295.00
SMY01 C5 ..... $495.00
SMY01 D1 ..... $115.00
SMY01 D5 ..... $220.00
SMY01 R3 ..... $515.00
SMY01 R5 ..... $1,030.00
SMY02 ..... $7,900.00
SMY02 01 ..... $1,050.00
SMY02 10 ..... $244.00
SMY02 1R $180.00
SMY02 B40 ..... $1,295.00
SMY02 C5 ..... $875.00
SMY02 D1 ..... $115.00
SMY02 D5 ..... $315.00
SMY02 R3 ..... $555.00
SMY02 R5 ..... $1,105.00
SMY43 ..... $9,950.00
SMY43 1R $195.00
SMY43 B1 ..... $990.00
SMY43 B10 ..... $244.00
SMY43 B40 ..... $1,295.00
SMY43 D1 ..... $115.00
SP232 ..... $695.00
SP232 01 ..... $0.00
SP232 02 ..... $0.00
SP232 03 ..... $0.00
SPG1000 ..... $7,595.00
SPG100016 ..... $0.00
SPG1000A1 ..... $0.00
SPG1000A2 ..... $0.00
SPG1000A3 ..... $0.00
SPG1000R3 ..... $365.00
SPG1000R5 ..... $725.00
SPG170A $3,995.00
SPG170A01 ..... $1,100.00
SPG170A1J $0.00
SPG170A2J $1,100.00
SPG170A52 ..... $0.00
SPG170AC3 ..... $460.00
SPG170AC5 ..... $915.00
SPG170AD1 ..... $125.00
SPG170AD3 ..... $210.00
SPG170AD5 ..... $420.00
SPG170AR3 ..... $230.00
SPG170AR5 ..... $460.00
SPG271 ..... $3,395.00
SPG271 01 ..... $795.00
SPG271 02 ..... $0.00
SPG271 A0 ..... $0.00
SPG271 A1 ..... $0.00
SPG271 A2 ..... $0.00
SPG271 A3 ..... $0.00
SPG271 C3 ..... $400.00
SPG271 C5 ..... $800.00
SPG271 D1 ..... $125.00
SPG271 D3 ..... $200.00
SPG271 D5 ..... $400.00
SPG271 R3 ..... $230.00
SPG271 R5 ..... $460.00
SPG422 ..... $3,995.00
SPG422 01 ..... $995.00
SPG422 02 ..... $995.00
SPG422 A1 ..... $0.00

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SPG422 A2 ..... $0.00
SPG422 A3 ..... $0.00
SPG422 A5 ..... $0.00
SPG422 C3 ..... $460.00
SPG422 C5 ..... $915.00
SPG422 D1 ..... $125.00
SPG422 D3 ..... $210.00
SPG422 D5 ..... $420.00
SPG422 R3 ..... $260.00
SPG422 R5 ..... $515.00
ST10U3H $4,500.00
ST112 ..... $23,000.00
ST112 04 ..... $15,600.00
ST112 07 ..... $2,500.00
ST112 08 ..... $5,500.00
ST112 1C $0.00
ST112 1M $200.00
ST112 2C $0.00
ST112 3C $0.00
ST112 4C $0.00
ST112 5H $2,000.00
ST112 5R $5,000.00
ST112 C3 ..... $2,140.00
ST112 D1 ..... $440.00
ST112 D3 ..... $640.00
ST112 R3 ..... $1,085.00
ST11F04 ..... $11,500.00
ST11F08 ..... $8,000.00
ST11F3C $3,000.00
ST11F5R $8,000.00
ST11FE4 ..... $15,500.00
ST11FR3 ..... $0.00
ST11FR4 ..... $0.00
ST2400A $41,895.00
ST2400A01 ..... $0.00
ST2400A02 ..... $0.00
ST2400A03 ..... $0.00
ST2400A05 ..... $250.00
ST2400A06 ..... $250.00
ST2400A07 ..... $250.00
ST2400A08 ..... $250.00
ST2400A13 ..... $23,745.00
ST2400A15 ..... $28,745.00
ST2400A17 ..... $38,745.00
ST2400A35 ..... $32,245.00
ST2400A41 ..... $1,950.00
ST2400A42 ..... $5,950.00
ST2400AA1 ..... $0.00
ST2400AA2 ..... $0.00
ST2400AA3 ..... $0.00
ST2400AA4 ..... $0.00
ST2400AA5 ..... $0.00
ST2400AR5 ..... $5,645.00
ST2400R $20,895.00
ST2400R01 ..... $0.00
ST2400R02 ..... $0.00
ST2400R03 ..... $0.00
ST2400R05 ..... $250.00
ST2400R06 ..... $250.00
ST2400R07 ..... $250.00
ST2400R08 ..... $250.00
ST2400R11 ..... $15,045.00
ST2400R42 ..... $3,950.00
ST2400RA1 ..... $0.00
ST2400RA2 ..... $0.00
ST2400RA3 ..... $0.00
ST2400RA4 ..... $0.00
ST2400RA5 ..... $0.00
ST2400RR5 ..... $3,290.00
ST2400T $24,900.00
ST2400T01 ..... $0.00
ST2400T02 ..... $0.00
ST2400T03 ..... $0.00
ST2400T05 ..... $250.00
ST2400T06 ..... $250.00
ST2400T07 ..... $250.00
ST2400T08 ..... $250.00
ST2400T13 ..... $14,745.00
ST2400T15 ..... $19,745.00
ST2400T17 ..... $28,145.00
ST2400T35 ..... $23,745.00
ST2400T41 ..... $1,500.00
ST2400T42 ..... $1,950.00
ST2400TA1 ..... $0.00
ST2400TA2 ..... $0.00
ST2400TA3 ..... $0.00
ST2400TA4 ..... $0.00
ST2400TA5 ..... $0.00
ST2400TR5 ..... $3,955.00
ST24AU42 ..... $9,000.00
ST24RU42 ..... $7,000.00
ST24U15 ..... $8,000.00
ST24U41 ..... $2,950.00
ST24U42 ..... $9,000.00
ST501 ..... $20.00
STRM100 ..... $16,000.00
STRM101 ..... $15,000.00
STRM102 ..... $20,000.00
SUW-DPU414-40B $610.00
TCP202 ..... $1,530.00
TCP202 C3 ..... $200.00
TCP202 C5 ..... $400.00
TCP202 D1 ..... $80.00
TCP202 D3 ..... $155.00
TCP202 D5 ..... $305.00
TCP202 R3 ..... $175.00
TCP202 R5 ..... $345.00
TD3F14A $525.00
TDC501 ..... $7,245.00
TDC501 D1 ..... $155.00
TDC501 R3 ..... $380.00
TDC501 R5 ..... $760.00
TDC502 ..... $7,245.00
TDC502 D1 ..... $155.00
TDC502 R3 ..... $380.00
TDC502 R5 ..... $760.00
TDM501 ..... $7,245.00
TDM501 D1 ..... $155.00
TDM501 KS $7,000.00
TDM501 R3 ..... $380.00
TDM501 R5 ..... $760.00
TDM502 ..... $7,245.00
TDM502 D1 ..... $155.00
TDM502 IS $6,750.00
TDM502 R3 ..... $380.00
TDM502 R5 ..... $760.00
TDM503 ..... $7,245.00
TDM503 D1 ..... $155.00
TDM503 R3 ..... $380.00
TDM503 R5 ..... $760.00
TDM504 ..... $7,245.00
TDM504 CG $6,750.00
TDM504 D1 ..... $155.00
TDM504 R3 ..... $380.00
TDM504 R5 ..... $760.00
TDM505 ..... $6,500.00
TDM505 D1 ..... $155.00
TDM505 R3 ..... $355.00
TDM505 R5 ..... $705.00
TDS210 ..... $1,195.00
TDS210 A0 ..... $0.00
TDS210 A1 ..... $0.00
TDS210 A2 ..... $0.00
TDS210 A3 ..... $0.00
TDS210 A4 ..... $0.00
TDS210 A5 ..... $0.00
TDS210 AC $0.00
TDS210 D1 ..... $150.00
TDS210 L1 ..... $0.00
TDS210 L2 ..... $0.00
TDS210 L3 ..... $0.00
TDS210 L4 ..... $0.00
TDS210 L5 ..... $0.00
TDS210 L6 ..... $0.00
TDS210 L7 ..... $0.00
TDS210 L8 ..... $0.00
TDS210 L9 ..... $0.00
TDS220 ..... $1,795.00
TDS220 A0 ..... $0.00
TDS220 A1 ..... $0.00
TDS220 A2 ..... $0.00
TDS220 A3 ..... $0.00
TDS220 A4 ..... $0.00
TDS220 A5 ..... $0.00
TDS220 AC $0.00
TDS220 D1 ..... $150.00
TDS220 L1 ..... $0.00
TDS220 L2 ..... $0.00
TDS220 L3 ..... $0.00
TDS220 L4 ..... $0.00
TDS220 L5 ..... $0.00
TDS220 L6 ..... $0.00
TDS220 L7 ..... $0.00
TDS220 L8 ..... $0.00
TDS220 L9 ..... $0.00
TDS224 ..... $2,395.00
TDS224 A1 ..... $0.00
TDS224 A2 ..... $0.00
TDS224 A3 ..... $0.00
TDS224 A4 ..... $0.00
TDS224 A5 ..... $0.00
TDS224 AC $0.00
TDS224 D1 ..... $150.00
TDS224 L1 ..... $0.00
TDS224 L2 ..... $0.00
TDS224 L3 ..... $0.00
TDS224 L4 ..... $0.00
TDS224 L5 ..... $0.00
TDS224 L6 ..... $0.00
TDS224 L7 ..... $0.00
TDS224 L8 ..... $0.00
TDS224 L9 ..... $0.00
TDS224 LR $0.00
TDS2CM $265.00
TDS2CM L1 ..... $0.00
TDS2CM L2 ..... $0.00
TDS2CM L3 ..... $0.00
TDS2CM L4 ..... $0.00
TDS2CM L5 ..... $0.00
TDS2CM L6 ..... $0.00
TDS2CM L7 ..... $0.00
TDS2CM L8 ..... $0.00
TDS2CM L9 ..... $0.00
TDS2CM LR $0.00
TDS2MM $495.00
TDS2MM L1 ..... $0.00
TDS2MM L2 ..... $0.00
TDS2MM L3 ..... $0.00
TDS2MM L4 ..... $0.00
TDS2MM L5 ..... $0.00
TDS2MM L6 ..... $0.00
TDS2MM L7 ..... $0.00
TDS2MM L8 ..... $0.00
TDS2MM L9 ..... $0.00
TDS2MM LR $0.00
TDS3012 ..... $2,995.00
TDS3012A1 ..... $0.00
TDS3012A2 ..... $0.00
TDS3012A3 ..... $0.00
TDS3012A5 ..... $0.00
TDS3012D1 ..... $90.00
TDS3012E1 ..... $0.00
TDS3012E2 ..... $0.00
TDS3012L1 ..... $0.00
TDS3012L2 ..... $0.00
TDS3012L3 ..... $0.00
TDS3012L4 ..... $0.00
TDS3012L5 ..... $0.00
TDS3012L6 ..... $0.00
TDS3012L7 ..... $0.00
TDS3012L8 ..... $0.00
TDS3012LR $0.00
TDS3012P1 ..... $0.00
TDS3014 ..... $4,495.00
TDS3014A1 ..... $0.00
TDS3014A2 ..... $0.00
TDS3014A3 ..... $0.00
TDS3014A5 ..... $0.00
TDS3014D1 ..... $110.00
TDS3014E1 ..... $0.00
TDS3014E2 ..... $0.00
TDS3014L1 ..... $0.00
TDS3014L2 ..... $0.00
TDS3014L3 ..... $0.00
TDS3014L4 ..... $0.00
TDS3014L5 ..... $0.00
TDS3014L6 ..... $0.00
TDS3014L7 ..... $0.00
TDS3014L8 ..... $0.00
TDS3014L9 ..... $0.00
TDS3014LR $0.00
TDS3014P1 ..... $0.00
TDS3032 ..... $3,695.00
TDS3032A1 ..... $0.00
TDS3032A2 ..... $0.00
TDS3032A3 ..... $0.00
TDS3032A5 ..... $0.00
TDS3032D1 ..... $110.00
TDS3032E1 ..... $0.00
TDS3032E2 ..... $0.00

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TDS3032L1 . . . . . $0.00
TDS3032L2 . . . . . $0.00
TDS3032L3 . . . . . $0.00
TDS3032L4 . . . . . $0.00
TDS3032L5 . . . . . $0.00
TDS3032L6 . . . . . $0.00
TDS3032L7 . . . . . $0.00
TDS3032L8 . . . . . $0.00
TDS3032L9 . . . . . $0.00
TDS3032LR $0.00
TDS3032P1 . . . . . $0.00
TDS3034 . . . . . $6,595.00
TDS3034A1 . . . . . $0.00
TDS3034A2 . . . . . $0.00
TDS3034A3 . . . . . $0.00
TDS3034A5 . . . . . $0.00
TDS3034D1 . . . . . $120.00
TDS3034E1 . . . . . $0.00
TDS3034E2 . . . . . $0.00
TDS3034L1 . . . . . $0.00
TDS3034L2 . . . . . $0.00
TDS3034L3 . . . . . $0.00
TDS3034L4 . . . . . $0.00
TDS3034L5 . . . . . $0.00
TDS3034L6 . . . . . $0.00
TDS3034L7 . . . . . $0.00
TDS3034L8 . . . . . $0.00
TDS3034L9 . . . . . $0.00
TDS3034LR $0.00
TDS3034P1 . . . . . $0.00
TDS3052 . . . . . $5,995.00
TDS3052A1 . . . . . $0.00
TDS3052A3 . . . . . $0.00
TDS3052A5 . . . . . $0.00
TDS3052C3 . . . . . $400.00
TDS3052C5 . . . . . $800.00
TDS3052D1 . . . . . $130.00
TDS3052D3 . . . . . $200.00
TDS3052D5 . . . . . $400.00
TDS3052E1 . . . . . $0.00
TDS3052E2 . . . . . $0.00
TDS3052L1 . . . . . $0.00
TDS3052L2 . . . . . $0.00
TDS3052L3 . . . . . $0.00
TDS3052L4 . . . . . $0.00
TDS3052L5 . . . . . $0.00
TDS3052L6 . . . . . $0.00
TDS3052L7 . . . . . $0.00
TDS3052L8 . . . . . $0.00
TDS3052L9 . . . . . $0.00
TDS3052LR $0.00
TDS3052P1 . . . . . $0.00

TDS3054 . . . . . $9,995.00
TDS3054A1 . . . . . $0.00
TDS3054A2 . . . . . $0.00
TDS3054A3 . . . . . $0.00
TDS3054A5 . . . . . $0.00
TDS3054C3 . . . . . $565.00
TDS3054C5 . . . . . $1,125.00
TDS3054D1 . . . . . $140.00
TDS3054D3 . . . . . $240.00
TDS3054D5 . . . . . $475.00
TDS3054E1 . . . . . $0.00
TDS3054E2 . . . . . $0.00
TDS3054L1 . . . . . $0.00
TDS3054L2 . . . . . $0.00
TDS3054L3 . . . . . $0.00
TDS3054L4 . . . . . $0.00
TDS3054L5 . . . . . $0.00
TDS3054L6 . . . . . $0.00
TDS3054L7 . . . . . $0.00
TDS3054L8 . . . . . $0.00
TDS3054L9 . . . . . $0.00
TDS3054LR $0.00
TDS3054P1 . . . . . $0.00
TDS3BAT $395.00
TDS3CHG $95.00
TDS3CHGA1 . . . . . $0.00
TDS3CHGA2 . . . . . $0.00
TDS3CHGA3 . . . . . $0.00
TDS3CHGA4 . . . . . $0.00
TDS3CHGA5 . . . . . $0.00
TDS3CHGA6 . . . . . $0.00
TDS3FFT $495.00
TDS3FFTL1 . . . . . $0.00
TDS3FFTL2 . . . . . $0.00
TDS3FFTL3 . . . . . $0.00
TDS3FFTL4 . . . . . $0.00
TDS3FFTL5 . . . . . $0.00
TDS3FFTL6 . . . . . $0.00
TDS3FFTL7 . . . . . $0.00
TDS3FFTL8 . . . . . $0.00
TDS3FFTL9 . . . . . $0.00
TDS3GM $395.00
TDS3TRG $495.00
TDS3TRGL1 . . . . . $0.00
TDS3TRGL2 . . . . . $0.00
TDS3TRGL3 . . . . . $0.00
TDS3TRGL4 . . . . . $0.00
TDS3TRGL5 . . . . . $0.00
TDS3TRGL6 . . . . . $0.00
TDS3TRGL7 . . . . . $0.00
TDS3TRGL8 . . . . . $0.00
TDS3TRGL9 . . . . . $0.00

