RACAL-DANA

INSTRUMENTS

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Alphabetical Index CONTINUED

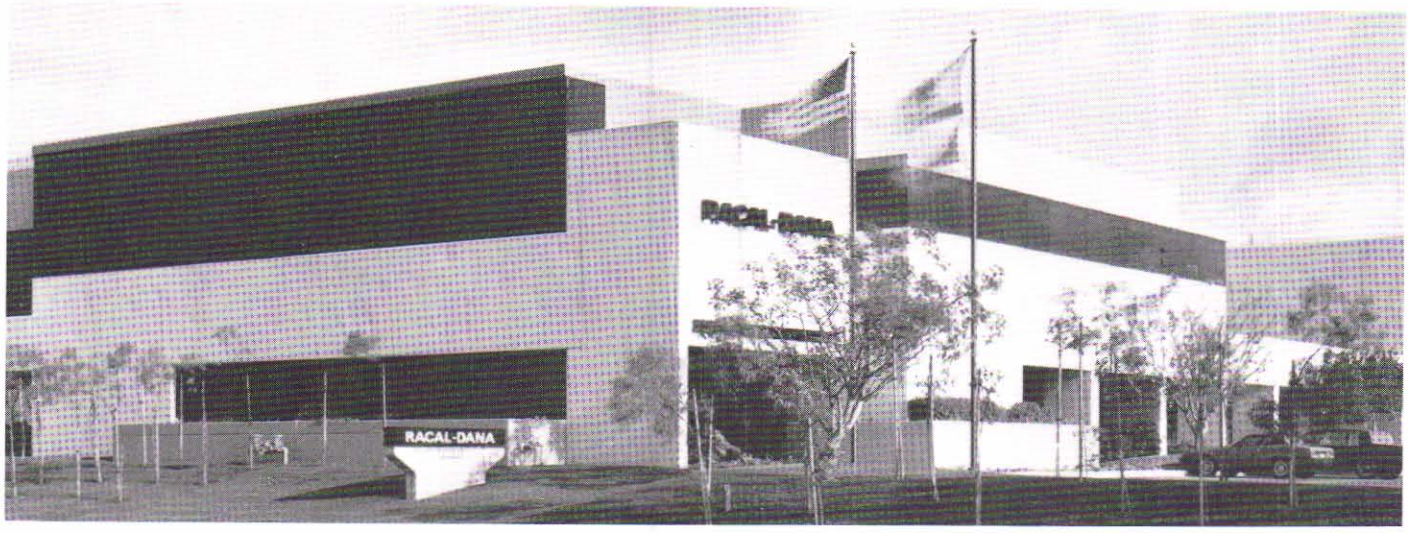
Model Number Index

* Indicates product new to this catalog

▪ Indicates GPIB

Note:
Catalog holders should also refer to pages 177-194 for international products available from Racal-Dana. Should pages be missing from this section it indicates that the products on those pages are not available from Racal-Dana in your country.

Introduction to Racal-Dana



Racal-Dana and History

A strong customer need for easier-to-use, more accurate and more reliable instruments was the driving force that led to the founding of both Racal Instruments and Dana Laboratories. Today, a commitment to this need is the primary purpose of Racal-Dana Instruments, formed in 1977 by the joining of the original companies. A continuing dedication to fulfilling our customers' needs led to the acquisition of the Interstate Electronics Signal Source product line in 1983. We have earned a position of leadership in the design and production of counters, digital multimeters, signal sources, communications test equipment, logic analyzers and GPIB (IEEE-STD-488) compatible products. We are aggressively expanding this product line to keep pace with our customers' growing test needs.

Racal-Dana and Engineering

Because of our commitment to product innovations, we maintain extensive engineering facilities in both North America and Europe. These are staffed by engineers who are specialists in RF, digital, low level, and high accuracy designs. In addition to jointly assigned projects, our engineering groups communicate on a regular basis to assure that our products meet the needs of our world wide customers. Racal-Dana engineering groups are comprised of highly trained engineers and scientists specializing in hardware, software and mechanical design. The integration of these specialists into project teams results in designs which provide exceptional performance and ease of use, while maintaining competitive pricing, high reliability and rugged packaging. This international engineering commitment means your Racal-Dana test equipment will solve your testing problems regardless of your location.

Modern, well-equipped engineering laboratories in both the U.S.A. and U.K support continuing new product introductions.

Racal-Dana and Innovation

For more than 20 years Racal-Dana has provided practical solutions to difficult instrumentation problems through design innovation. These efforts have been rewarded by many honors. From being selected to supply a major component in the tracking systems for United States space probes, to earning the coveted "Queen's Award for Technology" in the United Kingdom, our products continue to be recognized for their innovative solutions to the needs of our customers.

This commitment to innovation has also led to the awarding of many patents on our designs.

The real story is not in the patents we've earned, but in the problems we've solved for our customers. Some examples are:

Space Tracking

Our Digiphase design provides high resolution programming of phase and frequency. Using our 50 MHz synthesizer as the local oscillator allowed the California Institute of Technology (U.S.A.), Jet Propulsion Laboratory, to compensate for doppler shift when tracking space vehicles. The 1 microhertz programming resolution made computer tracking a reality.

Radar Monitoring

The auto-trigger design in our universal counter/timers, combined with the unique Racal-Dana "synchronous window" arming mode, made it possible for government aviation groups to automate the routine certification checks of traffic control radar. This eliminates human errors, and makes possible the remote monitoring and certification of less accessible sites.

Communication Testing

The channelized tuning feature of our signal generators reduces the time and expense of testing multichannel radios. A simple flip of a switch, or turn of the dial, instantly moves the signal frequency to another channel.

Our automatic modulation meters made possible the automatic testing of radios and eliminated the time-consuming manual tuning previously required.

These are only a few of the many innovations that have been pioneered by Racal-Dana. For over two decades, we have set the technological pace in the highly competitive world market; and recently pioneered the application of LSI and microprocessor techniques in electronic instrumentation. Our commitment is to remain an innovative pacesetter in equipment reliability, ease of use, and measurement techniques.

Racal-Dana and Technology

The goal of every Racal-Dana design team is to use the most effective technological advancements. Recent Racal-Dana technological firsts include:

1. World's first counter on a chip;
2. World's first microprocessor based counter/timer;
3. World's first GPIB timing generator;
4. World's first spin-wheel tuned synthesized signal generator.

Other technological firsts include providing greater than 3000 hour battery life on a handheld multimeter; designing an ultra-low noise, RF sampling voltmeter; and combining off-the-shelf, custom, and microprocessor LSI in a single design.

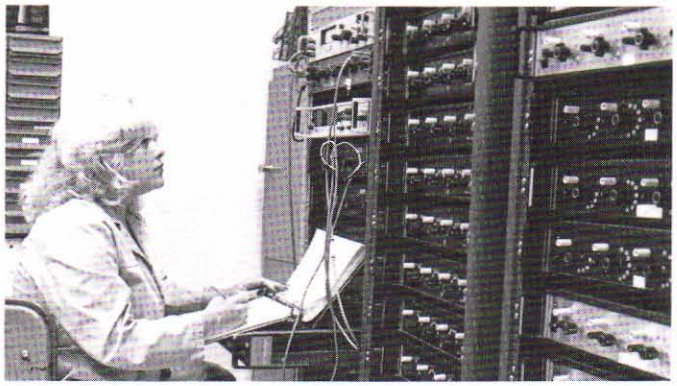
Manufacturing facilities use the latest automated, computer-controlled board stuffing techniques.

Racal-Dana and Manufacturing

To support our worldwide customers, we maintain manufacturing facilities in both Europe and North America. Located near Los Angeles, California, U.S.A.; and London, England, U.K.; they produce a broad range of test and measurement equipment for international distribution. Both operations make use of the latest manufacturing and automated test techniques. To assure a prompt delivery when you order standard products, manufacturing is scheduled against sales forecast requirements. Many of our products are available from stock at both manufacturing locations and your local sales office.

Introduction to Racal-Dana

A proprietary zener-reference facility provides high quality references for Racal-Dana digital multimeters.



Racal-Dana and Quality

At Racal-Dana, quality means more than an instrument that operates. Quality means careful and conservative use of components during design to eliminate underrated or over stressed parts. It means careful attention to safety; instruments that are designed to comply with worldwide standards, including UL, BS, IEC, and VDE specifications.

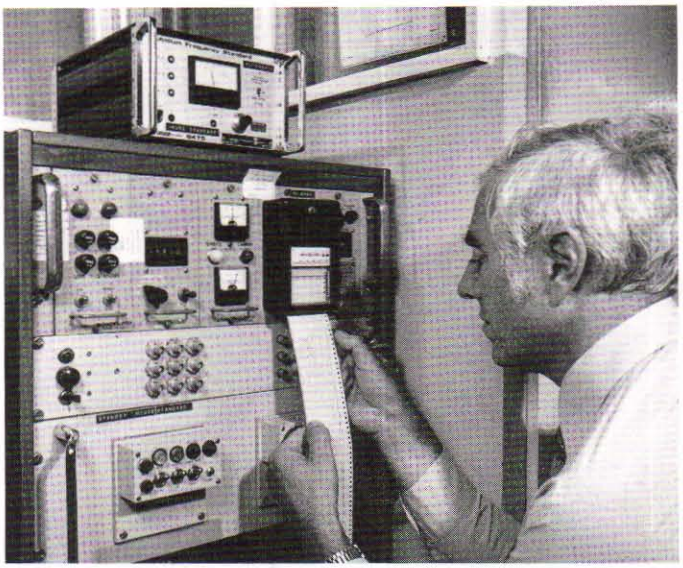
GPIB-based ATE allows rapid calibration of Racal-Dana products

Quality means thorough inspection and testing. Parts are carefully inspected, with active devices burned-in where necessary. PCB assemblies are tested by in-circuit ATE systems; mechanical assemblies are inspected, and completed units are burned-in at elevated temperature prior to final test. All units are then tested to stringent in-house test parameters that exceed the published specifications. Finally, all units are 100% inspected by a team of highly qualified Q.C. Audit Inspectors. An inspector even checks shipping to assure that your unit arrives with the proper accessories, options, and manuals.

Quality means guaranteed specifications. Each design is thoroughly evaluated on a continuing basis to make sure the unit you receive is better than the published specifications. Most units are provided with guaranteed long term specifications to assure accurate performance over an extended calibration cycle.

Quality means serviceability. Racal-Dana instruments provide easy access for servicing and calibration. Service manuals include full troubleshooting information and a complete parts list showing commercial part numbers in addition to the Racal-Dana part numbers. Most newer units have eliminated "factory selected values" and many include built-in diagnostics, auto-calibration, digital calibration, and signature analysis.

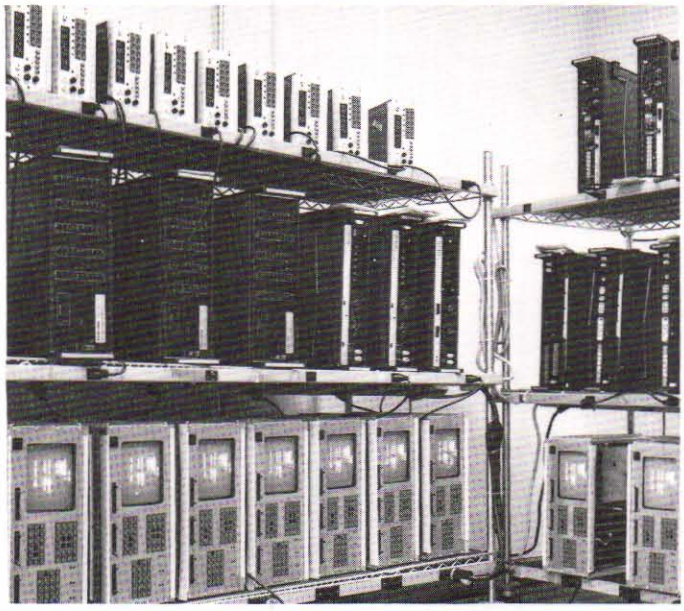
Quality means reliability. Our inspection and test procedures, burn-in program, and conservative design assure instruments that provide trouble-free operation. The Racal-Dana reputation for reliability has earned the company a place in major commercial, military and government programs worldwide.



High quality primary standards assure traceable accuracy to national standards around the world.

Quality means a certified Q.A. program. Our quality programs have been audited and certified to comply to MIL-Q-9858 (U.S.A.), and DEF-STAN 05-21 (U.K.).

Our aggressive quality program includes compliant design, rigorous incoming inspection, demanding in-process quality control, power on burn-in, thorough final testing, and a quality control audit prior to shipment. Quality means each instrument you receive from Racal-Dana will give years of reliable service.

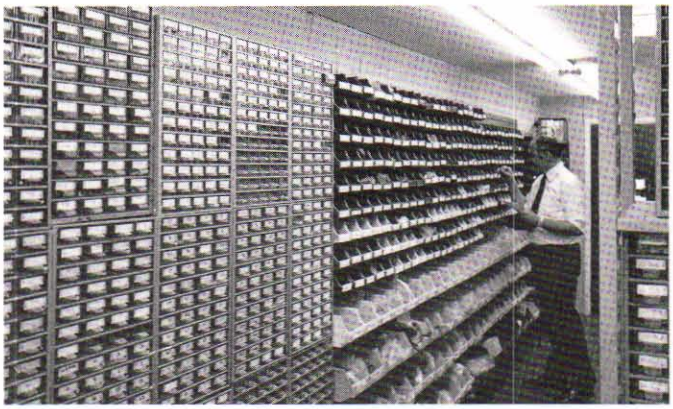


Racal-Dana products are burned-in at elevated temperatures prior to final test to maximize ultimate reliability.

Racal-Dana and Logistic Support

In the electronics industry, product support services are essential since many customers choose not to support the skills and expensive equipment required to maintain their sophisticated instrumentation products. Racal-Dana offers comprehensive customer support, including:

- Applications assistance;
- Engineering of complete systems and 'specials' adapted to particular requirements;
- Post design services for government and other large scale users;
- Full logistics support, including handbooks, quality certification, and spares;
- Worldwide repair and calibration facilities.



Large inventories of spare parts are maintained at each Racal-Dana service facility.

Racal-Dana and Service

Our commitment to service extends far beyond providing worldwide maintenance facilities. Service starts with an expert sales force. This group of instrumentation specialists is trained to assist you in filling your requirements. They are backed by factory teams of applications engineers dedicated to solving your unique testing problems.

After-sale service support is available on a factory-direct basis in France, Germany, Italy, the United Kingdom and the United States. In most other countries, service is provided by the factory trained and certified service centers of our representatives. To minimize downtime, we maintain an extensive stock of parts for service support. In addition, most of our component parts are cross-referenced in our manual to off-the-shelf commercial part numbers.

Certified calibration is available from all factory service centers and many Racal-Dana Representatives. All standards are traceable to national standards.

We maintain a staff of field service engineers to assist those who have in-house service capability. Simply call your nearest Racal-Dana factory service center for troubleshooting assistance.

Introduction to Racal-Dana

Extensive factory service facilities are available at all Racal-Dana factory locations.

Service training seminars are available at an economical price for customers desiring detailed training on specified products or product types.

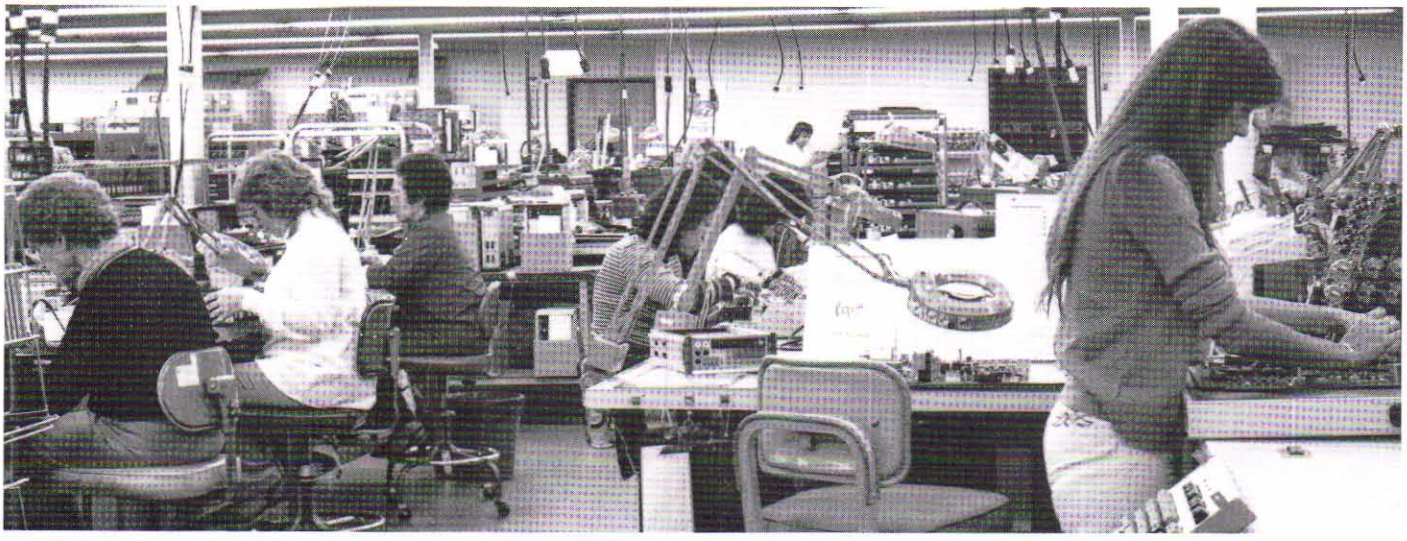
Racal-Dana service/support includes complete logistics support for parts, service, repair, calibration services and training. This commitment extends for the life of your Racal-Dana product. In fact, we guarantee total support for five years after we discontinue the product from our standard product list.

Product warranty protection is another major part of our service program. Most of our products carry a one year parts and labor warranty. We offer extended warranties of two years on some products, such as the 99 Hundred Series counters. In fact, the LSI chip at the heart of these counters carries a lifetime guarantee.

When you select Racal-Dana equipment, you can depend on service support that starts by helping you choose the proper instrument, and continues by assuring your complete satisfaction during its long lifetime.

Racal-Dana and Value

When you select Racal-Dana products for your applications, you are assured that you will be getting more value for your investment. A demanding quality program, innovative design management, highly qualified and dedicated engineers, the latest technology, and modern facilities combine to deliver a product of consistently high value. Backed by the worldwide Racal-Dana sales and service support, it results in the best value for your money available anywhere.



Modern manufacturing facilities in both the U.S.A. and U.K. provide substantial productive capacity and superior delivery capability.

GPIB and World Standards

In the early 1970s, work began within the instrumentation industry to develop a standard and flexible interface that could be used on a wide variety of instrument types and designs.

Racal-Dana's involvement with the GPIB (General Purpose Interface Bus) began in 1974. At that time both the IEEE Standards Board and the IEC (International Electro-Technical Commission) technical committee (IEC TC76) were in the process of approving the then draft standard.

The interface standard was approved as IEEE-STD-488-1975, "Digital Interface for Programmable Instrumentation" and first published in 1975. The IEC recommendation, using a different connector, was adopted in 1976 as IEC 625-1. Also in 1976, the American National Standards Institute adopted the IEEE-STD-488 and published it as ANSI Standard MC1.1.

While the draft documents were being reviewed, Racal-Dana began the design of our first generation GPIB. In 1975, the first five Racal-Dana models offering the "bus" interface were introduced. Today, most of our instruments are available with GPIB interface.

The standard has continued to be improved and was again published (with minor editorial changes) in 1978 as IEEE-STD-488-1978. Additional definition of the protocols and formats has been published by the IEEE committee as IEEE Standard 728, 1982 "ANSI/IEEE codes and formats conventions".

The present Racal-Dana GPIB interface is compliant to IEEE-STD-488-1978 and fully compatible to all of the above specifications.

What GPIB means

GPIB is a common term used to describe the interface structure defined by the above standards. At Racal-Dana, GPIB means more. In addition to meeting the mechanical, electrical, and functional specifications of IEEE-STD-488-1978, the Racal-Dana GPIB interface offers additional benefits. It features ease of programming, full implementation of highest applicable subset levels,

annunciation of bus address, convenient data output formats, complete and easy to understand programming documentation and full applications support. These extra benefits combine to make the Racal-Dana models with the GPIB the best instruments for your system. All units available with GPIB interface are designated in this catalog with the symbol:

The Talker, Listener designation identifies whether the unit is capable of talking (outputting data) to the bus, listening (receiving data or programming) from the bus, or both.

The development and worldwide acceptance of this IEEE/IEC standard now makes possible the automation of conventional manual methods without extensive cost or engineering time. A decision to automate a traditionally manual test set-up should be based on an engineering evaluation of benefits versus costs. Some of the many benefits of an automated system include:

- **Repeatable Results -** The measurement is not affected by operator skill or fatigue.
- **Greater Throughput -** An automated test is generally faster than manual methods.
- **Automatic Error Correction -** Correction factors and system errors can be corrected automatically.
- **More Complete Testing —** Faster speed allows more parameters to be tested in a shorter time.
- **Better Test Records -** The test results can be stored in memory, on tape, or printed on hard copy for future reference or analysis.
- **Better Utilization of Skilled Engineers and Technicians -** The use of automated testing releases the higher skilled personnel from repetitive test tasks and allows them to concentrate on engineering and troubleshooting.

Racal-Dana is committed to providing instruments that enhance your ability to automate. This is illustrated by our Series 1200 GPIB Switching System; Series 1500 GPIB Timing Generator; and Model 488 GPIB Analyzer. Each of these instruments offers features and capabilities that are unavailable from other manufacturers.

How the GPIB Operates

The IEEE/IEC interface bus (GPIB) provides the capability of interconnecting up to 15 devices using a standard passive cable.

The cable's role is limited to that of interconnecting all devices in parallel, whereby any one device may transfer data to one or more other participating devices.

Every participating device (instrument, controller, accessory module) must be able to perform at least one of the roles of TALKER, LISTENER or CONTROLLER. A TALKER can transmit data to other devices via the bus, and a LISTENER can receive data from other devices via the bus. Some devices can perform both roles (e.g., a programmable instrument can LISTEN to receive its control instructions and TALK to send its measurement).

A CONTROLLER manages the operation of the bus system primarily by designating which devices are to send and receive data; it may also command specific actions within other devices.

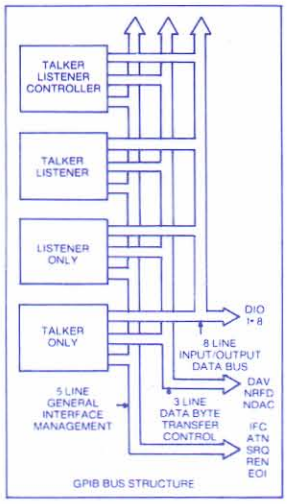
A minimum GPIB system configuration consists of one TALKER and one LISTENER, without a CONTROLLER. In this configuration, data transfer is limited to direct transfer between one device manually set to "talk only" and one or more devices manually set to "listen only" (e.g., a measuring instrument talking to a printer for data logging).

The full flexibility and power of the GPIB is available when a CONTROLLER/TALKER/LISTENER (e.g., calculator or computer) is interconnected with other devices which may be either TALKERS or LISTENERS, or both (e.g., frequency synthesizers, counters, switching systems, digital voltmeters, printers, etc.) depending on the application. A controller participates in the measurement by being programmed to schedule measurement tasks, set up individual devices so that they can perform these tasks, monitor the progress of the measurement as it proceeds, and interpret the results of the measurement.

GPIB Bus Structure

The GPIB has a party line structure where all devices on the bus are connected in parallel. The 16 signal lines within the passive interconnecting cable are grouped into three clusters according to their function as follows:

1) Data Bus (8 signal lines)
2) Data Byte Transfer Control Bus (3 signal lines)
3) General Interface Management Bus (5 signal lines)



The Data Bus consists of eight signal lines which carry data in bit parallel, byte serial format across the interface. These signal lines carry addresses, program data, measurement data, universal

commands, and status bytes to and from devices interconnected in a system. Identification of the type of data present on the DIO signal lines is indicated by the ATN (attention) signal. When the ATN signal is true (asserted), either addresses or universal commands are present on the data bus and all connected devices are required to monitor the DIO lines. When the ATN message is false, then device dependent data (e.g., programming data) is carried between devices previously addressed to talk and listen.

Transfer of each byte on the Data Bus is accomplished via a set of three signal lines: DAV (data valid), NRFD (not ready for data) and NDAC (not data accepted). These signals operate in an interlocked handshake mode. Two signal lines, NRFD and NDAC, are each connected in a logical AND (wired OR) to all devices connected to the interface. The DAV signal is sent by the TALKER and received by potential LISTENERS whereas the NRFD and NDAC signals are sent by potential listeners and received by the TALKER.

The General Interface Management Lines manage the bus to effect an orderly flow of messages. The IFC (interface clear) message places the interface system in a known quiescent state. SRQ (service request) is used by a device to indicate the need for attention or service and to request an interruption of the current sequence of events. REN (remote enable) is used to select between two alternate sources of device program data. EOI (end or identify) is used to indicate the end of a multiple byte transfer sequence or, in conjunction with ATN, to execute a polling sequence.

It is not possible in this limited space to go into detail on each signal line's role. But you should note that every device need not be able to respond to all the lines. To be practical and cost-effective, each GPIB device will usually be designed to respond only to those lines that are pertinent to its typical function on the bus. Details appear in each instruments operation manual.

High Level Subsets

The level of subset implementation is a key consideration when selecting instruments for your automated system or ATE design. Most Racal-Dana GPIB designs feature full implementation of subsets at their highest applicable level. The chart below summarizes the subset capability of our GPIB instruments.

GPIB Subset Summary

MODEL \ Subset	AH	C	DC	DT	E	L	LE	PP	RL	SH	SR	T	TE
Series 200	1	0	1	1	1	4	0	0	1	1	1	5	0
Model 488	GPIB MONITOR ONLY												
Model 845	1	0	0	0	0	4	0	0	2	0	0	0	0
Model 860	1	0	0	1	0	4	0	0	2	1	1	6	0
Series 1000	1	0	0	0	1	1	0	0	2	0	0	0	0
Series 1200	1	0	1	1	1	1	0	0	0	0	0	0	0
Series 1500	1	0	1	1	1	4	0	0	1	1	1	6	0
Series 2021	1	0	1	1	0	4	0	0	1	1	1	6	0
Series 4000	1	0	0	1	1	4	0	0	0	0	0	7	0
Series μ5000	1	0	1	1	1	4	0	0	1	1	1	5	0
Model 5001	1	0	1	1	1	4	0	0	0	1	0	7	0
Model 5002	1	0	1	1	1	4	0	0	1	1	1	5	0
Series 6000	1	0	1	1	1	4	0	0	1	1	1	5	0
Series 9000A	1	0	1	1	1	4	0	0	1	1	1	5	0
Model 9084	1	0	1	0	1	3	0	0	1	1	1	6	0
Model 9087	1	0	1	0	1	3	0	0	1	1	1	6	0
Model 9303	1	0	1	1	1	4	0	0	1	1	1	5	0
Series 9500	1	0	1	1	1	4	0	0	1	1	1	5	0
Series 9900	1	0	0	1	1	4	0	0	2	1	0	3/6	0

GPIB Instruments
General Information

System Components

Whether you are automating a previously manual test setup or designing a large scale ATE system, Racal-Dana offers instruments and system components tailored to your needs. The broad capabilities include measurement, recording, sourcing, switching, timing, and servicing. The table below is an example of our ever increasing range of GPIB products.

GPIB Product Summary

Function	Model	Description	See Page
Amplitude Measurement	4002A	Digital Multimeter, 4½ digit	34
	4003	Digital Multimeter, 4½ digit, 1μV resolution	34
	5001	Digital Multimeter, 5½ digit, computing	38
	5002	Wideband, AC level meter, DC-20 MHz	66
	5003	Digital Multimeter, 5½ digit, systems	41
	5004	Digital Multimeter, 5½ digit, MEP, systems	41
	5005	Digital Multimeter, 5½ digit, ratio, high accuracy AC	41
	5006	Digital Multimeter, 5½ digit, ratio, true rms AC	41
	6001	Amplitude Measurement System, 6½ digit	46
	6002	Amplitude Measurement System, 6½ digit, true rms AC	46
	9303	RF Level Meter, 10 kHz to 2 GHz	72
Time and Frequency Measurement	9015A	Microprocessing Universal Counter/Timer	103
	9015/11A	Microprocessing UCT with pulse parameter	103
	9035A	500 MHz Microprocessing UCT	103
	9035/11A	500 MHz Microprocessing UCT with pulse parameter	103
	9514	Universal Counter/Timer, 100 nSec, auto-trigger	107
	9515	Universal Counter/Timer, 10 nSec, auto-trigger	107
	9900	30 MHz Universal Counter/Timer	111
	9902	50 MHz Universal Counter/Timer	111
	9904	50 MHz Universal Counter/Timer	115
	9906	200 MHz Universal Counter/Timer	111
	9912	120 MHz Frequency Counter	86
	9914	200 MHz Frequency Counter	86
	9916	520 MHz Frequency Counter	88
	9917A	560 MHz Frequency Counter	90
	9918	560 MHz Frequency Counter	90
	9919	1.1 GHz UHF Frequency Counter	92
	9921	3 GHz Microwave Frequency Counter	94
Logic Analyzer	202	48 Channel Logic Analyzer	24
	205	48 Channel Logic Analysis System	27
Recording	1001	Thermal Printer, 20 column	16
	1002	Thermal Printer, 20 column with clock	16
Sourcing	1210	16 decade, BCD driver module	162
	1211	TTL/Relay Driver Module	162
	9084	HF Signal Generator, 10 kHz to 104 MHz	149
	9087	UHF Signal Generator, 10 kHz to 1.3 GHz	154
	845	14 MHz Function Generator	133
	860	20 MHz Function Generator	133
	2021	50 MHz Pulse Generator	142
	2021DS	50 MHz Pulse Generator (dual channel)	142
Switching	1202	Universal Switching System	162
	1203	Slave Switching Chassis	162
	1211	TTL/Relay Driver Module	164
	1212	High Power Switching Module	164
	1213	Low Thermal Switching Module	164
	1214	High Voltage/Low Thermal Switching Module	164
	1215	RF Switching Module	164
	1216	2 Channel, 18 GHz Microwave Switching Module	164
	1217	4 Channel, 18 GHz Microwave Switching Module	164
	1242 Series	Matrix Switching System	167
Timing	1510	GPIB Timing/Delay Generator	139
	1515	GPIB Timing Generator with real-time clock	139
Servicing	488	GPIB Analyzer	15

GPIB Instruments
IEEE-STD-488 Bus Analyzer
Model 488

Introduction

The Model 488 is a low-cost battery operated GPIB Analyzer designed to allow easy monitoring and servicing of bus systems. Now the service technician or system integrator can monitor bus activity easily and inexpensively. Its portability and low cost makes it an affordable tool for every GPIB service operation.

Memory

Up to 40 bus transactions can be stored for recall and analysis. The memory stores the conditions of the DIO1 through DIO8, ATN, SRQ, and EOI lines during each transaction. The memory can be set to capture data before, after, or on each side of, a trigger condition.

Trigger Control

Easy to use slide switches allow a trigger condition to be established using the DIO, SRQ, ATN, and EOI lines. The 488 memory can be set to trigger on any combination of asserted or unasserted conditions. In addition, an "X" position allows any of these lines to be masked from the trigger word.

Three Operating Modes

The 488 provides Passive, Trace and Single-Step operation. Passive is a simple monitoring of the bus activity. Trace provides memory storage, and Single-Step allows the bus transaction to be stopped and stepped one handshake at a time for close observation of bus activity.

LCD Display

The LCD provides an easy to read display of the conditions of each bus line. The DIO lines are displayed in hexadecimal format. All other lines are individually annunciated on the display. In addition, the memory location is displayed when in the Trace mode.

Fully Portable

The convenient size, battery operation, and LCD display make the 488 the first completely portable bus analyzer available.

Arming

Arming allows the memory to capture data as determined by the trigger conditions. In addition it may be used with the Single Step mode to allow the bus to proceed at high speed until a trigger condition is detected. The bus may then be stepped, one transaction at a time.

Specifications

GPIB Input

Handshake Time: <10 μSec or single-stepped
Bus Loads: CMOS input with termination to simulate a powered up device.

Controls

Trigger Condition: All DIO, SRQ, ATN, and EOI lines.
Trigger Location: At START, MIDDLE or END of memory.
Mode: Trace, Passive, or Single-Step.
Memory Control: Forward and backward
Arm/Step: Allows arming when in Trace mode or stepping when in Single-Step mode.

Display

Type: LCD
DIO Format: 2 digit hexadecimal
Memory Location: 2 digit decimal
Annunciators: ATN, SRQ, EOI, REN, IFC, DAV, NDAC, NRFD, LO BAT, ARM.

General

Power Requirements: 4 each 1.5 V "C" cell batteries.
Operating Temperature: 0°C to +50°C
Storage Temperature: −40°C to +70°C
Humidity: 75% RH at +40°C
Dimensions: 86 H × 158 W × 235 D mm
(3.4 H × 6.2 W × 9.25 D inches)
Weight: 0.9 kg (2 lb)

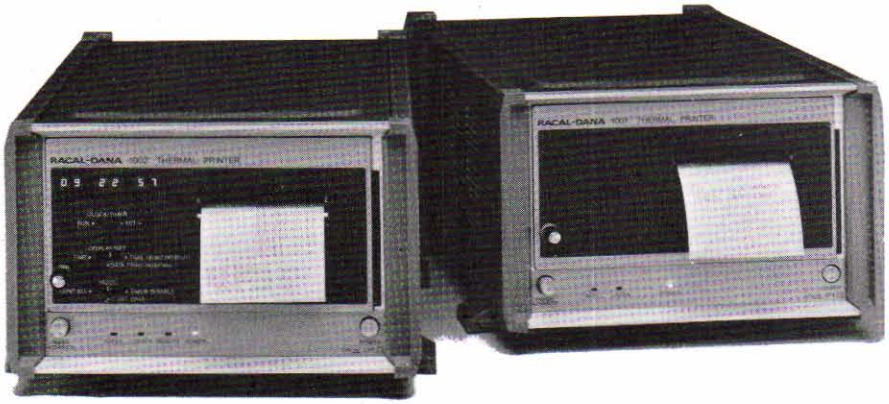
Ordering Information

Model 488: GPIB Analyzer

Accessories

406845: GPIB cable, 1 meter
406844: GPIB cable, 2 meter
406846: GPIB cable, 4 meter

Digital Printer Plotter
20 Column Thermal Printers
Series 1000



Introduction

The Series 1000 thermal printer can be used to provide a printout of data from a single instrument or as a printer for a complete automated system. The 1000 provides all the features you want in an instrumentation printer. Two models allow you to choose exactly the performance you need for each application.

Model 1002 is a full feature, 20 column, thermal printer. It provides time clock control and GPIB interface as standard features. The digital time clock displays and allows printout of time of day or elapsed time. The clock may also be used to control data print interval and time print interval.

Model 1001 provides all the capability of the 1002 except the time clock control and is ideal for use in systems containing a systems controller and the Racal-Dana Series 1500, GPIB Timing Generator.

Text or List

The Series 1000 can be set to either a TEXT or LIST format. For those applications requiring regular monitoring during printout, the LIST format provides a direct reading listing of the printed data. For applications that require printed instructions or other alpha characters, the TEXT format allows data to be printed in a reverse field. This eliminates the need to reformat data at the source to achieve readability. The TEXT mode may also be used on numeric data to provide a "first reading at the top" type of record for easy review after completion of a block of data.

Plotting Format

For recording of trends or waveshapes, the Series 1000 may be set to the PLOT mode. In this mode a numeric input of 0 to 99 creates a point control from zero to full scale on the paper. A 100 dot resolution is provided.

Grid or No-Grid Plotting

When in the PLOT mode, you may select a printed grid format. This provides a calibrated plot and may be used when recording the results of stability, frequency response, and other relative measurements.

GPIB Interface Standard

Both models are optimized for use on the GPIB (IEEE-STD-488 bus). The GPIB interface allows printing of a 64 character alphanumeric ASCII character set. The 5 × 7 matrix thermal printhead provides high resolution printing suitable for even your most demanding applications.

Series 1000 Model Summary

Feature / Model	GPIB Interface	Time Clock	Plot	Text/List
1001	x		x	x
1002	x	x	x	x

Specifications
Printer

Number of Columns: 20

Print Speed: 2.5 lines per second

Print Character Set: 64 ASCII characters as defined in columns 2 through 5 of code.

Character Format: 5 x 7 matrix

Printing Formats: Print text
Print list
Plot with grid
Plot without grid

Paper

Type: Thermal

Width: 63.5 mm (2.5 inches)

Time Clock—Model 1002

Range: 0 to 99 days, 23 hours, 59 minutes, 59 seconds

Resolution: 1 second

Printout: DD:HH:MM:SS

Display: HH:MM:SS

Clock Control—Model 1002

Controls: Data print interval
Time print interval

Display: May be selected to display present time, time print interval or data print interval

Printing Modes

Print All: Time is printed at "Time Print Interval"
Data is printed at "Data Print Interval"

Print Data: Data is printed at "Data Print Interval"

Timer Disable: Data is printed as received

Control Ranges

Data and Time Print Interval Ranges: 0 to 23 hours, 59 minutes, 59 seconds

GPIB Interface

Specification: Per IEEE-STD-488-1978

Subsets: AH1, DC0, DT0, C0, PP0, E1, SH0, T0, L1, SR0, RL0, (RL2 on Model 1002)

Addresses: Even addresses for data input, odd addresses for time clock programming

General

Front Panel Controls

Model 1001: Power on/off
Paper advance

Model 1002: Power on/off
Paper advance
Clock set/run
Printing modes
Display modes

Annunciators: Power on
Remote (1002)
Listen
Paper refill

Rear Panel Controls/Outputs: GPIB address switch
Plot/print switch
Grid/No Grid switch
Text/List switch
Trigger output

Temperature

Operating: 0°C to +40°C

Storage: −20°C to +70°C

Humidity

Operating: 75% RH

Storage: 90% RH

Power Requirements

Voltage: 100, 120, 220, or 240 V AC ±10%

Frequency: 48 to 420 Hz

Consumption: 45 watts

Dimensions: 147.3 H×215.9 W×342.9 D mm
5.8 H×8.5 W×13.5 D inches

Weight: 4.7 kg (10.5 lb)

Ordering Information

Model 1001 Thermal Printer/Plotter

Model 1002 Time Clock Controlled Thermal Printer/Plotter

Options

04 50 Hz operation

71 220/240 V AC operation

60 Rack mounting adapters

65 Chassis slides and rack mounting adapters

100 Thermal paper

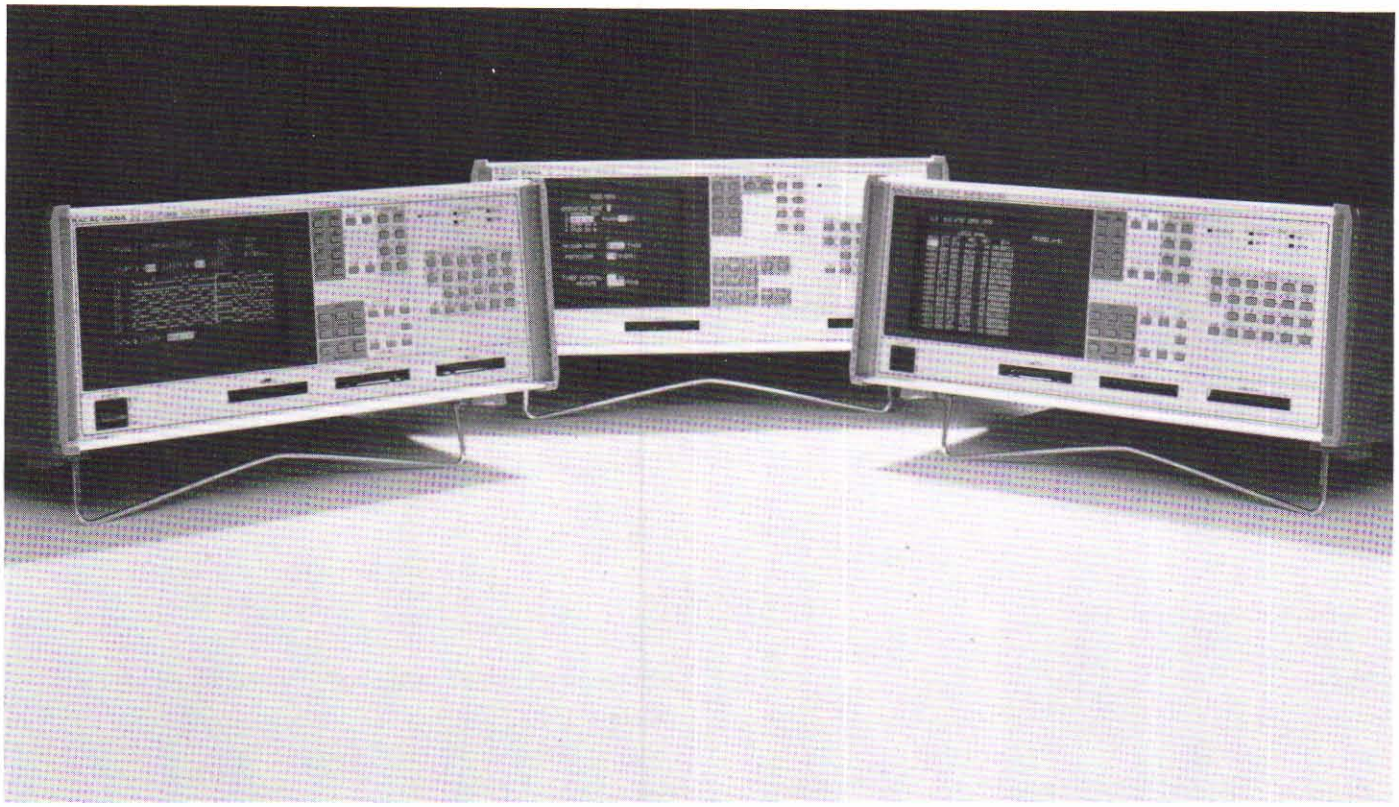
Accessories

406845: GPIB cable, 1 meter

406844: GPIB cable, 2 meter

406846: GPIB cable, 4 meter

Logic Analyzers
General Information



Introduction

In the complicated world of analyzing digital data, Racal-Dana Instruments offers a series of easy-to-use Logic Analyzers to aid in the design, evaluation, manufacture and maintenance of digital equipment. The Series 200 Logic Analyzers provide disassemblers for many of the popular microprocessors, making connection to your microprocessor chip a simple task. The reading of op-codes is only a pushbutton away. Because of the excellent value/cost ratio, the Series 200 Logic Analyzer may now be considered as a personal analyzer—similar to having a voltmeter and other test equipment in each user's work area.

Three Different Analyzers

The Model 201 is an easy-to-use 32-channel analyzer capable of analyzing 8-bit microprocessors and discrete logic. The Model 202 also is very easy to use, offering added channel capability for 16-bit microprocessors; optional Non-Volatile Memory for storing word generator patterns, menus or data; word generator; and IEEE-STD-488 interface.

The Model 205 Logic Analysis System offers the user 48 channels, word generator (16-bit wide by 250-deep selectable pattern output), IEEE-STD-488 interface and 24 Non-Volatile Memory locations to store setups, input reference data, and/or word generator patterns.

Easy to Operate

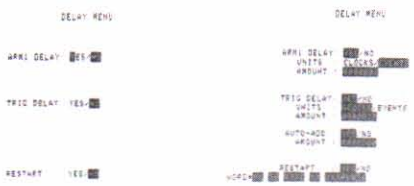
Every step has been taken to make operation fast and simple—to uncomplicate the logic analyzer and make it your most useful and productive software debugging tool.

Color-Coded Keyboard Simplifies Use—All keys are color-grouped by function to make identification and use easier.

Single-Function Keys Eliminate Confusion—The system sees all keys as single function. You never need to shift functions, mentally or manually. The analyzer automatically selects the function for you.

Interactive Menus Simplify Setup—Interactive menus insure fast, simple, user-friendly operation, even for the occasional operator. To keep menus simple, operator prompting occurs when additional setups are required. Only pertinent questions are asked to simplify operations and speed setups.

Hardware/software features and options that are included in your system are conveniently displayed in a separate UNIT menu.



Interactive Menus—Entry prompts are exceptionally interactive. For example, the DELAY menu can be nearly empty if delays and RESTART are not required, and can expand in stages if the various features are requested.

Easy to Operate (continued)

Simplified Entry/Editing—Reverse video and flashing cursor constantly advise you of field selected and area ready for editing. FIELD forward/backward keys advance the cursor to the next field or entry prompt. A right-justify feature and entry key speed entry of small numbers into large fields. A SKIP key enables you to skip quickly to a specific digit in a large field to edit a specific portion. This simplifies field modification.

Easy Format Selection—Display formats available include Hexadecimal, ASCII, Octal, Binary, Mnemonics or Waveform. Data may be displayed in 8 or 16 channel groupings. DISPLAY keys allow data to be reconfigured instantly into a single format. A single keystroke returns the display to the original format.

Fast Scrolling and Paging—You are free to scroll/page forward or backward through the 250-word memory one line/one page at a time. Holding the key down causes the system to scroll or page continuously. Twenty words are displayed on each page, more than most other analyzers.

Expanded Search and Locate Features—A *Locate* feature allows the user to display any part of memory. Single keystrokes allow either the beginning of memory, end of memory, or the trigger location to be displayed. In addition, the contents of any memory location may be immediately recalled by entering the memory location number.

The *Search* feature is a fast way to locate words associated with specific addresses, addresses related to specific words or data/addresses associated with a particular hardware state in the main (capture) and auxiliary memories. The search feature also displays the number of occurrences of the word being searched.

New Features Enhance Operating Ease

Several new features are incorporated into the Series 200 design which reduce the effort and time required for analyzer operation once the original setup has been made.

Direct Trigger Transfer—It is often necessary to capture preliminary data, then enter a word from the captured data as the next trigger condition. After initial capture, any word may be transferred directly from the capture memory to the trigger menu for use as the trigger word on subsequent data collections. This convenient feature enhances ease of use and eliminates the potential operator error associated with redefining the trigger word.

Auto-Add Creates Illusion of Infinite Logic Analyzer Memory Depth

As μP programs extend in length, it becomes too costly to require the logic analyzer to be able to collect the entire program on a single collection. However, it is inconvenient to change the triggering conditions each time a new section of the program is to be captured.

The *Auto-Add* feature on the Series 200 solves this dilemma. This feature speed up interrogation of large blocks of data by automatically advancing the data collection point by a fixed clock or event increment each time a "run" is initiated. Now a complete μP program may be observed without resetting any controls on the analyzer.

This feature is ideal for program troubleshooting to locate the fault area, or (when combined with auto-run) for video (all models) or GPIB (Models 202 and 205) printout of a program listing.

Multiple Clocks Extend Usefulness

Many designs require more than one clock (e.g., multiplexed clocks). The Series 200 provides two multiplexed clocks to give you the ability to examine data that is not coincident with the microprocessor-clocked address and data bus lines. In addition to the external clocks, a programmable internal clock is available for asynchronous data collection.

Extended Triggering for Faster Software Debugging

The Series 200 provides more triggering capability than any other analyzer in its price range. This extensive triggering allows the operator to select and capture only the data of interest. A front-panel LED indicates when trigger conditions have been met. On Models 202 and 205, a BNC connector at the rear of the instrument supplies a trigger output pulse for synchronizing external equipment.

Multiple Trigger Modes

The Series 200 features both *normal* and *trace* triggering modes. Both modes provide four levels of triggering, full masking on each trigger level, and full "don't care" selection throughout each trigger word.

Normal Trigger Mode—The *normal* trigger mode is used to capture data before, after, or on each side of, a trigger condition to a maximum of 250 words.

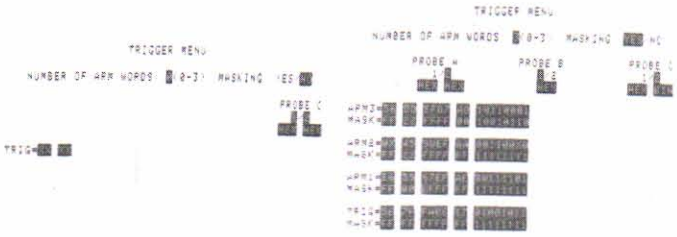
Trace Trigger Mode—This mode allows the Series 200 to exclusively capture a single, repetitive event each time it occurs. The *trace* mode can be used, for example, to capture data associated with a given address, the address of specific data, or data/address relationships to hardware events.

Post-Trace Mode—This mode extends the trace feature to allow capture of up to 16 additional words after the trace word. This allows the analyzer to only capture repeat occurrences of small subroutines or data following a fault condition.

Multiple Trigger Modes (continued)

Trigger Restart—The Series 200 allows a restart word to be entered and used to reset the triggering sequence. Use of the restart word assures that the trigger conditions are established on a single software pass. This makes certain that a trace of the proper software path has occurred prior to data collection.

Full Masking and "Don't Care" States on Each Trigger Word—Masking and "Don't Care" states may be used to allow triggering on selected group of addresses, data locations, and I/O ports. In addition, masking may be used to easily modify a trigger sequence without changing the selected trigger words.



The menu for a single probe 16-bit trigger word is shown above. If full trigger capabilities are required, the menu gradually expands as indicated.

Multiple Delays up to One Million Clocks or Events

Delays may be added at the last two trigger levels. Each delay may be set to either clocks or events, and a delay of up to one million may be specified. If events are selected, the analyzer counts the specified repetitive occurrences of the arm or trigger word before advancing to the next trigger level.

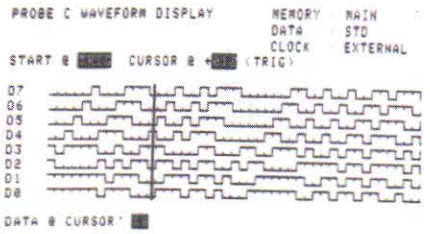
Selectable Pre-Trigger—Pre-trigger is selectable from 0 to 249 words, and is useful in capturing data when a trigger word does not occur, or in previewing data occurring before the trigger word.

Easy-to-Use Compare Functions—A separate auxiliary memory is available for the extensive compare features. Data may be transferred from the main memory to auxiliary memory by a single keystroke. An additional keystroke allows comparison of this data to newly acquired data. Differences are highlighted in reverse video.

"Stop on equals" or "stop-on-not-equals" modes allow continuous comparison of up to 250 words with reference data. This feature is especially useful during unattended operation, to await and identify inconsistencies, confirm logic program situations, and determine glitches to the bit level before acquisition is halted.

16 Channels of Timing Analysis

The Series 200 provides 16 channels of timing analysis for observing the conditions of hardware associated with the microprocessor. Unlike conventional timing analyzers, the Series 200 allows the internal timebase to be set to sampling periods as long as 999 seconds. This is ideal for observing electro-mechanical devices that are interfaced to the microprocessor. An optional glitch latching probe is available to capture glitches as short as 10 nanoseconds. See Logic Analyzer Accessories.



Waveform Display Allows Timing Analysis—The 16 channels of Input C may be displayed in two pages of waveform format for timing analysis. The 10 MHz internal clock provides variable resolution to 100 nanoseconds. Additional displays indicate the start of data, cursor location in memory and data byte at cursor.

Signature and Go/No-Go Tests—All Series 200 models offer CRC signatures of all the data collected in memory. These signatures may be used for Go/No-Go testing procedures which require an instant decision on the data collected.

Time Interval Measurements (Stopwatch Measurements)—The Series 200 makes it easy to measure the length of time or number of events required to execute the total program, program loop (loops), interrupts, and any other routines that are important to the user.

Probe, adapter and interfacing cables for the Z80 microprocessor.

Microprocessor Adapter/Disassemblers

Racal-Dana offers microprocessor disassemblers for popular 8-bit and 16-bit microprocessors. The disassembler provides a convenient connection between your logic analyzer and microprocessor board. The microprocessor adapter presets the logic analyzer to all the correct conditions to collect data from your specific microprocessor. The display screen then shows the microprocessor codes in mnemonics. For details, see Logic Analyzer Accessories.

GPIB-488 Probe

This optional probe reformats the GPIB to show the bus transactions in waveform format with all of the control and data lines labeled for easy identification.

Logic Analyzer Selection Guide

Requirement	Appropriate Model		
	201	202	205
Easy-To-Use	Y	Y	Y
Disassembly 8-Bit Micros	Y	Y	Y
16-Bit Micros	N	Y	Y
Automatic Menu Setup	Y	Y	Y
Test External Logic 74TTL	Y	Y	Y
74C, 4000	Y*	Y	Y
74LS, TTL	Y	Y	Y
74HC, HCT	Y	Y	Y
74F	Y	Y	Y
Bit Slicing (10 MHz)	Y	Y	Y
Hardcopy Video Printer	waveform data menus	waveform data menus word-generator	waveform data menus word-generator
GPIB Printer	N	All except waveform displays	
External Video Monitor	Y	Y	Y
Write to CRT from Controller	N	OPT	Y

*Needs optional variable threshold probe

Y=Yes; N=No.

Logic Analyzer Model Summary

Feature	Model 201	Model 202	Model 205
Channels/Depth	32/250	48/250	48/250
Speed (MHz)	10	12	12
Word Generator	—	OPT	X
Non-Volatile Memory	—	OPT (6 k bytes)	X (12 k bytes)
GPIB Interface	—	OPT	X
Standard Probes	2 TTL	3 Variable	3 Variable
Microprocessor Disassemblers	8-bit OPT	8/16-bit OPT	8/16-bit OPT
GPIB Analyzer	OPT	OPT	OPT
Storage Pouch	—	X	X

X = Standard feature

Logic Analyzers
32 Channel, Low Cost
Model 201

Full 8-Bit Microprocessor Support

The Model 201 features 32 channels of synchronous and asynchronous state analysis, 16 channels of timing analysis, and a full array of optional 8-bit microprocessor adapter/disassemblers. The 32 input channels permit display of all address and data lines as well as associated hardware activity. Optional 8-bit microprocessor probes permit easy connection to the CPU under test. Adapter/disassembler options are available for most popular 8-bit microprocessors and allow disassembly and display of mnemonic codes.

Microprocessor Disassembler Options—Probe, adapter and interfacing cables for many microprocessors permit disassembly of machine code to mnemonics. Probes and cables are common for most 8-bit μPs. To expand to a new μP family, simply order the low-cost adapter/disassembler for the new microprocessor type.

Low Cost

The low cost and broad capabilities of the Model 201 make it an ideal tool for use in technical schools, colleges or universities, and other educational applications. The simple operation allows the student to concentrate on learning about microprocessors or other digital circuits without spending excessive time learning to use the analyzer.

Menu Storage

The Model 201 contains a menu memory that allows storage of a complete menu setup in addition to the menu currently being used. This menu storage can save time and effort when repeated changes are made to a "base" setup for localizing software bugs. Both the active menu and the stored menu are reset when power is switched off.

Self-Diagnostics for System Integrity—The TEST key calls up several programs to verify integrity of keyboard and LEDs. A more sophisticated test feature, to verify probes and system operation, is available using the rear panel test output.

Logic Analyzers
32 Channel, Low Cost
Model 201

Specifications

Signal Inputs

Data Channels/Depth: 32/250

Clocks (Multiplexed): 2

Qualifiers (Clock/Trigger): 2/2

Probes: 2 (Fixed TTL)

Setup Time (Nominal): 30 nSec

Hold Time: 0 nSec

Maximum Input: −2.0 to +5.5 V

Input Impedance: 1 LSTTL

Logic Complement: Positive or negative

Clocks[1]

Minimum Pulse Width (At Threshold): 25 nSec

Internal Clock: Variable to 10 MHz (100 nSec to 999 Sec)

External Clock (+ or − slope): To 10 MHz (100 nSec)

Operating Modes

Normal Run: Initiates acquisition manually via RUN key

Auto Run: Reinitiates after selectable pause of 0 to 300 Sec

Stop-On-Equals (Stop-On Not-Equals): Run automatically reinitiates acquisition until data captured in main memory equals (or does not equal) auxiliary memory data. From 1 to 250 words may be selected for comparison

Data Display Formats

8-bit or 16-bit groupings selectable in Hexadecimal Binary, Octal, ASCII, Timing or Optional Mnemonics

Timing Display

Data Input: Input C (16 channels)

Resolution: 100 nSec maximum

Triggering: Full capability (See triggering specifications)

Triggering

Trigger Modes: Normal with 0–249 pre-trigger words
Trace with 0–16 post-trace words

Sequential Triggering: 1 to 4 levels (with 2 delays)

Delays: 0 to 999,999 clocks or events

Auto-Add Delay: Increments trigger delay on each run

Masking: Available at all trigger/arming levels

Restart: A full width restart word may be entered to reinitialize if restart word is encountered during triggering sequence

Memories

Main: For data acquisition, 32 bits × 250 words

Auxiliary: 32 bits × 250 words

Volatile Menu Storage: Stores one extra set of menu setups

Time Interval Measurement (Arm[1] to Trigger Word)

Clocks: 1 to 999,999 clock cycles

Time: 100 nSec to 290 hours in three ranges

Resolution: 1 cycle or 0.1 μSec

[1]Valid for data inputs up to 32 channels wide.

Compare Features

Modes: Auxiliary to Main memories compare (A/M), Stop-on-Equals (STOP =) or Stop-on-Not-Equals (STOP ≠) with field differences highlighted in reverse video.

Data Manipulation (Either Main or Auxiliary Memory)

Scrolling: Forward and reverse, single line or continuous

Paging: Forward and reverse, single page or continuous

Locate: Direct access to anywhere in memory

Search: Forward and reverse search to specific search word. Counter displays total search word occurrences in memory (99 max). All occurrences are highlighted.

Outputs

Composite Video: >1.5 volts into 75 ohms

General

Display: 7 inch (diagonal) CRT

Power Requirements: 100, 120, 200, 240 VAC, ±10%; 45 to 66 Hz; 150 VA

Operating Temperature: 0°C to +50°C

Storage: −40°C to +70°C

Dimensions: 178 H × 427 W × 475 D mm
(7 H × 16.8 W × 18.7 D inches)

Weight: Approximately 13.6 kg (30 lb)

Ordering Information

Model 201: 32 Channel Logic Analyzer, (Includes 2 Fixed Probes, Cables, Micrograbbers)

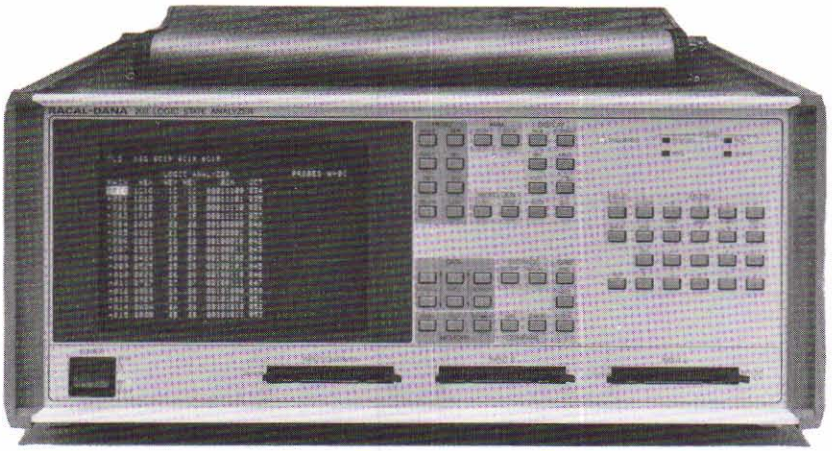
Options

04: 50 Hz operation

71: 220/240 V operation

For microprocessor pods and adapter/disassemblers, special probes, other Options and Accessories, see Logic Analyzer Accessories Section.

Logic Analyzers
48 Channel, Configurable
Model 202



Configurable

As an expandable system, the 48 channel Model 202 can be configured to provide an economical solution to a broad range of immediate logic analysis needs. Later it can be expanded to meet new requirements.

The basic 202 provides 48 channels of synchronous or asynchronous data analysis. These 48 data channels combine with additional trigger and clock qualifier inputs to provide full analysis capability for all 8-and 16-bit microprocessors.

The basic 202 also allows 16 channels to be used for timing analysis. This assures full capabilities for debugging both the software and hardware of microprocessor-based systems.

Configurable options include GPIB (IEEE-STD-488) interface, 16 x 250-bit word generator, non-volatile memory, and a full selection of microprocessor adapter/disassemblers.

Superior Human Engineering Expands Applications

Because the Model 202 is so easy to use, applications such as the use of logic analyzers as training aids in digital logic and microprocessor courses, are now practical. Every step has been taken to make operation fast and simple.

Menu Storage

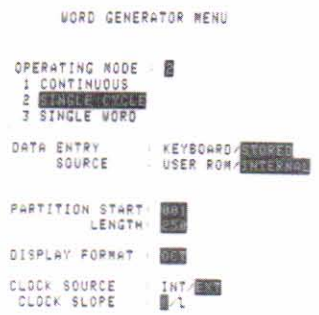
The Model 202 contains a menu memory that allows storage of a complete menu setup in addition to the menu currently being used. This menu storage can save time and effort when repeated changes are made to a "base" setup for localizing software bugs. Both active menu and stored menu are reset when power is switched off. An optional Non-Volatile memory is available for permanent storage of menu setups.

Optional Word Generator Provides Stimulus

Option 49 provides a 16-bit by 250 word, 5 MHz word generator for stimulating or simulating hardware circuits. This option allows the operator to convert 16 of the logic analyzer's input channels to word generator outputs by simply connecting the word generator output probe.

Desired output pattern may be loaded into the word generator memory from user-installed EPROMs, or the operator may use a fixed random pattern supplied in the option. In addition, patterns may be entered from a computer via the optional GPIB interface, by the operator from the front panel keypad, or from non-volatile memory.

RZ, Variable RZ and NRZ Formatted Outputs — The word generator probe offers the convenience of RZ, Variable RZ or NRZ output formats. The Variable RZ feature enables you to vary the width of the output pulse from 0.15 to 10.0 μSec. This allows use as a pulse generator, or 1 bit may be used to simulate RS-232 data.



Optional Word Generator Menu — Data may be outputted in either continuous, single cycle or single word modes for any portion of word generator memory. Words may be loaded from the keyboard, from user ROM or set by an internal subroutine. Words can be set up and edited in any base format, and the output displayed with the main memory data in Hexadecimal or Octal.

Optional GPIB Interface Allows Systems Operation

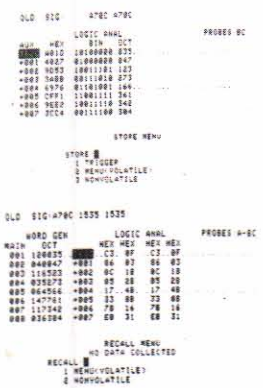
The Option 55 GPIB (IEEE-STD-488) interface provides additional analysis power to the Model 202. From the bus you can set up menus, initiate runs, transfer data, route displays to printers or peripherals, and move any full memory to other mass storage devices.

The interface also allows the display of GPIB messages on the CRT — a useful feature in prompting unskilled operators. When programming, the top line of the CRT can display the incoming GPIB programming string — a convenient means of verifying that the correct string has entered the unit. The GPIB address is shown on the UNIT menu.

Optional Non-Volatile Memory Saves Setup Time and Allows Use by Less Skilled Personnel

When Option 50 is installed, the 202 provides for storage of up to 12 menu setups, 12 word generator 16 x 250-bit output patterns, or 4 complete reference data patterns. The user may add additional EEPROMs to the option board to double the Non-Volatile Memory capacity.

Protective Features Safeguard Your Interests — When operating the Non-Volatile Memory, two protective features are included. For casual protection, a 2-digit hexadecimal password gives you an identifier for entry and prevents another operator from accidentally overwriting or erasing stored information. For permanent protection, a lockable rear panel inhibit switch protects stored information from being changed or erased. Data stored in Non-Volatile Memory is easily recalled. During such transfers the keyboard is inoperable.



Store Features — Mini-menus indicate the type of storage available. For Non-Volatile Memory, a full directory allows you to select the type of data to be stored; e.g., menu setups, word generator setups, or full auxiliary memory. The directory indicates the segments and types of data contained in each. When a specific segment is selected, the display indicates if that area is available. If available, the system allows you to write into or erase that section. Recall of setups or data is accessed via a separate mini-menu.

Self-Diagnostics for System Integrity — A test button calls up several programs to verify integrity of keyboard and LEDs. A more sophisticated test feature, to verify probes and system operation, is available using the rear panel test output.

Full 8- and 16-Bit Microprocessor Support

The Model 202 features 48 channels of synchronous and asynchronous state analysis, 16 channels of timing analysis, and a full array of optional 8-bit microprocessor adapter/disassemblers. The 48 input channels permit display of all address and data lines as well as associated hardware activity. Optional microprocessor probes permit easy connection to the CPU under test. Adapter/disassembler options are available for most popular 8-bit microprocessors and allow disassembly and display of mnemonic codes.

In addition, a full support program is planned for popular 16-bit microprocessors. Because of the increased complexity of today's 16-bit processors, a specific adapter/disassembler is necessary for each 16-bit microprocessor family.

Optional GPIB Analyzer Displays Bus Activity in Waveform Modes — A GPIB Analyzer probe enables the user to interrogate the external GPIB and to display activity in either data or timing format.

Using the internal clock, intervals as short as 100 nSec or periods of as long as several days may be interrogated. The external clock taken off the DAV line gives data compression.

In the waveform mode, data lines, handshake lines and the ATN lines are shown on one page; handshake lines and control lines are shown on a second page. You can move quickly between the display and the normal analyzer display via the display keys.

Logic Analyzers
48 Channel, Configurable
Model 202

Specifications

Signal Inputs

Data Channels/Depth: 48/250
Clocks (Multiplexed): 2
Qualifiers (Clock/Trigger): 2/2
Probes: 3 Variable Threshold
Setup Time (Nominal): 30 nSec
Hold Time: 0 nSec
Maximum Input: ±15 V
Input Impedance: 60 kilohm, ≤12 pF
Logic Complement: Positive or negative

Clocks[1]

Minimum Pulse Width (At Threshold): 25 nSec
Internal Clock: Variable to 10 MHz (100 nSec to 999 Sec)
External Clock (+ or − slope): to 12 MHz (83 nSec)

[1]Valid for data inputs up to 48 channels wide.

Word Generator-Option 49

Size/No. of Words: 16 bits/250
Max. External Clock Rate: 7 MHz
Internal Clock Period: 200 nSec to 999 Sec
External Clock to Data Sync: ≤100 nSec
Data Sync to Word Output: ≤30 nSec
Output Mode: NRZ, RZ, Variable RZ
Variable RZ Ranges: 0.15 to 1.0 μSec; 1 to 10 μSec
Output Drive (Open Collector): I_{OL} = 30 mA

GPIB Interface-Option 55

Operating Modes

Normal Run: Initiates acquisition manually via RUN key
Auto Run: Reinitiates after selectable pause of 0 to 300 Sec
Stop-On-Equals (Stop-On-Not-Equals): Run automatically reinitiates acquisition until data captured in main memory equals (or does not equal) auxiliary memory data.

Data Display Formats: 8-bit or 16-bit groupings selectable in Hexadecimal, Binary, Octal, ASCII, Timing, or Optional Mnemonics

Timing Display

Data Input: Input C (16 channels)
Resolution: 100 nSec maximum
Triggering: Full capability (See triggering specifications)

Triggering

Trigger Modes: Normal with 0—249 pre-trigger words
Trace with 0—16 post-trace words

Sequential Triggering: 1 to 4 levels (with 2 delays)
Delays: 0 to >999,999 clocks or events
Auto-Add Delay: Increments trigger delay on each run
Masking: Available at all trigger/arming levels
Restart: A full width restart word may be entered to reinitialize if restart word is encountered during triggering sequence

Memories

Main: For data acquisition 48 bits x 250 words
Auxiliary: 48 bits x 250 words
Volatile Menu Storage: Stores one extra set of menu setups
Non-Volatile Memory (Option 50): 6K bytes

Time Interval Measurement (Arm 1 to Trigger Word)

Clocks: 1 to 999,999 clock cycles
Time: 100 nSec to 290 hours in three ranges
Resolution: 1 cycle or 0.1 μSec

Compare Features

Modes: Auxiliary to Main memories compare (A/M), Stop-on-Equals (STOP =) or Stop-on-Not-Equals (STOP ≠).

Data Manipulation (Either Main or Auxiliary Memory)

Scrolling: Forward and reverse, single line or continuous
Paging: Forward and reverse, single page or continuous
Locate: Direct access to anywhere in memory
Search: Forward and reverse search to specific search word. Counter displays total search word occurrences in memory.

Auxiliary Outputs

Composite Video: >1.5 volts into 75 ohms
Trace Output: TTL level; goes high within ≈150 nSec when trigger conditions are met
Trigger Outputs: TTL pulse; clock width within ≈150 nSec of clock
Word Generator Sync: TTL pulse, 1 clock width coincident to first output word
Interface: GPIB (IEEE-STD-488)

General

Display: 7 inch (diagonal) CRT
Power Requirements: 100, 120, 200, 240 VAC, ±10%; 45—66 Hz; 150 VA
Operating Temperature: 0°C to +50°C
Storage: −40°C to +70°C
Dimensions: 178H x 427W x 475D mm
(7H x 16.8W x 18.7D inches)
Weight: Approximately 13.6 kg (30 lb)

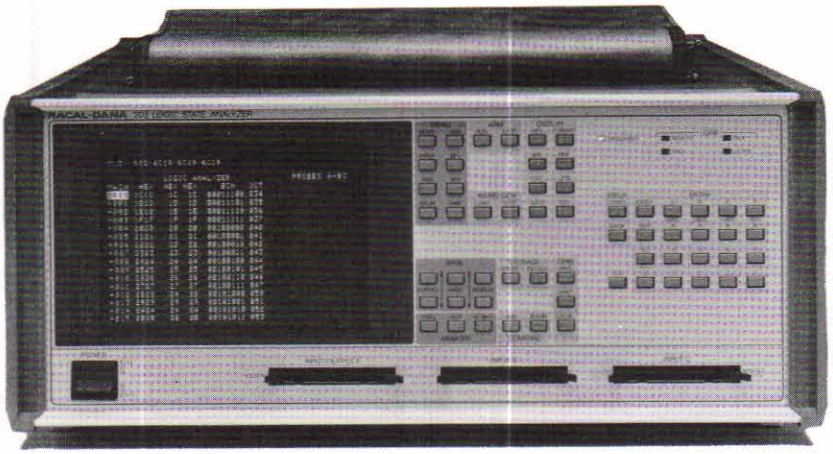
Ordering Information:

Model 202 48 Channel Configurable Logic Analyzer.

Options

49: 16 bit x 250 word, 5 MHz word generator (includes probe)
50: 6k byte Non-Volatile Memory.
55: GPIB (IEEE-STD-488) Interface
04: 50 Hz operation
71: 220/240 V operation
For microprocessor pods and other options, see Logic Analyzer Accessories section.

Logic Analyzers
48-Channel Logic Analysis System
Model 205



Complete Logic Analysis System

The Model 205 provides a total solution to troubleshooting and debugging microprocessor-based designs. It provides 48 input channels plus additional clock and qualifier inputs. This broad input capability allows observation of data, address, and control lines of both 8- and 16-bit microprocessors. 16 channels may be used for timing analysis of associated hardware circuits.

The 205 also provides a 16-channel word generator for applications that require stimulus of either hardware or software designs.

Expanded performance can be achieved by connecting Model 205 to your computer using the GPIB (IEEE-STD-488) interface. This standard interface makes the 205 ideal for ATE applications.

In addition to the above features, the 205 includes a 12 kilobyte Non-Volatile Memory that allows permanent storage of up to 24 complete menu setups, 24 word generator 16×250 bit output patterns, or 8 sets of 48×250 bit reference data.

Powerful Features are Easy-to-Operate

The Model 205 retains much of the operational simplicity of the lower-cost Model 201 even though it provides a full array of additional features. It may be easily operated by less skilled personnel. Use of the Non-Volatile Memory allows the engineer to transfer setup and analysis skills directly to an unskilled operator.

In addition to all of the features described in the introduction, the 205 provides these additional capabilities.

Wide Range of Memory

The Model 205 provides a wider selection of built-in memories than most analyzers. Memories available to the user include:

Setup Storage—A Volatile Memory allows you to store a group of menu setups for recall to return the instrument to a specific setup. This reduces time and effort needed for multiple tests when a slight variation of a basic setup is needed.

Capture Memory—The 205 provides a full 48 channel wide by 250 word deep capture memory. The unique auto-add feature extends the effective use of this memory for capture of long software or firmware programs.

Auxiliary Memory—A full 48-channel by 250-word auxiliary memory is provided for additional storage of captured data. This memory may also be used for reference data storage during "compare" operations.

Non-Volatile EEPROM Memory—Non-Volatile Memory enables storage of large amounts of data, menu setups or word generator setups, and gives full protection against accidental or intentional power interruptions.

Protective Features Safeguard Your Interests—When operating the Non-Volatile Memory, two protective features are included. For casual protection, a 2-digit hexadecimal password gives you an identifier for entry and prevents another operator from accidentally overwriting or erasing stored information. For permanent protection, a lockable rear panel inhibit switch protects stored information from being changed or erased.

Logic Analyzers
48-Channel Logic Analysis System
Model 205

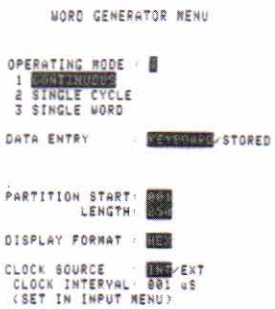
Store Features—Mini-menus indicate the type of storage available. For Non-Volatile Memory, a full directory allows you to select the type of data to be stored; e.g., menu setups, word generator setups, or full auxiliary memory. The directory indicates the segments and types of data contained in each. When a specific segment is selected, the display indicates if that area is available. If available, the system allows you to write into or erase that section. Recall of setups or data is accessed via a separate mini-menu.

Word Generator Provides Stimulus

Model 205 provides a 16-bit by 250 word, 5 MHz word generator for stimulating or simulating hardware circuits. This option allows the operator to convert 16 of the logic analyzer's input channels to word generator outputs by simply connecting the word generator output probe.

Desired output patterns may be loaded into the word generator memory from user-installed EPROMs, or the operator may use a fixed random pattern supplied. In addition, patterns may be entered from a computer via the optional GPIB interface or by the operator from the front panel keypad.

RZ, Variable RZ and NRZ Formatted Outputs—The word generator probe offers the convenience of RZ, Variable RZ or NRZ output formats. The Variable RZ feature enables you to vary the width of the output pulse from 0.15 to 10.0 μSec. This allows use as a pulse generator, or 1 bit may be used to simulate RS-232 data.



Word Generator Menu—Data may be outputted in either continuous, single cycle or single word modes for any portion of word generator memory. Words may be loaded from the keyboard, from user ROM or set by an internal subroutine. Words can be set up and edited in any base format, and the output displayed with the main memory data in Hexadecimal or Octal.

GPIB Interface Allows Systems Operation

The Model 205 features a GPIB (IEEE-STD-488) interface which provides additional analysis power. From the bus you can set up menus, initiate runs, transfer data, route displays to printers or peripherals, and move any full memory to other mass storage devices.

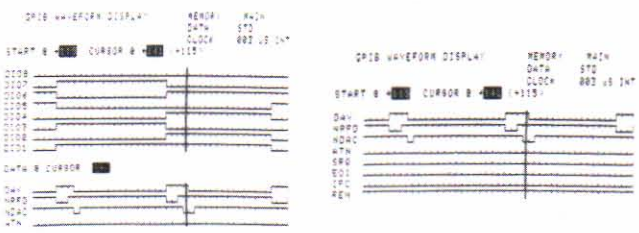
The interface also allows the display of GPIB messages on the CRT—a useful feature in prompting unskilled operators. When programming, the top line of the CRT displays the incoming GPIB programming string—a convenient means of verifying that the correct string has entered the unit. The GPIB address is shown on the UNIT menu.

Self-Diagnostics for System Integrity—A TEST key calls up several programs to verify integrity of keyboard and LEDs. A more sophisticated test feature, to verify probes and system operation, is available using the rear panel test output.

Full 8- and 16-bit Microprocessor Support

The Model 205 features 48 channels of synchronous and asynchronous state analysis, 16 channels of timing analysis, and a full array of optional 8-bit microprocessor adapter/disassemblers. The 48 input channels permit display of all address and data lines as well as associated hardware activity. Optional microprocessor probes permit easy connection to the CPU under test. Adapter/disassembler options are available for most popular 8-bit microprocessors and allow disassembly and display of mnemonic codes.

In addition, a full support program is planned for popular 16-bit microprocessors. Because of the increased complexity of today's 16-bit processors, a specific adapter/disassembler is necessary for each 16-bit microprocessor family.



Optional GPIB Analyzer Displays Bus Activity in Waveform Modes—A GPIB Analyzer probe enables the user to interrogate the external GPIB bus and to display activity in either data or timing format.

Using the internal clock, intervals as short as 100 nSec or periods of as long as several days may be interrogated. The external clock taken off the DAV line gives data compression.

In the waveform mode, data lines, handshake lines and the ATN lines are shown on one page; handshake lines and control lines are shown on a second page. You can move quickly between the display and the normal analyzer display via the display keys.

Specifications

Signal Inputs

Data Channels/Depth: 48/250

Clocks (multiplexed): 2

Qualifiers (Clock/Trigger): 2/2

Probes: 3 Variable Threshold

Setup Time (Nominal): 30 nSec

Hold Time: 0 nSec

Maximum Input: ±15 V

Input Impedance: 60 kilohm, ≤12 pF

Logic Complement: Positive or negative

Clocks[1]

Minimum Pulse Width (At Threshold): 25 nSec

Internal Clock: Variable to 10 MHz (100 nSec to 999 Sec)

External Clock Rate (+ or – slope): to 12 MHz (83 nSec)

[1]Valid for data inputs up to 48 channels wide.

Word Generator

Size/No. of Words: 16 bits/250

Max. External Clock Rate: 7 MHz

Internal Clock Period: 200 nSec to 999 Sec

External Clock to Data Sync: ≤100 nSec

Data Sync to Word Output: ≤30 nSec

Output Mode: NRZ, RZ, Variable RZ

Variable RZ Ranges: 0.15 to 1.0 μSec; 1 to 10 μSec

Output Drive (Open Collector): I_{OL} = 30 mA; (internal pull-up to +5 V)

Operating Modes

Normal Run: Initiates acquisition manually via RUN key

Auto Run: Reinitiates after selectable pause of 0 to 300 Sec

Stop-On-Equals (Stop-On-Not-Equals): Run automatically reinitiates acquisition until data captured in main memory equals (or does not equal) auxiliary memory data. From 1 to 250 words may be selected for comparison

Data Display Formats: 8-bit or 16-bit groupings selectable in Hexadecimal, Binary, Octal, ASCII, Timing, or Optional Mnemonics

Timing Display

Data Input: Input C (16 channels)

Resolution: 100 nSec maximum

Triggering: Full capability (See triggering specifications)

Triggering

Trigger Modes: Normal with 0–249 pre-trigger words
Trace with 0–16 post-trace words

Sequential Triggering: 1 to 4 levels (with 2 delays)

Delays: 0 to 999,999 clocks or events

Auto-Add Delay: Increments trigger delay on each run

Masking: Available at all trigger/arming levels

Restart: A full width restart word may be entered to reinitialize if restart word is encountered during triggering sequence

Memories

Main: For data acquisition, 48 bits × 250 words

Auxiliary: Transferred from Main or used as reference, 48 bits × 250 words

Volatile Menu Storage: Stores one extra set of menu setups

Non-Volatile Memory: 12K bytes

Time Interval Measurement (Arm 1 to Trigger Word)

Clocks: 1 to 999,999 clock cycles

Time: 100 nSec to 290 hours in three ranges

Resolution: 1 cycle or 0.1 μSec

Compare Features

Modes: Auxiliary to Main memories compare (A/M), Stop-on-Equals (STOP =) or Stop-on-Not-Equals (STOP ≠) with field differences highlighted in reverse video.

Data Manipulation (Either Main or Auxiliary Memory)

Scrolling: Forward and reverse, single line or continuous

Paging: Forward and reverse, single page or continuous

Locate: Direct access to anywhere in memory

Search: Forward and reverse search to specific search word. Counter displays total search word occurrences in memory (99 max). All occurrences are highlighted.