TDS3VID $495.00
TDS3VIDL1 . . . . . $0.00
TDS3VIDL2 . . . . . $0.00
TDS3VIDL3 . . . . . $0.00
TDS3VIDL4 . . . . . $0.00
TDS3VIDL5 . . . . . $0.00
TDS3VIDL6 . . . . . $0.00
TDS3VIDL7 . . . . . $0.00
TDS3VIDL8 . . . . . $0.00
TDS3VIDL9 . . . . . $0.00
TDS3VM $395.00
TDS420A $6,925.00
TDS420A1R $350.00
TDS420AA1 . . . . . $0.00
TDS420AA2 . . . . . $0.00
TDS420AA3 . . . . . $0.00
TDS420AA4 . . . . . $0.00
TDS420AA5 . . . . . $0.00
TDS420AC3 . . . . . $460.00
TDS420AC5 . . . . . $915.00
TDS420AD1 . . . . . $115.00
TDS420AD3 . . . . . $210.00
TDS420AD5 . . . . . $420.00
TDS420AL1 . . . . . $0.00
TDS420AL3 . . . . . $0.00
TDS420AL5 . . . . . $0.00
TDS420AR5 . . . . . $440.00
TDS420AXL $995.00
TDS430A $5,245.00
TDS430A1R $350.00
TDS430AA1 . . . . . $0.00
TDS430AA2 . . . . . $0.00
TDS430AA3 . . . . . $0.00
TDS430AA4 . . . . . $0.00
TDS430AA5 . . . . . $0.00
TDS430AC3 . . . . . $365.00
TDS430AC5 . . . . . $725.00
TDS430AD1 . . . . . $115.00
TDS430AD3 . . . . . $190.00
TDS430AD5 . . . . . $380.00
TDS430AL1 . . . . . $0.00
TDS430AL3 . . . . . $0.00
TDS430AL5 . . . . . $0.00
TDS430AR5 . . . . . $390.00
TDS430AXL $995.00
TDS460A $8,070.00
TDS460A1R $350.00
TDS460AA1 . . . . . $0.00
TDS460AA2 . . . . . $0.00
TDS460AA3 . . . . . $0.00
TDS460AA4 . . . . . $0.00
TDS460AA5 . . . . . $0.00

TDS460AC3 . . . . . $460.00
TDS460AC5 . . . . . $915.00
TDS460AD1 . . . . . $115.00
TDS460AD3 . . . . . $210.00
TDS460AD5 . . . . . $420.00
TDS460AL1 . . . . . $0.00
TDS460AL3 . . . . . $0.00
TDS460AL5 . . . . . $0.00
TDS460AR5 . . . . . $475.00
TDS460AXL $995.00
TDS4F13 . . . . . $619.00
TDS520D $9,760.00
TDS520D05 . . . . . $1,495.00
TDS520D13 . . . . . $495.00
TDS520D1G $0.00
TDS520D1K $775.00
TDS520D1M $1,495.00
TDS520D1R $400.00
TDS520D2C $3,250.00
TDS520D2F $995.00
TDS520D2M $4,495.00
TDS520D34 . . . . . $2,797.00
TDS520D35 . . . . . $315.00
TDS520D36 . . . . . $209.00
TDS520D3C $3,800.00
TDS520D4C $4,200.00
TDS520DA1 . . . . . $0.00
TDS520DA2 . . . . . $0.00
TDS520DA3 . . . . . $0.00
TDS520DA4 . . . . . $0.00
TDS520DA5 . . . . . $0.00
TDS520DC3 . . . . . $515.00
TDS520DC5 . . . . . $1,030.00
TDS520DD1 . . . . . $120.00
TDS520DD3 . . . . . $230.00
TDS520DD5 . . . . . $460.00
TDS520DHD $995.00
TDS520DL1 . . . . . $0.00
TDS520DL3 . . . . . $0.00
TDS520DL5 . . . . . $0.00
TDS520DL9 . . . . . $0.00
TDS520DR5 . . . . . $620.00
TDS540C $14,995.00
TDS540CD1 . . . . . $125.00
TDS540CGP $0.00
TDS540CXL $2,995.00
TDS540D $15,750.00
TDS540D05 . . . . . $1,495.00
TDS540D13 . . . . . $495.00
TDS540D1G $0.00
TDS540D1K $775.00
TDS540D1M $2,495.00

TDS540D1R $400.00
TDS540D2C $3,250.00
TDS540D2F $995.00
TDS540D2M $6,995.00
TDS540D34 . . . . . $2,797.00
TDS540D35 . . . . . $315.00
TDS540D36 . . . . . $209.00
TDS540D3C $3,800.00
TDS540D4C $4,200.00
TDS540DA1 . . . . . $0.00
TDS540DA2 . . . . . $0.00
TDS540DA3 . . . . . $0.00
TDS540DA4 . . . . . $0.00
TDS540DA5 . . . . . $0.00
TDS540DC3 . . . . . $580.00
TDS540DC5 . . . . . $1,160.00
TDS540DD1 . . . . . $130.00
TDS540DD3 . . . . . $250.00
TDS540DD5 . . . . . $495.00
TDS540DHD $995.00
TDS540DL1 . . . . . $0.00
TDS540DL3 . . . . . $0.00
TDS540DL5 . . . . . $0.00
TDS540DL9 . . . . . $0.00
TDS540DR5 . . . . . $875.00
TDS580D $18,490.00
TDS580D05 . . . . . $1,495.00
TDS580D13 . . . . . $495.00
TDS580D1K $775.00
TDS580D1M $2,495.00
TDS580D1R $400.00
TDS580D2C $3,250.00
TDS580D2F $995.00
TDS580D2M $6,995.00
TDS580D33 . . . . . $230.00
TDS580D34 . . . . . $2,797.00
TDS580D36 . . . . . $209.00
TDS580D37 . . . . . $1,187.00
TDS580D3C $3,800.00
TDS580D4C $4,200.00
TDS580DA1 . . . . . $0.00
TDS580DA2 . . . . . $0.00
TDS580DA3 . . . . . $0.00
TDS580DA4 . . . . . $0.00
TDS580DA5 . . . . . $0.00
TDS580DC3 . . . . . $640.00
TDS580DC5 . . . . . $1,275.00
TDS580DD1 . . . . . $140.00
TDS580DD3 . . . . . $260.00
TDS580DD5 . . . . . $515.00
TDS580DHD $995.00
TDS580DL1 . . . . . $0.00

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TDS580DL3 ..... $0.00
TDS580DL5 ..... $0.00
TDS580DL9 ..... $0.00
TDS580DR5 ..... $1,150.00
TDS654C..... $14,950.00
TDS654C05 ..... $1,495.00
TDS654C1K $775.00
TDS654C1R $400.00
TDS654C34 ..... $2,797.00
TDS654C35..... $315.00
TDS654C36 ..... $209.00
TDS654CA1 ..... $0.00
TDS654CA2 ..... $0.00
TDS654CA3 ..... $0.00
TDS654CA4 ..... $0.00
TDS654CA5 ..... $0.00
TDS654CC3 ..... $545.00
TDS654CC5 ..... $1,085.00
TDS654CD1 ..... $105.00
TDS654CD3 ..... $240.00
TDS654CD5 ..... $475.00
TDS654CHD..... $995.00
TDS654CL1 ..... $0.00
TDS654CL3 ..... $0.00
TDS654CL5 ..... $0.00
TDS654CL9 ..... $0.00
TDS654CR5 ..... $495.00
TDS680C..... $14,995.00
TDS680C05 ..... $1,495.00
TDS680C1K $775.00
TDS680C1R $400.00
TDS680C33 ..... $230.00
TDS680C34 ..... $2,797.00
TDS680C36 ..... $209.00
TDS680C37 ..... $1,187.00
TDS680CA1 ..... $0.00
TDS680CA2 ..... $0.00
TDS680CA3 ..... $0.00
TDS680CA4 ..... $0.00
TDS680CA5 ..... $0.00
TDS680CC3 ..... $545.00
TDS680CC5 ..... $1,085.00
TDS680CD1 ..... $105.00
TDS680CD3 ..... $240.00
TDS680CD5 ..... $475.00
TDS680CHD..... $995.00
TDS680CL1 ..... $0.00
TDS680CL3 ..... $0.00
TDS680CL5 ..... $0.00
TDS680CL9 ..... $0.00
TDS680CR5 ..... $495.00
TDS684C..... $23,620.00
TDS684C05 ..... $1,495.00
TDS684C1K $775.00
TDS684C1R $400.00
TDS684C33 ..... $230.00
TDS684C34 ..... $2,797.00
TDS684C36 ..... $209.00
TDS684C37 ..... $1,187.00
TDS684CA1 ..... $0.00
TDS684CA2 ..... $0.00
TDS684CA3 ..... $0.00
TDS684CA4 ..... $0.00
TDS684CA5 ..... $0.00
TDS684CC3 ..... $660.00
TDS684CC5 ..... $1,315.00
TDS684CD1 ..... $115.00
TDS684CD3 ..... $270.00
TDS684CD5 ..... $535.00
TDS684CHD..... $995.00
TDS684CL1 ..... $0.00
TDS684CL3 ..... $0.00
TDS684CL5 ..... $0.00
TDS684CL9 ..... $0.00
TDS684CR5 ..... $705.00
TDS694C..... $37,995.00
TDS694C1K $775.00
TDS694C1M $2,495.00
TDS694C1R $400.00
TDS694C31..... $697.00
TDS694C33 ..... $209.00
TDS694C37..... $1,117.00
TDS694C38 ..... $2,307.00
TDS694C39 ..... $3,007.00
TDS694CA1 ..... $0.00
TDS694CA2 ..... $0.00
TDS694CA3 ..... $0.00
TDS694CA5 ..... $0.00
TDS694CC3 ..... $690.00
TDS694CC5 ..... $1,330.00
TDS694CD1 ..... $145.00
TDS694CD3 ..... $430.00
TDS694CD5 ..... $690.00
TDS694CHD..... $995.00
TDS694CR5 ..... $1,695.00
TDS724D..... $12,695.00
TDS724D05 ..... $1,495.00
TDS724D1G $0.00
TDS724D1K $775.00
TDS724D1M $1,495.00
TDS724D1R $400.00
TDS724D2C..... $3,250.00
TDS724D2M $4,495.00
TDS724D34 ..... $2,797.00
TDS724D35..... $315.00
TDS724D36 ..... $209.00
TDS724D3C..... $3,800.00
TDS724D4C..... $4,200.00
TDS724DA1 ..... $0.00
TDS724DA2 ..... $0.00
TDS724DA3 ..... $0.00
TDS724DA4 ..... $0.00
TDS724DA5 ..... $0.00
TDS724DC3 ..... $535.00
TDS724DC5 ..... $1,065.00
TDS724DD1 ..... $125.00
TDS724DD3 ..... $230.00
TDS724DD5 ..... $460.00
TDS724DHD..... $995.00
TDS724DL1 ..... $0.00
TDS724DL3 ..... $0.00
TDS724DL5 ..... $0.00
TDS724DL9 ..... $0.00
TDS724DR5 ..... $760.00
TDS754D..... $17,990.00
TDS754D05 ..... $1,495.00
TDS754D1G $0.00
TDS754D1K $775.00
TDS754D1M $2,495.00
TDS754D1R $400.00
TDS754D2C..... $3,250.00
TDS754D2M $6,995.00
TDS754D34 ..... $2,797.00
TDS754D35..... $315.00
TDS754D36 ..... $209.00
TDS754D3C..... $3,800.00
TDS754D4C..... $4,200.00
TDS754DA1 ..... $0.00
TDS754DA2 ..... $0.00
TDS754DA3 ..... $0.00
TDS754DA4 ..... $0.00
TDS754DA5 ..... $0.00
TDS754DC3 ..... $620.00
TDS754DC5 ..... $1,235.00
TDS754DD1 ..... $135.00
TDS754DD3 ..... $260.00
TDS754DD5 ..... $515.00
TDS754DHD..... $995.00
TDS754DL1 ..... $0.00
TDS754DL3 ..... $0.00
TDS754DL5 ..... $0.00
TDS754DL9 ..... $0.00
TDS754DR5 ..... $1,010.00
TDS784D $22,495.00
TDS784D05 ..... $1,495.00
TDS784D1K $775.00
TDS784D1M $2,495.00
TDS784D1R $400.00
TDS784D2C..... $3,250.00
TDS784D2M $6,995.00
TDS784D33 ..... $230.00
TDS784D34 ..... $2,797.00
TDS784D36 ..... $209.00
TDS784D37 ..... $1,187.00
TDS784D3C..... $3,800.00
TDS784D4C..... $4,200.00
TDS784DA1 ..... $0.00
TDS784DA2 ..... $0.00
TDS784DA3 ..... $0.00
TDS784DA4 ..... $0.00
TDS784DA5 ..... $0.00
TDS784DC3 ..... $660.00
TDS784DC5 ..... $1,315.00
TDS784DD1 ..... $145.00
TDS784DD3 ..... $270.00
TDS784DD5 ..... $535.00
TDS784DHD..... $995.00
TDS784DL1 ..... $0.00
TDS784DL3 ..... $0.00
TDS784DL5 ..... $0.00
TDS784DL9 ..... $0.00
TDS784DR5 ..... $1,340.00
TDS794D..... $36,745.00
TDS794D1K $775.00
TDS794D1M $2,495.00
TDS794D1R $400.00
TDS794D2C..... $3,250.00
TDS794D2M $6,995.00
TDS794D31 ..... $697.00
TDS794D32 ..... $2,797.00
TDS794D33 ..... $230.00
TDS794D34 ..... $2,797.00
TDS794D37 ..... $1,187.00
TDS794D38 ..... $2,307.00
TDS794D39 ..... $3,007.00
TDS794DA1 ..... $0.00
TDS794DA2 ..... $0.00
TDS794DA3 ..... $0.00
TDS794DA4 ..... $0.00
TDS794DA5 ..... $0.00
TDS794DC3 ..... $800.00
TDS794DC5 ..... $1,600.00
TDS794DD1 ..... $165.00
TDS794DD3 ..... $295.00
TDS794DD5 ..... $590.00
TDS794DHD..... $995.00
TDS794DL1 ..... $0.00
TDS794DL3 ..... $0.00
TDS794DL5 ..... $0.00
TDS794DL9 ..... $0.00
TDS794DR5 ..... $1,900.00
TDS820..... $19,000.00
TDS820 13 ..... $495.00
TDS820 1D..... $0.00
TDS820 1R $410.00
TDS820 2F..... $1,495.00
TDS820 32..... $2,800.00
TDS820 A1..... $0.00
TDS820 A2..... $0.00
TDS820 A3..... $0.00
TDS820 A4..... $0.00
TDS820 A5..... $0.00
TDS820 C3..... $640.00
TDS820 C5..... $1,275.00
TDS820 D1..... $140.00
TDS820 D3..... $260.00
TDS820 D5..... $515.00
TDS820 R5..... $1,040.00
TDSCEM1 ..... $1,000.00
TDSCPM1 ..... $1,000.00
TDSDDM1 ..... $850.00
TDSDFEM2..... $4,495.00
TDSDFEM2 IF..... $135.00
TDSDFEM4..... $6,995.00
TDSDFEM4 IF..... $135.00
TDSJIT1 ..... $1,500.00
TDSPSM1..... $350.00
TDSPWR1..... $350.00
TDSXF05..... $1,495.00
TDSXF05IF $540.00
TDSXF13 ..... $619.00
TDSXF13IF $135.00
TDSXF1F..... $619.00
TDSXF1M2..... $2,495.00
TDSXF1M2 IF..... $135.00
TDSXF1M4..... $3,495.00
TDSXF1M4 IF..... $135.00
TDSXF2C..... $4,750.00
TDSXF2CIF..... $135.00
TDSXF2F..... $1,349.00
TDSXF2FIF $135.00
TDSXF3C..... $1,095.00
TDSXF3CIF..... $540.00
TDSXF4C..... $1,095.00
TDSXF4CIF..... $540.00
TDSXFHD $1,495.00
TDSXFHDIF..... $270.00
TFP2A..... $10,755.00
TFP2A 01 ..... $6,800.00
TFP2A 03 ..... $13,200.00

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TFP2A 06 ..... $18,400.00
TFP2A 08 ..... $18,400.00
TFP2A 09 ..... $14,200.00
TFP2A 11 ..... $11,200.00
TFP2A 14 ..... $995.00
TFP2A 16 ..... $1,795.00
TFP2A 17 ..... $2,995.00
TFP2A 19 ..... $125.00
TFP2A 1R $395.00
TFP2A 1S $595.00
TFP2A 20 ..... $0.00
TFP2A 21 ..... $0.00
TFP2A 22 ..... $0.00
TFP2A 23 ..... $0.00
TFP2A 24 ..... $0.00
TFP2A 25 ..... $0.00
TFP2A 26 ..... $0.00
TFP2A 27 ..... $0.00
TFP2A 28 ..... $0.00
TFP2A 29 ..... $0.00
TFP2A 2T $850.00
TFP2A 30 ..... $0.00
TFP2A 31 ..... $0.00
TFP2A 32 ..... $0.00
TFP2A 33 ..... $0.00
TFP2A 34 ..... $0.00
TFP2A 35 ..... $0.00
TFP2A 36 ..... $0.00
TFP2A 37 ..... $0.00
TFP2A 38 ..... $0.00
TFP2A 39 ..... $0.00
TFP2A 3T $1,005.00
TFP2A 41 ..... $0.00
TFP2A 42 ..... $0.00
TFP2A 4T $1,400.00
TFP2A 5T $695.00
TFP2A 6T $1,195.00
TFP2A 7T $2,895.00
TFP2A 8T $845.00
TFP2A 9T $1,525.00
TFP2A A1 ..... $0.00
TFP2A A2 ..... $0.00
TFP2A A3 ..... $0.00
TFP2A A4 ..... $0.00
TFP2A A5 ..... $0.00
TFP2A AU $0.00
TFP2A C3 ..... $640.00
TFP2A C5 ..... $1,275.00
TFP2A D1 ..... $145.00
TFP2A D3 ..... $260.00
TFP2A D5 ..... $515.00
TFP2A L1 ..... $0.00
TFP2A L3 ..... $0.00
TFP2A L4 ..... $0.00
TFP2A L5 ..... $0.00
TFP2A L6 ..... $0.00
TFP2A L7 ..... $0.00
TFP2A NF $200.00
TFP2A PF $735.00
TFP2A PG $735.00
TFP2A R3 ..... $630.00
TFP2A R5 ..... $1,255.00
TFP2A WT $5,600.00
TFS3031 ..... $4,725.00
TFS303101 ..... $5,245.00
TFS303103 ..... $9,655.00
TFS303104 ..... $4,700.00
TFS303106 ..... $6,245.00
TFS303110 ..... $9,425.00
TFS303111 ..... $400.00
TFS303119 ..... $125.00
TFS30311S $595.00
TFS30311T $295.00
TFS303120 ..... $0.00
TFS303121 ..... $0.00
TFS303122 ..... $0.00
TFS303124 ..... $0.00
TFS303125 ..... $0.00
TFS303126 ..... $0.00
TFS303128 ..... $0.00
TFS30312T $850.00
TFS303130 ..... $0.00
TFS303131 ..... $0.00
TFS303132 ..... $0.00
TFS303134 ..... $0.00
TFS303135 ..... $0.00
TFS303136 ..... $0.00
TFS303138 ..... $0.00
TFS30313T $1,005.00
TFS303141 ..... $0.00
TFS303142 ..... $0.00
TFS303143 ..... $0.00
TFS303144 ..... $0.00
TFS303145 ..... $0.00
TFS30315T $695.00
TFS30316T $1,195.00
TFS30317T $2,895.00
TFS30318T $845.00
TFS30319T $1,525.00
TFS3031A1 ..... $0.00
TFS3031A2 ..... $0.00
TFS3031A3 ..... $0.00
TFS3031A4 ..... $0.00
TFS3031A5 ..... $0.00
TFS3031A6 ..... $0.00
TFS3031AU $0.00
TFS3031D1 ..... $140.00
TFS3031L1 ..... $0.00
TFS3031L2 ..... $0.00
TFS3031L3 ..... $0.00
TFS3031L4 ..... $0.00
TFS3031L5 ..... $0.00
TFS3031L6 ..... $0.00
TFS3031L7 ..... $0.00
TFS3031L8 ..... $0.00
TFS3031LD $0.00
TFS3031LF $0.00
TFS3031R3 ..... $610.00
TFS3031R5 ..... $1,220.00
TG2000 ..... $7,995.00
TG2000 A1 ..... $0.00
TG2000 A2 ..... $0.00
TG2000 A3 ..... $0.00
TG2000 A5 ..... $0.00
TG2000 C3 ..... $600.00
TG2000 C5 ..... $1,200.00
TG2000 D1 ..... $175.00
TG2000 D3 ..... $250.00
TG2000 D5 ..... $495.00
TG2000 R3 ..... $375.00
TG2000 R5 ..... $745.00
THM5AC $125.00
THM5AC A1 ..... $0.00
THM5AC A2 ..... $0.00
THM5BAT $95.00
THM5CHG $239.00
THM5CHGA1 ..... $0.00
THM5CHGA2 ..... $0.00
THM5CHGA6 ..... $0.00
THM5HCA $130.00
THM5SCA $130.00
THS710A $2,195.00
THS710A1B $228.00
THS710A2B $228.00
THS710A3B $228.00
THS710AA1 ..... $0.00
THS710AA2 ..... $0.00
THS710AA3 ..... $0.00
THS710AA6 ..... $0.00
THS710AD1 ..... $150.00
THS710AL1 ..... $0.00
THS710AL2 ..... $0.00
THS710AL3 ..... $0.00
THS710AL4 ..... $0.00
THS710AL5 ..... $0.00
THS710AL6 ..... $0.00
THS710AL7 ..... $0.00
THS710AL8 ..... $0.00
THS710AL9 ..... $0.00
THS720A $2,295.00
THS720A1B $228.00
THS720A2B $228.00
THS720A3B $228.00
THS720AA1 ..... $0.00
THS720AA2 ..... $0.00
THS720AA3 ..... $0.00
THS720AA6 ..... $0.00
THS720AD1 ..... $150.00
THS720AL1 ..... $0.00
THS720AL2 ..... $0.00
THS720AL3 ..... $0.00
THS720AL4 ..... $0.00
THS720AL5 ..... $0.00
THS720AL6 ..... $0.00
THS720AL7 ..... $0.00
THS720AL8 ..... $0.00
THS720AL9 ..... $0.00
THS720P $3,295.00
THS720P1B $228.00
THS720P2B $228.00
THS720P3B $228.00
THS720PA1 ..... $0.00
THS720PA2 ..... $0.00
THS720PA3 ..... $0.00
THS720PA6 ..... $0.00
THS720PD1 ..... $150.00
THS720PL1 ..... $0.00
THS720PL2 ..... $0.00
THS720PL3 ..... $0.00
THS720PL4 ..... $0.00
THS720PL5 ..... $0.00
THS720PL6 ..... $0.00
THS720PL7 ..... $0.00
THS720PL8 ..... $0.00
THS720PL9 ..... $0.00
THS730A $3,395.00
THS730A1B $228.00
THS730A2B $228.00
THS730A3B $228.00
THS730AA1 ..... $0.00
THS730AA2 ..... $0.00
THS730AA3 ..... $0.00
THS730AA6 ..... $0.00
THS730AD1 ..... $150.00
THS730AL1 ..... $0.00
THS730AL2 ..... $0.00
THS730AL3 ..... $0.00
THS730AL4 ..... $0.00
THS730AL5 ..... $0.00
THS730AL6 ..... $0.00
THS730AL7 ..... $0.00
THS730AL8 ..... $0.00
THS730AL9 ..... $0.00
THS7BAT $85.00
THS7CHG $245.00
THS7CHGA0 ..... $0.00
THS7CHGA1 ..... $0.00
THS7CHGA2 ..... $0.00
THS7CHGA6 ..... $0.00
THS7HCA $279.00
TLA714 ..... $10,500.00
TLA714 1A $425.00
TLA714 1K $925.00
TLA714 1M $1,050.00
TLA714 1S $1,050.00
TLA714 2M $2,100.00
TLA714 A0 ..... $0.00
TLA714 A1 ..... $0.00
TLA714 A2 ..... $0.00
TLA714 A3 ..... $0.00
TLA714 A4 ..... $0.00
TLA714 A5 ..... $0.00
TLA714 C3 ..... $435.00
TLA714 D1 ..... $130.00
TLA714 D3 ..... $335.00
TLA714 IN $400.00
TLA714 R3 ..... $540.00
TLA714 S1 ..... $300.00
TLA714 S3 ..... $900.00
TLA720 ..... $16,500.00
TLA720 1A $425.00
TLA720 1K $925.00
TLA720 1M $1,050.00
TLA720 2M $2,100.00
TLA720 A1 ..... $0.00
TLA720 A2 ..... $0.00
TLA720 A3 ..... $0.00
TLA720 A4 ..... $0.00
TLA720 A5 ..... $0.00
TLA720 C3 ..... $580.00
TLA720 D1 ..... $150.00
TLA720 D3 ..... $390.00
TLA720 IN $400.00
TLA720 R3 ..... $720.00
TLA720 S1 ..... $300.00
TLA720 S3 ..... $900.00
TLA7D1 ..... $9,000.00
TLA7D1 C3 ..... $565.00
TLA7D1 D1 ..... $130.00
TLA7D1 D3 ..... $240.00