Auxiliary Outputs

Composite Video: >1.5 volts into 75 ohms

Trace Output: TTL level; goes high within ≈150 nSec when trigger conditions are met

Trigger Outputs: TTL pulse; clock width within ≈150 nSec of clock

Word Generator Sync: TTL pulse, 1 clock width coincident to first output word

General

Display: 7 inch (diagonal) CRT

Power Requirements: 100, 120, 220, 240 VAC, ±10%; 44 to 66 Hz; 150 VA

Operating Temperature: 0°C to +50°C

Storage Temperature: –40°C to +70°C

Dimensions: 178H × 427W × 475D mm
(7H × 16.8W × 18.7D inches)

Weight: Approximately 13.6 kg (30 lb)

Ordering Information

Model 205: Logic Analysis System
(Includes all necessary Probes, Cables, Micrograbbers)

Options

04: 50 Hz operation

71: 220/240 V operation

For microprocessor pods and adapter/disassemblers, special probes, other options, and accessories, see Logic Analyzer Accessories section.

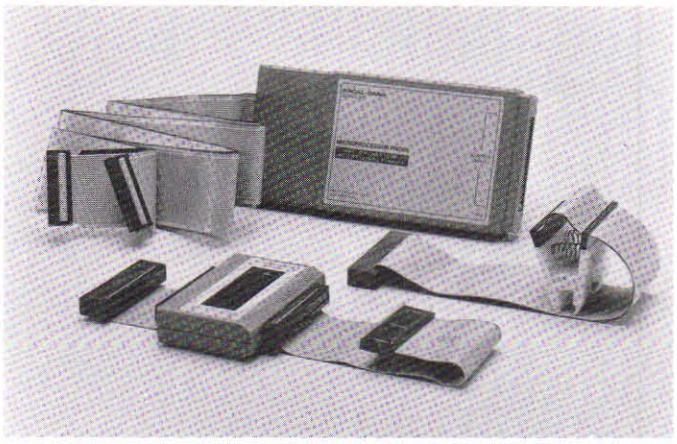
Logic Analyzers
Series 200
Microprocessor Support/Accessories

Microprocessor Type	Adaptor Required	Probe Required	Display			Clock Speed
			State[2]	Mnemonic	Timing	
Z80	—	OPT Z80	X	X	X	MAX
NSC 800	OPT NSC 80	OPT 08	X	X	X	MAX
1802	OPT 07[1]	OPT 08	X	—	X	MAX
6502/65C02	OPT 650A	OPT 08	X	X	X	MAX
6510	OPT 07[1]	OPT 08	X	—	X	MAX
6512	OPT 07[1]	OPT 08	X	—	X	MAX
6800/6802	OPT 68	OPT 08	X	X	X	MAX
6801/6803	OPT 07[1]	OPT 08	X	—	X	MAX
6808	OPT 68	OPT 08	X	X	X	MAX
6809/6809E	OPT 68	OPT 08	X	X	X	MAX
8080/8085	OPT 80	OPT 08	X	X	X	MAX
8031	OPT 07[1]	OPT 08	X	—	X	MAX
8035/8039	OPT 07[1]	OPT 08	X	—	X	MAX
8048/8049	OPT 07[1]	OPT 08	X	—	X	MAX
8051	OPT 07[1]	OPT 08	X	—	X	MAX
8748	OPT 07[1]	OPT 08	X	—	X	MAX
8751	OPT 07[1]	OPT 08	X	—	X	MAX
68000	—	OPT 68K	X	X	X	12.5MHz
68010	—	OPT 68K	X	—	X	12.5MHz

[1]Option 07 (microprocessor adapter) requires custom interconnect
[2]Binary, hex, octal or ASCII

The Series 200 provides a comprehensive array of 8-bit microprocessor support pods and adapters/disassemblers. You can support the majority of common 8-bit microprocessors with direct hardware connection and software disassembly to mnemonics...for what you would expect to pay to support a single microprocessor type.

Option 08—8-Bit Microprocessor Probe—This probe supports most comon 8-bit microprocessors except the Z80. It accepts any of the adapters shown in the above chart to allow direct connection to your target microprocessor.



Adapter/Disassembler Options—The adapter/disassembler options consist of hardware adapters and EPROM-based disassembler software.

The hardware adapters mate with the Option 08 probe to adapt the probe to the specific microprocessor, and also to identify the microprocessor type.

The EPROM disassemblers convert the collected data to mnemonics and set up the appropriate menus.

Option 07—Universal Adapter—This adapter module mates with the Option 08 probe and provides a "breadboard" for wiring customized connections. This is ideal for interconnecting to specialized microprocessors.

Option Z80—Z80 Probe and Disassembler—The Z80 microprocessor requires a dedicated probe/adapter. This option provides complete support for the Z80 and does not require an additional adapter.

Option 48—GPIB Analyzer Probe

A GPIB Analyzer probe enables interrogations of an external GPIB to display activity in either data or timing format. Using the internal clock, intervals as short as 100 nSec or periods as long as several days may be interrogated. An external clock taken off the DAV line gives data compression.

In the waveform mode, data lines, handshake lines and the ATN lines are shown on one page; handshake lines and control lines are shown on a second page.

Glitch Latching Probe—Option 92

The Option 92, Glitch Latching Probe, extends the logic analyzer timing features to allow the capture of random pulses which may occur between clock edges. The sampled data is stored along with the corresponding glitch records. By recording the data and the glitch(es) separately, it is easy to distinguish between single- or multiple-edge valid data transitions and a glitch.

The data may be sampled asynchronously or synchronously and may be displayed as either waveform (timing diagram) information or numerical data, such as binary.

The probe connects to channel C of any Series 200 logic analyzer, and includes clock qualifier, external clock and four data inputs.

The input threshold levels can be preset (TTL compatible) or adjusted between ±5 volts, providing triggering capability for all presently-available logic families.

The probe asserts the logic analyzer trigger qualifier input when a glitch is detected. The trigger qualifier control may now be used to capture only data associated with a glitch condition.

Specifications

Signal Inputs

Data Channels/Depth: 4/250
Clocks
Internal: Selectable from 0.1 μSec to 50 mSec
External: Selectable + or – slope, to 12 MHz
Qualifier Inputs: Clock
Setup Time: 30 nSec (Nominal)
Hold Time: 0 nSec
Maximum Overload: ±15 V
Input Impedance: 60 kilohm/10 pF
Minimum Logic Swing: ±250 mV

Minimum Glitch Data Width: 10 nSec
Trigger Qualifier Output: Goes true when a glitch is detected on any channel

16-Bit Microprocessor Support

68000 Adapter/Disassembler, Model 68K

The Model 68K, 68000 Adapter/Disassembler, which derives its power from the logic analyzer, is used with Models 202 and 205 to display the following modes:

State: Displays all bus information

Software Disassembly: Displays the data in mnemonic format and flags those fetches not already executed.

Cycle Qualifications

Front panel controls allow the following selective data recording modes to maximize effective memory depth.

6800 Bus Cycles Only/All Bus Masters—Allows co-processors and/or DMA data to be collected or ignored.

User/Supervisor—Useful when operating system calls must be monitored or suppressed.

Program/Data—Allows either collection of only program accesses or only data accesses.

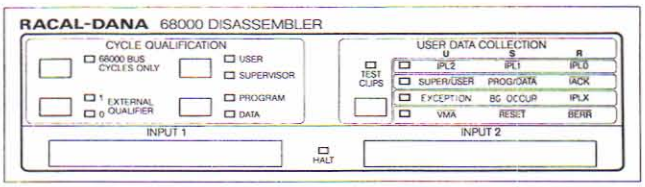
External Qualifier—For external cycle qualification.

Auxiliary Data Collection

Three auxiliary data collection channels are available for connection to external signals, or to four pre-defined groups of 68000 control lines.

Probe

Connection is made by inserting the 68000 microprocessor into a zero-insertion-force socket on the probe. An input cable then connects to the microprocessor socket.



Ordering Information

Options

Z80: Z80 probe/disassembler (Includes probe, EPROM, socket, cables, DIP Clip)
08: 8-bit microprocessor probe[1] (Includes probe, socket, cables, DIP Clip)
92: Glitch Latching Probe (Includes input cable, micrograbbers)
48: GPIB Analyzer Probe (Includes input cable)
60: Rack Mounting Kit
65: Chassis Slide/Rack Mounting Kit
68K: 68000 adapter/disassembler (Includes control unit, probe, cables)

[1]Requires Adapter/disassembler

Adapter/Disassemblers

07: Universal custom adapter[2]
68: 6800/6802/6809 adapter/disassembler[2]
80: 8080/8085 adapter/disassembler[2]
650A: 6502 adapter/disassembler[2]
NSC 80: NSC800 adapter/disassembler[2]

[2]Requires Option 08 8-bit microprocessor probe

Replacement Probes/Cables

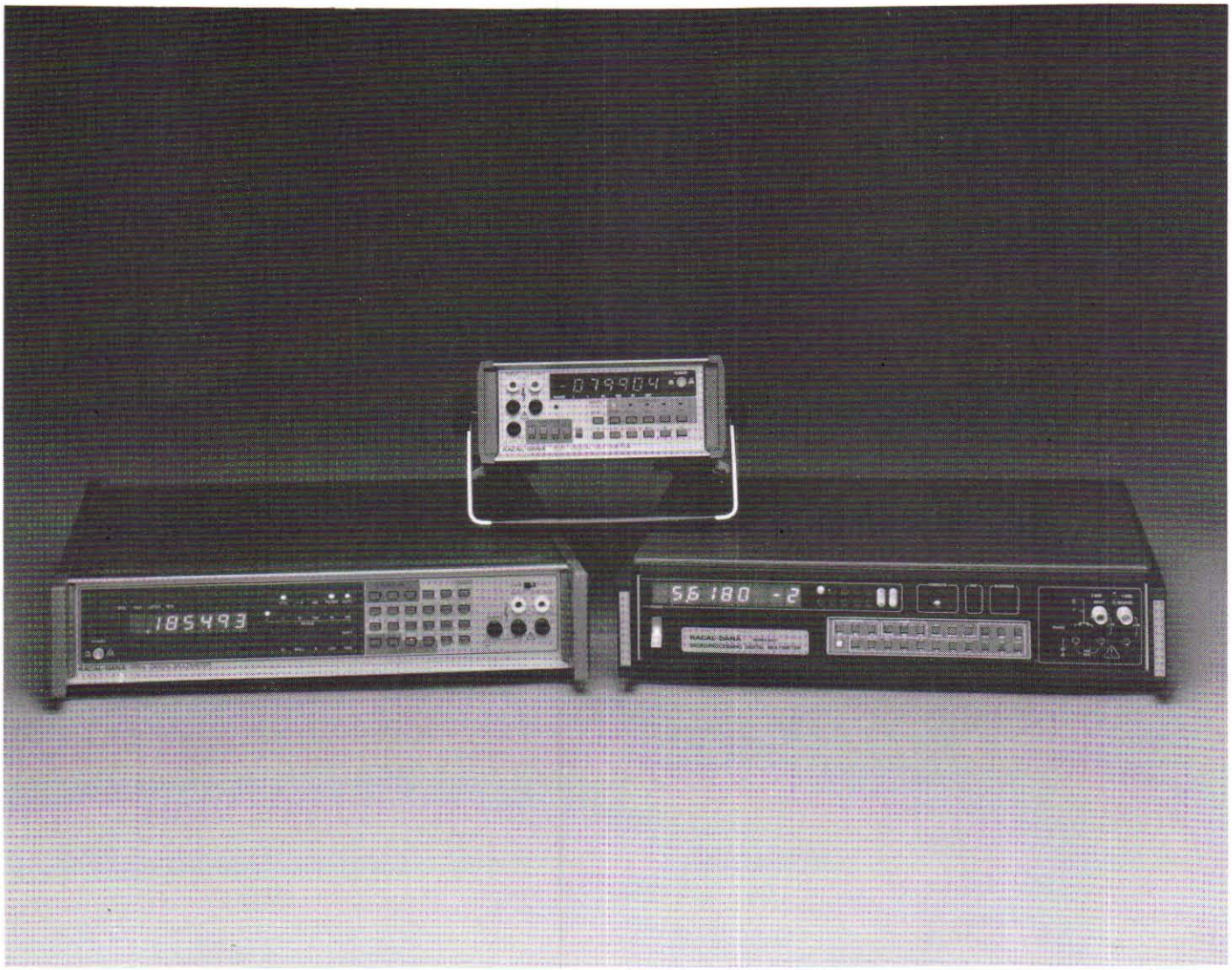
90: Variable threshold Input Probe[1]
91: Fixed TTL Input Probe[2]
404222: Word Generator Probe[3]
404231: Micrograbber Kit (20 micrograbbers)
601070: Input Cable
601100: 40 pin DIP Clip

[1]Furnished as standard with Models 202 and 205
[2]Furnished as standard with Model 201
[3]Furnished as standard with Model 202 Option 49 or Model 205

Accessories

61: Carrying Case
62: Storage/Carrying Case for Probes and Cables
404308: Extender Board Kit
406845: GPIB Cable (1 meter)
406844: GPIB Cable (2 meters)
406846: GPIB Cable (4 meters)

Digital Multimeters
General Information



Introduction

Because of their resolution, speed, and superior accuracy, Digital Multimeters (DMMs) are used in many applications, ranging from field service to the advanced research laboratory. Modern features such as auto-ranging, auto-polarity, and computing capability make the DMM an easy to use, simple to understand, and versatile measurement tool. Human error and tedium are reduced by direct numerical readout, and operator training is minimized by easily understood controls.

In 1963, Racal-Dana introduced the world's first self-contained digital multimeter. This solid-state instrument eliminated the need for separate, expensive AC to DC and Ohms to DC converters. This commitment to innovation has continued to make Racal-Dana a pacesetter in digital multimeter technology. You can obtain a wider range of capabilities than ever before from the current Racal-Dana product line. The modern DMMs shown in this catalog contain such diverse features as hi/lo ohms, battery operation, dB, full programmability, digital calibration, limits, time clock , and high speed digitizers.

Five Bench/Portable Models

Five models are available for your bench and portable applications. The three 4½ digit models in the Series 4000 provide a wide choice of performance and price combinations.

Models 4005 and 5001 provide 5½ digit performance in a portable package. They are ideal for general laboratory and service applications where higher resolutions and accuracies are sometimes needed. All five models are packaged in half rack, portable cases. The convenient handle also serves as a bail for bench use. Battery operation is available on the 4½ digit models.

Eleven Bench/System Models

For your bench and system applications, eleven programmable models are available. These range from the basic Model 5003 digital multimeter to the full feature Series 6000 Amplitude Measurement System . . . and include the Models 5900 and 6900 which have become "industry standards" of performance.

Accepted Worldwide

The repeated use of our DMMs worldwide by system designers testify to the high performance, quality, and reliability you can expect when you purchase a Racal-Dana product. Our digital multimeters have been selected for ATE systems that support such major programs as the Hawk, Rapier, Roland, and Phoenix missiles, and A7, F111, and F16 aircraft. You receive the same quality, reliability and versatile performance when you choose a Racal-Dana DMM for your commercial or in-house systems design.

Full Interface Selection

You may choose exactly the right interface level for your application from our wide selection. Eight models are available with full GPIB (IEEE-STD-488) interface. Three additional models provide a GPIB interface for data output. Eleven models on GPIB give you a wider choice than from any other manufacturer.

Noise Rejection

All Racal-Dana DMMs feature high rejection of noise related to the power frequency. In addition, most of the 5½ digit models feature a switchable filter for use when you encounter broadband noise. For further discussions on measurements with high noise see the technical section of this catalog.

Measurement Speed

The chart below shows the broadband choice of reading rates available. From lower speed bench measurements to high speed system digitizers, you may choose the right speed for your application.

	Maximum Read Rate		
Model	**Manual Reading**	**GPIB**	**Parallel**
4002A, 4003, 4004	≈2/Sec	≈2/Sec	≈2/Sec
4005	4/Sec	—	—
5001	4/Sec	4/Sec	—
Series μ5000[1]	40/Sec[2]	20/Sec[2]	—
5900	3.5/Sec	—	120/Sec[2]
6000	4/Sec	55/Sec[2]	55/Sec[2]
6000/03SH	5/Sec	6000/Sec	34,000/Sec

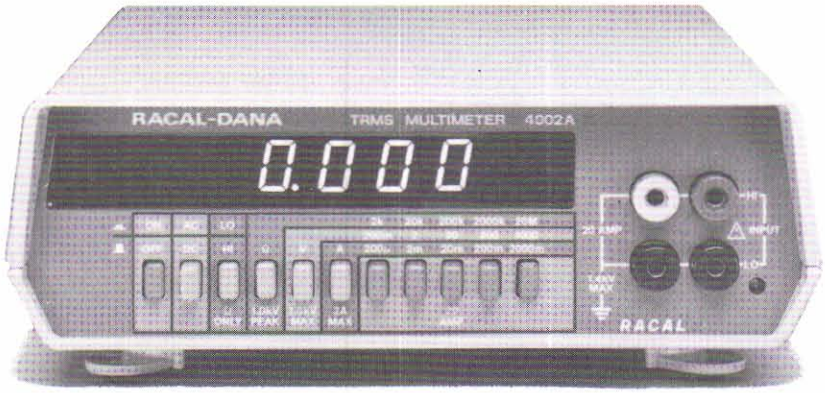
1. In "Time" function, read rate can be progammed from 1/second to 1 reading every 96 hours in 1 second increments.
2. In 4½ digit mode

Digital Multimeter Model Summary

Feature / Model	No. of Digits	Volts		True RMS AC	Current		Ohms	Interface		Auto Range	Sample & Hold HSD*	Battery Operations	AC/AC Ratio	Computing Functions	Time Clock
		DC	AC		AC	DC		GPIB	Parallel						
4002A	4½	X	X	X	X	X	X	OPT	OPT			OPT			
4003	4½	X	X	X	X	X	X	OPT	OPT			OPT			
4004	4½	X	X		X	X	X		OPT	X		OPT			
4005	5½	X	X				X							X	
5000	5½	X	OPT	OPT			OPT		OPT	X					
5001	5½	X	X	X	X	X	X	OPT		X				X	
5002	3½	X	X	X				X		X			X	X	
5003	5½	X	X	X			X	X		X					
5004	5½	X	X	X			X	X		X			GPIB	X	X
5005	5½	X	X				X	X		X			X	X	X
5006	5½	X	X	X			X	X		X			X	X	X
5900	5½	X	OPT	OPT			OPT		OPT	X					
5940	5½	X	X	X			X		X	X			X		
6000	6½	X	OPT	OPT				OPT	OPT	X	OPT		OPT	X	
6001	6½	X	OPT	OPT			X	X	OPT	X	OPT		OPT	X	
6002	6½	X	X	X			X	X	OPT	X	OPT		X	X	
6900	6½	X	OPT	OPT			OPT		OPT	X					

*HSD = High Speed Digitizer; X = Standard Feature; OPT = Option.

Digital Multimeters
4½, 5½ Digit Bench/Portable
Series 4000



TALKER GPIB

Four Models Provide Greater Accuracy for the Price

The Racal-Dana Series 4000 provides a broad choice of accuracy and performance for your portable and bench applications. The Series 4000 offers four models, permitting you to select the precise model for your requirement. Now you can purchase exactly the performance your applications require.

Model 4002A is a five function multimeter featuring true rms measurement on both AC voltage and current. It also offers a 200 millivolt range and GPIB output interface.

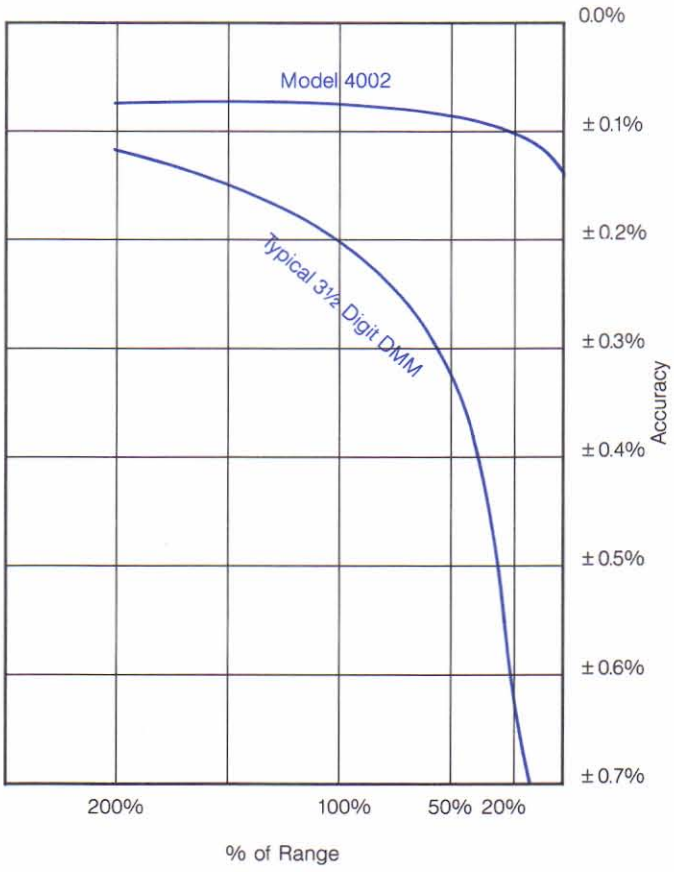
Model 4003 is designed for those applications requiring low level measurements. It features 20 millivolts DC range.

Model 4004 is an autoranging, high accuracy, five function multimeter. It features 4-terminal resistance measurement and full annunciation of functional settings.

Model 4005 provides 5½ digit performance at a price comparable to other 4½ digit multimeters. It offers DC voltage, AC voltage, and resistance measurements. It also features a null function for making offset or drift measurements.

Accuracy vs % Full Scale

The graph illustrates the significant difference in accuracy between a 3½ digit DMM and the Series 4000. Accuracy is guaranteed one full year without recalibration. To reduce calibration time, calibration instructions are provided on the internal shield.



Digital Multimeters
4½, 5½ Digit Bench/Portable
Series 4000

Ultimate Convenience

The Series 4000 is designed for truly convenient operation. Pushbutton range and function selection, bright ½-inch LED readout, and built-in operating instructions assist even the inexperienced with fast completion of measurements. Non-skid feet keep every Series 4000 securely in place. An attached power cord with integral cord wrap means no lost or misplaced pieces.

A 16-position locking handle lets you adjust your instrument for maximum viewing comfort.

Practical Reliability

Conservative design, superior overload protection, and a rugged, high-impact case assure superior performance under adverse conditions.

Series 4000 Model Summary

Feature / Model	Resolution			DC/AC Current	True rms	Battery Option	4 Wire Ohms	Hi/Lo Ohms	Analog Output	Basic Accuracy	No. Digits
	DC Volts	AC Volts	Ohms								
4002A	10 μV	10 μV	0.1 Ω	X	X	X		X		0.05%	4½
4003	1 μV	10 μV	0.001 Ω	X	X	X			X	0.04%	4½
4004	10 μV	10 μV	0.01 Ω	X		X	X	X		0.02%	4½
4005	1 μV	10 μV	0.001 Ω				X			0.005%	5½

X = Standard Feature.

Specifications

DC Voltage

Range		Maximum Reading			Input Resistance		Maximum Input Voltage
Models 4002A, 4004, 4005	Model 4003	Models 4002A, 4003	Model 4004	Model 4005	Models 4002A, 4003	Models 4004, 4005	
—	20 mV	19.999	—	—	10 megohm ±0.1% All Ranges	—	1200 V peak[1]
200 mV	200 mV	199.99	299.99	199.999		>1000 megohm	1200 V peak[1]
2 V	2 V	1.9999	2.9999	1.99999		>1000 megohm	1200 V peak[1]
20 V	20 V	19.999	29.999	19.9999		10 megohm	1200 V peak
200 V	200 V	199.99	299.99	199.999		10 megohm	1200 V peak
1200 V	1200 V	1200.0	1200.0	1200.00		10 megohm	1200 V peak

1. 600 V continuous or 1200 V for 3 seconds

Specification	Model Number		
	4002A/4003	4004	4005
Normal (Series) Mode Rejection	>60 dB	>80 dB	>60 dB
Common Mode Rejection (1 Kilohm unbalance) DC, 50/60 Hz	>120 dB	>120 dB	>120 dB
Settling Time	1 Sec	1 Sec	0.5 Sec

Temperature Coefficients ±(% Reading + No. Digits)/°C

Models / Range	Models 4002A, 4003		Model 4004		Model 4005	
	% Reading	No. Digits	% Reading	No. Digits	% Reading	No. Digits
20 mV	0.006%	0.6	—	—	—	—
200 mV	0.006%	0.6	0.001%	0.1	0.0007%	1.6
2 V	0.006%	0.2	0.001%	0.1	0.0007%	0.2
20 V	0.006%	0.2	0.0015%	0.1	0.0008%	0.2
200 V	0.006%	0.2	0.0015%	0.1	0.0008%	0.2
1200 V	0.006%	0.2	0.0035%	0.1	0.0012%	0.2

Accuracy 1 year ±(% Reading + No. Digits)[1] ±5°C

Models / Range	Model 4002A		Model 4003		Model 4004		Model 4005	
	% Reading	No. Digits	% Reading	No. Digits	% Reading	No. Digits	% Reading	No. Digits
20 mV	—	—	0.04%	2	—	1	—	—
200 mV	0.04%	3	0.04%	1	0.015%	1	0.007%	+3[2]
2 V	0.04%	1	0.03%	1	0.015%	1	0.007%	+2
20 V	0.04%	1	0.03%	1	0.015%	1	0.01%	+2
200 V	0.04%	1	0.03%	1	0.015%	1	0.01%	+2
1200 V	0.04%	1	0.04%	1	0.015%	1	0.01%	+2

1. 1 digit error equals 0.005% of range on all models except 4005, where 1 digit equals 0.0005% of range
2. With zero set by Null function

Digital Multimeters
4½, 5½ Digit Bench/Portable
Series 4000

Resistance

Range				Maximum Reading			Maximum Voltage Across Unknown					
Model 4002A	Model 4003	Model 4004	Model 4005	Models 4002A/4003	Model 4004	Model 4005	Model 4003	Model 4002A		Model 4004		Model 4005
								Lo	Hi	Lo	Hi	
—	20 Ω	—	—	19.999	—	—	5 V	—	—	—	—	—
—	200 Ω	200 Ω	200 Ω	199.99	299.99	199.999	5 V	—	—	0.3 V	—	0.4 V
2 kΩ	2 kΩ	2 kΩ	2 kΩ	1.9999	2.9999	1.99999	5 V	0.2 V	—	0.3 V	3 V	4 V
20 kΩ	20 kΩ	20 kΩ	20 kΩ	19.999	29.999	19.9999	5 V	0.2 V	2 V	0.3 V	3 V	4 V
200 kΩ	200 kΩ	200 kΩ	200 kΩ	199.99	299.99	199.999	5 V	0.2 V	2 V	0.3 V	3 V	4 V
2000 kΩ	2000 kΩ	2 MΩ	2000 kΩ	1999.9	2.9999	1999.99	5 V	0.2 V	2 V	0.3 V	3 V	4 V
20 MΩ	20 MΩ	20 MΩ	20 MΩ	19.999	29.999	19.9999	5 V	—	2 V	0.3 V	3 V	4 V
—	—	200 MΩ	—	—	299.99	—	—	—	—	—	3 V	—

Maximum Input Voltage
Model 4002A: 450 V rms
Model 4003: 350 V peak
Models 4004, 4005: 250 V rms

Configurations
Models 4002A, 4003: 2-wire
Models 4004, 4005: 4-wire or 2-wire

Accuracy ±(% Reading + No. Digits)[1] 1 year ±5°C

Range \ Model	Model 4003	Model 4002A		Model 4004		Model 4005
		Lo Ohms	Hi Ohms	Lo Ohms	Hi Ohms	
20 ohm	0.05% + 3	—	—	—	—	—
200 ohm	0.05% + 2	—	—	0.035% + 1	—	0.012% + 3[2]
2 kilohm	0.04% + 1	0.15% + 15	—	0.035% + 1	0.035% + 1	0.012% + 2
20 kilohm	0.04% + 1	0.15% + 15	0.04% + 1	0.035% + 1	0.035% + 1	0.012% + 2
200 kilohm	0.04% + 1	0.15% + 15	0.04% + 1	0.045% + 1	0.035% + 1	0.012% + 2
2000 kilohm	0.04% + 1	0.15% + 15	0.04% + 1	0.15% + 1	0.05% + 1	0.03% + 2
20 megohm	0.10% + 1	—	0.10% + 1	0.80% + 1	0.18% + 1	0.08% + 2
200 megohm	—	—	—	—	1.5% + 1	—

1. 1 digit error equals 0.005% of range on all models except 0.0005% of range on 4005.
2. With zero set by Null function.

DC/AC Current

Frequency Range
Models 4002A, 4003: 45 Hz to 10 kHz
Model 4004: 50 Hz to 5 kHz

Current Ranges
Model 4002A: 200 μA, 2 mA, 200 mA, 2 A, 20 A
Model 4003: 20 μA, 200 μA, 2 mA, 20 mA, 200 mA, 2000 mA
Model 4004: 200 μA, 2 mA, 20 mA, 200 mA, 2 A

Full Scale Reading
Models 4002A, 4003: 19999
Model 4004: 29999

Fuse Protection
Model 4002A: 2 A, 250 V DC or AC rms (except 20 A range)
Model 4003: 2 A, 250 V DC or AC rms
Model 4004: 3 A, 250 V DC or AC rms

Accuracy ± (% Reading + No. Digits) 1 year ± 5°C

Model / Range	Model 4002A		Model 4003		Model 4004	
	DC	AC[1]	DC	AC[1]	DC	AC[1]
≤ 2A	0.2% + 2	1% + 15	0.2% + 2	0.8% + 15	0.1% + 2	0.3% + 18
20A	0.5% + 2	1% + 15	—	—	—	—

1. Above 2000 counts

AC Voltage

Models 4002A, 4003: True rms
Models 4004, 4005: Average responding calibrated to the rms of a sinewave

Ranges
Models 4002A, 4003, 4004: 200 mV, 2 V, 20 V, 200 V, 1000 V AC rms
Model 4005: 2 V, 20 V, 200 V, 1000 V AC rms

Full Scale Reading
Models 4002A, 4003: 19999
Model 4004: 29999
Model 4005: 199999 (1000 V rms maximum)

Maximum Input: 1000 V rms, sinewave or DC (2×10^7 V•Hz maximum)

Settling Time: Zero to full scale step
Models 4002A, 4003: 2.5 seconds to 0.1% of final reading
Models 4004, 4005: 1.3 seconds to 0.5% of final readings

Input Impedance
Models 4002A, 4003: 1 megohm shunted by 75 pF
Models 4004, 4005: 2 megohm shunted by 50 pF

Common Mode Rejection: 1 kilohm unbalance; DC, 50/60 Hz
Models 4002A, 4003, 4005: > 60 dB
Model 4004: >100 dB

Crest Factor
Models 4002A, 4003: 3:1

Accuracy ± (% Reading + No. Digits) 1 Year ± 5°C

Model / Range	4002A[1]	4003[1]	4004[2]		4005[3]	
	100 Hz-10 kHz		50 Hz - 20 kHz	20 Hz - 50 Hz & 20 kHz - 100 kHz	50 Hz-20 kHz	20 Hz-50 Hz & 20 kHz-100 kHz
200 mV	0.7% + 15	0.5% + 15	0.20% + 6***	1.0% + 20	—	—
2V	0.6% + 15	0.5% + 15	0.20% + 6	1.0% + 20	0.10% + 10	1.0% + 20
20V	0.5% + 15	0.5% + 15	0.20% + 6	1.0% + 20	0.10% + 10	1.0% + 20
200V	0.5% + 15	0.5% + 15	0.20% + 6	1.0% + 20	0.10% + 10	1.0% + 20
1000 V	0.5% + 15	0.5% + 15	0.25% + 6*	1.0% + 20**	0.15% + 10*	1.0% + 20**

1. For readings >2000 counts
2. From 0.3 to 100% of full scale reading
3. For readings >1000 counts

* 50 Hz - 10 kHz
** 20 Hz-50 Hz & 10 kHz-20 kHz
*** With input shorted, display reads approximately 0.2mV

General

Power Requirements
Voltage: 105 to 125 or 210 to 250 V AC switch selected; 90-110 V AC optional. Rechargeable battery pack optional all models except 4005
Frequency: 50 or 60 Hz
Consumption
Models 4002A, 4003: 8 W
Model 4004: 20 VA
Model 4005: 25 VA

Maximum Common Mode Voltage: 1400 V peak

Ranging: Pushbutton control

Display: 0.5 inches LED digits, appropriate decimal position and polarity indication

Temperature Range
Operating: 0°C to +55°C
Storage: −25°C to +65°C

Humidity: 0 to 80% RH up to 35°C

Weight
Models 4002A, 4003: 1.7 kg (4 lb)
Models 4004, 4005: 2.3 kg (5 lb)

Dimensions: 85H x 235W x 275D mm (3.5H x 9.25W x 10.75D inches)

Options

GPIB Interface Option 55T

Applicable Models: 4002A, 4003
Description: Provides output of data only. See GPIB Instrument Section

BCD Output Option 51

Applicable Models: 4002A, 4003, 4004
Description: Provides 4 line per decade parallel BCD output.

Battery Pack Option 06

Applicable Models: 4002A, 4003, 4004
Description: Rechargeable battery pack provides up to six hours operation

Ordering Information

Model 4002A: Five function Digital Multimeter, 4½ digit
Model 4003: High sensitivity Digital Multimeter, 4½ digit
Model 4004: Autoranging Digital Multimeter, 4½ digit
Model 4005: High resolution Digital Multimeter, 5½ digit

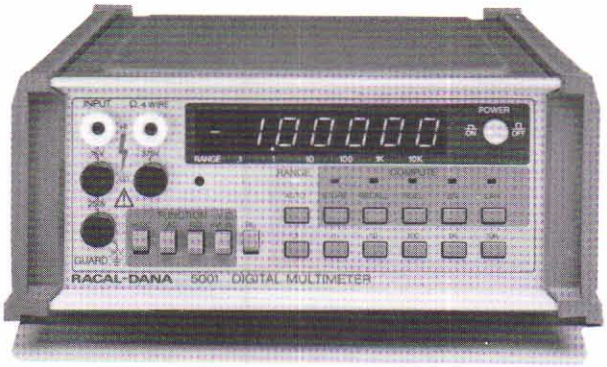
Options

55T*: GPIB interface (talker output) 4002A, 4003
51*: BCD output (4002A, 4003, 4004)
06*: Battery pack (4002A, 4003, 4004)
60: Single rack mount

Accessories—See DMM Accessories

*Instrument will accept only one of these options simultaneously.

Digital Multimeters
5½ Digit Bench
Model 5001



Introduction

Featuring the lowest life cycle cost available in a 5½ digit DMM, the Model 5001 provides those capabilities you most often need in a general purpose bench multimeter.

- True rms AC measurements
- AC and DC current measurements
- 99 megohm resistance measurements
- Switchable analog filter
- Non-recursive digital filter
- Peak readings storage/display
- Averaged measurements—1 to 10,000 samples per average
- Percent deviation measurements
- Null and offset measurements
- Signature analysis for easy maintenance
- Self-test and diagnostics
- Digital calibration
- Automatic 2-wire or 4-wire resistance measurements.

The list goes on and on . . . To see the impact of these features, let's review the benefits you receive when you acquire the Model 5001.

Lower Life-Cycle Costs

It is likely you will more than recover your original investment costs in life cycle savings on the 5001. First, the 5001 saves you time and money during routine calibrations. Our built-in digital calibration reduces calibration time to less than 15 minutes and allows the unit to be calibrated by automatic calibration systems.

Second, our increased use of LSI, microprocessor, and hybrid technology reduces parts count and enhances reliability. The use of these technologies reduces power consumption, saving energy costs and increasing reliability.

Third, this is all backed by a comprehensive built-in test capability. If your unit should ever fail, the defective part can be isolated and repaired within minutes. The 5001's self-test and signature analysis routines assure a low mean time-to-repair (MTTR).

Increased Measurement Capability

The five basic measurement functions of the 5001 can make most of the measurements you are likely to need on your test bench. Five DC voltage ranges, four AC voltages ranges, six resistance ranges, and four ranges each of DC and AC current are standard in every 5001.

All AC voltage and current measurements are made by a true rms AC converter. This true rms converter assures an accurate reading even with distorted waveforms.

A 20 megohm range with 500% overrange allows measurements to be made up to 99 megohm. This allows the 5001 to be used for most resistor testing applications.

New Ease of Use Features

The 5001 combines the power of the microprocessor with broad measurement functions to provide ease of use.

Automatic 4-Wire Ohms. A new automatic 2-wire/4-wire resistance mode eliminates the tedious effort of attaching (or unattaching) shorting links. To transfer from 2-wire to 4-wire measurements, simply connect the sensing leads. The 5001 automatically switches to the 4-wire measurement mode.

Real-value or Percentage Deviation. The microprocessing power of the 5001 enhances your ability to measure drift, tolerance deviations, and power supply regulation. The NULL and % modes can be used to "null out" the basic value and measure only the deviation from norm. This deviation can be displayed in real value or as a percentage of norm. For example, to test the regulation of a power supply, simply measure the output voltage with the 5001, press NULL, and all future 5001 measurements will indicate change in the power supply output.

Averaged Measurements. When you are measuring a voltage, resistance, or current that is drifting, you may wish to take the average of multiple samples. The LAH function of the 5001 allows the average mode to be continuously displayed and updated at the end of each sample group. The 5001 allows up to 9999 samples to be averaged for each updated reading. Random drifts can be averaged out of the results when monitoring long term stabilities.

Peak Storage and Display. The LAH feature may also be used to capture, store and display positive and negative peak readings. The average mode may be used, for example, to measure long term drift while the LAH mode captures the highest and lowest readings (peak-to-peak short term drift) for later recall.

Better Noise Rejection

Six features combine to give the 5001 the best noise immunity of any comparable DMM.

Switchable Analog Filter. The single pole, low pass analog filter provides broadband noise rejection.

Integrating A/D Converter. The charge-balance integrator circuit has automatic noise rejection at multiples of the power frequency. This integrating design provides a combination of fast settling and good noise rejection.

Specifications

DC Voltage

Ranges: 0.2, 2, 20, 200, 1000 volts

Resolution: 0.0005% range (1 μV on 0.2 V range)

Full Scale Reading: 199999, except 1000 V range 1000.00

Input Impedance

0.2, 2 V ranges: ≥1,000 megohms

20, 200, 1000 V ranges: ≥10 megohms

Normal (Series) Mode Rejection

Unfiltered: ≥60 dB at 50 Hz and 60 Hz

Filtered: ≥75 dB at 50 Hz and 60 Hz

Common Mode Rejection (1 kilohm unbalance): 120 dB at 50 Hz and 60 Hz, 140 dB at DC

Accuracy: ±(% Reading + No. Digits)[1]

Range	24 Hours ±1°C		1 Year ±5°C		Temperature[2] Coefficient	
	% Reading	No. Digits	% Reading	No. Digits	% Reading	No. Digits
0.2 V	0.007	3	0.02	6	0.0008	3
2.0 V	0.007	3	0.01	6	0.0008	0.5
20 to 1000 V	0.007	3	0.02	6	0.0013	0.5

1. After null in 0.2 V range.
2. ±(% Reading + No. Digits)/°C

Resistance

Ranges: 0.2, 2, 20, 200, 2000, 20,000 kilohm

Maximum Reading: 99 megohm on 20,000 kilohm range

Maximum Input Voltage: 375 V DC or peak AC

Voltage Across Unknown: 5 V maximum

Accuracy: ±(% Reading + No. Digits)[3]

Range	1 Year ±5°C		Temperature Coefficient[1]	
	% Reading	No. Digits	% Reading	No. Digits
20 to 200 kilohm	0.02%	5	0.004%	0.5
0.2 kilohm	0.02%	6	0.0035%	5
20,000 kilohm[2]	0.06%	5	0.01%	0.5

1. ±(% Reading + No. Digits)/°C
2. Above 20,000 kilohm, accuracy = ±1% of reading
3. After Null

Fully Guarded Operation. The 5001 is a fully guarded design offering improved common mode rejection and shielding against RFI and EMI effects.

Non-Recursive Digital Filter. The four reading, non-recursive filter automatically reduces low frequency and digitizer noise. To maintain fast response, this filter automatically resets when large excursions are detected.

Digital Averaging. The LAH function may be used to reduce by digital averaging the effects of long term, sub-hertz noise and drift.

Full Metal Case. The 5001 is packaged in a completely metal case to assure immunity to large RF or magnetic radiations. This case, combined with proper use of the other noise rejection features, allows the 5001 to be used in the presence of large RFI or EMI fields.

All these features are designed to give you the best performance and lowest ownership costs available.

AC Voltage

Type: True rms

Ranges: 2, 20, 200, 750 V AC rms

Input Impedance: 1 megohm shunted by 100 pF

Maximum Input Voltage: 1100 V peak, 750 V rms to 8 kHz, (6×10^6 V•Hz maximum)

Common Mode Rejection (1 kilohm unbalance): ≥60 dB, DC to 60 Hz

Crest Factor: 4:1 at full scale

Accuracy: ±(% Reading + No. Digits)

Frequency	1 Year ±5°C		Temperature[1] Coefficient	
	% Reading	No. Digits	% Reading	No. Digits
45 Hz to 10 kHz	0.5%	150	0.02%	10
10 kHz to 20 kHz	0.75%	180	0.02%	10

1. ±(% Reading + No. Digits)/°C

DC/AC Current

Ranges: 2, 20, 200, 2000 mA DC or AC rms

Resolution: 4½ digits—0.005% (0.1 μA on 2 mA range)

Maximum Voltage Burden: ≤0.3 V

Maximum Current: 2 A, fuse protected

Accuracy: ±(% Reading + No. Digits[1]), 1 Year ±5°C

Range	DC		AC 45 Hz to 1 kHz	
	% Reading	No. Digits	% Reading	No. Digits
2 to 200 mA	0.2%	2	0.7%	15
2000 mA	0.4%	3	1.0%	15
Temperature Coefficient[2]	0.01%	0.3	0.3%	1

1. 4½ digit display. 1 digit equals 0.005% of range
2. ± (% Reading + No. Digits)/°C

Digital Multimeters
5½ Digit Bench
Model 5001

Computing Functions

LAH

Description: Stores the lowest, highest, and average of N readings.

N: Keyboard selected from 1 to 9,999 readings

Display: Keyboard selected to continuously display present, lowest, highest, or average readings.

Percent Deviation

Description: Asserts the formula:

$$\text{Display} = \frac{X - C}{C} \times 100;$$

where X = measured value, and C = value stored as a constant. The constant may be either a present reading or a value entered from the keyboard.

Null

Description: A single pushbutton allows any reading to be stored as a zero offset. This allows lead resistance, system thermal voltages, or other inputs to be nulled.

GPIB Interface—Option 55T

Description: Provides GPIB compatible output. May be operated as talk only or addressable talker.

General

Filter

Description: Switchable single pole filter provides 20 dB rejection at 55 Hz.

Settling Time: 400 mSec on DC volts and 0.2 to 200 kilohm ranges. 1 Sec on 2000 kilohm, and 3 Sec on 20,000 kilohm ranges.

Environmental Conditions

Operating Temperature: 0 to +50°C

Storage Temperature: −40°C to +70°C

Humidity: 80% RH at 25°C

Power Requirements

Voltage: 100, 120, 220, or 240 VAC ± 10%

Frequency: 50/60 Hz

Consumption: 25 watts

Dimensions: 89 H x 216 W x 343 D mm
(3.5 H x 8.5 W x 13.5 D inches)

Weight: 4.5 kg (10 lb)

Ordering Information

Model 5001: Autoranging 5 Function Digital Multimeter

Options

04: 50 Hz operation

55T: GPIB interface

60: Rack mounting adapters

71: 220/240 volt operation

Accessories

404269: Signature Analysis Troubleshooting Adapter

See DVM Accessories

Digital Multimeters
4½, 5½ Digit Bench/System
Series μ5000

The Workhorse Series

The Series μ5000 has been designed to provide a state-of-the-art series of digital multimeters featuring those capabilities you have requested most often.

The marriage of standard off-the-shelf LSI circuits, Racal-Dana designed LSI, and microprocessor circuits provides a series of multimeters whose price/performance ratio is the best available. Key operational features that enhance the measurement power of the DMM, ease of operation, simple programming, and economical price make the Series μ5000 your best DMM buy.

Full GPIB System Features

All μ5000 models include full GPIB interface as a standard feature. Fully compliant to IEEE-STD-488-1978, the Racal-Dana GPIB provides the highest level of all applicable subsets. This assures ease of use in your system.

Fully guarded operation, automatic time-outs, and five trigger modes assure a full performance system voltmeter.

Choice of Capability

The Series μ5000 contains four models offering a broad range of capabilities. Now it is possible to match your requirements without sacrificing performance or paying for features you don't need.

Microprocessor-Enhanced Performance (MEP)©

Models 5004, 5005, and 5006 contain the unique Racal-Dana MEP© features. The power of the microprocessor has been used to improve and enhance the measurement power of the μ5000. To assure simplicity of operation, complicated "calculator" functions have been replaced by functional controls. These features include null, offset, percent deviation, LAH, time and buffer memory.

Null—A single pushbutton allows any present reading to be stored as a zero offset. This allows lead resistance, system thermal voltages, or other inputs to be nulled.

Offset—Allows any value to be stored from the numeric keyboard as a zero offset to be subtracted from future measurements.

Percent Deviation—Pushing this button asserts the formula:

$$\text{Display} = \frac{(X—C)}{C} \times 100;\ \text{where } X = \text{measured value,}$$

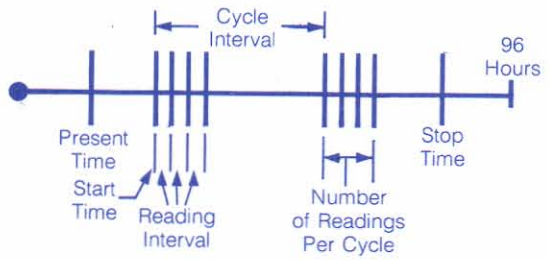
and C = value stored as a constant. The constant may be either a present reading or a value entered from the numeric keyboard.

Low/Average/High—Racal-Dana's LAH function allows the μ5000 to capture and store the lowest, highest, and average of all readings taken in a series of measurements. These values are available for recall either from the front panel or through the GPIB interface.

Through use of a scrolling technique from the front panel (or directly from the GPIB interface) a low peak, high peak, or average mode may be selected. The μ5000 will then update the display or output data only when a new peak or average is available. The average mode may be used for digital filtering or smoothing.

Time—This function allows the μ5000 to operate "off-line", under control of the internal time clock. Models 5004, 5005, and 5006, contain this 96-hour elapsed time clock. In addition to displaying elapsed time, the clock may be used to control the measurement timing. The time line on the following page highlights the broad control capability of this clock.

Digital Multimeters
4½, 5½ Digit Bench/System
Series μ5000



Buffer Memory

Internal RAMs allow storage of up to 120 readings. When combined with the time function, this allows unattended or off-line operation with data retrieval at the end of the measurement sequence.

This feature also may be used for storage of measurement setups. Up to 10 complete instrument configurations may be stored. These setups may then be recalled by front panel pushbutton or by two character program commands. This will significantly reduce the amount of time required to program the μ5000 during real time operation.

Digital Calibration

The Digital Calibration concept allows the Models 5003 and 5004 to be completely calibrated without any internal adjustments. All calibration constants are stored in non-volatile memory. To calibrate, simply set to "cal" mode, connect to your house standards, and press the appropriate front panel pushbuttons to correct for any errors.

Calibration Over GPIB

The μ5000 carries the Digital Calibration concept forward to allow for automatic calibration. When using an automatic calibration system, appropriate GPIB commands may be substituted for the front panel pushbutton operations.

Due to the wide bandwidth on the AC Voltage function of Models 5005 and 5006, the Digital Calibration techniques apply only to the DC Volts and Ohms functions of these models.

Switchable Filter

The Series μ5000 provides a 3-pole active filter which may be selected, when required, for increased broadband noise rejection. The basic integrating design provides a high level of rejection of power (mains) related noise frequencies.

Two Resolution Modes/Read Rates

The μ5000 provides 5½ and 4½ digit resolution modes. The 5½ digit mode provides maximum resolution and a read rate of 4 readings per second. (3.3/second at 50 Hz). For faster measurement speed, the 4½ digit mode provides ten times faster internal read rate and an externally triggered speed of 20 readings per second (18/second at 50 Hz).

Series μ5000 Model Summary

Feature / Model	DCV	Ohms	AC Volts: 20 Hz[1]–20 kHz True rms	AC Volts: 10 Hz–300 kHz True rms	AC Volts: 10 Hz–1 MHz[2] High Accuracy	Parallel Front/Rear Input	Switchable Front/Rear Input	MEP©	Digital Calibration: Total	Digital Calibration: Partial	GPIB	Ratio
5003	X	X	X			X			X		X	
5004	X	X	X				X	X	X		X	ON GPIB
5005	X	X			X	X		X		X	X	X
5006	X	X		X		X		X		X	X	X

X = Standard Feature
1. Unspecified below 45 Hz
2. Unspecified above 250 kHz

Specifications

DC Voltage

Ranges: 0.1 V, 1 V, 10 V, 100 V, 1 kV

Resolution: 0.001% of range in 5½ digit mode
(1 μV on 0.1 V range)
.01% of range in 4½ digit mode
(10 μV on 0.1 V range)

Overrange: 100%

Maximum Input Voltage: ±1000 V DC or peak AC

Input Impedance

0.1 V to 10 V ranges: ≥1000 megohms

100 V, 1000 V ranges: 10 megohms

Normal (Series) Mode Rejection

Filtered: 95 dB at 60 Hz
(90 dB at 50 Hz with Option 04)

Unfiltered: 60 dB at 60 Hz
(50 Hz with Option 04)

Settling Time (Up to 10 kilohm source)

Filtered: 470 mSec to within 10 digits of final value

Unfiltered

1 V, 10 V ranges: 5 mSec to within 10 digits of final value

0.1 V, 100 V, 1000 V ranges: 10 mSec to within 20 digits of final value

Common Mode Rejection: (Up to 1 kilohm imbalance either lead)
140 dB at DC
120 dB at 60 Hz (50 Hz with Option 04)

DC Voltage

Accuracy ±(% Input + No. Digits) 5½ digit mode (after digital-zero command)

Range	24 Hours, 23°C ± 1°C		6 Months, 23°C ± 5°C		Temperature Coefficient 0°C to 50°C ±(% Input + No. Digits) /°C	
	% Input	No. Digits	% Input	No. Digits	% Input	No. Digits
1 V	0.007%	3	0.01%	6	0.0003%	1
All Other Ranges	0.007%	3	0.02%	6	0.0003%	1

Resistance

Type: 2-wire or 4-wire

Ranges: 0.1, 1, 10, 100, 1000, and 10,000 kilohm

Resolution: 0.01% of range in 4½ digit mode
(10 milliohms in 0.1 kilohm range)

Maximum Input Voltage: 375 V DC or peak AC

Open Circuit Voltage: −6 V DC maximum

Current Through Unknown:

Range	Approximate Current
0.1 kΩ	10 mA
1 kΩ	1 mA
10 kΩ	100 μA
100 kΩ	10 μA
1000 kΩ	1 μA
10,000 kΩ	100 nA

Settling Time

Filtered: 500 mSec to within 10 digits of final value

Unfiltered

0.1 to 100 kilohm ranges: 30 mSec to within 10 digits of final value

1000 kilohm range: 40 mSec to within 10 digits of final value

10,000 kilohm range: 300 mSec to within 10 digits of final value

Accuracy ±(% Input + No. Digits) 5½ digit mode (after digital-zero command)

Kilohm Range	24 Hours, 23°C ± 1°C		6 Months, 23°C ± 5°C		Temperature Coefficient 0°C to 50°C ±(% Input + No. Digits) /°C	
	% Input	No. Digits	% Input	No. Digits	% Input	No. Digits
0.1 to 1000	0.03%	5	0.1%	10	0.01%	2
10,000	0.03%	5	0.1%	10	0.015%	2

AC Voltage—Models 5003, 5004

Conversion Type: True rms

Ranges: 1, 10, 100, 750 V rms

Resolution: 0.001% of range in 5½ digit mode
(10 μV in 1 V range)
0.01% of range in 4½ digit mode
(100 μV in 1 V range)

Maximum Input Voltage: 1100 V peak
(750 V rms sinewave)

Input Impedance: 1 megohm in series with .22 μF, shunted by less than 100 pF

Crest Factor: 4:1 at full scale

Settling Time
(To within 100 digits of final value)

	"Filter" Out	"Filter" In
Zero to Full Scale	250 mSec	350 mSec
Full Scale to 10% FS	250 mSec	350 mSec

Accuracy ±(% Input + No. Digits) 5½ digit mode (after digital-zero command)

Frequency	24 Hours, 23°C ± 1°C		6 Months, 23°C ± 5°C		Temperature Coefficient 0°C to +50°C ±(% Input + No. Digits) /°C	
	% Input	No. Digits	% Input	No. Digits	% Input	No. Digits
45 Hz to 10 kHz	0.3%	80	0.5%	100	0.02%	20
10 kHz to 20 kHz	0.5%	100	0.75%	150	0.02%	20

Digital Multimeters
4½, 5½ Digit Bench/System
Series μ5000

AC Voltage High Accuracy Sinewave—Model 5005

Conversion Type: Average responding calibrated to rms of sinewave

Ranges: 1 V, 10 V, 100 V, 1000 V rms

Resolution: 0.001% of range in 5½ digit mode
0.01% of range in 4½ digit mode

Maximum Input Voltage: 1000 V rms from 30 Hz to 10 kHz decreasing linearly to 100 V rms at 100 kHz.
100 V maximum above 100 kHz with maximum volt•Hz product of 2×10^7

Input Impedance: 1 megohm shunted by 200 pF

Settling Time: 400 mSec to within 0.1%

Common Mode Rejection: 80 dB at 60 Hz with 100 ohm unbalance in either lead

Accuracy ±(% Input + No. Digits)

Frequency	6 Months, 23°C ± 5°C		Temperature Coefficient ±(% Input + No. Digits/°C)	
	% Input	No. Digits	% Input	No. Digits
30 Hz to 50 Hz (Filtered)	0.2%	20	0.01%	2
50 Hz to 30 kHz	0.1%	20	0.01%	2
30 kHz to 100 kHz	0.15%	20	0.05%	5
100 kHz to 250 kHz*	1.0%	100	0.05%	5

*to 100 V maximum

AC Voltage Wide Bandwidth True rms—Model 5006

Conversion Type: True rms

Ranges: 1 V, 10 V, 100 V, 1000 V rms

Resolution: .001% of range in 5½ digit mode
(10 μV in 1 V range)
.01% of range in 4½ digit mode
(100 μV in 1 V range)

Maximum Input Voltage: 1000 V rms or 1500 V peak decreasing to 20 V rms at 1 MHz. 2×10^7 V•Hz maximum

Input Impedance (AC Coupling): 1 megohm ±0.1% in series with 0.22 μF, shunted by <200 pF

Crest Factor: 7:1 at full scale

Common Mode Rejection (100 Ω imbalance): 80 dB, DC and 60 Hz (50 Hz with Option 04)

Settling Time: (To within 10 digits of final value)
Zero to Full Scale: 400 mSec
Full Scale to 10% FS: 400 mSec

Temperature Coefficient ± (% of Input + No. Digits) /°C

Coupling Mode	% Input	No. Digits
AC	0.005%	3
AC & DC	0.005%	5

Accuracy[1]: Sinewave, AC coupled[2], 0.1% to 200% of range, ±(% Input + No. Digits)

Frequency	24 Hours, 23°C ± 1°C		90 Days, 23°C ± 5°C		6 Months, 23°C ± 5°C	
	% Input	No. Digits	% Input	No. Digits	% Input	No. Digits
10 Hz to 20 Hz (Filtered)	2.0%	30	2.0%	50	2.0%	60
20 Hz to 30 Hz (Filtered)	0.5%	30	0.5%	50	0.5%	60
30 Hz to 50 Hz (Filtered)	0.25%	30	0.25%	50	0.25%	60
50 Hz to 20 kHz	0.09%	30	0.11%	50	0.12%	60
20 kHz to 50 kHz	0.09%	90	0.1%	100	0.14%	130
50 kHz to 100 kHz	0.38%	180	0.4%	200	0.6%	300
100 kHz to 300 kHz	3.0%	500	3.0%	500	4.0%	1000
100 kHz to 300 kHz (1 V range)	5.0%	1000	5.0%	1000	6.0%	2000

1. For >500 volts, add 0.1% of reading.
2. For AC + DC, add 20 digits.

Maximum Read Rate (Readings per Second)

Resolution / Trigger Mode	4½ digits		5½ digits	
	50 Hz	60 Hz	50 Hz	60 Hz
Internal	33	40	3.3	4
External or GPIB	18	20	3.3	4

High Speed Mode

Number of Digits: 4½

Normal (Series) Mode Rejection: Same as 5½ digit mode

Accuracy: Same as 5½ digit with number of digits ÷ 10, or ±(0.01% reading + 3 digits) whichever is greater.

Ratio — Models 5005, 5006

Modes: DC/DC, Ω/DC, AC/DC, DC/AC, AC/AC, Ω/AC

Accuracy: ±(Signal accuracy + reference acuracy) × $\frac{RR}{RI}$

where RR = Reference Range
RI = Reference Input

Reference Ranges: Same as Normal AC and DC voltage ranges, including autorange

GPIB Interface

Subset Capability: AH1, DC1, DT1, E1, L4, LE0, PP0, RL1, SH1, SR1, T5, TE0

Handshake Time:
Programming Data (Average): 400 μSec/character
Output Data (Average): 130 μSec/character
Universal Commands: 12 μSec

Output Format: ±D.DDDDDE±DDCRLF

General

Maximum Common Mode Voltage: 1000 V peak or DC, guard to case. 250 V peak or DC, Analog common to guard.

Ranging: Manual and Autorange Standard. Upranges at approximately 225% of range: downranges at approximately 20% of range.

Display: 5 full decades plus overrange digit in 5½ digit mode. 4 full decades plus overrange digit in 4½ digit mode.

Overrange Indication: Indicates OL in display

Reading Indicator: LED illuminated while DMM is taking reading

Temperature Range
Operating: 0°C to + 50°C
Storage: −40°C to + 70°C

Humidity
Operating: <75% RH 0°C to + 40°C
<50% RH +40°C to +50°C
Storage: 80% RH

Shock/Vibration: Meets Class 4 requirements of MIL-T-28800C

Cooling: Convection

Power Requirement
Voltage: 100, 120, 220, or 240 V AC ± 10%
Frequency: 50 or 60 Hz
Consumption: 25 watts maximum

Dimensions
Models 5003, 5004: 89 H x 427.0 W x 475.0 D mm (3.5 H x 16.8 W x 18.7 D inches)
Models 5005, 5006: 89 H x 427.0 W x 345 D mm (3.5 H x 16.8 W x 13.6 D inches)

Weight
Models 5003, 5004: 5.7 kg (12.5 lb)
Models 5005, 5006: 7.0 kg (15 lb)

Ordering Information

Model 5003: Digital Multimeter with GPIB

Model 5004: Digital Multimeter with MEP© and GPIB

Model 5005: Digital Multimeter with MEP©, GPIB, ratio and high accuracy sinewave AC.

Model 5006: Digital Multimeter with MEP©, GPIB, ratio and wide bandpass true rms AC.

Options

04: 50 Hz operation

71: 220/240 V operation

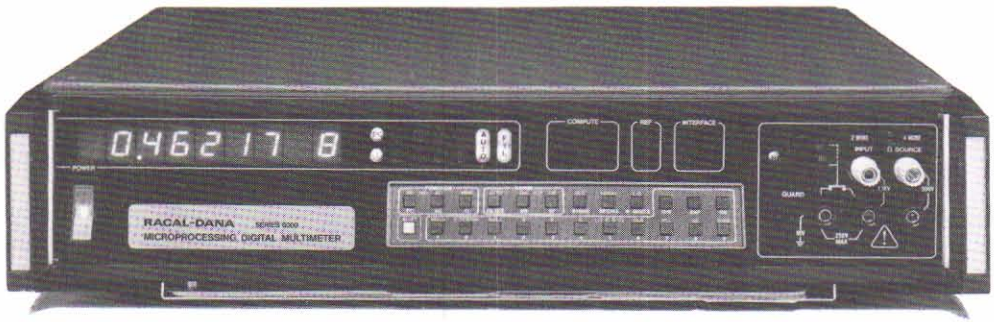
60: Rack mounting adapters

65: Chassis slides/rack mounting adapters

Accessories

See DMM Accessories

Digital Multimeters
Amplitude Measurement System
Series 6000



Introduction

We refer to the Series 6000 as an Amplitude Measurement System because it's so unique that descriptions such as Microprocessing DVM or Smart Digital Multimeter are no longer adequate.

In the 6000, we have combined highly stable analog technology with a microprocessor. The result is an instrument with features previously available only in expensive ATE systems.

The Series 6000 provides new measurement capabilities to both bench and systems users of amplitude measurement devices such as digital multimeters, A/D converters, high speed voltmeters, resistance bridges, AF voltmeters and peak-reading voltmeters.

It is specifically designed to meet these critical cost/performance considerations:

1. Reduced operator costs
2. Reduced calibration and maintenance expense
3. Reduced equipment downtime
4. Reduced engineering costs
5. Improved overall measurement accuracy and capability
6. Reduced equipment costs

Reduce your Operator Costs

Several unique features work together in the Series 6000 to allow faster testing, automatic testing and the use of less skilled operators.

Easy-to-Use Keyboard. An easy to use keyboard allows the Series 6000 to be set up and operated by even an inexperienced operator.

Results of Measurement Shown In High Level Units of Measure. Many voltage or resistance measurements are made only to be further calculated into high level units of measure such as temperature, strain, weight, gain, attenuation, deviation, etc. By combining features such as null, dB, mathematical scaling, and ratio; the Series 6000 will display the results of most measurements directly in the desired unit of measure. This eliminates the need for costly and time consuming operator calculations.

Internal Switching. The Series 6000 is provided with switchable (and programmable) front and rear inputs. This allows measurements from two different locations without requiring a skilled operator to move the input connections.

Automatic Recording Min/Max/Average. The Series 6000 may be operated unattended and, upon command, will display the minimum and maximum readings, the average of all readings (to 10,000 readings) and the number of readings taken. This eliminates the need for a full-time operator.

Built-in Memory. Not only will the Series 6000 remember the minimum and maximum for a series of readings, but it can be used to store up to 9 values for later recall. This reduces the need for logging of intermediate data.

Reduce Your Calibrations, Maintenance Costs and Equipment Downtime

The Series 6000 is built around a totally new concept of calibration and maintenance. No other digital multimeter can offer these combined features to reduce your equipment downtime and cut your maintenance and calibration expense. This concept can be summarized into four features.

Digital Calibration. You can calibrate the standard DC voltage and ohms functions of the Series 6000 automatically from the front panel without removing any covers. Digital correction factors are stored for these functions and ranges. You never have to worry about these correction factors because they are stored in EAROM and remain valid even when the power is off. They require no batteries that fail or potentiometers that change.

This exclusive feature reduces calibration time and expense to a minimum. Combined with guaranteed one year specification validity, this provides one of the lowest calibration costs possible.

ECM—Exchangeable Cal-Module. Applications in systems, production test, incoming inspection, QA, and R & D are far more efficient with an instrument that's

"on-the-job", and not "in-for-calibration." The exclusive Exchangeable Cal-Module allows complete on-site calibration of all standard functions and ranges. Simply replace the ECM with a recently calibrated one. This eliminates the need to send the entire unit away. Spare ECMs for use as exchange modules are available as an option.

Using the ECM, calibration downtime can be reduced to less than 3 minutes. The Exchangeable Cal-Module may be calibrated digitally in the calibration laboratory by inserting it into a Series 6000 Calibration Test Assembly or another Series 6000.

Non-Volatile Calibration. Since circuits that affect calibration traceability are contained inside the Exchangeable Cal-Module, other circuits may be repaired or replaced without invalidating the calibration certification. Most circuits are on plug-in assemblies and can be exchanged with minimal downtime.

Combining the ECM and the Non-Volatile Calibration concepts, the Series 6000 may never need to leave your system or bench.

Predictive Maintenance. Using the exclusive Auto-Test/Auto-Cal feature, the Series 6000 can actually predict many common types of failures before they affect the operation or accuracy of the measurement. The Auto-Test routine compares values within the Series 6000 to limits stored during manufacture in non-volatile read-only memory (ROM).

Each of these values is compared to two sets of limits. Limit set 1 contains the normal limits for each value. Limit set 2 contains the limits beyond which the Auto-Cal routine cannot correct. If the errors exceed the normal limits, a Predictive Maintenance code is displayed. This alerts the operator or system to a potential future failure. Should the error exceed the correctable limits, an error code is displayed continuously to alert the user to the need for immediate maintenance. The combination of the ECM, Non-Volatile Calibration, and Predictive Maintenance features means the Series 6000 will reduce downtime and maintenance expense to a minimum and allow you to schedule at your convenience.

Reduce Your Engineering Costs

For Your Bench Applications. Your engineering costs are reduced on bench applications by the elimination of many test fixtures and special setups normally required with the conventional digital multimeter.

For Your System Applications. An easy to use GPIB Interface (IEEE-STD-488, with all applicable subsets implemented) has been designed for speed and ease of programming. Drawing on three generations of GPIB design experience, Racal-Dana engineers have provided an instrument with unprecedented speed and versatility on the bus. When combined with the High Speed Digitizer Option, readings can be transferred on the bus at over 6000 readings per second.

Combine this interface with features such as the High Speed Digitizer, "7-bin" sorting, dB measurements, programmable front/rear inputs, Tri-function Ratio, etc., and you can reduce your system design time and cost significantly.

For customers using parallel systems, a BCD interface is available that enables you to update your system to include the Series 6000's exclusive calibration and maintenance concepts with minimum hardware or software redesign.

Improve Overall Measurement Accuracy and Capability

To provide better overall accuracies in the Series 6000, Racal-Dana looked outside the digital multimeter for sources of error. Features were added to the 6000 which allow you to reduce or eliminate errors external to the digital multimeter:

The Null feature allows external thermal voltages, lead resistance, or other offsets to be eliminated from the measurements, thereby improving overall accuracy.

The Software Ratio mode allows AC/AC ratios to be made using a single AC converter, thereby eliminating the effect of converter inaccuracy on many measurements.

These and other features such as switchable front and rear inputs, scaling, averaging, and selectable 4½ to 6½ digit resolution combine to make the Series 6000 the most comprehensive amplitude measurement system available.

Reduce Equipment Costs

In many applications, the Series 6000 can eliminate the need for expensive support equipment. For example, resistor sorting requires no external comparator box; the High Speed Digitizer Option eliminates the need for an A to D converter in systems; and the math and dB features may eliminate the need for a calculator or extensive computer software.

A New Standard for Bench Measurement

No other digital voltmeter gives you the on-the-bench performance and measurement capabilities of the Series 6000.

DC Volts

100 Nanovolt Resolution. Five DC ranges (0.1 V, 1 V, 10 V, 100 V, 1000 V) provide a resolution of 100 nV on the 0.1 V range.

0.001% Accuracy. The Series 6000 maintains 0.001% of full scale accuracy on its 10 V range for 24 hours, and ±(0.001% of reading + 0.001% of full scale) for 90 days over a 10°C temperature span.

Greater than 10,000 Megohm Input Resistance. A high input impedance increases accuracy with less than 0.001% loading error from up to a 100 kilohm source.

DC Millivolts (Option 41)

120% Overrange. The 10 mV/1 ohm Extended Range Option allows measurement of low level voltages from sources such as thermocouples, bridges and

detectors. The 120% overrange allows up to 22 mV to be measured with maximum resolution.

100 dB normal (series) mode rejection. Delayed dual slope integration combined with active input filtering assures a stable reading even with noise on the input signal. Multiple readings may also be averaged for an even greater integration of noise.

AC Volts

Broadband AC–20 Hz to 1 MHz. The Option 14 Averaging AC Converter has four AC ranges for making accurate measurements over a 20 Hz to 1 MHz frequency range. The AC Converter is located within the ECM and gives you AC/AC ratio capabilities. AC values may be displayed in dBm.

0.04% AC accuracy. The Averaging AC Converter maintains ±(0.04% of reading + 0.004% of full scale) accuracy for 90 days (±5°C) over a 100 Hz to 5 kHz frequency range.

True rms AC. The Model 6002 True rms Converter provides 0.1% typical accuracy over crest factors ranging from 7 to 22. The converter operates in either the AC mode or AC + DC mode.

Keyboard-controlled AC or DC coupling. The AC mode or AC + DC mode may be selected by keyboard control on the Model 6002. The GPIB interface also allows the coupling mode to be programmed remotely.

Two-speed measurement capability. The Series 6000 gives you the flexibility of two settling speeds for AC voltages. With the filter in, the input settles to within its rated accuracy in 400 mSec for the Model 6002 and in 600 mSec for the Option 14. With the filter out, the input settles to within its rated accuracy in 100 mSec for the Model 6002 and in 200 mSec for the Option 14.

Ohms

Nine ranges—1 ohm to 100 megohms. The 6001 and 6002 provide eight ranges of ohms. The Option 41 Extended Range gives you an additional range of 1 ohm full scale for measuring low resistance values.

Four-wire sensing. The 6001 and 6002 Ohms Converter provides four-wire sensing. Separate current and voltage leads eliminate errors caused by input lead resistance, and the use of Null feature lets you digitally correct lead resistance errors. A front panel switch converts the Series 6000 from two-wire to four-wire configuration.

0.003% ohms accuracy. The Models 6001 and 6002 maintain a ±(0.003% of readings + 0.001% of full scale) accuracy for 90 days (±5°C) on the 100 ohm to 1 megohm ranges.

Unique ohms guard. An ohms guard allows you to make certain in-circuit ohms measurements at full accuracy. This makes it possible to measure resistor networks (e.g., strain bridges) without disassembling individual resistors or calculating their values from a series of measurements. The ohms guard also prevents triboelectric errors in system applications where long input leads are utilized.

Microhm resolution. The Models 6001 and 6002 provide 10 μohm resolution when equipped with Option 41.

Tri-Function Ratio

24 different ratio configurations. The Tri-Function Ratio permits 24 different configurations, 10 reference ranges and 19 signal ranges. Capabilities equaled only by expensive computer-controlled ATE systems. And it also gives you three direct reading ratio function modes.

Computing Functions

Null. The null function is designed to permit rapid "zeroing" of the displayed value. When the null function is asserted, the display value is:

$$R = X - N$$

where: R = displayed value
X = measured value
N = value stored in null

The currently displayed value is stored as null function is asserted. Values other than the current reading may also be stored as null value.

Full math scaling

$$R = \frac{(X-A)B}{C}$$

Where R = displayed value
X = measured value
A = value stored in Memory A
B = value stored in Memory B
C = value stored in Memory C

This function may be used to convert the measured data into a variety of desired answers. For example:

Scale: $R = \frac{(X-A)}{C}$ Offset: $R = X-A$

Transducer Scaling: $R = \frac{[(X-N)-A]\ B}{C}$

Where N = value stored in null

% Deviation: $\% = \frac{(X-A)}{C} \times B$

Where A = C = 'norm'
B = 100

dB readings

The Series 6000 gives you a full 180 dB dynamic range.

Variable reference. On power-up, the Series 6000 automatically sets 0 dB = 1 mW into 600 ohms. Other impedance values may be entered directly from the keyboard or remotely for reference of 50 ohms, 75 ohms, etc.

Full function. dB indication may be displayed on all signal functions: DC Volts, AC Volts, and Ohms.

0.1 dB resolution. A 0.1 dB resolution is maintained over the entire 180 dB range.

Gain/Attenuation

AC or DC circuits. By combining the ratio and dB functions, decibels of gain or attenuation can be measured directly for either AC or DC circuits.

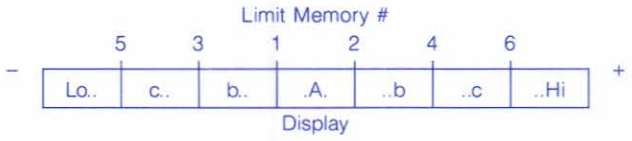
Gain/attenuaion vs. frequency. Scaling capabilities allow the frequency response of active or passive circuits to be measured directly in ±dB from the gain/attenuation at reference frequency.

Limit Testing (HLL)

The HLL function may be used for either go/no-go testing or for sorting operations. When combined with full-math function, limits may be stored in percent (i.e., −1% +1%).

Hi/low limits. The hi/low limit mode may be used for single or dual limit testing by storing values in either Limit Memory 1, Limit Memory 2, or both; and asserting the HLL function.

"7-bin" sorting. The HLL functions contain six memory locations (Limit Memories 1 through 6). Whenever values are stored in any memory locations other than Limit Memories 1 and 2, the HLL function is automatically converted to a "sorting bin" operation. The chart below shows the displayed indications when the HLL function is being used for sorting. The vertical lines represent the value stored in Limit Memories. The letters are displayed as shown for the measured values between each limit.



Any number of bins from 3 to 7 may be established by storing values in the appropriate Limit Memory.

Min/Avg/Max. The MAM function can be used for several measurements. It can continually update and store the minimum and maximum reading taken. And it can store the average of all readings and the total number of readings. Each of these values may be displayed when desired. Typical uses for the MAM function include storing and recalling + and − peak readings, digital averaging to achieve higher noise immunity, capturing average value of a signal with poor short-term stability, and power line monitoring.

Other Features

Switchable 3-pole active filter. The switchable 3-pole filter provides broadband noise rejection. Combined with the delayed dual slope integration which rejects the frequency noise, you get unequaled common and normal (series) mode noise rejection.

Three keyboard-controlled integration times. 1⅔ mSec, 16⅔ mSec and 100 mSec signal integration times are selectable from the keyboard (2 mSec, 20 mSec, 120 mSec for 50 Hz units). The selectable integration times allow the measurement speed to be optimized for the desired resolution and noise rejection.

Three keyboard-controlled resolution modes. You may set the Series 6000 for 4½, 5½, or 6½ digit display to eliminate unwanted digits when measuring imprecise signals.

High-speed autoranging. Most voltages will be measured with a maximum of two range changes, reducing the "wait time" when using autorange.

Up to 10 "scratch pad" memories. When the Full Function Math or HLL functions are not being used, the memory locations "A", "B", "C" and Limit Memories 1 through 6 may be used to store readings for recall and evaluation or recording.

Analog output. A scaled voltage output is available for driving a strip chart recorder or for use as a voltage source.

Switchable front and rear inputs. A useful feature for many applications where measurements are desired from two locations.

Externally triggered readings. A standard externally triggered reading feature is included for applications requiring precise timing of the integration period.

Fully guarded operation. The Series 6000 has full guarding on both the front and rear inputs.

Switchable input configuration. Front panel switches for two-wire ohms and low-to-guard operation eliminate time consuming and potentially dangerous shorting links from front panel inputs.

A New Standard for System Measurement

The Series 6000 is the result of our 10 years of experience as the leading systems digital voltmeter manufacturer. Along with all of its bench performance features, the Series 6000 gives you many state-of-the-art features designed exclusively for systems applications, at a price that's less than a traditional systems DVM.

Over 34,000 readings per second (Option 03SH). The Series 6000 serves as two separate and parallel analog-to-digital converters when equipped with the High-Speed Digitizer Option 03SH. The delayed dual slope converter provides high resolution and noise rejection, while a successive-approximation converter provides reading rates of over 34,000 readings per second with 3½ digit resolution (12-bit binary output). The sample and hold high-speed digitizer allows the Series 6000 to be used for applications requiring precise timing of measurement or extremely short sample times. The high speed digitizer also provides an adjustable delay circuit that delays the aperture point to compensate for system settling time, and a wide band-pass (1 MHz), fast settling (5 μSec) input.

Two independent digital outputs. Option 03SH provides12-bit parallel binary output. The GPIB (IEEE-STD-488) interface on Models 6001 and 6002 provides output of the high resolution data.

GPIB interface. This unique "3rd generation" IEEE interface is fully compatible with IEEE-STD-488. This interface lets you program all keyboard functions and controls. And it allows readings to be transferred over the bus at rates of over 6,000 readings per second when the unit is equipped with Option 03SH High Speed Digitizer. Implementation of the RL2 subset permits either full lockout of the keyboard or local operation while connected to the bus.

Parallel BCD interface. This interface is designed for present users of parallel instruments. It provides a BCD interface which allows the Series 6000 to be added to your system with minimum hardware or software redesign.

Fully isolated operation. Both the GPIB and the BCD interfaces provide full isolation between the analog and digital circuitry.

Full annunciation. The Series 6000 provides full annunciation of all programmed conditions for easy software development. The readout display may be blanked while still maintaining annunciation of programmed conditions when your system is operating.

Automatic timeouts. When programmed, proper timeouts are automatically inserted to prevent first reading errors due to instrument settling times. The timeouts vary from a few milliseconds to 500 msec, depending on function, range and filter conditions. Output is also inhibited during autorange to assure that only correct readings are available to your system.

Five integration times. A selection of five integration times from 1.66 mSec to 100 mSec, plus the 29 μSec High Speed Digitizer Option, gives you a read rate/resolution that will match your most demanding applications.

Six trigger modes. Six programmable trigger modes are available with the GPIB interface. The reading may be triggered internally, externally or by software command. And the High-Speed Digitizer (Option 03SH) may be triggered internally, externally with sample and hold, or externally with adjustable delay.

Auto-Test/Auto-Cal on command. The Auto-Test/Auto-Cal routine may be inhibited and performed only when commanded by your controller, or it may be performed any time you desire to ensure ultimate accuracy for your system.

Specifications

DC Voltage

Ranges
Standard: ±100.000 mV, ±1.00000, ±10.0000, ±100.000, ±1000.00 V
Option 41: ±10.0000 mV

Resolution: 0.001% range on 5½ digit mode

Overrange
100 mV to 100 V Ranges: 60% (e.g. ±1.6000)
1000 V Range: 1100 V DC, 1500 V peak AC
10 mV range: 120% (i.e., 22 mV)

Maximum Input Voltage: 1100 V DC or 1500 V peak AC, all ranges except 10 mV range. 10 mV range = 350 V DC or 250 V rms

Input Impedance
100 mV, 1 V, 10 V ranges: ≥10,000 megohm
100 V, 1 kV ranges: 10 megohm
10 mV range: 100 megohm minimum shunted by 4.8 kilohm in series with 1.5 μF.

Settling Time: (To within 0.01% with 10 kilohm source)
Filtered: 450 mSec
Unfiltered: 5 mSec
100 V range: 10 mSec
10 mV range: 850 mSec

Accuracy[3]: [5½ digit mode; after Auto-Cal] ±(% Input + No. Digits); T.C. = ±(ppm of Input + No. Digits)/°C

Range	24 Hours 23°C ±1°C		90 Days 23°C ±5°C		1 Year 23°C ±5°C		Temperature Coefficient[2] 0°C to 50°C	
	% Input	No. Digits	% Input	No. Digits	% Input	No. Digits	PPM Input	No. Digits
10 V	—	1	0.001%	1	0.003%	1	1.5 ppm	0.05
1, 100, 1000 V	0.001%	1	0.002%	1	0.004%	1	3 ppm	0.1
100 mV	0.002%	5	0.003%	5	0.005%	5	4 ppm	0.5
10 mV (option 41)[1]	0.005%	5	0.008%	5	0.01%	5	20 ppm	0.5

1. With source resistance ≤ 1 kilohm and input zeroed by pushing Null with shorted input leads.
2. With Auto-Cal after temperature change.
3. After 2-hour warmup.

Resistance—Models 6001, 6002

Resolution: 0.001% F.S. in all ranges. 5½ digit mode

Overrange: 60% (120% on 1 ohm range Opt 41)

Ranges

Standard: 10.0000Ω, 100.000Ω, 1.00000 kΩ, 10.0000 kΩ, 100.000 kΩ, 1.000000 MΩ, 10.0000 MΩ, 100.000 MΩ

Option 41: 1.00000 Ω

Maximum Input Voltage: ±350 V peak on 1 ohm range. ±500 V peak on 10 ohm to 100 megohm ranges.

Ohms Guard: Allows in-circuit ohms measurements

Accuracy: (5½ digit mode; after Auto-Cal) ±(% Input + No. of Digits)

Range	24 Hours 23°C±1°C		90 Days 23°C±5°C		1 Year 23°C±5°C		Temperature Coefficient[2] 0°C to 50°C (±%Input ±No. Digits)/°C	
	% Input	No. Digits	% Input	No. Digits	% Input	No. Digits	% Input	No. Digits
1 ohm (Option 41)[1]	0.15%	50	0.02%	50	0.03%	50	0.002%	2
10 ohm[3,4]	0.003%	5	0.005%	5	0.006%	5	0.0008%	0.5
100 ohm—1 megohm[4]	0.002%	1	0.003%	1	0.004%	1	0.0007%	0.1
10 megohm	0.01%	1	0.03%	1	0.04%	1	0.003%	0.1
100 megohm	0.02%	1	0.03%	1	0.04%	1	0.005%	0.1

1. With source resistance ≤ 1 kilohm and input zeroed by pushing NULL with shorted input leads.
2. With Auto-Cal after temperature change.
3. After Null with shorted inputs.
4. If using ECM, add ±0.005% input to 10Ω, 100Ω and 1 kΩ ranges.