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TLA7D1 IN $400.00
TLA7D1 R3 ..... $400.00
TLA7D2 ..... $15,000.00
TLA7D2 C3 ..... $820.00
TLA7D2 D1 ..... $170.00
TLA7D2 D3 ..... $305.00
TLA7D2 IN $400.00
TLA7D2 R3 ..... $570.00
TLA7E1 ..... $19,000.00
TLA7E1 C3 ..... $855.00
TLA7E1 D1 ..... $170.00
TLA7E1 D3 ..... $315.00
TLA7E1 IN $400.00
TLA7E1 R3 ..... $600.00
TLA7E2 ..... $29,500.00
TLA7E2 C3 ..... $1,200.00
TLA7E2 D1 ..... $215.00
TLA7E2 D3 ..... $400.00
TLA7E2 IN $400.00
TLA7E2 R3 ..... $800.00
TLA7F11 ..... $1,500.00
TLA7F1101 ..... $1,500.00
TLA7F1102 ..... $3,000.00
TLA7F1103 ..... $4,500.00
TLA7F1104 ..... $2,500.00
TLA7F1105 ..... $4,750.00
TLA7F1106 ..... $7,000.00
TLA7F1107 ..... $9,250.00
TLA7F1108 ..... $1,500.00
TLA7F1109 ..... $3,000.00
TLA7F1110 ..... $3,250.00
TLA7F1111 ..... $5,500.00
TLA7F1112 ..... $7,750.00
TLA7F1113 ..... $1,500.00
TLA7F1114 ..... $4,000.00
TLA7F1115 ..... $6,250.00
TLA7F1116 ..... $4,750.00
TLA7F1117 ..... $2,250.00
TLA7F1118 ..... $4,500.00
TLA7F1119 ..... $6,750.00
TLA7F1120 ..... $2,250.00
TLA7F1121 ..... $4,500.00
TLA7F1122 ..... $2,250.00
TLA7F11IF $300.00
TLA7F11IN $400.00
TLA7F12 ..... $1,500.00
TLA7F1201 ..... $3,000.00
TLA7F1202 ..... $6,000.00
TLA7F1203 ..... $9,000.00
TLA7F1204 ..... $3,875.00
TLA7F1205 ..... $8,375.00
TLA7F1206 ..... $12,875.00
TLA7F1207 ..... $17,375.00
TLA7F1208 ..... $3,000.00
TLA7F1209 ..... $6,000.00
TLA7F1210 ..... $5,375.00
TLA7F1211 ..... $9,875.00
TLA7F1212 ..... $14,375.00
TLA7F1213 ..... $3,000.00
TLA7F1214 ..... $6,875.00
TLA7F1215 ..... $11,375.00
TLA7F1216 ..... $8,375.00
TLA7F1217 ..... $4,500.00
TLA7F1218 ..... $9,000.00
TLA7F1219 ..... $13,500.00
TLA7F1220 ..... $4,500.00
TLA7F1221 ..... $9,000.00
TLA7F1222 ..... $4,500.00
TLA7F12IF $300.00
TLA7F12IN $400.00
TLA7F13 ..... $1,500.00
TLA7F1301 ..... $4,500.00
TLA7F1302 ..... $9,000.00
TLA7F1303 ..... $13,500.00
TLA7F1304 ..... $5,500.00
TLA7F1305 ..... $12,250.00
TLA7F1306 ..... $19,000.00
TLA7F1307 ..... $25,750.00
TLA7F1308 ..... $4,500.00
TLA7F1309 ..... $9,000.00
TLA7F1310 ..... $7,750.00
TLA7F1311 ..... $14,500.00
TLA7F1312 ..... $21,250.00
TLA7F1313 ..... $4,500.00
TLA7F1314 ..... $10,000.00
TLA7F1315 ..... $16,750.00
TLA7F1316 ..... $12,250.00
TLA7F1317 ..... $6,750.00
TLA7F1318 ..... $13,500.00
TLA7F1319 ..... $20,250.00
TLA7F1320 ..... $6,750.00
TLA7F1321 ..... $13,500.00
TLA7F1322 ..... $6,750.00
TLA7F13IF $300.00
TLA7F13IN $400.00
TLA7F14 ..... $1,500.00
TLA7F1401 ..... $6,000.00
TLA7F1402 ..... $12,000.00
TLA7F1403 ..... $18,000.00
TLA7F1404 ..... $7,500.00
TLA7F1405 ..... $16,500.00
TLA7F1406 ..... $25,500.00
TLA7F1407 ..... $34,500.00
TLA7F1408 ..... $6,000.00
TLA7F1409 ..... $12,000.00
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TLA7F1411 ..... $19,500.00
TLA7F1412 ..... $28,500.00
TLA7F1413 ..... $6,000.00
TLA7F1414 ..... $13,500.00
TLA7F1415 ..... $22,500.00
TLA7F1416 ..... $16,500.00
TLA7F1417 ..... $9,000.00
TLA7F1418 ..... $18,000.00
TLA7F1419 ..... $27,000.00
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TLA7F1421 ..... $18,000.00
TLA7F1422 ..... $9,000.00
TLA7F14IF $300.00
TLA7F14IN $400.00
TLA7F16 ..... $1,500.00
TLA7F1601 ..... $10,875.00
TLA7F16IF $300.00
TLA7F16IN $400.00
TLA7F18 ..... $1,500.00
TLA7F1801 ..... $21,500.00
TLA7F18IF $300.00
TLA7F18IN $400.00
TLA7F2 ..... $2,100.00
TLA7F2 1M $1,050.00
TLA7F2 1S $2,625.00
TLA7F2 2M $2,100.00
TLA7F2 2S $3,950.00
TLA7F2 3M $3,150.00
TLA7F2 3S $5,525.00
TLA7F2 4M $4,200.00
TLA7F2 4S $7,350.00
TLA7F2 5S $4,200.00
TLA7F2 6S $7,100.00
TLA7F2 7S $10,250.00
TLA7F2 8S $13,650.00
TLA7F2 IF $300.00
TLA7F2 IN $400.00
TLA7L1 ..... $5,250.00
TLA7L1 1P $0.00
TLA7L1 1S $2,625.00
TLA7L1 2S $1,050.00
TLA7L1 C3 ..... $400.00
TLA7L1 D1 ..... $110.00
TLA7L1 D3 ..... $200.00
TLA7L1 IN $400.00
TLA7L1 R3 ..... $250.00
TLA7M1 ..... $8,400.00
TLA7M1 1P $0.00
TLA7M1 1S $4,200.00
TLA7M1 C3 ..... $495.00
TLA7M1 D1 ..... $125.00
TLA7M1 D3 ..... $220.00
TLA7M1 IN $400.00
TLA7M1 R3 ..... $365.00
TLA7M2 ..... $14,175.00
TLA7M2 1P $0.00
TLA7M2 1S $7,100.00
TLA7M2 C3 ..... $695.00
TLA7M2 D1 ..... $150.00
TLA7M2 D3 ..... $280.00
TLA7M2 IN $400.00
TLA7M2 R3 ..... $460.00
TLA7N1 ..... $5,000.00
TLA7N1 1P $0.00
TLA7N1 1S $1,500.00
TLA7N1 2P $0.00
TLA7N1 2S $3,000.00
TLA7N1 3P $450.00
TLA7N1 3S $4,500.00
TLA7N1 4S $2,500.00
TLA7N1 5S $4,750.00
TLA7N1 6S $7,000.00
TLA7N1 7S $9,250.00
TLA7N1 C3 ..... $315.00
TLA7N1 D1 ..... $110.00
TLA7N1 D3 ..... $280.00
TLA7N1 IN $400.00
TLA7N1 R3 ..... $250.00
TLA7N2 ..... $7,750.00
TLA7N2 1P $0.00
TLA7N2 1S $3,000.00
TLA7N2 2P $0.00
TLA7N2 2S $6,000.00
TLA7N2 3P $900.00
TLA7N2 3S $9,000.00
TLA7N2 4S $3,875.00
TLA7N2 5S $8,375.00
TLA7N2 6S $12,875.00
TLA7N2 7S $17,375.00
TLA7N2 C3 ..... $390.00
TLA7N2 D1 ..... $120.00
TLA7N2 D3 ..... $310.00
TLA7N2 IN $400.00
TLA7N2 R3 ..... $350.00
TLA7N3 ..... $11,000.00
TLA7N3 1P $0.00
TLA7N3 1S $4,500.00
TLA7N3 2P $0.00
TLA7N3 2S $9,000.00
TLA7N3 3P $1,350.00
TLA7N3 3S $13,500.00
TLA7N3 4S $5,500.00
TLA7N3 5S $12,250.00
TLA7N3 6S $19,000.00
TLA7N3 7S $25,750.00
TLA7N3 C3 ..... $475.00
TLA7N3 D1 ..... $135.00
TLA7N3 D3 ..... $350.00
TLA7N3 IN $400.00
TLA7N3 R3 ..... $460.00
TLA7N4 ..... $15,000.00
TLA7N4 1P $0.00
TLA7N4 1S $6,000.00
TLA7N4 2P $0.00
TLA7N4 2S $12,000.00
TLA7N4 3P $1,800.00
TLA7N4 3S $18,000.00
TLA7N4 4S $7,500.00
TLA7N4 5S $16,500.00
TLA7N4 6S $25,500.00
TLA7N4 7S $34,500.00
TLA7N4 C3 ..... $575.00
TLA7N4 D1 ..... $150.00
TLA7N4 D3 ..... $390.00
TLA7N4 IN $400.00
TLA7N4 R3 ..... $595.00
TLA7P2 ..... $23,750.00
TLA7P2 1P $0.00
TLA7P2 1S $11,875.00
TLA7P2 2P $0.00
TLA7P2 3P $900.00
TLA7P2 C3 ..... $560.00
TLA7P2 D1 ..... $150.00
TLA7P2 D3 ..... $385.00
TLA7P2 IN $400.00
TLA7P2 R3 ..... $575.00
TLA7P4 ..... $43,000.00
TLA7P4 1P $0.00
TLA7P4 1S $21,500.00
TLA7P4 2P $0.00
TLA7P4 3P $1,800.00
TLA7P4 C3 ..... $910.00
TLA7P4 D1 ..... $205.00
TLA7P4 D3 ..... $540.00
TLA7P4 IN $400.00
TLA7P4 R3 ..... $1,045.00
TLA7QS $525.00
TLA7QS A1 ..... $0.00
TLA7QS A2 ..... $0.00
TLA7QS A6 ..... $0.00
TLA7UP $25.00
TLA7UP 01 ..... $1,375.00
TLA7UP 02 ..... $495.00
TLA7UP 03 ..... $245.00

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TLA7UP 04 ..... $595.00
TLA7UP 05 ..... $45.00
TLA7UP 06 ..... $0.00
TLA7UP 07 ..... $145.00
TLA7UP 08 ..... $395.00
TLA7UP IF $300.00
TLA7UP IN $400.00
TLS216 ..... $31,995.00
TLS216 1B $1,500.00
TLS216 1K $775.00
TLS216 1R $400.00
TLS216 1S $0.00
TLS216 24 ..... $780.00
TLS216 A1 ..... $0.00
TLS216 A2 ..... $0.00
TLS216 A3 ..... $0.00
TLS216 A4 ..... $0.00
TLS216 A5 ..... $0.00
TLS216 C3 ..... $1,160.00
TLS216 C5 ..... $2,320.00
TLS216 D1 ..... $205.00
TLS216 D3 ..... $390.00
TLS216 D5 ..... $780.00
TLS216 IN $380.00
TLS216 R5 ..... $1,220.00
TLS216 S3 ..... $600.00
TLS216 S5 ..... $900.00
TMF101 ..... $250.00
TMF101 D9 ..... $100.00
TMF102 ..... $250.00
TMF102 D9 ..... $100.00
TMF103 ..... $250.00
TMF103 D9 ..... $100.00
TMF104 ..... $250.00
TMF104 D9 ..... $100.00
TMF105 ..... $250.00
TMF105 D9 ..... $100.00
TMF106 ..... $250.00
TMF106 D9 ..... $100.00
TMF107 ..... $250.00
TMF107 D9 ..... $100.00
TMF109 ..... $250.00
TMF109 D9 ..... $100.00
TMF110 ..... $250.00
TMF110 D9 ..... $100.00
TMF111 ..... $250.00
TMF111 D9 ..... $100.00
TMF113 ..... $250.00
TMF140 ..... $250.00
TMF140 D9 ..... $100.00
TMF141 ..... $250.00
TMF141 D9 ..... $100.00
TMF142 ..... $250.00
TMF142 D9 ..... $100.00
TMF161 ..... $250.00
TMF161 D9 ..... $100.00
TMF163 ..... $250.00
TMF163 D9 ..... $100.00
TMF164 ..... $250.00
TMF164 D9 ..... $100.00
TMF165 ..... $250.00
TMF165 D9 ..... $100.00
TMF201 ..... $250.00
TMF201 D9 ..... $100.00
TMF202 ..... $250.00
TMF202 D9 ..... $100.00
TMF203 ..... $250.00
TMF203 D9 ..... $100.00
TMF204 ..... $250.00
TMF204 D9 ..... $100.00
TMF205 ..... $250.00
TMF205 D9 ..... $100.00
TMF220 ..... $250.00
TMF220 D9 ..... $100.00
TMF260 ..... $250.00
TMF260 D9 ..... $100.00
TMF261 ..... $250.00
TMF261 D9 ..... $100.00
TMF420 ..... $250.00
TMF420 D9 ..... $100.00
TMF480 ..... $250.00
TMF480 D9 ..... $100.00
TMF501 ..... $250.00
TMF501 D9 ..... $100.00
TMF540 ..... $250.00
TMF540 D9 ..... $100.00
TMF550 ..... $250.00
TMF550 D9 ..... $100.00
TMF600 ..... $250.00
TMF600 D9 ..... $100.00
TMF702 ..... $250.00
TMF702 D9 ..... $100.00
TMF801 ..... $250.00
TMF801 D9 ..... $100.00
TMF802 ..... $250.00
TMF802 D9 ..... $100.00
TMS101 ..... $2,050.00
TMS101 01 ..... $0.00
TMS101 D9 ..... $100.00
TMS102 ..... $2,050.00
TMS102 01 ..... $0.00
TMS102 02 ..... $0.00
TMS102 D9 ..... $100.00
TMS103 ..... $2,050.00
TMS103 01 ..... $0.00
TMS103 02 ..... $0.00
TMS103 D9 ..... $100.00
TMS104 ..... $3,100.00
TMS104 01 ..... $0.00
TMS104 02 ..... $0.00
TMS104 D9 ..... $100.00
TMS105 ..... $3,100.00
TMS105 01 ..... $0.00
TMS105 D9 ..... $100.00
TMS106 ..... $3,100.00
TMS106 01 ..... $0.00
TMS106 A1 ..... $0.00
TMS106 A2 ..... $0.00
TMS106 A3 ..... $0.00
TMS106 A5 ..... $0.00
TMS106 D9 ..... $100.00
TMS107 ..... $4,150.00
TMS107 01 ..... $0.00
TMS107 51 ..... $200.00
TMS107 D9 ..... $100.00
TMS109 ..... $5,200.00
TMS109 01 ..... $0.00
TMS109 02 ..... $0.00
TMS109 22 ..... $1,250.00
TMS109 A1 ..... $0.00
TMS109 A2 ..... $0.00
TMS109 A3 ..... $0.00
TMS109 A5 ..... $0.00
TMS109 D9 ..... $100.00
TMS109A $5,950.00
TMS109A01 ..... $0.00
TMS109A21 ..... $2,600.00
TMS109AA1 ..... $0.00
TMS109AA2 ..... $0.00
TMS109AA3 ..... $0.00
TMS109AA5 ..... $0.00
TMS110 ..... $9,400.00
TMS110 01 ..... $0.00
TMS110 A1 ..... $0.00
TMS110 A2 ..... $0.00
TMS110 A3 ..... $0.00
TMS110 A5 ..... $0.00
TMS110 D9 ..... $100.00
TMS111 ..... $9,400.00
TMS111 01 ..... $0.00
TMS111 22 ..... $1,250.00
TMS111 A1 ..... $0.00
TMS111 A2 ..... $0.00
TMS111 A3 ..... $0.00
TMS111 A5 ..... $0.00
TMS111 D9 ..... $100.00
TMS112 ..... $13,600.00
TMS112 01 ..... $0.00
TMS112 02 ..... $0.00
TMS112 03 ..... $0.00
TMS112 21 ..... $3,150.00
TMS112 A1 ..... $0.00
TMS112 A2 ..... $0.00
TMS112 A3 ..... $0.00
TMS112 A5 ..... $0.00
TMS113 ..... $11,000.00
TMS113P $11,000.00
TMS113PA1 ..... $0.00
TMS113PA2 ..... $0.00
TMS113PA3 ..... $0.00
TMS113PA5 ..... $0.00
TMS120 ..... $16,000.00
TMS140 ..... $2,050.00
TMS140 01 ..... $0.00
TMS140 D9 ..... $100.00
TMS141 ..... $2,600.00
TMS141 01 ..... $0.00
TMS141 02 ..... $0.00
TMS141 D9 ..... $100.00
TMS142 ..... $3,100.00
TMS142 01 ..... $0.00
TMS142 02 ..... $0.00
TMS142 22 ..... $1,250.00
TMS142 A1 ..... $0.00
TMS142 A2 ..... $0.00
TMS142 A3 ..... $0.00
TMS142 A5 ..... $0.00
TMS142 D9 ..... $100.00
TMS143 ..... $2,950.00
TMS143 01 ..... $0.00
TMS143 D9 ..... $100.00
TMS144 ..... $2,950.00
TMS144 11 ..... $1,000.00
TMS144 21 ..... $1,500.00
TMS144 D9 ..... $100.00
TMS161 ..... $3,600.00
TMS161 01 ..... $0.00
TMS161 02 ..... $0.00
TMS161 D9 ..... $100.00
TMS163 ..... $4,150.00
TMS163 01 ..... $0.00
TMS163 12 ..... $1,600.00
TMS163 22 ..... $1,250.00
TMS163 A1 ..... $0.00
TMS163 A2 ..... $0.00
TMS163 A3 ..... $0.00
TMS163 A5 ..... $0.00
TMS163 D9 ..... $100.00
TMS164 ..... $4,150.00
TMS164 01 ..... $0.00
TMS164 22 ..... $1,250.00
TMS164 A1 ..... $0.00
TMS164 A2 ..... $0.00
TMS164 A3 ..... $0.00
TMS164 A5 ..... $0.00
TMS164 D9 ..... $100.00
TMS165 ..... $4,150.00
TMS165 01 ..... $0.00
TMS165 21 ..... $1,050.00
TMS165 D9 ..... $100.00
TMS201 ..... $2,050.00
TMS201 01 ..... $0.00
TMS201 02 ..... $0.00
TMS201 03 ..... $0.00
TMS201 04 ..... $0.00
TMS201 D9 ..... $100.00
TMS202 ..... $3,100.00
TMS202 01 ..... $0.00
TMS202 02 ..... $0.00
TMS202 03 ..... $0.00
TMS202 D9 ..... $100.00
TMS203 ..... $3,600.00
TMS203 01 ..... $0.00
TMS203 02 ..... $0.00
TMS203 D9 ..... $100.00
TMS204 ..... $4,700.00
TMS204 01 ..... $0.00
TMS204 D9 ..... $100.00
TMS205 ..... $5,200.00
TMS205 01 ..... $0.00
TMS205 D9 ..... $100.00
TMS220 ..... $3,600.00
TMS220 11 ..... $1,000.00
TMS220 21 ..... $1,000.00
TMS220 D9 ..... $100.00
TMS221 ..... $3,450.00
TMS221 11 ..... $1,000.00
TMS221 21 ..... $1,500.00
TMS221 D9 ..... $100.00
TMS222 ..... $3,450.00
TMS222 01 ..... $0.00
TMS222 02 ..... $0.00
TMS222 21 ..... $1,950.00
TMS222 D9 ..... $100.00
TMS241 ..... $2,500.00
TMS241 D9 ..... $100.00
TMS260 ..... $3,100.00
TMS260 01 ..... $0.00
TMS260 02 ..... $0.00
TMS260 D9 ..... $100.00

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TMS261 ..... $4,150.00
TMS261 01 ..... $0.00
TMS261 22 ..... $1,250.00
TMS261 A1 ..... $0.00
TMS261 A2 ..... $0.00
TMS261 A3 ..... $0.00
TMS261 A5 ..... $0.00
TMS261 D9 ..... $100.00
TMS420 ..... $3,100.00
TMS420 01 ..... $0.00
TMS420 02 ..... $0.00
TMS420 D9 ..... $100.00
TMS440 ..... $5,000.00
TMS440 02 ..... $0.00
TMS440 21 ..... $1,500.00
TMS440 A1 ..... $0.00
TMS440 A2 ..... $0.00
TMS440 A3 ..... $0.00
TMS440 A5 ..... $0.00
TMS480 ..... $4,150.00
TMS480 01 ..... $0.00
TMS480 D9 ..... $100.00
TMS501 ..... $2,050.00
TMS501 01 ..... $0.00
TMS501 D9 ..... $100.00
TMS531 ..... $3,500.00
TMS540 ..... $4,700.00
TMS540 11 ..... $1,600.00
TMS540 12 ..... $2,350.00
TMS540 13 ..... $2,350.00
TMS540 14 ..... $2,350.00
TMS540 22 ..... $1,250.00
TMS540 A1 ..... $0.00
TMS540 A2 ..... $0.00
TMS540 A3 ..... $0.00
TMS540 A5 ..... $0.00
TMS540 D9 ..... $100.00
TMS541 ..... $5,000.00
TMS541 21 ..... $2,000.00
TMS541 D9 ..... $100.00
TMS550 ..... $4,450.00
TMS550 01 ..... $0.00
TMS550 21 ..... $1,500.00
TMS550 A1 ..... $0.00
TMS550 A2 ..... $0.00
TMS550 A3 ..... $0.00
TMS550 A5 ..... $0.00
TMS550 D9 ..... $100.00
TMS560 ..... $3,950.00
TMS560 21 ..... $1,500.00
TMS560 D9 ..... $100.00
TMS561 ..... $3,950.00
TMS561 21 ..... $1,950.00
TMS562 ..... $5,950.00
TMS562 21 ..... $2,600.00
TMS600 ..... $3,600.00
TMS600 01 ..... $0.00
TMS600 22 ..... $1,250.00
TMS600 A1 ..... $0.00
TMS600 A2 ..... $0.00
TMS600 A3 ..... $0.00
TMS600 A5 ..... $0.00
TMS600 D9 ..... $100.00
TMS702 ..... $3,100.00
TMS702 01 ..... $0.00
TMS702 02 ..... $0.00
TMS702 D9 ..... $100.00
TMS710 ..... $3,500.00
TMS710 21 ..... $1,950.00
TMS801 ..... $3,600.00
TMS801 01 ..... $0.00
TMS801 A1 ..... $0.00
TMS801 A2 ..... $0.00
TMS801 A3 ..... $0.00
TMS801 A5 ..... $0.00
TMS801 D9 ..... $100.00
TMS802 ..... $2,600.00
TMS802 01 ..... $0.00
TMS802 A1 ..... $0.00
TMS802 A2 ..... $0.00
TMS802 A3 ..... $0.00
TMS802 A5 ..... $0.00
TMS802 D9 ..... $100.00
TMS806 ..... $4,950.00
TMS806 01 ..... $0.00
TMS806 21 ..... $1,500.00
TMS810 ..... $24,950.00
TMS810 01 ..... $0.00
TMS810 21 ..... $4,550.00
TMS810 A1 ..... $0.00
TMS810 A2 ..... $0.00
TMS810 A3 ..... $0.00
TMS810 A5 ..... $0.00
TMSDS1 ..... $4,000.00
TMSDS1 A1 ..... $0.00
TMSDS1 A2 ..... $0.00
TMSDS1 A3 ..... $0.00
TMSDS1 A5 ..... $0.00
TMSDS2 ..... $4,000.00
TMSDS2 A1 ..... $0.00
TMSDS2 A2 ..... $0.00
TMSDS2 A3 ..... $0.00
TMSDS2 A5 ..... $0.00
TMSPGA $7,000.00
TMSPGA 21 ..... $3,900.00
TMSPGA A1 ..... $0.00
TMSPGA A2 ..... $0.00
TMSPGA A3 ..... $0.00
TMSPGA A5 ..... $0.00
TMSS1A $7,000.00
TMSS1A 21 ..... $3,900.00
TMSS1A A1 ..... $0.00
TMSS1A A2 ..... $0.00
TMSS1A A3 ..... $0.00
TMSS1A A5 ..... $0.00
TMSS2A $7,000.00
TMSS2A 21 ..... $3,900.00
TMSS2A A1 ..... $0.00
TMSS2A A2 ..... $0.00
TMSS2A A3 ..... $0.00
TMSS2A A5 ..... $0.00
TMSSM1 ..... $14,000.00
TMSSM1 21 ..... $5,200.00
TMSSM1 A1 ..... $0.00
TMSSM1 A2 ..... $0.00
TMSSM1 A3 ..... $0.00
TMSSM1 A5 ..... $0.00
TOP130 ..... $995.00
TOP130 30 ..... $0.00
TOP130 31 ..... $0.00
TOP130 32 ..... $0.00
TOP130 33 ..... $0.00
TOP130 34 ..... $0.00
TOP130 35 ..... $0.00
TOP130 36 ..... $0.00
TOP130 37 ..... $0.00
TOP130 38 ..... $0.00
TOP130 39 ..... $0.00
TOP130 C3 ..... $220.00
TOP140 ..... $1,255.00
TOP140 30 ..... $100.00
TOP140 31 ..... $0.00
TOP140 32 ..... $100.00
TOP140 33 ..... $0.00
TOP140 34 ..... $0.00
TOP140 35 ..... $0.00
TOP140 36 ..... $0.00
TOP140 37 ..... $100.00
TOP140 38 ..... $0.00
TOP140 39 ..... $0.00
TOP140 C3 ..... $420.00
TOP140 C5 ..... $840.00
TOP140 D1 ..... $110.00
TOP140 D3 ..... $200.00
TOP140 D5 ..... $400.00
TOP140 R3 ..... $210.00
TOP140 R5 ..... $420.00
TOP160 ..... $3,400.00
TOP160 30 ..... $100.00
TOP160 31 ..... $0.00
TOP160 32 ..... $100.00
TOP160 33 ..... $0.00
TOP160 34 ..... $0.00
TOP160 35 ..... $0.00
TOP160 36 ..... $0.00
TOP160 37 ..... $100.00
TOP160 38 ..... $0.00
TOP160 39 ..... $0.00
TOP160 41 ..... $0.00
TOP160 42 ..... $0.00
TOP160 43 ..... $0.00
TOP160 44 ..... $0.00
TOP160 45 ..... $0.00
TOP160 C3 ..... $335.00
TOP160 C5 ..... $665.00
TOP160 D1 ..... $95.00
TOP160 D3 ..... $185.00
TOP160 D5 ..... $365.00
TOP160 R3 ..... $305.00
TOP160 R5 ..... $610.00
TOP200 ..... $795.00
TOP200 30 ..... $0.00
TOP200 31 ..... $0.00
TOP200 32 ..... $0.00
TOP200 33 ..... $0.00
TOP200 34 ..... $0.00
TOP200 35 ..... $0.00
TOP200 36 ..... $0.00
TOP200 37 ..... $0.00
TOP200 38 ..... $0.00
TOP200 39 ..... $0.00
TOP200 C3 ..... $200.00
TOP200 D1 ..... $80.00
TOP200 D3 ..... $155.00
TOP200 R3 ..... $260.00
TOP220 ..... $995.00
TOP220 30 ..... $0.00
TOP220 31 ..... $0.00
TOP220 32 ..... $0.00
TOP220 33 ..... $0.00
TOP220 34 ..... $0.00
TOP220 35 ..... $0.00
TOP220 36 ..... $0.00
TOP220 37 ..... $0.00
TOP220 38 ..... $0.00
TOP220 C3 ..... $220.00
TOP220 D1 ..... $80.00
TOP220 D3 ..... $155.00
TOP300 ..... $1,445.00
TOP300 30 ..... $100.00
TOP300 31 ..... $0.00
TOP300 32 ..... $100.00
TOP300 33 ..... $0.00
TOP300 34 ..... $0.00
TOP300 35 ..... $0.00
TOP300 36 ..... $0.00
TOP300 37 ..... $100.00
TOP300 38 ..... $0.00
TOP300 39 ..... $0.00
TOP300 C3 ..... $240.00
TOP300 C5 ..... $475.00
TOP300 D1 ..... $85.00
TOP300 D3 ..... $165.00
TOP300 D5 ..... $325.00
TOP300 R3 ..... $270.00
TOP300 R5 ..... $535.00
TOP400 ..... $1,795.00
TOP400 30 ..... $100.00
TOP400 31 ..... $0.00
TOP400 32 ..... $100.00
TOP400 33 ..... $0.00
TOP400 34 ..... $0.00
TOP400 35 ..... $0.00
TOP400 36 ..... $0.00
TOP400 37 ..... $100.00
TOP400 38 ..... $0.00
TOP400 C3 ..... $260.00
TOP400 C5 ..... $515.00
TOP400 D1 ..... $85.00
TOP400 D3 ..... $165.00
TOP400 D5 ..... $325.00
TOP400 R3 ..... $270.00
TOP400 R5 ..... $535.00
TPG20 ..... $16,495.00
TPG20 1M $0.00
TPG20 2M $0.00
TPG20 A1 ..... $0.00
TPG20 A2 ..... $0.00
TPG20 A3 ..... $0.00
TPG20 A5 ..... $0.00
TPG20 R3 ..... $620.00
TPG20 R5 ..... $1,235.00
TPG625 ..... $4,500.00
TPG625 01 ..... $0.00
TPG625 A1 ..... $0.00
TPG625 A2 ..... $0.00
TPG625 A3 ..... $0.00
TQ13216 ..... $420.00
TQ82014 ..... $695.00
TQ82014C3 ..... $185.00

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TQ82014D1 ..... $80.00
TQ82014D3 ..... $145.00
TQ82014R3 ..... $95.00
TQ82015 ..... $1,155.00
TQ82015C3 ..... $240.00
TQ82015C5 ..... $475.00
TQ82015D1 ..... $80.00
TQ82015D3 ..... $165.00
TQ82015D5 ..... $325.00
TQ82015R3 ..... $125.00
TQ82015R5 ..... $250.00
TQ82017 ..... $375.00
TQ82017C3 ..... $200.00
TQ82017D1 ..... $80.00
TQ82017D3 ..... $155.00
TQ82017R3 ..... $80.00
TQ82021 ..... $1,195.00
TQ8210 ..... $925.00
TQ8210 C3 ..... $420.00
TQ8210 D1 ..... $110.00
TQ8210 D3 ..... $200.00
TQ8210 R3 ..... $115.00
TQ8215 ..... $3,695.00
TQ8215 C3 ..... $460.00
TQ8215 C5 ..... $915.00
TQ8215 D1 ..... $120.00
TQ8215 D3 ..... $210.00
TQ8215 D5 ..... $420.00
TQ8215 R3 ..... $270.00
TQ8215 R5 ..... $535.00
TQ8325 ..... $19,495.00
TQ8325 1R $550.00
TQ8325 40 ..... $0.00
TQ8325 C3 ..... $840.00
TQ8325 C5 ..... $1,675.00
TQ8325 D1 ..... $165.00
TQ8325 D3 ..... $305.00
TQ8325 D5 ..... $610.00
TQ8325 R3 ..... $875.00
TQ8325 R5 ..... $1,750.00
TR14201 ..... $770.00
TR14202 ..... $770.00
TR14203 ..... $770.00
TR14204 ..... $770.00
TR1711 ..... $6,055.00
TR1711 D1 ..... $155.00
TR1720 ..... $2,750.00
TR1720 D1 ..... $155.00
TR17201 ..... $7,155.00
TR17201D1 ..... $155.00
TR17203 ..... $3,855.00
TR17203D1 ..... $155.00
TR17204 ..... $6,395.00
TR17204D1 ..... $155.00
TR17207 ..... $550.00
TR17207D1 ..... $155.00
TR1722 ..... $2,750.00
TR1722 D1 ..... $155.00
TR17291 ..... $1,100.00
TR17291D1 ..... $155.00
TR210 ..... $1,050.00
TR210 A1 ..... $0.00
TR210 A2 ..... $0.00
TR45103 ..... $1,650.00
TS100 ..... $3,570.00
TS100 01 ..... $175.00
TS100 1C $0.00
TS100 2C $0.00
TS100 3C $0.00
TS100 C3 ..... $440.00
TS100 C5 ..... $875.00
TS100 D1 ..... $115.00
TS100 D3 ..... $210.00
TS100 D5 ..... $420.00
TS100 L1 ..... $0.00
TS100 L3 ..... $0.00
TS100 L4 ..... $0.00
TS100 L6 ..... $0.00
TS100 LD $0.00
TS100 LF $0.00
TS100 R3 ..... $410.00
TS100 R5 ..... $820.00
TS200 ..... $2,325.00
TS200 01 ..... $1,370.00
TS200 02 ..... $1,800.00
TS200 03 ..... $3,170.00
TS200 04 ..... $750.00
TS200 1C $0.00
TS200 2C $0.00
TS200 3C $0.00
TS200 6C $0.00
TS200 AU $0.00
TS200 C3 ..... $460.00
TS200 D1 ..... $100.00
TS200 D3 ..... $210.00
TS200 L1 ..... $0.00
TS200 L3 ..... $0.00
TS200 L4 ..... $0.00
TS200 L5 ..... $0.00
TS200 L6 ..... $0.00
TS200 L7 ..... $0.00
TS200 LA $0.00
TS200 LC $0.00
TS200 LD $0.00
TS200 LF $0.00
TS200 R3 ..... $440.00
TS90 ..... $1,495.00
TS90 L1 ..... $0.00
TS90 L3 ..... $0.00
TS90 L4 ..... $0.00
TS90 L6 ..... $0.00
TS90 LC $0.00
TS90 LD $0.00
TS90 LF $0.00
TS90 LS $0.00
TS90 R3 ..... $200.00
TS90 SB $0.00
TSG100 ..... $1,595.00
TSG100 01 ..... $0.00
TSG100 C3 ..... $365.00
TSG100 C5 ..... $725.00
TSG100 D1 ..... $125.00
TSG100 D3 ..... $190.00
TSG100 D5 ..... $380.00
TSG100 R3 ..... $175.00
TSG100 R5 ..... $345.00
TSG1001 ..... $19,795.00
TSG1001A1 ..... $0.00
TSG1001A2 ..... $0.00
TSG1001A3 ..... $0.00
TSG1001C3 ..... $980.00
TSG1001C5 ..... $1,960.00
TSG1001D1 ..... $250.00
TSG1001D3 ..... $345.00
TSG1001D5 ..... $685.00
TSG1001R3 ..... $755.00
TSG1001R5 ..... $1,505.00
TSG111 ..... $1,895.00
TSG111 01 ..... $0.00
TSG111 02 ..... $350.00
TSG111 10 ..... $195.00
TSG111 A0 ..... $0.00
TSG111 A1 ..... $0.00
TSG111 A2 ..... $0.00
TSG111 A3 ..... $0.00
TSG111 C3 ..... $380.00
TSG111 C5 ..... $760.00
TSG111 D1 ..... $125.00
TSG111 D3 ..... $190.00
TSG111 D5 ..... $380.00
TSG111 R3 ..... $185.00
TSG111 R5 ..... $365.00
TSG120 D3 ..... $200.00
TSG120 D5 ..... $400.00
TSG130A $3,195.00
TSG130A01 ..... $0.00
TSG130A02 ..... $350.00
TSG130A03 ..... $350.00
TSG130A04 ..... $350.00
TSG130A2J $350.00
TSG130AA1 ..... $0.00
TSG130AA2 ..... $0.00
TSG130AA3 ..... $0.00
TSG130AC3 ..... $420.00
TSG130AC5 ..... $840.00
TSG130AD1 ..... $125.00
TSG130AD3 ..... $200.00
TSG130AD5 ..... $400.00
TSG130AR3 ..... $230.00
TSG130AR5 ..... $460.00
TSG131A $3,195.00
TSG131A01 ..... $0.00
TSG131A02 ..... $350.00
TSG131A03 ..... $350.00
TSG131A04 ..... $350.00
TSG131A10 ..... $125.00
TSG131AA0 ..... $0.00
TSG131AA1 ..... $0.00
TSG131AA2 ..... $0.00
TSG131AA3 ..... $0.00
TSG131AC3 ..... $420.00
TSG131AC5 ..... $840.00
TSG131AD1 ..... $125.00
TSG131AD3 ..... $200.00
TSG131AD5 ..... $400.00
TSG131AR3 ..... $230.00
TSG131AR5 ..... $460.00
TSG170A $5,595.00
TSG170A01 ..... $1,095.00
TSG170A1J $0.00
TSG170A1V $0.00
TSG170A2J $1,100.00
TSG170A52 ..... $0.00
TSG170AC3 ..... $515.00
TSG170AC5 ..... $770.00
TSG170AD1 ..... $150.00
TSG170AD3 ..... $230.00
TSG170AD5 ..... $345.00
TSG170AR3 ..... $285.00
TSG170AR5 ..... $570.00
TSG170D $6,495.00
TSG170D1J $0.00
TSG170D1S $995.00
TSG170D1V $0.00
TSG170DA1 ..... $0.00
TSG170DC3 ..... $535.00
TSG170DC5 ..... $800.00
TSG170DD1 ..... $150.00
TSG170DD3 ..... $230.00
TSG170DD5 ..... $345.00
TSG170DR3 ..... $315.00
TSG170DR5 ..... $630.00
TSG200 ..... $2,595.00
TSG200 1J $0.00
TSG200 C3 ..... $400.00
TSG200 C5 ..... $800.00
TSG200 D1 ..... $125.00
TSG200 D3 ..... $200.00
TSG200 D5 ..... $400.00
TSG200 R3 ..... $200.00
TSG200 R5 ..... $400.00
TSG271 ..... $5,495.00
TSG271 01 ..... $700.00
TSG271 05 ..... $0.00
TSG271 A0 ..... $0.00
TSG271 A1 ..... $0.00
TSG271 A2 ..... $0.00
TSG271 A3 ..... $0.00
TSG271 C3 ..... $515.00
TSG271 C5 ..... $1,030.00
TSG271 D1 ..... $150.00
TSG271 D3 ..... $230.00
TSG271 D5 ..... $460.00
TSG271 R3 ..... $295.00
TSG271 R5 ..... $590.00
TSG422 ..... $5,925.00
TSG422 1S $995.00
TSG422 A1 ..... $0.00
TSG422 A2 ..... $0.00
TSG422 A3 ..... $0.00
TSG422 C3 ..... $535.00
TSG422 C5 ..... $1,065.00
TSG422 D1 ..... $150.00
TSG422 D3 ..... $230.00
TSG422 D5 ..... $460.00
TSG422 R3 ..... $305.00
TSG422 R5 ..... $610.00
TSG601 ..... $3,195.00
TSG601 01 ..... $75.00
TSG601 A1 ..... $0.00
TSG601 A2 ..... $0.00
TSG601 A3 ..... $0.00
TSG601 A6 ..... $0.00
TSG601 C3 ..... $420.00
TSG601 C5 ..... $840.00
TSG601 D1 ..... $125.00
TSG601 D3 ..... $200.00
TSG601 D5 ..... $400.00
TSG601 R3 ..... $230.00
TSG601 R5 ..... $460.00