AC Voltage True rms—Model 6002

Ranges: 1.00000, 10.0000, 100.000, 1000.00 V rms

Resolution: 0.001% of range

Overrange: 60% except 1000 volt range

Maximum Input Voltage: 1000 V rms or 1500 V peak, decreasing to 50 V rms at 300 kHz. 1.5 x 10^7 V•Hz maximum any range.

Input Impedance: 1 megohm in series with 0.22 μF, shunted by less than 200 pF.

Crest Factor: 7:1 at full scale

Temperature Coefficient: ±(0.004% input +5 digits)/°C

Settling Time:
(To within 0.1% of range).

	"Filter" Out	"Filter" In
Zero to F.S.	80 mSec	350 mSec
F.S. to 10% F.S.	100 mSec	400 mSec

Accuracy (After Auto-Cal, sinewave input. For ≥500 V add 0.1% of input): ±(% Input + No. of digits)

Frequency	24 Hours, 23°C±1°C		90 Days, 23°C±5°C		6 Months, 23°C ±5°C	
	% Input	No. Digits	% Input	No. Digits	% Input	No. Digits
20 Hz-30 Hz (Filtered)	0.5%	50	0.5%	60	0.52%	70
30 Hz-50 Hz (Filtered)	0.2%	50	0.2%	60	0.22%	70
50 Hz-100 Hz (Filtered)	0.1%	50	0.1%	60	0.12%	70
100 Hz-20 kHz (Filtered)	0.06%	50	0.07%	60	0.08%	70
200 Hz-20 kHz (Unfiltered)	0.06%	50	0.07%	60	0.08%	70
20 kHz-50 kHz (Both)	0.09%	100	0.1%	100	0.11%	110
50 kHz-100 kHz (Both)	0.38%	180	0.4%	200	0.42%	220
100 kHz-300 kHz (Both)* (10 V, 100 V, 1000 V ranges) (1 V range)	3% 5%	500 1000	3% 5%	500 1000	4% 6%	600 1100

* For voltages above 150 V AC, the filter should be in.

Digital Multimeters
Amplitude Measurement System
Series 6000

AC Voltage High Accuracy Sinewave—Option 14

(Models 6000, 6001 only)

Conversion Type: Averaged responding calibrated to rms of sinewave

Ranges: 1.00000, 10.0000, 100.000, 1000.00 V AC

Resolution: .001% of range.

Maximum Input Voltage: 1000 V rms or 1500 V peak, decreasing to 20 V rms at 1 MHz; 2 x 10^7V•Hz max. on any range.

Input Impedance: 1 megohm in series with 0.22 μF, shunted by less than 100 pF.

Settling Time
(To rated accuracy)

	"Filter" Out	"Filter" In
Zero to F.S.	200 mSec	600 mSec
F.S. to 10% F.S.	200 mSec	600 mSec

Temperature Coefficient[2] (% Input + No. Digits)/°C

Frequency	% Input	No. Digits
50 Hz-20 kHz (Filt.)	0.003%	0.5
20 kHz-100 kHz (Both)	0.005%	2
100 kHz-1 MHz (Both)	0.02%	10

2. With Auto-Cal after temperature change.

Accuracy (After Auto-Cal, sine wave input. For ≥250 V add 0.2% of input): ±(% Input + No. of digits)

Frequency	24 Hours, 23°C±1°C		90 Days, 23°C±5°C		6 Months, 23°C±5°C	
	% Input	No. Digits	% Input	No. Digits	% Input	No. Digits
20 Hz-30 Hz (Filtered)	0.3%	2	0.31%	4	0.32%	5
30 Hz-50 Hz (Filtered)	0.2%	2	0.21%	4	0.22%	5
50 Hz-100 Hz (Filtered)	0.05%	2	0.06%	4	0.07%	5
100 Hz-5 kHz (Filtered)	0.03%	2	0.04%	4	0.05%	5
300 Hz-5 kHz (Unfiltered)	0.03%	2	0.04%	4	0.05%	5
5 kHz-50 kHz (Both)	0.04%	5	0.05%	7	0.06%	8
50 kHz-100 kHz (Both)	0.05%	10	0.06%	12	0.07%	13
100 kHz-300 kHz (Both)	0.6%	20	0.61%	22	0.62%	23
300 kHz-1 MHz (Both)	2.5%	70	2.5%	72	2.5%	73

Noise Rejection

Function	Normal (Series) Mode Rejection		Common Mode Rejection[1]	
	Filtered	Unfiltered	Filtered	Unfiltered
DC Volts	100 dB at 60 Hz	48 dB at multiples of 60 Hz[2]	140 dB, DC to 61 Hz 126 dB, 61 Hz to 100 kHz	140 dB at DC 120 dB at ≤61 Hz 174 dB at 60 Hz Harmonics
Ohms				
AC Volts	N/A	N/A	DC to 60 Hz	

Range	CMR
1 V	120 dB
10 V	100 dB
100 V	80 dB
1000 V	60 dB

1. 100 ohms unbalance on either lead
2. 50 Hz with Option 04

High Speed Sample and Hold Digitizer—Option 03SH

Input 1

Range: May be used with any function and range, except Option 41

Input: Normal signal input terminals

Output: 12-bit binary parallel on all models, GPIB (IEEE-STD-488) on models 6001, 6002

Resolution: 0.1% of range

Accuracy: 1 year 23°C±5°C
±(0.57% reading +0.35% range) +function error

Settling Time: Same as function selected

Temperature Coefficient: ±(0.015% reading +0.01% range)/°C + function T.C.

(High Speed Option 035H continued)
Input 2

Input: Wide bandwidth input on rear connector
Bandwidth: DC-1 MHz (3 dB), (8 V P-P)
Settling Time: 6 μSec to 0.5% of final value for 20 V step with 1 kilohm source impedance.
Input Range: ±20 V
Max Input: 100 V DC or Peak AC
Input Resistance: 100 kilohms
Accuracy: 24 hours 23°C ±1°C ±(0.05% reading ±0.15% range) 1 year 23°C ±5°C ±(0.35% reading +0.3% range)
Adjustable Delay: 2 μSec to 20 μSec (potentiometer adj.)
Programmable Read Rate
(Internal Trigger)
(Models 6001, 6002): From approximately 80 readings/second to 6000 readings/second in 255 steps
Aperture Time:
No Delay: 240 nSec ±50 nSec
Delayed: 240 nSec ±50 nSec + adjustable delay
Digitizing Time: 29 μSec

Math Ratio

Description: Implements formula R=X÷C
Where R = Ratio reading
X = Measured value
C = Stored constant

Accuracy: ±(Measurement accuracy + 1 digit)

Automatic Software Ratio

Description: Implements formula $R = V_1 \div V_2$
Where R = Ratio reading
V_1 = Signal voltage
V_2 = Reference voltage

Isolation: 1000 megohms between any signal terminal and any reference terminal
Signal Ranges: Standard functions and ranges
Reference Ranges: 1, 10, 100, 1000 V DC
1, 10, 100, 1000 V AC

Accuracy — DC/DC
Same Reference/Signal Range*:

$$\pm 0.001\% \text{ Input } \pm \left(0.001\% \text{ range } \frac{RR}{RI}\right)$$

Different Signal/Reference Range

≥1 V Range: $\pm 0.002\%$ Input $\pm \left(0.002\% \text{ FS } \frac{RR}{RI}\right)$

100 mV Range: $\pm 0.007\%$ Input $\pm \left(0.1\% \text{ FS } \frac{RR}{RI}\right)$

Accuracy — AC/AC
Same Reference/Signal Range

100 Hz –20 kHz: $\pm 0.06\%$ Input $\pm \left(0.05\% \text{ FS } \frac{RR}{RI}\right)$

50 Hz –50 kHz: $\pm 0.1\%$ Input $\pm \left(0.1\% \text{ FS } \frac{RR}{RI}\right)$

Accuracy — Mixed Functions: Signal function specification plus reference function specification with % of range multiplied by RR/RI.
*RR=Ref. Range
RI=Ref. Input

Computing Functions

High/Low Limit (HLL): Provides 7 memories which may be used for pass/fail or sorting operations
Min/Avg/Max (MAM): Accumulates minimum and maximum reading and average of up to 10,000 readings. Min, Max, or average can be recalled with or without clearing values.
Math Scaling: Implements the formula

$$X = \frac{(X - A)\,B}{C}$$

Where,
R = Reading
X = Measured value
A,B,C = Constants stored in math memories

dB: Displays dB, dBm, dBV, or dB of ratio

Hardware Ratio

DC Reference — Option 34
Readout: Signal Input ÷ Ref. Input. Ratios are displayed in scientific notation.
Signal Ranges: Same as Selected Function
Maximum Common Mode Voltage: ±15 V between reference input and –signal input
Accuracy: Selected function error x $\left(\frac{10\text{ V}}{\text{Ref}}\right)$
AC Reference — Option 11: (Model 6002)
Readout: Signal Input ÷ reference input. Ratios are displayed in scientific notation.
Reference Ranges: 1 V, 10 V, 100 V, 1000 V rms
Signal Ranges: Same as Selected Function
Maximum Signal Voltage: Same as Selected Function
Reference Voltage Range: 10% of range to 100% of range
Ratio Accuracy: ±(Accuracy of Function + Accuracy of true rms AC) multiplied by $\frac{\text{Reference Range}}{\text{Reference Input}}$

Frequency Range: 20 Hz to 10 kHz

General

Maximum Common Mode Voltage: 1000 V DC or peak AC guard to case, 250 V analog common to guard
Display: 6 full decades plus overrange digit and decimal point. All functions, ranges, and keyboard operations are annunciated
Overrange Indication: "OL" is displayed
Temperature Range
Operating: 0°C to +50°C
Storage: –40°C to +70°C
Cooling: Fan
Humidity: 75% RH, 0°C to +40°C;
50% RH, +40°C to +50°C;
Shock/Vibration: 0.025 inches double amplitude to 50 Hz for 15 minutes
Power Requirement: 100, 120, 220 or 240 V AC, selectable from rear panel. 60 Hz standard (50 Hz Option 04), 75 watts
Dimensions: 89 H x 425 W x 456 D mm
(3.5 H x 16.75 W x 18 D inches)
Weight: 11.4 kg (25 lb.)

Digital Multimeters
Amplitude Measurement System
Series 6000

GPIB Interface

Request Application Note 6000-5 for detailed description on program codes

Output Information: Numeric data, polarity and special flags

Input Information: Functions, ranges, microprocessing functions. Full control of all instrument capabilities

Compatibility: IEEE-STD-488-1978

Subsets: AH1, DC1, DT1, RL1, SH1, SR1, T5

Handshake Time

Address/Universal Commands: 75 μSec (15 μSec typical)

Programming Codes: 350 μSec per character

Data Output: 100 μSec per character (85 μSec per character HSD)

Annunciator (Front Panel): Remote/local, addressed to talk, addressed to listen, service request, bus address

Analog Signal Output

Description: Scaled and buffered DC output for driving a recorder etc.

Output Level: 0 to ±10 volts for zero to ±full scale

BCD Interface—Option 59

Compatibility: Similar to Racal-Dana Model 5900

Programming: DC V, AC V, Ohms, Filter. Remote /local, timeouts, trigger, range, ratio, superfast

Output: BCD data + range and function

Read Rate

Maximum continuous reading rates at 100% of ranges. All function and ranges except computing and ratio

Under System Control — Model 6001, 6002

Condition \ Resolution	Option 03SH	No. Digits				
		4½	5½		6½	
Integration time		1.67 mSec	4.1 mSec	16.67 mSec	41 mSec	100 mSec
Internal Trigger	6000	55	55	25	3.0	3.0
External Trigger	34,000	50	40	20	3.0	3.0

Keyboard Control — All Models

Condition \ Resolution	Option 03SH	No. Digits		
		4½	5½	6½
Internal Trigger	200	12	4	3.5
External Trigger	34,000	11	4	3.5

Ordering Information

Model 6000: 6½ Digit Digital Voltmeter

Model 6001: Amplitude Measurement System (DC V, Ohms, GPIB)

Model 6002: Amplitude Measurement System (DC V, AC V, Ohms, GPIB)

Options

03SH: High speed digitizer with sample and hold[1]

04: 50 Hz operation

71: 220/240 V operation

11: True rms AC reference (Model 6002)

14: High accuracy sinewave AC (Models 6000, 6001)

34: DC hardware ratio

41: 10 mV/1 ohm extended ranges

59: BCD interface[1]

60: Rack mount adapters

66: Chassis slides (including rack mounts)

1. Series 6000 will accept only one of these options simultaneously.

Accessories

980513: Extra Operator's Manual

980514: Maintenance Manual

400988: Calibration Test Assembly

454015: Spare Cal Module (for Model 6000)[3]

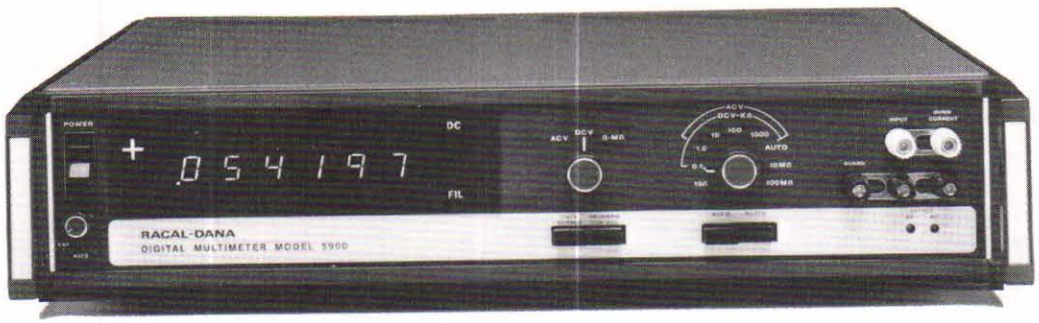
404172: Spare Cal Module (for Model 6001)[3]

404170: Spare Cal Module (for Model 6002)[3]

404044: 6000 Maintenance Kit

3. When ordering spare cal module, if option 11, 14 or 34 is in the original instrument, these options must be ordered with the spare cal module.

Digital Multimeters
5½ Digit High Accuracy Bench/System
Models 5900, 5940



The Model 5900 is the world's standard for a five-digit voltmeter. It offers five DC ranges, 60% overrange, full ratio capability, 0.03% AC accuracy, and the flexibility of two measurement speeds.

Accuracy

The basic 5900 maintains ±0.001% full scale accuracy on its ten volt range for 24 hours. The one-year guaranteed specification on this range (±0.003% of reading ±1 digit) highlights the exceptional stability of this voltmeter.

Unique Ohms Guard

The 5900 offers the Racal-Dana ohm guard which allows certain in-circuit ohms measurements to be made at full accuracy. The measurement of resistor networks (e.g., strain bridges) without the need to disassemble individual resistors or to calculate their values from a series of measurements is now possible.

100 Readings Per Second

With a 5900, more than 20 readings per second can be made on all measurements. A programmable super-fast mode of operation is also standard. This high-speed measuring capability provides a speed of over 100 readings per second.

Specifications

DC Voltage

Ranges: ±.100000 V, ±1.00000 V, ±10.0000 V, ±100.000 V, ±1000.00 V

Maximum Input Voltage: 1100 V DC or 1400 V peak AC on all ranges

Input Impedance
0.1 V to 10 V ranges: ≥10,000 megohm
100 V to 1000 V ranges: 10 megohm

Normal (Series) Mode Rejection
Filtered: 100 dB at 60Hz
Unfiltered: 48 dB at every multiple of 60 Hz

Settling Time
Filtered: Settles to within 0.01% in 450 mSec with 10 kilohm source
Unfiltered: Settles to within 0.01% in 5 mSec with 10 kilohm source, 10 mSec on 100 V range.

Common Mode Rejection (with 100Ω imbalance in either lead)
Filtered: 140 dB DC to 61 Hz
126 dB, 61 Hz to 100 kHz
Unfiltered: 140 dB at DC, 120 dB at 61 Hz and below plus an additional 54 dB at harmonics of 60 Hz.

Accuracy: ±(% input + No. digits)

Range	24 Hours 23° C ±1°C		90 Days 23° C ±5°C		1 Year 23° C ±5°C		Temperature Coefficient 0°C to 50°C ±(PPM Input + No. Digits)/°C	
	% Input	No. Digits	% Input	No. Digits	% Input	No. Digits	PPM Input	No. Digits
10 V	—	1	0.001%	1	0.003%	1	1.5 ppm	0.05
1 V – 1000 V	0.001%	1	0.002%	1	0.004%	1	3 ppm	0.1
0.1 V	0.002%	5	0.003%	5	0.005%	5	4 ppm	0.5

Digital Multimeters
5½ Digit High Accuracy Bench/System
Models 5900, 5940

RESISTANCE—Option 52

Ranges: 10 ohms to 100 megohm in decade steps

Resolution: 0.001% of range
(100 μohm on 10 ohm range)

Maximum Input Voltage: ±500 V peak on all ranges

Settling Time to rated Accuracy

10 ohm – 10 megohm: 30 mSec
100 meghom: 300 mSec

Accuracy ±(% Input + No. of digits)

	24 Hours 23°C ±1°C		90 Days 23°C ±5°C	
Range	% Input	No. Digits	% Input	No. Digits
10 ohm	0.003%	5	0.005%	5
1 – 1000 kilohm	0.002%	1	0.003%	1
10 megohm	0.01%	1	0.003%	1
100 megohm	0.02%	1	0.03%	1

AC Voltage True rms—Option 32

Ranges: 1.00000 V, 10.0000 V, 100.000 V, 1000.00 V rms

Input Impedance: 1 megohm ±0.1% in series with 0.22 μF shunted by less than 100 pF to common

Settling Time
(To within 100 digits of final value)

	Unfiltered	Filtered
Zero to Full Scale	80 mSec	350 mSec
Full Scale to 10% FS	100 mSec	400 mSec

Accuracy ±(% input + No. of digits)[1]

	90 Days, 23°C ± 5°C	
Frequency	% Input	No. Digits[2]
20 Hz to 30 Hz (Filtered)	0.5%	40
30 Hz to 50 Hz (Filtered)	0.2%	40
50 Hz to 100 Hz (Filtered)	0.1%	40
100 Hz to 20 kHz (Filtered)	0.07%	40
200 Hz to 20 kHz (Unfiltered)	0.07%	40
20 kHz to 50 kHz (Both)	0.1%	100
50 kHz to 100 kHz (Both)	0.4%	200
100 kHz to 300 kHz (Both)	3.0%	500
100 kHz to 300 kHz, IV range	5.0%	1000

1. For inputs >500 V, add 0.1% of input.
2. For AC & DC Mode, add 20 digits.

AC Voltage High Accuracy Sinewave—Option 33

Ranges: 1.00000 V, 10.0000 V, 100.000 V, 1000.00 V rms.

Input Impedance: 1 megohm ±0.1% in series with 0.22 μF shunted by less than 100 pF to common.

Settling Time

Filtered: Settles to within rated accuracy in 600 mSec
Unfiltered: Settles to within rated accuracy in 200 mSec

Accuracy ±(% Input + No. of digits)[1]

	90 Days, 23°C ±5°C	
Frequency	% Input	No. Digits
20 Hz to 30 Hz (Filtered)	0.31%	2
30 Hz to 50 Hz (Filtered)	0.21%	2
50 Hz to 100 Hz (Filtered)	0.06%	2
100 Hz to 5 kHz (Filtered)	0.04%	2
100 Hz to 300 Hz (Unfiltered)	0.11%	2
300 Hz to 5 kHz (Unfiltered)	0.04%	2
5 kHz to 100 kHz (Both)	0.06%	10
100 kHz to 300 kHz (Both)	0.11%	10
300 kHz to 1 MHz (Both)	0.51%	50

1. For ≥500 V, add ±0.2% of reading.

General

Display: 5 full decades plus overrange digit (LED 0.4 inches high) plus decimal point and function annunciator.

Temperature Range

Operating: 0°C to +50°C
Storage: −40°C to +60°C

Humidity: 75% RH; +25°C to +40°C
50% RH; +40°C to +50°C

Power Requirement: 100–240 V AC (selectable)
50 or 60 Hz standard
400 Hz optional
40 watts maximum

Dimensions

Model 5900: 89 H × 425 W × 356 D mm
(3.5 H × 16.75 W × 14 D inches)
Model 5940: 89 H × 425 W × 456 D mm
(3.5 H × 16.75 W × 18 D inches)

Weight: 7.4 kg (16 lb.)

AC/AC Ratio—Model 5940

Modes: DC/DC, AC/DC, Ω/DC, DC/AC, AC/AC, Ω/AC

Readout: (Input Volts/Ref Volts) x Reference Range

Reference Input
Ranges: 1, 10, 100, 1000 volts
Voltages: AC, DC, or AC + DC

3-Wire Ratio—Model 5900 only

Modes: DC/DC, AC/DC, Ω/DC

Readout: $\frac{10V}{\text{Ref V}} \times \frac{\text{Input}}{\text{Signal Range}} \times 10$

Reference Input
Voltage Range: + 1 to + 10.5 V DC
Input Impedance: 1000 megohm
Settling Time: 10 mSec to 0.01%

Accuracy: (24 Hours ±1°C)
Function Spec x $\frac{10V}{\text{Ref V}}$

Options

4-Wire Ratio—Option 62

Modes: DC/DC, AC/DC, Ω/DC

Readout: $\frac{10V}{\text{Ref V}} \times \frac{\text{Input}}{\text{Signal Range}} \times 10$

Reference Input
Voltage Range: + 1 to + 10.5 V DC
Input Impedance: 1000 megohm
Isolation: 10 megohm ±10%, Ref to input low
Settling Time: 50 mSec to 0.01%
Maximum Common Mode Voltage: ±15 V DC to low input

Ordering Information

Model 5900-1: Digital Voltmeter (with ratio, BCD output, and parallel front/rear inputs)

Model 5900-1-12-52: Digital Voltmeter/Ohmmeter

Model 5900-1/12/52/32: Digital Multimeter

Model 5940-1S/12/32/42/52/62: Digital Ratiometer

Options

-1B: Parallel rear signal input with Amphenol Connector MS3102A14S-6S

-1S: Isolated switchable front/rear inputs

-1SB: Switchable rear signal inputs with Amphenol Connector MS3102A14S-6S

71: 230 V operation

04: 50 Hz operation

12: Accessory card (required with options 32, 33, and/or 52)

32: True rms AC converter[1]

33: Average sensing AC converter[1]

42: Parallel remote programming

62: 4-wire ratio

Accessories (See DMM Accessories)

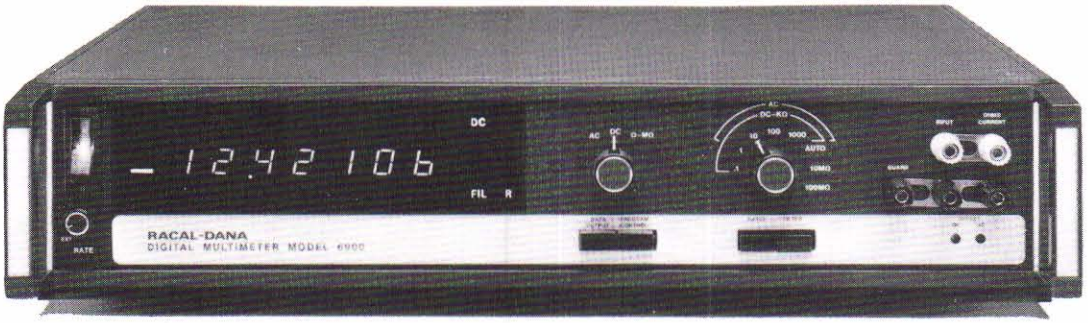
403402: Rack mounting adapter

65: Chassis slides/rack mounting adapters for 5900 only

66: Chassis slides/rack mounting adapters for 5940 only

1. Unit must include Option 12

Digital Multimeters
6½ Digit Precision Digital Voltmeter/Ratiometer
Series 6900



The Series 6900 Precision Voltmeter is a 6½-digit (1,600,000 counts) instrument, combining the stability of a transfer standard with the speed, ease of use, and multifunction capability of a digital voltmeter.

1 ppm Sensitivity

The 6900's 6½-digit readout permits 1 ppm resolution on each of 5 DC voltage ranges. Voltage changes as small as ±1 ppm (±1 digit) can be effectively detected on the 1 V–1000 V ranges.

High Input Impedance

The 6900 provides greater than 100,000 megohms input impedance on the 0.1, 1 and 10 volt ranges. This means, for example, that outputs from low-level sensors with impedances as high as 100 kilohms can be measured with less than 1 ppm loading errors.

The 6900 as a DC Transfer Standard

Because of the 6900's high resolution and short-term stability, it becomes an extremely versatile working transfer standard.

Just measure your standard with the 6900 and record the reading. Then take the 6900 to the source to be calibrated, connect the voltmeter, and adjust the source until the voltmeter displays the same reading as recorded for the standard. Your source is now calibrated to your standard within the short-term stability of the 6900.

Specifications

DC Voltage

Ranges: ±0.100000 V, ±1.000000 V, ±10.00000 V, ±100.0000 V, ±1000.000 V

Resolution: 0.0001% of range, 1μV on 0.1 V range

Maximum Input Voltage: 1000 V DC or 1400 V peak AC on all ranges.

Input Impedance
0.1 V to 10 V ranges: ≥100,000 megohm
100 V, 1000 V ranges; 10 megohm

Normal (Series) Mode Rejection
Filtered: 110 dB at 60 Hz
Unfiltered: 58 dB at every multiple of 10 Hz

Common Mode Rejection
Filtered: 150 dB, DC to 61 Hz; 136 dB, 61 Hz to 100 kHz
Unfiltered: 150 dB at DC, 130 dB at 61 Hz and below

Accuracy ±(PPM of reading ±number of digits) (Basic Model 6900 DC accuracy excluding the uncertainties of calibration sources.)

Range	24 Hours 23°C ±1°C		90 Days 23°C ±5°C		1 Year 23°C ±5°C		Temperature Coefficient 0°C to 50°C ±(ppm of Input + No. Digits)/°C	
	PPM	No. Digits	PPM	No. Digits	PPM	No. Digits	PPM	No. Digits
10 V	3	3	10	6	30	8	1.5	0.5
100 V–1000 V	5	5	15	8	35	9	3	1
1 V	6	5	16	8	36	9	3	1
0.1 V	20	50	30	50	50	50	4	5

RESISTANCE —Option 24

Ranges: 0.1 kilohm to 100 megohm in decade steps

Resolution: .0001% of range

Maximum Input Voltage: ±500 V peak on all ranges

Normal (Series) Mode Rejection

Filtered: 110 dB at 60 Hz
Unfiltered: 58 dB at every multiple of 10 Hz

Accuracy ±(% Reading + No. Digits)

Range	24 Hours 23° C ±1° C		90 Days 23° C ±5°C		Temperature Coefficient 0° C to 50° C ±(PPM Input+No. Digits)/°C	
	% Input	No. Digits	% Input	No. Digits	PPM	No. Digits
1–1000 kilohm	.002%	10	0.003%	10	7 ppm	1
10 megohms	0.01%	10	0.03%	10	30 ppm	1
100 megohms	0.03%	10	0.03%	10	50 ppm	3

AC Voltage True rms —Option 10

Refer to specifications for Model 5900, Option 32. All specifications are identical for this option

AC Voltage High Accuracy Sinewave —Option 14

Refer to specifications for Model 5900, Option 33. All specifications are identical for this option

Data Output

Information: All BCD outputs of display, 4-bit range code, function flags, polarity flags, special flags, and logic supplies.

Remote Programming —Option 50

Input Information: Provides isolated programming of all DMM functions and ranges

Command Modes: Direct command
Timeout command
Superfast

General

Temperature Range

Operating: 0° C to +50° C

Storage: −40° C to +50° C

Humidity: 75% RH; +25° C to +40° C
50% RH; +40° C to +50° C

Maximum Read Rate

Internal Trigger: From hold to 2 readings per Sec

External Trigger: 3⅓/Sec at 6½ digits
133/Sec at 4½ digits (superfast mode)

Power Requirement: 115 or 230 V ±10%
50 or 60 Hz standard
400 Hz optional
40 watts maximum

Dimensions: 89 H × 425 W × 356 D mm
(3.5 H × 16.75 W × 14 D inches)

Weight: 7.3 kg (16 lb)

Ordering Information

Model 6900/09 Digital Voltmeter/Ratiometer (with BCD Output and Front/Rear Inputs)

Options

04	50 Hz operation
71	240 V AC operation
10	True rms AC converter
14	Average sensing AC converter
24	4-wire ohms
34	4-wire ratio
50	Remote programming
60	Rack mounting adapters
65	Chassis slides/rack mounting adapters

Accessories

See DMM Accessories

Digital Multimeters
Accessories

A wide variety of accessories is available to enhance the performance and versatility of your Racal-Dana digital multimeter. Unless otherwise noted each accessory will work with all DMM models shown in this catalog.

High Voltage Probes

Model 641 High Voltage Probe, 10 kV

The Model 641 consists of a precision molded probe assembly, a five-foot (1.5 meter) cable, and a control assembly with a dual banana plug connector.

The probe assembly contains a 1000:1 resistance divider network that reduces input to a maximum of 10 volts before it enters the cable. The cable and instrument connector are, therefore, always at a safe level. The probe assembly is terminated with a stainless-steel contact and a spring clip for attaching it to high voltage sources.

The control assembly incorporates a selector switch for DC and AC measurements and a screwdriver adjustment for periodic calibration of the divider network.

Specifications

Input Impedance: 100 megohms ±1%

Input Capacitance: 0.5 pF

Accuracy (30 Days) into 1000 megohms
- **DC (to 10 kilovolts):** .01%
- **AC (to 7.5 kilovolts):** 0.5%

AC Frequency: Up to 400 Hz

Temperature Coefficient: 25 ppm/°C

Voltage Coefficient: 0.1 ppm/V

Divider Ratio: 1000:1

Accessory No. 82 High Voltage Probe, 5 kV

Extends the DC measurement capability of the instrument to 5000 volts.

Specifications

Accuracy: (0–5kV, 0 to +50°C) ±2% of input with 10 megohm DMM load

Maximum Input: 5 kV DC

Input Resistance: 900 megohms nominal

Division Ratio: 1000:1

Model T-10 Temperature Probe

The Racal-Dana Model T-10 Temperature Probe is a constant current battery-powered bridge circuit which uses a solid state temperature sensor. An output of 1 mV/°C is produced on any digital multimeter having better than 1 millivolt DC resolution. A dual banana plug connector body houses the printed circuit assembly and 9 volt battery. The probe, constructed of high temperature plastic, is connected to the housing via a spiraled retractable 20-inch (50.8 cm) cord which has an extended length of 6 feet (1.8 meters). The sensor is embedded in a low mass brass tip for improved thermal response time.

Specifications

Output: 1 mV/°C

Accuracy: ±2°C from 0°C to +100°C
±3°C from −50°C to +150 °C

Power: Disposable 9 volt alkaline battery

Controls: Power ON/OFF with LED indicator

RF Probes

Accessory No. 90 RF Probe, 520 MHz

Extends the capabilities of the instrument to the measurement of RF voltage from 100 kHz to 520 MHz at rms levels up to 30 volts. The probe converts the RF signal to the DC equivalent voltage.

Specifications

Accuracy
- **100 kHz to 200 MHz:** ±1 dB
- **200 MHz to 520 MHz:** ±3 dB

Input Impedance: 2 megohm/4 pF

Maximum Input: 200 V DC

Accessory No. 84 RF Probe, 200 MHz

Extends the capabilities of the instrument to the measurement of RF voltage from 1 kHz to 200 MHz at levels up to 25 volts. The probe converts the RF signal to the DC equivalent voltage.

Specifications

Accuracy
- **1 kHz to 10 MHz:** ±(1% input + 50 mV)
- **10 MHz to 100 MHz:** ±(1 dB Input + 50 mV)
- **100 MHz to 200 MHz:** ±(3 dB input + 50 mV)

Input Impedance: 1.6 megohm/7 pF

Maximum Input: 125 V rms AC, 60-400 Hz; 250 V DC

Current Shunts

Accessory No. 85 Model 651 Current Shunt Set

The Model 651 Current Shunt Set consists of six precision shunt assemblies designed to plug into the input terminals of a digital voltmeter. Each shunt is clearly marked with the full-scale range that is established for the DVM. All six are packaged in a wooden box lined with formed foam to prevent loss or damage of the shunts.

Specifications

Resistance Value (current ranges)
- **0-1000 mA shunt:** 0.1 ohms
- **0-100 mA shunt:** 1.0 ohms
- **0-10 mA shunt:** 10 ohms
- **0-1 mA shunt:** 100 ohms
- **0-100 μA shunt:** 1000 ohms
- **0-10 μA shunt:** 10,000 ohms

Accuracy: ± .01% plus DVM accuracy

Overrange Current without Damage: 500%

Temperature Coefficient
- **0-1000 mA & 0-100 mA shunts:** 20 ppm/°C
- **0-10 mA shunt:** 10 ppm/°C
- **0-1 mA & μA shunts:** 5 ppm/°C

Connectors: Banana plugs and jacks

Dimensions
- **Shunt Body:** 32 H × 15.9 W × 15.9 D mm (1¼ H × ⅝ W × ⅝ D inches)
- **Shunt Set Box:** 165 H × 88.9 W × 50.8 D mm (6½ H × 3½ W × 2 D inches)

Accessory 91 Twenty Ampere Shunt

The 91 allows any DC digital voltmeter to be used as high current ammeter to 20 amps.

Input Cables and Probes

Accessory No. 80 Input Cable

This is a 5 foot (1.5 meters) shielded cable with hooded alligator clip probes and dual banana plug for mating the cable to the instrument. Especially useful in high noise environments.

Accessory No. 88 Deluxe Test Lead Set

Designed to withstand the everyday on-the-line use in production testing or field use. The probes come equipped with assorted tips and carrying case.

Accessory No. 89 Standard Test Lead Set (not shown)

Standard test leads with 90 degree banana plugs and replaceable "phonograph needle" tips.

Accessory No. 403764 Shielded Cable with Stackable Tips

This is a 5 foot (1.5 meter) shielded cable with solderless pin tip, stack-up probes and dual banana plug for mating to the instruments.

Carrying Case

Accessory No. 61 Carrying Case

Designed to provide protection for portable models, the carrying case also allows storage space for leads, manuals and other accessories.

GPIB Cables

These cables contain molded connectors on both ends to allow direct connection between any instrument with IEEE-STD-488 interface. Three lengths are available, all conform to the requirements of IEEE-STD-488, 1978.

Ordering Information

Model 641: 10 kV High Voltage Probe

Accesssory 82: 5 kV High Voltage Probe

Model T10: Temperature Probe

Accessory 84: 200 MHz RF Detector Probe

Accessory 90: 520 MHz RF Detector Probe

Accessory 85: Current Shunt Set (Model 651)

Accessory 91: 20 Amp Current Shunt

Accessory 80: Shielded Input Cable

Accessory 88: Deluxe Test Lead Set

Accessory 89: Standard Test Lead Set

Accessory 403764: Stackable Shielded Input Cable

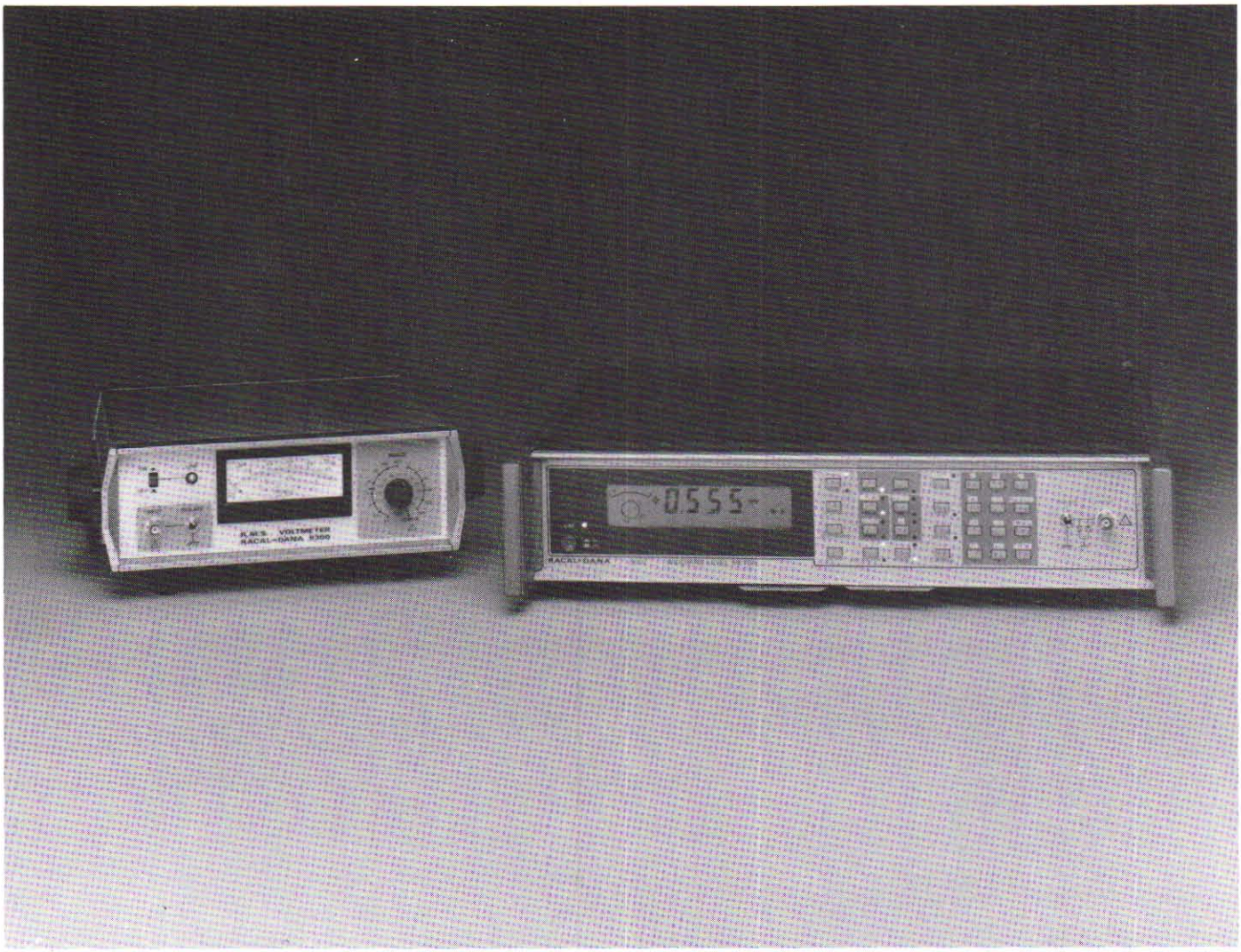
Accessory 61: Carrying Case

Accessory 406845: GPIB Cable (1 meter)

Accessory 406844: GPIB Cable (2 meter)

Accessory 406846: GPIB Cable (3 meter)

AC Voltmeters
General Information



Introduction

The need for wideband AC Voltmeters has expanded so that now almost every ATE system and laboratory or shop bench must include this versatile instrument. Applications include power supply testing, noise measurements, measurements of transducer outputs, and amplifier/attenuator testing.

Racal-Dana provides a model perfect for each application. The Model 9300 is an analog true rms voltmeter for low-cost system applications. The Model 5002 expands the measurement capability to include peak and average measurements as well as AC power.

Featuring the Racal-Dana "pseudo-analog meter" and a digital readout, the 5002 is a total solution to more demanding bench and systems applications. Both of these voltmeters feature our patented true rms converter and our patented noise-cancelling circuit.

True rms

When measuring distorted signals or non-sinusoidal waveforms, it is important that the measurement be made in terms of the true rms value. The rms value of an AC waveform is equivalent to the DC value which would produce the same heating effect in a purely resistive load. A true rms circuit makes accurate measurements even if the waveform is not a pure sine wave.

The major limiting factors in most true rms circuits are bandwidth and crest factor.

Bandwidth

The energy in a non-sinusoidal waveform is distributed between the fundamental and harmonic frequencies. Therefore, to make an accurate measurement of the rms value, the true rms circuit must have sufficient bandwidth to include the harmonic frequencies. If, for example, a 5 MHz signal with significant 3rd Harmonic distortion is to be accurately measured, then the voltmeter must have a bandwidth of at least 15 MHz.

Racal-Dana's patented true rms circuit features a 3 dB bandwidth to 60 MHz to assure accurate measurement over a frequency range of 5 Hz to 20 MHz.

Crest Factor

The ability of true rms circuits to accept signals with a high crest factor is another important measure of their usefulness. This is especially important when measuring noise or pulse signals. Crest factor is the ratio of the peak value to the rms value of the voltage.

To assure accurate measurements and eliminate signal clipping and circuit saturation—major causes of measurement error—Racal-Dana's patented true rms circuit provides a broad dynamic input voltage range capable of measuring signals with crest factors of up to 7:1 at full scale.

The combination of wide bandwidth and high crest factor capabilities makes the Racal-Dana true rms voltmeters the best available anywhere.

Noise Canceling

AC voltmeters are used very often for nulling and other low level measurement applications. In these applications, it is important to have the best sensitivity possible. Sensitivity is defined as the lowest signal that can be observed on the meter.

The limiting factor on most voltmeters is inherent noise in the measuring circuitry. All Racal-Dana analog voltmeters use our patented noise canceling circuit. This allows us to achieve greater than 10 times the sensitivity of traditional AC voltmeters.

The Racal-Dana true rms technique consists of three major elements, a squaring, average and square root circuit. Input voltage is fed into the squaring circuit and from there through the averaging module to the square root elements.

Total voltage is simple to calculate:

$$V_T = \sqrt{V_s^2 + V_n^2}$$

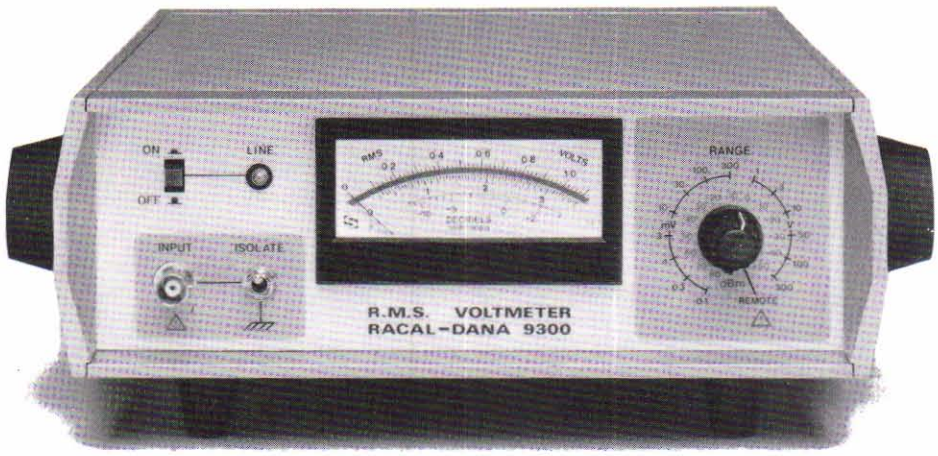
V_T = Display Value
V_s = Input Voltage
V_n = Inherent Noise

If there is no input signal, the V_s^2 goes to zero, thus producing a square value of the noise. This value is subtracted by the patented noise canceling circuit to produce a measured rms voltage equal to the square of the input voltage. This is then applied to the square root circuit to achieve the V_T.

AC Voltmeter Model Summary

Model	Description	Voltage Ranges	Frequency Range
9300	True rms voltmeter. Provides rms reading of complex signals. Programmable and has DC output for driving DVM or recorder.	100 μV to 316 V rms 14 ranges	5 Hz to 20 MHz (–3 dB at 60 MHz)
5002	Wideband AC Level Meter. Provides true rms, peak, and average responding measurements. Features both voltage and power measurements in absolute or logarithmetic (dB) values.	100 μV to 316 V rms 14 ranges 1 mV to 316 V peak and mean, 12 ranges	RMS: DC–20 MHz Mean: DC–10 MHz Peak: DC–10 MHz

AC Voltmeters
True RMS Voltmeter
Model 9300



Introduction

The Model 9300 is an analog, true rms, AC voltmeter featuring wide bandwidth of 5 Hz to 60 MHz and a dynamic measurement range of 10 microvolts to 316 volts.

The instrument is probably the most sensitive wide-band, true rms AC voltmeter in the world. With a basic accuracy of ±1% of full scale and less than 10 microvolts of residual noise, the 9300 is ideal for research, production, and service applications.

Its rugged metal case provides RFI shielding and added protection for field use. While its small size makes it ideal for laboratory and field applications, the DC analog output and remote programming allows easy use in production or ATE systems.

True rms

Using a patented true rms circuit that is fast acting, wide-band, and virtually impossible to damage, the 9300 provides true rms reading over its entire voltage and frequency range.

The specified frequency range of the 9300 is from 5 Hz to 20 MHz but the frequency response extends well beyond 60 MHz, the nominal 3 dB point. This ensures that it can handle the harmonic content of distorted signals — and therefore make true rms measurements over its full 20 MHz bandwidth.

Negligible Inherent Noise

The Racal-Dana patented noise-canceling circuit used in the 9300, when combined with the 100 microvolts range, allows measurements to be made down to 10 microvolts. This usable sensitivity opens up a whole new field of precision wide-band voltage measurement.

Wide Range

The 9300 has a total voltage measuring range of 10 microvolts to 316 volts — approximately 150 dB. It is therefore capable of making most measurements in the audio and video frequency bands — from component noise levels to high power amplifier outputs.

Its high sensitivity and low residual noise offer major advantages when making noise measurements in wideband circuits.

Many Applications

Providing 14 ranges scaled in both voltage and dB, the 9300 is ideal for such applications as noise measurement, power supply ripple testing, amplifier gain testing, transducer testing, audio measurements, telecommunications testing, and even many HF measurements.

Specifications

AC Voltage

Frequency Range: 5 Hz to 20 MHz (usable to 60 MHz)

Ranges: 100 μV to 316 V rms full scale in 14 ranges

Lowest Reading: 10 μV

Meter Scales: 0.1 to 1.1
0.3 to 3.5
−12 to +3 dB

dB Reference: 0 dB = 1 mW into 600 ohms

Input Impedance: 1 megohm shunted by less than 40 pF.

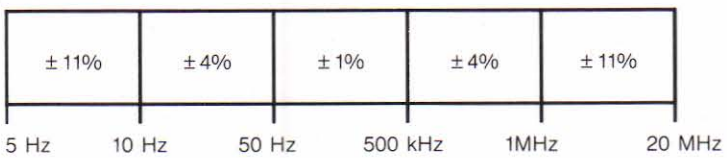
Maximum Input: 500 V DC + Peak AC all ranges

Crest Factor: 7:1 at full scale

Residual Noise: <10 μV with input shorted

Response Time: <2 seconds

Accuracy (23°C ±5°C): All ranges — % of full scale



General

Input Isolation: Input circuitry is isolated from chassis ground by two back-to-back diodes to prevent ground loops. This can be bypassed by operating the isolator switch on the front panel.

DC Output Level: 0 to 1 volt for zero to full scale deflection
Source Impedance: 1 kilohm ±2%
Isolation: Output low connected to isolated input low terminal

Operating Temperature: 0°C to +55°C

Storage Temperature: −40°C to +70°C

Humidity: 95% RH at +40°C

Power Requirements
Voltage: 100, 120, 220, 240 V AC ±10%
Frequency: 45 to 440 Hz
Consumption: 5 VA

Dimensions: 83 H x 241 W x 268 D mm
(3.2 H x 9.45 W x 10.55 D inches)

Weight: 2.5 kg (5.5 lb.)

Options

BCD Interface—Option 02

Programmable Functions: Range and reading hold

Isolation: Opto-isolated

Format: 4 line BCD

Levels:
0: +0.8 V to −15 V
1: +2.4 V to +15 V

Rear Input: An isolated rear BNC input is provided in addition to the front input supplied.

Accessories for Model 9300

A full range of accessories is available to support the Model 9300. These expand the versatility of the unit and enhance your measuring capability when using Racal-Dana precision analog voltmeters.

Model 9932C—GPIB Interface

Allows the 9300 with Option 02 to be programmed from the GPIB. Ranges may be programmed by the 9932 and a DC output can be digitized by use of a DVM to allow total systems use of the analog voltmeter.

Carrying Case

Accessory No. 15-0444 Soft carrying case.

The soft carrying case protects your voltmeter and provides space for leads, manuals, and small accessories.

Accessory No. 15-0450 Rigid carrying case.

The rigid carrying case provides firm protection and storage space for manuals, leads, etc.

Ordering Information

Model 9300: True rms AC Voltmeter

Options

02: BCD interface

9932C: GPIB interface

11-1126: Rack-mounting adapters

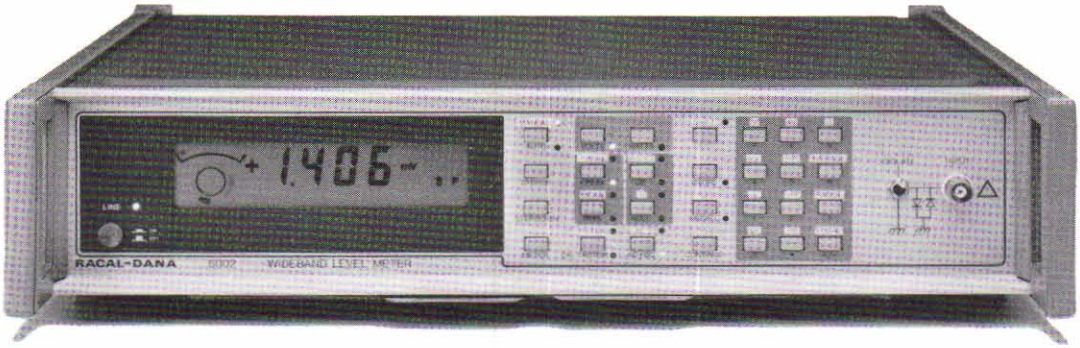
Accessories

23-3293: BNC to double banana adapter

15-0444: Soft carrying case

15-0450: Rigid carrying case

AC Voltmeters
Wideband Digital Level Meter
Model 5002



Introduction

The Model 5002 is the most versatile wideband AC voltmeter available. Featuring a frequency range of DC and 5Hz to 20MHz, the 5002 employs the microprocessor power to make measurements of voltage, power or ratio. Three types of detection provide a wide choice of voltage or power measurements. Results can be displayed in volts, watts, absolute ratio, dBm, relative decibels, percentages, scaled value, or differences relative to internally stored values.

All readings are displayed on a large, four-digit LCD display which incorporates units annunciators and a pseudo-analog "meter" for peaking and nulling applications.

The 5002 is easy to use both as a bench instrument and in systems applications. The GPIB (IEEE-STD-488) interface provides full programming and data output capabilities.

Multiple Detection Circuits

The Model 5002 features three types of AC detection circuits – true rms, averaging (mean) and peak. The detection circuits may be individually selected or combined with the microprocessor to measure a variety of signal characteristics. The 5002 will measure the following signal values in either volts, watts or dBm:

DC Level
True rms AC
True rms, AC + DC
Peak, positive or negative
Average (mean)

In addition, the microprocessor-enhanced performance feature allows the 5002 to measure these additional values:

Peak-to-peak
Averaged Peak
Peak Hold
Average (mean) scaled to rms of sinewave
Crest factor
Form factor

Broad Dynamic Range

The Model 5002 features a dynamic range of over 140dB. Use of the Racal-Dana noise cancelling circuit allows rms measurements to be made of values as low as 30μV. In addition, all ranges are protected up to 350 volts rms (500 volts peak).

Full Function Peak Measurements

The peak detectors in the Model 5002 may be used to measure either positive or negative peak values. In addition, by using the microprocessor-enhanced performance, peak-to-peak values may be computed and displayed. This broad flexibility is especially useful for measurement of signals associated with shock and vibration testing. The wide bandwidth also makes the 5002 a perfect choice for testing spikes associated with switching power supplies.

Variable Signal Smoothing (Digital Filtering)

In order to minimize reading jitter and retain fast response, a form of digital filtering or smoothing can be applied by averaging the detected values. The Model 5002 allows averaging to be varied between 100 milliseconds and 99.9 seconds in 100 millisecond steps.

Power Measurements

The Model 5002 displays power when the "WATTS" key is depressed. This is computed by squaring the voltage reading and dividing by the value in the ohms reference memory.

Power computation is done before ratio, dB, percentage or null calculations, so that these functions can all be applied to power measurements.

AC Voltmeters
Wideband Digital Level Meter
Model 5002

Ideal for ATE System Use

The 5002 provides a GPIB interface for systems applications. An optional optically isolated interface is also available. This interface, combined with a front panel "isolate" switch, assures measurement isolation from system noise.

Automatic timeouts ensure that the first reading is correct after range or function changes. Complete measurement settings may be stored and recalled from non-volatile memory to provide increased system speed.

Microprocessor-Enhanced Performance

The microprocessor in the 5002 allows a wide variety of answers to be displayed. Both voltage and power measurements may be converted to dB, ratio, % deviation, or offset.

Specifications

Frequency Range: DC and 5Hz to 20MHz (3db frequency typically 40MHz)

Voltage Range: 30μV to 316V (10μV detectable) RMS
316μV to 316V Peak and Mean

Ranges

RMS: 100.0μV, 316.2μV, 1.000mV, 3.162mV, 10.00mV, 31.62mV, 100.0mV, 316.2mV, 1.000V, 3.162V, 10.00V, 31.62V, 100.0V, 316.2V

Peak and Mean: 1.000mV, 3.162mV, 10.00mV, 31.62mV, 100.0mV, 316.2mV, 1.000V, 3.162V, 10.00V, 31.62V, 100.0V, 316.2V

Ranging: Autorange or manual front panel selectable
Autorange at 31.5% and 115% of range

Power Range: 18pW to 2kW in a 50Ω system
Computed as $\frac{V^2}{R}$ where R is the external load resistance
(0.0001 ohms<R<9999 ohms)

Input Impedance: 1 Megohm/50pF

Maximum Input: 350V rms up to 140kHz. Thereafter not to exceed 5.0×10^7 V.Hz

Crest Factor: 4:1 at full scale (300μV to 100V) increasing to 12:1 at one third of full scale

Display Resolution: 0.1% range

Decibel Resolution: 0.01 dB

Measurement Modes

RMS: Measures the true rms value of the input signal. AC and DC coupling ensures valid measurements on waveforms with DC components.

Mean: On AC, the rectified mean of the signal is measured. On (AC+DC) the AC component is removed and the DC component is measured.

Peak: On AC, the positive or negative peak of the signal relative to its mean or DC value

Cal-Factor

The Cal-factor may be used to scale input readings. This mode performs the following calculation:

$$\text{Display} = \frac{\text{Input Reading}}{\text{value in Cal-factor memory}}$$

This function may be used for storing correction factors or for scaling transducer output to physical units.

Non-Volatile Memory

The 5002 features a non-volatile memory for storage of measurement setups. Up to 12 complete front panel settings may be stored. This allows use by lower skilled personnel or faster systems operation.

(Peak cont.): is measured. On (AC+DC) it measures the positive or negative peak relative to 0 volts.

Peak-to-Peak: Displays the algebraic difference of the positive and negative peaks.

Voltage Accuracy

(50Hz to 500kHz (see also frequency response curve) 23°C±5°C, 30% to 100% Range)

AC

RMS: 0.5% Reading +0.5% Range +4μV

Mean: 1.5% Reading +0.5% Range +30μV

Peak: 1.5% Reading +0.5% Range +100μV

AC+DC

RMS: 0.7% Reading +0.5% Range +30μV

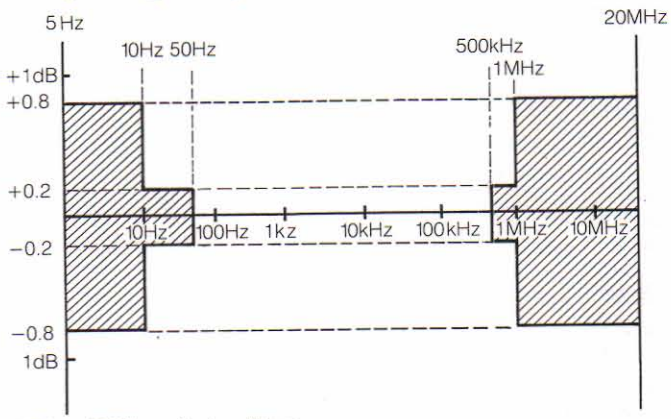
Mean: 0.5% Reading +0.5% Range +60μV

Peak: 1.5% Reading +0.5% Range +130μV

DC

All: 0.5% Reading +0.5% Range +60μV

Frequency Response*



** 5Hz to 10MHz on Peak and Mean.*

AC Voltmeters
Wideband Digital Level Meter
Model 5002

Temperature Coefficient

Mode	For All Ranges	For 10mV Range and Below
AC	0.04%/°C	Add 0
(AC+DC)	0.10%/°C	Add 10μV/°C
DC	0.10%/°C	Add 10μV/°C

Power Accuracy

Corresponding percentage voltage accuracy multiplied by 2 plus any errors in external load resistance.

Response Times

RMS and Mean: 1 second plus autorange time. A special version is available with 0.1 second response times for frequences ≥50Hz

Peak: 1μS per 20% of range plus autorange time

Measurement Time: Variable 0.1 to 99.9 seconds

Autorange Time: 200mS/step

Microprocessor-Enhanced Computing Functions

Mode	Display
dB	$20 \log_{10} \frac{\text{Vin}}{\text{dB Store}}$
Ratio	$\frac{\text{Vin}}{\text{Ratio Store}}$
Percentage	$\frac{\text{Vin} - \%\ \text{Store}}{\%\ \text{Store}} \times 100$
Null	Vin – Null Store
Cal Factor	$\frac{\text{Vin}}{\text{Cal Factor Store}}$

GPIB Interface

Programming Control: All front panel functions are duplicated by the GPIB except POWER ON/OFF METER and ISOLATE switches

Non-Volatile Memory: 12 front panel settings, including all calibration and reference constants, can be stored or recalled by a single GPIB command

Automatic Timeout: Software delays ensure that first readings are correct after range or function changes

Read Rate: The maximum read rate over the GPIB is 10 readings per second

Subset Capability: SH1, AH2, T5, TE0, L4, LE0, SR1, RL1, PP0, DC1, DT1, C0 and E1.

General

Display: 4 digit, 16mm liquid crystal display with units annunciation and 1% resolution analog indication

Signal Smoothing: Digital averaging from 0.1 to 99.9 seconds

Power Requirements: 100, 120, 220, 240 +5% –10% 45–440Hz
Approximately 40V A

Environmental: Operating temperature range 0°C to +55°C
Storage temperature range –40°C to +70°C

Weight: Nett 6.75kg (14.91lb)
Shipping 11.0kg (24.2lb)

Ordering Information

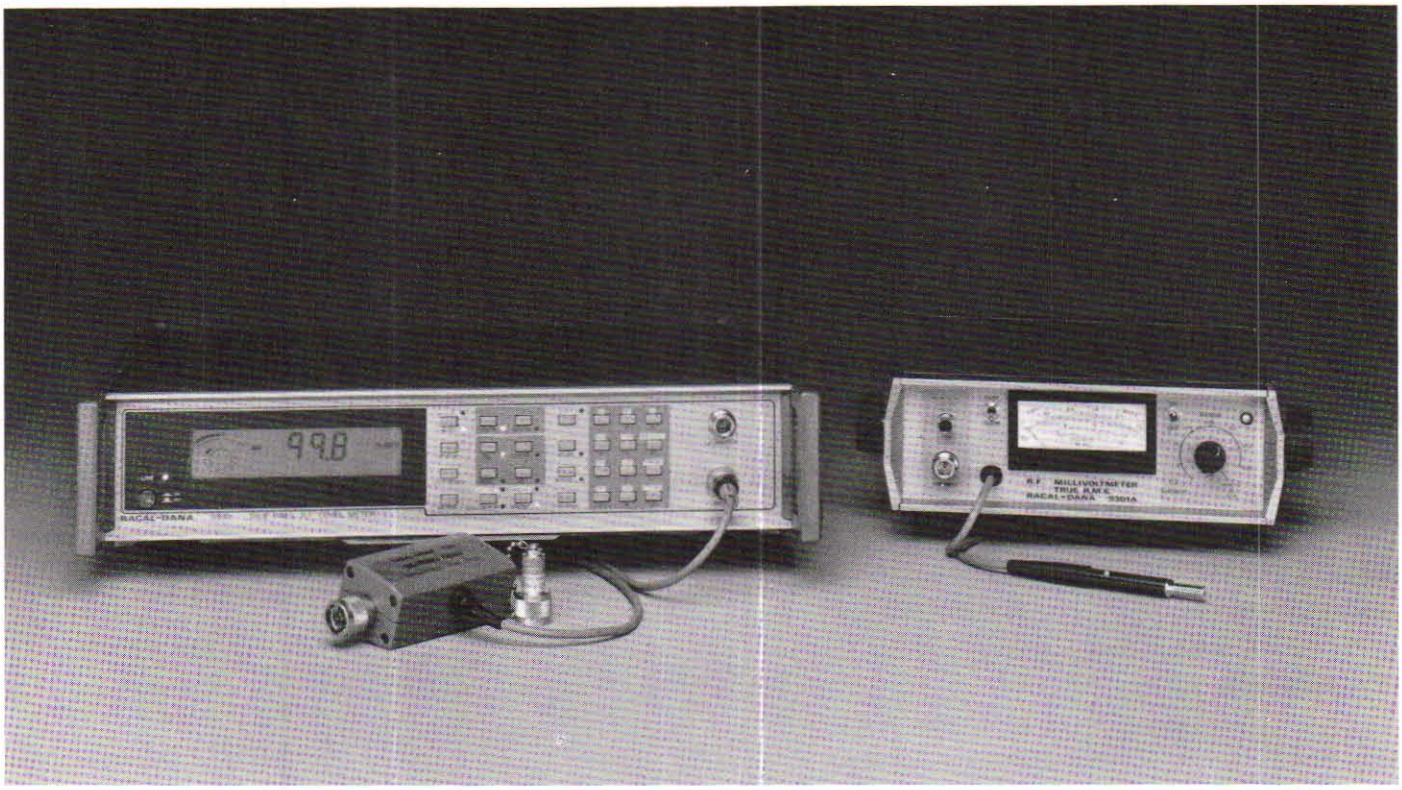
Model 5002: Wideband AC Level Meter (Including GPIB Interface)

Options

01: Rear input
60: Rack mount kit
65: Chassis slide/rack mount kit
CS093: Full accuracy at 10 reading/second (frequency range limited to ≥50Hz)
550: Optically isolated GPIB interface

Accessories

406845: GPIB Cable (1 meter)
406844: GPIB Cable (2 meters)
406846: GPIB Cable (4 meters)
Model 1002: GPIB Thermal Printer



Introduction

All Racal-Dana RF Millivoltmeters feature the patented true rms circuits discussed in detail under the AC voltmeter section of this catalog. The rms circuits have good accuracy, excellent temperature stability, wide dynamic range, high overload protection, and high reliability at an economical price. Use of the Racal-Dana patented noise canceling circuit allows measurement to be made down to 30 μV.

Sampling

The low noise rms converters are extended over a bandwidth of 10 kHz to 2 GHz through the use of extended-time sampling techniques. Unlike real-time sampling (that requires a sampling rate greater than the signal frequency), extended-time sampling allows a lower frequency sampling rate.

In extended-time sampling, the signal frequency is greater than the sampling frequency. The sampling circuit converts frequency and retains the wave shape of input signal. This is achieved through the use of a sampling mixer which is able to accept input signals over a wide frequency range. The sampling frequency, however, need only cover a narrow band. This technique means that an exceptionally wide bandwidth can be covered with a single local oscillator — a considerable advantage over the conventional mixer. These random sampling techniques which are used in both the models 9301A and 9303, cover the range from 10 kHz to 2 GHz and retain the essential peak, average and rms values of the original input signal. This makes it relatively easy to obtain an accurate true rms measurement of any wideband signal.

RF Millivoltmeter Model Summary

Model Number	Display		Frequency Range	Voltage Ranges			Basic Accuracy	Power	Ratio	Computing	GPIB
	Digital	Analog		Number	Lowest	Highest					
9301A		X	10 kHz to 1.5 GHz	8	1 mV	3V	±(1.5% reading + 1% range)				
9303	X	X	10 kHz to 2 GHz	9	300 μV	3V	±(2.5% reading + 0.1% range)	X	X	X	Option

X = Standard Feature

RF Voltmeters
Analog RF Millivoltmeter
Model 9301A

Introduction

The Model 9301A is a wide band millivoltmeter designed to meet the requirement of the communications industry for accurate true rms measurement of RF sinusoidal, pulse and noise waveforms. It provides exceptional accuracy over a frequency range from 10 kHz to 1.5 GHz and can be used as an indicator up to 2 GHz. Using a dual sampling process followed by rms conversion, it gives true rms readings at all frequencies and over the complete voltage range of 100 microvolts to 300 volts. The true rms characteristics ensure accurate readings on distorted signals and make the instrument ideal for wide band noise measurement.

Applications

Typical applications in the laboratory, production test and service areas include measurement in amplifiers, receivers, filters and many types of transmission paths. In addition, the 9301A can be used for measuring broadband noise — its sensitivity and low inherent noise are such that measurement of residual noise in wide-band circuits becomes practical.

For system applications, the 9301A features remote programming and a DC output.

High Accuracy

The sampling system employed in the 9301A gives a frequency response which is independent of voltage range and virtually unaffected by temperature changes from 0 to 55°C. Its true rms reading capability means that accuracy is not influenced by harmonic distortion of sinusoidal waveforms. For these reasons the accuracy can be quoted and guaranteed under all operating conditions.

Probe Unit

The probe unit incorporates a sampling circuit that is linear down to a few microvolts, has a frequency response over 1.5 GHz, and has the same wide temperature operating range (0 to 55°C) as the main instrument.

It is calibrated for optimum accuracy when used in terminated 50 ohm systems, but may be adapted to high impedance systems by using the isolator tip. The tip is accurate to within ±3% up to 200 MHz.

Built-In 50 Ohm Load

The 9301A features a 50 ohm termination built into the instrument. This eliminates the need for external accessories in many applications and provides a 50 ohm termination with excellent VSWR.

Measurement in 75 ohm circuits may also be made on the same termination by employing a 50 to 75 ohm adapter.

Type N Tee Connector

An optional type N tee connector is available which can be connected to allow the probe to be used for in-line measurements in terminated 50 ohm systems.

Residual Noise

The 9301A employs a unique noise-canceling circuit that reduces the residual noise to a value of less than 20 microvolts — a figure at least an order better than that obtainable on other wide-band millivoltmeters. Measurement to below 100 microvolts can now be made with ease.

Dual Time Constant

The 9301A provides a choice of two time constants selected by a switch on the front panel. In the 'slow' position, the response is optimized to large and rapid changes of signal amplitude while retaining the inertia necessary to minimize the effect of jitter. A quicker response is achieved simply by selecting the 'fast' position which is ideal for applications such as transmitter peaking or tuning.

Read/Hold Capability

The probe provides a "press to hold" button which allows readings to be held for up to 3 minutes. This is valuable when measurements need to be made in positions where the operator is unable to observe the meter and position the probe at the same time.

Specifications

RF Input

Voltage Ranges: 1 mV to 3 V rms full scale in 8 ranges. Lowest reading 100 μV

Frequency Range: 10 kHz to 1.5 GHz (usable as an indicator to 2 GHz)

Input Impedance Probe: 100 kilohm in parallel with less than 3 pF

Probe with Isolation Tip: 100 kilohm in parallel with less than 10 pF

Internal Terminated Input: 50 ohm, VSWR 1.1 to 1 GHz

Accuracy (Using internal 50 ohm termination)

20°C to 25°C	±1% FS ±1.5% Reading	±1% FS ±6.5% Reading	±1% FS ±11.5% Reading
0°C to 40°C	±3% FS ±2% Reading	±3% FS ±7% Reading	±3% FS ±12% Reading
	10 kHz	500 MHz 1 GHz*	1.5 GHz*

*With use of calibration chart above 500 MHz

Maximum Input to Probe: 100 V DC. 20 V AC p-p

Crest Factor: Greater than 12 dB at full scale on all ranges up to 1 volt increasing inversely for reading below full scale, e.g. 18 dB at half scale

Meter

Read/Hold Accuracy: Within 0.5% for 3 minutes

Response

Slow: <3 seconds to final value with zero to full scale step

Fast: <1 second to final value with zero to full scale step

Jitter: <1% with meter response in slow

BCD Interface

DC Output: 0 to −1 V for zero to full scale from 1 kilohm source

Programming: Voltage ranges are programmable by BCD code. TTL levels.

General

Power Requirements

AC: 94 to 130 V and 188 to 260 V 45 to 440 Hz

DC: ±17 to 25 V

Consumption: 8 V A

Operating Temperature: 0°C to +55°C

Storage Temperature: −40°C to +70°C

Humidity: 95% RH at +40°C

Dimensions: 83 H × 241 W × 268 D mm
(3.2 H × 9.45 W × 10.55 D inches)

Weight: 2.5 kg (5.5 lb)

Standard Accessories

Probe Isolation Tip

Frequency Range: 10 kHz to 200 MHz

Accuracy: ±3% of reading

Impedance: 100 kilohm in parallel with <10 pF.

Spare Probe Tips

Flexible Ground Lead

Ground Clip-Prod

Optional Accessories

50 Ohm Tee Connector—Option 11-1353

Frequency Range: 10 kHz to 1.5 GHz (usable to 2 GHz)

VSWR: Better than 1.1:1 when the output is terminated in a load with a VSWR not greater than 1.05:1 and the probe is inserted and powered.

Insertion Loss: 0 dB up to 300 MHz
0.3 dB ±0.2 dB up to 500 MHz
1.0 dB ±0.5 dB up to 1 GHz
7.0 dB ±1.4 dB up to 1.5 GHz

Maximum Input: 18 V AC p-p
±100 V DC

Dimensions: 100 H × 25 W × 37 D mm
(4 H × 1 W × 1.5 D inches)

Connections: Type N Female

Probe/BNC Adapter—Option 11-1131

Description: Adapts probe or isolator to BNC male connector

20 dB Attenuator—Option 11-1155

Accuracy: ±6% of reading from 10 kHz to 500 MHz

Impedance: 100 kilohm in parallel with less than 3 pF

40 dB Attenuator—Option 11-1156

Accuracy: ±6% of reading from 1 MHz to 500 MHz

Input Capacitance: Less than 3 pF

75 to 50 ohm Adapter—Option 23-3230

Voltage Attenuation: 10 dB

Accessory Box—Option 11-1162

Description: Provides storage of accessories listed above

Accessory Kit—Option 11-1371

Description: Includes Accessory Box (Option 11-1162) plus Options 11-1131, 11-1155, 11-1156, and 23-3230

Ordering Information

Model 9301A: True RMS RF Millivoltmeter

Accessories

11-1126 Rack mounting kit
11-1131 Probe to BNC adapter
11-1155 20 dB attenuator
11-1156 40 dB attenuator
11-1162 Accessory box
11-1353 50 ohm tee connector
11-1371 Accessory kit
15-0444 Soft carrying case
15-0450 Rigid carrying case
23-3230 75 to 50 ohm adapter

RF Voltmeters
Autoranging, Digital RF Level Meter
Model 9303

Introduction

The Model 9303 is the most versatile, wide-band, RF millivoltmeter available. Operating over the frequency range 10 kHz to 2 GHz and level range 30 μV to 3 V, the 9303 employs microprocessor power to make measurements of true rms voltage, power or ratio. It can display the answers in volts, watts, absolute ratio, and decibels, percentages, or differences relative to internally stored values.

All readings are displayed on a large four digit LCD display which incorporates units annunciators and a pseudo-analog "meter" for peaking and nulling.

For maximum accuracy, measurements can be made with either one or two precision 50 ohm tee heads. Standard high impedance oscilloscope probes may be used for limited bandwidth applications.

The 9303 may be used as a bench instrument or in system applications with full programming and data output from the optional GPIB interface.

Digital Calibration

The 9303 features the digital calibration concepts pioneered in Racal-Dana digital multimeters. These techniques make the 9303 one of the most accurate RF instruments available.

Automatic Self-Calibration

All internal measuring circuits are calibrated automatically under microprocessor control. An internal calibration generator is switched in place of the tee head at appropriate intervals and calibration corrections made to the measuring circuits. The calibration sequence can be inhibited by the user if desired and can be initiated at any time.

Tee Head Calibration

The tee heads used with the 9303 are fully interchangeable, and a calibrating feature is incorporated to enable the instrument to be standardized to any tee head. A stable 0 dBm signal (223.6 mV or 1.000 mW) is provided from connectors on the front and rear panels. An accurate external source may be used if calibration at a particular frequency is desired. After connecting the tee head to the source, calibration is initiated by pressing the "EXT CAL" key. The instrument then measures the input applied to the head and computes a correction factor that will be applied automatically to all future measurements made by that head.

When two heads are used, one on the front and one on the rear socket, both can be calibrated by using the "FRONT" and "REAR" keys. Both correction factors will then be stored and will be automatically applied to whichever head is switched in circuit.

This calibrating procedure can also be employed to correct for an attenuator used in front of the head for high level measurements or for an oscilloscope divider probe used with the head.

Automatic Frequency Response Correction

Each tee head is individually calibrated for frequency response, and carries a label showing the calibration curve. Correction factors from this curve can be entered into the instrument to enable the display to be automatically corrected for frequency.

Variable Signal Smoothing

In order to minimize reading jitter while retaining fast response, a form of selectable smoothing can be applied by averaging the input signal. The 9303 allows the averaging to be varied between 0.1 second and 99.9 seconds in 0.1 second steps.

Multi-Function

The 9303 provides both voltage and power measurements to allow the user full flexibility of measurement choice.

The 9303 measures the true rms voltage of any signal in the frequency range 10 kHz to 2 GHz and level range 30 μV to 3V. It has a basic accuracy of 1% and will deal with crest factors between 14 dB and 24 dB according to range and input level.

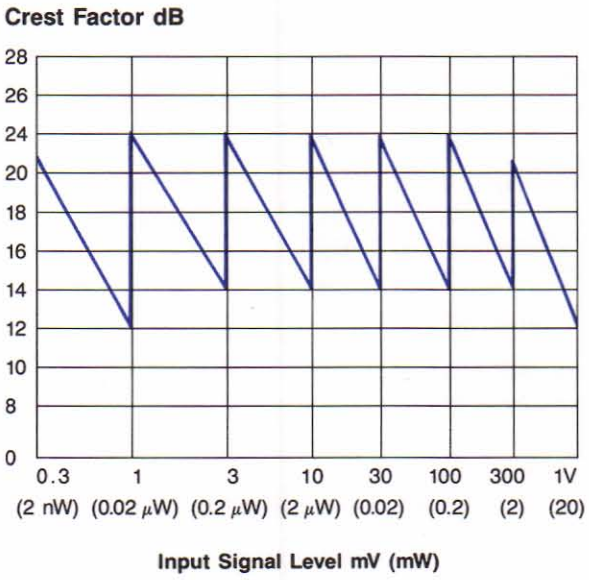


Figure 1. Maximum Crest Factor

Power Measurements

The 9303 displays power when the "WATTS" key is depressed. This is computed by squaring the rms voltage reading and dividing by the value in the ohms reference memory. The power range with 50 ohms reference is 18 pW to 180 mW. This can be extended by the use of suitable attenuators in front of the tee-head (to 1.8 kW).

Since the 9303 responds accurately to rms values, it provides true power readings of complex and distorted waveforms as well as of pure sinewaves. Power computation is done before ratio, dB, percentage or null calculations, so that these functions can all be applied to power measurements.

Computing Functions

The microprocessor in the 9303 allows a wide variety of answers to be displayed. Both voltage and power measurements may be converted to dB, ratio, % deviation, or offset.

Decibels

The decibels mode performs the following calculation on voltage values:

$$\text{Decibels} = 20 \times \log_{10} \frac{\text{(input voltage)}}{\text{(voltage value in dB memory)}}$$

Both the input and the dB reference can be in terms of power, in which case the instrument converts the values to volts before carrying out the above calculation.

The instrument powers up with 223.6 mV (1 mW in 50 ohms) in the dB reference memory and will therefore indicate dBm directly when called. In these circumstances the display annunciator indicates dBm rather than dB. Other standard references such as 1 volt or 1 microvolt may be entered in the memory with a few keystrokes.

Frequency response or gain/attenuation measurements may be made by storing an input reading taken at a reference frequency or from the input to a device. The instrument then shows variations relative to this standard level directly.

Ratio

The Ratio function displays the input reading divided by the value in the ratio memory. In the power measurement mode, both numbers are converted to equivalent power before the division is performed.

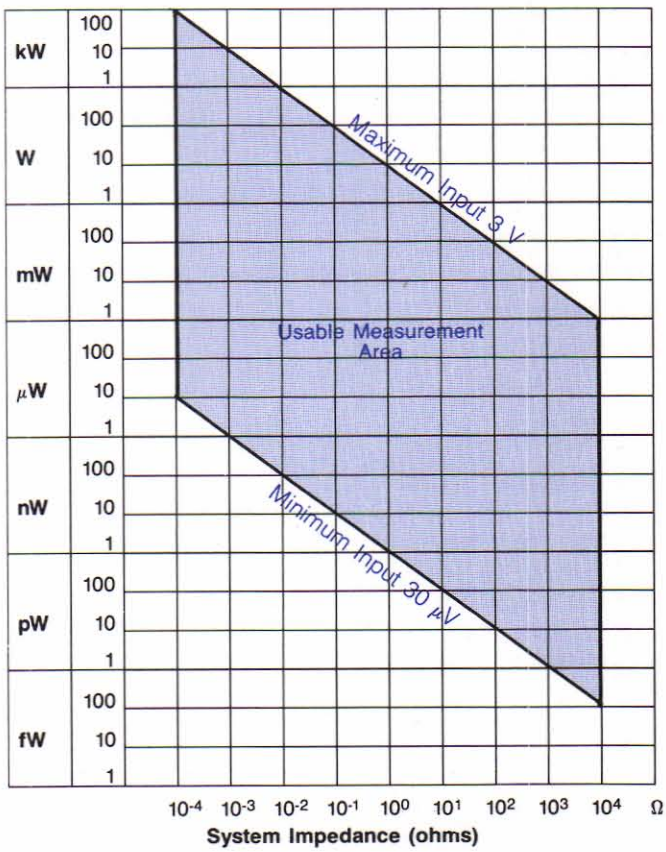


Figure 2. Power Measurement Range

RF Voltmeters
Autoranging, Digital RF Level Meter
Model 9303

Percentage Difference Mode

The percent mode performs the calculation:

$$\text{Percent} = \frac{\text{Input reading} - \text{Value in \% memory}}{\text{Value in \% memory}} \times 100$$

This function is useful when testing between limits. Frequency response checks may also be carried out in this mode.

Null Function

The null function allows the values in the NULL memory to be subtracted from the input reading. This function is especially useful in the power mode where it can be used to cancel the effect of non-coherent noise or interfering signals. For example, background noise produced at a receiver front end can be stored and automatically subtracted from subsequent measurements made with an input signal applied. The 9303 will then read the true IF output power at that signal level corrected for spurious signals and local oscillator break-through.

Specifications (All specifications apply using 50 ohm tee-head terminated with a 50 ohm load)

Input Characteristics

Input Impedance: 50 ohms

Input VSWR: 1.1:1 up to 1 GHz rising linearly with frequency to better than 1.5:1 at 2 GHz

Maximum Input to Tee Head

Without 50 Ohm Load: 20 VAC p-p ±100 VDC
With 50 Ohm Load: 7 V rms AC or DC

Response Time: For maximum accuracy, a time of 3 Sec is required. The response time of the pseudo-analog display is approximately 0.5 Sec

Voltage Range: 31.62 μV to 3.162 V rms

Power Range: 20 pW to 200 mW (50 ohms)

dBm Range: −77 to +23 dBm rms (50 ohms)

Alternate Impedances: See Figure 2

Crest Factor: See Figure 1

Frequency Range: 10 kHz to 2 GHz

General

Display: LCD with 4 decades of digital display plus analog indicator and unit annunciation

Maximum Read Rate: Approximately 10/second

Tee Head Connectors: Type N male and female

Power Requirements

Voltage: 100, 115, 220, 240 VAC ±10%

Frequency: 45 to 440 Hz

Consumption: Approximately 50 VA

Temperature Range

Operating: 0°C to +55°C

Storage: −40°C to +70°C

Humidity: 95% RH at +40°C

Dimensions

9303: 89 H × 427 W × 345 D mm
(3.5 H × 16.8 W × 13.6 D inches)

Tee Head (including connectors)
36 H × 45 W × 130 D mm
(1.4 H × 1.8 W × 5.1 D inches)

Weight: 7.1 kg (15.62 lb)

Ordering Information

Model 9303: Autoranging Digital RF Level Meter.

Options

15: Additional sensing head, 1 meter cable

16: Additional sensing head, 2 meter cable

55: GPIB interface

60: Rack mounts

65: Chassis slides/rack mounting kit

Accessories

Input Probes

11-1512: Probe kit 20 dB high impedance

11-1573: Probe kit 20 dB low capacitance

11-1574: Probe kit 40 dB low capacitance

Precision Attenuators*

23-3413: 20 dB ±0.4 dB, 25 watt

23-3414: 30 dB ±0.75 dB, 50 watt

23-3415: 30 dB ±0.6 dB, 150 watt

*Each unit is fitted with one male and one female type N connector and is supplied with a calibration certificate.

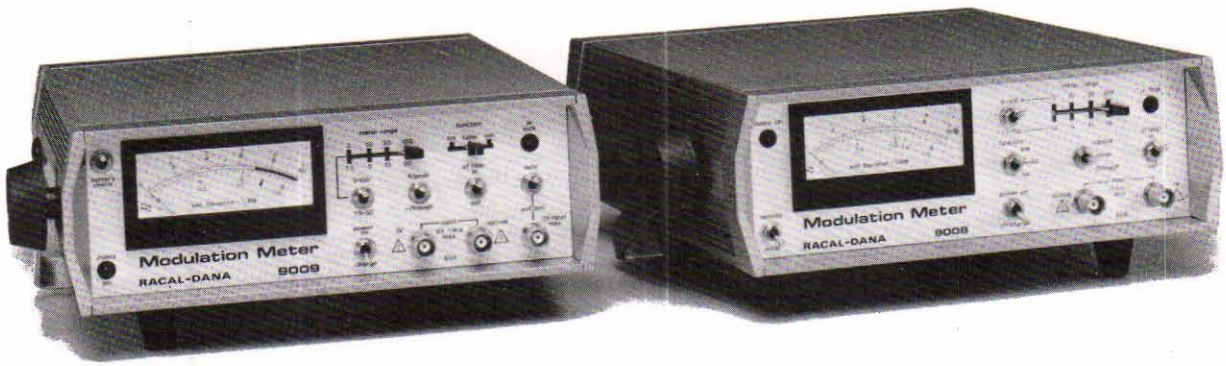
Accuracy: ±(% Reading + % Range)

23°C ±5°C				
	Cal freq.	**10 KHz to 500 MHz**	**500 MHz to 1 GHz**	**1 GHz to 2 GHz**
Voltage	(1.0 + 0.1)	(2.5 + 0.1)	(3.75 + 0.1)	(5.0 + 0.1)
Power	(2.0 + 0.2)	(5.0 + 0.2)	(7.5 + 0.1)	(10.0 + 0.1)

0°C to 55°C				
	Cal. freq.	**10 KHz to 500 MHz**	**500 MHz to 1 GHz**	**1 GHz to 2 GHz**
Voltage	(1.5 + 0.1)	(4.0 + 0.2)	(5.5 + 0.2)	(7.0 + 0.2)
Power	(3.0 + 0.4)	(8.0 + 0.4)	(11.0 + 0.2)	(14.0 + 0.4)

(On 3.162V and 316.2μV ranges, add 1% of reading. On 200mw and 2nw ranges, add 2% of reading. On 316.2 μV range, additional error of ±20μV [±30μV 0°C to 50°C] added as root sum squared.)

Modulation Meters
Automatic
Models 9008, 9009



Introduction

The Racal-Dana Models 9008 and 9009 modulation meters overcome the disadvantages of manually tuned units and provide a simple, unambiguous means of measuring peak, trough, and mean modulation depth of AM signals, or positive, negative, and mean deviation of FM signals.

Automatic tuning and amplitude leveling guarantee measurement accuracy without relying on the personal skill of the operator. These features together with an easy-to-read meter, color-coded front panel markings, and straight forward controls allow the unskilled operator to make precision measurements with confidence.

The lightweight and rugged construction of the 9008 and 9009 make them equally suitable for use in the laboratory, workshop, and (by addition of an optional battery pack) in field applications.

The remote programming features of the 9008 also allow it to be used in ATE systems.

Outputs

The IF and demodulated AF output are both available on the rear panel. An outstanding feature of the demodulated AF output is the low level of harmonic distortion introduced by the instrument—less than 0.5% for deviation up to 100 kHz and AM depths up to 80%. This allows both the 9008 and the 9009 to be used with a distortion factor meter or an LF wave analyzer for making modulation distortion measurements. Both the 9008 and 9009 provide a DC reference output for use with external analog or digital meters—the level is linearly related to meter readings providing 1.0 volt at full scale deflection.

Automatic Operation

Both the 9008 and 9009 use a sampling principle together with search and lock techniques to make fully automatic measurements of AM and FM signals. Once the instrument has tuned itself to the appropriate frequency and made the necessary amplitude adjustment, a lock lamp lights and the modulation depth or frequency deviation is indicated on the meter.

High Resolution Display

Modulation depth and frequency deviation are clearly displayed on a large scale meter.

Eight FM ranges of 1.5, 3, 5, 10, 15, 30, 50 and 100 kHz and six AM ranges of 5, 10, 15, 30, 50 and 100% modulation depth are provided on both models. These have been chosen so that the most common measurements are in the area of greatest meter accuracy.

In particular the 1.5 kHz range is extremely useful for measuring low values of deviation without relying upon an external meter.

Modulation Meter Model Summary

Model Number	Frequency Range	Maximum Peak Deviation	Programmable	Battery Operation	AF Filter Band/Pass
9008	1.5 MHz to 2 GHz	100 kHz	X	Option	300 Hz to 3 kHz
9008M	1.5 MHz to 2 GHz	100 kHz	X		300 Hz to 3 kHz/150 Hz Notch
9009	8 MHz to 1.5 GHz	100 kHz		Option	300 Hz to 3 kHz
9009N	8 MHz to 1 GHz	150 kHz		Option	300 Hz to 3 kHz

Modulation Meters Automatic Models 9008, 9009

The Model 9008 covers a frequency range of 1.5 MHz to 2 GHz. It features a low noise oscillator and a switchable audio filter that combine to offer −52 dB residual FM with reference to a 10 kHz peak deviation at 250 MHz. Remote programming makes the 9008 ideal for ATE system use. A militarized version (Model 9008M) is available with a 150 Hz audio notch filter.

The 9009 covers the frequency range of 30 MHz to 1.5 GHz and may be manually tuned with an external signal generator. It is ideal for laboratory, workshop, and field applications. The Model 9009N version features a 150 kHz peak deviation range and is ideal for military applications.

Specifications

Input Characteristics

Model Number	9008	9009	9009N
Carrier Frequency			
Automatic Operation	1.5 MHz to 2 GHz	30 MHz to 1.5 GHz Automatic measurements can also be made in the bands 10 to 13 MHz and 20 to 27 MHz	25 MHz to 1 GHz Automatic measurements can also be made in the bands 7.5 to 10.5 MHz and 15.5 to 21.5 MHz
Manual Tuning		8 MHz to 1.5 GHz using external local oscillator with a range of 17 to 28 MHz	8 MHz to 1 GHz using external local oscillator with a range of 16 to 32 MHz
Input Level			
Low Input	5 to 100 mV rms up to 500 MHz	10 to 100 mV rms to 500 MHz	50 to 700 mV rms up to 500 MHz
	10 to 150 mV rms from 500 MHz to 1 GHz	20 to 150 mV rms from 500 MHz to 1 GHz	100 to 700 mV rms from 500 MHz to 1 GHz
	20 to 150 mV rms from 1 GHz to 2 GHz	50 to 150 mV rms from 1 GHz to 1.5 GHz	
High Input	50 mV to 1 V rms up to 500 MHz	100 mV to 1 V rms to 500 MHz	500 mV to 7 V rms up to 500 MHz
	150 mV to 1 V rms from 500 MHz to 2 GHz	150 mV to 1 V rms from 500 MHz to 1 GHz	700 mV to 7 V rms from 500 MHz to 1 GHz
Level Setting	Fully Automatic		
Input Impedance	50 Ohms Nominal		

FM Measurement

Model Number	9008	9009 and 9009N
Deviation Ranges	1.5, 3, 5,* 10, 15, 30, 50* and 100 kHz (150 kHz on 9009N) deviation full scale. Measurements of positive and negative deviations can be made. (Also mean deviations on Model 9008)	
Modulation Frequency Range	50 Hz to 30 kHz	
Accuracy	±2% of full scale ±1% of reading at 1 kHz	
Frequency Response	±0.2 dB with respect to 1 kHz from 300 Hz to 3 kHz ±0.5 dB with respect to 1 kHz from 50 Hz to 30 kHz	±0.2 dB with respect to 1 kHz from 300 Hz to 3 kHz ±0.5 dB with respect to 1 kHz from 50 Hz to 10 kHz −3 dB ±0.75 dB with respect to 1 kHz at 30 kHz
Residual FM Noise	−52 dB with respect to 10 kHz peak deviation measured on the AF output with the 3 kHz filter in at carrier frequencies up to 250 MHz then increasing at 6 dB per octave above this frequency	−46 dB with respect to 10 kHz peak deviation measured on the AF output with the 3 kHz filter in at carrier frequencies up to 250 MHz then increasing at 6 dB per octave above this frequency
AM Rejection	Additional deviation is less than 250 Hz with an AM depth of up to 80% and a modulating frequency in the range 300 Hz to 3 kHz.	

*Except 9009N

Modulation Meters Automatic Models 9008, 9009

AM Measurement

Modulation Depth Ranges: 5, 10, 15, 30, 50 and 100% full scale modulation depth. Measurements of peak, trough, (or mean on 9008) AM may be measured.

Modulation Frequency Range: 50 Hz to 30 kHz

Accuracy: ±2% of full scale ±1% of reading at 1 kHz

Frequency Response

Model 9008: ±0.2 dB with respect to 1 kHz from 300 Hz to 3 kHz
±0.5 dB with respect to 1 kHz from 50 Hz to 30 kHz

Model 9009: ±0.2 dB with respect to 1 kHz from 300 Hz to 3 kHz
±0.5 dB with respect to 1 kHz from 50 Hz to 10 kHz
−3 dB ±0.75 dB with respect to 1 kHz at 30 kHz

Residual AM: Less than 1%

IF Output

Frequency

Model 9008: 430 kHz nominal

Model 9009: 500 kHz nominal

Level: 100 mV rms nominal

Output Impedance: 600 ohms nominal

AF Output

Response

Model 9008

Normal: ±0.5 dB over the frequency range 50 Hz to 30 kHz.

Filter In: 300 Hz to 3 kHz at 3 dB points.

Model 9009

Normal: ±0.5 dB over the frequency range 50 Hz to 10 kHz, −3 dB ±0.75 dB at 30 kHz.

Filter In: 300 Hz to 3 kHz at 2 dB points

Level: 1 volt rms ±2 dB at meter full scale

Output Impedance: 600 ohms nominal

Harmonic Distortion

FM: Less than 0.5% for FM deviations up to 100 kHz

AM: Less than 1%, typically 0.5% for AM depths up to 80%

DC Output

Level: 1 Volt ±0.5 dB at meter full scale

Output Impedance: 10 kilohm nominal

Remote Programming

(Model 9008 only)

Function Controlled: AM/FM, Range, Filter, Peak/Trough Mean (+/−/Mean)

Level: TTL Compatible

Battery Pack—Option 07

Type: Rechargeable Nickel/Cadmium

Battery Life: 6 hours continuous operation minimum

Recharge: 14 hours after selecting charge trickle charged during normal operation

General

Power Requirements

Voltage

Model 9008: 94 to 130, 188 to 260 VAC, or 16-0-16 VDC ±4 V

Model 9009: 104 to 126 or 207 to 253 VAC

Frequency: 45 to 440 Hz

Consumption: 15 VA

Applicable Environmental Specifications: IEC 68, MIL-T-28800

Operating Temperature: 0°C to +55°C
0°C to +40°C with battery pack

Storage Temperature: −40°C to +70°C
−40°C to +50°C with battery pack

Dimensions: 83 H × 241 W × 268 D mm
(3.2 H × 9.45 W × 10.55 D inches)

Model 9008: 122 mm (4.8 inches) high with battery pack

Weight

Model 9008: 3.2 kg (7 lb)
With Battery: 5 kg (11 lb)

Model 9009: 2.5 kg (5.5 lb)
With Battery: 4 kg (9 lb)

Ordering Information

Model 9008: Programmable Automatic Modulation Meter

Model 9008M: Militarized Automatic Modulation Meter

Model 9009: Automatic Modulation Meter

Model 9009N: Wide Deviation Automatic Modulation Meter

Options

07: Rechargeable battery pack

11-1126: Rack mounting adapters

Accessories

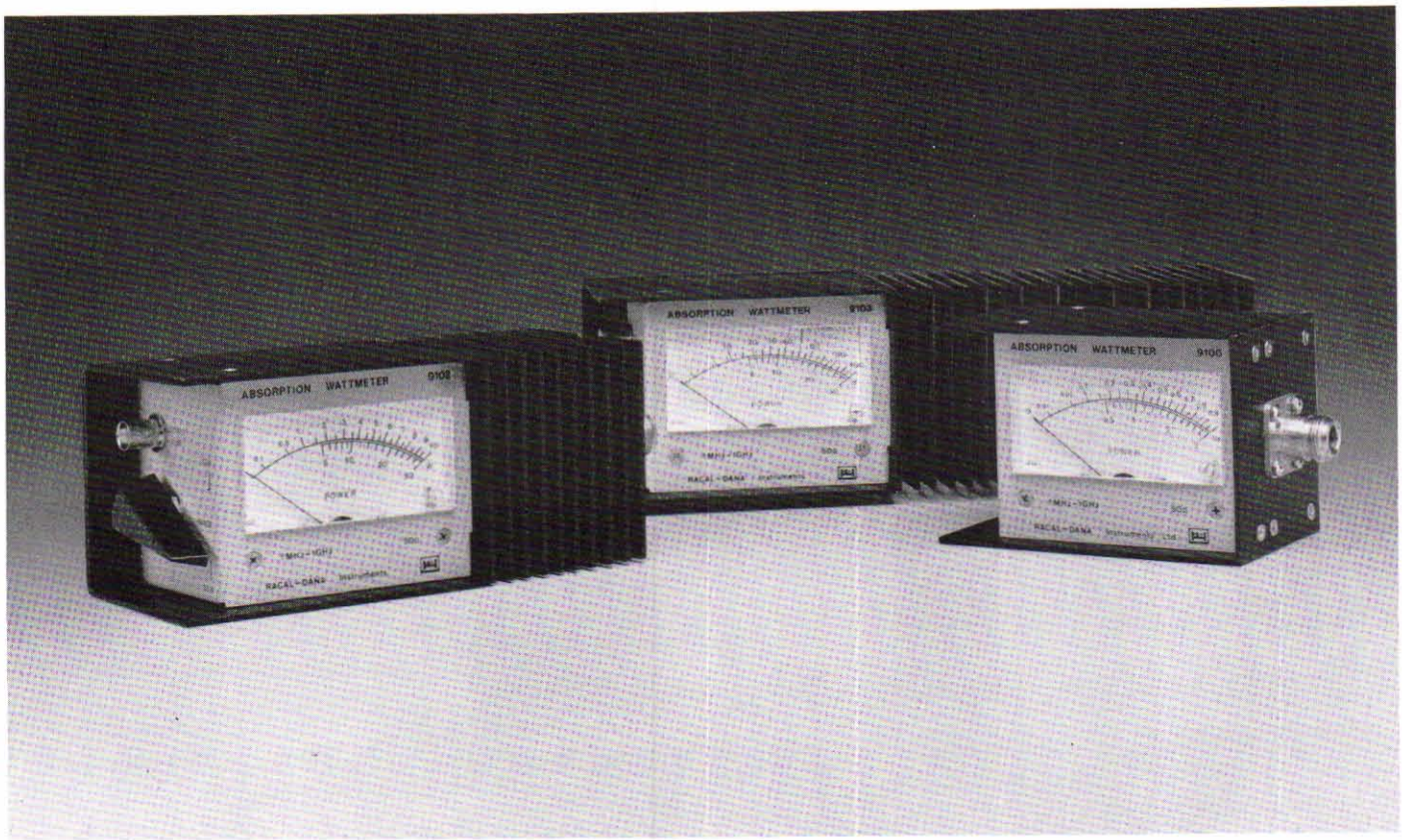
23-9020: Telescopic Antenna

15-0450: Rigid Carrying Case

15-0444: Soft Padded Carrying Case

15-0435: Rigid Carrying Case (For 9008 with Battery Pack)

Wattmeters
General Information



Introduction

Racal-Dana offers a wide choice of RF Absorption Wattmeters for applications involving powers from a few nanowatts to hundreds of watts.

The Models

Model 9105 RF Power Meter features a 10 kHz to 1.5 GHz frequency range and a dynamic range of 2 nanowatts to 200 milliwatts. A sampling technique eliminates the need for expensive and unstable bolometer or thermistor elements.

Models 9100, 9102, and 9103 Portable Absorption Wattmeters provide power ranges from 10 milliwatts to 100 watts. They are ideal for field service applications.

Model 9104 High Power Absorption Wattmeter is suitable for production or shop applications. Featuring seven linear ranges, it allows measurement from below 100 milliwatts to 300 watts and includes a built-in overload relay.

All the wattmeters feature a fast response, high overload characteristics and a rugged construction. All except the 9105 provide an attenuated output for use with oscilloscopes, frequency meters, modulation meters etc.

Absorption Wattmeter Model Summary

Model Number	Frequency Range	Dynamic Power Range	Description	Attenuated Output	DC Output	Programmable
9100	1 MHz to 1 GHz	10 mW to 3 W	Portable	X		
9102	1 MHz to 1 GHz	100 mW to 30 W	Portable	X		
9103	1 MHz to 1 GHz	5 W to 100 W	Portable	X		
9104	1 MHz to 1 GHz	10 mW to 300 W	High Power	X	X	
9105	10 kHz to 1.5 GHz	2 nW to 200 mW	Microwattmeter		X	X

X = Standard Feature

Wattmeters
Portable Absorption Wattmeters
Models 9100, 9102, 9103

Introduction

Racal-Dana's portable absorption wattmeters are small and light enough to be held in the hand. Able to withstand severe shock and capable of use in any plane, they are ideal for bench or field use in both the manufacture and servicing of radio communications equipment.

Wide Frequency Range

All instruments measure power over the frequency range 1 MHz to 1 GHz. In addition, they can be used as accurate 50 ohm loads down to DC.

Three Models

Ideal for low power applications, Model 9100 includes a meter with 1 watt and 3 watt scales that allow measurements down to 10 milliwatts.

Model 9102 is a medium power instrument with full scales of 10 watts and 30 watts. It allows measurement down to 100 milliwatts.

Model 9103 is for higher power use with ranges of 30 and 100 watts and a minimum measurement capability of 1 watt.

Small and Self-Contained

Each power meter is an absorption type requiring no external power supply. Compact, lightweight construction and a wide operating temperature range has been achieved by using specially designed aluminum fins which eliminate the need for oil cooling and thick-film resistive elements which provide excellent VSWR characteristics.

Attenuated Output

All three power meters provide an attenuated output for connection to other test equipment such as oscilloscopes, frequency counters and modulation meters.

Rugged

The units feature rugged construction with cases designed for maximum protection of the meter, range switch and connectors.

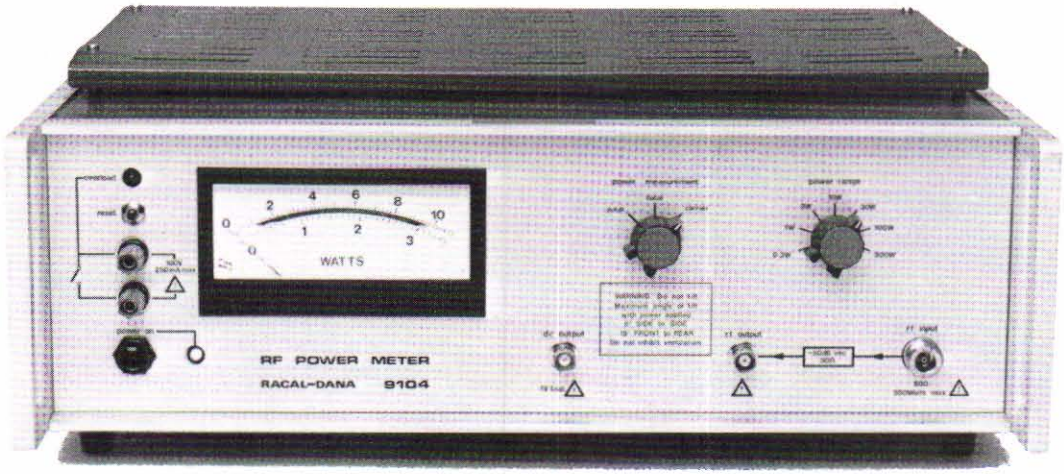
Specifications

Model Number		9100	9102	9103
Frequency Range (as power meter)		1 MHz to 1 GHz		
Frequency Range (as a load)		DC to 1 GHz		
Power Ranges		0.01 to 1 W and 0.5 to 3 W	0.1 to 10 W and 5 to 30 W	5 to 30 W and 1 to 100 W
Continuous Power Rating		3 W	30 W	50 W
Maximum Intermittent Power Rating (1 minute in 3 at 45°C ambient)		—	—	100 W
Peak Power		10 W	100 W	300 W
Input Impedance		50 ohms		
Input Connector		Type N Female		
VSWR		<1.2:1		
Electrical Accuracy		±6% of full scale at 30 MHz		
Meter Accuracy		±1.5% of full scale		
Frequency Response		±0.3 dB referred to 30 MHz		
Attenuated Output (terminated with 50 ohms)		−26 dB	−36 dB	−41 dB
Output Connector		BNC		
Operating Temperature Range		−10°C to +45°C		
Storage Temperature Range		−25°C to +75°C		
Dimensions:	Height	75mm (3.0 inches)		
	Width	107 mm (4.2 in)	170 mm (6.7 in)	190 mm (7.7 in)
	Depth	70 mm (2.8 inches)		
Weight		0.4 kg (0.9 lb)	0.7 kg (1.5 lb)	1.0 kg (2.2 lb)

Ordering Information

Model 9100: 3 Watt Portable Absorption Wattmeter
Model 9102: 30 Watt Portable Absorption Wattmeter
Model 9103: 100 Watt Portable Absorption Wattmeter

Wattmeters
High Power Absorption Wattmeter
Model 9104



Introduction

The Model 9104 is ideal for making accurate power measurements on all types of RF signals. It provides for measurement of total power, carrier power, and peak envelope power (PEP).

Applications include power measurements on CW signals as well as modulated signals such as telephone, facsimile, television, and pulsed transmissions. Carrier power of CW, AM, FM and PM signals and total or peak envelope power of AM signals (including DSB, SSB, VSB and ISB) may be easily measured.

Fast, Accurate Response

The 9104 provides true rms measurements of modulated waveforms, and the fast-responding detector allows the 9104 to be used for peaking or nulling applications when tuning transmitters or RF generators.

The linear scales provide ease of reading and improved accuracies.

Overload Immunity

One of the most important features of the 9104 is its ability to withstand excessively large inputs. You can safely apply 350 watts continuous RF power to any range without damage. In addition, the instrument can tolerate up to 600 watts for short periods on all ranges.

For additional protection, a fast acting reed relay is included. This overload relay provides a pair of front panel contacts which may be used to switch off the RF power source when a large overload occurs. Proper use of this relay will make it impossible to damage the 9104.

Attenuated Output

An attenuated RF output allows direct connection to frequency counters, modulation meters, or other test equipment, which eliminates the need for external attenuators when measuring the output of high power sources.

DC Output

The reading may be digitized by connecting the DC output to a digital voltmeter. This is a linear voltage, directly proportional to power.

High Power Absorption Wattmeter Model 9104

Specifications

Frequency Range: 1 MHz to 1 GHz

Measurement Functions: 1. Total Power
2. Peak Envelope Power
3. Carrier Power (on DSB AM signals)

Power Ranges: 10 mW to 300 W in 7 ranges with full scales of 300 mW, 1 W, 3 W, 10 W, 30 W, 100 W and 300 W

Maximum Input Power: 350 W continuous on any range (+35°C ambient)

Overload: 600 watts (AC + DC component) for 1 minute in any 15 minute period

Overload Relay: A pair of contacts (0.25 A, 100 V rating) available via front panel terminals

Input Impedance: 50 ohms

Input VSWR: 1.25:1 up to 150 MHz increasing to 1.3:1 at 1 GHz

Accuracy

Sinusoidal carrier 20°C to 30°C, including mismatch errors: ±3% full scale ±2% reading at 30 MHz, ±3% full scale ±7% reading; 1 MHz to 500 MHz rising linearly to ±3% full scale ±12% reading at 1 GHz

0°C to 50°C: Additional ±2% reading 1 MHz to 300 MHz
Additional ±4% reading 300 MHz to 1 GHz

Modulation Frequency Range
AM: 50 Hz to 30 kHz
FM: Unlimited

Modulation Depth Range
AM: 0-85% up to 15 kHz reducing linearly to 45% at 30 kHz
FM: Unlimited

Attenuated Output Level (into 50 Ohms): Approximately 50 dB below input signal. Source impedance 25 ohms.

DC Output: 1 volt ±0.01V at full scale on 10 scale, 1 kilohm source impedance

Operating Temperature: 0°C to +55°C

Storage Temperature: −40°C to +70°C

Humidity: 95% RH at +40°C

Power Requirements

Voltage: 90 to 130 and 180 to 260 VAC

Frequency: 45 to 440 Hz

Consumption: Approximately 6 VA

Dimensions: 177 H × 419 W × 373 D mm (7 H × 16.5 W × 14.7 D inches)

Weight: 11.75 kg (26 lb)

Ordering Information

Model 9104 High Power Absorption Wattmeter

Options

11-1367 Rack mounting kit

Wattmeters
Absorption Microwattmeter
Model 9105

Introduction

The Model 9105 Absorption Microwattmeter allows power measurements to be made from 2 nanowatts to 200 milliwatts over the frequency range 10 kHz to 1.5 GHz. It incorporates a precision 50 ohm load and utilizes a sampling detector followed by a mean square sensing circuit to provide true power readings on complex waveforms as well as sinewaves. Two time constants are provided: fast for peaking and nulling applications, and slow for minimum jitter on noise waveforms.

Key features include low inherent noise, ability to withstand overloads, and both manual and remote control.

Compact, lightweight, and rugged; it can be used in the field, on the bench, or in automatic test systems.

Sampling Techniques

The 9105 uses a sampling circuit followed by a true mean square converter plus patented noise canceling circuit.

The advantages of this method of power measurement over thermal techniques include a faster response and greater immunity to damage from overload. At the same time, the ability is retained to make true power measurements on pulse waveforms, wide band noise and distorted as well as pure sinewaves.

Specifications

Frequency Range: 10 kHz to 1.5 GHz

Power Ranges: 2 nW to 200 mW in 8 switched ranges having full scale of 20 nW, 200 nW, 2 μW, 20 μW, 200 μW, 2 mW, 20 mW and 200 mW

Maximum Input Power: 0.5 W continuous, 1 W peak

Input Impedance: 50 ohms

Input VSWR
10 kHz to 1 GHz: 1.2:1

Meter Scales:
Power: 0.2 to 2.0 linear scale with divisions of 0.05.
dB: −7 to +3, (0 dB = 1 mW)

Accuracy (23°C ±5°C)

10 kHz to 500 MHz: ±4.5% of reading ±1.5% of full scale

500 MHz to 1.0 GHz: ±10% of reading ±1.5% full scale

1 GHz to 1.5 GHz: ±30% of reading ±1.5% full scale

Crest Factor

$$\frac{\text{Pk power}}{\text{RMS power}} = 16{:}1 \text{ at full scale}$$

Response Time: Fast or Slow selected by front panel switch

Residual Noise: Adjustable to less than 0.2 nW by front panel control

DC Output: 0 to −1 V for full scale; 1 kilohm source

Programming: Selected by REMOTE position on front panel range switch. BCD coded TTL compatible control signals applied to 9-pin connector on rear panel provide range selection

Operating Temperature: 0°C to +55°C

Storage Temperature: −40°C to +70°C

Humidity: 95% RH at +40°C

Power Requirements

Voltage: 110, 120, 220, 240 VAC ±10%

Frequency: 45 to 440 Hz

Consumption: Approximately 8 VA

Dimensions: 83 H × 241 W × 268 D mm
(3.2 H × 9.45 W × 10.55 D inches)

Weight: 2.5 kg (5.5 lb)

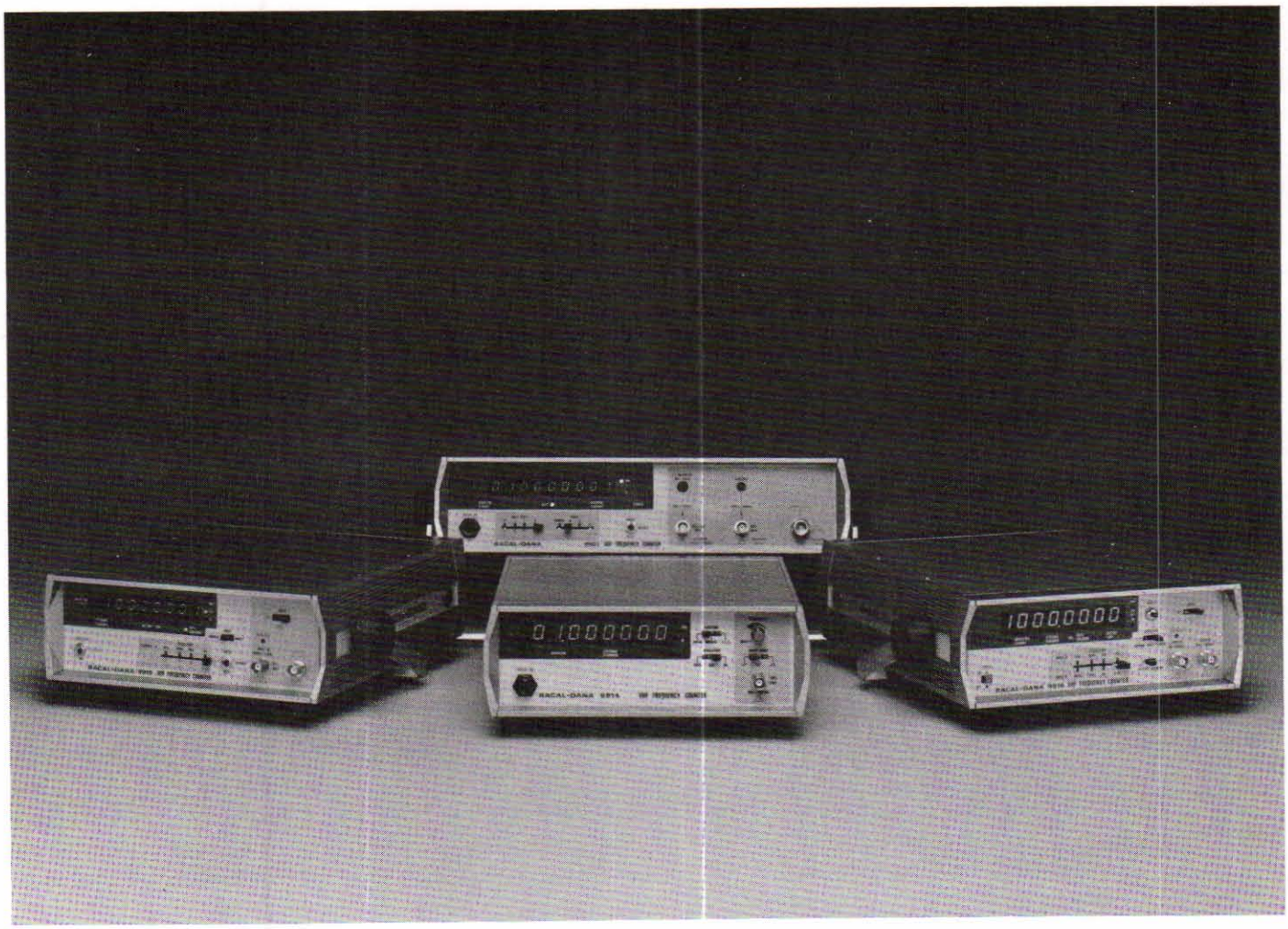
Ordering Information

Model 9105 Absorption Microwattmeter

Options

23-3303 75 Ω input/50 Ω output adapter

23-3316 20 dB attenuator, 20 W, 50 Ω



It's the Heart That Counts.

At the heart of every frequency counter in the 99 Hundred Series is an LSI package with dedicated processing power.

A bipolar package with the computing power of a microprocessor, it operates in excess of 60 MHz, and provides the measurement capability of an entire counter on a single chip.

The chip is manufactured to our specification using the CDI process (Collector Diffusion Isolation). A bipolar technology, CDI is basically as simple as a MOS process, but with the additional benefits of high speed and excellent signal handling ability. Above all, it has high reliability. Accelerated life tests indicate that the life expectancy of the chip in normal use is at least 20 years. And our experience confirms this. We've used more than 10,000 CDI devices without a single failure. So you can be sure that our chip is reliable. We can prove it.

In fact, we guarantee it for life!

Lifetime Guarantee

Racal-Dana will replace, free of charge, any CDI chip which fails during the lifetime of any 99 Hundred Series universal counter or frequency counter while the instrument remains in the possession of the original purchaser, provided that the limits of the published specification have not been exceeded.

In addition to this lifetime guarantee, we also provide a warranty on the complete instruments for two full years. So when you buy a 99 Hundred Series counter, you buy assured reliability.

Overload Protection

All HF input channels have an impedance of 1 megohm shunted by 25 pF and are compatible with most standard scope probes. They can withstand inputs of 250 volts up to 10 kHz.

The sensitive 50 ohm VHF/UHF channels, which can operate up to 560 MHz, are protected by fast-acting PIN diode attenuators. On overload, a reed relay disconnects the input to prevent any possibility of damage, and a warning LED comes on. You'll still get a valid reading, however, because we allow a safe amount of the signal through to the measuring circuits. If the input is too small, the display will read zero. So you'll get either the right answer or no answer at all.

Frequency Counters
General Information

Large Display

The reliable 7 segment LED readouts are easy to read under most ambient lighting conditions. They're multiplexed to give a brighter image for less power — an important consideration in battery operated instruments. A segment check feature allows you to verify the operation of each LED segment.

Measurement units and status are indicated by LEDs. If your instrument is being remotely programmed, you can check its correct operation at a glance.

Battery Portables

For portable applications, you can choose between two battery operated frequency counters — the 520 MHz, 9916; or the 1.1 GHz, 9919. Both offer a standby mode in which power is applied to only the internal ovened timebase. This keeps the instrument ready for immediate use with maximum accuracy, but with minimum drain on the battery. To take a measurement, you press a button and full operation is restored for about one minute. A battery saver then automatically switches back to the standby position in order to conserve power.

A front panel warning LED lights when the battery is low, indicating that recharging will soon be required. A built-in battery charger allows you to recharge the battery by connecting the counter to a suitable AC supply.

All 99 Hundred Series instruments can also be operated from 45 to 60 Hz square wave supplies — a key feature which allows you to power your counter from a vehicle battery inverter.

LF Multiplier

The LF multiplier improves the resolution of frequencies from 10 Hz to 25 kHz by 100 times without increasing the measurement time. It is invaluable for accurate measurement and adjustment of audio and sub-audio signals. Using the Multiplier, for example, you can resolve frequencies as low as 10 Hz to an accuracy of 0.01 Hz in two seconds or less.

The multiplier uses a phase-locked loop with a sharp low-pass filter characteristic. This improves the out of band signal-to-noise ratio and helps prevent the spurious triggering problems associated with reciprocatic LF measurement techniques.

Burst Measurement

The burst capability enables you to count short duration signals. In this mode, gating is inhibited until an input signal is detected. After a short arming period the gate opens for the time required to complete the desired measurement, and the result is then held on the display until you reset it.

Pulse Measurement

You can measure sine and square waveforms with all 99 Hundred Series Frequency Counters. Models 9912 and 9914 also include a pulse mode so that you can count narrow logic pulses too. You can count positive or negative-going pulses only a few nanoseconds wide.

EMC/RFI Protection

Input spill back prevention circuitry, line filtering and RF sealed metal cases eliminate EMC/RFI problems. You can use any 99 Hundred Series counter next to sensitive communications equipment without fear of miscounting or interference due to spurious radiation.

Systems Capability

Buffered serial BCD outputs and control signals are provided for connection to peripheral equipment such as line printers or recorders. If you want parallel BCD outputs, there is an optional serial/parallel interface.

IEEE-STD-488 systems compatibility is provided by our microprocessor-based GPIB interface Model 9932. It can be used with either our programmable or manually operated frequency counters.

All instruments can be supplied with a rackmounting kit for installing in standard 19 inch systems.

Frequency Counter Model Summary

Feature / Model	Frequency (MHz)		No. of Digits	Sensitivity	Programmable	GPIB	RFI Shielding	Battery Operation	Low Frequency Multiplier	BCD Output
	Direct	Prescaled								
9912		120	7	10 mV		OPT	X		OPT	X
9914	200		8	10 mV		OPT	X		OPT	X
9916	60	520	8	10 mV		OPT	X	OPT	OPT	X
9917A	560		9	10 mV		OPT	X		X	X
9918	560		9	10 mV	OPT	OPT	X		OPT	OPT
9919		1100	8	10 mV	X	OPT	X	OPT	OPT	X
9921	560	3000	9	10 mV/50 mV	OPT	OPT	X		OPT	OPT

X = Standard Feature

Wide Choice

There are seven instruments in this family of Frequency Counters; between them they cover a spectrum from 10 Hz to 3 GHz. You can choose a model to suit your application and frequency range, whether you want an instrument for bench, battery portable, or IEEE system use.

Models 9912 and 9914 cover the MF, HF and most of the VHF band. The 9912 is a 120 MHz instrument with a 7 digit display. The 9914 has a frequency range extending to 200 MHz, an 8 digit display, and is directly gated. Both include a pulse mode for measuring narrow pulses such as those encountered in modern logic circuitry.

There are three instruments for VHF/UHF applications. The Model 9917A is a precision bench instrument with a directly gated frequency range from 10 Hz to 560 MHz. It has a 9 digit display and a built-in LF Multiplier for the fast, accurate measurement of frequencies below 25 kHz. For field use, the 8 digit, 520 MHz Model 9916 can be supplied with an optional battery pack. For systems applications, the fully programmable 9918 has a 9 digit display and is directly gated throughout the frequency range 10 Hz to 560 MHz.

Models 9919 and 9921 are microwave instruments with full remote programming available. Covering the band 10 Hz to 1.1 GHz, the Model 9919 has an 8 digit display and can be powered from line supplies or from internal rechargeable batteries. It is a highly versatile counter for use on the bench, in IEEE systems or portable roles. The 9921 — for systems or bench use — is a 9 digit instrument with a frequency range extending to 3 GHz.

Highest Accuracy

Accuracy of measurement depends upon the quality of the frequency standard used for the time-base in your counter. We offer a choice of three internal timebases. There is a crystal oscillator with an aging rate less than 0.3 ppm per month or an ovened oscillator with an aging rate of 3 parts in 10^9 per day.

And for highest accuracy, an ovened oscillator is available with a daily aging rate better than 5 parts in 10^{10}. That represents a daily offset of only 0.5 Hz in 1 GHz and means that you can allow longer intervals between necessary recalibrations.

We manufacture both of the rugged ovened oscillators. Their accuracy is traceable directly to national standards. Fast warm-up and excellent retrace characteristics ensure that your counter will reach high accuracy only a few minutes after power is applied. If you prefer, you can use your own in-house standard or one of our portable rubidium standards as the reference source.

Ease of Use

The 99 Hundred Series is easy to use. The clearly annotated controls are in logical groups defined by shaded areas on the front panels. Operation is largely self-explanatory. Features such as full AGC, automatic overload protection, and full annunciation of measurement units and status, make operation simple and straight-forward.

AGC

Automatic Gain Control (AGC) on the HF and UHF channels simplifies high frequency measurement and enables you to measure noisy signals or complex waveforms with ease.

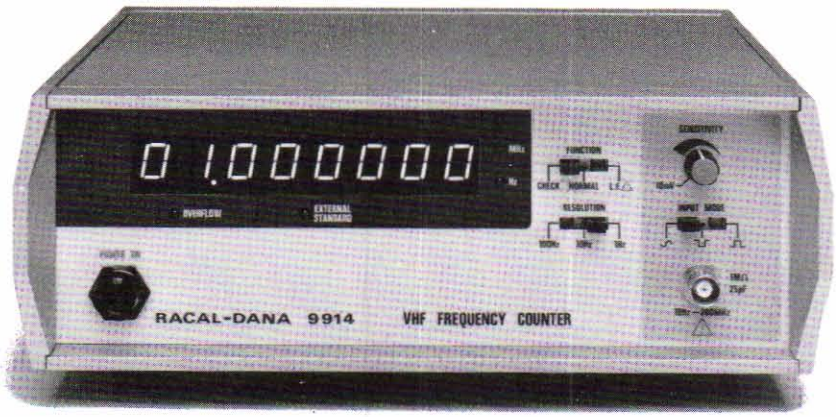
Our counters are generally able to make measurements accurately in the presence of high level voice or tone traffic when measuring AM or FM radio communications signals.

Internal Reference Oscillators

Specification	Standard 04C	Option 04A	Option 04B
Aging Rate	$<3 \times 10^{-7}$/month*	$<3 \times 10^{-9}$/day*	$<5 \times 10^{-10}$/day*
Warm-up Time	N/A	6 minutes to 2×10^{-7}	20 minutes to 1×10^{-7}
Temperature Stability	$\pm 8 \times 10^{-6}$ (0 to +55°C) $\pm 3 \times 10^{-6}$ (+20 to +40°C)	$\pm 3 \times 10^{-9}$/°C (0°C to +45°C)	$\pm 6 \times 10^{-10}$/°C (Avg Over 0° to +45°C)

* Over 10 days after 3 months continuous operation

Frequency Counters
Low Cost Bench Models
Models 9912, and 9914



The Models 9912 and 9914 offer a choice of two economical solutions to frequency measurement. Both include the Racal-Dana CDI/LSI chip with its lifetime guarantee. Both units feature a pulse mode which allows PRF measurement of narrow logic pulses.

Model 9912 provides a seven-digit, 120 MHz frequency range and 10 millivolt sensitivity.

For higher frequency applications, Model 9914 features an eight-digit, direct count, 200 MHz range. It also has 10 millivolt sensitivity.

Both models feature AC line filtering and a metal case for optimum EMI/RFI performance in addition to BCD output as a standard feature and interfacing to the IEEE-STD-488 bus using the optional GPIB interface.

Input Characteristics

Specification	Model 9912	Model 9914
Frequency Range	10 Hz to 120 MHz	10 Hz to 200 MHz
Coupling	AC	AC
Sensitivity (Continuously variable by front panel control)		
Sinewave	10 mV rms	10 mV rms to 150 MHz 50 mV rms to 200 MHz
Square Wave	28 mV P-P	28 mV P-P to 150 MHz 140 mV P-P to 200 MHz
Pulse	100 mV peak for positive or negative pulses.	100 mV peak for positive or negative pulses (to 150 MHz)
Input Impedance	1 megohm in parallel with 25 pF.	1 megohm in parallel with 25 pF.
Maximum input	250 V rms up to 10 kHz 50 V rms up to 100 kHz 10 V rms above 100 kHz 400 VDC	250 V rms up to 10 kHz 50 V rms up to 100 kHz 10 V rms above 100 kHz 400 VDC

Frequency Measurements

Specification	Model 9912	Model 9914
Frequency Range	10 Hz to 120 MHz	10 Hz to 200 MHz
Scaling Factor **Resolution**	÷2 1 Hz in 2 Sec (.01 Hz with LF multiplier option)	direct 1 Hz in 1 Sec (.01 Hz with LF multiplier option)
Accuracy	±1 count ±timebase accuracy.	±1 count ±timebase accuracy.
Gate Time	20 mSec, 200 mSec, 2 Sec	10 mSec, 100 mSec, 1 Sec
Display	MHz or Hz	MHz or Hz
Self Test	Reads 1 MHz	Reads 1 MHz
No. of Digits	7	8

Frequency Counters
Low Cost Bench Models
Models 9912 and 9914

BCD Interface

Data Output
Display: Serial BCD outputs providing 8 digits and decimal point, TTL levels
Static: Function, timebase, and overflow information.
Control Inputs: Print hold and reset

General

Internal Reference Output
Model 9912: 500 kHz, rectangular waveform ≈600 mV p-p into 50 ohms
Model 9914: 1 MHz, rectangular waveform ≈600 mV p-p, into 50 ohms

External Reference Input: 1 MHz, sine or rectangular wave, ≥ 100 mV to ≤ 10 V rms into 200 ohms, AC coupled

Display
Model 9912: Seven, 7-segment, 11 mm LEDs
Model 9914: Eight, 7-segment, 11 mm LEDs

Status Indicators: Units, overflow, external timebase

Input Connectors: BNC

Operating Temperature: 0°C to +55°C

Storage Temperature: −40°C or +70°C

Humidity: 95% RH at +40°C

Power Requirements
Voltage: 94 to 132, 188 to 265 V AC in eight ranges
Frequency: 45 to 450 Hz
Power Consumption: 17 VA

Dimensions: 83 H x 241 W x 268.5 D mm
(3.25 H x 9.45 W x 10.55 D inches)

Weight: 2 kg (4.4 lb)

Options

LF Multiplier—Option 09

Frequency Range
Model 9912: 10 Hz to 50 kHz
Model 9914: 10 Hz to 25 kHz

Resolution: 1 Hz, 0.1 Hz, 0.01 Hz

Measurement Times: Same as basic frequency mode

Selection: Front panel switch

Serial to Parallel Adapter—Option 01

Description: Converts serial BCD output to 4 lines per decade parallel BCD. See Counter Accessories

GPIB Interface—Model 9932A

See Counter Accessories

Ordering Information

Model 9912: 120 MHz Frequency Counter, 7 digit
Model 9914: 200 MHz Frequency Counter, 8 digit

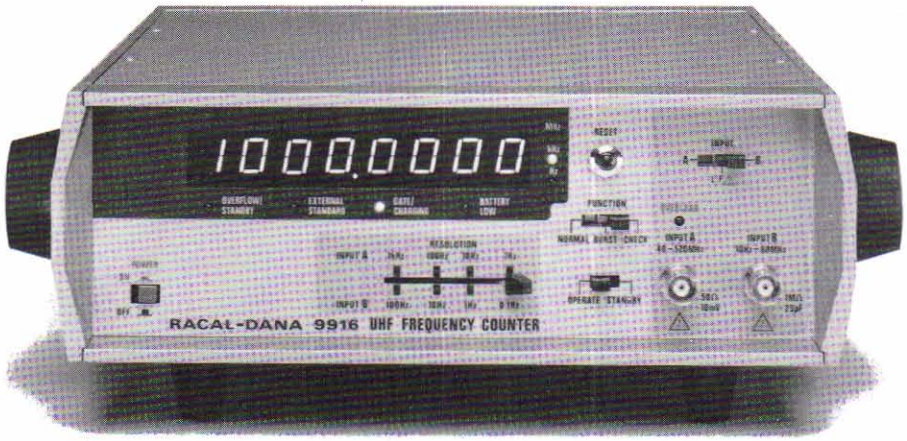
Options

01: Serial to parallel adapter
04A: < 3 x 10^{-9}/day oven oscillator
04B: < 5 x 10^{-10}/day oven oscillator
04C: < 3 x 10^{-7}/month reference oscillator
09: LF multiplier
9932A: GPIB interface

Accessories

See Counter Accessories

Frequency Counters
520 MHz, Portable Communication Counter
Model 9916



The Model 9916 is an 8 digit, 520 MHz frequency counter designed for servicing and calibrating mobile communications equipment and AM/FM broadcast equipment. Standard features include automatic gain control (AGC) on both input channels, frequency burst mode for measurement of short duration signals, and data output.

For greater reliability, the 520 MHz input channel is protected against high input signal levels (up to 35 V rms) by a fast acting PIN diode attenuator and reed relay. Full RFI filtering and shielding allow the 9916 to be used in high RFI environments. For field applications, an internal Ni/Cad battery pack is available.

Input Characteristics

Specification	Channel A	Channel B
Frequency Range	40 MHz to 520 MHz	10 Hz to 60 MHz
Coupling	AC	AC
Sensitivity Sinewave	10 mV rms	10 mV rms
Input Impedance	50 ohms	1 megohm in parallel with 25 pF.
Maximum Operating Input	5 V rms	10 V AC p-p
Maximum Input (Without Damage)	35 V rms, 25 watts	250 V rms up to 10 kHz 50 V rms up to 100 kHz 10 V rms above 100 kHz 400 V DC
AGC Range	50 dB minimum	50 dB minimum

Frequency Measurements

Specification	Channel A	Channel B
Frequency Range	40 MHz to 520 MHz	10 Hz to 60 MHz
Scaling Factor	÷10	Direct
Maximum Resolution	1 Hz in 10 Sec	0.1 Hz in 10 Sec (0.001 Hz)
Accuracy	±1 count ± timebase accuracy	±1 count ± timebase accuracy
Burst Mode	Standard	Standard
Gate Time	0.01 Sec, 0.1 Sec, 1 Sec, 10 Sec	0.01 Sec, 0.1 Sec, 1 Sec, 10 Sec
Display	MHz	MHz, kHz, Hz
Self Test	Reads all 8s	Reads 1 MHz
No. of Digits	8	8

BCD Interface

Data Output

Display: Serial BCD outputs providing 8 digits plus decimal point, TTL levels

Static: Function, timebase and overflow information

Control Inputs: Print hold and reset

Options

Battery Pack—Option 07

Description: Internal battery pack. Battery operation selected by rear panel switch.

Battery Life: 4 hours at +20°C (15 hours on standby with option 04A installed)

Charge Time: 14 hours fast charge (100 hours on trickle charge)

LF Multiplier—Option 09

Frequency Range: 10 Hz to 25 kHz

Resolution: 1 Hz, 0.1 Hz, 0.01 Hz, 0.001 Hz

Measurement Time: 0.01 Sec, 0.1 Sec, 1 Sec, 10 Sec

Selection: Front panel switch

Serial Parallel Interface Adapter—Option 01

Converts serial BCD output to 4 lines per decade, parallel BCD. See Counter Accessories

GPIB Interface—Model 9932A

See Counter Accessories

Ordering Information

Model 9916: 520 MHz, portable communication counter, 8 digit

Options

01: Serial to parallel adapter

04A: $< 3 \times 10^{-9}$/day oven oscillator

04B: $< 5 \times 10^{-10}$/day oven oscillator

04C: $< 3 \times 10^{-7}$/month reference oscillator

07: Battery pack

09: LF multiplier

9932A: GPIB interface

Accessories See Counter Accessories

Frequency Counters
560 MHz, Direct Count
Models 9917A and 9918

Models 9917A and 9918 are 9 digit, 560 MHz frequency counters featuring direct count operation over their entire frequency range. The units feature automatic gain control (AGC) on both channels for ease of use and high noise immunity.

The 560 MHz input channel on both models is protected up to 35 V rms by a fast acting PIN diode attenuator and reed relay.

Model 9917A includes an LF multiplier circuit for fast, accurate measurements of audio and sub-audio signals. A frequency burst mode for measurement of short duration signals and data output are also standard features. A channel C input allows the 9917A to make frequency ratio measurements.

Model 9918 features a full programming option for systems use, and optional GPIB interface is available for both models.

Frequency Measurements

Specification	Model 9917A HF Channel	Model 9918 HF Channel	Model 9918 UHF Channel Model 9917A UHF Channel
Frequency Ranges	10Hz to 60 MHz	10 Hz to 100 MHz	40 MHz to 560 MHz
Scaling Factor	Direct	Direct	Direct
Resolution	0.1 Hz in 10 Sec (0.001 Hz in LF multiplier mode)	0.1 Hz in 10 Sec (0.001 Hz with LF multiplier mode)	0.1 Hz in 10 Sec
Accuracy	±1 count ± timebase accuracy	±1 count ± timebase accuracy	±1 count ± timebase accuracy
Burst Mode	Standard		Standard on 9917A
Gate Time	0.01 Sec, 0.1 Sec, 1 Sec, 10 Sec	0.01 Sec, 0.1 Sec, 1 Sec, 10 Sec	0.01 Sec, 0.1 Sec, 1 Sec, 10 Sec
Display	MHz, kHz, Hz	MHz and Hz	MHz
Self Test	Reads 1 MHz	Reads 1 MHz	Reads all 8s
No. of Digits	9	9	9

Frequency Counters 560 MHz, Direct Count Models 9917A and 9918

Frequency Ratio (Model 9917A only)

Frequency Range

Channel A: 40 MHz to 560 MHz
Channel B: 10 Hz to 60 MHz
Channel C: 1 kHz to 10 MHz

Ratio Modes: (A/C)N, (B/C)N

Multiplier (N): 10 to 10^4 in decade steps

BCD Interface (Model 9917A only)

Data Output

Display: Serial BCD outputs providing 8 digits and decimal point. TTL logic levels
Static: Function, timebase, and overflow information
Control Inputs: Print hold and reset

General

Internal Reference Output: 1 MHz, rectangular waveform ≈ 600 mV p-p into 50 ohms

External Reference Input: 1 MHz, sine or rectangular wave, ≥ 100 mV to ≤ 10 V rms into 1 kilohm, AC coupled (≥ 500 mV to ≤ 10 V rms into 200 ohms — Model 9918)

Display: Nine 7-segment LEDs

Display Time

Model 9917A: Gate time + 50 mSec
Model 9918: Gate time + 30 mSec

Status Indicators: Units, overflow, gate, external timebase, overload. Model 9918 only: standby, remote

Input Connectors: BNC

Operating Temperature

Model 9917A: 0°C to + 55°C
Model 9918: −5°C to +55°C

Storage Temperature: −40°C to +70°C

Humidity: 95% RH at +40°C

Power Requirements

Filtering: EMI/RFI filtering standard
Voltage: 94 to 132, 188 to 265 V AC
Frequency: 45 to 450 Hz
Power Consumption
Model 9917A: 20 VA
Model 9918: 24 VA

Dimensions

Model 9917A: 84 H x 241 W x 268.5 D mm (3.25 H x 9.5 W x 10.5 D inches)
Model 9918: 84 H x 355.5 W x 298.5 D mm (3.25 H x 14.0 W x 11.75 D inches)

Weight

Model 9917A: 2.7 kg (6 lb)
Model 9918: 3.25 kg (7.2 lb)

Options

Data Output and Remote Control— (Option 02, Model 9918)

Data Output: 4 line BCD per display digit; 3 line decimal point position; Single line: units, overflow; data ready: (1 mSec pulse) TTL levels

Remote Control:

Selection: Front panel switch or remote signal
Programming: Timebase — 3 line binary; Channel — 2 line binary; Standby — single line; Hold/reset; Print hold

LF Multiplier—Option 09 (Standard on 9917A)

Frequency Range: 10 Hz to 25 kHz

Selection: Front panel switch

Resolution: 1 Hz, 0.1 Hz, 0.01 Hz, 0.001 Hz

GPIB Interface—Option 9932B, Model 9918 Option 9932A, Model 9917A

See Counter Accessories

Serial to Parallel Interface Adapter— (Option 01, Model 9917A)

Description: Converts serial BCD output to 4 line per decade parallel BCD. See Counter Accessories

Ordering Information

Model 9917A: 560 MHz direct count Frequency Counter

Model 9918: 560 MHz direct count Frequency Counter

Options

01: Serial to parallel adapter (Model 9917A)
02: BCD interface (Model 9918)
04A: < 3 x 10^{-9}/day oven oscillator
04B: < 5 x 10^{-10}/day oven oscillator
04C: < 3 x 10^{-7}/month reference oscillator
09: LF multiplier (Standard on Model 9917A)
9932A: GPIB interface (Model 9917A)
9932B: GPIB interface (Model 9918)

Accessories See Counter Accessories

Frequency Counters
1.1 GHz Portable Communications Counter
Model 9919

Introduction

The Model 9919 is an 8 digit, 1.1 GHz frequency counter especially designed for servicing and calibrating communications equipment. Standard features include AGC on both input channels, frequency burst mode for the measurement of short duration signals, and a fast acting PIN diode attenuator to protect the sensitive UHF channel from damage.

Full remote programming is also included as a standard feature to allow use in ATE systems. An optional GPIB interface is available for connecting to the IEEE-STD-488 bus.

RFI filtering and shielding allow the 9919 to be used in the presence of large amounts of RFI or in the screen room environment.

For field applications, an internal Ni/Cad battery pack is available.

Input Characteristics

Specification	Channel A	Channel B
Frequency Range	80 MHz to 1.1 GHz	10 Hz to 100 MHz
Coupling	AC	AC
Sensitivity Sinewave	10 mV rms to 1 GHz 50 mV rms to 1.1 GHz	10 mV rms to 80 MHz 50 mV rms to 100 MHz
Input Impedance	50 ohms	1 megohm in parallel with 25 pF.
Maximum Operating Input	7 V rms (1 watt)	10 Vp-p
Maximum Input (Without Damage)	10 V rms (2 watts)	250 V rms up to 10 kHz 50 V rms up to 100 kHz 10 V rms above 100 kHz 400 V DC
AGC Range	50 dB minimum	50 dB minimum

Frequency Measurements

Specification	Channel A	Channel B
Frequency Range	80 MHz to 1.1 GHz	10 Hz to 100 MHz
Scaling Factor	÷20	÷2
Resolution	1 Hz in 20 Sec	0.1 Hz in 20 Sec (.001 Hz with LF multiplier option)
Accuracy	±1 count ± timebase accuracy	±1 count ± timebase accuracy
Burst Mode	Standard	Standard
Gate Time	0.02 Sec, 0.2 Sec, 2.0 Sec, 20 Sec	0.02 Sec, 0.2 Sec, 2.0 Sec, 20 Sec
Display	MHz	MHz, kHz, or Hz
Self Test	Reads all 8s	Reads 1 MHz
No. of Digits	8	8

1.1 GHz Portable Communications Counter Model 9919

BCD Interface

Data Output

Display: Serial BCD outputs providing 8 digits and decimal points TTL levels

Static: Function, timebase, and overflow information

Control Inputs: Print hold and reset

Remote Control Selection: Remote signal overrides front panel controls

Programmable Functions: Timebase, input channel, and LF multiplier

Levels: Standard TTL levels

General

Internal Reference Output: 1 MHz, rectangular waveform ≈ 600 mV p-p into 50 ohms

External Reference Input: 1 MHz, sine or rectangular wave ≥ 500 mV to ≤ 10 V rms into ≈ 200 ohms, AC coupled

Display: Eight 7-segment LEDs

Display Time: Gate Time + 2 mSec

Status Indicators: Units, overflow/standby, gate/charging, low battery, external timebase, overload

Input Connectors: BNC

Operating Temperature: 0°C to + 55°C

Storage Temperature: −40°C to + 70°C

Humidity: 95% RH at +40°C

Power Requirement

Filtering: EMI/RFI filtering standard

Voltage: 94 to 132,188 to 265 V AC in 8 ranges

Frequency: 45 to 450 Hz

Power Consumption: 20 VA

Dimensions: 84 H x 241 W x 268 D mm (3.26 H x 9.45 W x 10.55 D inches)

Weight: 2.7 kg (6 lb) excluding battery pack
4.4 kg (9.7 lb) with battery pack

Options

Battery Pack—Option 07

Internal battery pack. Battery operation by rear panel switch.

Battery Life: 3½ hours continuous at + 20°C. (15 hours on standby with option 04A installed).

Charge Time: 14 hours normal charge (100 hours when operating on normal AC power).

LF Multiplier—Option 09

Frequency Range: 20 Hz to 25 kHz

Resolution: 1 Hz, 0.1 Hz, 0.01 Hz, 0.001 Hz

Measurement Times: 20 mSec, 200 mSec, 2 Sec, 20 Sec

Selection: Front panel switch or remote

Serial to Parallel Interface Adapter—Option 01

Converts serial BCD output to 4 lines per decade parallel BCD. See Counter Accessories

GPIB Interface (Model 9932A)

See Counter Accessories

Ordering Information

Model 9919: 1.1 GHz Portable Communications Counter

Options

01: Serial to parallel adapter

04A: < 3 x 10^{-9}/day oven oscillator

04B: < 5 x 10^{-10}/day oven oscillator

04C: < 3 x 10^{-7}/month reference oscillator

07: Battery pack

09: LF multiplier

9932A: GPIB interface

Accessories

See Counter Accessories

Frequency Counters
3.0 GHz Microwave Bench/System
Model 9921

Introduction

The Model 9921 is a 3 GHz frequency counter with a 9 digit display. With full remote programming capability, the 9921 is ideal for both bench and systems use. AGC is included for ease of operation, and the high sensitivity VHF channel is protected from damage by a fast-acting PIN diode attenuator and reed relay.

Specifications

Input Characteristics

Specification	Channel A	Channel B	Channel C
Frequency Range	10 Hz to 100 MHz	40 MHz to 560 MHz	300 MHz to 3 GHz
Coupling	AC	AC	AC
Sensitivity Sinewave	10 mV rms: 10 Hz to 70 MHz 50 mV rms: 70 MHz to 100 MHz	10 mV rms	50 mV rms (−13 dBm)
Input Impedance	1 megohm in parallel with 25 pF.	50 ohm	50 ohm
Maximum Operating Input	10 Vp-p	5 v rms	1 V rms (+13 dBm)
Maximum Input (Without Damage)	250 V rms up to 100 kHz decreasing to 10 V rms above 10 MHz 400 V DC	35 V rms (25 watts)	2.25 V rms (+20 dBm)

Frequency Measurements

Specification	Channel A	Channel B	Channel C
Frequency Range	10 Hz to 100 MHz	40 MHz to 560 MHz	300 MHz to 3 GHz
Scaling Factor	Direct	Direct	÷200
Maximum Resolution	0.1 Hz in 10 Sec	0.1 Hz in 10 Sec	10 Hz in 20 Sec
Accuracy	±1 count ± timebase accuracy	±1 count ± timebase accuracy	±1 count ± timebase accuracy
Gate Times	0.01, 0.1, 1, 10 Sec	0.01, 0.1, 1, 10 Sec	0.02, 0.2, 2, 20 Sec
Display	MHz and Hz	MHz	MHz
Self Test	Reads 1 MHz	Reads all 8s	Reads all 8s
No. of Digits	9	9	9

Frequency Counters
3.0 GHz Microwave Bench/System
Model 9921

General

Internal Reference Output: 1 MHz, 600 mV p-p into 50 ohms

External Reference Input: 1 MHz, 500 mV to 10 V rms into 200 ohms

Display: Nine, 7 segment LEDs

Display Time: Gate time + 30 mSec

Status Indicators: Overflow/standby; Overload (Channel B only); Remote; Gate; External timebase

Input Connectors: Channel A & B—BNC; Channel C—Type N

Operating Temperature: 0°C to +50°C

Storage Temperature: −40°C to +70°C

Humidity: 95% RH at +40°C

Power Requirements

Consumption: Approximately 24 VA

Filtering: EMC/RFI Filtering Standard

Voltage: 94 to 132 V AC; 188 to 264 V AC Switch selectable

Frequency: 45 to 450 Hz

Dimensions: 84 H × 355.5 W × 298.5 D mm (3.25 H × 14 W × 11.75 D inches)

Weight: 3.75 kg (8.25 lb)

Options

Low Frequency Multiplier—Option 09

Frequency Range: 10 Hz to 25 kHz

Selection: Front panel switch

Resolution: 1 Hz, 0.1 Hz, 0.01 Hz, 0.001 Hz

Data Output and Remote Control—Option 02

Data Output: 4 line BCD per display digit — 3 line decimal position, single line: units, overflow; data ready 1 mSec pulse; TTL levels

Inputs: Hold/reset; Print/hold

Remote Control

Selection: Front panel switch or remote signal

Programming: Timebase — 3 line binary
Channel — 2 line binary
Standby — single line

GPIB Interface—Model 9932B (Requires Option 02)

See Counter Accessories

Ordering Information

Model 9921: 3.0 GHz Microwave Frequency Counter, 9 digit

Options

02: BCD interface

04A: $<3 \times 10^{-9}$/day oven oscillator

04B: $<5 \times 10^{-10}$/day oven oscillator

04C: $<3 \times 10^{-7}$/month reference oscillator

09: LF multiplier

9932B: GPIB Interface

Accessories See Counter Accessories

Frequency Counters
Accessories

Model 9932A, B—GPIB Interface Unit

The Model 9932 is designed to adapt the serial BCD output of the 99 Hundred Series to the IEEE-STD-488 GPIB.

GPIB Interface Summary

Model	Model 9932A	Model 9932B	Additional Option Required	Data Output & Programming	Data Output Only
9912	X	—	—	—	X
9914	X	—	—	—	X
9916	X	—	—	—	X
9917A	X	—	—	—	X
9918	—	X	02	X	—
9919	X	—	—	X	—
9921	—	X	02	X	—

Serial to Parallel Interface (Option 01)

This external interface adapter converts the Serial BCD to a parallel BCD output.

High Impedance Probe (23-9104)

This "scope" type probe may be used with all 99 Hundred Series models to reduce loading with "in circuit" measurements.

Carrying Case (15-0450)

This hard case provides the ultimate protection for your frequency counter. Available for all models except 9918 and 9921.

Soft Carrying Case (15-0444 or 15-0478)

A soft padded vinyl carrying case is available for all 99 Hundred Series models. Space is provided for power cables, manuals and accessories.

Telescopic Antenna (23-9020)

A BNC Telescopic Antenna ideal for use with RF counters to "off air" couple close proximity transmitters (i.e., hand-held radio telephones, etc.)

Ordering Information

Model 9932A: GPIB Interface Unit for Models 9912 to 9917A and 9919

Model 9932B: GPIB Interface Adapter for Models 9918 and 9921

Option 01: Serial-to-Parallel Interface Adapter

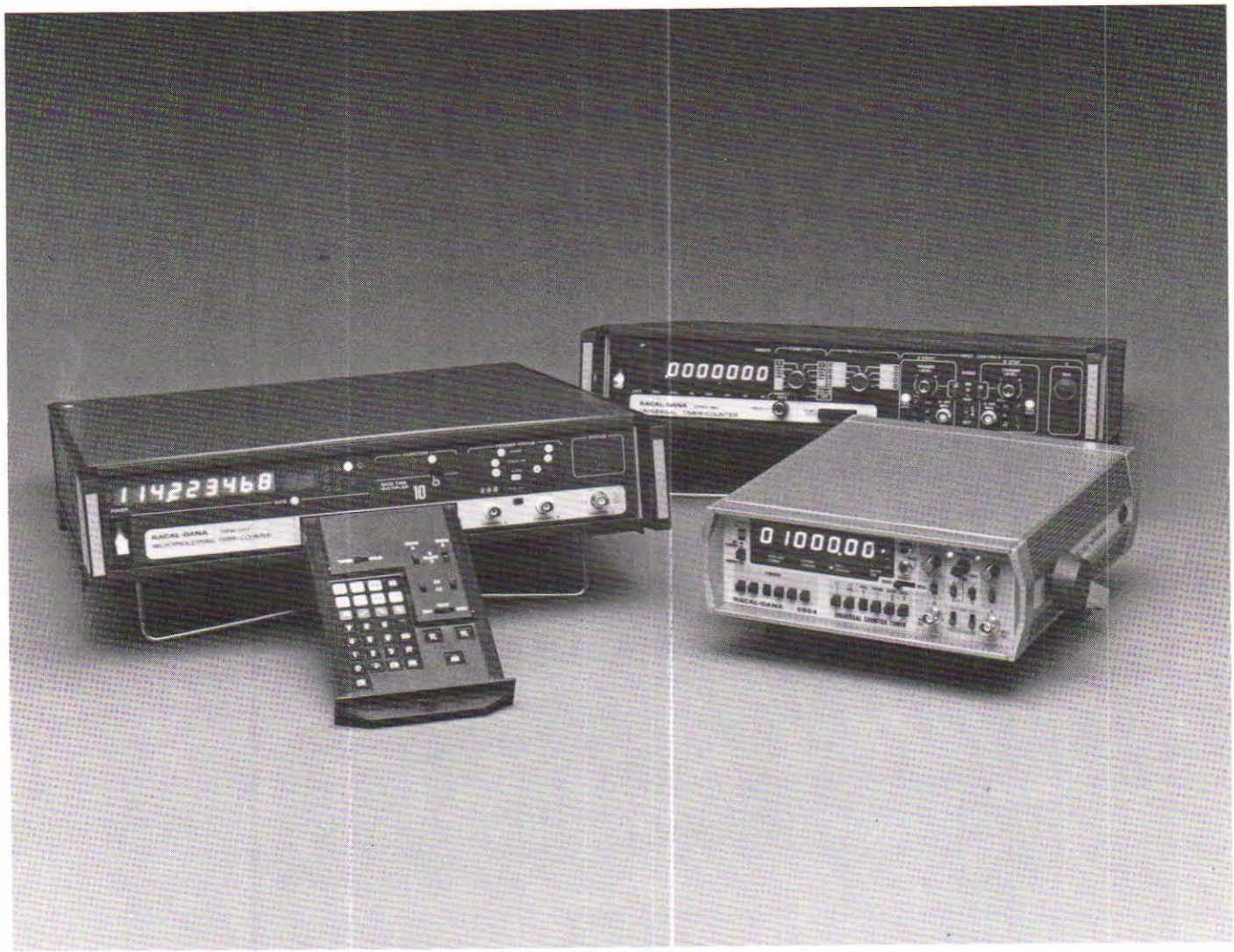
15-0450: Carrying Case

15-0444: Soft Carrying Case for all models except 9918 and 9921

15-0478: Soft Carrying Case for Models 9918 and 9921

23-9020: Telescopic Antenna

23-9104: High Impedance Probe



Introduction

As the need for time domain measurements has increased, the traditional frequency counter has been expanded to include a variety of time domain functions. This multi-function instrument is known as a universal counter/timer. All Racal-Dana counter/timers (UCTs) provide frequency, period, time interval, period average, time interval average, and totalize measurement modes.

The Racal-Dana UCT product line includes thirteen models grouped into three product series. The 99 Hundred Series is designed for bench, portable, and field applications. The five models in the series all include the unique Racal-Dana "counter on a chip" CDI/LSI circuit with its lifetime guarantee.

The Series 9500 includes four models designed for bench and system use. All of these models feature expanded performance including six arming modes and the "Event C, A to B" function. The Models 9514 and 9515 provide the Racal-Dana patented auto-trigger capability.

The Series 9000A offers microprocessor based features available only from Racal-Dana. Simple keyboard control with full annunciation, combined with auto-trigger, makes the Series 9000A one of the easiest counters to use. The four models in this series provide a choice of frequency range and automatic pulse parameter or math functions.

Universal Counter/Timers
General Information

Universal Counter/Timer Summary

Model	Frequency (MHz)		No. of Digits	Frequency Sensitivity	Period T.I.A., Ratio & Totalize	Trigger Level			Programmable	GPIB	µP Design	Trigger Hold-Off			Battery Operation	Reciprocal Measurements
	Direct	Pre-Scaled				Auto	Adjust	Fixed				Adjust	Fixed	Ext.		
9900	30		6	15 mV	X			X		OPT						
9902	50		6	10 mV	X			X		OPT			X			
9904	50		7	10 mV	X		X			OPT		X			OPT	
9906	50	200	8	10 mV	X			X		OPT			X			
9510	500	1250	9	25 mV	X		X	X						X		
9512	500	1250	9	25 mV	X		X	X	X					X		
9514	500	1250	9	25 mV	X	X	X	X	X	X	X			X		
9515	500	1250	9	25 mV	X	X	X	X	X	X	X			X		
9015A	100		9	25 mV	X	X	X	X	OPT	OPT	X			X		X
9035A	100	512	9	15 mV	X	X	X	X	OPT	OPT	X			X		X
9015/11A	100		9	25 mV	X	X	X	X	OPT	OPT	X			X		X
9035/11A	100	512	9	15 mV	X	X	X	X	OPT	OPT	X			X		X

X = Standard Feature

Resolution Frequency

Since conventional measurement of low frequency signals does not provide the desired degree of resolution, other methods of improving the low frequency resolution must be adopted.

All Racal-Dana UCTs provide period and period average functions which may be used to increase the resolution of these LF signals. In addition, the Series 9000A includes a 1/X, reciprocal mode, to automatically convert the reading back into frequency.

Time Interval

When measuring short time intervals, resolution can become a major source of measurement error. On repetitive signals, resolution may be improved by use of time interval averaging. All Racal-Dana UCTs contain this important function which provides resolution as low as 100 picoseconds.

For single-shot time interval measurement we offer a wide choice of resolution. For example, the Series 9500 may be used (with external reference) in the Events C, A to B function to achieve 2 nanosecond single-shot resolution.

Summary of Time Interval Resolution Available

Model/Series	Single Shot		Averaging
	Internal Reference	External Reference	
99 Hundred Series	100 nSec	100 nSec	100 pSec
9510, 9512, 9514	100 nSec	2 nSec	100 pSec
9515	10 nSec	2 nSec	100 pSec
Series 9000A	10 nSec	10 nSec	100 pSec

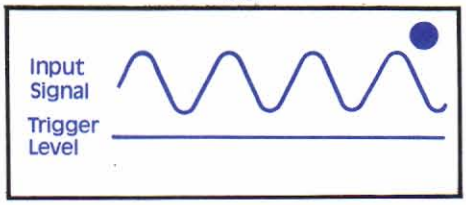
Accurate Triggering

Racal-Dana UCTs make setting the trigger level an easy task. This traditionally difficult task is simplified on models with variable trigger levels by use of Tri-state trigger LEDs and/or Racal-Dana's patented auto-trigger circuit. In addition, the Series 9500 and 9000A provide analog trigger level output and marker output for monitoring the trigger conditions. The Series 9000A also provides full 3 digit annunciation for both trigger level settings.

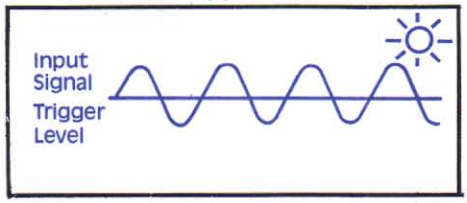
Tri-State Trigger LEDs

Setting up trigger levels is simple and precise on the Model 9904 and Series 9500. You just connect the signal to the input socket and adjust a front panel control until an LED flashes on and off to indicate that the trigger level is correct. If the input level is more positive than the trigger level, the LED will remain ON; less positive and will stay OFF. The charts below illustrate this feature.

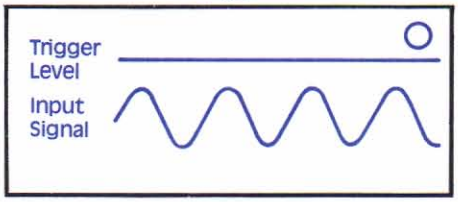
Not Triggered



Triggered

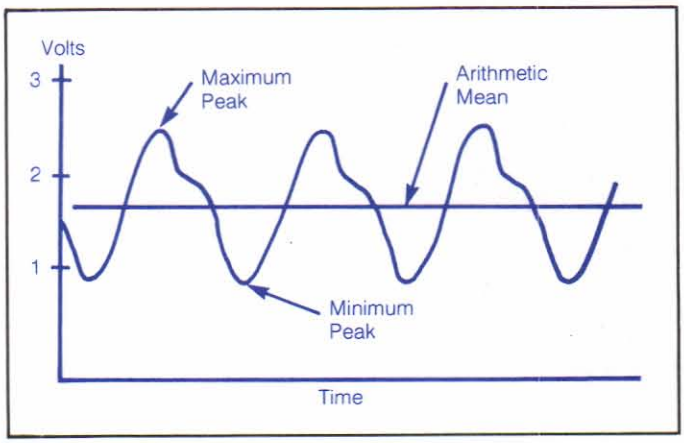


Not Triggered



Automatic Trigger Setting

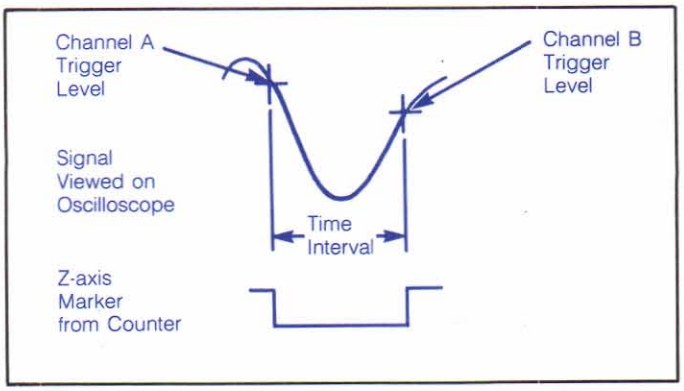
It is often necessary to measure signals of unknown magnitude. In the past, the operator had to "hunt" with the trigger controls to make a correct measurement. This guesswork is eliminated by the Racal-Dana patented auto-trigger circuit. Simply push the "auto" button and the counter's microprocessor takes over. It first sets the attenuator range to ×100 and scans the signal to see if its peak is greater than 30 volts. If not, the microprocessor automatically downranges and again scans the signal. If the signal is still too small to be optimally measured, the microprocessor then sets the range to ×1. During the scan, the microprocessor measures the maximum and minimum peaks of the input signal. It then calculates and sets the trigger levels to the arithmetic mean of the two values. This setting minimizes false counting due to noise and ringing on the input signal during frequency and period measurements. This unique feature is available on Models 9514, 9515 and all Series 9000A models.



Marker Output

For time measurements on complex waveforms, it may be advisable to use an oscilloscope to identify the time interval measured. The marker output pulse can be applied to the second channel of a dual-trace oscilloscope or to the z-axis input to bracket and identify the measured interval.

All Series 9500 and 9000A models provide a marker output as a standard feature.



Broad Choice of Arming Modes

For maximum flexibility, Racal-Dana UCTs offer a wide choice of arming modes. A brief description and typical application of each mode, along with the model vs mode chart, will allow you to choose the right model for your application.

Arming Modes Summary

Model Number	Arming Modes		Trigger Delay	Variable Trigger Hold-Off (delay)	Start Inhibit	External Arming	External Hold Off	Selective Gate	Synchronous Window	Programmable Arming Modes
	Automatic	Continuous								
9900		X	X							
9902		X	X							
9904		X		X	X					
9906		X	X							
All Models Series 9500	X	X				Option Models 9914, 9915	X	X	X	Option on Models 9914, 9915
All Models Series 9000A	X						X	X	X	Option

X = Standard Feature

Universal Counter/Timers
General Information

Automatic Arming

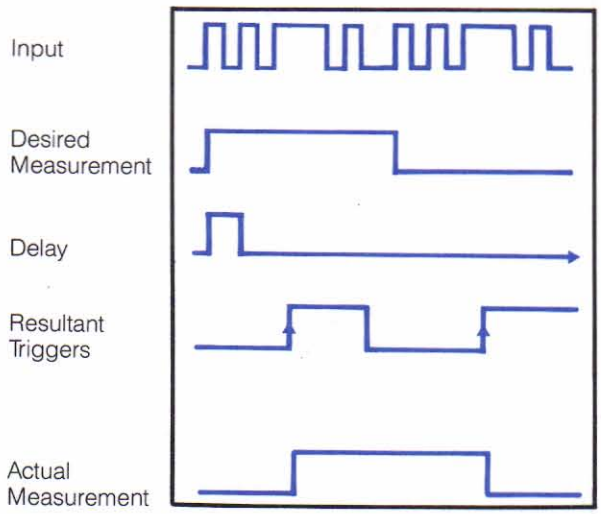
In normal operation, the Series 9500 and 9000A are armed (i.e., made ready to start the measurement) by the input signal. After application of the input signal to Channel A, the counter arms the gating circuitry and allows a measuremnt to begin. This permits burst frequencies (such as found in tone-burst signaling and pulsed RF communications) to be measured as automatically as CW. Of course, you should select a gate time less than the width of the burst.

Continuous Arming

In normal operation, the input is armed by the sample rate control. When frequency function is selected, the reading will be intitiated at the selected sample rate independent of input signal condition.