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TSG95 ..... $990.00
TSG95 01 ..... $75.00
TSG95 A1 ..... $0.00
TSG95 A2 ..... $0.00
TSG95 A3 ..... $0.00
TSG95 A6 ..... $0.00
TSG95 C3 ..... $355.00
TSG95 D1 ..... $125.00
TSG95 D3 ..... $190.00
TSG95 R3 ..... $155.00
TV1340 ..... $24,336.00
TV1340 10 ..... $0.00
TV1340 20 ..... $0.00
TV1340 23 ..... $0.00
TV1340 31 ..... $0.00
TV1340 40 ..... $0.00
TV1340 41 ..... $0.00
TV1340 46 ..... $0.00
TV1340 C3 ..... $1,125.00
TV1340 C5 ..... $2,245.00
TV1340 D1 ..... $200.00
TV1340 D3 ..... $380.00
TV1340 D5 ..... $760.00
TV1340 R3 ..... $875.00
TV1340 R5 ..... $1,750.00
TV1350 ..... $28,450.00
TV1350 01 ..... $2,250.00
TV1350 02 ..... $0.00
TV1350 10 ..... $0.00
TV1350 11 ..... $0.00
TV1350 16 ..... $3,240.00
TV1350 20 ..... $3,240.00
TV1350 21 ..... $3,240.00
TV1350 22 ..... $3,240.00
TV1350 23 ..... $3,240.00
TV1350 24 ..... $3,240.00
TV1350 25 ..... $3,240.00
TV1350 26 ..... $3,240.00
TV1350 27 ..... $3,240.00
TV1350 28 ..... $3,240.00
TV1350 29 ..... $3,240.00
TV1350 30 ..... $3,240.00
TV1350 31 ..... $3,240.00
TV1350 40 ..... $3,240.00
TV1350 41 ..... $3,240.00
TV1350 42 ..... $3,240.00
TV1350 43 ..... $3,240.00
TV1350 44 ..... $3,240.00
TV1350 45 ..... $3,240.00
TV1350 46 ..... $3,240.00
TV1350 C3 ..... $3,090.00
TV1350 C5 ..... $6,175.00
TV1350 D1 ..... $220.00
TV1350 D3 ..... $875.00
TV1350 D5 ..... $1,750.00
TV1350 R3 ..... $600.00
TV1350 R5 ..... $1,200.00
TV220 ..... $2,995.00
TV220 1C $0.00
TV220 2C $0.00
TV220 3C $0.00
TV220 6C $0.00
TV220 C3 ..... $420.00
TV220 C5 ..... $840.00
TV220 D1 ..... $110.00
TV220 D3 ..... $200.00
TV220 D5 ..... $400.00
TV220 L2 ..... $0.00
TV220 L4 ..... $0.00
TV220 R3 ..... $220.00
TV220 R5 ..... $440.00
TV90 ..... $1,495.00
TV90 R3 ..... $200.00
TVA001 ..... $400.00
TVGF01 ..... $1,300.00
TVGF01 2J $0.00
TVGF02 ..... $895.00
TVGF03 ..... $595.00
TVGF10 ..... $295.00
TVGF11A $115.00
TVGF13 ..... $225.00
TVGF14 ..... $295.00
TVGF15 ..... $295.00
TVGF1V $400.00
TVGF1V 01 ..... $0.00
TVS621A $8,220.00
TVS621AC3 ..... $475.00
TVS621AC5 ..... $950.00
TVS621AD1 ..... $115.00
TVS621AD3 ..... $220.00
TVS621AD5 ..... $440.00
TVS621AR5 ..... $305.00
TVS625A $16,750.00
TVS625AC3 ..... $565.00
TVS625AC5 ..... $1,125.00
TVS625AD1 ..... $125.00
TVS625AD3 ..... $240.00
TVS625AD5 ..... $475.00
TVS625AR5 ..... $525.00
TVS641A $13,600.00
TVS641AC3 ..... $535.00
TVS641AC5 ..... $1,065.00
TVS641AD1 ..... $125.00
TVS641AD3 ..... $230.00
TVS641AD5 ..... $460.00
TVS641AR5 ..... $450.00
TVS645A $29,875.00
TVS645AC3 ..... $695.00
TVS645AC5 ..... $1,390.00
TVS645AD1 ..... $145.00
TVS645AD3 ..... $280.00
TVS645AD5 ..... $555.00
TVS645AR5 ..... $850.00
TX1 ..... $305.00
TX1 D1 ..... $150.00
TX1 L0 ..... $0.00
TX1 L1 ..... $0.00
TX1 L2 ..... $0.00
TX1 L3 ..... $0.00
TX1 L4 ..... $0.00
TX1 L5 ..... $0.00
TX1 L6 ..... $0.00
TX1 L7 ..... $0.00
TX1 L8 ..... $0.00
TX1 L9 ..... $0.00
TX3 ..... $345.00
TX3 D1 ..... $150.00
TX3 L0 ..... $0.00
TX3 L1 ..... $0.00
TX3 L2 ..... $0.00
TX3 L3 ..... $0.00
TX3 L4 ..... $0.00
TX3 L5 ..... $0.00
TX3 L6 ..... $0.00
TX3 L7 ..... $0.00
TX3 L8 ..... $0.00
TX3 L9 ..... $0.00
TXMDXPB $99.00
U3641 ..... $14,540.00
U3641 15 ..... $700.00
U3641 20 ..... $900.00
U3641 26 ..... $700.00
U3641 60 ..... $1,795.00
U3641 70 ..... $4,995.00
U3641 72 ..... $1,950.00
U3641 74 ..... $5,495.00
U3641 78 ..... $500.00
U3641 C3 ..... $980.00
U3641 C5 ..... $1,960.00
U3641 D1 ..... $180.00
U3641 D3 ..... $345.00
U3641 D5 ..... $685.00
U3641 R3 ..... $610.00
U3641 R5 ..... $1,220.00
U3641N $15,800.00
U3641N 15 ..... $700.00
U3641N 20 ..... $900.00
U3641N 26 ..... $700.00
U3641N 72 ..... $1,950.00
U3641N 74 ..... $5,495.00
U3641N 78 ..... $500.00
U3641N C3 ..... $980.00
U3641N C5 ..... $1,960.00
U3641N D1 ..... $180.00
U3641N D3 ..... $345.00
U3641N D5 ..... $685.00
U3641N R3 ..... $620.00
U3641N R5 ..... $1,235.00
U3661 ..... $24,995.00
U3661 20 ..... $900.00
U3661 26 ..... $700.00
U3661 60 ..... $2,250.00
U3661 72 ..... $1,950.00
U3661 74 ..... $5,495.00
U3661 78 ..... $550.00
U3661 C3 ..... $1,580.00
U3661 C5 ..... $3,155.00
U3661 D1 ..... $225.00
U3661 D3 ..... $495.00
U3661 D5 ..... $990.00
U3661 R3 ..... $895.00
U3661 R5 ..... $1,790.00
U4342 ..... $20,950.00
U4342 C3 ..... $1,490.00
U4342 R3 ..... $940.00
U4342 R5 ..... $1,810.00
UPD-B1 ..... $1,100.00
UPD-B2 ..... $1,990.00
UPD-B22 ..... $2,500.00
UPD-B3 ..... $4,260.00
UPD-B4 ..... $1,290.00
UPD-B5 ..... $1,138.00
UPD-K2 ..... $553.00
UPD05 ..... $21,750.00
UPD05 B1 ..... $1,100.00
UPD05 B2 ..... $1,990.00
UPD05 B22 ..... $2,500.00
UPD05 B3 ..... $4,260.00
UPD05 B4 ..... $1,290.00
UPD05 B5 ..... $1,138.00
UPD05 C3 ..... $530.00
UPD05 C5 ..... $1,055.00
UPD05 D1 ..... $190.00
UPD05 D3 ..... $185.00
UPD05 D5 ..... $365.00
UPD05 R3 ..... $810.00
UPD05 R5 ..... $1,615.00
UPDK1 ..... $1,100.00
UPIK196 ..... $2,500.00
UPIK3M $495.00
UPIK44 ..... $495.00
UPIK52 ..... $495.00
UPIK68 ..... $495.00
UPIK84 ..... $495.00
UPL-B1 ..... $1,150.00
UPL-B10 ..... $735.00
UPL-B2 ..... $1,720.00
UPL-B21 ..... $480.00
UPL-B22 ..... $735.00
UPL-B4 ..... $735.00
UPL-B5 ..... $675.00
UPL-B6 ..... $295.00
UPL-B7 ..... $3,490.00
UPL-U6 ..... $1,150.00
UPL-Z1 ..... $75.00
UPL06 ..... $14,000.00
UPL06 1R $195.00
UPL06 B1 ..... $1,150.00
UPL06 B10 ..... $735.00
UPL06 B2 ..... $1,720.00
UPL06 B21 ..... $480.00
UPL06 B22 ..... $735.00
UPL06 B4 ..... $735.00
UPL06 B5 ..... $675.00
UPL06 B6 ..... $295.00
UPL06 B7 ..... $3,490.00
UPL06 C3 ..... $1,160.00
UPL06 C5 ..... $2,320.00
UPL06 D1 ..... $255.00
UPL06 D3 ..... $390.00
UPL06 D5 ..... $780.00
UPL06 R3 ..... $505.00
UPL06 R5 ..... $1,010.00
UPL06 U3 ..... $150.00
UPL06 Z1 ..... $95.00
UPL16 ..... $24,900.00
UPL16 1R $195.00
UPL16 B1 ..... $1,150.00
UPL16 B5 ..... $675.00
UPL16 C3 ..... $1,380.00
UPL16 C5 ..... $2,755.00
UPL16 D1 ..... $250.00
UPL16 D3 ..... $450.00
UPL16 D5 ..... $895.00
UPL16 R3 ..... $885.00
UPL16 R5 ..... $1,770.00
UPL16 Z1 ..... $95.00
UPL66 ..... $12,000.00
UPL66 1R $195.00
UPL66 B1 ..... $1,150.00