Trigger Delay

When you measure a signal derived from a noisy source, contact bounce, noise spikes, or ringing may cause unwanted triggering and give significant measurement errors. You can overcome this by switching in the delay circuit on all 99 Hundred Series UCTs. This delays start and stop signals by approximately 10 milliseconds—adequate for most applications.

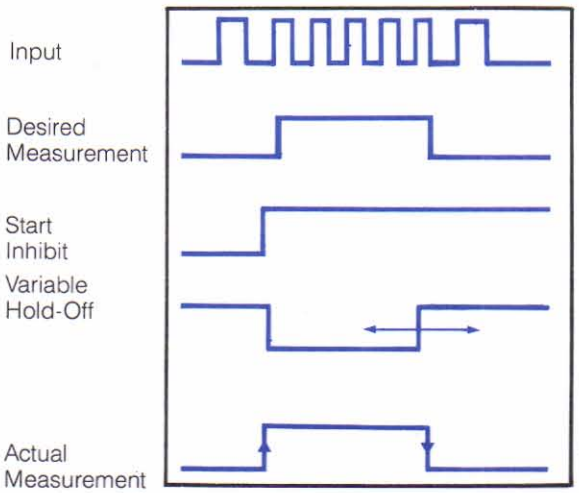


The 10 mSec delay avoids miscounting caused by noise on the leading and trailing edges of the input signal.

The delay affects both input channels simultaneously and can be used for time interval, ratio and totalize measurements.

Variable Trigger Hold-Off

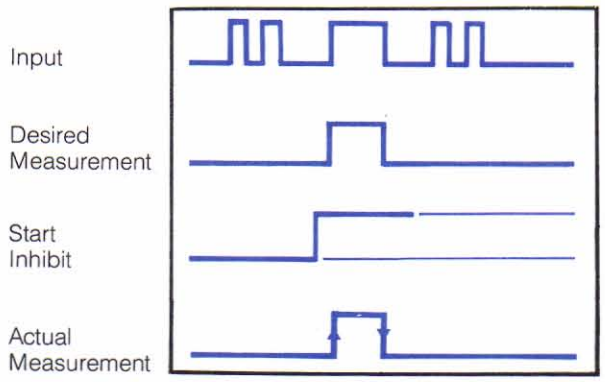
On the Model 9904, variable trigger hold-off inhibits the stop signal by a period which can be set with the front panel control. The hold-off time can be read digitally on the display. Hold-off operates in time interval and totalize modes and can be used to avoid incorrect triggering due to noise. Used in combination with start inhibit, variable hold-off is a powerful feature, allowing you to make selective measurements on pulse bursts or complex wave-trains such as those common in pulse width modulation systems.



Stop signals are ignored until the end of the hold-off period.

Start Inhibit

The start inhibit capability on Model 9904 operates in all modes and is particularly useful for time interval and totalize measurements. A TTL level may be used to inhibit the start of a measurement so that you can examine a particular part of a pulse train.



Counting cannot begin until the inhibit is removed. The required measurement can then be made by selecting the appropriate trigger edge polarities.

External Arming

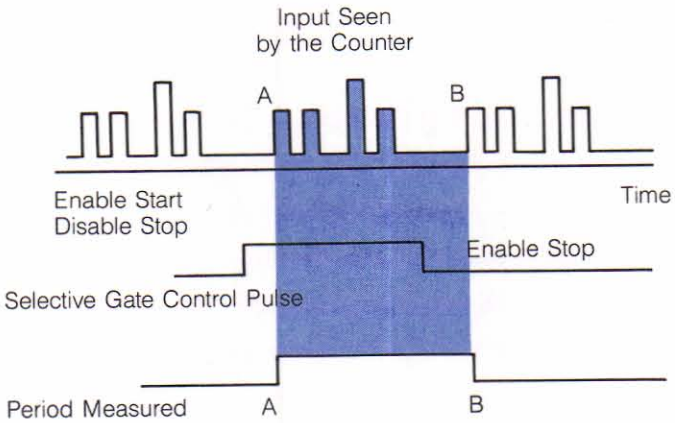
When the extended programming option (option 55E) is installed in Models 9514 or 9515, an external arming mode is available. This mode allows an input level, applied to the gate control input, to arm the counter. This mode may be used to synchronize the measurement gate to an external signal.

External Hold-Off

In normal operation, an external level (DC or pulse) may be applied to the gate control input of the Series 9500 or 9000A to prevent the closing of the measurement gate. This feature is especially valuable when testing relay switching or pulses that contain ringing. In addition, this feature can be used to measure the time between RF or tone bursts.

Selective Gate

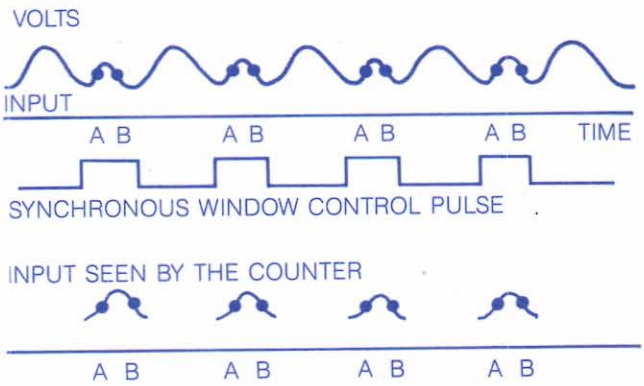
The selective gate mode allows the level applied to the gate control input to control both arming and hold-off of the measurement gate. The application of a voltage to the gate control input "arms" the counter. The closing of the measurement gate is inhibited until the voltage is returned to zero. This mode allows measurements to be made between selected pulses of a pulse train. It also allows measurement of a specific frequency or period within a swept frequency or FSK (Frequency Shift Key) transmission.



Synchronous Window

In this mode, a pulse level applied to the gate control input arms both the start and stop inputs when TIA function is selected. By "sliding" the control pulse back and forth in time and controlling its pulse width, a measurement window is created which isolates the area of the input signal on which the counter will make its measurements. This mode is used to isolate a specific pulse or section of the input waveform to be measured and is available on all Series 9500 and Series 9000A models.

In this mode, the auto-trigger level is established by the part of the input signal which occurs within the measurement window. This arming mode is especially valuable when combined with the Series 9000A automatic pulse parameter functions. It allows parameters of pulses within a train to be analyzed.



Programmable Arming Modes

On the Models 9514 and 9515 or the Series 9000A, this option allows programming of arming modes through GPIB. It also provides programmable 1 megohm or 50 ohm input impedance on channels A or B.

Precision Timebase

Four frequency standards are available for the internal timebase in our universal counter/timers. For many applications, our standard crystal oscillator with an aging rate of 0.3 ppm per month will be adequate. For better stability, both Series 9500 and Series 9000A feature a TCXO as standard. If you want higher measurement accuracy or longer intervals between re-calibration, we suggest you order an instrument with one of our optional oven oscillators. These are manufactured by Racal-Dana and feature fast warm-up characteristics. Aging rate is either 3 parts in 10^9 or 5 parts in 10^{10} per day, and accuracy can be traced to National Standards.

All Racal-Dana universal counter/timers can operate from an external source such as a rubidium, cesium or your own house frequency standard.

The Chart on the following page lists the specifications of available Internal Reference Oscillators.

Universal Counter/Timers
General Information

Oscillators Available

Internal Reference Oscillator	Aging Rate	Temperature Stability
Standard 99 Hundred	$<3 \times 10^{7}$/month*	$\pm 8 \times 10^{-6}$ 0° C to +55° C
Standard 9500, 9000A	$<3 \times 10^{7}$/month	$\pm 5 \times 10^{-6}$ 0° C to +50° C
Options 04A & 22A	$<3 \times 10^{9}$/day*	$\pm 3 \times 10^{-9}$/°C 0° C to +50° C
Options 04B & 24A	$<5 \times 10^{10}$/day*	$\pm 6 \times 10^{-10}$/°C 0° C to +50° C

*After three months operation

System Interfaces

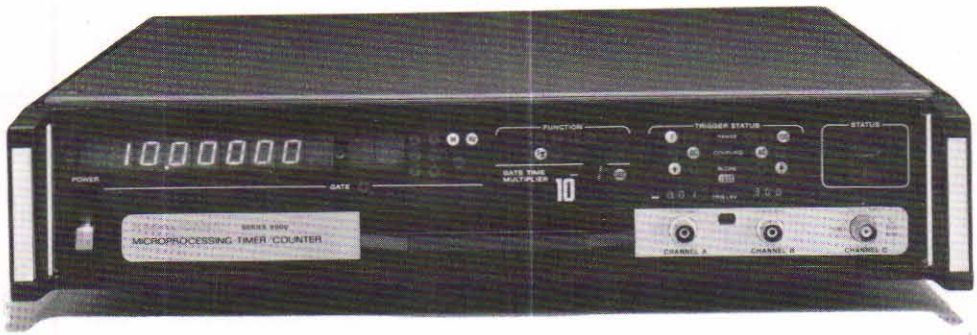
The Racal-Dana UCTs offer a broad range of interfaces to match your application. The chart below summarizes the variety of interfaces available.

Interface Summary

Model Number	Serial BCD Output	Parallel BCD Output	High Speed Binary Interface	Parallel Programming	GPIB	
					Talk Only	Full
All Models 99 Hundred Series	X	Option			Option	
9512		X		X		
9514, 9515						X
Series 9000A			Option			Option

X = Standard Feature

Universal Counter/Timers
Microprocessor Based Bench/System
Series 9000A



Introduction

The Series 9000A is the world's most advanced line of electronic counter/timers. The four 9000A models feature calculator-type keyboards for manual control. The keyboard is located in a front panel drawer and disappears from view when not in use. LED status indicators give total annunciation of control status. An amber, eleven digit, LED display provides an easy-to-see readout for bench applications.

Full Measurement Capability

All models provide full measurement capability to 100 MHz; frequency, period, period average, time interval, time interval average, frequency ratio, and totalize. In addition, Models 9035A and 9035/11A provide prescaled frequency measurement capability to 512 MHz.

Automatic Operation

Because of microprocessor control, any measurement can be made at a touch of a button. The counter automatically selects the appropriate gate time or multiplier to provide a "quick" reading. More or less resolution can then be selected through a single keyboard entry. Both the voltage range and trigger level can also be automatically set to minimize measurement errors. Pulse parameters can automatically be determined by selection of any one of three push buttons on /11A models.

Digital Trigger Level Control and Readouts

Trigger levels are easily set by entering their values on the keyboad or through the system interfaces. The correct voltage range is automatically selected. Two 3-digit LED readouts continuously display the entered trigger levels for both channels A and B. Annunciators display the range, as well as coupling and slope status.

9-Digit Resolution

Full 9-digit resolution is available for most measurement situations. With its calculating capability, the 9000A can be used as either a universal counter/timer, a reciprocal counter, or a preset counter to achieve maximum resolution.

Burst Mode of Operation

Because of its high speed, the 9000A counter operates at all times in the burst or armed mode of operation. Thus, if the frequency of a burst is to be measured, the 9000A will always wait until the burst is detected, then it will take a correct reading. With only a three microsecond setup time, the 9000A counter is able to measure bursts as short as four microseconds.

Arithmetic Capabilities (Models 9015A and 9035A)

Direct readout in engineering units and "preset" operations are easily achieved with the 9000A. Now with keyboard entry and microprocessing control, measurements can easily be scaled, biased, or inverted to provide direct readout in engineering units. The Series 9000A can also be set up as a deviation meter. The readout displays the plus or minus deviation from the entered frequency. Constants with 9-digit resolution can be entered in scientific notation from the keyboard or system interface.

Automatic Rise/Fall Time and Pulse Width Measurements (Models 9015/11A and 9035/11A)

Both /11A models offer automatic calculation of rise/fall time and pulse width to 100 pSec resolution. Each measurement can be made in less than a second for frequencies above 400 Hz. Option 12 permits measurement on pulses with pulse repetition rates as low as 75 Hz.

Universal Counter/Timers Microprocessor Based Bench/System Series 9000A

10 Nanoseconds Single Shot Resolution

The resolution for both period and time interval measurements is 10 nanoseconds. Two identical, independent channels can be used to determine the start and finish of the measurement. This permits the time between events occurring in different circuits to be measured in a straightforward manner.

100 pSec Resolution with Time Interval Averaging

With time interval average capability, measurement accuracy and resolution can be improved when measuring repetitive signals. For example, propagation delays through integrated circuits can be measured to a resolution of 100 pSec when the input signal is asynchronous with respect to the counter time base.

High Accuracy, Low Frequency Measurements

The Series 9000A counters, with their microprocessing capability, provide both direct and reciprocal measurements to give full nine-digit resolution at any frequency from DC to 100 MHz.

"Period" Measurements to 2 nSec

With the Models 9035A and 9035/11A, frequency measurements to 512 MHz can be displayed as either frequency or time with the single key entry of "1/X". Thus, 9-digit resolution is obtained for period measurements from 2 nanoseconds to more than 10 seconds.

Two Systems Interfacing Options

To meet your system interfacing requirements, two options are available: The General Purpose Interface Bus (GPIB), and a high speed computer interface for situations where high speed data transmission is required. Both the GPIB and High Speed Computer options allow all keyboard controls, even the local key, to be overridden by the system control to provide system protection.

With the inclusion of the 06PA Option, both selective gate and synchronous window capabilities can be programmed through the bus.

Series 9000A Model Summary

Model Number	Frequency Range		Computation Capability	Automatic Pulse Parameter Measurements
	Direct 0 to 100 MHz	Pre-Scale 100 to 512 MHz		
9015A	X		X	
9035A	X	X	X	
9015/11A	X			X
9035/11A	X	X		X

Specifications

Input Characteristics

Specification	Channel A & B	Channel C (Models 9035A, 9035/11A)
Frequency Range DC Coupled AC Coupled	 0 to 100 MHz 20 Hz to 100 MHz	 100 MHz to 512 MHz
Coupling	DC or AC, switch selectable	AC
Sinewave Sensitivity Pulse	 25 mV rms to 1 MHz 50 mV rms to 50 MHz 100 mV rms to 100 MHz 150 mV p-p; 8 nSec minimum width	 15 mV rms
Input Impedance	(Std): 1 megohm shunted by less than 65 pF. (Opt): 50 ohms programmable with 06PA	 50 ohms nominal
Maximum Input Without Damage	250 V rms or 300 V peak on all ranges. On 1 V range, degrades by 20 dB/decade above 1 MHz to 2.5 V rms at 100 MHz; 5 V rms with 50Ω input selected	5 V rms (fuse protected)
Voltage Ranges	1 V, 10 V, 100 V	
Trigger Level	Digitally adjustable (keyboard entry) to ±300% of voltage range; with resolution of ±1.25% of voltage range	
Input Trigger Level Accuracy	±5% of range ±0.1% of range per °C	
AGC Control	—	40 dB

Frequency

Specification	Channel A	Channel C (Models 9035A, 9035/11A)
Frequency Range		
DC Coupled	0 to 100 MHz	—
AC Coupled	20 Hz to 100 MHz	100 MHz to 512 MHz
Scaling Factor	Direct	÷10
Maximum Resolution	0.1 Hz	1 Hz
Accuracy	±1 count ±reference error	±1 count ±reference error
Gate Time	1 μSec to 10 Sec in decade steps	1 μSec to 10 Sec in decade steps
Display	9 digits; mHz, Hz, kHz, MHz	9 digits; MHz
Self Test	10.00000 MHz	—
Reciprocal Mode	Displays period 10 nSec to 10^6 Sec	Displays period 2 nSec to 0.1 μSec

Period (Channel A)

Range: 10 nSec to 10^9 Sec

Resolution: 10 nSec

Accuracy: ±1 count ± reference error ±trigger error**

Display: nSec, μSec, mSec, Sec, kSec, or MSec

Reciprocal Mode: Displays Frequency

Period Average (Channel A)

Range: 10 nSec to 1 Sec

Accuracy:

$$\pm\left(\frac{\text{Trigger Error}^{**}}{\text{No. of Periods Averaged}}\right) \pm \text{Reference Error} \pm 1 \text{ count}$$

Intervals Averaged: 1 to 10^8, selectable in decade steps

Display: nSec, μSec, mSec, or Sec

Reciprocal Mode: Displays Frequency

Time Interval

Range: 10 nSec to 10^9 Sec

Resolution: 10 nSec

Accuracy: ±1 count ±reference error ±trigger error*

Input

Separate Mode: Channel A start and Channel B stop
Common Mode: Channel A start and stop

Display: nSec, μSec, mSec, Sec, kSec, or MSec

Reciprocal Mode: Displays: $\frac{1}{\text{time interval}}$

Time Interval Average

Range: 100 pSec to 10 Sec

Accuracy:

$$\pm\left(\frac{(\text{Trigger Error}^{*} + 10 \text{ nSec})}{\sqrt{\text{No. of Intervals Averaged}}}\right) \pm \text{Reference Error} \pm 2 \text{ nSec}$$

Intervals Averaged: 1 to 10^9, selectable in decade steps

Dead Time: Minimum time between stop and start: 50 nSec

Input

Separate Mode: Channel A start and Channel B stop
Common Mode: Channel A start and stop

Display: pSec, nSec, μSec, mSec, Sec

Reciprocal Mode: Displays: $\frac{1}{\text{time interval average}}$

Frequency Ratio

Frequency Range
Channel A: 0 to 100 MHz
Channel B: 0 to 100 MHz

Ratio Modes: $f_A \div$ multiplier f_B

Ratio: 10^{-8} to 10^8

Multiplier: f_B scaled by 1 to 10^9 selectable in decade steps

Accuracy: ±1 count of f_A ±trigger error* of f_B

Reciprocal Mode: Displays: multiplier $f_B \div f_A$

Totalize

Frequency Range: 0 to 100 MHz

Count Range: 0 to 10^9

Accuracy: ±1 count

Scaling

Frequency Range: 0 to 100 MHz

Input: Channel A

Scaling Range

≤10 MHz: 1 to 10^9 in decade steps
>10 MHz: 10 to 10^9 in decade steps

Output: Rear panel/BNC connector

Calculating Functions (Models 9015A, 9035A only)

Direct: $\frac{(x + k_1)\, k_3}{k_2}$

Reciprocal: $\frac{(\frac{1}{x} + k_1)\, k_3}{k_2}$

where: k_1, k_2, k_3 are user entered constants and x is the measurement

Memory: Three memory fields: + constant, ÷ constant, and x constant

Constant Range: ±999.999999E ±99

Operation: The constant operates on successive measurements until either the measurement mode is changed or the constant/operation is changed, or the unit is reinitialized.

*trigger error = $\frac{\leq 0.0025\ \mu\text{Sec}}{\text{signal slope (in V } \mu\text{Sec)}}$

**trigger error = $\frac{\leq 0.3}{(S/N)f}$

Universal Counter/Timers Microprocessor Based Bench/System Series 9000A

Pulse Parameters (Models 9015/11A, 9035/11A Only)

Rise Time

Start Point: 10% of pulse amplitude, positive slope.

Stop Point: 90% of pulse amplitude, positive slope.

Fall Time

Start Point: 90% of pulse amplitude, negative slope.

Stop Point: 10% of pulse amplitude, negative slope.

Pulse Width

Start Point: 50% of pulse amplitude, positive slope.

Stop Point: 50% of pulse amplitude, negative slope.

Range: Same as the measurement function used (TI or TI Average).

Time Measurement Accuracy: Same as the measurement function used.

Trigger Level Setting Accuracy: ±5% of voltage range

Input: Channel A

Minimum Pulse Height: 0.5 V

Minimum Pulse Repetition Rate: 400 Hz Standard

Option 12: 75 Hz

Display: nSec, μSec, mSec, Sec, kSec, or MSec

Automatic Trigger Level

Description: The counter measures the maximum and minimum peak of the input signal, calculates the arithmetic mean, and automatically sets the trigger level at the mean. Standard on both Channels A and B. For inputs ≥400 Hz, ≥50 mV rms.

Automatic Ranging: Voltage ranges for Channels A and B are automatically selected as a function of the voltage levels of the input signals.

Trigger Level Display: Two 3 digit 2.8 mm (.11 inch) red LEDs

Accuracy: ±5% of range ±0.1% of range/°C

Analog Trigger Level Output: Scaled analog voltage (+3V to −3V) outputs representing Channels A and B trigger points

Output Trigger Level Accuracy: ±2% of range

Arming Features

Modes: Automatic, selective gate, synchronous window, external hold-off

Selection: Rear panel switch (GPIB with Option 06PA)

Gate Control Input

Maximum Control Input: −5V to +12V

Low Level: −5V to +0.5V

High Level: +1V to +12V

General

Internal Reference Output: 10 MHz square wave, buffered, TTL compatible

External Reference Input: 1, 5, or 10 MHz; 1 V rms into 1 kilohm counter automatically locks to external reference; if present, front panel indicator lights

Marker Output: Negative-going pulse (+3V to −12V) available on a rear panel BNC, with duration equal to Channel A trigger point to Channel B trigger point.

Display: Eleven 11 mm (.43 inch) yellow LEDs, leading and following zeros suppressed.

Status Indicators: LED lamps show status of counter controls; function measurement time, system control, external reference, input voltage range, slope, coupling, separate/common, and test. LED lamps show numeric readout, dimensional units, overflow condition and Channel C input status.

Input/Output Connectors: BNC

Operating Temperature: 0°C to +50°C

Storage Temperature: −20°C to +70°C

Power Requirements

Voltage: 100, 120, 220, or 240 VAC, +5%, −10%

Frequency: 50 to 60 Hz

Power Consumption: 120 watts maximum

Dimensions: 89 H × 425 W × 456 D mm
(3.5 H × 16.75 W × 18 D) inches

Weight: 8.6 kg (19 lb)

Ordering Information

Model 9015A: 100 MHz Microprocessing Counter/Timer, with computing

Model 9035A: 512 MHz Microprocessing Counter/Timer with computing

Model 9015/11A: 100 MHz Microprocessing Counter/Timer with automatic pulse parameter measurement

Model 9035/11A: 512 MHz Microprocessing Counter/Timer with automatic pulse parameter measurement

Options

04: 50 Hz operation

71: 220/240V operation

01: Rear panel signal input (no front panel signal input)

06PA: Synchronous window, selective gate control programmability thru GPIB option

12: Pulse parameter measurements from 75 Hz (only available on /11A instruments)

22: Oven oscillator ($<1 \times 10^{-9}$ per day aging rate)

24: Oven oscillator ($<5 \times 10^{-10}$ per day aging rate)

41: 512 MHz prescaler for 9015 (Converts 9015 to 9035)

55*: General purpose interface bus (per IEEE-STD-488-1978)

56*: High speed computer interface

60: Rack-mounting adapters

*Only one of these options may be used in a single instrument

Accessories

406845: GPIB cable (1 meter)

406844: GPIB cable (2 meters)

406846: GPIB cable (4 meters)

406857: Extender board kit

Universal Counter/Timers
Microprocessor Controlled Bench/System
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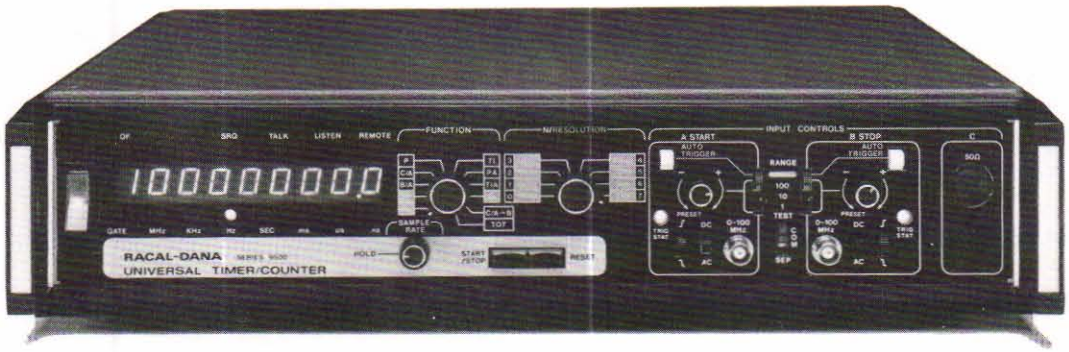


Introduction

The Racal-Dana Series 9500 universal counter/timers cover the entire range of user applications, from bench to sophisticated systems operations.

Automatic Operation

With microprocessing control, measurements can be made at the touch of a button. The instrument automatically sets trigger levels to the ideal trigger point of an incoming waveform. The built-in General Purpose Interface Bus (GPIB) on Models 9514 and 9515 provides you with a versatile way to interface other instruments, printers, calculators or computers.

9-Digit Resolution

Full 9-digit resolution is available for most measurement situations. Combined with the 512 Hz direct count Channel C (Option 41), this allows RF signals to be measured with 1 Hz resolution in one second.

Full Measurement Capability

The Series 9500 provides full measurement capability: frequency, period, period average, time interval, time interval average, frequency ratio and totalize. Additional options provide direct frequency measurement capability to 512 MHz and pre-scaled frequency measurement to 1.25 GHz.

Burst Mode of Operation

Because of their high speed, these counter/timers operate in the burst mode. They wait until the burst is detected, then take a correct reading. With only one microsecond arming time, they are able to measure bursts as short as two microseconds. In addition to this automatic arming mode, the Series 9500 has five other arming modes available.

High Resolution Time Interval

The Series 9500 offers a choice of high resolution time interval capabilities. These include:

10 Nanosecond Time Interval Resolution—Model 9515 provides 10 nanosecond single shot time interval measurement. Other models provide 100 nanosecond resolution.

2 Nanosecond Single Shot Time Interval—By selecting the "Event C/A to B" function, and applying an external 500 MHz reference source to Channel C (Option 41), single shot time intervals between Channels A and B can be measured with a resolution of 2 nanoseconds.

100 pSec Resolution with Time Interval Averaging—In time interval average function, measurement accuracy and resolution are improved when measuring repetitive signals. For example, propagation delays through integrated circuits can be measured to resolutions of 100 pSec. In this function, the input signal should be asynchronous with respect to counter's timebase.

Universal Counter/Timers
Microprocessor Controlled Bench/System
Series 9500

Digital Trigger Control

Trigger levels can be set either automatically or with digital entry to the microprocessor-controlled 9-bit DACs on Models 9514 and 9515 via the GPIB.

The Auto Trigger mode will measure and store the 50% level, positive peak and negative peak of the input signal. This data may then be recalled by the computer or controller.

Series 9500 Model Summary

Model	Single Shot T.I. Resolution	Systems Interface	Auto Trigger	Programmable Trigger Levels	Systems DC Voltmeter
9510	100 nSec	None			
9512	100 nSec	BCD		X	
9514	100 nSec	IEEE-STD-488	X	X	X
9515	10 nSec	IEEE-STD-488	X	X	X

X = Standard feature

Specifications
Input Characteristics

Specification	Channels A & B	Channel C	
		(Option 41)	(Option 42)
Frequency Range **DC Coupled** **AC Coupled**	 DC to 100 MHz 20 Hz to 100 MHz	 50 MHz to 512 MHz	 50 MHz to 1.25 GHz
Scaling Factor	Direct	Direct	÷4
Resolution	1 Hz in 1 second	1 Hz in 1 second	1 Hz in 4 seconds
Coupling	DC or AC, switch selectable	AC	AC
Sensitivity **Sinewave** **Pulse**	 25 mV rms to 1 MHz 50 mV rms to 30 MHz 100 mV rms to 100 MHz 150 mV p-p; 10 nSec minimum width	 15 mV rms, 50 MHz to 512 MHz	 30 mV rms 50 MHz to 1.25 GHz
Input Impedance	1 megohm shunted by less than 25 pF.	50 ohms nominal	
Voltage Ranges	1, 10, 100 V		
Trigger Level	Adjustable to ±300% of voltage range		
Preset Condition	Zero trigger level		
Maximum Operating Input	 300% of Range	 1 V rms	
Maximum Input (Without Damage)	250 V rms or 300 V peak on all ranges except 150 V rms or 200 V peak to 1 kHz on X1 range	 5 V rms (fuse protected)	

Frequency

Specification	Channel A	Channel B	Channel C	
			(Option 41)	(Option 42)
Frequency Range **DC Coupled** **AC Coupled**	 DC to 100 MHz 20 Hz to 100 MHz	 DC to 100 MHz 20 Hz to 100 MHz	 50 MHz to 512 MHz	 50 MHz to 1.25 GHz
Accuracy	±1 count ± reference error	±1 count ± reference error	±1 count ± reference error	
Measurement Time **Standard Mode**	 1 μSec to 10 seconds selectable in decade steps	 1 μSec to 10 seconds selectable in decade steps	 1 μSec to 10 seconds selectable in decade steps	 4 μSec to 40 seconds selectable in decade steps
Display	9 digits, MHZ, kHz, Hz	9 digits, MHZ, kHz, Hz	9 digits, MHZ, kHz, Hz	
Self Test (10^{-1} Sec time base)	 10.00000 MHz	 10.00000 MHz		

Period

Range: 100 nSec to 10^{10} Sec
10 nSec to 10^9 Sec (Model 9515)
Resolution: 100 nSec (10 nSec on Model 9515)
Accuracy: ±1 count ± reference error ± trigger error**
Input: Channel A
Display: μSec, mSec, Sec

Period Average

Range: 100 nSec to 100 Sec
10 nSec to 10 Sec (Model 9515)
Accuracy:

$$\pm \text{ reference error } \pm 1 \text{ count } \pm \frac{\text{trigger error}^{**}}{\text{No. of periods averaged}}$$

Intervals Averaged: 1 to 10^7, selectable in decade steps
Input: Channel A
Display: nSec, μSec

Time Interval

Range: 100 nSec to 10^{10} Sec; (10 nSec to 10^9 Sec, Model 9515)
Resolution: 100 nSec (10 nSec on Model 9515)
Accuracy: ±1 count ± reference error ± trigger error*
Input
Separate Mode: Channel A start and Channel B stop
Common Mode: Channel A start and stop
Display: nSec, μSec, mSec, Sec

Time Interval Average

Range: 100 pSec to 10 Sec (1 Sec on Model 9515)
Accuracy:

$$\pm \text{reference error } \pm 2 \text{ nSec } \pm \frac{(\text{trigger error}^{*} + 100 \text{ nSec}^{1})}{\sqrt{\text{No. of intervals averaged}}}$$

[1](10 nSec on Model 9515)
Intervals Averaged: 1 to 10^7, selectable in decade steps
Dead Time: Minimum time between stop and start; 200 nSec (50 nSec Model 9515)
Input
Separate Mode: Channel A start and Channel B stop
Common Mode: Channel A start and stop
Display: nSec, μSec

Frequency Ratio

Frequency Range
Channel A: DC to 10 MHz
Channel B: DC to 100 MHz
Channel C
Option 41: 50 Hz to 512 MHz
Option 42: 50 Hz to 1.25 GHz
Ratio Modes: B/A; C/A
Ratio: 10^{-7} to 10^9
Multiplier: f_A scaled by 1 to 10^7 selectable in decade steps
Accuracy:

$$\frac{\pm 1 \text{ count } \pm \text{ trigger error}^{*} \text{ of } f_A}{\text{multiplier}}$$

$$^{*}\text{trigger error} = \frac{\leq 0.0025\ \mu\text{Sec}}{\text{signal slope (in V/}\mu\text{Sec)}}$$

Totalize

Frequency Range: DC to 100 MHz
Count Range: 0 to 10^9
Accuracy: ±1 count per gate
Input: Channel A

Parallel BCD System Interface—(Model 9512)

BCD logic accepts TTL, 74LS Series parameters where positive true logic equals "1", and zero or false equals "0". Command lines are biased at logic "1" level, permitting control settings to pull the appropriate control lines to ground. Remote trigger levels programmable by BCD or analog control voltages.

Data Output Information: All BCD outputs of display, 4-bit range code, function flags, polarity flags

Logic Type: Low power Schottky TTL levels 8-4-2-1 BCD

Remote Programming
Input Information: Provides programming of all functions, ranges and trigger conditions

General Purpose Interface Bus—(Models 9514 & 9515)

Models 9514 & 9515 contain a GPIB compatible interface. This interface is compliant with IEEE-Std-488-1978. Both models make programming easy by the use of an expandable program string. For simple measurements you need only to program those functions, ranges, and controls that affect the measurement. For more complex measurement requirements, "high level" controls may be programmed. Use of the extended programming option (Option 55E) further expands the 9514 or 9515 to allow arming mode and input impedance to be programmed.

Programmability Inputs: All front panel controls except line power and sample rate.
(see GPIB section of catalog for more information)

System DC Voltmeter—(Models 9514 & 9515)

Models 9514 and 9515 may be used as 3-digit system voltmeters. Voltage values are not displayed in the front panel readout, but are available for output over the GPIB Interface. To measure DC input, simply command an auto-trigger on the appropriate input channel (either A or B), then output the trigger level setting. This setting will be equal to the DC voltage applied to the selected input channel.

Ranges: 1 V, 10 V, 100 V
Maximum Input: 300 V DC
Minimum Input: 5% of range
Resolution: 3 digits (12.5 mV on 1 V range)
Accuracy: ±5% of range

$$^{**}\text{trigger error} = \frac{\leq 0.3}{(S/N)f}$$

Universal Counter/Timers
Microprocessor Controlled Bench/System
Series 9500

Arming Capabilities

Arming Modes: Automatic arming F_A, F_C; Continuous arming F_B; External hold-off; External arming (Option 55E); Selective gate; Synchronous window

Selection: Rear panel switch (programmable Opt 55E)

Gate Control Input

Input: Rear panel BNC connector

Maximum Voltage Input: −5 V to +12 V

Low Level: −5 V to +0.5 V

High Level: +1 V to +12 V

Reference Oscillator

Aging Rate: 3 x 10^{-7} per month

Temperature Stability: ±5 x 10^{-6} 0°C to +50°C

Automatic Trigger Level (Models 9514 and 9515 only):

The counter measures the maximum and minimum peak of the input signal, calculates the arithmetic mean, and automatically sets the trigger level at the mean. Standard on both Channels A and B. For inputs ≥400 Hz, ≥50 mV rms (optional 40 Hz)

Trigger Level Accuracy
(When programmed over GPIB or set automatically):
±5% of range ±0.1% of range per °C

Ranging

Automatic: Voltage ranges for Channels A and B are automatically selected as a function of the input signal voltage level

Manual: Voltage ranges for Channels A and B are selected by front panel switch

General

Internal Reference Output: 10 MHz square wave, buffered, TTL compatible

External Reference Input: 10 MHz; 1 V rms into 1 kilohm, switch selectable. (1, 5, 10 MHz—Option 10)

Marker Output: Negative-going pulse (TTL level) available on a rear panel BNC, with duration equal to Channel A trigger point to Channel B trigger point

Display Numeric: Nine 11 mm (0.42 inch) yellow LED's Leading Zeros suppressed

Status Indicators: Trigger status; Display overflow; Gate indicator; Units indicators. Models 9514 & 9515 only; GPIB status indicators; Talk (addressed to talk); Listen (addressed to listen); Remote; SRQ (service request)

Input/Output Connectors: BNC

Operating Temperature: 0°C to +50°C, 75% RH to +40°C

Storage Temperature: −40°C to +70°C

Display Time: Adjustable 25 mSec to 5 seconds and hold

Power Requirements

Voltage: 100, 120, 220, 240 VAC +5%, −10%

Frequency: 50 to 400 Hz (50 to 60 Hz—Models 9514 & 9515)

Power Consumption: 100 watts maximum

Dimensions: 89 H x 425 W x 345.4 D mm
(3.5 H x 16.75 W x 13.6 D inches)

Model 9515: 89 H × 425 W × 477 D mm
(3.5 H × 16.75 W × 17.6 D inches)

Weight: 8.6 kg (19 lb)

Ordering Information

Model 9510: Bench Counter/Timer

Model 9512: BCD Systems Counter/Timer

Model 9514: Microprocessor Controlled GPIB Counter/Timer

Model 9515: Microprocessor Controlled GPIB Counter/Timer

Options

01: Rear input (9512, 9514 and 9515 only)

04: 50 Hz operation

71: 220/240 V operation

10: Reference multiplier

12: 40 Hz auto trigger (Models 9514 and 9515)

22A: Oven oscillator (3 x 10^{-9} per day aging rate)

24A: Oven oscillator (5 x 10^{-10} per day aging rate)

41: 512 MHz direct count channel C

42: 1.25 GHz prescaled channel C

55E: Extended programming (Models 9514 and 9515)

60: Rack mounting adapters

65: Chassis slides (14 inches)*

66: Chassis slides (18 inches)*

70: Analog trigger level output

Accessories

406845: GPIB Cable (1 meter)

406844: GPIB Cable (2 meters)

406846: GPIB Cable (4 meters)

*includes mounting hardware

Universal Counter/Timers
Bench Models
99 Hundred Series

Introduction

The 99 Hundred family of universal counter/timers is designed for the bench and small system user. All models feature the Racal-Dana lifetime guarantee on our CDI/LSI chip and a full two year warranty on the complete instrument.

Three basic instruments provide a wide range of measurement capabilities.

The 9900 is a 30 MHz universal counter with a 6 digit display, and provides performance and versatility at a budget price. It can trigger from pulse or contact closure inputs.

The 9902 is a 50 MHz universal counter with frequency autoranging and a 6 digit display. Trigger delay is provided for contact bounce protection. As a general-purpose bench instrument, the 9902 is ideal.

The 9906 is a 200 MHz universal counter with an 8 digit display. It is designed as a high accuracy bench instrument. Trigger delay is included for contact bounce protection and the measurement of noisy signals.

All Models Feature:

High Impedance Input

All 1 megohm input channels are shunted by less than 25 pF and are ideal for use with standard X1 or X10 oscilloscope probes when you need more input attenuation or improved isolation.

Clear Display

The large LED displays are easy to read under all normal lighting conditions. A total segment check, which displays an 8 in every window, is easily accomplished on all models. There is also a measurement check to verify that the counter is working correctly.

Portable Size

All 99 Hundred Series counters are light and rugged enough to be taken anywhere. You can operate them from whatever AC line voltage is available, from 95 to 265 volts, 40 to 450 Hz.

Rugged Design

Every instrument is enclosed in a metal case which is light weight, but extremely strong. Built to satisfy stringent military specifications, it is capable of withstanding rough treatment and provides excellent screening to eliminate EMI/RFI problems. Electronic protection is included to minimize the chance of damaging the input amplifiers if accidentally overloaded.

Universal Counter/Timers
Bench Models
99 Hundred Series

Input Characteristics

Specification	Model 9900		Model 9902		Model 9906	
	Channel A	Channel B	Channel A	Channel B	Channel A	Channel B
Frequency Range						
AC Coupled	10 Hz to 30 MHz	—	10 Hz to 50 MHz	100 Hz to 20 MHz	10 Hz to 200 MHz	10 Hz to 20 MHz
DC Coupled	DC to 10 MHz	DC to 10 MHz	DC to 20 MHz	DC to 10 MHz	DC to 20 MHz	DC to 20 MHz
Coupling	AC or DC	DC	AC or DC	AC or DC	AC or DC	AC or DC
Sensitivity Sinewave						
AC Coupled	15 mV rms variable	—	10 mV rms variable	100 mV rms	10 mV rms to 150 MHz variable	100 mV rms
DC Coupled	±500 mV	±500 mV	±150 mV	±150 mV	±150 mV	±150 mV
Input Impedance						
AC Coupled	1 megohm in parallel with 25 pF	—	1 megohm in parallel with 25pF*	10 kilohm in parallel with 25 pF	1 megohm in parallel with 25 pF*	1 megohm in parallel with 25 pF
DC Coupled	10 kilohm in parallel with 25 pF	10 kilohm in parallel with 25 pF	10 kilohm in parallel with 25 pF	10 kilohm in parallel with 25 pF	1 megohm in parallel with 25 pF*	1 megohm in parallel with 25 pF
Maximum Input						
AC Coupled	250 V rms up to 10 kHz 50 V rms up to 100 kHz 10 V rms above 100 kHz	—	250 V rms up to 20 kHz 50 V rms up to 100 kHz 10 V rms above 100 kHz	100 V DC + peak AC	250 V rms up to 10 kHz 50 V rms up to 100 kHz 10 V rms above 100 kHz	200 V DC + peak AC
DC Coupled	±35 V DC or AC rms	±35 V DC or AC rms	±100 V DC + peak AC	±100 V DC + peak AC	±140 V DC + peak AC	±140 V DC + peak AC
Trigger level						
AC Coupled	0.0 V	—	0.0 V	0.0 V	0.0 V	0.0 V
DC Coupled	+1.0 V or contact closure to ground	+1.0 V or contact closure to ground	+0.8 V	+0.8 V	+0.8 V	+0.8 V
Front Panel Input Controls	Slope, Coupling, Sep/Comm, Contact/Pulse	Slope, Contact/Pulse	Slope, Coupling, Sep/Comm, Delay	Slope, Coupling, Sep/Comm	Slope, Coupling, Sep/Comm, Delay	Slope, Coupling, Sep/Comm

*Falling to 100 kilohm at 4V rms with sensitivity control in maximum position.

Frequency Measurements

Specification	Model 9900	Model 9902	Model 9906
Frequency Range			
DC Coupled	DC to 10 MHz	DC to 20 MHz	DC to 20 MHz
AC Coupled	10 Hz to 30 MHz	10 Hz to 50 MHz	10 Hz to 200 MHz
Scaling Factor	Direct	Direct	HF: Direct; VHF: ÷4
Accuracy	±1 count ±timebase accuracy	±1 count ±timebase accuracy	±1 count ±timebase accuracy
Inputs	Channel A	Channel A	Channel A
Gate Time			
Manual Ranging	1 mSec to 100 Sec	1 mSec to 100 Sec	HF: 1 mSec to 100 Sec; VHF: 4 mSec to 400 Sec
Automatic Ranging	1 mSec to 1 Sec	1 mSec to 1 Sec	—
Display	kHz	kHz	Indicates Units
Self Test	Reads 1 MHz	Reads 1 MHz	Reads 1 MHz

Universal Counter/Timers
Bench Models
99 Hundred Series

Period (10 MHz Bandwidth)

Specification	Models 9900, 9902	Model 9906
Range	1 μSec to 1 Sec	1 μSec to 100 Sec
Resolution	1 μSec	1 μSec
Accuracy[1]	±(0.3% + 1 count + Timebase Accuracy)	
Input	Channel A	
Display	μSec	

Period Average (10 MHz Bandwidth)

Specification	Models 9900, 9902	Model 9906
Range	100 nSec to 1 Sec	100 nSec to 100 Sec
Accuracy[1]	$\pm\left(\frac{0.3\%}{\text{No. of Per. Avg.}} + 1\text{ Count} + \text{Timebase Accuracy}\right)$	
Intervals Averaged	1 to 10^5 in decade steps	
Input	Channel A	
Display	μSec	

[1] At 50 mV rms with 40 dB S/N Ratio.

Time Interval

Specification	Models 9900, 9902	Model 9906
Range	100 nSec to 10^4 Sec	100 nSec to 10^6 Sec
Resolution	100 nSec to 10 mSec in decade steps	
Accuracy	±1 Count ±trigger error* ±Timebase accuracy.	
Input		
Separate Mode	Start Channel B Stop Channel A	
Common Mode	Channel B	
Display	Sec, mSec	

*Trigger Error = $\frac{5\text{ nSec}}{\text{Signal Slope at the Trigger Point (V/μSec)}}$

Time Interval Average

Specification	Models 9900, 9902	Model 9906
Range	150 nSec to 100 mSec	150 nSec to 10 Sec
Accuracy	±Timebase Accuracy ±system error** ±averaging error***	
Intervals Averaged	1 to 10^5 in decade steps	
Dead Time	150 nSec	
Input		
Separate Mode	Start Channel B Stop Channel A	
Common Mode	Channel B	
Display	μSec, nSec	

**System Error = 10 nSec maximum per input channel. This is the difference in delays between Start and Stop signals and can be minimized by matching externally.

***Averaging Error = $\frac{\text{Trigger Error*} + 100\text{ nSec}}{\sqrt{\text{intervals averaged}}}$

Frequency Ratio: (A/B)N

Specification	Model 9900	Model 9902	Model 9906
Frequency Range Channel A Channel B	 DC-30 MHz DC-10 MHz	 DC-50 MHz DC-10 MHz	 DC-30 MHz DC-10 MHz
Multiplier	1 to 10^5 in decade steps		
Accuracy	±1 count ±trigger error* on Channel B		

Totalize

Frequency Range: DC to 10 MHz

Input: Channel A

Prescaling: Decade multiples from 1 to 10^5

Start/Stop: Channel B or manual

General

Automatic Ranging: Models 9900 and 9902 provide automatic selection of gate times in the frequency mode.

Stop Delay: With Delay "In" selected, the stop channel is delayed from triggering by ≈10 mSec (not available on Model 9900)

Internal Reference Output: 1 MHz, 600 mV p-p into 50 ohms, approximately rectangular

External Reference Input: 1 MHz, 500 mV to 10 V rms, Applied to Channel B

Display

Model 9900: Six, 7-segment 7 mm LEDs

Model 9902: Six, 7-segment 11 mm LEDs

Model 9906: Eight, 7-segment 11 mm LEDs

Status Indicators: Overflow, gate, and external timebase LEDs on all models except 9900. Model 9906 includes unit indicator LEDs.

Operating Temperature: 0°C to +55°C

Storage Temperature: −40°C to +70°C

Humidity: 95% RH at +40°C

Power Requirements:

Voltage: 94 to 132 VAC, 188 to 265 VAC in 8 selectable ranges

Frequency: 45 to 450 Hz

Consumption: 20 VA

Universal Counter/Timers
Bench Models
99 Hundred Series

Dimensions

Models 9900, 9902, 9906: 83 H × 241 W × 268 D mm (3.25 H × 9.45 W × 10.55 D inches)

Weight

Models 9900, 9902, 9906: 2.7 kg (6 lb)

BCD Interface

Data Output: Serial BCD output, 8 digits plus decimal point

Status Outputs: Function, Timebase, Overflow

Control Inputs: Print Hold, Reset

Ordering Information

Model 9900: 30 MHz Counter/Timer

Model 9902: 50 MHz Counter/Timer

Model 9906: 200 MHz Counter/Timer

Options

01: Serial to parallel BCD adapter

04A: Oven oscillator ($\leq 3 \times 10^{9}$/day aging rate)

04B: Oven oscillator ($\leq 5 \times 10^{10}$/day aging rate)

04C: Standard unovened oscillator

9932A: GPIB interface

60: Rack mounting adapters

Accessories

23-9020: Telescopic antenna

23-9124: High impedance probe

406845: GPIB cable (1 meter)

406844: GPIB cable (2 meters)

406846: GPIB cable (4 meters)

15-0450: Carrying case

15-0444: Soft carrying case

Universal Counter/Timers
High Performance Bench
Model 9904

Introduction

The Model 9904 is a seven digit, 50 MHz, universal counter/timer providing trigger hold-off (delay) and external gate control as standard features.

Full input triggering control is provided including adjustable trigger levels, slope controls, and tri-state trigger LEDs on each channel. The combination of external gate control and trigger hold-off allows a wide choice of measurement windows to be established.

The BCD output, optional GPIB interface, and battery pack option make the 9904 the ideal choice for field bench, or portable applications. As with all other 99 Hundred Series Models, the 9904 carries a full two-year warranty plus a lifetime guarantee on the Racal-Dana CDI/LSI chip.

Featuring a full seven functions, RFI protection, and a choice of fast warm up oscillators, the 9904 offers a complete solution to your general purpose frequency and time measurement requirements.

Input Characteristics

Specification	Model 9904 Channel A AC Coupled	Model 9904 Channel A & B DC Coupled
Frequency Range	10 Hz to 50 MHz	DC to 20 MHz
Sensitivity	10 mV rms adjustable	±140 mV or ±1.4 V (× 10 attenuator)
Input Impedance	1 megohm in parallel with 25 pF, with sensitivity control at maximum	1 megohm in parallel with 25 pF, falling to 100 kilohm at ±5 V (±50 V with × 10 attenuator)
Maximum Input	250 V rms up to 20 kHz 50 V rms up to 100 kHz 10 V rms above 100 kHz 400 VDC	100 V rms up to 1 MHz decreasing to 10 V rms at 20 MHz (40 V rms with × 10 attenuator)
Voltage Ranges		×1, ×10
Trigger Level		±3 V, ±30 V continuously variable
Trigger Display		Tri-State LEDs

Universal Counter/Timers High Performance Bench Model 9904

Frequency

Frequency Range:

DC Coupled: DC to 20 MHz

AC Coupled: 10 Hz to 50 MHz

Scaling Factor: Direct

Maximum Resolution: 0.01 Hz

Input: Channel A

Accuracy: ±1 count ±timebase accuracy

Coupling: AC or DC

Gate Time: 1 mSec to 100 Sec

Self Test: Reads 1 MHz

Period

Range: 1 μSec to 10 Sec

Resolution: 1 μSec

Accuracy[1]: ±(0.3% +1 count + timebase accuracy)

Input: Channel A

Period Average

Range: 100 nSec to 10 Sec

Resolution: 100 nSec

Accuracy[1]:

$$\pm \left(\frac{\pm 0.3\%}{\text{No. of per. avgd.}} + 1 \text{ count} + \text{timebase accuracy}\right)$$

Periods Averaged: 1 to 10^5 in decade steps

Input: Channel A

Time Interval

Range: 100 nSec to 10^5 Sec

Resolution: 100 nSec to 10 mSec in decade steps

Accuracy: ±1 count ±trigger error* ±timebase accuracy

Input:

Separate Mode: Start Channel B, Stop Channel A

Common Mode: Channel B

Time Interval Average

Range: 150 nSec to 1 Sec

Accuracy: ±timebase accuracy ±system error** ±averaging error***

Intervals Averaged: 1 to 10^5 in decade steps

Dead Time: 150 nSec

Input:

Separate Mode: Start Channel B, Stop Channel A

Common Mode: Channel B

$$\text{*Trigger Error} = \frac{5 \text{ nSec}}{\text{Signal Slope at the Trigger Point (V/μSec)}}$$

**System Error: 10 nSec maxium per input channel. This is the difference in delays between start and stop signals and can be minimized by matching externally.

$$\text{***Averaging Error} = \frac{\text{Trigger Error*} + 100 \text{ nSec}}{\sqrt{\text{intervals averaged}}}$$

1. At 50 mV with 40 dB S/N Ratio.

Frequency Ratio

Frequency Range

Channel A: DC to 50 MHz

Channel B: DC to 10 MHz

Ratio Modes: (A/B)N

Multplier (N): 1 to 10^5 in decade steps

Accuracy: ±count ±trigger error on Channel B*

Totalize

Frequency Range: DC to 10 MHz

Accuracy: +1, −0 counts

Input: Channel A

Prescaling: Decade multiplies from 1 to 10^5

Start/Stop: By front panel pushbutton or external signal, Channel B

Trigger Hold-Off (Delay)

Description: Inhibits stop channel for set delay after start.

Range (Approximately): 100 nSec to 100 mSec

Applicable Functions: Time Interval, Totalize

Control: Front panel control with readout of delay in display.

External Gate Control

Description: Allows external signal to be used to inhibit start channel

Input: Rear panel connection

Level: TTL Logic 0

Applicable Functions: Time Interval, Time Interval Average Totalize

BCD Interface

Data Output:

Display: Serial BCD output providing 8 digits and decimal point TTL levels.

Static: Function, timebase, and overflow information

Control Inputs: Print hold and reset

Options

Battery Pack—Option 07

Description: Internal battery pack. Battery operation is selected by rear panel switch.

(Not available with option 04B ovened oscillator)

Battery Life: 4½ hours continuous at +20°C, (15 hours on standby with option 04A installed)

Charge Time: 14 hours normal charge (100 hours if operating on AC line)

Serial to Parallel Interface Adapter—Option 01

Description: Converts serial BCD output to 4 lines per decade parallel BCD

GPIB Interface—Model 9932A

See Counter Accessories

Universal Counter/Timers
High Performance Bench
Model 9904

General

Internal Reference Output: 1 MHz, rectangular waveform ≈600 mV p-p into 50 ohms

External Reference Input: 1 MHz, sine or rectangular wave applied to channel B

Display: Seven, 7-segment, 11 mm LEDs

Status Indicators: Units, overflow/standby, gate/charging, low battery external timebase

Input Connectors: BNC

Operating Temperature: 0°C to +55°C

Storage Temperature: −40°C to +70°C

Humidity: 95% RH at +40°C

Power Requirements

Filtering: EMI/RFI filtering standard

Voltage: 94 to 132, 188 to 265 VAC in eight ranges

Frequency: 45 to 450 Hz

Power Consumption: Approximately 19 VA

Dimensions: 84 H × 241 W × 268 D mm
(3.25 H × 9.45 × 10.55 D inches)

Weight: 2.7 kg (6 lb.) excluding battery pack
4.4 kg (9.7 lb) with battery pack

Ordering Information

Model 9904: 50 MHz High Performance Bench Counter/Timer

Options

01: Serial to parallel BCD adapter

04A: Oven oscillator ($\leq 3 \times 10^{-9}$/day aging rate)

04B*: Oven oscillator ($\leq 5 \times 10^{-10}$/day aging rate)

04C: Standard unovened oscillator

07*: Battery pack

60: Rack mounts

9932A: GPIB interface

*Options 04B and 07 cannot be used at the same time

Accessories

23-9020: Telescopic antenna

23-9124: High impedance probe

15-0450: Carrying case

15-0444: Soft carrying case

406845: GPIB cable (1 meter)

406844: GPIB cable (2 meters)

406846: GPIB cable (4 meters)

Universal Counter/Timers Accessories

Model 9932A GPIB Interface Unit (Talk Only)

Converts the standard serial BCD data output on all 99 Hundred Series models to IEEE-STD-488 GPIB. This option may be used to interconnect the 99 Hundred Series Counters to the Series 1000 Thermal Printers.

Serial-to-Parallel Interface

This external interface adapter converts the serial BCD to a parallel BCD output for all 99 Hundred Series models.

Telescopic Antenna

A telescoping antenna with a BNC connector and swivel joint that allows off-the-air frequency measurements.

High Impedance Probe

This "scope" type probe may be used with all 99 Hundred Series models to reduce loading with "in circuit" measurements.

Carrying Case

Designed to provide the ultimate protection to the Models 9900, 9902, 9904 and 9906.

Soft Carrying Case

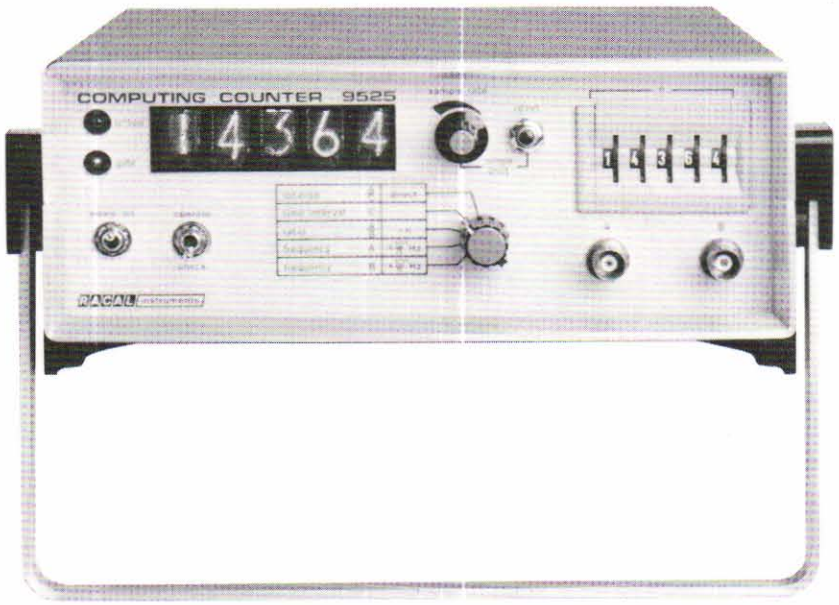
A soft padded vinyl carrying case is available for all 99 Hundred Series UCTs. Space is provided for power cables, manuals and accessories.

Ordering Information

Model 9932A: GPIB Interface Adapter

Options

Option 01: Serial-to-parallel interface adapter
15-0450: Carrying case
15-0444: Soft carrying case.
23-9020: Telescopic antenna
23-9104: High impedance probe



Introduction

The Racal Dana Industrial Frequency Counters are designed specifically for use as digital tachometers and ratemeters. Their frequency measuring range extends from 5 Hz to 10 MHz, and they include features such as variable timebases and simple computing capabilities.

Typical uses include the measurement of high and low pressure turbine speeds in jet engines, and the speed of both rotating and linear movements on machinery used in the paper, steel and glass industries.

Industrial Counter Summary

Model	Frequency Range	No. of Digits	Timebase	Recipromatic	Sensitivity	Data Output Option
9520	5 Hz to 10 MHz	4	Fixed Decade Steps 0.001 to 1 Sec	No	100 mV	BCD
9523	5 Hz to 10 MHz	5	Variable 0.0001 to 10 Sec	Yes	100 mV	BCD
9525	5 Hz to 10 MHz	5	Variable 0.0001 to 10 Sec	No	100 mV	BCD

Industrial Counters
General Information

Precision Speed Measurements

Each model may be used with a Racal-Dana Speed Transducer as a tachometer, the digital display then providing a fast, unambiguous readout of speed.

Variable Timebase Function

Models 9523 and 9525 include a variable timebase controlled by thumbwheel switches on the front panel. This feature allows the display to be scaled in convenient engineering units (revolutions/minute, feet/second, liters/minute etc.) so that results can be read directly without the need for tedious calculations.

Speed Ratio Measurements

Many industrial applications not only require the speed of the system to be continuously monitored, but also the speed ratios between sections of the process to be checked. Models 9523 and 9525 include speed ratio functions for this purpose.

Low Frequency Resolution Improvement

In addition to a variable timebase, the 9523 includes a special recipromatic feature to allow frequencies between 0.1 Hz and 1 kHz to be measured with a resolution 1000 times better than can be obtained using conventional methods.

Speed Transducers

Racal-Dana offers two speed transducers designed especially for use in the industrial environment. The Model MA38 is a rotational speed transducer which, when coupled to a shaft under test, generates 60 electrical signals per revolution for application to the industrial counters. It operates over a speed range of 10 to 10,000 rpm.

For applications where direct connection to the shaft under test is not possible, the magnetic transducer Model MA536 can be used. The pole piece of this transducer is positioned close to the shaft under test so that gear teeth, splines or keyways on the shaft vary the magnetic path reluctance and generate a voltage pulse suitable for application to a counter.

Ordering Information

Model 9520: General Purpose Multifunction Counter

Model 9523: Reciprocal, Variable Timebase Counter

Model 9525: Variable Timebase Counter

Options

01: BCD data output

03: Latched display (Model 9520)

08: Rear input (Models 9523/9525)

Accessories

MA 38: Direct coupled speed transducer

MA 536: Magnetic speed transducer

For more detailed technical specifications, request individual data sheets.

Frequency Standards
Component Oscillators
Series 9400

Introduction

Racal-Dana crystal controlled frequency standards feature low power consumption, good temperature stabilization, and excellent aging performance. This makes them ideal for use in communications equipment and precision instruments. They are built to stringent military specifications and use high quality glass or coldweld sealed crystals. During production, the temperature and aging performance of each oscillator is checked and recorded. Small size, rugged construction, and fast warm-up characteristics make these oscillators particularly suitable for transportable equipment.

Specifications

Model Number	9420	9421	9442/5, 12	9443
Output Frequency	5 MHz			
Output Level (Peak-to-Peak)	1V into 50 ohms		1V into 1000 ohms	
Operating Temperature	−10°C to +60°C			
Daily Aging Rate (after 3 months)	$<5 \times 10^{-10}$		$<3 \times 10^{-9}$	
Warm-up Time	20 minutes to 1×10^{-7}		6 minutes to 2×10^{-7}	
Stability with Temperature Change (per °C)	$\pm6 \times 10^{-10}$		$\pm3 \times 10^{-9}$	$\pm4 \times 10^{-9}$
Stability with 10% Supply Voltage Change	$\pm5 \times 10^{-9}$	$\pm3 \times 10^{-9}$	$\pm4 \times 10^{-8}$	
Stability with 10% Load Change	$\pm5 \times 10^{-9}$	$\pm3 \times 10^{-9}$	$\pm5 \times 10^{-9}$	
Trim Range (parts in 10^7)	−8 to +2	−7 to +3	−60 to +30	
Supply Voltage	12V	5V	5V or 12V	5V
Typical Supply Current (after Warm-up)	120 mA	250 mA	150 mA (5V) 60 mA (12V)	170 mA
Dimensions	51 × 51 × 96 mm (2 × 2 × 3.75 inches)		51 × 51 × 51 mm (2 × 2 × 2 inches)	51 × 51 × 32 mm (2 × 2 × 1.25 inches)
Base	B7G			

Series 9400 Ordering Information

Model 9420: Oven Reference Oscillator

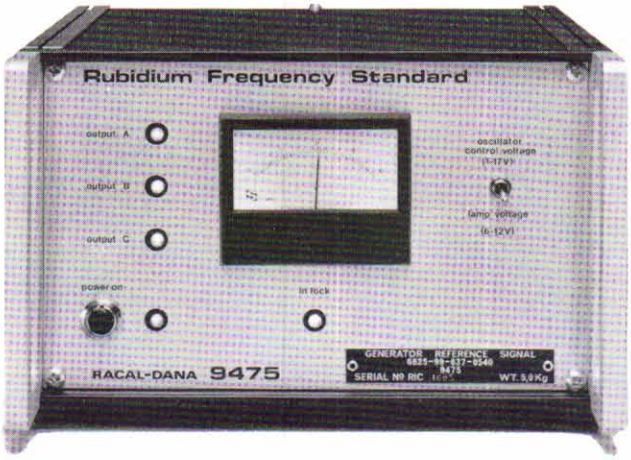
Model 9421: Oven Reference Oscillator

Model 9442/5: Fast Warm-Up Oven Oscillator

Model 9442/12: Fast Warm-Up Oven Oscillator

Model 9443: Miniature Fast Warm-Up Oven Oscillator

Frequency Standards
Rubidium Frequency Standard
Model 9475



Introduction

The Racal Dana Model 9475 Rubidium Frequency Standard is an ultra stable atomic oscillator. Because of its small size and rugged construction it provides an accurate, fast warm-up standard for use in the field and laboratory. It can be employed as a standard for precise timekeeping and calibration of crystal oscillators, or it may be incorporated in high performance communications and navigation systems to assure adequate carrier and sub-carrier frequency and phase stability. Further applications are found in TV frequency control, radio astronomy, doppler radar, precise time interval generators and standard time installations.

Principles of Operation

The Model 9475 makes use of the atomic resonance of Rb 87 to control and lock the frequency of a quartz crystal oscillator. The light of a rubidium spectral lamp is passed through a rubidium vapor cell and applied to a photo detector. The vapor cell is contained within a microwave cavity which is excited at 6.834 GHz, the resonant frequency of rubidium. The 6.834 GHz signal is generated by a frequency synthesizer which is phase locked to a voltage controlled 10 MHz crystal oscillator (VCXO). When the VCXO frequency is precisely 10 MHz, the output frequency of the synthesizer is exactly at the rubidium atomic resonance and the light from the spectral lamp is absorbed to the maximum extent in the vapor cell, causing the photo detector current to reach a minimum. This effect is used to generate an error control signal which permits continuous automatic regulation of the VCXO.

Ordering Information

Model 9475: Rubidium Frequency Standard

Options

60: Rack mounting adapters

Specifications

Output Signals

Outputs: Three isolated and protected outputs are provided

Frequency: 1 MHz (Consult factory for 5 or 10 MHz)

Amplitude: Greater than 1 volt rms into 50 ohms

Impedance: 50 ohms

Signal-To-Noise Ratio: Greater than 100 dB measured in a 1 Hz band at 200 Hz offset

Line Related Sidebands: Greater than 80 dB below carrier

Harmonic Distortion: Greater than 30 dB below carrier

Stability

Long Term: Average drift rate $<4 \times 10^{-11}$/month. Typically $<4 \times 10^{-11}$/year rms.

Short Term: $<3 \times 10^{-11}$ over a sampling time of 1 second

Warm-Up Characteristics: 2×10^{-10} of final frequency within 15 minutes
1×10^{-10} of final frequency within 1 hour
(These times are after switch-on following 24 hours switch-off in the temperature range +5°C to +30°C)

Temperature Effect: Less than 1×10^{-11} per °C between 0°C and +45°C

Effect of External Magnetic Field on Frequency Stability: Less than 1×10^{-10} for 1 gauss DC

Range of Frequency Adjustment: Greater than 2×10^{-9}

Power Requirements

Voltage: 100 to 120 or 200 to 250 VAC ±6%

Frequency: 50 to 60 Hz ±10%

Consumption: 65 VA initially
40 VA after warm-up

Environmental Conditions

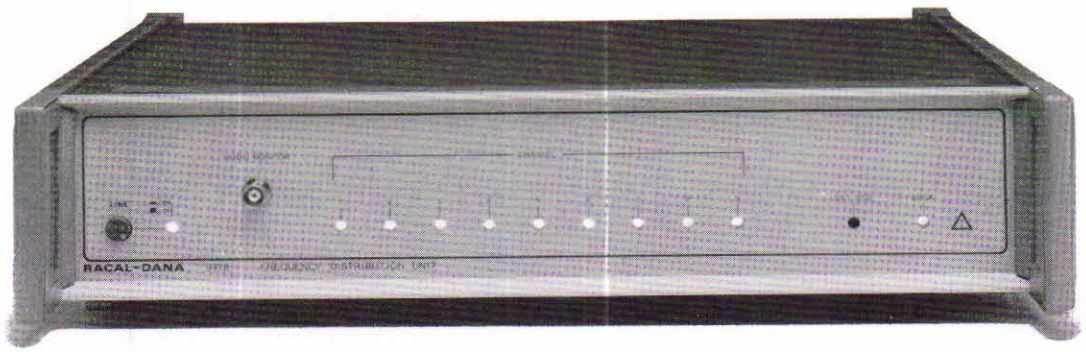
Operating Temperature: 0°C to +45°C

Storage Temperature: −40°C to +70°C

Dimensions: 132 H × 216 W × 287 D mm
(5.2 H × 8.5 W × 11.3 D inches)

Weight: 5.2 kg (11.5 lb.)

Frequency Standards
Frequency Distribution Systems
Model 9478



Introduction

Time and frequency management is vital for the efficient operation of today's instrumentation, communications and navigation systems. These and many other areas demand extreme precision in time and frequency control. The Model 9478 is a low-cost frequency distribution system that meets these requirements.

Frequency Standard or Distribution System

Designed for laboratory applications or for specialized test systems, the Model 9478 can be used either as a precision frequency standard or as a comprehensive distribution system.

In applications where a number of different instruments are configured in a test system (e.g., a frequency synthesizer, a universal counter, a pulse generator and a microwave counter), compatibility problems often arise when comparative measurements are made. Hence, it is often necessary to operate these instruments from a common time base. The instruments may have different frequency standard input requirements. Instruments may require 1, 5, or 10 MHz external time bases. In the past, special interfaces were required to operate the instruments from a common standard. The 9478 is the ideal choice for this frequent system need.

Operates from Internal or External Oscillator

The Model 9478 distribution system can be supplied with a range of internal precision, oven-controlled crystal oscillators, or it can be phase locked to an external signal derived from a master oscillator or atomic frequency standard. The system will automatically lock to an external signal above 100 mV, and with a standard frequency of 1, 5 or 10 MHz. "In lock" indication is provided together with a front panel 10 MHz monitor output.

Nine Isolated Outputs

The system outputs are positioned on the rear panel. The standard configuration consists of nine fully isolated, independently buffered outputs: three outputs at 1 MHz, three at 5 MHz and three at 10 MHz. It is a very simple procedure to configure the system to provide any combination of these frequencies at the output sockets. Front panel LED status indication of each output is given together with a single "NAND" TTL-compatible alarm signal.

The standard outputs are at a level of 1 volt rms when terminated in 50 ohms. Special care has been taken to ensure low distortion and best possible purity. When used with an external standard, the internal high level crystal oscillator is phase locked to the external signal to reduce noise and unwanted sidebands.

The system, which is designed to be cascaded to provide as many outputs as required, is a cost-effective approach to Standard Frequency distribution.

Frequency Standards
Frequency Distribution Systems
Model 9478

Specifications

Input

Frequency[1]: 1, 2, 2.5, 5, or 10 MHz

Level: 100 mV to 1 V rms

Impedance: 50 ohms

[1]Within ±10 ppm for auto phase lock

Output

Frequency: 1, 5 and 10 MHz

Quantity: 9 (standard configuration 3 at each frequency)

Level: 1 V rms into 50 ohms

Impedance: 50 ohms

Harmonics: < −30 dB (into 50 ohms)

Spurious: < −80 dB (into 50 ohms)

Accuracy

External Timebase: Automatic phase lock to input frequency

Internal Timebase

Standard: Better than $\leq 3 \times 10^{-9}$ per day

Option 04B: Better than $\leq 5 \times 10^{-10}$ per day

Temperature Coefficient

Standard: Better than $\pm 3 \times 10^{-9}$/°C

Option 04B: Better than $\pm 6 \times 10^{-10}$/°C

Status Indicators

Input

Status Indication (Front Panel): "External Input" and "In Lock" LEDs

Status Signal (Rear Panel): TTL-compatible signals for External Input and In Lock

Connector: Rear panel, BNC

Output

Status Indication (Front Panel): Monitor LED for each channel

Status Signal (Rear Panel): TTL-compatible alarm signal indicates failure of any channel

Monitor Output: A low-level 10 MHz signal is provided on the front panel

General

Power Requirements

Voltage: 100, 115, 230, 240 VAC ±10%

Frequency: 45–440 Hz

Power Consumption: Approximately 15 VA

Operating Temperature: 0°C to +55°C

Storage Temperature: −40°C to +70°C

Dimensions: 89H × 427W × 345D mm
(3.5H × 16.8W × 13.6D inches)

Weight: 4 kg (8.8 lb)

Ordering Information

Model 9478 Frequency Distribution System

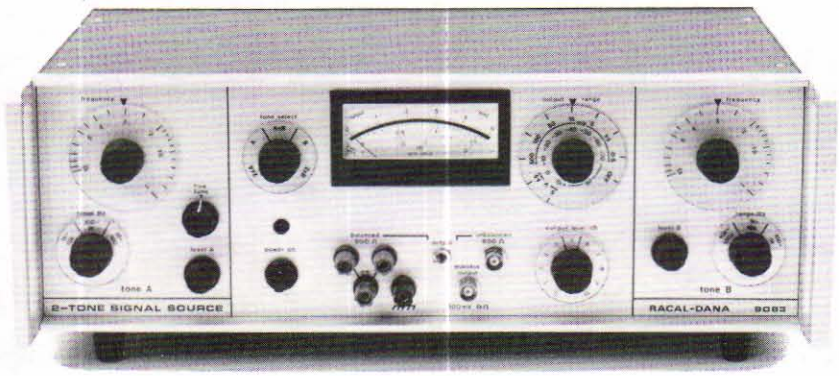
Options

04B: Oven oscillator (5×10^{-10}/day aging rate)

60: Rack mount kit

65: Chassis slides/rack mounting adapters

Test Oscillators
Two-Tone Generator
Model 9083



Introduction

The Model 9083 is a two-tone signal generator designed primarily for the measurement of inter-modulation distortion in SSB transmitters. It includes two highly stable oscillators which can be used individually or combined to provide a two-tone output. The 9083 is ideal as a low distortion AF signal source. It is ideal for testing high quality amplifiers. Balanced and unbalanced 600 ohm outputs are selected by a front panel switch.

Low Harmonic Distortion and Intermodulation Products

The 9083 has less than 0.1% harmonic distortion over the frequency range 100 Hz to 10 kHz and intermodulation products better than 75 dB below the wanted signal.

Specifications

Frequency

Parameter	Tone A	Tone B
Frequency Ranges	10 Hz to 100 Hz 100 Hz to 1 kHz 1 kHz to 10 kHz —	— 100 Hz to 1 kHz 1 kHz to 10 kHz 10 kHz to 100 kHz
Frequency Accuracy	±5% of setting ±3 Hz	
Temperature Coefficient	0.04%/°C after 30 minutes stabilizing period	

Output

Level: Continuously variable over a 12 dB range

Functions: Tone A, Tone B
Tone (A + B), Tone A × 2, Tone B × 2

Ranges: 0.5 mV, 1.5 mV, 5 mV, 15 mV, 50 mV, 150 mV, 500 mV 1.5 V, 5 V (−70 dB to +10 dB in 10 dB steps)

Range Accuracy: ±0.2 dB/Step to ±1 dB maximum error

Attenuator: 0 to 10 dB in 1 dB steps

Attenuator Accuracy: ±0.02 dB/step to ±0.1 dB maximum error

Level Flatness: ±0.4 dB

Meter Accuracy: ±0.5 dB

Output Summary

Parameter	Balanced	Unbalanced
Frequency Range	100 Hz to 10 kHz	10 Hz to 100 kHz
Connector	Terminals	Single ended BNC
Output Impedance	600 Ω ±2%	
Total Harmonic Distortion	≤0.1%	<0.1% from 100 Hz to 10 kHz <0.3% from 10 Hz to 100 Hz and from 10 kHz to 100 kHz
Intermodulation (dB below output signal)	≥65 dB	≥75 dB
Hum and Noise	≤0.05% of full output	≤0.05% +5 μV

Monitor Output

Connection: Buffered, single-ended BNC

Output Impedance: 1 kilohm ±10%

Level: 100 mV rms nominal

General

Operating Temperature: 0°C to +40°C

Storage Temperature: −40°C to +70°C

Humidity: 95% RH at +40°C

Power Requirements:

Voltage: 90 to 130 or 180 to 260 VAC

Frequency: 45 to 440 Hz

Consumption: 6 VA

Dimensions: 132 H × 402 W × 312 D mm
(5.12 H × 15.8 W × 12.3 D inches)

Weight: 5 kg (11 lb)

Ordering Information

Model 9083: Two-Tone Generator

Function Generators
General Information

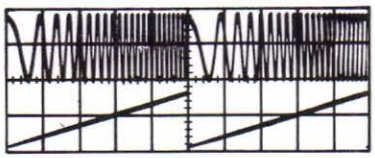
Introduction

Racal-Dana function generators are designed for the demanding bench and systems user. All models feature industry-leading performance.

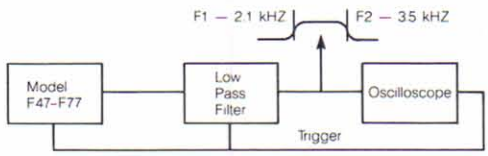
Function generators are especially versatile signal sources because they produce a broad selection of waveforms. Many of the Racal-Dana models also provide sweep capability. This is especially valuable for bandpass testing of filters, amplifiers and other frequency sensitive devices.

Typical Function Generator Applications

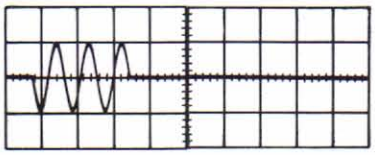
Bandwidth Response in Filter Circuits Using a Swept Sine Wave



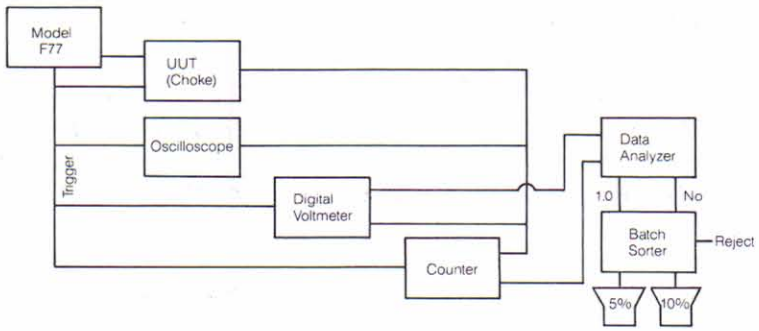
Generator Output



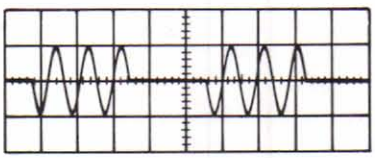
Incoming Inspection Choke Specification Test Using a Gated Sine Wave



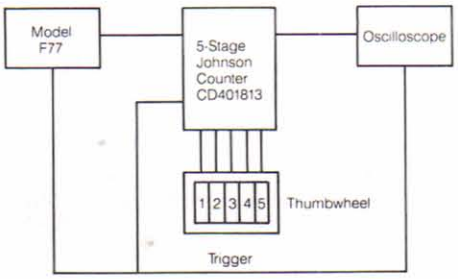
Generator Output



Burst-Counted Sine Wave Fed into a 5-Stage Johnson Counter



Generator Output



Thumbwheel presets inputs and trigger enables chip. Oscilloscope verifies gated output of chip. Equal to length (in Time) of three counts.

Choice of Models

Racal-Dana offers three series of function generators. Whatever the application, one of them is likely to be the perfect solution. The Series F40 offers three models, two of which provide a sweep function. These 4 MHz models are ideal for general purpose lab use.

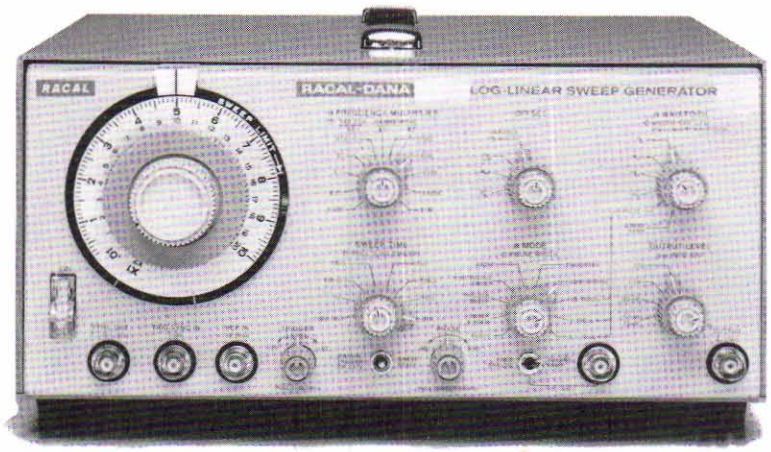
The 20 MHz Model F77 features expanded frequency range, true pulse generator capabilities, burst output, and a full selection of operating modes.

For ATE system applications, the Series 800 provides full function and pulse generator performance coupled with a high-speed GPIB interface.

Function Generator Model Summary

Feature	F41	F44	F47	F77	845	860
Minimum Frequency	0.0004 Hz	0.0004 Hz	0.0004 Hz	0.00002 Hz	0.01 Hz	0.01 Hz
Maximum Frequency	4 MHz	4 MHz	4 MHz	20 MHz	14 MHz	20 MHz
Internal Linear Sweep	—	X	X	X	—	—
Internal Log Sweep	—	—	X	X	—	—
DC Offset	±20 V	±20 V	±20 V	±15 V	±7.5 V	±7.5 V
Frequency Accuracy	±2% F.S.	±2% F.S.	±2% F.S.	±1% F.S. ±1% setting	±0.001%	±0.001%
Pulse Output	X	X	X	X	X	X
Variable Rise/Fall	—	—	—	—	OPT	X
Programmable	—	—	—	—	X	X
Burst Mode	—	—	—	X	OPT	X
Pulse Delay Generator	—	—	—	—	OPT	X

Function Generators
4 MHz Function/Sweep
Series F40



Introduction

This high-voltage, high-performance line offers three models—F41, F44 and F47. All models deliver an output of 20 volts peak-to-peak into 50 ohms (40 volts peak-to-peak open circuit)—ideal for MOS applications, enhancement of harmonic amplitudes, line drive applications, and circuit stress testing. All three models provide a wide 0.0004 Hz to 4 MHz frequency range as well as a choice of bipolar and unipolar pulses down to 120 nanoseconds. Model F44 adds the benefits of a true sweep generator—1000:1 linear sweep capabilities, sweep ramp output, continuous and triggered sweep, sweep marker, and direct-reading sweep limit. The F47 provides all the features of the F44 plus a 10,000:1 logarithmic sweep.

Variable Pulsewidth, Constant Duty Cycle

The three pulse selections on the waveform dial allow a choice of bipolar, unipolar-positive, or unipolar-negative pulse with variable width and constant duty cycle. Pulse outputs are generated to a maximum output frequency of 4 MHz. Duty cycle is controlled by the width/variable symmetry vernier. The Series F40 will automatically preserve the pulse duty cycle selected, even when repetition rates are changed. This permits testing of circuits that are sensitive to duty cycle without continual readjusting as repetition rates are varied.

Variable Start-Stop Phase Control

The start/stop phase angle for triggered or gated waveforms may be controlled over a full 180 degrees. This feature may be used with unipolar waveforms to generate zero-based "haversines," "havertriangles," and triggered waveforms.

Independent Sweep and Auxiliary Outputs

Models F44 and F47 incorporate a comprehensive, independent sweep generator that may be either used to sweep the function generator output frequency or operated as an independent linear-ramp/pulse signal source. Sweep time is selectable from 10 microseconds to 100 seconds with a continuously variable 100:1 vernier.

Model 47 Adds Logarithmic Sweep

The Model F47 also provides switch selectable logarithmic sweep, to give the lower frequency portion of the sweep greater "visibility." Selecting logarithmic sweep will not affect the operating mode.

Calibrated Frequency Step Control

Models F41 and F47 provide the ability to preset and step between 10 equal frequency intervals with a calibrated 11-point step control. This allows rapid testing of bandwidths at preset test frequencies. Steps are numbered for easy use by lower skilled operators.

Frequency Marker

Models F44 and F47 feature a frequency marker output. This marker output allows a DC step to be adjusted to coincide with any frequency point in the sweep signal spectrum. Using this output, the exact frequency of a "glitch" or aberration in a swept waveform may be easily determined.

Specifications

Waveforms

Bipolar: Sine, square, triangle, pulse

Unipolar: Sine, square, triangle, pulse

Variable Symmetry: Sine, square, triangle

Modes—All Models

Continuous: Generator provides uninterrupted wavetrain.

Step Calibrated: Main and limit cursors establish preset upper and lower frequencies and ten equal (or logarithmically spaced) steps between.

Modes—Models F44 and F47 Only

Triggered: Manual or external signal initiates one complete waveform cycle.

Gated: Same as Triggered, but wavetrain continues as long as trigger signal is present.

Sweep Marker Calibrate: Generator produces continuous wavetrain at the marker frequency.

Continuous Sweep: Internal generator provides ramp up times from 100 seconds to 10 microseconds and frequency deviations up to 1000:1 (linear) and 10,000:1 (log) on Model F47

Triggered Sweep: Main generator starts from DC baseline set by phase control, and when triggered, produces a swept frequency output for one sweep cycle, then returns to baseline.

Frequency

Range

Symmetrical and Pulse Waveforms: 0.04 Hz to 4 MHz, 6 ranges[1]

Nonsymmetrical Waveforms: 0.004 Hz to 400 kHz

Dial Accuracy (Linear Scale): ±2% of full scale

Time Symmetry: ±1% to 400 kHz

Sweep—Models F44 and F47 Only

Sweep Time: 100 uSec to 100 Sec, 5 ranges with 100:1 continuous adjustment in any range

Sweep Mode

Model F44: Linear

Model F47: Linear or logarithmic, switch selectable

[1]Selection of X0.01f extends output to 0.0004 at reduced accuracy

Amplitude (Main Output)—All Models

Bipolar Waveforms: 40 V p-p, open circuit, 20 V p-p into 50 ohms maximum

Unipolar Waveforms: 20 V p-p, open circuit, 10 V p-p into 50 ohms maximum

Attenuator: Precision four-position step attenuator provides 20 dB steps to 60 dB combined with 30 dB vernier: 90 dB total attenuation is achieved. Minimum output is ≤1.0 mV p-p into 50 ohms

Amplitude (600 Ohm Output)—Model F41 Only

Bipolar Waveform: 40 V p-p, open circuit, 20 V p-p into 600 ohms maximum

Unipolar Waveform: 20 V p-p, open circuit, 10 V p-p into 600 ohms maximum

Offset Range: ±20 V, open circuit (signal and offset range limited to ±20 V)

Waveform Characteristics

Sine Flatness: Better than or equal to 0.1 dB to 400 kHz; better than or equal to 0.5 dB to 4 MHz

Sine Distortion: ≤0.5% to 40 kHz; <1% to 400 kHz. All harmonics greater than 30 dB below the fundamental from 400 kHz to 4 MHz

Triangle Linearity: Better than or equal to 99% to 100 kHz

Squarewave and Pulse: Fixed rise and fall times are ≤35 nSec for 10 V p-p, increasing to 60 nSec for 20 V p-p signals into 50 ohms. Aberrations ≤5% of amplitude

Stability (Amplitude, Frequency and Offset): Better than or equal to 0.05% change in 10 minutes; better than or equal to 0.25% in 24 hours.

Auxiliary Inputs: Trigger/Sync (Models F44 and F47 only)

Auxiliary Outputs

All Models: Sync, Frequency Analog

Models F44 and F47 Only: Sweep Ramp, Sweep Sync, Sweep Marker

General

Isolation: Rear panel slide switch isolates all BNC connectors and circuit ground from case and power ground

Power Requirements

Voltage: 100, 115, 200, 230 VAC ±10%, switch selectable

Frequency: 50–400 Hz

Power Consumption: 50 W

Operating Temperature: 0°C to +50°C

Storage Temperature: −20°C to +70°C

Dimensions: 155H × 290W ×380D mm
(6H × 11.25W × 15D inches)

Weight: 5.7 kg (12.5 lb)

Accessory Kit: Kit contains two 50 ohm feed-through terminations and three coaxial cables

Ordering Information

Model F41: 4 MHz Function Generator

Model F44: 4 MHz Function Generator with Linear Sweep

Model F47: 4 MHz Function Generator with Linear and Logarithmic Sweep

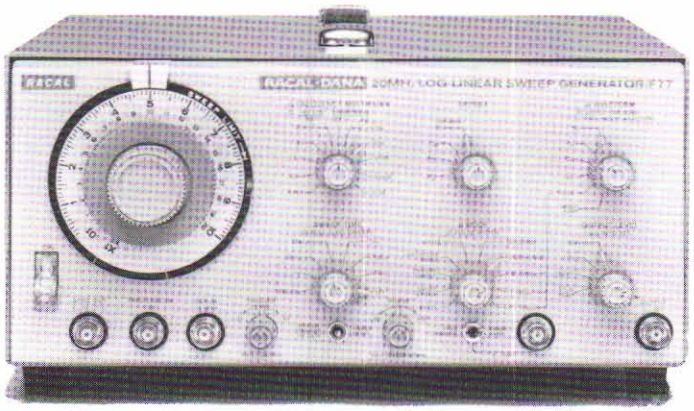
Options

R: Rack mount kit

Accessories

P00332057: Accessory kit

Function Generators
20 MHz Sweep/Function/Pulse
Model F77



Introduction

The F77 is an ideal source for use in engineering applications that require a broad range of waveforms. In addition to traditional sine, square and triangular waveforms, the F77 also delivers pulse and sweep capabilities. Output amplitude is specified at 15 volts peak-to-peak into 50 ohms. And with a wide frequency range of 0.00002 Hz to 20 MHz, you can test with frequencies from infrasonics through video and beyond. A comprehensive selection of operating modes, variable symmetry control to 1 MHz, selectable logarithmic/linear sweep, and a variety of synchronization outputs make the F77 a perfect choice for equipment pool type applications that require highly flexible performance features.

Pulse Capabilities

The F77 delivers real pulse generator capability—a stable, 15 nanosecond risetime pulse with an adjustable pulse width that can be set down to 30 nanoseconds. Features include ±15 volt offset, 8 operating modes, a fully calibrated attenuator, and unipolar pulse output amplitudes of up to 15 volts into high-impedance loads. There's even a "constant duty cycle" pulse for a variety of digital signal applications.

Sweep Capabilities

Model F77 provides a price and benefit package to meet almost any engineering application. It features a very capable, independent sweep generator and a selection of related auxiliary outputs. The unit may be set to sweep up or down, with either a linear or logarithmic ramp. Continuous, triggered burst and sweep-and-hold modes may be selected. A sweep ramp output and a sweep sync output (rectangular waveform) are available for chart recorder applications.

Function Generators
20 MHz Sweep/Function/Pulse
Model F77

Specifications

(Except where otherwise indicated, performance characteristics apply at +25°C ±5°C with 10 V p-p output terminated in 50-ohm resistive load, 0 VDC offset, frequency dial set between 0.1 full scale and full scale, all external inputs removed, inverting switch off, and dial scale switch set at symmetrical.)

Modes

Continuous: Generator produces a continuous wavetrain. May be synchronized to an external periodic waveform applied to TRIG-SYNC IN when the input frequency is within −0 +1% of the internal set frequency

Triggered: Manual or external trigger pulse initiates one complete waveform cycle

Cycle Start-Stop Point: Continuously variable ±90° using PHASE control

Start-Stop Aberrations: ≤5% up to 1 MHz; usable to 5 MHz

Gated: Manual or external trigger signal starts wavetrain which continues until trigger is removed. The last cycle of the wavetrain is always completed before the generator stops

Start-Stop Aberrations: ≤5% up to 1 MHz; usable to 5 MHz

Cycle Start-Stop Point: Continuously variable ±90° using PHASE control

Sweep: Sweeps the main generator frequency between limits established by the main dial cursor and concentric sweep limit cursor. Both linear and logarithmic (Log) sweep are provided. Log sweep provides logarithmically shaped "ramp" for full three-decade frequency range

Frequency

Main Function Generator Range

Sine, Square, Triangle and Pulse Waveforms: 0.00002 Hz to 20 MHz in ten decade ranges (Pulse: to 10 MHz).

Nonsymmetrical Sine, Square and Triangle Waveforms: 0.00002 Hz to 1 MHz in ten decade ranges.

Sweep-Ramp Generator Range: Sweep times from 1000 Sec to 10 μSec (exclusive of retrace) in seven decade ranges.

Dial Accuracy (With dial scale switch at SYMMETRICAL X1 or X2):
0.00002 Hz to 20 Hz ±2% of full scale ±1% of setting
20 Hz to 200 kHz ±1% of full scale ±1% of setting
200 kHz to 2 MHz ±2% of full scale ±1% of setting
2 MHz to 20 MHz ±3% of full scale ±2% of setting

Time Symmetry (With dial scale switch in X1 or X2): >99% to 20 Hz; >99.5%, 20 Hz to 100 kHz; >98%, 100 kHz to 2 MHz

Amplitude

Maximum Signal Output: 30 V p-p (bipolar) into open circuit or high-impedance loads, 15 V p-p into 50 ohm load. (Sweep ramp is unipolar.)

Combined Signal Plus Offset: ±15 V open circuit or ±7.5 V into 50-ohm load

Maximum Output Current: 200 mA short-circuit-proof, any waveform

Source Impedance: 50 ohms

Attenuator: Precision attenuator provides three 20 dB (10:1 in voltage) steps plus continuously variable 0–20 dB vernier; permits 80 dB output adjustment to 1.5 mV p-p minimum

Waveform Characteristics

Frequency Response

Sine, Triangle, Square Wave and Pulse: Better than 0.1 dB to 100 kHz; 0.25 dB, 100 kHz to 2 MHz; 2 dB, 2 MHz to 20 MHz

Square Wave and Pulse (50-ohm termination) Pulse Width: Adjustable 30 nSec to 10 mSec, independent of repetition rate

Rise and Fall Times: 15 nSec

Total Aberrations: <5%

Amplitude Differential: <5% p-p variation between symmetrical triangle, sine, pulse and square waveforms to 2 MHz

Sine Distortion: 0.5% to 100 kHz; 1% 100 kHz to 1 MHz; all harmonics greater than 26 dB down from 1 MHz to 20 MHz

Triangle Linearity: >99% to 100 kHz; >95% 100 kHz to 2 MHz

Offset: Selection of zero offset, positive or negative fixed offset, or variable offset (±15 V range into open circuit). NOTE: signal plus offset must not exceed ±15 V level.

Stability: Amplitude, frequency and offset (after 30-minute warmup) better than 0.05% for 10 minutes; 0.25% for 24 hours

Waveforms (Selectable, Main Output): Sine, square, triangle, standard pulse, sweep sawtooth (or ramp and hold), and DC level. Waveforms may be inverted, attenuated or offset using front panel controls

Symmetry (Duty Cycle): Symmetry of sine, square and triangle waveforms may be adjusted over a range of 5% to 95% to produce pulses or ramps whose duty cycle remains constant as frequency is varied

Phase: Start/stop phase of triggered and gated waveforms may be varied to create haversine and havertriangle waveforms.

Sweep Generator

Sweep Modes

Continuous: Sweeps the main generator repetitively at the rate established by the sweep generator controls. Retrace is not blanked

Trigger Sweep: Main generator starts from set baseline when triggered and produces a swept frequency output for one complete sweep cycle; returns to set baseline

Sweep and Hold: Main generator operates at start cursor frequency until triggered, then sweeps to other preset cursor frequency and holds until manually reset. Can be used to measure swept frequency excursions

Burst: Integral number of main generator waveform cycles are repetitively triggered by sweep generator at a rate established by sweep time controls

Sweep Limit Accuracy: ±5% of full scale

Sweep Direction: Switch selectable up or down

Function Generators
20 MHz Sweep/Function/Pulse
Model F77

Specifications (Continued)

Maximum Swept Frequency Change: 1000:1 with dial scale switch at X2 and 500:1 with dial scale at X1. Note: Internal main generator slew rate limitations (typically 0.3 V/μSec) decreases maximum peak-to-peak frequency change to approximately 6 major dial divisions in a 10 μSec (linear) sweep time

Auxiliary Sweep Outputs: Selectable constant amplitude, linear sweep ramp, or frequency analog outputs are provided for driving display x-axis. A rectangular waveform sweep sync output is available for pen lift function on chart recorders.

Auxiliary Inputs

VCF: Allows external DC or AC voltage control of output frequency

Input Levels: 0 to +5 V maximum varies frequency upward 1000:1 from minimum dial setting

Bandwidth: 100 kHz, limited to 0.3 V/μSec input slew rate

Input Impedance: 7500 ohms

Linearity: ±0.2% on all ranges except X1M

Amplifier External Input

Description: External signals and/or offset may be introduced to the main output amplifier (inverting). Offset, inverter and attenuator controls fully active for these inputs

Input Impedance: 50 ohms

Amplifier Gain: Approximately X6

TRIG-SYNC

Description: This circuit initiates triggered or gated waveforms or may be used to synchronize the internal generator (when in continuous mode) to the fundamental or harmonics of an external signal frequency

Input Level: 1 volt p-p between ±5 volts

Input Impedance: 10 kilohm shunted by 50 pF

Controls: Trigger level and slope

Auxiliary Outputs

Sync: Rectangular or square waveform, unipolar positive, 0–3 V, open circuit (TTL compatible), 50 ohm source impedance

Sweep Ramp: Linear ramp waveform, unipolar positive, 3 V p-p open circuit, 600 ohm source impedance

Frequency Analog: DC voltage proportional to generator frequency. 0 to +3 V open circuit, 600 ohm source impedance. Static linearity of conversion ±0.25% to 100 kHz

Sweep Sync: Rectangular waveform unipolar positive, 3 V p-p open circuit (TTL compatible), 50-ohm source impedance

General Isolation: Rear panel slide switch isolates all BNC connectors and circuit grounds from case and power line ground

Power

Voltage: 110, 115, 200 or 230 VAC ±10%, switch selectable

Frequency: 50–400 Hz

Consumption: 50 W maximum

Operating Temperature: 0°C to +50°C

Dimensions: 290 W × 380 D × 155 H mm
(11¼ W × 15 D × 6 H inches)

Weight: 7.5 kg (16.5 lb) net; 9 kg (20 lb) shipping

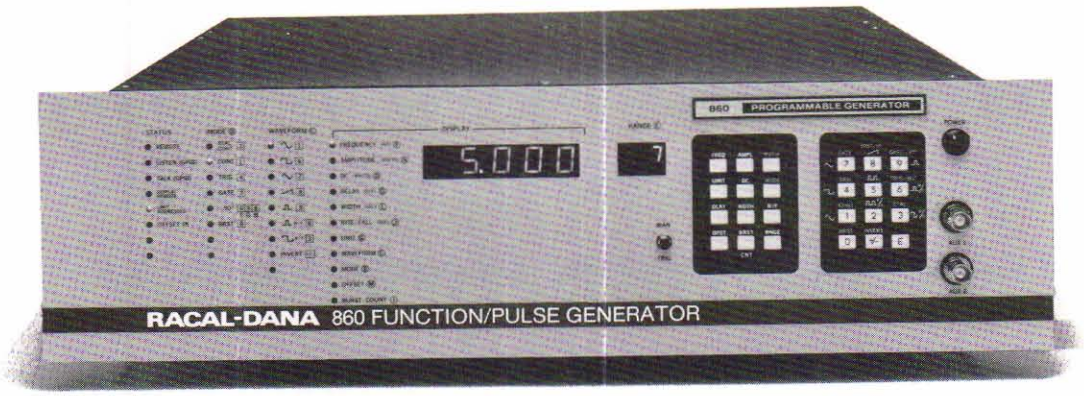
Ordering Information

Model F77: 20 MHz Sweep/Function/Pulse Generator

Options

R: Rack mounting kit

Function Generators
Programmable, Function/Pulse
Series 800



Introduction

Precision, speed and versatility mark the Racal-Dana Series 800 as high-performance programmable signal sources. Whether your applications call for crystal-frequency accuracy, a programmable power supply, or precision amplitudes for varied waveforms, the Series 800 can meet that need.

The Series 800 consists of two models. Model 845 produces outputs to 14 MHz in nine overlapping ranges. Options expand the 845 to include full pulse generator capabilities. Model 860 produces outputs to 20 MHz in ten overlapping ranges and includes pulse generator capabilities with variable rise/fall times from 10 nanoseconds. Both models offer output levels of up to 30 volts peak-to-peak, open circuit. The Model 860 features a non-volatile memory for storage of up to 20 complete test steps.

The use of this setup memory can significantly reduce test times in both bench and system applications. Three simple keystrokes will recall complex test setups quickly and without error; thus, repeated test sequences (such as manual "sweeping" from 20 Hz to 20 kHz in half-octave steps) are easily executed.

High-Speed GPIB Operation

The Models 845 and 860 Programmable Generators require only an average of 1.25 microseconds to handshake each data character over the IEEE-STD-488 interface. This high speed interface is over 20 times faster than competitive sources. The Model 860 provides a "Learn" mode for transferring setups directly to the computer. This mode allows the 860 to report status of all current operating parameters.

On the Model 860, any two of the multiple input/output connectors may be patched from the rear to the front panel (including the digitally programmed ±16 volts DC power supply). This eliminates the need for external patch panels. When used in conjunction with the Racal-Dana Series 1200 GPIB Switching System, the front panel auxiliary BNC connectors may be used as a system-defined operator input/output.

Easy and Accurate Bench Operation

Both Series 800 models have front-panel keyboard control. The Model 860 complements the skilled technician at the test bench by providing an unmatched array of signal stimuli with pushbutton frequency and amplitude accuracies.

External AM and FM are standard features of both models. Bursts of a precise number of cycles with the manual trigger is standard with Model 860 (optional with Model 845).

Programmable Pulse Capability

The Model 860 (and 845 with the addition of Options 02, 03, and 12) features a true pulse generator with some capabilities that other pulse generators don't have at all. Like AM and FM—simultaneously. Or crystal-frequency accuracy on the repetition rate.

Every pulse parameter is programmable: repetition rate, delay, width, rise time, fall time, offset, amplitude, external trigger and gate modes, double pulse, and counted burst wavetrains to 19,999 counts (39,998 for double pulses).

Function Generators
Programmable Function/Pulse
Series 800

Specifications

Main Output

Waveforms: Selectable waveforms are sine, square, triangle, ramp haversine, havertriangle, pulse, double pulse, invert (180°), and DC (haverfunction and ramps to 14 kHz maximum).

Note: Sine, triangle and ramp waveforms of less than 14 kHz may be interrupted and held indefinitely at any value

Amplitude

Range

Model 845: 10 mV to 15 V p-p in three decade ranges

Model 860: 1 mV to 15 V p-p in four decade ranges

Resolution: 3½ digits

Accuracy—Model 845

Programmed Amplitude (V p-p)	All Waveforms	Sine, Square and Pulse (for triangles above 100 kHz, add 5%)		
3–15	±2%	±2%	±5%	±12%
0.03–3	±3%	±3%	±6%	
0.01–0.03	±3%			

0.01 Hz — 10 kHz — 1 MHz — 10 MHz — 14 MHz

Output Frequency

Accuracy—Model 860

Programmed Amplitude (V p-p)	All Waveforms	Sine, Square and Pulse (for triangles above 100 kHz, add 5%)			
3–15	±2%	±2%	±3%	5%	±10%
0.03–3	±3%	±3%	±4%		
0.001–0.03			±5%	±10%	

0.01 Hz — 10 kHz — 1 MHz — 10 MHz — 14 MHz — 20 MHz

Output Frequency

Offset

Range: ±10 mV to ±7.50 V in 1 range (offset is attenuated by the amplitude range attenuator)

Resolution: 3 digits

Accuracy

Model 845: 0.5% setting ±2 mV

Model 860: ±32 mV

Amplifier DC Drift

Model 845: ±75 mV (20° to 40°C)

Model 860: ±60 mV (20° to 40°C)

Frequency

Range

Model 845: 0.01 Hz to 13.999 MHz in 9 overlapping ranges

Model 860: 0.01 Hz to 19.99 MHz in 10 overlapping ranges.

Resolution

Model 845: 4½ digits to 13.999 MHz

Model 860: 4½ digits to 13.999 MHz; 3½ digits above 14 MHz

Accuracy (unsynthesized)

0.01 Hz to 100 Hz: Less than 2%

100 Hz to 10 kHz: Less than 3%

10 kHz to 500 kHz: Less than 2%

500 kHz to 14 MHz: Less than 3%

10 MHz to 20 MHz (Model 860 only): Less than 3%

Frequency (Synthesized)

Range: 0.01 Hz to 13.999 MHz

Resolution: 4½ digits in each of 9 overlapping ranges

Accuracy: ±0.001%

Stability

Long-Term: $\pm 5 \times 10^{-6}$ parts per year

Short-Term: $\pm 5 \times 10^{-8}$ parts per day

Temperature Coefficient: $\pm 1 \times 10^{-6}$ parts per °C

Settling Time: Less than 25 mSec to within 1 least significant bit

Auxiliary Outputs

31 to 44 MHz: 31 to 44 MHz in 1 kHz steps correlated with 1.000 to 13.999 on each display range (Sine wave at approximately 1 V rms, 50 ohm source impedance)

1 MHz: TTL from internal synthesizer

TTL Pulse: Same as main pulse waveform except at fixed TTL level and without variable rise and fall.

Sync: Squarewave at TTL levels synchronized with each output waveform cycle

DC Volts

Maximum Output

Model 845: ±9.99 V at 10 mA

Model 860: ±15.99 V at 100 mA

Resolution: 3 digits/10 mV

Accuracy: 0.1% of full scale, ±2 mV; Z_{out} less than 1 ohm

Auxiliary Inputs: All inputs isolated from case/power line ground

Trigger: Initiates trigger, gate and burst modes with TTL zero or switch closure: Z_{in}=5 kilohms shunted by 45 pF. Unit also may be triggered by manual pushbutton or remote ASCII H

FM: DC or AC signals for algebraic addition to programmed frequency. Z_{in}=5 kilohms. Bandwidth: 40 kHz minimum—larger for small signals <1 V p-p. All ranges may be swept up to 1000:1. May be used in conjunction with DC voltage output to produce sweep and X-axis chart recorder drive

AM: DC or AC signals for algebraic addition to programmed amplitude. Z_{in}=2.7 kilohms. Bandwidth: 40 kHz minimum. Distortion: 1 percent at 95% modulation

1 MHz: Accepts external frequency reference of more than 0.2 V p-p, sinewave or squarewave (Synthesizer Mode) Z_{in}=1 kilohm

Function Characteristics

Sinewave Distortion: Total harmonic distortion referred to the fundamental: −42.5 dB to 100 kHz, −40 dB to 1 MHz. All harmonics down more than 30 dB for fundamental in the 1 to 10 MHz range, less than 27 dB above 10 MHz

Triangle Ramp Linearity: 99.8% to 14 kHz, 99% to 100 kHz, 97% to 1 MHz, 95% to 10 MHz

Retrace Time: 1% of period plus 1 μSec

Burst Count (Model 860 only): 1 to 19,999 frequency ranges 10^{-2} through 10^{6}

Squarewave and Pulse

Rise/Fall Time

Model 845: Less than 20 nSec unless variable rise and fall times are programmed

Model 860: Less than 10 nSec unless variable rise and fall times are programmed

Aberrations: Less than 5% of p-p voltage may increase to less than 10% below 3 V p-p

Pulse Generator—Option 2, Model 845; Standard, Model 860

Delay Range

Model 845: Programmable from 30 nSec to 990 mSec in 8 decade ranges

Model 860: Programmable from 15 nSec to 990 mSec in 8 decade ranges

Delay Resolution: 2 digits

Width Range

Model 845: 30 nSec to 990 mSec in 8 decade ranges

Model 860: 15 nSec to 990 msec in 8 decade ranges

Width Resolution: 2 digits

Double Pulse: Two output pulses for each clock interval

Jitter: Less than 0.1% ± 1 nSec

Delay Offset

Sync Out to Main Out: 90 nSec unless used with optional delay line

Trigger to Main: 120 nSec maximum

Variable Rise/Fall—Option 03, Model 845; Standard, Model 860

Range: 20 nSec to 990 mSec in 8 decade ranges: 10^{-9} to 10^{-2} Sec. Applicable to both square waves and pulses

Resolution: 2 digits: 10 to 99

Accuracy: ± 5% of full scale range, except ± 10% of full scale range on 10^{-9} Sec range

Counted Burst—Option 12, Model 845; Standard, Model 860

Number: 1 to 19,999 (×2 for double pulses)

Resolution: To nearest cycle

Modes: Burst, Burst −90° (Burst −90° below 10 kHz produces "haversine" and "havertriangle" wavetrain

Initiation Trigger: External switch closure negative true TTL. ASCII character H or manual

Operating Modes

Standard: Continuous, triggered, gate, −90° phase, offset, AM and FM, crystal synthesizer, counted burst to 19.999 cycles; DC output.

Auxiliary: Waveform pause, Ramp and Hold.

Settling Time:

Frequency Without Range Change:	Less than 100 μSec
Frequency With Range Change:	Less than 2 mSec
Amplitude Without Range Change:	Less than 100 μSec
Amplitude With Range Change:	Less than 5 mSec
Offset Waveform and Mode:	Less than 2 mSec
Crystal Referenced Mode:	≤25 mSec to settle to within 1 least significant digit of specified value

Store/Recall—(Model 860 Only)

Capacity: 20 test setups, all parameters

Recall Time: 1.5 mSec, maximum

Storage Time: Data retained 4 weeks at room temperature. Internal battery trickle-charged; 30-hour operation recharges fully

General

Power: 100, 120, 220, 240 VAC ± 10%, 50/60 Hz at 300 VA max. Power switch breaks both sides of line.

Isolation: Case ground isolated from circuit ground and control ground. An optically isolated GPIB interface is available.

Dimensions: 133H × 429W × 559D mm
(5.25H × 16.9W × 22D inches)

Weight: 22 kg (48 lb)

Ordering Information

Model 845: 14 MHz GPIB Programmable Function Generator

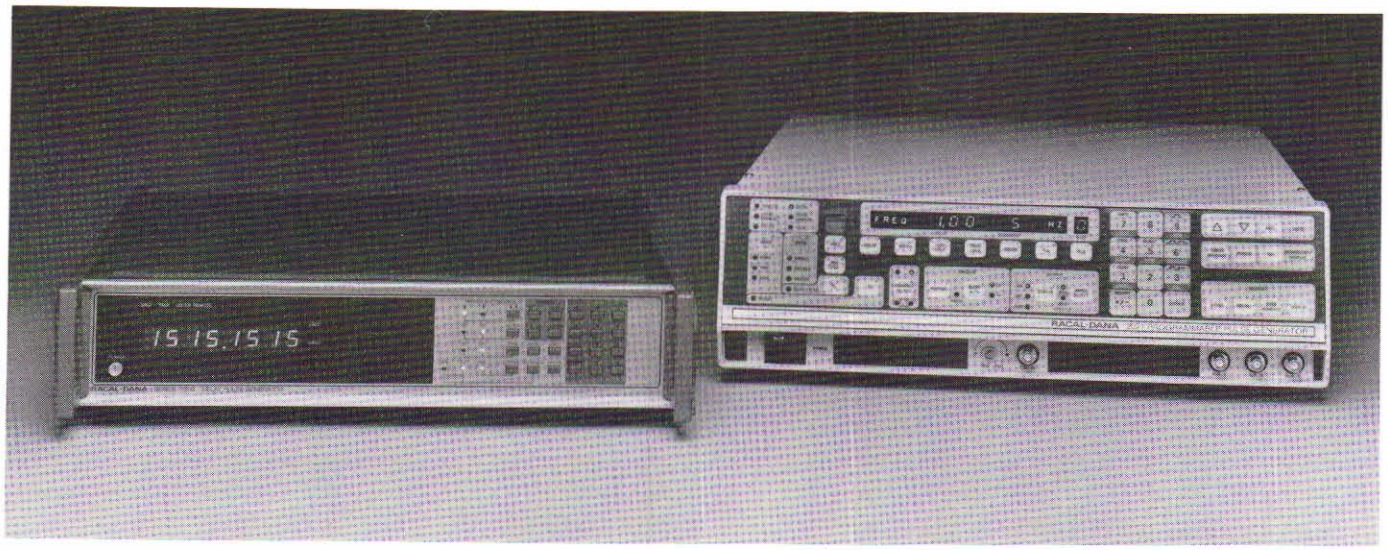
Model 860: 20 MHz GPIB Programmable Function/Pulse Generator

Options

02: Pulse generator[1]
03: Variable rise/fall time[1, 2]
05: Digital data interface[3]
051: Optically isolated digital data interface[3]
08: RS232C interface[4]
09: Chassis slides
10: Benchtop case
11: Extender Card
12: Burst Counter[1, 2]
13: Delay line[5]
61: Optical isolators for GPIB interface

[1]Standard on Model 860
[2]Requires Option 02
[3]Model 845 only
[4]Replaces GPIB interface
[5]Model 860 only

Pulse Generators
General Information



Introduction

Racal-Dana's line of pulse generators offers a broad selection of features and capabilities. An instrument is available to meet the requirements of almost every pulse generator user. In addition to the pulse generators shown in this section, many of the function generators shown earlier in this catalog contain pulse generator capability.

Wide Selection of Models

The Racal-Dana pulse generator line-up includes the Series P20, 1500, and 2021. The Series 800 Function Generators also provide complete pulse generator performance. Within each Series are several models, each designed to meet specific user requirements.

The Series P20 provides full 50 MHz pulse capabilities for the bench user. Two models offer a choice of features.

The Series 800 (shown in the function generator section) provides a 20 MHz programmable pulse generator combined with a full-featured function generator. This Series also features two models.

The 5 MHz Series 1500 offers 10 nanosecond resolution for both pulse width and delay settings. This series contains two models for gating, triggering and delay applications that do not require variable offset or transition times. Both models provide GPIB interface as standard and maintain 10 nanosecond resolution over a range of 100 nanoseconds to 1 second.

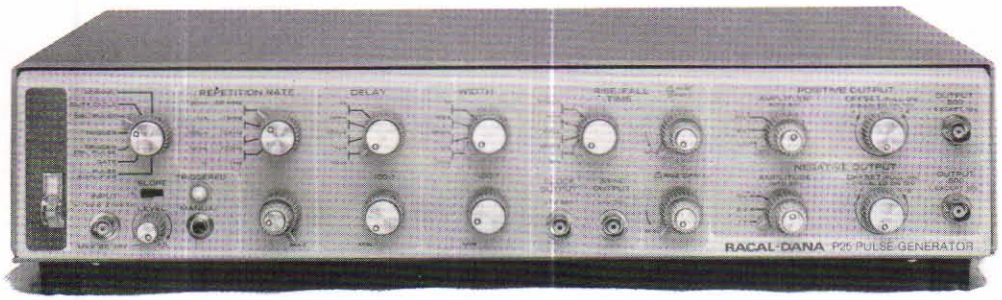
The Series 2021 contains two 50 MHz models. Both models provide full programmability of all parameters and operating modes. These high performance generators are ideal for both bench and system use.

Pulse Generator Model Selection Chart

Feature \ Model	P24	P25	845	860	1510	1515	2021	2021DS
Frequency	50 MHz	50 MHz	14 MHz	20 MHz	5 MHz	5 MHz	50 MHz	50 MHz
Minimum Transition Times	5 nSec	5 nSec	20 nSec	10 nSec	20 nSec	20 nSec	5 nSec	5 nSec
Maximum Output (50 ohm)	10 V p-p	10 V p-p	15 V p-p	15 V p-p	2.2 V p-p[1]	2.2 V p-p[1]	10 V p-p	10 V p-p
Variable Offset	X	X	X	X	—	—	X	X
Variable Rise/Fall Times	X	X	OPT	X	—	—	X	X
Dual Output	—	X	—	—	—	—	—	X
Pulse Burst	—	—	OPT	X	X	X	X	X
Dual Output Summing	—	—	—	—	—	—	—	X
Programmable	—	—	X	X	X	X	X	X
Resolution (Width/Delay)	N/A	N/A	2 digit	2 digit	10 nSec	10 nSec	3 digit	3 digit

X=Standard Feature
OPT=Option
[1]T.T.L. Compatible

Pulse Generators
50 MHz, Bench
Series P20



Introduction

The Series P20 pulse generators are the ideal solution to bench requirements for stable, highly-accurate pulse signals in the 1 Hz to 50 MHz frequency range. Model P24 provides a single output with selectable positive or negative pulses, and separately adjustable offset and amplitude. Model P25 provides dual outputs for applications which require simultaneous positive and negative outputs. Rise and fall times are adjustable from 5 nanoseconds to 0.5 seconds in four ranges. Output is adjustable from 100 millivolts to 10 volts (into 50 ohms). A 3-step range attenuator provides good adjustment resolution even at low signal levels. Offset is not attenuated, so millivolt level pulses can be offset as much as 5 volts from ground.

Versatile Performance to Suit Your Requirements

Seven operating modes satisfy nearly every requirement. A unique constant duty cycle mode guarantees pulse presence and allows you to easily vary repetiton rates without changing the other controls. Both single and double pulse modes are available as well as a gate mode for burst output applications.

Ease of Operation

The controls arrangement is simple and highly functional. All inputs go through one BNC; all inputs, outputs, and operating controls are located on the front panel.

Control of pulse repetition rates, delay, and width is simplified by use of operating controls which feature a two-decade adjustment range. Because of their log-taper design, these 100-to-1 controls offer excellent resolution. Resolution of the repetition rate setting is further enhanced by an extra vernier control.

Pulse Generators 50 MHz Bench Series P20

Specifications

(Unless noted, all specifications apply with 50 ohm resistive load, 5 V output level, zero offset, amplitude verniers set to maximum)

Pulse Characteristics

Repetition Rate: 1 Hz to 50 MHz, 4 ranges with continuous 100:1 adjustment on lower 3 ranges. 50:1 on 50 MHz range

Width: ≤10 nSec to 1 Sec, 4 ranges with continuous 100:1 adjustment in any range

Delay: ≤10 nSec to 1 Sec (reference sync output) 4 ranges with continuous 100:1 adjustment in any range

Jitter (Rate, Delay and Width): 0.1% +50 pSec

Amplitude

Into 50 Ohms: 1, 5, 10 V peak ranges. Continous 10:1 adjustment in any range

Open Circuit: Amplitude doubles on 1 and 5 volt ranges

Polarity

Model P24: Switchable positive or negative

Model P25: Simultaneous positive and negative on dual channels with individually adjustable offset and amplitude

Offset[1] (Positive Polarity Pulse)–

Into 50 Ohms: –6 to +1 volts

Open Circuit: –12 to +2 volts

Offset[1] (Negative Polarity Pulse)–

Into 50 Ohms: –1 to +6 volts

Open Circuit: –2 to +12 volts

[1]Independent of attenuator setting (disabled on 10 V range)

Output Impedance: 50 ohms (internal 50 ohm disconnected on 10 V range)

Rise and Fall Times

Range: 5 nSec to 500 mSec, 4 ranges with 100:1 adjustment on any range

Linearity: >95% between 10% and 90% points for >30 nSec rise/fall times

Aberrations (Overshoot, Undershoot, and Ringing) ≤5% of pulse amplitude

Output Protection: Will withstand short-to-ground without damage

Modes

Normal: Internal clock provides trigger for standard delay and width functions

Duty Cycle: Duty cycle of pulse set by width vernier as percent of pulse period and maintained essentially constant over entire pulse rate range. Duty cycle continuously adjustable from 5 to 95% of period with pulse rates to 1 MHz, decreasing to 50% duty cycle at 50 MHz

Double Pulse: Provides two pulses for each generator cycle. Pulses separated by delay period. Maximum effective rate is 50 MHz (internal clock at 25 MHz)

Trigger: Manual or external trigger at trigger input generates one complete pulse cycle

Gate: Manual or external signal at trigger input enables generator for duration of applied signal. Last cycle is completed even if gate is removed in mid-cycle

Triggered Double Pulse: Same as triggered pulse except two pulses separated by delay period are initiated with each trigger command

Pulse Amplifier: External waveform applied to input BNC connector is squared and applied directly to output amplifier. Offset, amplitude, and rise/fall controls may be independently adjusted as in normal mode. May be activated with manual trigger

External Trigger Input

Input Range: 0.7 V p-p minimum, 35 V p-p maximum

Trigger Level: Threshold adjustable ±5 V with trigger level control

Slope: Positive or negative — switch selectable

Input Impedance: 1000 ohms in parallel with 15 pF

Trigger Light: On whenever internal clock or external trigger is providing adequate trigger to following circuits and sync output. Will blink at extremely slow trigger rates. In constant duty cycle mode, light off if pulsewidth settings are either too narrow or too wide for proper operation.

Auxiliary Outputs

Sync Output

Level: 0 to +2.5 V nominal, open circuit

Rise/Fall Times: ≤5 nSec

Output Impedance: 50 ohms

Waveform: Square wave except in duty cycle mode where duty cycle is identical to main output and external modes where duty cycle is identical with external drive signal

Clock Output

Level: 0 to +2.5 V nominal, open circuit

Rise/Fall Times: ≤5 nSec

Output Impedance: 50 ohms

Waveform: Square wave in all modes, coherent with main output in normal and duty cycle modes, and during gate interval. Nonsynchronous free-running in trigger and pulse amplifier modes.

General

Power Requirements

Voltage: 100, 115, 200, 230 VAC, ±10%, switch selectable

Frequency: 48 to 440 Hz

Power Consumption: 75 W max

Operating Temperature: 0°C to +50°C

Storage Temperature: –20°C to +70°C

Dimensions: 88.9 H x 431.8 W x 342.9 D mm (3.5 H x 17 W x 13.5 D inches)

Weight: 7.1 kg (15.5 lb)

Ordering Information

Model P24: 50 MHz Single Output Pulse Generator

Model P25: 50 MHz Dual Output Pulse Generator

Option

R: Rack mount

Accessory

P00332057: Accessory Kit (Contains two 50 ohm terminations and three coaxial cables)

Pulse Generators
GPIB Timing/Delay Generators
Series 1500

Timing Generator Solves All GPIB Timing Needs

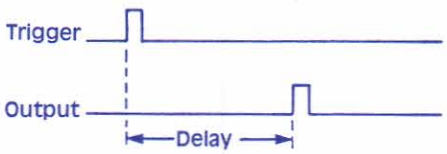
The increased use of GPIB (IEEE-STD-488) compatible instruments and controllers to automate previously manual test stations requires that many of the timing functions previously performed by the test technician be automated.

The Series 1500 GPIB Timing Generators fill both the analog (hardware) and software timing needs of these systems.

The Series consists of Models 1510 and 1515. Both models provide hardware timing capabilities. The 1515 also includes a real-time clock and software timing features.

Delay

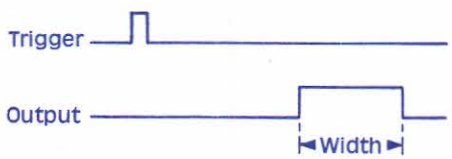
Defined as the ability to provide an output, "X" amount of time, after receipt of an input trigger.



The Series 1500 provides fully programmable delay from 100 nanoseconds to 1 second with 10 nanoseconds resolution over the entire range.

Pulse Width

The 1500 allows control of the output pulse width.

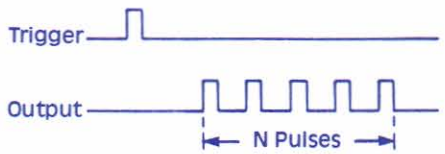


Like the delay, the pulse width is programmable over a range of 100 nanoseconds to 1.0 second and provides 10 nanoseconds resolution over the entire range.

Combined programming of delay and width allows the user to establish a wide variety of output timing conditions.

Multiple Pulse "Burst" Triggering

The Series 1500 has the ability to output "N" number of pulses after receipt of a trigger. This could be used, for example, to trigger a high speed A/D converter to digitize a waveform.



This feature can be programmed to output from 1 to 9999 pulses for each input trigger.

Ability to Trigger Selectively

Since the signal under measurement may be the signal from which you wish to trigger, other timing needs relate to the need to choose a trigger point on the waveform.

Examples of these needs are:

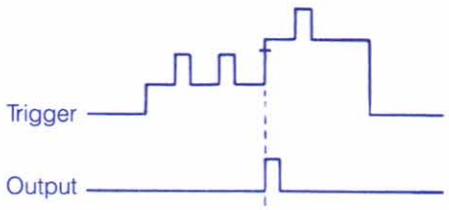
Creating defined triggers. You may select a point on a complex waveform from which to create a defined trigger pulse.

Pulse Generators
GPIB Timing/Delay Generators
Series 1500

The 1500 provides full programming of trigger level, slope, coupling and attenuation.

Either the marker output or the delayed output may be used for this application.

Selective Triggering: The Series 1500 may be programmed to ignore events which do not pass through a defined analog level/slope.



Real Time Clock

The 100 day digital clock in the 1515 is fully programmable and provides time of day information both on the front panel and through the GPIB interface. Data is available on the GPIB in either traditional time format, DD:HH:MM:SS, or in the ATLAS compatible format, DDHH.MMSS.

Real-Time Interrupt

On the 1515, SRQ interrupts may be programmed to occur at regular intervals or after a timecount delay. These interrupts may be programmed with 10 mSec resolution.

Software Time Interval Measurements

Software start and stop commands can be used to cause the 1515 to measure time interval with a resolution of 10 milliseconds...useful for measuring program execution time.

Elapsed Time Clock

By presetting the time of day clock to zero, the 1515 will measure elapsed time from start of a measurement sequence. This may be used to measure duration of a long-term test.

GPIB Interface

Both the Series 1500 models come complete with a full GPIB interface. All applicable subsets have been implemented at their highest level.

Front Panel Control

Front panel control is available for all hardware timing features except trigger level control. This allows the Series 1500 to be used in manual setups as well as allowing manual programming during debugging of ATE systems.

Series 1500 Model Summary

Model Number	Delay	Pulse Width	Burst	Programmable Trigger Levels	Real-Time Clock	Interrupts	Time Interval	GPIB
1510	X	X	X	X				X
1515	X	X	X	X	X	X	X	X

Specifications

Delay and Pulse Width

Range: 100 nSec to 1 Sec

Resolution
Single Pulse: 10 nSec
Multiple Pulse: 100 nSec

Accuracy: ±10 nSec ±(Delay or width × timebase error)

Jitter
Marker to delayed output: ±2 nSec
External Trigger to Marker Pulse: ±10 nSec ±Trigger Error[1]

Marker Delay: ≤100 nSec from external trigger.

1. Trigger Error (≥40 dB, S/N ratio) $= \frac{0.0025\ \text{V}}{\text{Slope of input trigger (V/Sec)}}$

Multiple Pulse (Burst) Mode

Range: 1 to 9999 pulses

Resolution: Increments of 1 pulse

External Trigger Input

Frequency Range: DC to 5 MHz

Input Level
X1 : ±2.5 V DC or peak
X20: ±50 V DC or peak

Sensitivity: 150 mV p-p X attenuator setting

Input Impedance: 1 megohm shunted by ≤35 pF

Minimum Pulse Width: 20 nSec

Maximum Input

Frequency	Attenuator Range X1	Attenuator Range X20
DC–10 kHz	250 V rms	250 V rms
10 kHz–500 kHz	$\frac{2.5 \times 10^6 \text{ V rms}}{\text{Frequency}}$	250 V rms
500 kHz–5 MHz	5 V rms	40 V rms

Maximum Trigger Rate: $\frac{1}{N^1 \text{ (pulse width + delay)} + 100 \text{ nS}}$

Manual Trigger Level: 0.0 or +1.4 volts, switch selectable

Remote Trigger Level

Ranges: ±2.5 V, ±50 V

Resolution: 0.4% range
(10 mV on 2.5 V range)

Outputs

Logic: Positive or negative true selectable

Levels

Positive State: ≥+2.2 V into 50 ohms
≤+5.2 V open circuit

Negative State: ≤+0.4 V into 50 ohms

Output Impedance: 50 ohms

Rise/Fall Times: ≤20 nSec

Marker Pulse Width: ≥20 nSec

Trigger Modes

Manual: External
Internal-continuous

Remote: External
Internal-continuous

External-one shot
"GET" command
Software trigger

Reference Oscillator

Internal

Frequency: 10 MHz

Aging Rate: $\leq \pm 1 \times 10^{-5}$/year

Temperature Stability: $\leq \pm 5 \times 10^{-6}$ (20°C to 30°C)

External: 10 MHz, 1 V rms, switch selectable

Real-Time Clock—Model 1515 only

Range: 0 to 100 days

Resolution: 1 second

Display Format: DDHH.MMSS

Output Format: DDHH.MMSS[2]
or
DD:HH:MM:SS

1. N = Number of output pulses selected (1 to 9999).
2. Leading spaces are transmitted for a total of 11 characters.

Software Time Interval—Model 1515 only

Range: 0 to 9999.99 Sec

Resolution: 10 mSec

Overflow Indication: OF

Display: Not available

GPIB Commands: Start, Stop, Reset, and Output Data

Output Format[2]

No Overflow: SSSS.FF

With Overflow: OFSSSS.FF

Real-Time Interrupts

Range: 0.01 to 99.99 seconds

Resolution: 10 mSec

Formats: Single after delay or multiple

GPIB Commands: Single interrupt
Multiple interrupts
Start
Stop
Acknowledge

GPIB Interface

Description: Provides full programming of all functions and output of time and time interval information

General

Temperature Range

Operating: 0°C to +50°C

Storage: −20°C to +60°C

Operating Humidity Range

0°C to +40°C: ≤75% RH

+40°C to +50°C: ≤50% RH

Power Requirements

Voltage: 100, 120, 220, or 240 VAC ±10%

Frequency: 50 or 60 Hz

Consumption: 70 watts

Dimensions: 89 H × 427 W × 475 D mm
(3.5 H × 16.8 W × 18.7 D inches)

Weight: 11.3 kg (25 lb)

Ordering Information

Model 1510: Delayed Pulse Generator

Model 1515: GPIB Timing Generator

Option

04: 50 Hz operation

71: 220/240 VAC operation

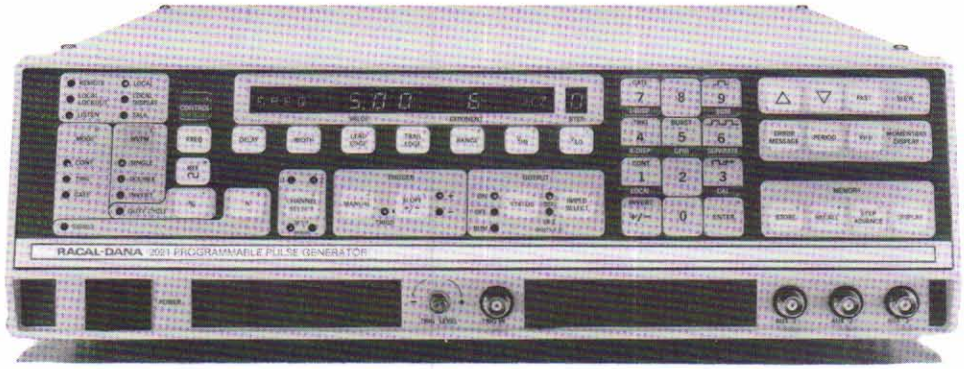
60: Rack mounting adapters

65: Chassis slides and rack mounting adapters

Accessories

See GPIB Instrument Section

Pulse Generators Programmable, 50 MHz Series 2021



Two Models

The Series 2021 programmable pulse generators offer a combination of features never before available. The series consists of two models. Model 2021 fulfills ATE and bench testing requirements. It provides 50 MHz, ±20-volt pulse output with transition times from 5 nanoseconds. Model 2021DS adds a second output channel with direct summing to 40 volts peak-to-peak. A highly flexible microprocessor-based design permits manual or remote control of all operating modes, waveforms, repetition rates, high and low voltage levels, rise/fall times, delay, width, percent of constant duty cycle, impedance, and output status.

Easy-To-Use Controls for Bench Operation

All front-panel controls are functionally grouped and color-coded for easy programming. Front-panel touch contact controls combined with annunciator-enhanced displays show status and operating conditions at a glance. The system of color-related controls makes it easy to quickly call to the display the function name, numeric value, exponent and memory location of each parameter addressed by the front panel.

All pulse parameters are displayed with 3-digit resolution; pulse bursts may be set to output up to 9999 pulses maximum. Two independent up/down slew rates permit vernier adjustment of any pulse parameter.

GPIB Interface with Rapid Programming Enhances ATE System Operation

A simple, complete GPIB (IEEE-STD-488) interface offers both talker and listener capability. The self-contained program memory may be used for rapid programming during system operation. The front panel annunciators clearly display instrument status for assistance during software development and for confidence checking during system operation.

Automatic Self-Calibration and Set up Checking

This microprocessor-based pulse generator features Racal-Dana's unique "Auto-Cal," which provides internal self-calibration to ensure that waveform parameters are within specification. Upon command, the 2021's processor draws feedback from the instrument's main output and accomplishes calibration of frequency, voltage levels, delay, and width. Inability to automatically calibrate a given parameter results in a displayed diagnostic error message, defining the need for conventional calibration.

All pulse parameters inputed during setup are checked for incompatibilities (e.g., width > period). Warning messages guide the operator to a valid pulse setup. This testing may be disabled in remote operation to increase programming speed.

A "learn" mode allows a waveform to be optimized by front panel control, and subsequently read into bus controller memory for future programming use.

Built-in Program Memory

The Series 2021 has ten memory locations. Each accommodates a complete pulse parameter setup. Rechargeable battery backup is a standard feature and retains memory data for up to four weeks without AC power.

Dual-Output Summing

Model 2021DS provides a second output channel as well as direct summing of the outputs of the two channels. Sharing only a common repetition rate, burst count, and mode with Channel 1, Channel 2 has independently programmable voltage levels, output impedance, waveform, delay, width, duty cycle, and transition times. With dual output summing, maximum output amplitude is increased to 40 volts peak-to-peak. Summing the outputs permits simulation of "glitches" and other complex digital waveforms. An exclusive VMOS design makes the output stage immune to both short- and open-circuit conditions.

Specifications

Output (All Specifications into 50 ohms)

Amplitude[1]

Source Impedance	V_{LO} and V_{HI} Amplitude Window	Amplitude Range V_{P-P}
50 ohms	−9.99 to +9.99	0.5 to 9.99
50 ohms (with attenuator)	−0.999 to +0.999	0.05 to 0.999
High Impedance	−19.98 to +19.98	1.0 to 19.98

[1]Amplitude is dètermined by setting both V_{LO} and V_{HI}

Accuracy:
V_{LO} ±(1% of setting +3% of $V_{HI}-V_{LO}$) ±50 mV
V_{HI} ±(1% of setting +3% of $V_{HI}-V_{LO}$) ±50 mV

Repeatability: 1% ±20 mV

Minimum Rise/Fall Time: 5 nSec ±2 nSec from 50-ohm source impedance into 50-ohm load

Waveform Aberrations: 5% of amplitude ±10 mV

Ranges

Repetition Rate

Single Pulse: 10 Hz to 50 MHz

Double Pulse: 10 Hz to 25 MHz

Constant Duty Cycle: Programmable from 1 to 99% independent of repetition rate. Limited to pulse width of 10 nSec to 9.99 mSec

Modes

Continuous: Free running clock

Triggered: One pulse generated with each trigger input pulse. Either positive or negative going edge may be selected for triggering.

Gated: Wavetrain generated for duration of trigger signal.

Burst Count: Each trigger pulse causes generation of a predetermined (1 to 9999) number of output pulses. Operates to 20 MHz repetition rate.

Repetition Rate

Frequency Range: 10 Hz to 50 MHz in seven ranges, with 3-digit resolution

Period Range: From 20 nSec to 0.1 Sec

Accuracy: ±2% of programmed value ±1 nSec

Repeatability: 1% ±1 nSec

Maximum Jitter: 0.15% ±50 pSec

Pulse Width

Range: 10 nSec to 9.99 mSec in six ranges

Accuracy: 1% of programmed value ±3 nSec

Repeatability: 1.0% ±2 nSec

Maximum Jitter: 0.1% ±50 pSec

Pulse Delay

Range: 0 to 9.99 mSec in six ranges

Accuracy: 1% of programmed value ±4 nSec

Repeatability: 1% ±2 nSec

Maximum Jitter: 0.1% ±50 pSec

Adjustable Rise/Fall Time

Range: 5 nSec to 9.99 mSec in six ranges. Times are referenced to the 10% and 90% amplitude points. Rise and fall times are independently programmed within a common range.

Accuracy: 5% of programmed value ±2 nSec

Repeatability: 2% ±2 nSec

Auxiliary Outputs

Out A (J1): Output pulses from Channel 1 (on Model 2021 DS this connector also provides the summed output of both channels).

Out B (J2): Output pulses from Channel 2 (Model 2021 DS only)

Sync (J3): Negative going TTL output sync pulse (outputs J1 or J2 occur after sync pulse is delayed by a time equal to delay command value).

Sync ÷ N (J4): TTL compatible sync output with its repetition rate equal to the programmed generator repetition rate divided by the programmed "N" value of the Burst function.

Clock Out (J5): Provides TTL compatible external connection to generator's internal clock.

Trig In (J9): Connects external trigger source to generator (identical function to front panel TRIG IN connector).

General

Power Requirements

Voltage: 100, 120, 220, 240 V AC ±10%

Frequency: 48 to 63 Hz

Power Consumption: 175 watts

Weight: 18 kg (38 lb)

Dimensions: 133H × 431W × 610D mm
(5¼H × 17W × 24D inches)

Ordering Information

Model 2021: 50 MHz Programmable Pulse Generator

Model 2021DS: Dual Channel 50 MHz Programmable Pulse Generator

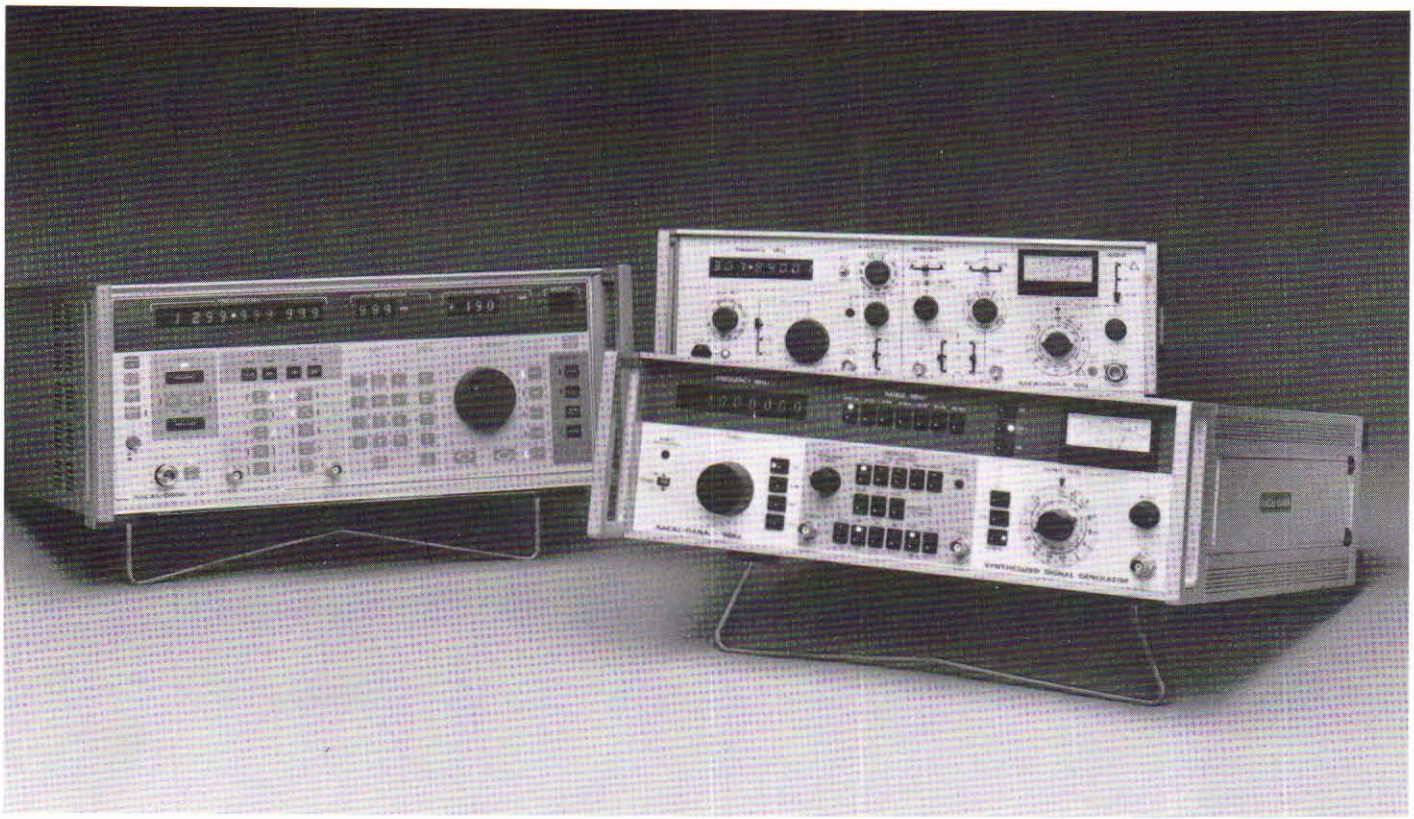
Options

Option E1: 3½" extender card

Option E2: 7" extender card

Option RM: rack mount with slides

Signal Generators/Synthesizers
General Information



Introduction

Racal-Dana manufactures a comprehensive range of synthesized signal generators offering a broad spectrum of performance and capability.

Racal-Dana pioneered the synthesized signal generator concept. It combines the excellent stability, resolution, accuracy, and programmability of the high performance synthesizer with the variable calibrated output level, low noise, modulation capabilities, and simplicity of tuning offered by the more conventional analog generator.

These generators are designed for a wide range of general and systems applications associated with radio communications testing including selectivity and sensitivity testing of ultra-sensitive RF radio receivers. The Racal-Dana products are particularly suited to these applications because of their excellent calibrated output level characteristics, low VSWR and versatile automatic levelling circuits. In addition, the overall design has been engineered to reduce leakage and RFI levels to extremely low levels, typically less than 0.5 microvolt.

The synthesized generators offer a wide range of performance functions which allow their use for signal-to-noise ratio measurements, as drive sources for mixers and bridges, and for many other applications including automatic test systems.

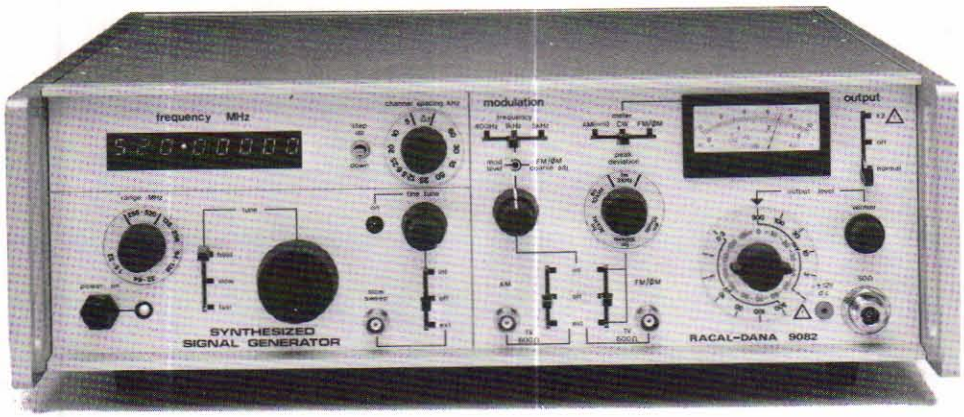
Channelized frequency selection, spin-wheel tuning, and a choice of internal reference oscillators make the Racal-Dana synthesized signal generators a cost-effective solution to measurement and stimulus requirements in the HF, VHF and UHF bands.

Signal Generators Model Summary

Model No.	Frequency Range	Output Level	Modulation AM	FM	ϕ	Pulse	GPIB	Application
9082	1.5–520 MHz*	–130 to +9 dBm	X	X	X	X		HF/VHF/UHF channelized Radio
9082H	1.5–520 MHz*	–130 to +19 dBm	X	X	X	X		High power output
9082P	1.5–520 MHz*	–130 to +9 dBm	X	X	X	X		High performance Pulse Modulation
9084	10 kHz–104 MHz*	–130 to +19 dBm	X	X		X	X	HF Radio
9087	10 kHz–1.3 GHz*	–140 to +19 dBm	X	X	X	X	X	Low phase noise, fast switching

*External Frequency Doubler Available.

Signal Generators Synthesized, Spin Wheel Tuned Series 9082



Introduction

The Series 9082 signal generators feature a new design concept combining the advantages of digital synthesis with the tuning characteristics of the conventional analog generator.

Three Models

The series contains three models designed for a wide variety of applications. All of the units provide the excellent stability and accuracy of a synthesizer while maintaining low noise performance and ease of use.

The Model 9082H has been designed for applications that require higher output power. Delivering a +19 dBm output, it is ideal for selectivity and adjacent channel testing.

For tests requiring high performance pulsed RF, the Model 9082P offers improved pulse modulation characteristics. An on/off ratio of greater than 60 dB, rise/fall time of less than 1 microsecond, and a minimum pulse width of 4 microseconds make the 9082P the perfect solution to radar and transponder testing.

Channelized Tuning

The channelized tuning modes pioneered by Racal-Dana make receiver testing easy. A front panel control allows selection of any one of the ten internationally accepted channel spacings. The output of the signal generator can then be adjusted in precise channel increments by either the spin wheel control or an up/down step switch. This time saving feature makes it possible to move from channel to channel without continuously monitoring the display or tedious re-tuning.

Spin Wheel Tuning

The single spin wheel tuning control operates exactly like an analog frequency dial.

The output frequency is set by tuning the spin wheel until the desired frequency is shown on the digital display. While tuning, the output always remains locked to the reference oscillator to assure accuracy and stability. Fast and slow tuning speeds provide a choice of resolutions for ease of use. An electronic "hold" allows the spin wheel to be "disconnected" after the desired frequency is obtained. In addition, a fine tune control provides interpolation between selected frequency steps on the spin wheel tuning.

Built-In Counter

Whatever the mode of operation, the exact frequency being generated is monitored by a built-in electronic counter and displayed on an 8 digit LED display with a resolution of 10 Hz at all output frequencies.

Complete Modulation Capability

Full AM, FM, phase, and pulse modulation capabilities are offered by the 9082 instruments. The RF output may be modulated from the internal oscillator or an external drive source. In all modes, the front panel meter provides a clear indication of modulation amplitude or frequency/phase deviation.

Signal Generators Synthesized, Spin Wheel Tuned Series 9082

Low EMC

The rugged construction of the Series 9082 generators provides extremely low carrier leakage, making these instruments ideal for measurements associated with VHF/UHF receivers with integral antennas.

Output Level Accuracy

Automatic leveling maintains the output signal to within ±0.5 dB over the entire frequency range. The attenuator and vernier control provide a range from −130 dBm (0.07 μV) to +3 dBm (316 mV). The output can be increased by × 2 on CW/FM; this is especially useful when making receiver blocking tests.

9082 Model Summary

Model Number	User	Application	Performance Improvement
9082	Radio Communications Manufacturers and Service Shops	Receiver Testing	1.5 MHz Low Frequency Channelized Tuning
9082H	Radio Communications Manufacturers	Receiver testing instruments checks	Provides 2 V rms output
9082P	Military and Defense	Navigation aid testing	Enhanced pulse modulation

Specifications

Frequency

Range: 1.5 MHz to 520 MHz
Bands: 5

Tuning Control: Spin-Wheel tuning
Channelized step switch
Fine Tuning control

Tuning Resolution
Channelized: 5 kHz, 6.25 kHz, 10 kHz
12.5 kHz, 15 kHz, 20 kHz
25 kHz, 30 kHz, 50 kHz, 60 kHz

Δf Increments

Band	Frequency Range	Fine Tuning	Spin Wheel
1	1.5 to 35 MHz	Continuous	2.5 kHz
2	31 to 65 MHz	Continuous	0.675 kHz
3	61 to 134 MHz	Continuous	1.25 kHz
4	122 to 268 MHz	Continuous	2.5 kHz
5	244 to 520 MHz	Continuous	5.0 kHz

Stability
(Fine tune off): Phase locked to internal reference oscillator

Fine Tuning Control: Internal, External, Off

Internal Counter

Display: 8 digit LED display

Resolution
Fast: 100 kHz
Slow: 1 kHz
Hold: 10 Hz

Accuracy: ±1 count ±timebase accuracy

RF Output Level

Model Number	9082, 9082P	9082H
Normal	−130 dBm to +3 dBm (71 nV to 316 mV rms into 50 ohms)	−130 dBm to +13 dBm (71 nV to 1 V rms into 50 ohms)
X2	−124 dBm to +9 dBm (142 nV to 632 mV rms into 50 ohms)	−124 dBm to +19 dBm (142 nV to 2 V rms into 50 ohms)

Spectral Purity

Harmonics

Above 5 MHz: 2nd and 3rd > −30 dBc
Remaining harmonics > −40 dBc

Below 5 MHz: > −20 dBc

Sub-Harmonics: > −40 dBc (typically −55 dBc)

Discrete Spurious

Above 5 MHz: Spurious signals in the frequency range 5 to 520 MHz are at least −70 dBc at 20 kHz or more off carrier

Below 5 MHz: Spurious signals in the frequency range 1.5 to 5 MHz are at least −50 dBc at 20 kHz or more off carrier

Residual FM ON CW: Less than 50 Hz rms deviation in 300 Hz to 3 kHz bandwith

AM on FM: Less than 1% for deviations of 100 kHz and less.

SSB Phase Noise

Bands (1), (4), and (5): Better than −100 dBc/Hz at 20 kHz from carrier

Bands (2) and (3): Better than −110 dBc/Hz at 20 kHz from carrier

Carrier Leakage

(2 turn, 1 inch loop, 1 inch from any surface) $<1\ \mu V$ into a 50 ohm receiver

Attenuator: 0 to 120 dB in 10 dB steps, calibrated in dBm into 50 ohms and volts. (0 to 130 dB on Model 9082H)

Attenuation Accuracy: ±0.1 dB/10 dB step ±0.2 dB

Output impedance: 50 ohm (type 'N' connector)

Output VSWR: 1.1:1 with ≥ 10 dB attenuation selected

Output Protection: The output withstands reversed RF inputs up to 1 watt (50 watt optional)

Output Switch: A 3-way switch with Off, Normal and × 2 position

Output Level Flatness: (Relative to 50 MHz level)

Frequency	Flatness	
	Models 9082, 9082P	Model 9082H
≥5 MHz	±0.7 dB	±1.2 dB
≤5 MHz	±2.5 dB	±3.0 dB

Output Level Accuracy (0 dB Attenuator Setting)

Ambient Temp	9082		9082H	
	≥5 MHz	≤5 MHz	≥5 MHz	≤5 MHz
25°C ±5°C	±0.8 dB	±3.3 dB	±1.5 dB	±4.0 dB
0°C to 50°C	±1.5 dB	±4.0 dB	±2.7 dB	±4.7 dB

Frequency Modulation

Frequency Range

Internal Oscillator: 400 Hz, 1 kHz, 5 kHz

External Oscillator: 20 Hz to 100 kHz (3 dB points) on 30 kHz and 100 kHz deviation ranges

20 Hz to 20 kHz (3 dB points) on 10 kHz deviation range

20 Hz to 5 kHz (3 dB points) on 3 kHz deviation range

Deviation Range: 3 kHz, 10 kHz, 30 kHz, 100 kHz full-scale

External Input: 1 V rms into 600 ohms for full scale

Distortion: Less than 5% at maximum deviations, using internal oscillator (typically 3% at 50% of full scale)

Accuracy of Indication: ±5% of full scale at mid-band frequency on each deviation range

Amplitude Modulation

Frequency Range

Internal: 400 Hz, 1 kHz, 5 kHz

External: DC to 20 kHz

Modulation Depth

Internal: Up to 90%

External: 0 to 90% at modulation frequencies to 20 kHz and carrier frequencies below 400 MHz. Decreasing to 50% at 500 MHz.

Distortion

Above 5 MHz: Less than 5% at 80% modulation depth using internal oscillator.

Below 5 MHz: Less than 15% at 80% modulation depth.

Accuracy

Above 5 MHz: ±3% of full scale ±2% of reading below 80% modulation depth.

Below 5 MHz: Better than ±5% of full scale ±10% of reading.

Phase Modulation

Frequency Range

Internal: 400 Hz, 1 kHz, 5 kHz

External: 400 Hz to 5 kHz

Phase Range: 10 radians full scale

External Input: 1 V rms into 600 ohms for 10 radians

Distortion

Above 5 MHz: Less than 5% at 10 radians

Below 5 MHz: Less than 15% at 10 radians

Accuracy: 5% of full scale

Pulse Modulation

Carrier Range

Model 9082H: 10 MHz to 520 MHz

Other Models: Over entire output range

PRF Range

Model 9082: DC to 10 kHz

Model 9082P: DC to 50 kHz

Rise/Fall Time

Model 9082: $<15\ \mu$Sec

Model 9082P: $<1\ \mu$Sec

Minimum Pulse Width:

Model 9082: 40 μSec

Model 9082P: 4 μSec

Pulse On/Off Ratio

Model 9082: ≥40 dB at maximum vernier.

Model 9082P: >60 dB to 50 MHz
>40 dB 50 to 520 MHz

Output Level Accuracy

Model 9082: Standard specification

Model 9082P: ±3 dB

Multiple Modulation

AM/FM, AM/Phase, Pulse/FM, Pulse/Phase

Modulation Oscillator

Frequencies: 400 Hz, 1 kHz, 5 kHz

Accuracy: ±5%

Distortion: <1% total harmonic distortion

Output: 1 V rms from 600 ohms ±0.5 dB from rear panel socket.

Signal Generators
Synthesized, Spin Wheel Tuned
Series 9082

Internal Reference Oscillators

Specification	Option 04C	Option 04A	Option 04D
Aging Rate	$<3 \times 10^{-7}$/month*	$<3 \times 10^{-9}$/day**	$<5 \times 10^{-10}$/day**
Warm-up Time	N/A	6 min (2×10^{-7})	20 min (1×10^{-7})
Temperature Stability	$\pm 8 \times 10^{-6}$ (0 to +55°C) $\pm 3 \times 10^{-6}$ (+20 to +40°C)	$\pm 3 \times 10^{-9}$/°C (0°C to +45°C)	$\pm 6 \times 10^{-10}$/°C (Avg Over 0° to +45°C)

*After 3 months continuous operation
**Over 10 days after 3 months continuous operation

General

Operating Temperature: 0°C to +55°C

Storage Temperature: −40°C to +70°C

Power Requirements

Voltage: 94 to 130 V, 188 to 260 VAC in 4 ranges

Frequency: 45 to 440 Hz

Consumption: 25 VA

Dimensions: 133 H × 420 W × 445 D mm
(5.2 H × 16.5 W × 17.5 D inches)

Weight: 15.5 kg (34.1 lb)

Options

50 Watt Automatic Reverse Power Protection

Description: Protects the signal generator from being damaged by the accidental application of up to 50 watts continuous power to the output socket. The unit is fail-safe and gives full protection even in event of a supply failure. It is non-latching and resets automatically when the overload is removed.

Frequency Range: 1.5 to 550 MHz

Insertion Loss: Less than 0.1 dB up to 100 MHz increasing to a maximum of 0.5 dB at 550 MHz

Isolation: Greater than 30 dB up to 100 MHz decreasing to 20 dB at 550 MHz

VSWR: Better than 1.1:1 when terminated in a 50 ohm load with a VSWR of better than 1.05:1.

Trigger Level: <1 watt

Input Connector: Type 'N' Male

Output Connector: Type 'N' Female

Dimensions (External Option): 97 H × 40 W × 30 D mm
(3.8 H × 1.6 W × 1.2 D inches)

Frequency Doubler

Input Frequency Range: 240 to 520 MHz

Output Frequency Range: 480 to 1040 MHz

Input Power Range: +8 to +12 dBm (operating)
+22.5 dBm (maximum)

Insertion Loss: Less than 13 dB in 50 ohm system

Flatness: ±3 dB in 50 ohm system

Input VSWR: Less than 2:1 in 50 ohm system

Harmonic Supression

Input Fundamental: −20 dB

3rd Harmonic: −25 dB

4th Harmonic: −12 dB

Input Connector: Type 'N' Male

Output Connector: Type 'N' Female

Dimensions: 97 H × 30 W × 30 D mm
(3.8 H × 1.2 W × 1.2 D inches)

Weight: 180 g (0.4 lb)

Ordering Information

Model 9082: 1.5 MHz to 520 MHz Synthesized Signal Generator

Model 9082H: High Output Synthesized Signal Generator

Model 9082P: High Performance Pulse Modulation Signal Generator

Options

60: Rack mounting adapter

04A: Oven oscillator ($<3 \times 10^{-9}$/day aging rate)

04D: Oven oscillator ($<5 \times 10^{-10}$/day aging rate)

04C: Standard unovened oscillator

11-1250: Fused reverse power protection

11-1390: Automatic 50 watt reverse power protection (internal)

11-1405: Automatic 50 watt reverse power protection (external)

11-1356: Frequency doubler

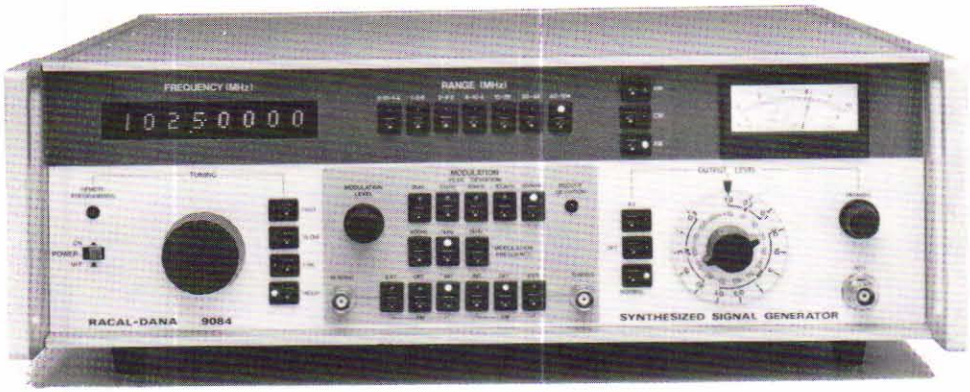
R-MM-9082: Maintenance manual

Accessories

23-3174: 50 to 75 ohm adapter

15-0456: Padded soft carrying case

Signal Generators
Low Noise, HF Synthesized Signal Generator
Model 9084



GPIB LISTENER

Introduction

The Model 9084 Synthesized Signal Generator is one of the most advanced instruments of its kind. With a frequency range from 10 kHz to 104 MHz it covers the entire HF radio band, including high IF frequencies, and has the added capability of operating in specialized LF and low-band VHF areas.

Incorporating the latest in custom LSI technology, this high performance instrument incorporates all the features needed to satisfy the stringent demands of the HF communications market—low noise, high stability, comprehensive modulation capabilities, precision frequency setting and simplicity of operation.

Fast Frequency Selection

The output frequency is indicated on an 8-digit LED display which has an instantaneous response to frequency change and provides a resolution of 1 Hz up to 10 MHz and 10 Hz up to 104 MHz.

Frequency selection is by the patented Racal-Dana Spin-Wheel system that combines the precision of digital control with the smoothness and feel of an analog system.

Foolproof Operation

Simplicity is a key feature of the 9084. A frontpanel keyboard allows the selection of frequency band, tuning rate, operating mode, type of modulation and meter function. Each key incorporates a color coded LED which illuminates when the key is depressed.

Several features have been included to reduce operator error. For example, a unique warning system is incorporated that causes the key lamp to flash if the keys are operated incorrectly. In addition, if an FM deviation range is selected that is too wide for the carrier frequency in use, the REDUCE DEVIATION lamp will illuminate. If this is ignored the instrument will auto-range downwards until an acceptable FM deviation range is reached.

Three tuning rates are provided: FAST, SLOW and FINE, which represent tuning steps of 10 kHz, 100 Hz and 1 Hz respectively at carrier frequencies below 10 MHz and 100 kHz, 1 kHz and 10 Hz at carriers above 10 MHz. This feature combined with the instant follow display, enables any change in frequency (large or small) to be made in the minimum possible time.

A HOLD key electronically disables the spin wheel control when the required setting has been made.

High Accuracy

The 9084 is a true synthesizer and the output signal is phase locked at all times to the built-in crystal standard or to an external standard signal applied to a rear panel socket. Phase locking of the carrier frequency is maintained in both FM and AM modulated modes.

The internal frequency standard normally supplied provides a daily aging rate of 3 parts in 10^9. A higher stability oscillator, having a daily aging rate of better than 5 parts in 10^{10} can be supplied as an option. Both oven oscillators have fast warm-up characteristics so that the 9084 reaches full accuracy and stability within a few minutes of switch-on.

Even higher accuracies can be achieved by using a Racal-Dana Rubidium Frequency Standard applied to the external standard input socket.

Exceptional Spectral Purity

Although the 9084 is fully synthesized, it has phase noise and spurious signal performance comparable to the best fundamental generators.

Among the innovative design features contributing to this performance is a separate high level crystal oscillator locked to the frequency standard employed, and the incorporation of the Racal patented transfer loop system.

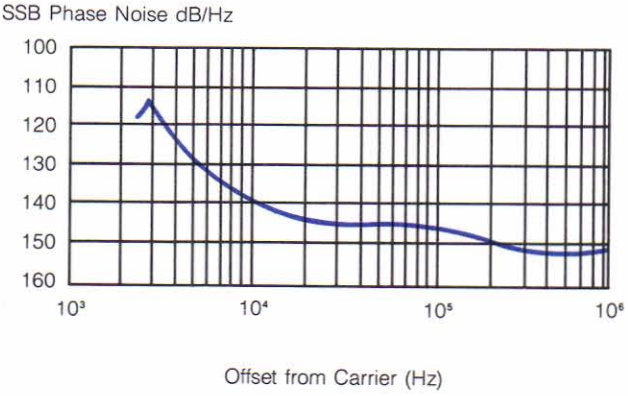
A phase noise of better than 140 dBc/Hz is achieved, at 20 kHz off carrier, up to frequencies of 10 MHz. It is typically 130 dBc/Hz up to the highest carrier frequency of 104 MHz.

Signal Generators
Low Noise, HF Synthesized Signal Generator
Model 9084

Harmonics are at least 40 dB below carrier and sub-harmonics are zero. Amplitude noise is greater than 70 dB below carrier in a 0.3—3 kHz bandwidth and residual FM on CW is less than 5 Hz rms (typically 2 Hz).

This high spectral purity enables the generator to be used for all types of test on communications equipment. Tests such as cross modulation or blocking, supression of intermodulation, or adjacent channel selectivity can easily be made with the 9084.

Typical SSB Phase Noise at 10 MHz Carrier Frequency



Ultra Low RFI

By special design of the internal screening and the application of the latest gasket material technology, the RF leakage has been kept to a level that is almost undetectable. In fact, the 9084 offers better RFI performance than most other signal generators currently available.

The 9084 can therefore be used with complete confidence, even in applications in close proximity to sensitive receivers with integral antennas.

Wide Output Level Range

The 9084 has a total output level range of 149 dB from 0.07 μV to 2 volts into 50 ohms (−130 dBm to +19 dBm). The output is automatically levelled to within ±0.5 dB over the whole frequency range. The output meter and attenuator are calibrated in both dBm and "volts into 50 ohms".

Complete Modulation Capabilities

The output signal can be amplitude, frequency or pulse modulated from either an internal or external source. Simultaneous AM (or pulse modulation) with FM is available, using either one internal and one external oscillator or two external oscillators.

The internal oscillator provides modulating frequencies of 400 Hz, 1 kHz and 3 kHz to allow testing over the audio frequency band of communication receivers. The output may be externally modulated at modulating frequencies up to 20 kHz.