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UPL66 B10 ..... $735.00
UPL66 B2 ..... $1,720.00
UPL66 B21 ..... $480.00
UPL66 B22 ..... $735.00
UPL66 B5 ..... $675.00
UPL66 B6 ..... $295.00
UPL66 B7 ..... $3,490.00
UPL66 C3 ..... $1,040.00
UPL66 C5 ..... $2,075.00
UPL66 D1 ..... $255.00
UPL66 D3 ..... $365.00
UPL66 D5 ..... $725.00
UPL66 R3 ..... $450.00
UPL66 R5 ..... $895.00
UPL66 U3 ..... $150.00
UPL66 Z1 ..... $95.00
URE2 ..... $4,131.00
URE2 C3 ..... $240.00
URE2 C5 ..... $475.00
URE2 D1 ..... $85.00
URE2 D3 ..... $165.00
URE2 D5 ..... $325.00
URE2 R3 ..... $270.00
URE2 R5 ..... $535.00
URE3 ..... $5,600.00
URE3 01 ..... $775.00
URE3 C3 ..... $280.00
URE3 C5 ..... $555.00
URE3 D1 ..... $85.00
URE3 D3 ..... $175.00
URE3 D5 ..... $345.00
URE3 R3 ..... $325.00
URE3 R5 ..... $650.00
URV3502 ..... $2,795.00
URV3502C3 ..... $170.00
URV3502C5 ..... $335.00
URV3502D1 ..... $100.00
URV3502D3 ..... $95.00
URV3502D5 ..... $185.00
URV3502R3 ..... $210.00
URV3502R5 ..... $420.00
URV3503 ..... $2,995.00
URV3503C3 ..... $170.00
URV3503C5 ..... $335.00
URV3503D1 ..... $100.00
URV3503D3 ..... $95.00
URV3503D5 ..... $185.00
URV3503R3 ..... $220.00
URV3503R5 ..... $440.00
URV5 ..... $6,095.00
URV5 01 ..... $535.00
URV5 1R $340.00
URV5 C5 ..... $420.00
URV5 D1 ..... $110.00
URV5 D3 ..... $100.00
URV5 D5 ..... $200.00
URV5 R3 ..... $345.00
URV5 R5 ..... $685.00
URV55 ..... $3,475.00
URV55 C5 ..... $355.00
URV55 D1 ..... $100.00
URV55 D3 ..... $95.00
URV55 D5 ..... $190.00
URV55 R3 ..... $240.00
URV55 R5 ..... $475.00
URV5Z1 ..... $450.00
URV5Z1 C3 ..... $80.00
URV5Z1 D1 ..... $75.00
URV5Z1 D3 ..... $70.00
URV5Z1 R3 ..... $90.00
URV5Z25 ..... $1,150.00
URV5Z25D1 ..... $100.00
URV5Z25R3 ..... $125.00
URV5Z25R5 ..... $250.00
URV5Z26 ..... $1,480.00
URV5Z26C3 ..... $220.00
URV5Z26C5 ..... $440.00
URV5Z26D1 ..... $80.00
URV5Z26D3 ..... $155.00
URV5Z26D5 ..... $305.00
URV5Z26R3 ..... $145.00
URV5Z26R5 ..... $285.00
URV5Z44 ..... $1,425.00
URV5Z44C3 ..... $200.00
URV5Z44C5 ..... $400.00
URV5Z44D1 ..... $80.00
URV5Z44D3 ..... $155.00
URV5Z44D5 ..... $305.00
URV5Z44R3 ..... $135.00
URV5Z44R5 ..... $270.00
URV5Z45 ..... $1,550.00
URV5Z45C3 ..... $220.00
URV5Z45C5 ..... $440.00
URV5Z45D1 ..... $80.00
URV5Z45D3 ..... $155.00
URV5Z45D5 ..... $305.00
URV5Z45R3 ..... $145.00
URV5Z45R5 ..... $285.00
URV5Z46 ..... $1,425.00
URV5Z46C3 ..... $200.00
URV5Z46C5 ..... $400.00
URV5Z46D1 ..... $80.00
URV5Z46D3 ..... $155.00
URV5Z46D5 ..... $305.00
URV5Z46R3 ..... $135.00
URV5Z46R5 ..... $270.00
URV5Z47 ..... $1,575.00
URV5Z47C3 ..... $220.00
URV5Z47C5 ..... $440.00
URV5Z47D1 ..... $80.00
URV5Z47D3 ..... $155.00
URV5Z47D5 ..... $305.00
URV5Z47R3 ..... $155.00
URV5Z47R5 ..... $305.00
URV5Z70 ..... $1,395.00
URV5Z70C3 ..... $200.00
URV5Z70C5 ..... $400.00
URV5Z70D1 ..... $80.00
URV5Z70D3 ..... $155.00
URV5Z70D5 ..... $305.00
URV5Z70R3 ..... $135.00
URV5Z70R5 ..... $270.00
URV5Z72 ..... $1,325.00
URV5Z72C3 ..... $200.00
URV5Z72C5 ..... $400.00
URV5Z72D1 ..... $80.00
URV5Z72D3 ..... $155.00
URV5Z72D5 ..... $305.00
URV5Z72R3 ..... $135.00
URV5Z72R5 ..... $270.00
URV5Z73 ..... $1,276.00
URV5Z73D1 ..... $100.00
URV5Z73R3 ..... $135.00
URV5Z73R5 ..... $270.00
URV5Z9 ..... $1,450.00
URV5Z9 C3 ..... $110.00
URV5Z9 C5 ..... $220.00
URV5Z9 D1 ..... $95.00
URV5Z9 D3 ..... $80.00
URV5Z9 D5 ..... $155.00
URV5Z9 R3 ..... $145.00
URV5Z9 R5 ..... $285.00
URVZ $225.00
URVZ D1 ..... $100.00
URVZ3 ..... $595.00
URVZ3 D1 ..... $100.00
URVZ4 ..... $1,785.00
URVZ4 C3 ..... $220.00
URVZ4 C5 ..... $440.00
URVZ4 D1 ..... $100.00
URVZ4 D3 ..... $155.00
URVZ4 D5 ..... $305.00
URVZ4 R3 ..... $155.00
URVZ4 R5 ..... $305.00
URVZ50 ..... $325.00
URVZ50 D1 ..... $80.00
URVZ6 ..... $410.00
URVZ6 D1 ..... $80.00
URVZ7 ..... $1,425.00
URVZ7 C3 ..... $200.00
URVZ7 C5 ..... $400.00
URVZ7 D1 ..... $80.00
URVZ7 D3 ..... $155.00
URVZ7 D5 ..... $305.00
URVZ7 R3 ..... $135.00
URVZ7 R5 ..... $270.00
URVZ8 ..... $1,120.00
URVZ8 C3 ..... $200.00
URVZ8 C5 ..... $400.00
URVZ8 D1 ..... $80.00
URVZ8 D3 ..... $155.00
URVZ8 D5 ..... $305.00
URVZ8 R3 ..... $125.00
URVZ8 R5 ..... $250.00
UZ-22 ..... $295.00
UZ-35 ..... $60.00
UZ-354 ..... $80.00
VITS100 ..... $2,995.00
VITS10002 ..... $0.00
VITS1001J $0.00
VITS1001M $295.00
VITS100R3 ..... $220.00
VITS100R5 ..... $440.00
VITS200 ..... $5,995.00
VITS2001C $0.00
VITS2001J $0.00
VITS2001K $0.00
VITS200C3 ..... $515.00
VITS200C5 ..... $1,030.00
VITS200D1 ..... $150.00
VITS200D3 ..... $230.00
VITS200D5 ..... $460.00
VITS200R3 ..... $305.00
VITS200R5 ..... $610.00
VITS201 ..... $4,895.00
VITS20105 ..... $0.00
VITS20110 ..... $0.00
VITS20115 ..... $0.00
VITS201A1 ..... $0.00
VITS201A2 ..... $0.00
VITS201A3 ..... $0.00
VITS201C3 ..... $475.00
VITS201C5 ..... $950.00
VITS201D1 ..... $150.00
VITS201D3 ..... $220.00
VITS201D5 ..... $440.00
VITS201R3 ..... $270.00
VITS201R5 ..... $535.00
VM100 ..... $5,513.00
VM100 A1 ..... $0.00
VM100 A2 ..... $0.00
VM100 A3 ..... $0.00
VM100 C3 ..... $515.00
VM100 C5 ..... $1,030.00
VM100 D1 ..... $120.00
VM100 D3 ..... $230.00
VM100 D5 ..... $460.00
VM100 R3 ..... $285.00
VM100 R5 ..... $570.00
VM101 ..... $5,513.00
VM101 A1 ..... $0.00
VM101 A2 ..... $0.00
VM101 A3 ..... $0.00
VM101 C3 ..... $515.00
VM101 C5 ..... $1,030.00
VM101 D1 ..... $120.00
VM101 D3 ..... $230.00
VM101 D5 ..... $460.00
VM101 R3 ..... $285.00
VM101 R5 ..... $570.00
VM140 ..... $10,818.00
VM140 A1 ..... $0.00
VM140 A2 ..... $0.00
VM140 A3 ..... $0.00
VM140 C3 ..... $895.00
VM140 D1 ..... $170.00
VM140 D3 ..... $325.00
VM140 D5 ..... $650.00
VM140 R3 ..... $380.00
VM140 R5 ..... $760.00
VM141 ..... $10,818.00
VM141 A1 ..... $0.00
VM141 A2 ..... $0.00
VM141 A3 ..... $0.00
VM141 C3 ..... $895.00
VM141 C5 ..... $1,790.00
VM141 D1 ..... $170.00
VM141 D3 ..... $325.00
VM141 D5 ..... $650.00
VM141 R3 ..... $380.00
VM141 R5 ..... $760.00
VM700T $21,515.00
VM700T 01 ..... $5,200.00
VM700T 11 ..... $5,200.00
VM700T 1C $20.00
VM700T 1F $1,995.00
VM700T 1G $1,199.00
VM700T 1P $799.00
VM700T 1S $8,798.00
VM700T 1Z $750.00

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VM700T 20 ..... $3,599.00
VM700T 21 ..... $5,340.00
VM700T 22 ..... $2,099.00
VM700T 30 ..... $3,099.00
VM700T 3Z $1,699.00
VM700T 40 ..... $4,950.00
VM700T 41 ..... $5,450.00
VM700T 42 ..... $1,995.00
VM700T 48 ..... $3,140.00
VM700T 5R $0.00
VM700T 74 ..... $125.00
VM700T A1 ..... $0.00
VM700T A2 ..... $0.00
VM700T A3 ..... $0.00
VM700T A4 ..... $0.00
VM700T A5 ..... $0.00
VM700T C3 ..... $1,520.00
VM700T C5 ..... $3,040.00
VM700T D1 ..... $267.00
VM700T D3 ..... $475.00
VM700T D5 ..... $950.00
VM700T IN $380.00
VM700T R3 ..... $650.00
VM700T R5 ..... $1,295.00
VM700T S1 ..... $300.00
VM700T S3 ..... $600.00
VM700T S5 ..... $900.00
VM7FC1 ..... $399.00
VM7FP1 ..... $720.00
VM7FR1 ..... $390.00
VMBKUP $350.00
VMTB $5,612.00
VMTB 1G $1,199.00
VMTB 20 ..... $3,599.00
VMTB 21 ..... $5,340.00
VMTB 22 ..... $2,099.00
VMTB 2S $6,515.00
VMTB 30 ..... $3,099.00
VMTB 3B $4,373.00
VMTB 3D $1,699.00
VMTB 40 ..... $4,950.00
VMTB 41 ..... $5,450.00
VMTB 42 ..... $1,995.00
VMTB 48 ..... $3,140.00
VMTX $6,735.00
VMTX 1G $1,199.00
VMTX 20 ..... $3,599.00
VMTX 21 ..... $5,340.00
VMTX 22 ..... $2,099.00
VMTX 30 ..... $3,099.00
VMTX 3B $4,373.00
VMTX 3D $1,699.00
VMTX 40 ..... $4,950.00
VMTX 41 ..... $5,450.00
VMTX 42 ..... $1,995.00
VMTX 48 ..... $3,140.00
VMUPG $10.00
VMUPG 1G $1,199.00
VMUPG 1S $8,798.00
VMUPG 20 ..... $3,599.00
VMUPG 21 ..... $5,299.00
VMUPG 22 ..... $2,099.00
VMUPG 2S $10,332.00
VMUPG 30 ..... $3,099.00
VMUPG 3B $4,373.00
VMUPG 3D $1,699.00
VMUPG 40 ..... $4,950.00
VMUPG 41 ..... $5,450.00
VMUPG 42 ..... $1,995.00
VMUPG 48 ..... $3,140.00
VX1410A $7,240.00
VX1410A1M $310.00
VX1410A1R $460.00
VX1410A1U $205.00
VX1410A2R $690.00
VX1410A2U $230.00
VX1410A3R $340.00
VX1410AA1 ..... $0.00
VX1410AA2 ..... $0.00
VX1410AA3 ..... $0.00
VX1410AA4 ..... $0.00
VX1410AA5 ..... $0.00
VX1410AC3 ..... $295.00
VX1410AC5 ..... $590.00
VX1410AD1 ..... $90.00
VX1410AD3 ..... $175.00
VX1410AD5 ..... $345.00
VX1410AR5 ..... $475.00
VX1411A $5,770.00
VX1411A1R $460.00
VX1411A1U $205.00
VX1411A2R $690.00
VX1411A2U $230.00
VX1411AA1 ..... $0.00
VX1411AA2 ..... $0.00
VX1411AA3 ..... $0.00
VX1411AA4 ..... $0.00
VX1411AA5 ..... $0.00
VX1411AC3 ..... $280.00
VX1411AC5 ..... $555.00
VX1411AD1 ..... $85.00
VX1411AD3 ..... $175.00
VX1411AD5 ..... $345.00
VX1411AR5 ..... $390.00
VX1420A $8,815.00
VX1420A1R $455.00
VX1420A1U $205.00
VX1420A2R $690.00
VX1420A2U $230.00
VX1420AA1 ..... $0.00
VX1420AA2 ..... $0.00
VX1420AA3 ..... $0.00
VX1420AA4 ..... $0.00
VX1420AA5 ..... $0.00
VX1420AC3 ..... $335.00
VX1420AC5 ..... $665.00
VX1420AD1 ..... $95.00
VX1420AD3 ..... $185.00
VX1420AD5 ..... $365.00
VX1420AR5 ..... $580.00
VX1630 ..... $849.00
VX1630M $129.00
VX1630S $295.00
VX1650 ..... $259.00
VX1650S $189.00
VX1657P $389.00
VX1657S $389.00
VX1660 ..... $595.00
VX1661 ..... $129.00
VX1662 ..... $159.00
VX1663 ..... $339.00
VX1664 ..... $179.00
VX1665 ..... $339.00
VX1666 ..... $419.00
VX1667 ..... $439.00
VX1729 ..... $129.00
VX1729 01 ..... $0.00
VX1729 03 ..... $0.00
VX1729 10 ..... $0.00
VX1730 ..... $75.00
VX1730 01 ..... $0.00
VX1730 03 ..... $0.00
VX1730 10 ..... $0.00
VX1730 7L $40.00
VX1732 ..... $229.00
VX1733 ..... $315.00
VX1734 ..... $315.00
VX1735 ..... $190.00
VX1742P $189.00
VX1744 ..... $200.00
VX1760 ..... $70.00
VX1780P $89.00
VX1780S $89.00
VX1784P $39.00
VX1784S $35.00
VX1786S $59.00
VX4101A $5,950.00
VX4101A1A $1,255.00
VX4101A1C $520.00
VX4101A1D $940.00
VX4101A1T $555.00
VX4101A2C $1,150.00
VX4101AC3 ..... $565.00
VX4101AC5 ..... $1,125.00
VX4101AD1 ..... $80.00
VX4101AR5 ..... $335.00
VX4240 ..... $9,650.00
VX4240 02 ..... $1,155.00
VX4240 C3 ..... $475.00
VX4240 C5 ..... $950.00
VX4240 D1 ..... $115.00
VX4240 D3 ..... $220.00
VX4240 D5 ..... $440.00
VX4240 R5 ..... $325.00
VX4244 ..... $15,100.00
VX4244 C3 ..... $2,625.00
VX4244 C5 ..... $5,245.00
VX4244 D1 ..... $125.00
VX4244 D3 ..... $755.00
VX4244 D5 ..... $1,505.00
VX4244 R5 ..... $200.00
VX4286 ..... $3,745.00
VX4286 C3 ..... $620.00
VX4286 C5 ..... $1,235.00
VX4286 D1 ..... $80.00
VX4286 D3 ..... $260.00
VX4286 D5 ..... $515.00
VX4286 R5 ..... $185.00
VX4287 ..... $4,845.00
VX4287 C3 ..... $240.00
VX4287 C5 ..... $475.00
VX4287 D1 ..... $85.00
VX4287 D3 ..... $165.00
VX4287 D5 ..... $325.00
VX4287 R5 ..... $325.00
VX4320 ..... $3,735.00
VX4320 01 ..... $625.00
VX4320 D1 ..... $95.00
VX4320 R5 ..... $185.00
VX4330 ..... $3,405.00
VX4330 01 ..... $625.00
VX4330 D1 ..... $95.00
VX4330 R5 ..... $175.00
VX4350 ..... $2,660.00
VX4350 01 ..... $625.00
VX4350 D1 ..... $95.00
VX4350 R5 ..... $200.00
VX4351 ..... $2,155.00
VX4351 01 ..... $625.00
VX4351 D1 ..... $90.00
VX4351 R5 ..... $175.00
VX4357 ..... $2,640.00
VX4357 D1 ..... $95.00
VX4357 R5 ..... $135.00
VX4380 ..... $5,095.00
VX4380 01 ..... $625.00
VX4380 D1 ..... $105.00
VX4380 R5 ..... $230.00
VX4428 ..... $10,345.00
VX4428 10 ..... $945.00
VX4469A $7,720.00
VX4469A02 ..... $9,335.00
VX4610 ..... $20,000.00
VX4610 02 ..... $3,900.00
VX4610 03 ..... $8,400.00
VX4610 04 ..... $10,500.00
VX4610 05 ..... $11,000.00
VX4610 10 ..... $12,900.00
VX4610 22 ..... $6,800.00
VX4610 36 ..... $8,900.00
VX4610 58 ..... $16,800.00
VX4610 C3 ..... $720.00
VX4610 C5 ..... $1,435.00
VX4610 D1 ..... $245.00
VX4610 D3 ..... $230.00
VX4610 D5 ..... $460.00
VX4610 R5 ..... $1,505.00
VX46F01 ..... $1,900.00
VX46F01R5 ..... $375.00
VX46F02 ..... $4,100.00
VX46F03 ..... $8,400.00
VX46F04 ..... $11,000.00
VX46F05 ..... $11,000.00
VX46F10 ..... $12,900.00
VX46F22 ..... $7,200.00
VX46F36 ..... $9,300.00
VX46F58 ..... $17,000.00
VX46U80 ..... $5,000.00
VX46U80D1 ..... $155.00
VX4730 ..... $4,550.00
VX4730 C3 ..... $600.00
VX4730 C5 ..... $1,200.00
VX4730 D1 ..... $85.00
VX4730 D3 ..... $250.00
VX4730 D5 ..... $495.00
VX4730 R5 ..... $220.00
VX4750 ..... $7,200.00
VX4750 C3 ..... $295.00
VX4750 C5 ..... $590.00
VX4750 D1 ..... $90.00