Five FM deviation ranges with full scale peak deviations of 3, 10, 30, 100 and 300 kHz are selectable. A vernier control allows the FM deviation or AM modulation depth to be adjusted and indicated on the front panel meter which monitors both internal and external modulation.

50 Watt Reverse Power Protection

When checking transceivers there is a risk of damage to the signal generator by accidental switching to "transmit". With the 9084 there is a choice of protection from damage of this type.

First, the output stage is designed to withstand an RF output up to 1 watt power level without damage.

Second, a 50 watt reverse power protection unit can be installed internally as an option.

Flexible Remote Control

In addition to manual control, the Model 9084 offers three methods of remote control—standard, parallel BCD, remote programming; control from handheld Remote Store Unit (Option 10); and programming via GPIB Interface Unit (Option 12). These alternatives allow the generator to be used to maximum advantage in widely differing applications, from straight-forward bench or field operation to incorporation in the most sophisticated automatic test systems.

Rugged and Reliable

Extensive use of custom LSI contributes to the small size and high reliability of the 9084. It is designed to meet MIL-T-28800 and IEC environmental specifications for this type of equipment. Although light and easily portable, it can be rack-mounted for use in systems.

Plug-in boards are used with high quality connectors to ensure both reliability and ease of servicing.

Low Noise, HF Synthesized Signal Generator Model 9084

Specifications

Frequency

Range: 10 kHz to 104 MHz in 7 bands

Bands: (I) 10 kHz to 1.4 MHz
(II) 1 MHz to 2.6 MHz
(III) 2 MHz to 5.2 MHz
(IV) 4 MHz to 10.4 MHz
(V) 10 MHz to 26 MHz
(VI) 20 MHz to 52 MHz
(VII) 40 MHz to 104 MHz

Display

Type: The output frequency is indicated on an 8 digit LED display with instantaneous response to a change in setting.

Resolution: 1 Hz up to 10.4 MHz (Band I to IV) 10 Hz from 10 MHz to 104 MHz (Bands V to VII)

Tuning

Controls: A spin-wheel control, the sensitivity of which is controlled by three keys providing Fast, Slow and Fine Tuning.

Resolution

Sensitivity	Bands I to IV	Bands V to VII
Fast	10 kHz	100 kHz
Slow	100 Hz	1 kHz
Fine	1 Hz	10 Hz

Hold: A Hold Key electrically disconnects the spin wheel control.

Accuracy: The output frequency is phase locked in all conditions to the internal or external frequency standard. The accuracy and stability will be that of the standard employed.

Spectral Purity

Harmonics: < −40 dBc on normal output

Sub-Harmonics: None

Discrete Spurious: < −70 dBc at 20 kHz or more from carrier

SSB Phase Noise: At 20 kHz or more from carrier (vernier at maximum)

Band	Guaranteed dBc/Hz	Typical dBc/Hz
I to IV	< −140	< −145
V	< −135	< −140
VI	< −130	< −135
VII	< −125	< −130

Residual FM on CW: < 5 Hz averaged rms in 0.3 to 3 kHz bandwidth at 100 MHz. (Typically 2 Hz)

AM on FM: < 1% for deviation of 100 kHz and less

Amplitude Noise: At least −70 dBc in 0.3 to 3 kHz bandwidth

Carrier Leakage (Induced in a 2 turn 1 in. [2.5 cm] diameter loop 1 in. [2.5 cm] away from any surface): ≤ 0.5 microvolt into 50 ohms

RF Output

Level

Normal: Continuously variable from −130 dBm to +13 dBm (71 nanovolts to 1 volt into 50 ohms) by means of step attenuator and vernier control

X2: Maximum of +19 dBm (2 volts into 50 ohms) without AM

Level Flatness: ± 0.5 dB relative to 10 MHz level.

Level Accuracy: Attenuator at straight through setting

25°C ± 5°C: ± 0.5 dB of meter reading

0°C to 55°C: ± 1.2 dB of meter reading

Attenuator

Range: 130 dB in 10 dB steps

Calibrated: Calibrated in dBm from +10 dBm to −120 dBm and in volts from 1V to 0.3 μV into 50 ohms

Accuracy: ± 0.1 dB per 10 dB step ± 0.2 dB

Vernier Control: Provides continuous control of output level from 0.225 volts to 1 volt into 50 ohms. (0 dBm to +13 dBm)

Output Impedance: 50 ohms

Output VSWR: 1.1:1 with 10 dB or more attenuation selected

Output Protection: The output withstands RF inputs up to 1 watt (50 watts—Option 11)

Frequency Modulation

Modulation Frequency

Internal: 400 Hz, 1 kHz, 3 kHz

External: 20 Hz to 20 kHz

Deviations Ranges: 3 kHz, 10 kHz, 30 kHz, 100 kHz, 300 kHz

Deviation Control

Internal: Fine adjustment by vernier control and indication on front panel meter of both internal and external modulation.

External: 1V rms into 600 ohms for full scale deviation (above 100 kHz carrier)

Maximum Deviation

Bands I to III: 10 kHz above 100 kHz carrier

Band IV: 30 kHz

Bands V and VI: 100 kHz

Band VII: 300 kHz

Distortion: ≤ 3% (typically 1% at maximum deviation at 1 kHz audio frequency) ≤ 1% at 30% deviation (using internal oscillator or external oscillator with THD < 0.5%)

Accuracy: ± 5% of full scale at 1 kHz

Signal Generators
Low Noise, HF Synthesized Signal Generator
Model 9084

Amplitude Modulation

Modulation Frequency

Internal: 400 Hz, 1 kHz, 3 kHz

External: DC to 20 kHz (±3 dB bandwidth)

Ranges

Band	Carrier Frequency	Modulation Frequency	Maximum Modulation Depth
I	10 kHz to 100 kHz	None	None
I	100 kHz to 1.4 MHz	DC to 5 kHz	30%
II to VII	1 MHz to 104 MHz	DC to 20 kHz	90%

Modulation Control

Internal: Adjustment by vernier control and indication on front panel meter of both internal and external modulation

External: 800 mV rms into 600 ohms to give 80% modulation

Distortion: ≤3% (typically 1% at 80% modulation at 1 kHz audio frequency)
≤1% at 30% modulation (using internal oscillator or external oscillator with THD <0.5%)

Accuracy: ±3% full scale ±2% of reading below 80% at 1 kHz (typical accuracy at 80% and 1 kHz is ±1%)

Pulse Modulation

Modulating Signal: Pulse of −1.4 V to 0 V provides modulation from zero to 100% carrier. A level of +1.4 V provides 200% carrier

PRF Range And Rise/Fall Times

Carrier Frequency	PRF	Rise/Fall Times
100 kHz to 1 MHz	DC to 1 kHz	<200 μSec
1 MHz to 104 MHz	DC to 10 kHz	<20 μSec

Carrier Suppression: 26 dB

Multiple Modulation

Features: Simultaneous AM or pulse modulation combined with FM using either one internal and one external oscillator or two external oscillators

Modulation Oscillators

Frequencies: 400 Hz, 1 kHz, 3 kHz

Accuracy: ±5%

Distortion: <1% total harmonic distortion

Output: 1 V from 600 ohm ±0.5 dB

Remote Control

Functions Controlled: Frequency
Carrier-Normal/Off/X2
AM-Internal/Off/External
FM-Internal/Off/External

Control Signals: Logic inputs with logic 0 equivalent to ≤ +0.5 V and logic 1 equivalent to ≥ +3.5 V

Remote Indication: By LED lamp on front panel

General

Power Requirements

Voltage Ranges: 100 to 130 V, 200 to 260 VAC selected by lockable slide switches on rear panel

Frequency: 45 to 66 Hz

Consumption: Approximately 100 VA

Operating Temperature: 0°C to +55°C
Storage Temperature: −40°C to +70°C

Dimensions: 132.8 H × 525 W × 420 D mm
(5.23 H × 20.67 W × 16.53 D inches)

Weight: Approximately 16 kg (35.25 lb)

Internal Reference Oscillators

Specification	Standard	Option 04B
Aging Rate	$\leq 3 \times 10^{-9}$/day	$\leq 5 \times 10^{-10}$/day[1]
Warm-up Time	6 minutes to $\pm 2 \times 10^{-7}$	20 minutes to better than 1×10^{-7}
Temperature Stability	$\pm 3 \times 10^{-9}$/°C (0°C to +45°C)	$\pm 6 \times 10^{-10}$/°C (0°C to +45°C)

1. After 3 months continuous operation

Options

Remote Store—Options 10 A, B

Description: The Remote Store is a small hand-held controller incorporating a non-volatile memory and fitted with a numerical keyboard, coded 0-9. It allows the storing and subsequent retrieval of up to 96 frequencies (Option 10B) or 32 frequencies (Option 10A).

An address is selected by operating the numbered keys and is indicated on a 2-digit LED display. If a frequency is set manually on the Model 9084, it can then be stored in the memory at this address by setting the RECALL/STORE switch to STORE and operating the STORE key "S".

When the RECALL/STORE switch is returned to the RECALL position, the 9084 controls are inhibited, the REMOTE lamp is illuminated and control of the signal generator is transferred to the Remote Store. The output frequency of the 9084 will then be adjusted to whatever value is stored in the memory address selected, and the modulation and carrier conditions will be those set on the AM, FM and CW function switches on the Store Unit front panel.

Address Locations: Option 10A: 32 addresses.
Option 10B: 96 addresses

Stored Information: Eight frequency digits and range.

Display: A 2 digit display shows addressed location from 00 to 99.

Controls: 9 digit keyboard
Store Key
Recall/Store Switch
AM switch
FM switch
CW switch

GPIB Interface—Option 12

Description: Programming of the 9084 via the IEEE 488 General Purpose Interface Bus is easily achieved by the use of the GPIB Interface Unit (9934A) which fits on the generator in place of its bottom cover. The Interface Unit is fitted with feet and a tilt stand so that generator plus interface form a completely integrated unit which maintains the exceptionally good RFI performance of the 9084.

A programmable attenuator is included in the GPIB Interface Unit so that control of the output level in 1 dB steps over a total range of 139 dB is obtained in addition to the control of carrier frequency and modulation functions.

The GPIB Interface Unit allows the 9084 to be used as easily in quickly assembled bench-top GPIB systems as in dedicated automated test systems.

Functions Controlled

Frequency: Each of the 8 digits of 9084 Synthesizer frequency as well as the range can be controlled independently.

Level: Carrier-On/Off/X2, Attenuation—Each digit of attenuation (100, 10 or 1 dB) can be controlled separately. Total range 139 dB.

Modulation: AM-Internal/External/Off
FM-Internal/External/Off

Address: Set on rear panel switch bank and indicated by front panel LEDs.

Programmable Attenuator

Range: 139 dB

Resolution: 1 dB steps

Accuracy

1 dB Steps: ±2% ±0.1 dB

10 dB Steps: ±1% ±0.2 dB

Dimensions: 71 H × 408 W × 452 D mm
(2.8 H × 16 W × 17.8 D inches)

Weight: 5 kg (11 lb)

Reverse Power Protection—Option 11

Installation: Factory or field installed internally

Protection Level: Up to 50 watts continuous (10 kHz to 104 MHz)

Insertion Loss: <0.1 dB

Trigger Level: <1 watt above 10 kHz

Isolation: >30 dB

Operation: Non-latching—reset automatically when overload is removed.

Frequency Doubler

Input Frequency Range: 52 to 104 MHz

Output Frequency Range: 104 to 208 MHz

Input Power Range: +8 to +12 dBm (operating)
+22.5 dBm (maximum)

Insertion Loss: <13 dB in 50 ohm system

Flatness: ±2 dB in 50 ohm system

Input VSWR: <2:1 in 50 ohm system

Harmonic Suppression

Input Fundamental: −20 dB

3rd Harmonic: −25 dB

4th Harmonic: −12 dB

Operating Temperature: 0°C to +55°C

Storage Temperature: −40°C to +70°C

Input Connector: Type BNC Male

Output Connector: Type BNC Female

Dimensions: 97 H × 30 W × 30 D mm
(3.8 H × 1.2 W × 1.2 D inches)

Weight: 180 gm (0.4 lb)

Ordering Information

Model 9084: HF Synthesized Signal Generator

Options

04B: Oven oscillator (<5 × 10^{-10}/day aging rate)

10A: Remote store with 32 addresses

10B: Remote store with 96 addresses

11: 50 watt automatic reverse power protection

12: GPIB interface (Model 9934A)

35: Frequency doubler

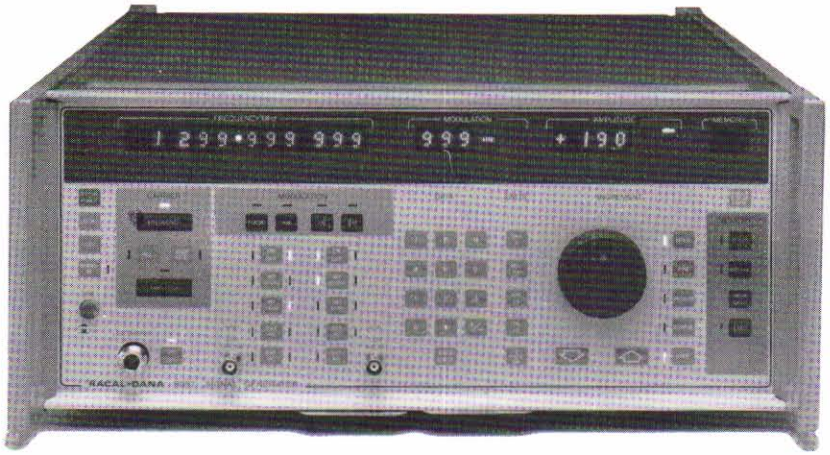
60: Rack mounting adapter

Accessories

23-3291: 50 to 75 ohm adapter

15-0456: Padded soft carrying case

Signal Generators
1.3 GHz, Synthesized, Low Noise
Model 9087



Introduction

The Racal-Dana 9087 generates entirely new standards in spectral purity, frequency agility and modulation capability. Microprocessor enhancement, combined with an outstanding technical specification guarantees high integrity measurements with total user confidence.

Wide Frequency Range With High Accuracy

The 9087 covers the complete frequency range, from 10 kHz to 1300 MHz without frequency doubling. Consequently, there are no sub-harmonics and the full output level is maintained over the entire frequency range. Frequency is indicated on a 10-digit LED display with resolution of 1 Hz.

The output signal is phase-locked to a Racal-Dana precision temperature controlled quartz oscillator. This standard reference oscillator provides a stability of better than 3 parts in 10^9 per day. For better performance, an optional oscillator with a stability of better than 5 parts in 10^{10} per day is available. Alternatively, the 9087 can be phase-locked to an external standard.

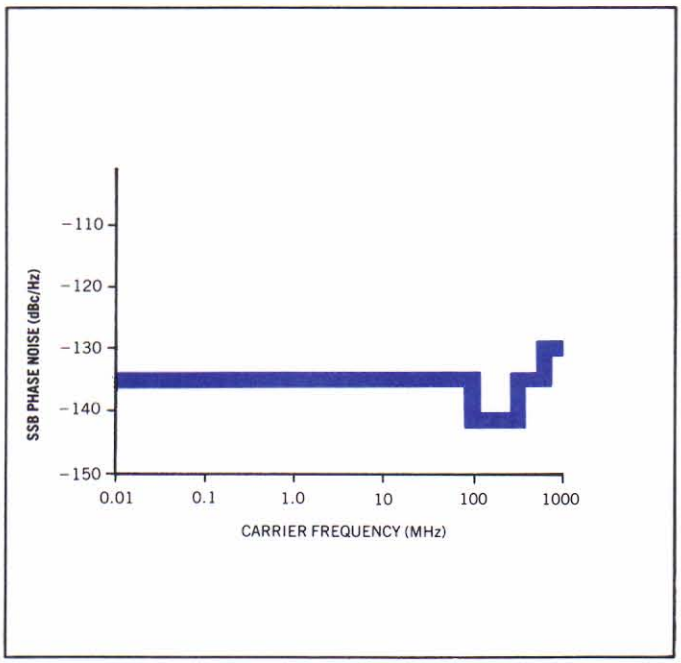
Spectral Purity

Innovative oscillator design techniques are combined with new methods of synthesis to give the 9087 its exceptional signal purity. Whether you are evaluating state-of-the-art transceivers in the heavily congested VHF and UHF bands, or require a microwave reference source for satellite communications, the 9087's performance will satisfy your needs for years to come.

The exceptional phase-noise performance is achieved by interposing a high level, low-noise 100 MHz quartz oscillator between the generator reference standard and the synthesizer drive circuits. In operation, the output signal from the generator is phase-locked to this low-noise oscillator reducing the noise multiplication factor by more than 20 dB.

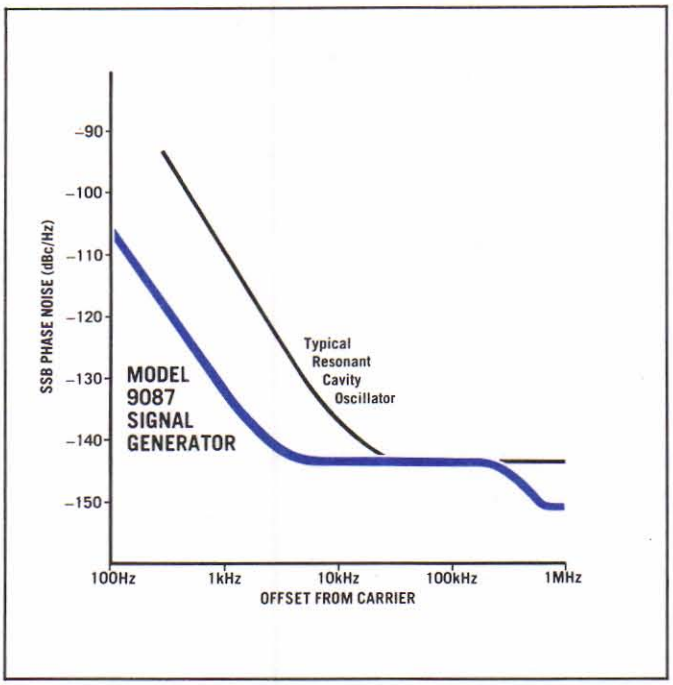
The broadband noise performance is maintained to within 3 kHz of the carrier frequency. This performance is preserved, even when using an external frequency standard. Very close-in noise and other line-related spurious signals are of correspondingly low levels. This makes the 9087 ideal for all forms of communications testing and as a custom low-noise drive source for multiplication into the microwave bands.

TYPICAL SSB PHASE NOISE BETWEEN 3 kHz AND 1 MHz OFFSET FROM CARRIER.



Broadband noise floor — 150 dBc/Hz

TYPICAL SSB PHASE NOISE AT 150 MHz CARRIER FREQUENCY



Frequency Agility

Fast frequency switching (<400 μSec) has been achieved by a patented synthesizer technique which uses wide-band phase-lock loops. In the 'Fast-Learn' mode, over one thousand complete changes of frequency can be programmed per second. For even faster response, the 9087 offers a Direct Frequency Access mode (DFA) allowing direct control of the microbus. At these high switching speeds the precision attenuator preserves level integrity and eliminates the degradation in performance associated with ROM corrected levelling systems. In addition the capability for output level processing minimizes transients during frequency switching. Together these features make the 9087 ideal for FSK simulation, fast frequency sweep applications and testing frequency agile communications systems.

Versatile Modulation Characteristics

Racal-Dana's 9087 offers total modulation versatility including AM, FM, Phase (ϕM) and Pulse modulation (PM) from a combination of internal or external sources. Simultaneous AM + FM, AM + ϕM, PM + FM and PM + ϕM enable accurate simulation of Electronic Counter Measures (ECM and ECCM) and "chirp" signals.

Internal modulation is from 400 Hz and 1 kHz sources phase-locked to the reference standard. AC and DC coupled inputs allow the generator to be modulated externally over wide bandwidths. Automatic gain control of the external modulating signal ensures that variations over a 10:1 range do not affect calibration of the modulation setting.

AM depth is digitally selectable and is displayed in 1% steps from 0 to 99%. The DC coupled AM mode provides analog levelling or ramping of the RF output; linearity and phase shift have been optimized for ILS and VOR NAVAIDS testing.

Frequency modulation with up to 1 MHz deviation at rates from DC to 100 kHz, or phase modulation to 5 radians at modulating frequencies from 20 Hz to 10 kHz can be selected. A 3-digit LED display provides 0.1% resolution settings and a novel frequency modulator reduces residual FM in proportion to the deviation range selected.

DC coupled FM allows the 9087 to be used for analog sweeping, as a VCO which can be phase-locked to another frequency source and for error free digital modulation.

The 9087 can be pulse modulated from internal or external sources at carrier frequencies from 10 MHz to 1300 MHz.

Excellent Dynamic Range & Level Accuracy

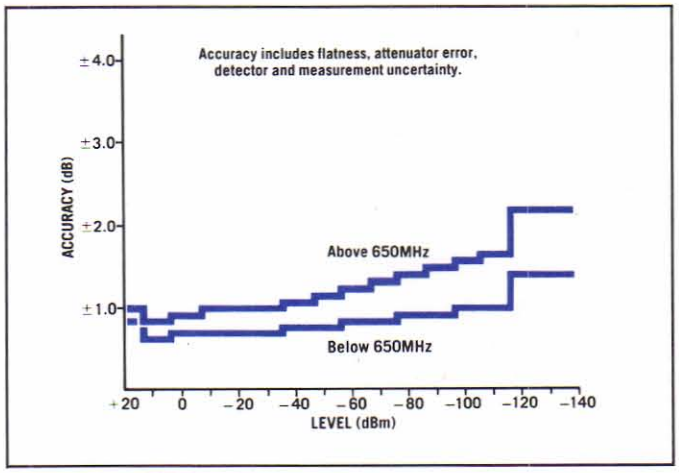
By combining the high output level, +19 dBm (2V rms) up to 1300 MHz and wide dynamic range (159 dB) with its exceptional phase-noise performance and ultra-low RF leakage, the 9087 achieves a major advance in measurement technology.

It is this combination of features that makes possible realistic performance measurements on modern communications systems over a wider range than ever before.

A precision attenuator and patented AGC provide level control of the RF signal from +19 dBm in 0.1 dB steps down to −140 dBm (22 nV into 50 Ω) with an accuracy of better than 1 dB up to 650 MHz.

A 4-digit LED display allows level indication in voltage, dBm or dB relative to any user selected reference, e.g. dB μvolt.

OUTPUT LEVEL ACCURACY



Ultra-Low RF Leakage

Critical sensitivity measurements on radio communication systems demand precise antenna drive levels. When testing mobile transceivers and personal pagers,

Signal Generators
1.3 GHz, Synthesized, Low Noise
Model 9087

sensitivity measurements below 100 nanovolts are now common. For these applications, the patented construction techniques of the 9087 assure measurement integrity. The unique packaging and multiple shielding of the RF circuits means that less than 0.5 μV is induced into a two turn 1 inch diameter loop 1 inch away from any surface and measured into a 50 Ω receiver.

Simplicity of Operation

Microprocessor enhanced performance maximizes versatility, avoids tedious resetting of controls, and monitors systems integrity, bringing precision signal generation to your finger tips.

The touch-sensitive front panel and the analog friendliness of the spin knob tuning make the 9087 so simple to use. Frequency level, modulation and memory store are set using the touch keys or controlled by the spin knob. In addition, all parameters may be controlled in preset steps using the increment keys. The user friendly design and logically positioned touch-sensitive front panel controls make it possible for both the casual user and the experienced engineer to interface easily with this sophisticated signal generating system.

Operator convenience is enhanced even further by the inclusion of a non-volatile memory.

Advanced μP control means versatile GPIB programmability. ATE and systems compatibility are achieved with full GPIB control of all functions including access to the non-volatile memories and a host of special features including digital sweep, learn modes and diagnostics.

User interactive software enables many special functions and alerts the user to programming errors or the selection of out-of-range values. Mnemonics and protocol are in accordance with IEEE recommended practice.

Flexible Digital Sweep

Digital Sweep is featured as standard in the 9087. Sweep widths and step sizes are selectable with 1 Hz resolution over the full frequency range. Sweep may be controlled manually using the spin knob or automatically by preprogramming the step size and width using the special function (SF) key, which also selects one of four predetermined sweep rates.

The flexibility of the sweep mode means that the full synthesizer performance is maintained. The smooth transitions between frequency steps optimize FSK simulation and crystal filter testing.

Relative Frequency & Amplitude Display

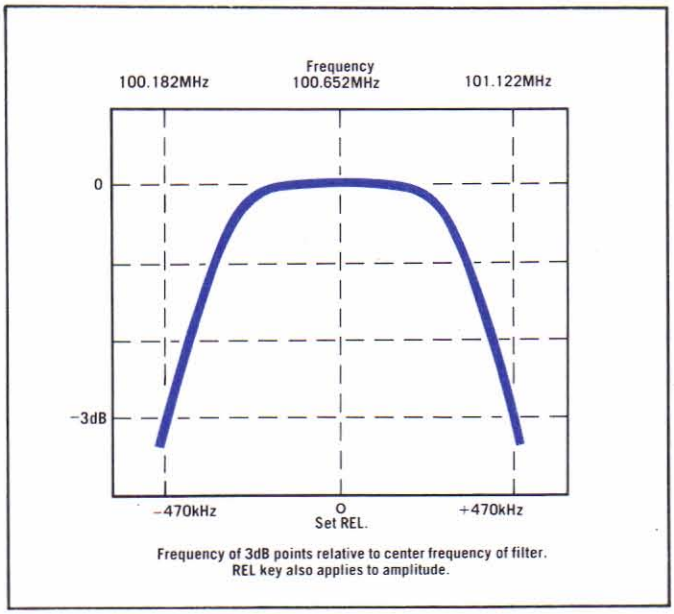
The REL key allows the user to select a convenient reference datum for the display of frequency and amplitude. This feature is particularly useful when combined with the spin knob action to simplify IF and receiver image testing, filter bandwidth and frequency response measurements.

Non-Volatile Memory

Up to 100 complete front panel settings may be stored in the non-volatile memory for recall either manually or under remote control.

In the event of a power interruption or failure, the front panel settings are automatically stored and are immediately available when power is restored.

Relative Frequency & Amplitude



Frequency of 3dB points relative to center frequency of filter.
REL key also applies to amplitude.

Auto-Test Routine for Operator Confidence

On power-up, the 9087 performs a self-test routine on the power supplies, the phase-lock conditions, instrument temperature and also a check-sum of the memories. All front panel LEDs are illuminated for visual inspection, and the GPIB address is displayed in binary and decimal formats. Completion of this test routine returns the front panel to the settings in use at the time of power-down.

Programmable for All ATE Roles

For the system user, the 9087 offers full GPIB programming with "learn", "fast-learn", "deferred" and "immediate" modes of operation.

All instrument functions including memory access, diagnostics and special functions are controllable using the comprehensive GPIB capability. Systems software debug and diagnostic routines are accessed by using the SRQ, status byte masking and error code features.

The 9087 is both "talker" and "listener" for interactive operation. In the learn modes the controller is used as a memory, with complete front panel settings being transferred to the controller for subsequent recall. The immediate and deferred modes of operation optimize data transfer rates to suit the overall systems configuration.

Fast Learn and Direct Frequency Access (DFA) modes ensure fast frequency switching. In the fast learn mode, data from the controller is transferred via the GPIB to the 9087, bypassing the frequency computing circuits to achieve switching rates up to 1 kHz. Applications that require even faster responses can be accommodated using the DFA mode which reduces switching time to <400 μSec.

A rear panel connector to access the increment controls allows remote operation without the use of intelligent peripherals. Rear panel RF output, often essential for automated systems, is also available making the 9087 the ideal choice for your application.

Flexible, easy to use GPIB programming means that the 9087 can be used with all its performance benefits in applications ranging from simple 'Rack-and-Stack' systems to the most sophisticated ATE.

Specifications

Range: 10 kHz to 1.3 GHz (1300.000000 MHz)

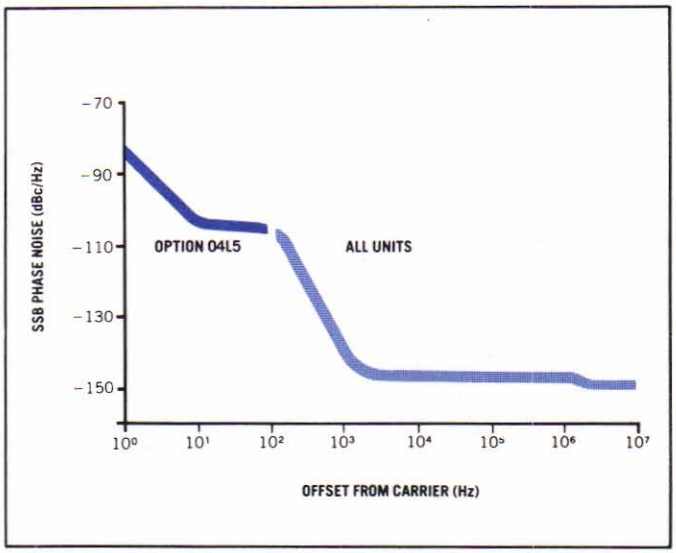
Resolution: 1 Hz throughout entire frequency range

Spectral Purity

	Frequency Range			
	0.01–100 MHz	**100–325 MHz**	**325–650 MHz**	**650–1300 MHz**
SSB Phase Noise[1] 3 kHz to 1 MHz offset from carrier (AM & CW modes)	–136 dBc/Hz	–142 dBc/Hz	–136 dBc/Hz	–130 dBc/Hz
SSB broadband noise floor (≥ +13 dBm O/P level)	–150 dBc at >5 MHz offset	–150 dBc at >2.5% offset		
Residual FM in 300 Hz to 300 kHz bandwidth	0.5 Hz rms	0.25 Hz rms	0.5 Hz rms	1 Hz rms
Spurious Signals >3 kHz off carrier	–90 dBc	–97 dBc	–91 dBc	–85 dBc
Power Line[2] related and microphonically generated	–82 dBc	–82 dBc	–76 dBc	–70 dBc
Harmonics typically (≤ +13 dBm)	< –35 dBc			< –30 dBc
Sub-Harmonics	None			

[1]Typically Absolute (includes residual and reference oscillator noise).
[2]May be 3 dB higher at 50 Hz line.

ABSOLUTE SSB PHASE NOISE AT 100 MHz (MEASURED)



Absolute SSB Phase Noise (dBc/Hz) with Option 04L5 (Measured)

Offset From Carrier	Carrier Frequency		
	100 MHz	**500 MHz**	**1 GHz**
1 Hz	–84	–70	–64
10 Hz	–104	–90	–84
100 Hz	–107	–93	–87
1 kHz	–139	–125	–119

Frequency Accuracy: Same as reference oscillator

Reference Oscillator

Internal

Standard: Aging rate $< 3 \times 10^{-9}$ per day after 3 months continuous operation. Warm up 6 minutes to $\pm 1 \times 10^{-7}$. Temperature stability $\pm 3 \times 10^{-9}$ per °C from 0°C to +45°C.

Option 04B: Aging rate $< 5 \times 10^{-10}$ per day after 3 months continuous operation. Warm up 20 minutes for $\pm 1 \times 10^{-7}$. Temperature stability $\pm 6 \times 10^{-10}$ per °C from –10°C to +45°C.

Option 04L5: Aging rate $< 1 \times 10^{-9}$ per day. Warm up 30 minutes to $\pm 1 \times 10^{-7}$. Temperature stability 4×10^{-9} from 0°C to +50°C.

External: Any 10 MHz ±100 Hz frequency standard at a level between 0.1V and 5V rms into 50Ω nominal.

Reference Output: 10 MHz sinewave at 0 dBm ±2 dB from BNC socket on rear panel. Output impedance 50 Ω nominal.

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Switching Speed: The total time to change frequency depends upon the method of programming. The table below gives times for any frequency change to be within 100 Hz of final frequency.

Mode	Processor Time	Settling Time	Total Switching Time	Maximum Repetition Rate
Deferred	12.5 mSec	0.4 mSec	12.7 mSec	80/Sec
Immediate	11.8 mSec	0.4 mSec	12 mSec	85/Sec
Fast Learn	0.47 mSec	0.4 mSec	0.87 mSec	1500/Sec
DFA	0.15 mSec	0.4 mSec	0.4 mSec	2500/Sec

Output

Range: Variable from +19 dBm to −140 dBm (2 V to 0.0224 μV rms into 50 Ω)

Resolution: 0.1 dB

Flatness: ±0.4 dB from 10 kHz to 650 MHz
±0.7 dB from 650 MHz to 1300 MHz
(above figures referenced to 400 MHz)

Absolute Level Accuracy (into 50 ohm)

Frequency Ranges / Output Level	10 kHz to 650 MHz	650 MHz to 1300 MHz
+13 dBm to −37 dBm	±0.6 dB	±1.0 dB
−37 dBm to −120 dBm	±1.0 dB	±1.8 dB
−120 dBm to −140 dBm	±1.5 dB	±2.3 dB

Notes 1. applicable at 23°C ±5°C
2. for 0° to 55°C, add ±0.8 dB to above figures
3. absolute level accuracy includes flatness, attenuator accuracy, detector error, measurement uncertainty, and SWR and is valid in all operating modes.

Impedance: 50 Ω nominal

SWR

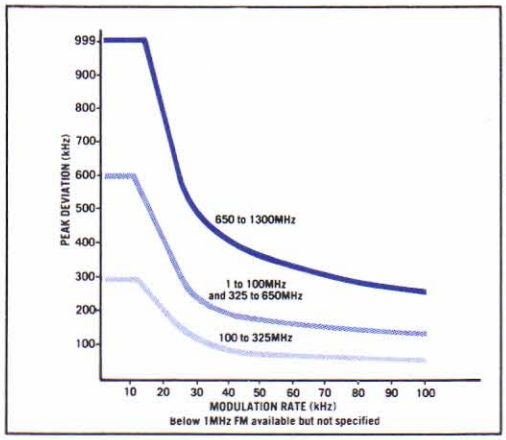
Output Level	≤500 MHz	>500 MHz
≥3 dBm to 19 dBm	1.6:1	1.8:1
<3 dBm	1.2:1	1.3:1

Protection: The output is protected against reverse power inputs up to 1 W
Reverse Power Protection Unit (RPPU) is available to protect against reverse power up to 50 W
See Option 11

Level Switching Times: 10 mSec to 50 mSec from last command statement to stable output, dependent on level change

Frequency Modulation

Peak Deviation



Resolution: 3 digit resolution to minimum of 10 Hz

Accuracy (1 kHz rate): ±5% of reading or 20 Hz (whichever is greater)

Modulation Bandwidth (3 dB)

AC Coupled: 20 Hz to 100 kHz

DC Coupled: DC to 100 kHz

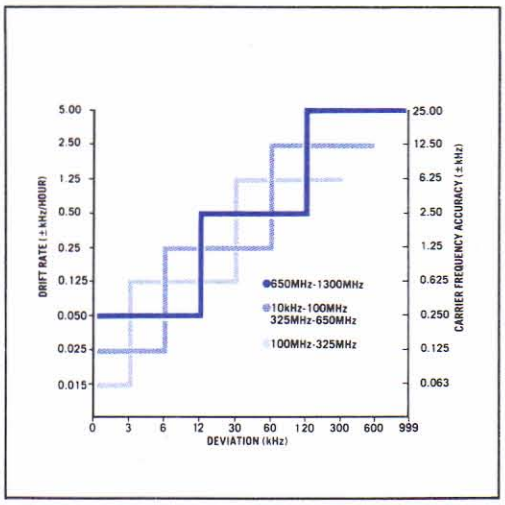
Input Level

AC Coupled: Any level between 0.56 V and 5.6 V (peak to peak) gives specified accuracy

DC Coupled: 1.414 V peak gives calibrated display

Input Impedance: 600 Ω nominal

DC FM — CARRIER FREQUENCY STABILITY (23°C ±5°C)



Note: Valid after warm up

Distortion (1 kHz rate): <3% at maximum deviation
<1% at 50% maximum deviation
<0.3% at 75 kHz deviation from 88 to 108 MHz carrier frequency

Incidental AM on FM: <0.2% (−60 dBc) for deviations of 20 kHz at 1 kHz rate

Amplitude Modulation

Modulation Depth: 0 to 99% up to +13 dBm reducing to zero at +19 dBm

Resolution: 1%

Accuracy (1 kHz rate): ±2% of reading ±3% AM below 80%.

Note: Up to +13 dBm, the variation of modulation depth with carrier amplitude is less than ±0.5% AM for VOR and ILS operation.

Frequency Range	Modulation Bandwidth (3 dB)
1.5–1300 MHz	AC 20 Hz–20 kHz DC DC–20 kHz
0.4–1.5 MHz	AC 20 Hz–5 kHz DC DC–5 kHz
10 kHz to 400 kHz	AC 20 Hz–0.1 kHz DC DC–0.1 kHz

Distortion (1 kHz rate): <1.5% up to 30% AM
<3% up to 80% AM

Incidental Phase Modulation (1 kHz rate): <0.1 radian at 30% AM

Input Level

AC Coupled: Any level between 0.56 V and 5.6 V (peak to peak) for specified accuracy

DC Coupled: 1.414 V peak gives calibrated display

Input Impedance: 600 Ω nominal

Phase Modulation

Phase Deviation: 5 radians maximum above 60 kHz carrier frequency

Resolution: 0.01 radian

Modulation Bandwidth (3 dB): 20 Hz to 10 kHz

Accuracy (1 kHz rate): ±10%

Distortion (1 kHz rate): <3% at maximum phase deviation

Input Level

AC Coupled: Any level between 0.56 V and 5.6 V (peak to peak) gives specified accuracy.

Input Impedance: 600 Ω nominal

Pulse Modulation

Rise and Fall Times: 40 nSec (10%–90%)

Minimum Pulse Width: 200 nSec

Pulse Repetition Rate

Carrier Frequency	AC	DC
10–1300 MHz	20 Hz–2.5 MHz	DC–2.5 MHz
0.01–10 MHz	Available but not specified	

On/Off Ratio: >50 dB (10 MHz to 750 MHz)
>35 dB (750 MHz to 1300 MHz)

Input Level

AC Coupled: 2.0 V peak to peak

DC Coupled: Carrier off below +0.9 V threshold. Carrier on above +1.7 V threshold.

Input Impedance: 16 kΩ nominal

Output Level: Accuracy remains valid during pulse on ("Off" period <25 mSec)

Indication: Front panel annunciator

Internal Modulation Sources

Frequencies: 400 Hz, 1 kHz

Frequency Accuracy: Same as reference oscillator

Distortion: <1% total harmonic distortion

Outputs: 2 V rms ±0.5 dB from 600 Ω Rear panel BNC connectors

Digital Sweep

Sweep Limits: Variable from 10 kHz to 1300 MHz with 1 Hz resolution

Step Size: Variable from 1 Hz to 1299.99 MHz with 1 Hz resolution

Sweep Speed: Four selectable dwell times: 2 mSec/step, 20 mSec/step, 200 mSec/step and 1 Sec/step nominal

Non-Volatile Memory

Function: Allows storage of complete front panel settings of frequency, output level and modulation

Number of Stores: 33 (100 with Option 10).

Location 00 is used to store instrument status at switch-off or power interruption

Memory Retention: 30 days minimum at +40°C with instrument unpowered

Signal Generators
1.3 GHz, Synthesized, Low Noise
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Remote Programming

GPIB Interface: IEEE-STD-488, 1978

Functions Controlled: All front panel functions except line power switch.

Status Indication: SRQ, Talk, Listen and Remote Annunciators.

Auxiliary Control: Auxiliary controls are provided via rear panel 50-way connector.

Functions Controlled

Step Up/Step Down with selectable debounce by contact closure to ground or negative edge triggered TTL compatible signal.

DFA provides access to microbus for remote control

Options

01: Rear panel connectors. Alternative type N carrier output and BNC modulation inputs available on rear panel.

04B: Alternative frequency standard Rácal-Dana Model 9421

04L5: Low noise precision frequency standard for optimum phase noise performance at carrier offsets of less than 100 Hz

10: 100 store non-volatile memory
Expands Non-Volatile Memory to allow storage of 100 front-panel setups.

11: Reverse Power Protection

It is recommended that the optional 50W Reverse Power Protection Unit (RPPU) be installed to protect the generator output circuits from high power feedback when, for example, testing transceivers. The RPPU generates audio, visual and GPIB alarm signals when activated and automatically disconnects the source of reverse power. Reset can be either manual or under GPIB control.

Insertion Loss: ±0.2 dB (≤650 MHz); +0.2 dB to −0.8 dB (>650 MHz)

Typical SWR at <3 dBm: 1.3:1 (≤500 MHz); 1.5:1 (>500 MHz)

General

Operating Temperature: 0°C to +55°C

Storage Temperature: −40°C to +70°C (memory retention not guaranteed below −20°C or above 65°C)

Humidity: 95% RH at +40°C

EMC: Meets radiated and conducted limits of MIL-STD-461A, methods RE02 and CE03, and VDE 0871

Carrier Leakage: The voltage induced in a two turn 1 inch diameter loop 1 inch away from any surface is less than 0.5 μV measured into a 50 Ω receiver

Power Requirements

Voltage Ranges: 100 (90 to 110) VAC
120 (103 to 127) VAC
220 (193 to 237) VAC
240 (207 to 253) VAC

Frequency: 45–66 Hz (for 400 Hz, consult factory)

Consumption: Approximately 320 VA

Dimensions: 178 H × 427W × 493D mm
(7.0H × 16.8W × 19.4D inches)

Weight: 25 kg (55 lb)

Ordering Information

9087: Synthesized Signal Generator.

Options

01: Rear panel connectors

04B: Oven Oscillator (<5 x 10^{-10}/day aging rate)

04L5: Low noise frequency standard

10: 100 store memory

11: Reverse power protection[1]

60: Rack mounting kit (fixed)

65: Rack mounting kit (slides)

[1]Factory-installed option; cannot be ordered separately

Accessories

A comprehensive range of accessories is available for the 9087 including:

35: External Frequency Doubler

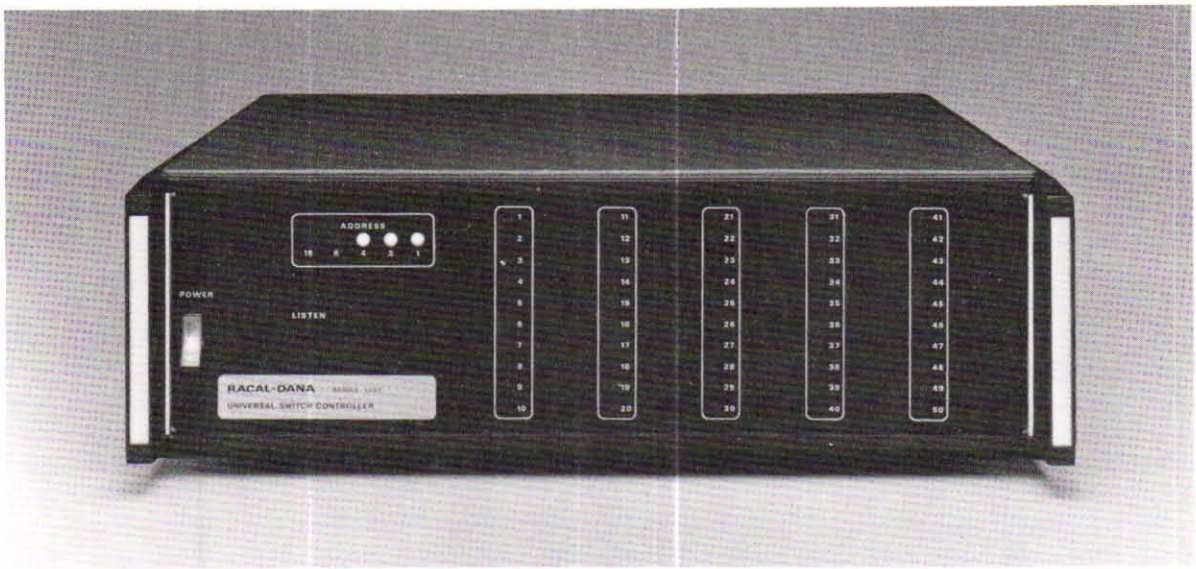
61: Transit Case

23-3174: 50 to 75 Ω adapter (10 dB attenuation)

23-3190: N to BNC adapter

11-1579: Service support kit

Switching Systems General Information



Introduction

The development of a standard instrument interface and low-cost desktop computers has now made it practical to automate previously manual test benches. The era of "Rack and Stack" automated systems has created the need for instruments that can be used to switch the analog inputs and outputs between measuring instruments, sources, and the unit(s) under test. Racal-Dana switching systems are designed to meet this need for easily configured, highly flexible analog switching.

Easily Configured

The Racal-Dana switching systems allow a wide variety of configurations. Capable of switching levels from microvolts to 1000 volts, they may be connected to provide matrix switching, switching trees, scanning, isolated switching, multiplexing, fan-out switching, or a wide combination of the above to meet the exact needs of your system.

Models for Both "Rack and Stack" and Large ATE Systems

Racal-Dana offers two series of GPIB switching systems to satisfy the requirements of both the large-scale ATE system designer and the test engineer automating a previously manual test bench.

The Series 1200 offers the ultimate in flexibility and is the ideal solution for applications that require the switching of a wide variety of signal types.

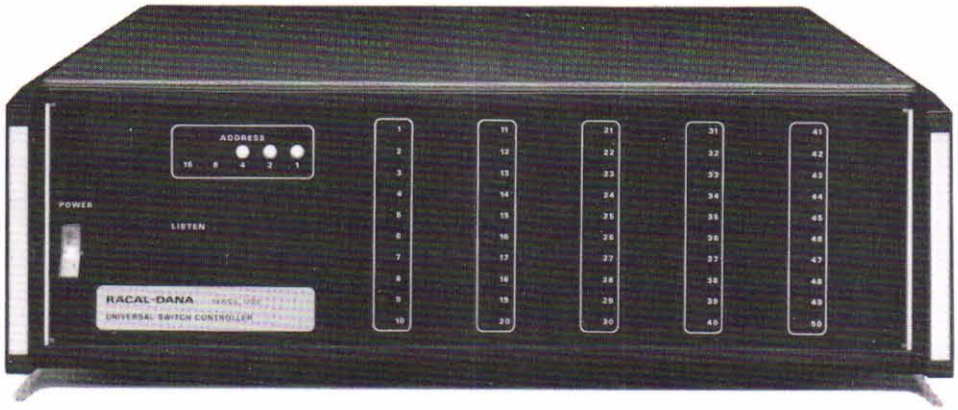
The Series 1240 should be considered for large-scale ATE systems that require a high-density matrix configuration. The 1240 is fully compatible to the U.S. Air Force MATE (Modular Automatic Test Equipment) program requirements and uses the high-level CIIL programming language.

GPIB Switching System Model Summary

Feature / Series	Configuration		Switching Type				
	Matrix Size (Maximum)	Scanning	High Voltage	Low Thermal	RF	General Purpose	Microwave
1200	150 Crosspoints	X	X	X	X	X	X
1240	23×60	—	X	—	X	X	—

X = Standard Feature

Switching Systems
Universal GPIB Switching System
Series 1200



GPIB LISTENER

A Solution to the Routing Problems of Analog Signals in GPIB Systems

The Series 1200 Universal Switching System is the world's first GPIB instrument designed specifically to switch signals ranging from microvolts to 750 volts, from DC to 18 GHz, and from picoamps to 30 amps.

The Series 1200 routes the analog output of signal sources and the input of measuring instruments, permitting control of the routing by a programmable calculator and simple, direct software.

Select the Modules to Satisfy Your Requirements

The Series 1200 virtually eliminates the need to design and debug a complex, custom-engineered switching system. By simple selection of an appropriate mix of standard switching modules, plugging them into the universal mainframe, and initiating a simple program string, the design is accomplished.

The Series 1200 is available with a selection of dedicated switching modules, which can be chosen to match your specific requirements.

This allows you to turn traditional manual connections and reconnections into a neat and simple automated system using your GPIB controller. It makes automated testing as simple as turning a switch.

The low cost of the Series 1200 means automatic testing is now affordable and extremely practical for short run production, prototype, and R&D testing. It gives you more time to review the results rather than manually taking data.

This system demonstrates the following measurable savings:

- Reduced measurement errors
- Reduced system design time
- Reduced test system cost
- Reduced manual set-up time
- AND, it permits you the opportunity to set up an ATE system for even short run production, engineering and Q.A. testing.

Capacity to Handle Your Largest System

Up to five modules, representing up to 50 channels, may be plugged into the microprocessor controlled master chassis of the Model 1202 which operates as a listener device on the bus.

For larger systems, a slave chassis is available. Model 1203 slave chassis allows expansion up to to 15 modules.

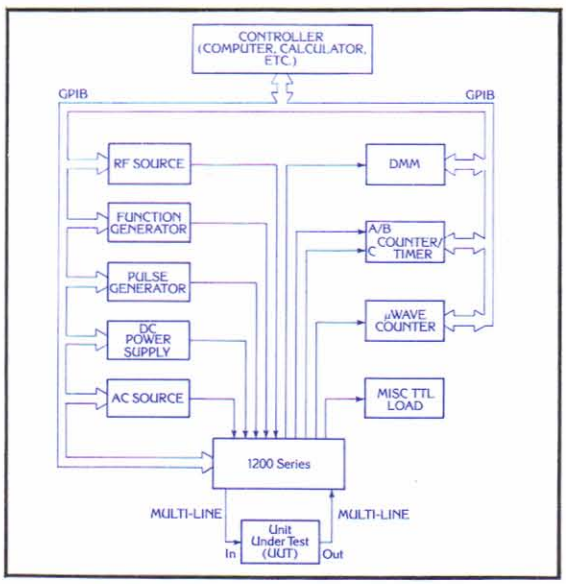


Figure 1 shows the block diagram of a typical system using the Series 1200.

The Series 1200 is Virtually Invisible

Pre-engineered compensation factors within each of the Series 1200 plug-in modules eliminate a host of serious measurement errors.

These permit measurement, for instance, with less than 1 microvolt thermal EMF uncertainty and extremely low contact resistance, even at low current levels. To prevent degradation in resistance and current measurements, contact resistance is held to milliohms in those channels intended for such measurements.

Resistance is added, however, for high voltage switching to suppress transients caused by parasitic capacitance and in-rush currents.

Other modules guarantee dynamic performance up to 18 GHz, 10 A, 100 MHz, etc. When used in combinations, they can provide channel groups configured as scanners, matrices, trees, or individual isolated switches. This facilitates distribution, convergence, and scanning of a wide variety of signals.

Plug-in personality connectors on Models 1211 through 1214 make connecting these switching modules easy. By pre-wiring these connectors for your specific test requirements, you can quickly change from one "custom" setup to the next.

Series 1200 Switching Module Summary

Model Number	Modules	Maximum Input Level Per Channel	Frequency Range	Lines Per Channel	Channels Per Module	Configuration
1210	BCD driver	N/A	N/A	1-wire per channel (common ground)	64	64 TTL sinks (16 decades BCD)
1211	TTL switching	N/A	N/A	1-wire per channel (common ground)	10	Independent TTL sinks
1212	Power switching	270 V rms, 150 VA 10 AMPS at 5 volts	DC to 400 Hz	2-wire per channel	10	Independent channels
1213	Low level switching	50 volts DC or rms AC	DC to 1 MHz	3-wire per channel	10	2 each, 1 × 5, 3-wire
1214	High voltage switching	5-channels— 750 VDC or 200 V rms 5-channels— 100 VDC or Peak AC	DC to 1 MHz	3-wire per channel	10	2 each, 1 × 5, 3-wire
1215	RF switching	250 V DC or Peak AC	DC to 100 MHz	1-wire per channel (common ground)	10	2 each, 1 × 5 matrix
1216	Microwave switching	100 W at 100 MHz 7.5 W at 18 GHz	DC to 18 GHz	Single pole/ double throw (common ground)	2	Independent channels
1217	Microwave switching	100 W at 100 MHz 7.5 W at 18 GHz	DC to 18 GHz	Single pole/ double throw (common ground)	4	Independent channels

Specifications

Universal Switch Controller—Model 1202

Description: The 1202 provides microprocessor control logic, GPIB interface, relay power supply, and front panel status annunciators

Channel Capacity: 5 switching modules

External Trigger: Rear panel BNC connector, TTL level

Cooling: Fan

GPIB Interface: Programming of switch conditions, closure modes, trigger modes, and self-test

Modes: Listen only and addressable listener

Front Panel Indicators: Power on/off
50 LED channel status annunciators
GPIB address LED annunciators
Listen LED

Temperature Range

Operating: 0°C to +50°C

Storage: −20°C to +70°C

Humidity: ≤75% RH, 0°C to +40°C
≤50% RH, +40°C to +50°C

Power Requirements

Voltage: 100, 120, 220, or 240 VAC ±10%

Frequency: 50 or 60 Hz

Consumption: 85 watt maximum

Dimensions: 133 H × 425 W × 498 D mm
(5.5 H × 16.75 W × 19.6 D inches)

Weight: 9.1 kg (20 lb)

Switching Systems
Universal GPIB Switching System
Series 1200

Slave Chassis—Model 1203

Description: Identical to the 1202 except the GPIB interface and microprocessor control logic are not included

BCD Switching Module—Model 1210

Description: Designed to allow interface with BCD programmable instruments, the 1210 provides 64 lines of TTL level control. It is ideal for use in converting from GPIB to BCD for controlling non-GPIB compatible devices

TTL Module—Model 1211

Description: Designed as a general purpose device, the TTL switching module may be used to program BCD or parallel controlled devices. In addition, external relays, lamps, alarms, etc. may be controlled by this module. Front panel indicators in the chosen slot may be used for system annunciation when this module is installed.

Configurations: Model 1211 provides 10 independently controlled power sinks, 10 complementary TTL level outputs and 10 access lines to the front panel channel annunciators. Power is also provided for TTL and relay sourcing.

Power Sinks: Up to 30 mA per line with clamp diodes for inductive overswing protection. 50 V maximum input.

Power Output: Nominal 24 V DC unregulated at 300 mA maximum
Nominal 5 V DC regulated at 80 mA maximum

Complementary TTL Logic Outputs: 8 mA maximum at 0.5 V sink (sourcing requires external pull-up resistors)

Annunciator Access Lines: Driving to ground through a minimum of 1 kilohm will cause the associated front panel LED to illuminate.

Input/Output Connector: 40 pin, KULKA Type 2597A-10 terminal blocks.

Power Switching Module—Model 1212

Description: This is designed to provide switching for AC line (mains) power, DC power supplies, and AC or DC current sources. Other voltage or current levels may be switched with this module when thermal offsets and series (contact) resistance are not critical. This module contains 10 independent two-wire channels.

Frequency Range: DC to 400 Hz

Series Resistance (per wire): ≤150 milliohm at 5 amps DC

Open Switch Isolation (per wire): ≥10,000 megohm

Thermal Offset: ≤10 μV per channel (differential)

Isolation Resistance: $\geq 10^{10}$ ohms between any two terminals or between any terminal and case with switches open

Maximum Switching Voltage: 270 V rms, 50 to 400 Hz, 200 VDC

Maximum Common Mode Voltage

Channel to Channel: 380 VDC or peak AC

Terminal to ground: 500 VDC or Peak AC

Maximum Switchable Current

Per Wire: 5 A rms AC, 5 A DC

Per Channel: 10 A rms AC, 10 A DC

Per Module: 30 A rms AC, 50 to 400 Hz, & DC (with wires paralleled)

Maximum Switchable Power

Per Wire: 100 VA rms AC, 125 VA DC

Per Channel: 150 VA rms AC, 200 VA DC

Switching Time: ≤35 mSec

Input/Output Connector: 40 pin, KULKA Type 2597A-10 terminal blocks

Low Level Switching Module—Model 1213

Description: This module is designed for switching inputs to high impedance instruments such as digital multimeters, true rms voltmeters, high speed digitizing voltmeters, A/D converters and phase angle-voltmeters. Featuring low thermal offsets, excellent dry switching characteristics and low series contact resistance, it is ideal for most low level switching applications. It contains 10 three-wire channels organized as two 1 x 5 matrices.

Frequency Range: DC to 1.0 MHz

Thermal Offset: ≤1 μV differential per channel (Hi/Lo terminals).

Series Resistance (per channel): ≤200 milliohm at 2 A DC

Open Switch Isolation: ≥10,000 megohms

Isolation Resistance: $\geq 10^{10}$ ohms between any two terminals or between any terminal and case with switches open. .

Switching Time: ≤35 mSec

Cross-Talk Isolation*: ≥100 dB at 500 VDC
≥100 dB at 50/60 Hz
≥60 dB at 20 kHz
≥50 dB at 1 MHz

Maximum Switching Voltage*: 50 V rms, DC to 100 kHz
6 V rms, 100 kHz to 1 MHz

Maximum Common Mode Voltage*

High or Low to Case: 500 VDC or peak AC to 400 Hz

Low to Guard: 200 VDC or peak AC to 400 Hz

Guard to Case: 500 VDC or peak AC to 400 Hz

*With common channels connected to Racal-Dana Series 6000 Digital Multimeter or equivalent load.

Maximum Switchable Current per Channel: 2 A rms, DC to 100 kHz
1 A rms at 1 MHz

Maximum Switchable Power per Channel: 2 VA DC or peak AC

Maximum Instantaneously Switched Power: 2 VA per module

Input/Output Connector: 40 pin, KULKA Type 2597A-10 terminal blocks

High Voltage/Low Thermal Switching Module—Model 1214

Description: This is designed for switching inputs to instruments such as digital multimeters, true rms AC voltmeters, high speed digitizing voltmeters, A/D converters and phase angle voltmeters. The high switching voltage capability allows measurements to be made that previously required a hard-wired configuration. Voltages up to 750 volts may be scanned or switched. After switches are positioned, differential voltages up to 1000 volts may be applied.

The combination of this high voltage capability and low thermal offsets makes the Model 1214 an ideal switching system for automatic DVM calibration systems. It may also be used for high voltage power supply testing.

Frequency Range: DC to 1.0 MHz

Thermal Offset: ≤1 μV differential per channel (Hi/Lo terminals).

Series Resistance (Per Channel)
Group 1 Channels: 540Ω ± 5%
Group 2 Channels: ≤200 milliohm at 2 A DC.

Open Switch Isolation: ≥10,000 megohms

Isolation Resistance: $\geq 10^{10}$ ohms between any two terminals or between any terminal and case with switches open.

Switching Time: ≤35 mSec

Cross-Talk Isolation*: ≥100 dB at 500 VDC
≥100 dB at 50/60 Hz
≥60 dB at 20 kHz
≥50 dB at 1 MHz

Maximum Switching Voltage*
Group 1 Channels: 750 VDC
200 V rms to 1 kHz
125 V rms at 10 kHz
100 V rms at 100 kHz
20 V rms at 1 MHz
Group 2 Channels: 100 VDC or peak AC to 100 kHz

Maximum Common Mode Voltage*
Hi or Low to Case: 1000 VDC or peak AC to 400 Hz
Low to Guard: 300 VDC or peak AC to 400 Hz

Maximum Switchable Current per Channel
Group 1 Channels: 25 mA DC or rms AC
Group 2 Channels: 2 A rms, DC to 100 kHz

Maximum Instantaneously Switched Power: 2 VA per module

Input/Output Connector: 40 pin, KULKA Type 2597A-10 terminal blocks

*With common channels connected to Racal-Dana Series 6000 Digital Multimeter or equivalent load.

RF Switching Module—Model 1215

Description: The 1215 is designed to switch the input of such high frequency devices as frequency counters, oscilloscopes, true rms voltmeters, and RF voltmeters. It is ideal also for switching outputs from function generators, signal generators, frequency synthesizers and other RF devices.

Because of the wide bandwidth, the 1215 is suitable for routing and switching TTL and other logic signals.

It contains 10 single wire channels configured as two 1×5 matrices.

Frequency Range: DC to 100 MHz

Thermal Offset: ≤175 μV

Insertion Loss: ≤0.5 dB at 100 MHz with 50 ohm termination

Switching Time: ≤2 mSec

Input/Output Connector: BNC

Shunt Capacitance: ≤60 pF added as measured at common terminal

Open Switch Isolation: ≥120 dB at 250 VDC
≥36 dB at 100 MHz
Common to any branch with 50 ohm termination

Maximum Switching Voltage: 250 VDC or peak AC

Maximum Common Mode Voltage Between Channels: 350 VDC or peak AC

Maximum Switching Current: 200 mA DC or peak AC per channel

Maximum Switching Power: 20 VA DC or peak AC to 100 kHz maximum sum of all channels derating by 5 VA per decade above 100 kHz to 5 VA at 100 MHz

Connectors: BNC

Microwave Switching Modules—Models 1216 & 1217

Description: These modules are designed for switching in a 50 ohm system. The DC to 18 GHz frequency range makes them ideal for switching inputs to such devices as microwave counters, power meters, RF millivoltmeters, modulation meters and network analyzers. They are also well suited for switching fast risetime signals.

Frequency Range: DC to 18 GHz

Insertion Loss: ≤0.5 dB to 18 GHz

Open Channel Isolation: >60 dB to 18 GHz

VSWR: 1.25:1, DC to 6 GHz
1.40:1, 6 to 12 GHz
1.50:1, 12 to 18 GHz

Connectors: SMA

Switching Systems
Universal GPIB Switching System
Series 1200

Ordering Information

Model 1202: Universal Switch Controller
Model 1203: Slave Expansion Chassis
Model 1210: BCD Switching Module
Model 1211: TTL Switching Module
Model 1212: Power Switching Module
Model 1213: Low Level Switching Module
Model 1214: High Voltage Switching Module
Model 1215: RF Switching Module
Model 1216: 2 Channel Microwave Switching Module
Model 1217: 4 Channel Microwave Switching Module

Options

04: 50 Hz operation
71: 220/240 VAC operation

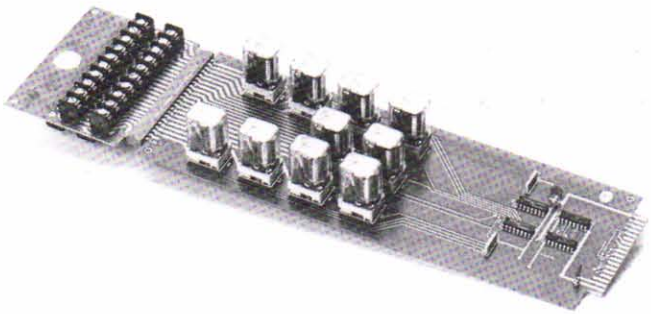
Accessories

See GPIB Instrument Section

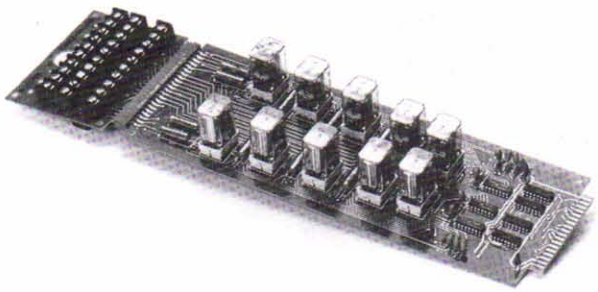
New

Model 1235: 100 MHz 2×4 RF Switching Module
Model 1236: 1 GHz Tree or 5 Individual Coax Switches

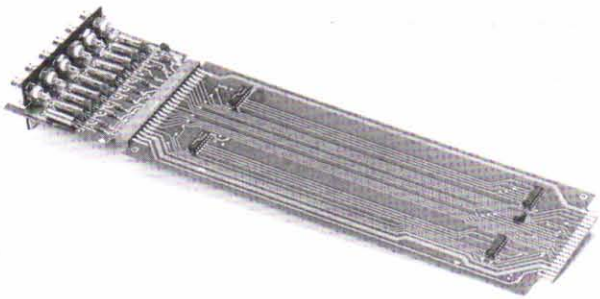
Please refer to Catalog Supplement for full specifications.



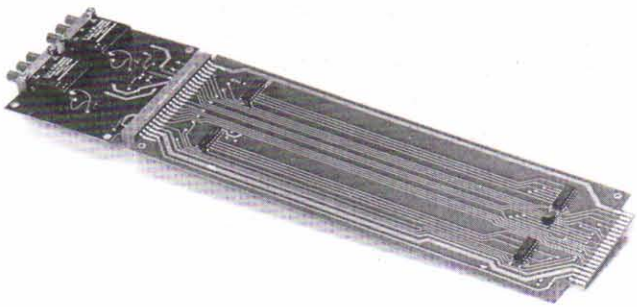
Model 1212 — Power Switching Module



Model 1213 — Low Thermal Switching Module

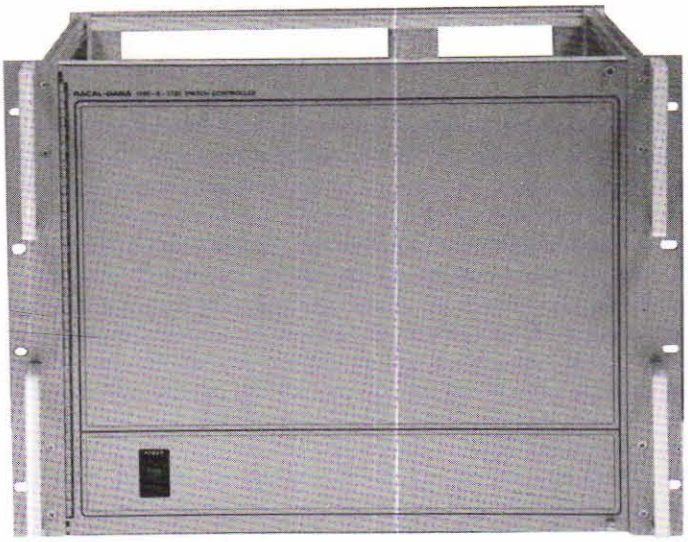


Model 1215 — RF Switching Module



Model 1216 — Microwave Switching Module

Switching Systems
MATE Compatible, High Density Matrix
Series 1240



Universal and High Density Matrix Switch

The Series 1240 is both a universal and high-density-matrix switching system. Designed to be compatible with the U.S. Air Force MATE* program, the Series 1240 uses high level CIIL* language programming and the GPIB (IEEE-STD-488) to control both the expandable matrix switch and optional slave assembly.

Switching configurations include:

- 45 MHz matrices up to 23 × 60
- DC to 200 MHz extended RF switching
- 1000 volt DC switching
- 3 amp power switching
- Custom modules for UHF or microwave switching

*MATE and CIIL are acronyms of the U.S. Air Force program for standardized automatic test equipment.
MATE: Modular Automatic Test Equipment
CIIL: Control Intermediate Interface Language

Expandable Matrix

The Model 1242 Matrix Switch Controller accepts up to six Model 1242-10 matrix switching modules. These modules, which plug into the front of the 1242, provide a 10 × 23 matrix and feature BNC connectors. Each module may be used individually or paralleled to expand the matrix in 10 channel increments to 20 × 23, 30 × 23, 40 × 23. . . .etc.

The module inputs have terminations that may be programmed into the circuit when desired. Termination values may be user-specified.

The 1242—which contains the master processor, GPIB interface and optical slave interface—may be used independently or with the slave chassis.

Expandable General Purpose Capacity

In addition to the expandable RF matrix, the Model 1242 also supports the Model 1243 slave chassis. The 1243 can accept an additional six switching modules in the 1243 Series which plug into the front of the 1243 mainframe. The connector inputs/outputs for these additional modules are available at the rear of the mainframe. One DC power switching module (1243-12), one general purpose switching module (1243-13), and up to four extended performance RF switching modules may be supported by the Model 1243. The RF switching modules can be customized for UHF or microwave switching.

An optical fiber interface and cable are used to link the 1243 to the 1242 switch controller. The use of an optical interface insures total isolation of all high power and high frequency switches from the main matrix, master microprocessor and GPIB interface.

Full Mate Compatibility

The Series 1240 which is fully programmable via the GPIB (IEEE-STD-488) is compatible with the MATE program. The programming structure and commands are a defined subset of the MATE CIIL specification (Modular Automatic Test Equipment, Control Intermediate Interface Language). This allows use in all military programs requiring MATE compatibility. The CIIL high level language is derived from ATLAS and allows each relay in the matrix and the expansion chassis to be addressed, either individually or as a defined group.

Designed to function as both a listener and talker on the GPIB, the Series 1240 has the ability to verify that program commands have been executed via the status (STA) command and also to perform automatic self test.

Switching Systems
MATE Compatible, High Density Matrix
Series 1240

Fail-Safe Operation

To ensure fail-safe operation, the master microprocessor resets all relays to their normally open state in the event of permanent or intermittent (brown out, etc.) power line failure. This is essential for true matrix switching where external equipment can easily be damaged by the erroneous operation of certain relays. When combined with the status (STA) command, this feature ensures the complete confidence necessary for complex ATE signal switching and routing.

Built-In-Test and Diagnostics

A comprehensive internal self-test allows most failures to be identified down to the replaceable module level. The self-test results are available via the GPIB to allow the system controller to analyze any failures and alert the ATE system operator. In addition, LEDs on each module provide a visual go/no-go indication of correct operation. To further aid diagnostics and reduce mean-time to repair (MTTR), the Internal-Self-Test (IST) and confidence (CNF) GPIB commands may be used to obtain a "Bit-Map" to locate a faulty relay.

Matrix Module

Each Model 1242-10 matrix module provides a 10×23 matrix with a guaranteed bandwidth of 45 MHz. Paths within the module vary in bandwidth from 45 MHz to 500 MHz. Care must be taken when using paths above 45 MHz to avoid path lengths equal to the quarter wavelength of the signal. The 1242 controller can accept up to six matrix modules. The guaranteed 3 dB bandwidth for a 60×23 matrix is better than 45 MHz.

DC Switching Module

The Model 1243-12 DC Power Switching Module provides ten 4-pole, single-throw switches especially designed for switching power supply outputs. Each switch contains two 3-amp contacts and two gold-plated sensing contacts. A double-pole, double-throw, 1000 volt, high voltage switch and two single-pole, single-throw, general purpose switches are also included in this module.

General Purpose Switching Module

The Model 1243-13 General Purpose Module provides 25 single-pole, single-throw relays. These may be used, in addition to the two general purpose relays provided in Model 1243-13, for switching up to 100 volts or up to 1 amp at 28 volts.

Extended Performance RF Switching

The Model 1243-14 Extended Performance RF Switching Module consists of seven single-pole double-throw relays with extended RF performance characteristics. Featuring a 200 MHz bandwidth, this module is ideal for switching inputs to frequency counters and other measuring instruments.

The 1243-14 Module may also be customized for UHF and microwave switching with bandwidths of up to 18 GHz. From one to four 1243-14 modules may be installed in a single 1243 chassis.

Specifications

Model 1242 Matrix Switch Controller

Configuration: Accepts up to six model 1242-10 matrix switching modules

Power Requirements

Voltage: 120 VAC ±10%
240 VAC ±10% optional

Frequency: 47 Hz to 66 Hz

Power Consumption: 120 VA with 100 relays closed

Weight: 32 kg (70 lb)

Dimensions: 355.6H × 444.5W × 571.5D mm
(14.0H × 17.5W × 22.5D inches)

Rack Mounting: 19″ rack mount per MIL STD 189

Slide Compatibility: Compatible with Jonathan P/N 1504657

Environmental Requirements

Temperature Range

Operating: 0°C to +50°C
Storage: −55°C to +75°C

Humidity (non-condensing): 75% RH to +40°C

Model 1243 Slave Controller

Configuration: Accepts the following 1243 series modules
1 Model 1243-12 Power Switching Module
1 Model 1243-13 General Purpose Switching Module
up to 4 Model 1243-14 Extended performance RF Switching Modules

Interface: Optical fiber interface with Model 1242 Matrix Switch Controller

Power Requirements

Voltage: 120 VAC ±10%
240 VAC ±10% optional

Frequency: 47 Hz to 66 Hz

Power Consumption: 75 VA with all relays closed

Weight: 14.5 kg (32 lb)

Dimensions: 266.7H × 444.5W × 520.7D mm
(10.5H × 17.5W × 20.5D inches)

Rack Mounting: 19″ rack mount per MIL STD 189

Slide Compatibility: Jonathan P/N 1201734

Environmental Requirements

Temperature Range

Operating: 0°C to +50°C
Storage: −55°C to +75°C

Humidity (non-condensing): 75% RH to +40°C

Model 1242-10 Matrix Switching Module

Configuration: 10 × 23, single pole

Bandwidth*: 45 MHz in a 50 ohm system (−3 dB)

Crosstalk: < −35 dB at 10 MHz

Maximum Voltage: 250 VDC or 240 V rms AC (≤50 μA).

Maximum Current: 2A steady state
1A switched (at 28 VDC)

Contact Resistance: ≤0.5 ohm

Shunt Capacitance: 150 pF (single path)

Termination: Programmable terminations available on each input. (consult factory)

Switching Speed: ≤5 mSecs

Connectors: (all access from rear panel)
Input: Rear mounted BNC
Output: Top mounted SMB, crossbars use BNC.

*Paths vary in bandwidth from 45 MHz to 500 MHz.

Model 1243-12 Power Switching Module

Configuration: 10×4 pole single-throw power switches
2× single-pole single-throw general purpose switches
1× double-pole double-throw high voltage switch

Power Supply Switching

Configuration: 10×4 PST relays. 2 poles with 3A high current contacts. 2 additional poles with gold plated contacts (0.5A) for "voltage sense" switching.

Maximum Voltage: 50 VDC switched

Maximum Current: 3A to 50 VDC high current contacts
0.5A at 50 VDC sense contacts

Maximum Switched Power: 150 watts high current contacts
25 watts sense contacts

Contact Resistance: ≤200 milliohms high current contacts
≤500 milliohms sense contacts
(at maximum rated current)

Switching Speed: ≤30 mSecs

General Purpose Switching

Configuration: 2×SPST relays

Maximum Voltage: 50 VDC switched

Maximum Current: 1A at 28 VDC

Maximum Switched Power: 28 watts

Switching Speed: ≤5 mSecs

High Voltage Switching

Configuration: 1×DPDT relay (high-voltage switching on normally open contacts)

Maximum Voltage: 1000 VDC or peak AC (normally open contacts)
300 VDC or peak AC (normally closed contacts)

Maximum Current: 0.5 A at 28 VDC

Maximum Switched Power: 14 watts

Switching Speed: ≤30 mSecs

Module Connectors: 4 Burndy SMS24 quickmate

Model 1243-13 General Purpose Switching Module

Configuration: 25×single-pole single-throw relays

Maximum Voltage: 100 VDC at 100 μA

Maximum Current: 2A steady state
1A switched (at 28 VDC)

Contact Resistance: ≤0.5 ohms

Switching Speed: ≤5 mSec

Connectors: AMP 50 pin HD 20 series

Model 1243-14 Extended Performance RF Switching Module

Configuration: 7×single-pole double-throw relays

Bandwidth*: 200 MHz in a 50 ohm system (−3dB)

Crosstalk: < −35 dB at 10 MHz between any one active path and all other paths.

Maximum Voltage: 250 VDC or 240 V rms AC (≤50 μA)

Maximum Current: 2A steady state
1A switched (at 28 VDC)

Contact Resistance: 0.5 ohms

Shunt Capacitance: 20 pF

Switching Speed: ≤5 mSec

Connectors: BNC

*Custom configurations on the 1243-14 Module allow bandwidths of up to 18 GHz using proprietary microwave relays

Ordering Information

Model 1242: Master Switch Controller
Model 1243: Slave Chassis
Model 1242-10: RF Matrix Module
Model 1243-12: Power Switching Module
Model 1243-13: General-Purpose Switching Module
Model 1243-14: Extended Performance Switching Module

Options

71: 240 VAC operation
1242-11: Matrix bus connector assembly
1242-65: Chassis slides for 1242
1243-65: Chassis slides for 1243

Precision Laboratory Power Supplies 9230 Series

Introduction

The Racal-Dana 9230 series laboratory bench power supplies are designed for applications where precision and clarity of indication are of paramount importance. In addition to fully variable operation in either constant voltage or constant current mode, they feature simultaneous digital monitoring of voltage and current with high accuracy and resolution. High resolution controls allow precise setting of the output, and the current limit can be accurately set at levels down to 1mA, providing total circuit protection.

The output voltage is variable from 0 to 30 volts at currents up to 1A on the 9231, and 2A on the 9232. The 9234 provides up to 4A at 0–15 volts.

A unique feature is the ability to set both voltage and current levels accurately before connection to the load and without shorting the output. Both input terminals are fully floating and provision is made for remote sensing via two additional front panel terminals.

Digital Accuracy and Resolution

The Racal-Dana 9230 series power supply units incorporate digital readouts with a 3¾ digit scale length (3999) to provide accuracy and resolution an order of magnitude higher than the best analog meters. High brightness wide angle LED's of 12.5mm (0.5") height provide a clear, precise reading, viewable from up to 5 metres without the problems of parallax error or scale misinterpretation.

Two readouts per output are provided giving simultaneous monitoring with constant resolution of voltage and current thus eliminating any possibility of misinterpretation. Switchable damping is included on the current meter to simplify measurements on rapidly varying loads.

High Stability and Setting Accuracy

Integrated band-gap voltage reference diodes are used as the basis for stabilization of both voltage and current. These provide better stability and lower temperature coefficients than the zener diodes normally used. Voltage setting is by coarse and fine controls giving a setting resolution of better than 0.005 volts. The current control uses a conductive plastic semi-logarithmic potentiometer to provide maximum resolution at all current settings.

The incorporation of a DC – output switch enables precise setting of voltage and current limit *before* the load is connected. With the switch in the "off" position, the current meter decimal points light up indicating that the meter is now displaying the value of the current limit. With the switch "on" the decimal points go out and the meter displays the value of current flowing. When the limit is reached, the decimal points flash to indicate that the power supply is operating in the constant current mode.

Remote Sense Feature

To enable full use to be made of the high precision of these power supplies under all circumstances, provision for remote sensing is incorporated. At high currents, the voltages at the source and load may be significantly different (two 0.1 ohm connecting leads will drop 0.2 volts at 1 Amp), but this problem can be eliminated by connecting the two "sense" terminals to the load instead of to the source.

This ensures that the voltage meter and stabilizing circuit monitor the true load voltage and therefore the effect of the connecting leads resistance on the power supply output impedance is removed.

Models 9231Q and 9232Q

The models 9231Q and 9232Q are dual units comprising two models in a single case. Push buttons allow selection of four separate modes of operation.

Isolated: Completely independent operation of the two supplies.

True Parallel: Converts the Master unit to a 0–2A or 0–4A supply.

Series: Internal series linking of the two supplies gives outputs up to 60 volts.

Series Tracking: Master voltage control sets up equal voltages on both supplies.

Models 9231K and 9232K

Models 9231 and 9232 are also available combined with an additional K module to form a triple power supply.

The K module incorporates two supplies. The first is a high current 5 volt supply for logic work, featuring ± 1 volt variability, overvoltage crowbar, remote sense, and digital current metering. The second is a 0 to 30 volt supply which can be switched either to track with the 9231/2 supply, or can be operated independently in a fully floating mode.

All outputs are fully protected against short circuits and overloads, and overcurrent indication is built in.

Models 9231T and 9232T

Two single units may be supplied together as a twin unit.

Specifications

Model 9231/9232/9234

Input Voltage: 110, 120, 220, 240V AC ± 10% at 48–63 Hz.

Output Voltage: 0–31V nominal (15V Model 9234).

Output Current: Model 9231 0–1.1A nominal. Model 9232 0–2.2A nominal. Model 9234 0–4A nominal*.

Output Terminations: 4mm terminals on 19mm (0.75") spacing, DC – output switch isolates positive terminal.

Sensing: Remote via 4mm terminals or Direct via shorting links (provided).

Line Stability: <0.01% of maximum output for 10% line change.

Load Regulation: <0.01% of maximum output for 90% load change.

Protection: Full short circuit and overload protection.

Ripple and Noise: <1 mV typically.

Output Impedance: <5 milliohms at 1 kHz.

Temperature Coefficient: <0.01% °C typically.

Transient Response: <20µsec to <50mV of setting for 100% load change.

Constant Current Output Impedance: 50kohm typically with voltage limit at maximum.

Voltage Controls: Continuously variable by coarse and fine controls, resolution 0.005 volts.

Current Limit: Continuously variable from 0 to 110% of maximum current rating. Automatic indication of constant current operation.

Meters: Dual 3¾ digit (3999 count) with 12.5mm (0.5") LED's. Reading rate 4 per second.

Meter Resolution: Voltage 0.01 volts over entire range. Current 0.001 amps over entire range.

Meter Accuracy 20°C–25°C: Voltage 0.1% reading ± 0.05% full scale. Current 0.3% reading ± 0.1% full scale.

Current Meter Damping: Normally 20msec switchable to 2 secs for averaging of rapidly varying loads.