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VX4750 D3 ..... $175.00
VX4750 D5 ..... $345.00
VX4750 R5 ..... $475.00
VX4780 ..... $5,960.00
VX4780 C3 ..... $420.00
VX4780 C5 ..... $840.00
VX4780 D1 ..... $105.00
VX4780 D3 ..... $200.00
VX4780 D5 ..... $400.00
VX4780 R5 ..... $270.00
VX4790A $4,215.00
VX4790A01 ..... $695.00
VX4790A02 ..... $1,380.00
VX4790AC3 ..... $565.00
VX4790AC5 ..... $1,125.00
VX4790AD1 ..... $80.00
VX4790AD3 ..... $240.00
VX4790AD5 ..... $475.00
VX4790AR5 ..... $440.00
VX4801 ..... $2,410.00
VX4801 93 ..... $2.65
VX4801 R5 ..... $115.00
VX4802 ..... $2,410.00
W73048-A3004-A $60.00
W73048-A3014 ..... $120.00
W73072-U3601-U1 ..... $40.00
W73079-U2002-A4 ..... $30.00
W73089-G10 ..... $720.00
WFM1125 ..... $12,995.00
WFM11250A $0.00
WFM11250B $0.00
WFM11250C $2,000.00
WFM11250D $3,000.00
WFM1125C3 ..... $1,160.00
WFM1125D1 ..... $250.00
WFM1125D3 ..... $390.00
WFM1125R3 ..... $505.00
WFM300A $4,995.00
WFM300A10 ..... $0.00
WFM300A14 ..... $0.00
WFM300AA1 ..... $0.00
WFM300AA2 ..... $0.00
WFM300AA3 ..... $0.00
WFM300AR5 ..... $220.00
WFM601A $5,995.00
WFM601AA1 ..... $0.00
WFM601AA2 ..... $0.00
WFM601AA3 ..... $0.00
WFM601AA5 ..... $0.00
WFM601AC3 ..... $565.00
WFM601AC5 ..... $1,125.00
WFM601AD1 ..... $150.00
WFM601AD3 ..... $240.00
WFM601AD5 ..... $475.00
WFM601AR5 ..... $250.00
WFM601E $7,855.00
WFM601EA1 ..... $0.00
WFM601EA2 ..... $0.00
WFM601EA3 ..... $0.00
WFM601EA5 ..... $0.00
WFM601EC3 ..... $715.00
WFM601EC5 ..... $1,425.00
WFM601ED1 ..... $150.00
WFM601ED3 ..... $280.00
WFM601ED5 ..... $555.00
WFM601ER5 ..... $305.00
WFM601M $9,660.00
WFM601MA1 ..... $0.00
WFM601MA2 ..... $0.00
WFM601MA3 ..... $0.00
WFM601MA5 ..... $0.00
WFM601MC3 ..... $780.00
WFM601MC5 ..... $1,560.00
WFM601MD1 ..... $175.00
WFM601MD3 ..... $295.00
WFM601MD5 ..... $590.00
WFM601MR5 ..... $345.00
WFM90 ..... $2,195.00
WFM90 01 ..... $95.00
WFM90 33 ..... $245.00
WFM90 A1 ..... $0.00
WFM90 A2 ..... $0.00
WFM90 A3 ..... $0.00
WFM90 A6 ..... $0.00
WFM90 R3 ..... $230.00
WFM90 R5 ..... $460.00
WFM91 ..... $2,195.00
WFM91 01 ..... $95.00
WFM91 33 ..... $245.00
WFM91 A1 ..... $0.00
WFM91 A2 ..... $0.00
WFM91 A3 ..... $0.00
WFM91 A6 ..... $0.00
WFM91 R3 ..... $145.00
WFM91 R5 ..... $285.00
WSTR31 ..... $395.00
WSTR31U $115.00
WSTR31X $23,600.00
WSTR325 ..... $6,600.00
WSTRM $159.00
WSTRO $319.00
WSTROU $99.00
WVR500 ..... $1,995.00
WVR500 A1 ..... $0.00
WVR500 A2 ..... $0.00
WVR500 A3 ..... $0.00
WVR500 R5 ..... $540.00
YT1S $1,100.00
YT1S R3 ..... $125.00
YT1S R5 ..... $250.00
YT5060 ..... $59.00
Z740/N $2,095.00
Z740/P $2,895.00
ZCAN52 ..... $2,900.00
ZCAN72 ..... $3,000.00
ZRA $975.00
ZRB252 ..... $3,200.00
ZRB252 R3 ..... $220.00
ZRB252 R5 ..... $440.00
ZRB253 ..... $1,990.00
ZRB253 R3 ..... $175.00
ZRB253 R5 ..... $345.00
ZRB255 ..... $3,400.00
ZRB255 R3 ..... $230.00
ZRB255 R5 ..... $460.00
ZRB256 ..... $1,990.00
ZRB256 R3 ..... $175.00
ZRB256 R5 ..... $345.00
ZRB273 ..... $2,100.00
ZRB273 R3 ..... $165.00
ZRB273 R5 ..... $325.00
ZRB276 ..... $2,090.00
ZRB276 R3 ..... $175.00
ZRB276 R5 ..... $345.00
ZRC52 ..... $4,400.00
ZRC72 ..... $4,200.00
ZV-Z11 ..... $1,900.00
ZV-Z12 ..... $2,100.00
ZV-Z21 ..... $2,900.00
ZV-Z23 ..... $4,600.00
ZV-Z24 ..... $2,100.00
ZV-Z26 ..... $1,800.00
ZV-Z27 ..... $1,800.00
ZV-Z28 ..... $2,100.00
ZV-Z29 ..... $2,900.00
ZV-Z4102 ..... $2,100.00
ZV-Z4103 ..... $2,100.00
ZV-Z4302 ..... $2,900.00
ZV-Z4303 ..... $2,900.00
ZV-Z5102 ..... $170.00
ZV-Z5103 ..... $170.00
ZV-Z5302 ..... $190.00
ZV-Z5303 ..... $190.00
ZV-Z5402 ..... $180.00
ZV-Z5403 ..... $180.00
ZV-Z61 ..... $800.00
ZVC $56,000.00
ZVC 1R $225.00
ZVC 49 ..... $1,400.00
ZVC B1 ..... $8,900.00
ZVC B1402 ..... $5,900.00
ZVC B1403 ..... $5,900.00
ZVC B15 ..... $2,400.00
ZVC B16 ..... $1,350.00
ZVC B17 ..... $1,350.00
ZVC B2 ..... $6,100.00
ZVC B21 ..... $1,100.00
ZVC B22 ..... $1,550.00
ZVC B23 ..... $1,550.00
ZVC B24 ..... $1,550.00
ZVC B25 ..... $1,550.00
ZVC B4 ..... $3,900.00
ZVC B6 ..... $1,400.00
ZVC B7 ..... $1,400.00
ZVC B8 ..... $4,800.00
ZVC C3 ..... $3,040.00
ZVC C5 ..... $6,080.00
ZVC D1 ..... $290.00
ZVC D3 ..... $855.00
ZVC D5 ..... $1,710.00
ZVC K9 ..... $5,900.00
ZVC R3 ..... $1,485.00
ZVC R5 ..... $2,965.00
ZVCE $47,000.00
ZVCE 1R $225.00
ZVCE 49 ..... $1,400.00
ZVCE B1 ..... $8,900.00
ZVCE B1402 ..... $5,900.00
ZVCE B1403 ..... $5,900.00
ZVCE B15 ..... $2,400.00
ZVCE B16 ..... $1,350.00
ZVCE B17 ..... $1,350.00
ZVCE B2 ..... $6,100.00
ZVCE B21 ..... $1,100.00
ZVCE B23 ..... $1,550.00
ZVCE B24 ..... $1,550.00
ZVCE B25 ..... $1,550.00
ZVCE B4 ..... $3,900.00
ZVCE B6 ..... $1,400.00
ZVCE B7 ..... $1,400.00
ZVCE B8 ..... $4,800.00
ZVCE C3 ..... $2,550.00
ZVCE C5 ..... $5,095.00
ZVCE D1 ..... $290.00
ZVCE D3 ..... $735.00
ZVCE D5 ..... $1,465.00
ZVCE R3 ..... $1,285.00
ZVCE R5 ..... $2,565.00
ZVR-A75 ..... $2,800.00
ZVR-A76 ..... $2,900.00
ZVR-B1 ..... $8,900.00
ZVR-B1402 ..... $5,900.00
ZVR-B1403 ..... $5,900.00
ZVR-B15 ..... $2,400.00
ZVR-B2 ..... $6,100.00
ZVR-B21 ..... $1,100.00
ZVR-B22 ..... $1,550.00
ZVR-B23 ..... $1,550.00
ZVR-B24 ..... $1,550.00
ZVR-B25 ..... $1,550.00
ZVR-B4 ..... $3,900.00
ZVR-B6 ..... $1,400.00
ZVR-B7 ..... $1,400.00
ZVR-B8 ..... $4,800.00
ZVR-K9 ..... $5,900.00
ZVR-U1 ..... $6,750.00
ZVR-U2 ..... $11,750.00
ZVR-U3 ..... $14,750.00
ZVR-Z1 ..... $1,900.00
ZVR61 ..... $49,000.00
ZVR61 1R $225.00
ZVR61 49 ..... $1,400.00
ZVR61 B1 ..... $8,900.00
ZVR61 B1402 ..... $5,900.00
ZVR61 B1403 ..... $5,900.00
ZVR61 B15 ..... $2,400.00
ZVR61 B16 ..... $1,350.00
ZVR61 B17 ..... $1,350.00
ZVR61 B2 ..... $6,100.00
ZVR61 B21 ..... $1,100.00
ZVR61 B22 ..... $1,550.00
ZVR61 B23 ..... $1,550.00
ZVR61 B24 ..... $1,550.00
ZVR61 B25 ..... $1,550.00
ZVR61 B4 ..... $3,900.00
ZVR61 B6 ..... $1,400.00
ZVR61 B7 ..... $1,400.00
ZVR61 B8 ..... $4,800.00
ZVR61 C3 ..... $2,660.00
ZVR61 C5 ..... $5,320.00
ZVR61 D1 ..... $290.00
ZVR61 D3 ..... $760.00
ZVR61 D5 ..... $1,520.00
ZVR61 K9 ..... $5,900.00
ZVR61 R3 ..... $1,330.00
ZVR61 R5 ..... $2,660.00
ZVR62 ..... $49,000.00
ZVR62 1R $225.00
ZVR62 49 ..... $1,400.00
ZVR62 B1 ..... $8,900.00

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ZVR62 B1402 ..... $5,900.00
ZVR62 B1403 ..... $5,900.00
ZVR62 B15 ..... $2,400.00
ZVR62 B16 ..... $1,350.00
ZVR62 B17 ..... $1,350.00
ZVR62 B2 ..... $6,100.00
ZVR62 B21 ..... $1,100.00
ZVR62 B22 ..... $1,550.00
ZVR62 B23 ..... $1,550.00
ZVR62 B24 ..... $1,550.00
ZVR62 B25 ..... $1,550.00
ZVR62 B4 ..... $3,900.00
ZVR62 B6 ..... $1,400.00
ZVR62 B7 ..... $1,400.00
ZVR62 B8 ..... $4,800.00
ZVR62 C3 ..... $2,660.00
ZVR62 C5 ..... $5,320.00
ZVR62 D1 ..... $290.00
ZVR62 D3 ..... $760.00
ZVR62 D5 ..... $1,520.00
ZVR62 K9 ..... $5,900.00
ZVR62 R3 ..... $1,330.00
ZVR62 R5 ..... $2,660.00
ZVRE51 ..... $38,000.00
ZVRE51 1R $225.00
ZVRE51 49 ..... $1,400.00
ZVRE51 B1 ..... $8,900.00
ZVRE51 B1402 ..... $5,900.00
ZVRE51 B1403 ..... $5,900.00
ZVRE51 B15 ..... $2,400.00
ZVRE51 B16 ..... $1,350.00
ZVRE51 B17 ..... $1,350.00
ZVRE51 B2 ..... $6,100.00
ZVRE51 B21 ..... $1,100.00
ZVRE51 B23 ..... $1,550.00
ZVRE51 B24 ..... $1,550.00
ZVRE51 B25 ..... $1,550.00
ZVRE51 B4 ..... $3,900.00
ZVRE51 B6 ..... $1,400.00
ZVRE51 B7 ..... $1,300.00
ZVRE51 B8 ..... $4,800.00
ZVRE51 C3 ..... $2,170.00
ZVRE51 C5 ..... $4,335.00
ZVRE51 D1 ..... $290.00
ZVRE51 D3 ..... $640.00
ZVRE51 D5 ..... $1,275.00
ZVRE51 R3 ..... $1,125.00
ZVRE51 R5 ..... $2,245.00
ZVRE52 ..... $38,000.00
ZVRE52 1R $225.00
ZVRE52 B1 ..... $8,900.00
ZVRE52 B1402 ..... $5,900.00
ZVRE52 B1403 ..... $5,900.00
ZVRE52 B15 ..... $2,400.00
ZVRE52 B16 ..... $1,350.00
ZVRE52 B17 ..... $1,350.00
ZVRE52 B2 ..... $6,100.00
ZVRE52 B21 ..... $1,100.00
ZVRE52 B23 ..... $1,550.00
ZVRE52 B24 ..... $1,550.00
ZVRE52 B25 ..... $1,550.00
ZVRE52 B4 ..... $3,900.00
ZVRE52 B6 ..... $1,400.00
ZVRE52 B7 ..... $1,400.00
ZVRE52 B8 ..... $4,800.00
ZVRE52 C3 ..... $2,170.00
ZVRE52 C5 ..... $4,335.00
ZVRE52 D1 ..... $290.00
ZVRE52 D3 ..... $640.00
ZVRE52 D5 ..... $1,275.00
ZVRE52 R3 ..... $1,125.00
ZVRE52 R5 ..... $2,245.00
ZVRL $35,000.00
ZVRL 49 ..... $1,400.00
ZVRL B1402 ..... $5,900.00
ZVRL B1403 ..... $5,900.00
ZVRL B15 ..... $2,400.00
ZVRL B16 ..... $1,350.00
ZVRL B17 ..... $1,350.00
ZVRL B2 ..... $6,100.00
ZVRL B21 ..... $1,100.00
ZVRL B23 ..... $1,550.00
ZVRL B24 ..... $1,550.00
ZVRL B25 ..... $1,550.00
ZVRL B4 ..... $3,900.00
ZVRL B6 ..... $1,400.00
ZVRL B7 ..... $1,400.00
ZVRL B8 ..... $4,800.00
ZVRL C3 ..... $2,005.00
ZVRL C5 ..... $4,010.00
ZVRL D1 ..... $290.00
ZVRL D3 ..... $600.00
ZVRL D5 ..... $1,200.00
ZVRL R3 ..... $1,055.00
ZVRL R5 ..... $2,110.00
ZZA-211 ..... $95.00
ZZA-923 ..... $90.00
ZZA-924 ..... $110.00
ZZA-925 ..... $110.00
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ZZA93 ..... $195.00
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ZZG93 ..... $105.00
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ZZK943 ..... $720.00
ZZK944 ..... $770.00
ZZK945 ..... $825.00
ZZK953 ..... $750.00
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ZZK955 ..... $840.00
ZZT-222 ..... $195.00
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