Operating Temperature Range: 0°C to 45°C.

Weight: 9231 – 3.75kg (8.41lb); 9232 and 9234 – 4.7kg (10.6lb)

Dimensions: 175H x 155W x 235Dmm (6.9H x 6.15W x 9.25D inches.)

Electrical Safety: Designed to comply with IEC 348

*Model 9234 has switchable current limit delay making peak currents up to 7 amps available to fluctuating loads.

Model 9231T/9232T

Form: Dual unit consisting of two models of 9231 or 9232 each with specification given above.

Mode of Operation: Isolated – 2 independent supplies.

Model 9231Q/9232Q

Form: Dual unit comprising two models 9231 or 9232 each to specification given above.

Modes of Operation: (via push button switches) Isolated – 2 independent supplies. True Parallel – to provide 0–2A (9231) or 0–4A (9232). Series – to provide 0–60V supply. Series tracking – master control sets equal voltage on each supply.

Tracking Accuracy: 0.3% of setting ± 0.1% of full scale.

Weight: 7kg (15.7lb)

Dimensions: 175H x 345W x 235Dmm (6.9H x 13.6W x 9.25D inches.)

Model 9231K/9232K

Form: Either model 9231 or 9232 can be fitted with a module type K to form a triple power supply.

Output A
Output: –5V ± 1V fully floating 3.5 amps (9231 K) or 7.0 amps (9232 K).

Voltage Control: Via calibrated control.

Current Limit: Foldback current limit with automatic indication.

Current Metering: 3¾ digit (3999 count) with 12.5mm (0.5") LED's. Reading rate 4 per second. Switchable damping.

Overvoltage Crowbar: Dual Speed. User adjustable trip point 10msec at +5%, 1µsec at +100%.

Sensing: Remote via 4mm terminals or direct via shorting links (provided).

Output B
Output: 0–30V fully floating or tracking 0.5 amps (9231 K) or 1.0 amp (9232 K).

Voltage Control: Via calibrated control, or tracking with 9231/9232.

Current Limit: Fixed at 110% of rated output LED overcurrent indication.

Other Electrical Parameters: As 9231/9232 specification.

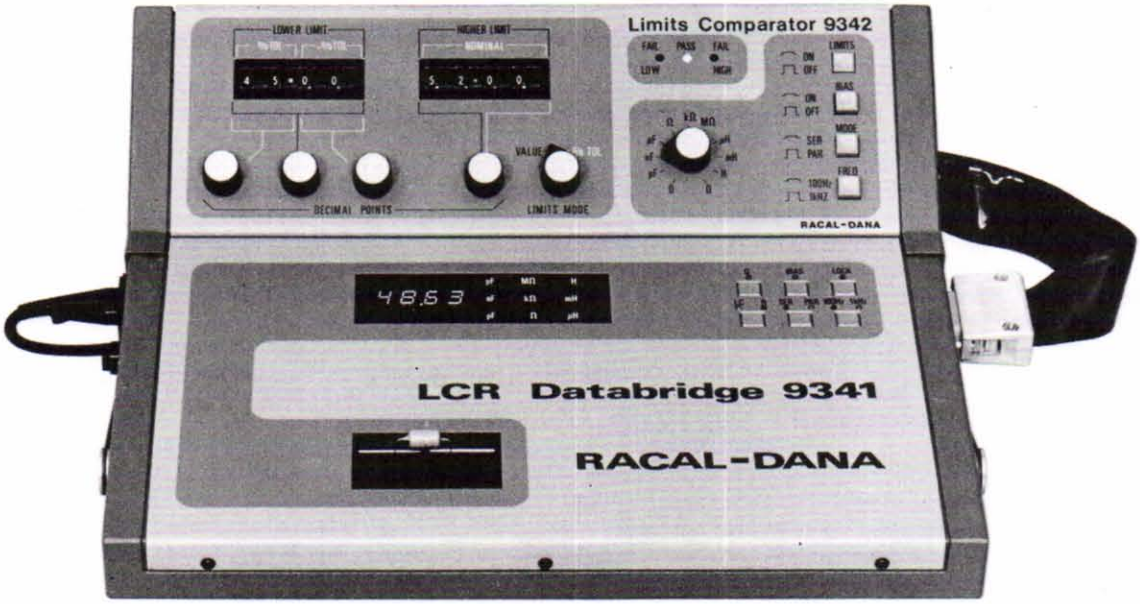
Weight: 7kg (15.7lb) 9231 K; 9kg (20lb) 9232 K.

Dimensions: 175H x 310W x 235Dmm (6.9H x 12.2W x 9.25D inches.)

Ordering Information

Model 9231:	**Bench Power Supply** (30V 1A)
Model 9231Q:	**Bench Power Supply** (Quad Mode Dual)
Model 9231K:	**Bench Power Supply** (Triple Output)
Model 9231T:	**Dual Power Supply** (30V 1A Dual)
Model 9232:	**Bench Power Supply** (30V 2A)
Model 9232Q:	**Bench Power Supply** (Quad Mode Dual)
Model 9232K:	**Bench Power Supply** (Triple Output)
Model 9232T:	**Dual Power Supply** (30V 2A Dual)
Model 9234:	**Bench Power Supply** (15V 4A)

LCR Databridge and Limits Comparator Models 9341 and 9342



Introduction

The 9341 LCR Databridge provides fast, accurate measurement of resistance, capacitance, inductance and quality factor (Q). Having full auto-ranging with manual override capabilities, the Databridge requires minimal operator involvement to obtain measurements to within 0.25% in less than one second.

Adding the 9342 Limits Comparator to the LCR Databridge produces a powerful pass/fail component sorting system suitable for a wide range of goods-in inspection, component matching production and laboratory applications. The combination allows the additional measurement of D (tan δ) as well as providing limit comparisons on any parameter.

The operation of the 9341, together with the management of all measurement functions and computations is under full microprocessor control. The microprocessor sets the display readout to be compatible with the required measurement precision and prompts the user to make any changes necessary for maximum accuracy.

Display

The measured value is displayed on a four digit, LED display with automatic decimal point positioning. In the event of a component value being too large or too small, the display indicates 'OR' (over range) or 'UR' (under range) as appropriate. If the Q of the component under test causes excessive measurement uncertainty, the least significant digits are automatically blanked.

User Guidance

The measuring sequence is monitored by the microprocessor which indicates to the operator, by means of LED's, ways in which the measurement accuracy may be optimized.

Such messages include range data, choice of series/parallel measurement configuration and choice of measurement frequency.

Test Fixture

The integral test fixture allows FOUR TERMINAL measurements to be made on the majority of wire ended components to maximize accuracy by eliminating the capacitance, inductance and resistance of the connecting leads.

A special 4 terminal adaptor is available to allow leads to be connected for remote testing or to allow a user to wire directly to his own test fixture.

Limits Comparator

The 9342 Limits Comparator may be fitted to the 9341 to form a complete component measuring set. This may be done either at the time of purchase or retrospectively.

Control of the instrument as a whole is from the comparator which is equipped with switches that do not change state even in the event of a power failure.

Limit Options

There are two comparison modes for the 9342 test limits. In the first mode upper and lower limits are used while in the second a nominal value is selected together with positive and negative percentage tolerances.

Indicators

Three pass and fail indicators are provided: one green for pass and two red for fail – one indicating FAIL LOW and the other FAIL HIGH.

There are also three outputs from the 9342, each one corresponding to an indicator reflecting the pass/fail decision.

LCR Databridge and Limits Comparator Models 9341 and 9342

Specifications

9341 LCR Databridge

Variables Measured: R, L, C & Q.

Modes: Series or parallel equivalent circuit.

Measurement Frequency: Selectable 100Hz or 1kHz.

Accuracy of Measurement Frequency: ±0.025% of nominal.

Maximum Voltage on Component: 0.3V rms.

Measurement Update Rate: 2 per second.

Maximum time for First Valid Reading: 1 second.

Display: 4 digit LED with automatic decimal point.

Connection to Unknown: 4 terminal via integral test fixture, or remotely with options.

Automatic Functions:
1) Full auto-range.
2) Automatic discrimination between L and C.
3) User prompts to change measurement mode for maximum accuracy.

Measurement Ranges:
– **R** 0.000 Ω to 100MΩ. (Ultimate Resolution 1mΩ).
– **L** 000.0 µH to 9999H (Ultimate Resolution 0.1 µH).
– **C** 000.0pF to 9999µF (Ultimate Resolution 0.1pF).
– **Q** 0.0 to 99 (Ultimate Resolution 0.1).

Basic Accuracy: ±0.25% of reading ±1 digit.

Conditions for Specified Accuracy

Measurement Frequency:

	100Hz	1kHz
L(Q>10)	2mH to 2000H	200µH to 200H.
C(Q>10)	2nF to 2000µF	200pF to 200µF
R(Q<0.1)	1Ω to 2MΩ	1Ω to 2MΩ.

Bias for Electrolytic Capacitors: 2V Int., up to 50V Ext.

Input Protection: The input is protected against connection of capacitors of up to 10,000µF charged up to 50 volts.

Digital Outputs (Optional): Digital output of reading and range available for use with limits comparator model 9342.

Operating Temperature Range: 0°C to +50°C.

Power Requirements: 195V to 255 V, 50 or 60Hz, 25VA (95V to 135V option).

Weight: Nett: 5.6kg (12.3lb). Shipping: 11.0kg (23.2lb).

Dimensions: 9341, 50H x 452W x 250Dmm.

9341 LCR Databridge with Limits Comparator

To use 9341 with the 9342 it is first necessary to fit option A which consists of an internal circuit board and a 24 pin socket. Option A may be fitted in the field, although it is usually factory fitted. Specification as for the 9341 alone except for the following additions:

Limit Modes: Absolute value limits or nominal value with % tolerance.

Limit Setting Precision: 4 digits for value, 2 digits for % tolerance.

Measurement Ranges: D, pF, nF, µF, Ω, kΩ, MΩ, µH, mH, H, Q.

Weight of Limits Comparator: nett: 4.2kg (9.3lb). Shipping: 6.0kg (13.0lb).

Weight of Limits Comparator & Databridge Combination: Nett: 9.8kg (21.5lb). Shipping: 20.0kg (44.0lb).

Dimensions: 9341 plus 9342, 185H x 445W x 386Dmm.

Ordering Information

Model 9341: LCR Databridge (specify 230V or 115V operation)

Model 9342: Limits Comparator (requires Option A in 9341)

Options and Accessories

Model A: Interface (to be fitted inside 9341)

Model 1401: Extender Cables

Model 3401: Extender Cables (with clips)

Digital Multimeter 4¾ Digit Field Model 4008

LATE ADDITION

Introduction

Model 4008 is a 4¾ digit multimeter providing more resolution, more effective accuracy and more versatility than any other meter in its price range. High stability components, low power dissipation and maximum emphasis on quality ensures a long calibration cycle and minimum cost of ownership.

The Model 4008 combines a crisp clear liquid crystal display with low power consumption to give hundreds of hours of operation from each set of batteries, while the availability of an AC line adaptor makes Model 4008 ideal for laboratory as well as field use. Its rigid construction protects it from damage in hostile environments.

High Sensitivity

With a maximum resolution of 10μV and 10 milliohms, Model 4008 is ten times more sensitive than the best 3½ digit meters. Ultra-wide current handling copes with currents from 1nA, for measuring such parameters as capacitor leakage, up to 10 amps. The input impedance which is normally 10 Megohms can be increased to greater than 1,000 Megohms on voltages up to ±3.2V for applications where impedance is critical.

Frequency Measurement

Model 4008 provides direct frequency measurement up to 4MHz with a resolution of 0.1kHz with high accuracy and stability ensured by the internal crystal reference.

Lightweight and Portable

This highly versatile digital multimeter is ideally suited for use in field service/repair applications. The exceptionally low power consumption, ensuring that a set of batteries gives many hours of service, plus its light weight make it easy to handcarry to any location.

True RMS on AC

On AC functions Model 4008 has a true rms capability providing accurate and repeatable measurements on non-sinusoidel signals.

Specifications

D.C. Voltage

Ranges:	320mV, 3200.0mV, 32.000V, 320.00V, 1200.0V
Polarity:	Positive or Negative
Accuracy:	Typically ±(0.07% reading +0.005% scale)

DC Current

Ranges:	80.00μA, 800.0μA, 8.000mA, 80.00mA, 800.0mA, 10.00A
Polarity:	Positive or Negative
Accuracy:	Typically ±(0.15% reading +0.02% scale)

AC Voltage (True RMS)

Ranges:	3200.0mV, 32.000V, 320.00V, 750.0V
Accuracy:	Typically ±(0.35% reading +0.5% scale)

AC Current (True RMS)

Ranges:	800.0μA, 8.000mA, 80.00mA, 800.0mA, 10.00A
Accuracy:	Typically ±(0.4% reading +0.2% scale)

Resistance

Ranges:	320.00Ω, 3200.0Ω, 32.000kΩ, 320.00kΩ, 3200.0kΩ, 3200.0MΩ
Accuracy:	Typically ±(0.1% reading +0.005% scale)

Frequency

Range:	4000.0kHz
Accuracy:	±(0.005% reading +0.0025% scale)
Sensitivity:	Typically 1V pk-pk

Diode Test

Range:	3200.0mV
Excitation Current:	1mA

General

Reading Rate:	3.125/sec
Display:	9mm LCD
Overrange:	Display flashes
Input Impedance:	10MΩ/40pF (>1000MΩ available on 3200mV range)
NMR:	>60dB at 50Hz
1kCMR:	>100dB AC line
Temperature Range:	0 to 40°C
Weight:	1.2kg (2.6lbs)
Dimensions:	60H×230W×230D mm
Power Requirements:	Battery, 6×C cells

Ordering Information

Model 4008: 4¾ Digit, Seven Function Digital Multimeter.

Accessories

See under DMM Section.

Digital Multimeter 5½ Digit Bench Model 4009

LATE ADDITION

Introduction

Model 4009 is a high performance, microprocessor controlled 5½ digit bench multimeter incorporating DC and AC voltage and current, resistance and diode test ranges as standard. Model 4009 is also equipped with powerful computing and data-logging features in addition to all the functions and features associated with a high quality bench multimeter. An optional GPIB-IEEE-488 interface is available allowing the 4009 to be incorporated into ATE systems.

Resolution and Accuracy

Model 4009 has a 5½ digit, 13mm LED display providing ten times the resolution of conventional 4½ digit multimeters and the added advantage of increased effective accuracy. The resolutions obtainable are 1μV, 1 milliohm and 1nA allowing measurements to be made in areas previously impossible with 4½ digit meters including switch contact resistance, thermocouple junctions and capacitor leakage.

0703 843265
CHRIS TAYLOR

Specifications

D.C. Voltage

Ranges:	210.000mV, 2100.00mV, 21.0000V, 210.000V, 1100.00V
Polarity:	Positive or Negative
Accuracy:	Typically ±(0.025% reading +0.001% scale +1 digit)

D.C. Current

Ranges:	210.000μA, 2100.00μA, 21.0000mA, 210.000mA, 2100.00mA, 5.0000A
Polarity:	Positive or Negative
Accuracy:	Typically ±(0.1% reading +0.0015% scale +2 digits)

A.C. Voltage (Mean Sensing RMS)

Ranges:	210.00mV, 2100.0mV, 21.000V, 210.00V, 750.0V
Accuracy:	Typically ±(0.2% reading +0.02% scale +4 digits) AC FREQ RESPONSE 20kHz

A.C. Current (Mean Sensing RMS)

Ranges:	210.00μA, 2100.0μA, 21.000mA, 210.00mA, 2100.0mA, 5.00A
Accuracy:	Typically ±(0.3% reading +0.05% scale +10 digits)

Resistance

Ranges:	210.000Ω, 2100.00Ω, 21.0000kΩ, 210.000kΩ, 2100.00kΩ, 21.0000MΩ
Accuracy:	Typically ±(0.04% reading +0.001% scale +2 digits)

Diode Test

Range:	2100.00mV
Excitation Current:	1mA

General

Reading Rate:	3/sec
Display:	13mm LED
Overrange:	Displays OR
NMR:	>70dB at 50/60Hz
1k Unbalance CMR:	>120dB at DC/50Hz/60Hz
Temperature Range:	0 to 35°C
Weight:	1.9kg (4.2lbs)
Dimensions:	90H×230W×230D mm
Power Requirements:	200–264V, 50Hz or 90–125V, 60Hz

Microprocessor Enhanced Performance

Microprocessor enhanced performance is used to assure simplicity of operation and measurement capability. A simple entry sequence, clear display prompts and a logical keyboard make programming quick and easy. Various computing functions can also be operated simultaneously and include: scaling/offset (Ax+b); percentage deviation from a reference; pass/fail limits comparison and direct reading in dB (absolute or relative). Special single-key functions such as 'Null' are also available. No other DMM in this price range offers comparable capabilities.

Excellent Noise Performance

An in-built programmable, digital filter is highly effective in eliminating unwanted noise while responding rapidly to reading changes. The characteristics of the filter may be reprogrammed quickly and easily from the keyboard if required.

Automatic Data Storage

Model 4009 will store up to 100 readings for future recall and analysis allowing tedious repetitive measurement sequences to be carried out automatically. Model 4009 will also store highest, lowest and average values. It has a read rate variable from 3/sec to 1/hour.

Full Protection

The instrument is fully protected against accidental overload with a tough case providing protection against mechanical damage.

Ordering Information

Model 4009: Intelligent Digital Multimeter, 5½ digit.

Options

50kHz

10: True rms AC Converter (in place of mean sensing rms).
52: RS232 Serial Data Output. — £25
55T: GPIB Adaptor. £165

£369 -5%
£90-00

Accessories

See under DMM Section.

2 WKS

Notes

International Test and Measurement Instruments

Racal-Dana is the exclusive U.K. distributor for a number of selected companies, each of which has an international reputation for reliable, high quality products. Our relationship with these companies has been built up over two decades of mutual respect ensuring stability and confidence.

The products available are advanced, high performance designs which complement our own range enhancing our capability in test instruments and systems. Racal-Dana is, therefore, able to offer you the widest possible choice and assistance to help you solve your measurement problems.

You can have complete confidence when choosing any instrument or system from Racal-Dana that it is backed by our complete sales and service support. Our comprehensively equipped service facility in Windsor is staffed by a team of specialists skilled in instrument servicing, quality assurance and calibration.

This Section

The following section of the catalog gives a brief description of some of the products available from each of these companies. For detailed specifications and full information on any product please contact:

Racal-Dana Instruments Ltd.,
Duke Street, Windsor,
Berks. SL4 1SB.
Tel: 07535-68101. Telex 847013.

Our Principals and Their Products

Adret:	Synthesized signal generators, attenuator calibrators, voltage calibrators, standard frequency receivers, transmitter drive synthesizers.
Cushman:	Radio communications test sets, spectrum monitors, field service monitors, frequency selective level meters, radio systems analyzers, cellular radio test sets.
Efratom:	Atomic frequency standards, standard frequency receivers, frequency and time generating systems.
EIP:	Microwave counters, microwave sweepers, microwave signal generators.
Exact:	Function generators, sweep function generators, pulse generators, materials testing generators, quadrature generators, digital phase generators, programmable pulse/function generators.
Giga:	Microwave signal generators, microwave sweepers, microwave pulsed generators.
Oscilloquartz:	Atomic frequency standards, quartz crystal oscillators, customized frequency management systems.
Telewave:	Frequency difference meters, standard frequency receivers, MSK converters.
Tracor:	Frequency difference meters, standard frequency receivers.

Adret Electronique

Adret Electronique was founded in 1966 by Jean Royer and Roger Charbonnier, both experts in the field of electronic instrumentation.

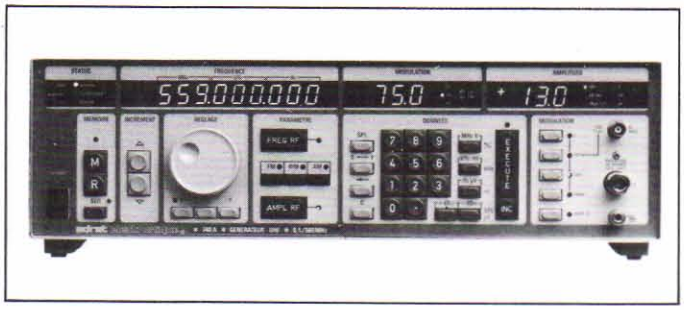
The company has built up an international reputation for the development, manufacture and marketing of programmable test equipment. In particular their experience in frequency synthesis has led to a range of high performance synthesized signal generators as well as voltage calibrators and standard frequency receivers all utilizing frequency synthesis techniques.

Adret has also developed dedicated drive synthesizers for HF, VHF, SATCOM and TV transmitter equipment.

The main application areas for Adret products are the radio communication and telecommunications markets.

Adret has been represented by Racal-Dana in the U.K. for over a decade.

740A and 730A Signal Generators



The Adret 740A and 730A are advanced general purpose signal generators incorporating the latest developments in frequency synthesis and microprocessor control. They have been designed to combine exceptional versatility with simplicity of operation.

The 740A has a frequency range of 100kHz to 1120MHz derived from a crystal reference offering excellent accuracy, stability and spectral purity. The comprehensive modulation capabilities – amplitude, frequency, phase and pulse – make the 740A an ideal signal generator for communications applications.

The 730A has a frequency range of 300Hz to 180MHz also derived from a crystal reference with the same advantages as those found in the 740A. The 730A is equipped with amplitude, frequency and phase modulation and has been designed with stereo testing very much in mind. It can also be given a DC-FM capability with a 10kHz bandwidth making it ideal for testing digital paging equipment.

Both generators have a unique 'EXECUTE' command allowing new configurations to be prepared and checked in memory before being implemented thus eliminating the need to change settings parameter by parameter.

These generators have the ability to store up to 40 complete test set-ups in non-volatile memory simplifying and speeding up routine test procedures. They are fully GPIB programmable.

Model 740A

Frequency Range:	100kHz to 1120MHz
Resolution/Step Size:	10Hz
Dynamic Range:	– 129.9dBm to + 13dBm, into 50Ω
Reverse Power Protection:	50 watts
Spectral Purity:	– 120dBc/Hz at 20kHz, – 140dBc/Hz noise floor
Spurious:	– 70dBc
Amplitude Modulation:	0 to 99.9%
Frequency Modulation:	0 to 199.9kHz
Phase Modulation:	0 to 19.99 Radians
Pulse Modulation:	
Frequency Range:	10MHz to 1120MHz
Pulse Repetition Freq:	100Hz to 2MHz
Non-Volatile Memory:	40 complete configurations
GPIB Control:	IEEE-488

Model 730A

Specification as for Model 740A except for the following:

Frequency Range:	300Hz to 180MHz
Resolution/Step Size:	1Hz
Dynamic Range:	129.9dBm to + 19.9dBm into 50Ω
Frequency Modulation (DC coupled):	0 to 10kHz

(Model 730A is not equipped with pulse modulation)

7100D Universal R.F. Generator

The 7100D Universal R.F Generator is a high performance instrument combining the advantages of cavity-tuned generators with those of the synthesizer. It is a microprocessor based signal generator providing ease-of-operation in both manual and remote modes (GPIB IEEE-488).

The wide frequency range of 100kHz to 1300MHz is achieved in one range and the instrument has full a.m., f.m., Ø.m., and p.m. capabilities, making it ideal for r.f. communication and telecommunication applications. The 7100D is also equipped with standard channel spacings for use in receiver testing.

The output level range is from −140dBm to +20dBm into 50 ohms in steps of 1dB or 10dB with a resolution of 0.1dB.

The spectral purity of the 7100D is extremely good, being −136dBc/Hz at 10kHz offset with a noise floor of −150dBc/Hz.

The high-performance pulse modulation capability is fully compatible with civil and military radionavigation systems.

This easy-to-use signal generator is protected, against the application of reverse power, by an electronic circuit breaker which has an automatic reset capability.

Frequency Range:	100kHz to 1300 MHz.
Resolution:	1Hz.
Dynamic Range:	−140dBm to +20dBm into 50Ω.
Reverse Power Protection:	50 Watts.
Spectral Purity:	−136dBc/Hz at 10kHz offset, noise floor −150dBc/Hz.
Amplitude Modulation:	0 to 100%.
Frequency Modulation:	0 to 300kHz.
Phase Modulation:	0 to 300° (5 radians) peak.
Pulse Modulation Frequency Range:	10MHz to 1300MHz.
Pulse Repetition Frequency:	10Hz to 2.5MHz.
GPIB Control:	IEEE-488.

7200A High Performance Signal Generator

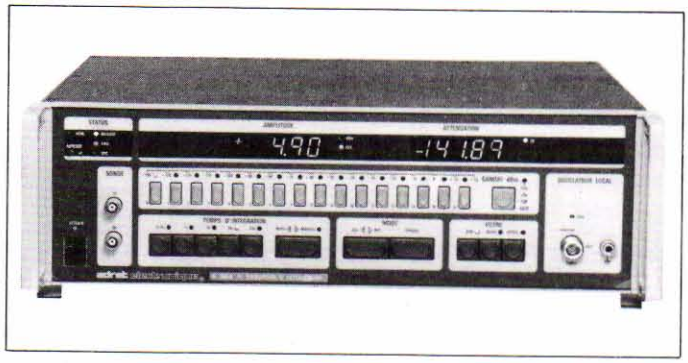
The 7200A Signal Generator provides the same high spectral purity as the 7100D with the added benefits of keyboard control and a high accuracy output. The high performance resulting from the software controlled level calibration system makes it a precision instrument ideally suited to use in the laboratory, offering accuracy and repeatability.

The 7200A is an excellent generator for use on the bench or as the heart of an automatic test system being fully GPIB compatible (IEEE-488). It is equipped with non-volatile storage allowing up to 40 complete front panel settings to be stored and recalled thus greatly simplifying routine test procedures. The internal a.f. generator may be used as an independent l.f. signal source as well as providing an internal modulating source for the 7200A's comprehensive modulation capabilities. This powerful generator also has the ability to sweep all parameters: frequency, level, modulation and even the memories.

Complete measuring sequences can be built-up locally or remotely by virtue of the powerful in-built firmware. The GPIB capability permits remote control of all front panel controls, checking of all internal circuitry, and a learn mode allowing any computer to read and store complete functional settings ready for rapid recall and use even by inexperienced operators.

Frequency Range:	100kHz to 1300MHz.
Resolution:	1Hz.
Stability:	5×10^{-9}/day.
Dynamic Range:	−140dBm to +20dBm into 50Ω up to 650MHz. −140dBm to +12dBm into 50Ω up to 1300MHz.
Resolution:	0.1dB.
Spectral Purity:	−136dBc/Hz at 10kHz offset, −150dBc/Hz noise floor.
Spurious:	−100dBc.
Amplitude Modulation:	0 to 100%.
Frequency Modulation:	0 to 300 kHz.
Phase Modulation:	0 to 300° (5 radian).
Pulse Modulation Frequency Range:	10MHz to 1300MHz.
Pulse Repetition Frequency:	10Hz to 2.5MHz.
A.F Output:	10Hz to 300kHz.
Non-Volatile Memory:	40 complete configurations.
GPIB Control:	IEEE 488.

Model 190A Signal Source Attenuation Calibrator



The Model 190A Automatic Signal Source Attenuation Calibrator has been designed specifically to allow rapid calibration of signal generators and attenuators, in a highly cost-effective manner ensuring accuracy and confidence.

The 190A covers a frequency range of 2kHz to 18GHz and has a dynamic range of −130dBm to +20dBm making it ideal for most signal generators and signal sources. The instrument is also fully GPIB programmable allowing it to be incorporated into automatic test systems enabling whole sequences of measurements to be carried out quickly and easily.

The Model 190A is also able to make absolute level measurements and to eliminate the effects of unwanted signals by virtue of its switch selectable bandpass filters.

Frequency Range:	2kHz to 18GHz.
Dynamic Range:	−130dBm to +20dBm.
Accuracy:	Typically better than ±1dB at 1μV.

4101A Frequency Standard Receiver

The 4101A Frequency Standard Receiver has been designed to receive long wave transmitted signals derived from atomic standards and provide high accuracy, high stability reference signals. These signals have the same long-term stability as the standard driving the received transmitter and the same spectral purity as a high stability crystal oscillator. The output reference signals have frequencies of 1MHz, 5MHz and 10MHz.

Model 4101A is essentially a high stability crystal master oscillator frequency locked and not phase locked to the transmitted carrier. In the event of a failure or degradation in the transmitted carrier, it is possible to inhibit locking if it would throw off the high stability oscillator.

The frequency range of the 4101A is 15kHz to 200kHz with a resolution of 20Hz.

Frequency Range:	15kHz to 200kHz
Resolution:	20Hz
Sensitivity:	5μ Vrms
Outputs:	1MHz, 5MHz and 10MHz (2 outputs each)
Level:	0.9 Vrms to 1.3 Vrms into 50Ω
Harmonic Content:	−40dB
Master Oscillator Stability (without lock):	$\pm 5 \times 10^{-10}$/24 hours
Locking Time Constant:	Variable from 1,000 sec. to 64,000 sec.

Other Adret Products

Model 103A:	Programmable DC Voltage and Current Reference Standard
Model 104A:	Programmable DC Voltage and Current Reference Standard with GPIB IEEE-488 and BCD programmability
Model 2230A:	50Hz to 1MHz Programmable Frequency Synthesizer
Model 3100B:	0.01Hz to 200kHz Programmable Frequency Synthesizer
Model 3300A:	300Hz to 60MHz Programmable Frequency Generator
Model 3310A:	300Hz to 60MHz Programmable Frequency Synthesizer
Model 4110A:	Frequency Error Multiplier and Error Counter
Model 5104:	Master Oscillator for Microwave Sources
Model 5130:	Master Oscillator for Medium Wave Transmitters

Cushman Electronics Inc.

Cushman

Cushman Electronics Inc. was founded in 1959 by L.T. 'Roy' Cushman, whose goal was to develop precision instruments that offered operational simplicity and convenience for engineers and technicians in the communications industry.

Today, Cushman is a leading manufacturer of test equipment for AM, FM and SSB two-way radios, as well as for the telephone and data communications industry. The company is based in San Jose, California.

Many of the company's products are in the form of multi-function monitors, incorporating a range of test functions which provide all the equipment necessary to service and maintain two-way communication systems.

CE-15 Spectrum Monitor 1 MHz to 1500MHz

The CE-15 Spectrum Monitor is designed for use in testing two-way radios, both in the laboratory and in the field. It is essentially two instruments in one unit, being both a sensitive easy-to-use spectrum analyser and an FM/AM receiver with a built-in speaker. The CRT provides a clear display of signal spectra and any AM or FM signal can be demodulated and monitored on the speaker. The CE-15 provides a fast indication of radio performance.

Frequency Range:	1 to 1000MHz (1500MHz with Option M-2)
Receiver:	FM and AM with built-in speaker
Level Accuracy:	±3dB (levels ≥ −100dBm in 10kHz/div scan)
Sensitivity:	−115dBm (freq. ≥5MHz)
Display Range:	70dB
Scan Width:	100kHz, 1MHz, 10MHz, 100MHz
Input Protection:	RF fuse
Demod Output:	0.1V p-p for 50% AM or 6kHz FM
Supply:	115/230V AC, 12V DC

CE-4000 Radio Communications and Digital Paging Test Set

The CE-4000 Radio Communications Test Set contains everything necessary to test FM transceivers in one instrument with the ability to add extra features as and when required. The standard features of the CE-4000 include an FM signal generator, an FM receiver, an oscilloscope, a deviation meter and peak indicator, a SINAD meter, a power meter, a frequency error meter and an internal 1kHz audio tone generator.

Additional features which can be added when required include an audio synthesizer, a simulcast (quasi-sync) tester, digital and analog coded squelch and a universal encoder providing all the common tone and digital paging formats.

R.F. Signal Generator

Frequency Range:	455kHz to 999.9999MHz
Resolution:	100Hz
Output Level:	0.1μV to 10mV (low), 200mV min (high)

Monitor

Frequency Range:	25MHz to 999.9999MHz
Resolution:	100Hz
Sensitivity:	2μV for 12dB SINAD

Modulation/Demodulation

Meter:	0–1.5kHz and 0–15kHz peak deviation
Int. Mod:	0–15kHz

Oscilloscope

Internal Vertical (AC coupled):	2kHz, 6kHz (cal. full scale) to 15kHz in uncal. position
External Vertical (AC or DC coupled):	Voltage Range: 5mV, 50mV, 5V and 5V per division
Frequency Range:	DC to 500kHz
Horizontal Sweep Range:	10mS, 1mS, 100μS and 10μS per division

SINAD Meter

Range:	0 to 30dB

CE-5110 FM/AM Communications Monitor

The CE-5110 is a self-contained mobile radio maintenance service facility. The instrument contains a synthesized AM/FM signal generator, a receiver, a frequency error meter, an AM/Deviation meter, a power meter, an oscilloscope, an audio tone generator, a synthesized offset generator, a tracking generator and a spectrum monitor. In addition it is able to carry out SSB and simulcast measurements and adjustments. The whole package may be battery powered for mobility and flexibility.

This powerful instrument provides all that is necessary for fast, efficient mobile radio maintenance.

Specific tests for which the CE-5110 is ideally suited include fast, accurate repeater servicing; cable/antenna fault location, insertion loss measurements in filters, transmission lines and attenuators, harmonic identification; receiver alignment and precise SSB and simulcast transmitter adjustment.

Signal Generator

Frequency Range: 0.45MHz to 999.9999MHz (usable to 10kHz)
Output Level: 0.1 μV to 300mV rms
Modulation: AM, FM and Pulsed FM

Monitor

Functions: FM deviation, AM depth, frequency error, power, SINAD, audio frequency (Lissajou), SSB/Zero beat
Frequency Range: 0.45MHz to 999.9999MHz (usable to 50kHz)
Resolution: 100Hz
Sensitivity: 2 μV

Offset Generator

Frequency Range: 10MHz to 999.9999MHz
Frequency Offset: ±0.1MHz to 12.00MHz and ±45.00MHz
Output Level: 0.1 μV to 300mV

Spectrum Monitor

Frequency Range: 10MHz to 1000MHz (usable to 100kHz)
Dynamic Range: −115dbm to 0dBm
Display Range: 70dB (10dB/div), 7dB (1dB/div)
Scan Widths: 10kHz to 100MHz/Div in fixed steps, 10MHz to 350MHz variable

Tracking Generator

Swept frequency output is exactly equal to input frequency of the spectrum monitor.

Output Level: 0.1 μV to 300mV

Audio Synthesizer

Frequency Modes
GEN: 10.00Hz to 9999Hz
GEN +1kHz: Simultaneous 1kHz tone + GEN frequency
MOD OUT Level Range: 0–2V p-p into 1 kilohm
Burst: Tone Burst adjustable 0.03 sec to 1.0 sec

Oscilloscope

Frequency Range: DC to 1MHz
Vertical Sensitivity: 5mV/div, 50mV/div, 0.5V/div, 5V/div
Horizontal Sweep Rate: 1 μsec/div to 10m sec/div
Input Impedance: 1MΩ/30pF

New Cushman Products

CE-6000 Radio Systems Analyzer: A complete family of microprocessor controlled communications monitors capable of performing all the traditional tests required in the mobile radio industry.

CE-6488 Automatic Test Set: Functions with the IEEE-488 bus for automatic mobile radio testing under computer control.

CE-4416 Cellular Radio Test Set: One unit meets all the unique test requirements of mobile cellular radios.

CE-7000 Communications Monitor: A compact, low-cost monitor meeting the basic needs of international two-way radio testing.

Other Cushman Products

CE-24A: Frequency Selective Level meter

CE-31B: Radio Test Set

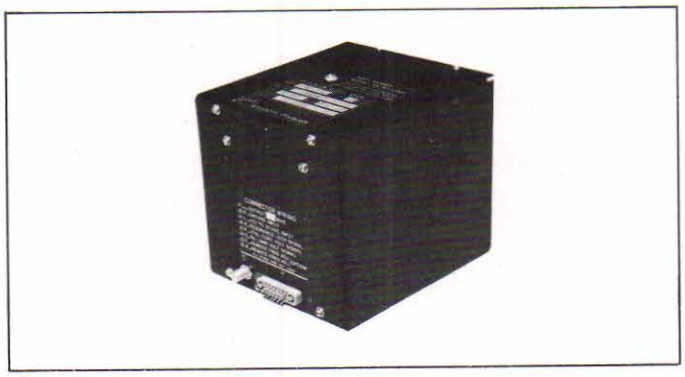
CE-50A-1: Field Service Monitor

CSM-50: Cell Site Monitor

Efratom

Efratom, a division of the Ball Corporation, specialises in the design and development of advanced time and frequency standards. It was recognized many years ago by Ernst Jechart, founder of Efratom, that advanced electronic systems, both military and civil, require excellent stability and accuracy in both time and frequency. Such systems include navigation, position location, narrow band and secure communications. Frequency or time references with accuracies in the range 10^{-9} to 10^{-12}, are called for to enable these systems to provide the expected level of performance, often in hostile environments. Efratom's range of miniature rubidium oscillators provide the answer. The Clansman and Ptarmigan communication systems employ Racal-Dana supplied frequency standards. The Company is actively engaged in research into hydrogen masers as the frequency standard of the future.

FRK Rubidium Oscillator



The FRK is a miniature rubidium oscillator the performance of which has closed the gap between today's most advanced crystal oscillators and the larger more expensive atomic frequency standards.

The rugged design, small size, low weight and modest power consumption allow direct installation as a component into airborne, mobile or portable systems. It is extremely reliable, even under severe environmental conditions.

Two models are available, The FRK-L and the FRK-H. Both feature fast warm-up, short stabilization time, low sensitivity to shock and acceleration as well as low drift rate.

For most operations the FRK-L is the ideal unit. However, when more demanding stability and long term drift requirements must be met, the FRK-H model is recommended.

Output Frequency:	10MHz, 0.5 Vrms into 50 ohms	
Option: LN:	5 MHz, 1.0Vrms into 50 ohms	
	FRK-L	**FRK-H**
Long-Term Drift/Month:	$\leq 4 \times 10^{-11}$	$\leq 1 \times 10^{-11}$
Short-Term (1 sec):	3×10^{-11}	1×10^{-11}
Trim Range:	2×10^{-9}	1×10^{-9}
Operating Temperature:	−40°C to +65°C	−25°C to +65°C
Option:	−55°C	−55°C
Phase Noise: SSB 1Hz:	120dB (100Hz), 145dB (1,000Hz)	
Option LN:	125dB (10Hz), 155dB (100Hz)	
Supply Voltage:	22 to 32 VDC	
Power Consumption:	13W at 25°C	
Warm-Up:	10 minutes to $< 2 \times 10^{-10}$ at 25°C	
Dimensions:	100 x 99 x 112mm	
Weight:	1,3kg (2.9lb)	

M-100 Rubidium Oscillator

The M-100 Rubidium Oscillator is designed to meet both ground and airborne military specifications. It is manufactured for high reliability under severe environmental conditions such as ground and airborne vibration levels, tactical radiation hardening requirements and EMI. Each M-100 also meets MIL-E-5400, Class I temperature requirements.

All parts are QPL or screened to equivalent MIL-STD-883 Level B specifications and derated conservatively to assure reliable operations. Every M-100 is tested to military acceptance test procedures and a detailed test data package is included with each unit.

Test and analysis reports are available for radiation hardening, EMI, reliability assessment, and qualification tests.

Output:	10MHz 0.5 Vrms into 50 ohms. 5MHz low noise option available
Input Power:	18 Watts at 26 VDC and 25°C ambient, 22.5 to 32 VDC
Warm Up Characteristics:	$\leq$ 10 mins. to reach 2×10^{-10} at +25°C. $\leq$ 22mins. to reach 2×10^{-10} at −50°C. $\leq$ 5 mins. fast warm-up option
Long Term Drift:	6×10^{-11} for the first month after 14 days of continuous operation. $\leq 3.6 \times 10^{-10}$ for the first year, total period: $\leq 2 \times 10^{-10}$ second year. 1×10^{-11}/month option available
Short Term Stability:	( ) = 4×10^{-11} ($^{-1/2}$) for 1 sec $\leq$ $\leq$ 100 sec
Signal to Noise:	> 120dB @ 100Hz, > 135dB @ 1kHz
Trim Range:	3×10^{-9}
Operating Temperature:	$< 4 \times 10^{-10}$ from −55°C (ambient) to +68°C (baseplate). Meets MIL-E-5400, Class 1
Reliability:	> 34,000 hrs, ground, stationary > 19,000 hrs, airborne, > 11,000 hours, ground, mobile
Size:	100 x 100 x 122mm
Weight:	1.8kg (4lbs maximum)

Ball Efratom Division

FRT Rubidium Frequency Standard

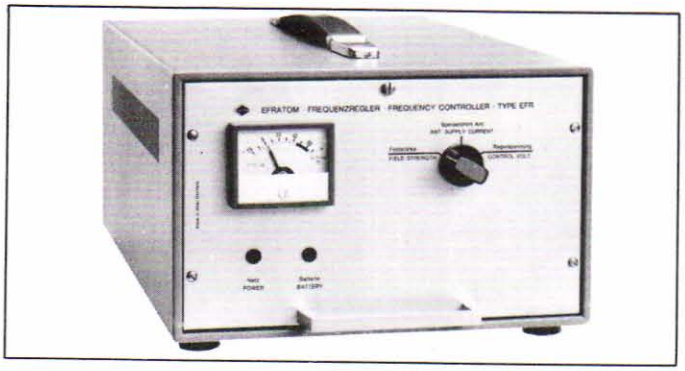
The FRT is an ultra-stable atomic frequency standard. It is housed in a portable case and can be easily installed in standard 19-inch equipment racks where it takes up only half the width.

An internal battery pack can support operation of the FRT for more than five hours during a prime power failure or during transportation. The unit provides 10, 5, 1 and 0.1 MHz, both on the front and rear panels. Options include: low phase noise; 1-pps output.

Two models are available: the FRT-L, which contains the rubidium oscillator model FRK-L; and the FRT-H containing the FRK-H oscillator. Both models can be connected to the receiver controller EFR which offers an economical alternative to more expensive primary standards.

Output Frequency:	(2 ea.) 10, 5, 1, 0.1 MHz 1 Vrms into 50 ohms	
	FRT-L	**FRT-H**
Long-Term Drift/Month:	$\leq 4 \times 10^{-11}$	$\leq 1 \times 10^{-11}$
Short-Term (1 sec):	3×10^{-11}	1×10^{-11}
Trim Range:	2×10^{-9}	1×10^{-9}
Phase Noise: SSB 1Hz:	120dB (100Hz), 145dB (1,000Hz)	
Option LN:	125dB (10Hz), 155dB (100Hz)	
Supply Voltage:	115/220 V AC or 23 to 32 V DC	
Power Consumption:	50W AC or 50 W DC Internal battery: 5 hours of operation	
Warm-Up:	< 10 minutes to $< 2 \times 10^{-10}$ at 25°C	
Operating Temperature:	−10°C to 50°C	
Dimensions:	235 x 150 x 400mm	
Weight:	12kg (27lb) with batteries	

EFR Receiver/Controller



The receiver/controller EFR is used to synchronize a local frequency standard such as the FRT to the signal of a standard LF or VLF transmitter such as WWVB. The EFR is available either for installation in a standard 19-inch equipment rack (half width) or in a portable case. It can be operated from either 115/220 V AC or 22/32 V DC to assure continuous operation in case of power failure.

Suppression of the radio signal's propagation anomalies is achieved by (1) selecting the synchronization loop time constant optimally to the local conditions and (2) interrupting the loop automatically at times of maximum disturbance.

The EFR provides the capability to monitor the phase difference between a local standard and the received radio signal. It can also be used by itself as a time signal receiver to drive a precision digital clock such as the Efratom model EDU.

Frequency Coverage*:	16kHz to 200kHz
Sensitivity:**	appr. 10µV/m
Local Standard Input:	10 MHz sine, > 0.3 V rms, 50 Ohms
Control Output:	±5V, 5k Ohms
5 MHz Output:	TTL, phaselocked to received signal
Operating Time Constant:	appr. 100,000 sec, adjustable
Starting Time Constant:	appr. 6,250 sec
Supply Voltage:	115/220 V AC or 22 to 32 V DC
Power Consumption:	25 W AC or 15 W DC
Operating Temperature:	−10°C to +50°C
Dimensions:	235 x 150 x 400mm half width in 19 inch rack
Weight:	4kg (8.8lb)
Warranty:	1 year

*Specify frequency with your order **With Efratom Ferrite Loop Antenna AAF

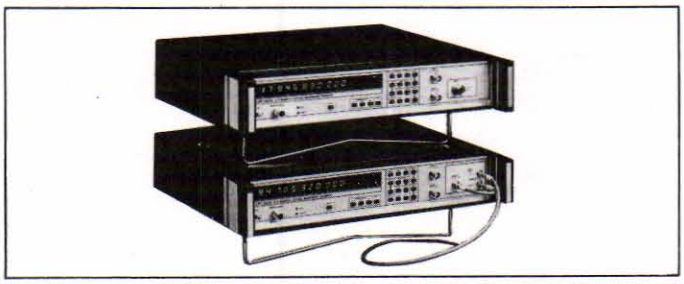
Other Efratom Products

Customized Time/Frequency Systems
Digital Clocks
Distribution Amplifiers
Automatic Changeover

E.I.P. Inc.

EIP Inc. specializes in the design and manufacture of high quality microwave test and measurement instruments. The company's principal customers worldwide include the telecommunications industry, military and non-military government agencies, military sub-contractors and research and development organizations. EIP's product range including microwave/millimeter frequency counters and microwave sources, is used in the design, manufacture and field service of microwave systems and components.

Model 575/578 Source Locking Counter



The EIP Model 578 Source Locking Counter provides fully automatic control for phase locking virtually any swept signal source to the same accuracy and long-term stability as the counter's own time base. It is also a superb microwave frequency meter with a choice of frequency ranges, the widest being 10Hz to 110GHz.

The source locking capability effectively converts a conventional signal source into a synthesizer at much reduced cost. Model 578 automatically tunes the signal source to the required frequency and optimizes acquisition time and spectral purity by selecting the appropriate phase-lock loop bandwidth. For repetitive tests, up to 9 pre-programmed frequencies can be stored for fast, simple recall making the 578 ideal for production testing.

As a frequency meter, the Model 578 will lock on to the largest signal present. In addition it has the capability to look at a narrow band as selected from the front panel, allowing it to be highly selective. Frequency offsets may be introduced for measuring deviation and there is a multiply function used in conjunction with the offset to facilitate measurements on low-level receivers where frequency multiplication and IF offsets are required.

Model 575 has all the capabilities of the Model 578 with a frequency range of 10Hz to 18GHz in three bands.

GPIB is included as standard with an optional power measurement capability on Band 3.

Frequency Range:	10Hz to 18GHz (Model 575) 10Hz to 110GHz (Model 578)
Resolution:	1Hz
Sensitivity:	25m V rms Band 1 (10Hz to 100MHz) −20dBm Band 2 (10MHz to 1 GHz) −30dBm decreasing to −15dBm Band 3 (1GHz to 26.5GHz) −25dBm Band 4 (Up to 110GHz Model 578 only)
Impedance:	Band 1 1MΩ/20pF Bands 2 and 3 50Ω
Damage Level:	Band 1 150V rms Band 2 +27dBm Band 3 + 37dBm (5 watts) Band 4 + 10dBm (Model 578 only)
Display:	12 digit LED
GPIB:	IEEE-488

Model 928 Microwave Source

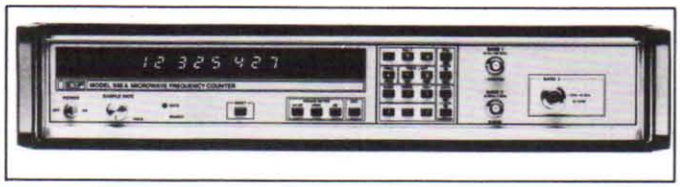
The Model 928 is a combined microwave sweeper and signal generator operating over a frequency range of 1 to 18.6GHz. The interactive CRT display and non-volatile memory make the Model 928 the most versatile and easy-to-use source available in this frequency range.

The CRT is used to provide function data, warning and error messages. The easily understood display simplifies operation, speeds up testing and minimizes operator error. In secure areas, the CRT can be blanked and the controls locked to ensure that sensitive frequency information is not available to onlookers.

A unique power control system provides output power to an accuracy of ±0.3dBm from −2 to +10dBm reducing test time and improving measurement accuracy. The output can be leveled either at the output or at the connection to the device under test. Model 928 provides exceptional power flatness. The 928 has the ability to step frequency and output levels and to provide multiple sweeps with up to 9 markers. There are 15 non-volatile memories, 9 for CRT displays and 6 for functions, which both simplify operation and increase user convenience. An optional 70dB step attenuator is also available to provide an output range of 79 dBm in 0.1 dB steps. The 928 is GPIB controllable being both 'talker' and 'listener'.

Frequency Range:	1 to 18.6GHz
Max. Residual FM:	<10kHz
Calibrated Power Range:	−2 to +10dBm (−72dBm to +7dBm with optional step attenuator).
Power Level Accuracy:	± 0.3dB typically
Typical Power Level Flatness:	± 0.1dB <8GHz ± 0.3dB ≥8GHz
Spectral Purity:	<−25dBc Harmonics <−55dBc Non-Harmonics
VSWR:	<1.7:1
Modulation: Functions:	Internal and External AM, External FM CW, Delta-F, Frequency Sweep, Marker Sweep, Power Sweep, Power Stepping, Frequency Stepping, Manual Sweep.

Model 545A/548A Microwave Counter



The EIP Model 545A is a 'smart' microprocessor-based microwave frequency counter incorporating EIP's frequency-selective heterodyne technique for operation from 10Hz to 18GHz. The 545A is exceptionally easy to use with the microprocessor interpreting the general instructions provided by the operator. The full 12 digit LED display provides clear unambiguous readings without shifting decimal points or the need for overflow.

Model 545A has the capability to look at a narrow band of frequencies as defined by front panel programming to eliminate unwanted signals even if they are of significant amplitude. Positive or negative frequency offsets may be programmed from the front panel – a particularly useful feature when measuring deviation from a reference signal. It is also possible to multiply the frequency by an integer between 1 and 99 and then introduce an offset. This is very useful in applications involving low-level receivers where frequency multiplication and IF offsets are required. An optional simultaneous power measurement feature is also available on Band 3.

Model 548A has all the capabilities of the Model 545A plus extended, direct frequency coverage to 26.5 GHz. In addition, external mixers are available to provide coverage up to 110GHz.

Full GPIB control is available to allow integration of the EIP 545A/548 A into automatic test systems.

Frequency Range:	10Hz to 18GHz in 3 bands (Model 545A) 10Hz to 110GHz with options (Model 548A)
Resolution:	1Hz
Sensitivity:	25m V rms Band 1 (10Hz to 100MHz) −20dBm Band 2 (10MHz to 1GHz) −30dBm Band 3 (1GHz to 12.4GHz) −25dBm decreasing to −15dBm Band 3 (12.4GHz to 26.5GHz) −25dBm Band 4 (26.5GHz to 110GHz, Model 548A)
Impedance:	Band 1 1MΩ/20pF Bands 2 & 3 50Ω
Damage Level:	Band 1 150V rms Band 2 +27dBm Band 3 +37dBm (5 watts) Band 4 + 10dBm (Model 548A only)
Display:	12 digit LED
GPIB: (Option):	IEEE-488

Other EIP Products

Model 451: 925MHz–18GHz Microwave Pulse Counter.

Exact Electronics

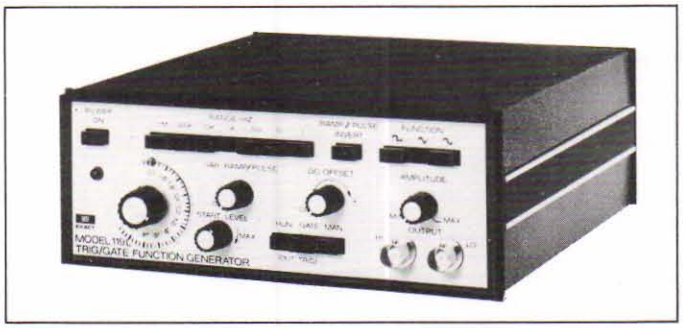
Exact Electronics, a Division of Dynatech Nevada Inc., was founded in 1956 by a group of engineers who saw the need for a company specialising in the design and manufacture of high performance function generators.

Initially the company concentrated on developing a range of very low frequency generators for use in materials testing. These generators are employed when measuring a material's resistance to various stress conditions such as low cycle fatigue, tension, compression, stress relaxation and creep.

After the success of these products, Exact moved on to produce low cost function generators which have proved to be equally successful.

Now the company is able to offer a comprehensive range extending from the materials testing generators to sophisticated programmable pulse/function generators employing the very latest technology – and providing all that is required of bench or systems instruments.

Model 119AL Function Generator



The Model 119AL Function Generator provides sine, square, triangle, pulse and ramp waveforms over the frequency range 0.02Hz to 2.2MHz. A signal amplitude of 20V P-P open circuit is available from the 50 ohm output with up to 70dB of attenuation. Front panel features include a variable ramp/pulse control and invert switch, a VCF input which allows the frequency to be varied over three decades by an external voltage, a TTL compatible pulse output capable of sinking 20 TTL loads, and DC offset. The generator can be free run, triggered or gated by an external signal or by depressing the manual pushbutton. The starting and stopping level of the signal is adjustable over 180 degrees.

Frequency Range:	0.02Hz to 2.2MHz (7 ranges) (0.002Hz to 220 kHz with "B" option).
VCF:	0 to +10V for 1000: 1 for maximum multiplier setting.
Waveforms:	Sine, square, triangle, ramp, pulse.
Main Output:	20 volts P-P open circuit.
Impedance:	50 ohms.
Attenuator:	0, 20 or 40dB fixed steps, 30dB continuously variable.
DC Offset (Variable):	+10V to −10V open circuit.
Sine Distortion:	<1% 0.2Hz to 100 kHz. Typically less than 0.5%.
Sine Frequency Response:	<±0.1dB 0.2Hz to 100kHz. <±0.5dB 100kHz. to 2MHz.
Square Wave:	Rise time: 100nSec. Aberrations: ±5% of max. P-P amplitude.
Pulse Output:	TTL compatible.
Trig Input:	DC coupled; approx. 10k ohms input impedance. Requires manual or external voltage of approx. 500mV for turn on.

Model 528 Log Sweep 20MHz Function Generator

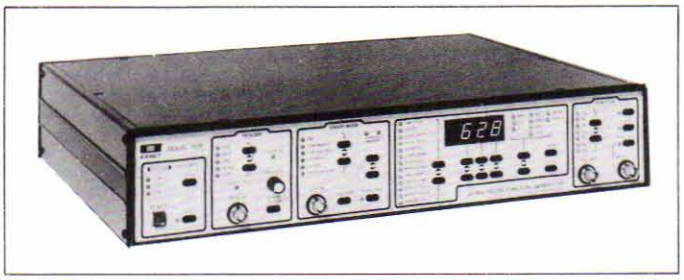
The Model 528 is two generators in one package. The main generator is a VCF generator covering 0.001Hz to 20MHz and producing sine, square, triangle, pulse, haversine, and havertriangle waveforms. The other is a ramp generator producing ramps with periods from 10μ sec. to 100 sec. (1000 sec. with Option E) and is used both for direct output and for sweeping the main generator.

When sweeping the main generator with the internal ramp, the sweep mode may be either linear or logarithmic, up or down. The start and stop frequencies are independently settable and both can be easily set and measured using the RUN/HOLD and TRIG/HOLD positions of the Ramp Mode switch. It can also be manually swept up to 3 decades linearly or up to 5 decades logarithmically using the FREQ START outer dial.

Other Model 528 features include: variable DC offset; gate, trigger, pulse, and burst modes; variable symmetry, variable start phase; 30V P-P output and sync outputs.

Waveforms:	Sine, triangle, square, + square,– square,haversine, havertriangle, ramp.
Modes of Operation:	Run, gate, trigger, pulse, burst, linear sweep, logarithmic sweep, variable symmetry.
Frequency Range:	0.001Hz to 20MHz.
Main Output:	50 ohm output impedance. 30V P-P o/c (15V Peak+ square, – square,ramp).
Attenuator:	60dB in 10dB steps plus 20dB continuously variable.
DC Offset:	Variable, +15V to–15V o/c.
Sine Distortion:	<0.5% 1Hz to 100kHz. No harmonics <30dB down 100kHz to 20MHz.
Sine Frequency Response:	<±0.1dB to 100kHz, <±2dB to 20MHz.
VCF Range:	Approximately 5V input for 100,000:1 logarithmic frequency control (1000:1 linear). 1kHz range and above.
V:f Outputs:	(Voltage proportional to frequency) Linear and logarithmic outputs. Approximately 0 Volts to +5 Volts for a 100,000:1 logarithmic (1000:1 linear) sweep range.
Ramp Generator:	
Modes of Operation:	Run, gate, trigger, run/hold, and trigger/hold.
Ramp Time Range:	10µ sec. to 100 sec. (10µ sec. to 1000 sec. with option E.)

Model 628 20MHz Programmable Pulse–Function Generator



The Model 628 Programmable Pulse-Function Generator bridges the gap between sophisticated systems function generators and microprocessor based benchtop models. It is equipped with full GPIB control and acts as both talker and listener. No other programmable function generator in the price range can match its versatility or ease of operation.

A non-volatile memory is fitted as standard with storage capacity for up to 20 complete front panel settings speeding up testing and simplifying operation. The frequency range of the 628 is 0.001Hz to 20MHz with a wide selection of waveforms and operating modes. The main output is protected against the accidental application of reverse power. The 628 also has an automatic self-calibration capability to guarantee accuracy and confidence in the output signal.

As well as being a programmable pulse generator and sweep generator the Model 628 is equipped with amplitude, frequency and pulse width modulation capabilities using an external signal source.

Frequency Range:	0.001Hz to 20MHz.
Waveforms:	Sine, triangle, haversine, havertriangle, square, inverted function waveforms, pulse, double pulse, complementary pulse waveforms and DC.
Operating Modes:	Run, triggered, gated, burst and sweep.
Main Output:	5mV to 15 volts P-P into 50 ohms.
DC Offset:	± 7.5 volts into 50 ohms.
Sine Freq. Response:	0.1dB to 100kHz. 2dB to 20MHz.
Sine Distortion:	<0.5% 1Hz to 100kHz. Harmonics < – 30dBc at any other frequency.
Pulse Width:	20nS to 2000 sec.
Pulse Delay:	20nS to 2000 sec.
Sweep Rate Range:	10mS to 2000 sec.
VCF Range:	5 Volts for 2000:1 frequency change.
Amplitude Modulation Range:	5 Volts P-P for 100% Modulation.
Pulse Width Modulation Range:	5 Volts for 2:1 change in pulse width.
Burst Range:	Bursts of selected waveform may be set from 1 to 2000 cycles internal or external trigger.
GPIB:	IEEE-488.

Other Exact Products

Racal-Dana markets a comprehensive range of Exact function, pulse and sweep generators. For full details contact Racal-Dana.

Giga Instrumentation

Giga Instrumentation specializes in the design and manufacture of sophisticated, high performance microwave test equipment. The Giga range of microwave signal generators is the most comprehensive and diverse available. The company was founded in 1976 and has grown to be a leading European manufacturer of microwave test equipment for radar and telecommunication applications. Giga and Racal-Dana have established a long lasting relationship in marketing these high quality products in the U.K.

GR 1100/1300 Series Pulse Modulated Signal Generators

The GR 1100A and GR 1300A series of signal generators have been designed specifically for use in the fields of ground, air and marine radar design and testing. The series covers the frequency range from 1GHz to 18GHz with narrow and wideband units.

The GR 1100A and GR 1300A incorporate YIG tuned oscillators which ensure high performance, reliability and precision in frequency settability. The YIG oscillator also eliminates the need for moving parts with associated play, leakage, microphony and weight.

The output frequency can be set to within 100kHz and the excellent stability permits measurements on narrow band receivers without the need for readjustment.

The internal pulse modulator provides 60dB of carrier suppression (90dB with Option O4) and may be used in conjunction with the internal pulse generator or an external signal source. The internal pulse generator has variable repetition rate, delay and width all derived from a crystal reference. Pulse width may be adjusted down to less than 50nS with rise and fall times typically better than 10nS. Using an external signal, pulse widths of 10nS with rise and fall times of 5nS are obtainable.

An internal calibrator allows accurate output levels to be set at the far end of the test cable where it connects on to the unit under test rather than at the signal generator output.

Optional sweep and GPIB capabilities are available for both series of generators.

Frequency Range of Series:	1GHz – 18GHz.
Temperature Stability:	0.1MHz – 0.5MHz/°C (depending on model).
Stability over 5 minutes:	20ppm – 50ppm (depending on model).
Residual F.M.:	<15kHz.
Noise at offset of $10^{-4}\times$ carrier:	–100dBc/Hz.
Maximum Output Level:	Typically +10dBm (depending on model).
Output Impedance:	50Ω.
Pulse Modulation (internal):	
Repetition:	10μS to 99.999mS.
Delay:	<2μS to 999μS.
Width:	50nS to 100μS.
Rise and Fall Time:	<15nS.
Modulation (external):	External frequency and pulse modulation available.

GU 1200/1300 Series Universal Microwave Signal Generators

The GU 1200/1300 Microwave Signal Generators are lightweight, portable instruments employing highly advanced YIG oscillator technology. The GU 1200/1300 generators are available as narrow or wideband instruments providing a cost-effective solution to microwave signal generation problems.

These sophisticated generators are equipped with a 121dB variable attenuator and the ability to compensate for the frequency response of the output cable using slope correction. They also have the capability of setting accurate levels at the output end of the connecting cable. Modulation is available using the fixed 1kHz internal source or an external signal.

Options for use with the GU 1200/1300 include GPIB control of frequency and attenuation and a sweep capability offering narrow, octave and wideband sweeping. Also available is a 90dB Pulse Modulator which can be used with any suitable pulse generator to give very fast rise and fall times and narrow pulses making it ideal for radar applications. For applications requiring extra stability the GU 1200/1300 can be source locked to a suitable counter (see EIP section for further information).

These generators are ideally suited for use in testing microwave communications systems, components and radar systems.

Frequency Range: 10MHz to 26.5GHz.

Maximum Output Level: Up to 9dBm leveled depending on model.

Output Impedance: 50Ω.

Modulation: Amplitude and frequency modulation; Internal or External.

Amplitude Modulation: 30dB

Frequency Modulation: 100MHz deviation.

Options

GPIB: IEEE-488 or IEC-625.

Sweep: Using GW 1300.

Pulse Modulation: Using Option 46 or 48.

GP 2000 Programmable Microwave Sweep Generator

The GP 2000 Series comprises a range of microwave sweep generators covering the frequency range 10MHz to 26.5GHz. This new generation of sweep generators is microprocessor controlled to provide full programmability, a superb specification and ease of use.

The GP 2000 family is ideally suited for precision laboratory use as well as being excellent for incorporation into automatic test systems. Each generator has comprehensive internal and external sweep capabilities.

The GP 2000 series is equipped with internal and external leveling allowing accurate levels to be set at the generator output or at the end of the output cable. The instruments also have slope correction providing compensation for the frequency response of the cable. All output parameters are displayed on an alphanumeric display and a non-volatile memory allows complete front panel settings to be stored for rapid recall – an ideal feature for repetitive measurements.

Frequency Range: 10MHz to 26.5GHz.

Maximum Output Level: 8 to 12dBm leveled (depending on model).

Other Giga Products

GS1300 Series: Microwave Sweep Generators with a total frequency coverage of 1GHz to 18GHz

GX9001A: Large Screen XY Display

Oscilloquartz S.A.

OSA OSCILLOQUARTZ SA

Oscilloquartz S.A. is a research oriented engineering organisation engaged in the development and manufacture of electronic components, instruments and systems for all aspects of time and frequency control in telecommunications, navigation and metrology.

The Company's capabilities include standard and custom designed equipment to meet specific requirements in time and frequency management applications.

Oscilloquartz manufactures quartz crystal and cesium beam tube frequency sources that are among the most accurate and stable available.

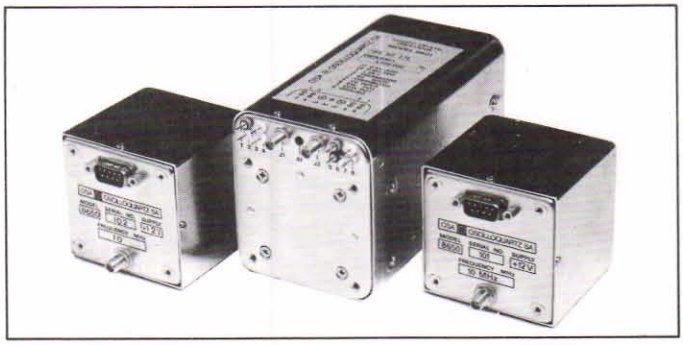
Model 3210 Cesium Frequency Standard

The Model 3210 Cesium Frequency Standard is a compact instrument package built around the 5MHz Model 3000 Cesium Frequency Source. The instrument includes a primary AC power supply and a secondary 24V DC battery with automatic battery charger, control circuits, monitoring instruments and indicators. The Model 3210 is also equipped with individual buffers for the 1, 5 and 10MHz frequency outputs.

For users with the need to generate and maintain an accurate time scale a clock module option is available generating a one-pulse-per-second output. There is also a lead acid stand-by battery option and a 100kHz output option available if required.

Accuracy:	$\pm 7 \times 10^{-12}$.
Long Term Stability:	$\pm 3 \times 10^{-12}$.
Settability:	$\pm 2 \times 10^{-13}$.
Reproducibility:	$\pm 3 \times 10^{-12}$.
Output Frequencies:	1, 5, 10MHz (100kHz Option).
Amplitude:	1V rms/50 ohms.
Harmonics:	−40dB.
Spurious:	−80dB (typically).

Oven controlled Crystal Oscillators



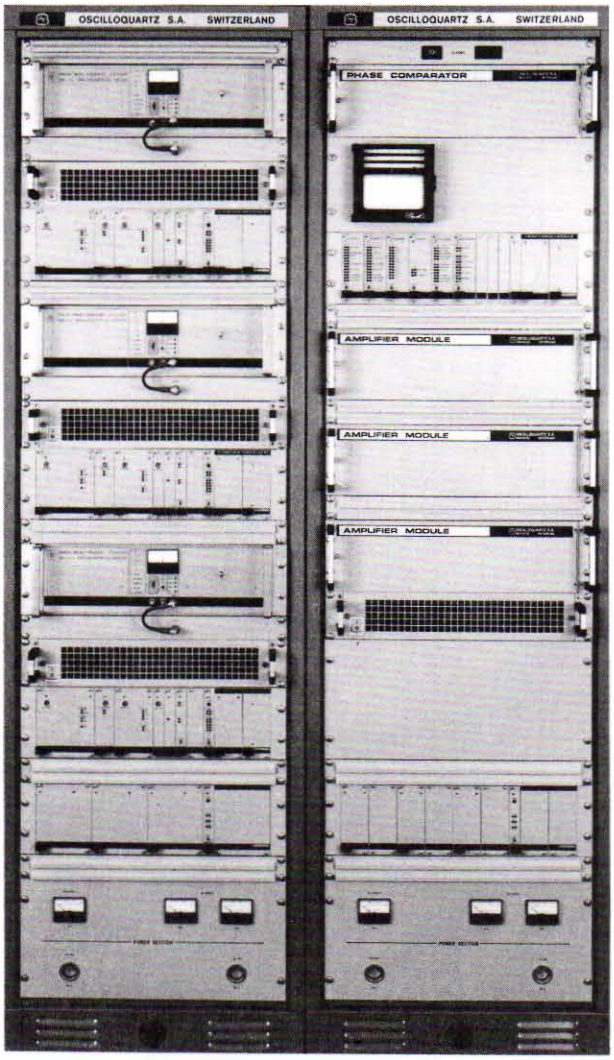
Oscilloquartz manufactures a comprehensive range of quartz crystal oscillators including a superb selection with the added advantage of oven control. The range offers a selection of frequencies, spectral purities, output levels, supply voltages, sizes, stabilities and prices – ensuring that there is a model to suit most applications.

Oscilloquartz employs a combination of advanced technology, dedicated craftsmanship and very low noise oscillator design to achieve the best short-term stability frequency sources available. These state-of-the-art oscillators have been used to refine the performance of multi-channel communications, phase-modulated data and Doppler radar systems.

Model	Freq. Range MHz	Aging	Operating Temp Range °C	Temp. Stability	Supply Voltage
B-1325	4-6	1.5×10^{-7}/yr 5×10^{-10}/day	−40 to +60	$<8\times10^{-9}$	+24V
B-1326	4-6	1.5×10^{-7}/yr 5×10^{-10}/day	−40 to +60	$<8\times10^{-9}$	+12V
8601	5	5×10^{-9}/yr 2×10^{-11}/day	−30 to +55	5×10^{-10}	+24V
8610/8611	4-7	$<3\times10^{-8}$/yr $<1\times10^{-10}$/day	−30 to +55	$<5\times10^{-10}$	+24V
8614	4-7	$<3\times10^{-8}$/yr $<1\times10^{-10}$/day	0 to +70	$<3\times10^{-9}$	+24V
8650/8655	4-16.384	$<1.5\times10^{-7}$/yr 5×10^{-10}/day	−40 to +70	$<8\times10^{-9}$	+24V
8651/8656	4-16.384	$<1.5\times10^{-7}$/yr 5×10^{-10}/day	−40 to +70	$<8\times10^{-9}$	+12V
8770	8-12 and 16-24	$<1.5\times10^{-7}$/yr 5×10^{-10}/day	−40 to +60	$<8\times10^{-9}$	+12V

Frequency Management Systems

OSA OSCILLOQUARTZ SA



Oscilloquartz expertise in the field of time and frequency standards allows the company to develop customized frequency management control and distribution for use in a wide range of systems.

The company's capacity to generate, maintain, compare and distribute stable frequencies and accurate time have been proven through established services with the telecommunications industry, the radio-navigation equipment industry, national time institutes, national metrological associations and a host of other industrial, aerospace and scientific organisations.

Other Oscilloquartz Products

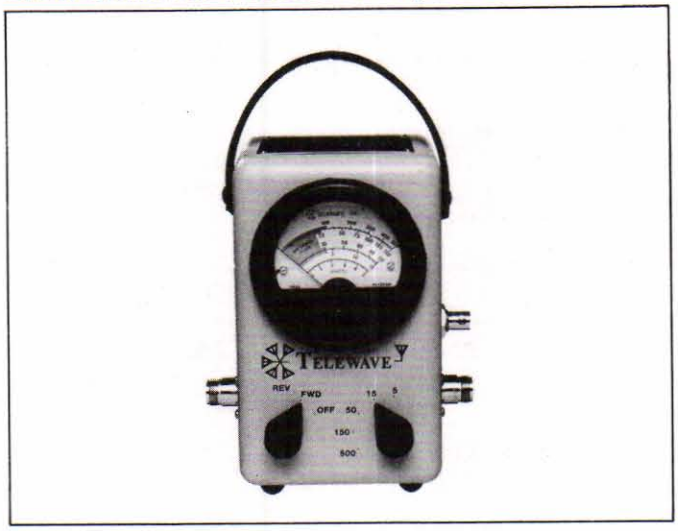
	Quartz Frequency Standards Temperature Controlled Crystal Oscillators
Model 5111:	Frequency Switching Module
Model 5210:	Linear Phase Comparator (3 channels)
Model 5211:	Linear Phase Comparator (4 channels)

Telewave Inc.

Telewave Inc. designs and manufactures master antenna systems, multicouplers and r.f. power monitoring equipment for the communications industry.

Located in Mountain View, California, in a modern 15,000 square foot factory, Telewave is dedicated to providing state-of-the-art equipment to satisfy the needs of the two-way communications market. The product line includes ferrite isolators, cavity filters, duplexers, amplifiers, receiver distribution systems, dual directional couplers, terminations and wattmeters.

Broadband RF Power Meter, Model 44AP



The Model 44AP RF Power Meter is a compact, versatile instrument for measurement of radio frequency power, giving direct readings of incident and reflected power. The wide band width and dynamic range of the instrument are achieved without inserts or bandswitching.

The 20μA Taut Band Meter movement provides the sensitivity needed to tune low power portables.

It is ideal for mobile radio installations in vehicles, aircraft or ships as well as base stations. The metal die-cast case is constructed to withstand rugged field use.

Description

The Model 44AP bi-directional power meter is a portable instrument used in measuring forward and reflected power in a coaxial transmission line under any load condition.

The Model 44AP is a wideband instrument covering a frequency band of 25MHz–1000MHz with a power range of 1 Watt to 500 Watts. The meter movement can be turned off when not in use. The case has a leather carrying strap for maximum portability.

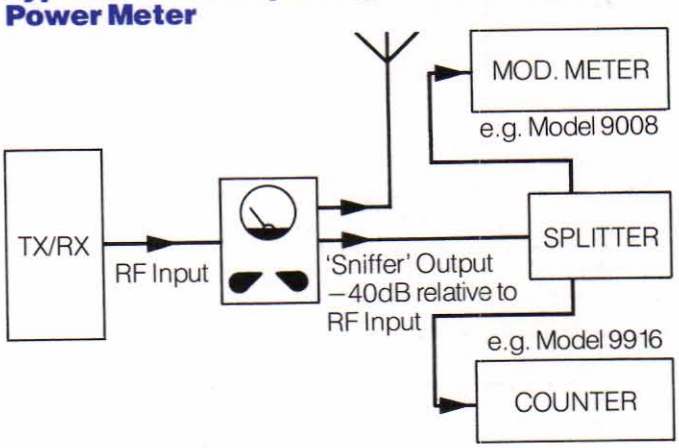
Operation

The Model 44AP has a built-in precision dual-directional detector which samples forward and reverse CW power flow in coaxial transmission lines. The sample current is scaled to drive the 20μA taut band meter. Incident and reflected power can easily be measured by rotating the FWD-REV switch. The Model 44AP can measure VSWR (Voltage Standing Wave Ratio) by comparing incident and reflected power measurements. A convenient chart on the rear of the meter converts these meter readings directly to VSWR.

Sniffer Output

Model 44AP is equipped with a 'sniffer' output to provide an attenuated signal for use by other measuring equipment. The signal from the BNC sniffer output is non-directional and at a level of −40dB relative to the RF input to the power meter. It may be fed directly to other instruments such as counters, modulation meters or osciloscopes for further signal analysis.

Typical test set-up using the Model 44AP Power Meter



Specifications

Power Ranges:	5, 15, 50, 150, 500 Watts
Line Impedance:	50Ω nominal
VSWR:	1.1:1 maximum
Accuracy:	6% from 25MHz to 1GHz (to 500MHz with UHF connectors). A calibration curve is used below 50MHz
Dimensions:	
Height	6⅝ inches (16.9cms)
Width	4 inches (10cms)
Depth	3¼ inches (8.3cms)
Weight:	3lb (1.4kg)

Accessories

Item	Model No.
Protective Carrying Case	TC 44
Dry Dielectric Loads, 35 Watt	TWL 35
Dry Dielectric Loads, 50 Watt	TWL 50
Dry Dielectric Loads, 75 Watt	TWL 75
Dry Dielectric Loads, 100 Watt	TWL 100
Dry Dielectric Loads, 150 Watt	TWL 150
Wet Dielectric Loads, 300 Watt	TWL 300

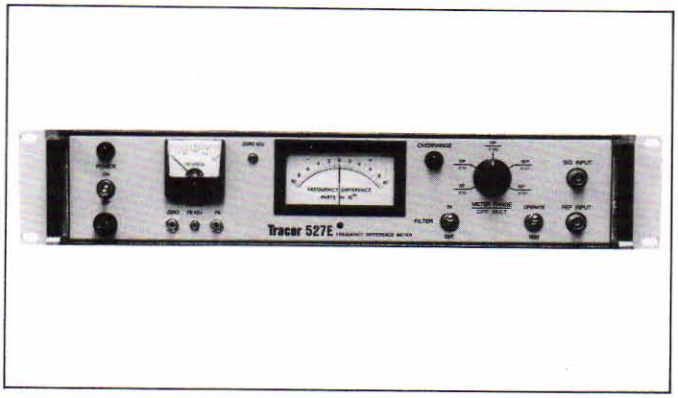
All loads operate DC to 1GHz

Connectors: All items are type N connectors as standard. If UHF connectors are required, order as Part Number/UHF

Tracor Instruments

Tracor, Inc., is an International Technological Products and Services Company, founded in 1955 as a multidisciplined research and development firm. The company has expanded its technological competence into compatible scientific, engineering, design, and production areas. Today, the company is a major technical contractor in sonar and communications programs, a leader in the development and production of passive electronic countermeasures systems and military telecommunications terminals, and a major manufacturer of scientific instruments and electrical and electromechanical components.

Model 527E Frequency Difference Meter



The Model 527E Frequency Difference Meter is designed for instant determination of the fractional frequency difference (FFD) between two stable frequency sources with an accuracy of one part in 10^{11}. This allows the 527E to be used to adjust the sources to the same frequency; to measure the difference in frequency between them; to offset one from the other by a specified amount and to characterize both long and short-term stability.

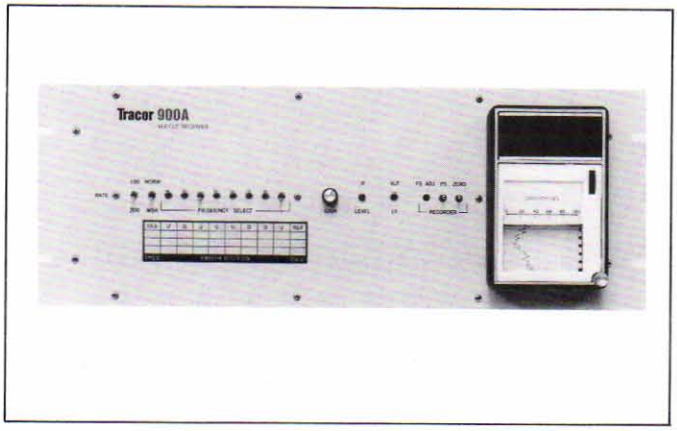
The FFD is displayed on a centre zero meter as parts in 10^7, 10^8, 10^9, 10^{10} or 10^{11}, as selected by the front panel range switch. A second front panel meter indicates the phase relationship between the two input signals with the FFD multiplied by 10, 100, 1,000, or 10,000, providing a fast, accurate means of monitoring adjustments to the frequency source.

There is an external recorder output providing a d.c. voltage proportional to the fractional frequency difference. This feature allows long-term monitoring of stability between two frequency standards.

Model 527E accepts input signals with nominal frequencies of 100kHz, 1MHz, 2.5MHz, 5MHz and 10MHz.

Input Frequencies:	100kHz, 1MHz, 2.5MHz, 5MHz and 10MHz (signal only – not reference)
Input Level:	0.5 to 10.0V rms
Output Frequencies:	1MHz derived from REF input 1MHz + 10^N ΔF signal input
Output Level:	2 volts peak-to-peak
Recorder Output:	DC current proportional to front panel meter reading
Indicators Frequency Meter:	Front panel, zero centre, scale from −10 to +10 parts in 10^N
Phase Meter:	The phase of the signal with multiplied differential error is shown with respect to the reference

Model 900A VLF/LF Receiver



The Model 900A VLF/LF Receiver compares the phase of a local frequency standard with the received carrier of a frequency stabilized transmitter. This approach provides the advantage of traceability to national standards with an accuracy of parts in 10^{11} over a 24 hour period. The 900A plots a phase record and provides all that is necessary for frequency comparison. It can be used worldwide and is the lowest-cost, most versatile receiver available.

Typical applications for the Model 900A include monitoring atomic standards against national standards, checking counter time-base accuracies and determining the offset and drift of crystal oscillators.

A wide variety of transmissions can be selected in the VLF band from 10kHz to 25kHz or in the LF band from 60kHz to 75kHz. Reception is not limited to one or two transmissions. The Model 900A Receiver is supplied complete with a roof mounting whip antenna unit, cable and a front panel chart recorder.

Frequency Coverage:	100Hz steps from 9.9kHz to 25.6kHz 100Hz steps from 59.9kHz to 75.6kHz
Sensitivity:	Will track a signal of 60μV/m minimum field strength
Phase Tracking Servo:	A versatile all-electronic phase tracking servo maintains phase shifted reference signal in phase null condition relative to the VLF carrier
Accuracy:	Typically 1×10^{-11} for a one day period
Frequency Standard Input:	1MHz 0.5 to 5.0V standard (100kHz optional)

Technical Information
Abbreviations

A

A—Ampere
AC—Alternating current
AF—Audio frequency
AGC—Automatic gain control
AM—Amplitude Modulation
ANSCII—American National Standards Committee for Information Interchange
ANSI—American National Standards Institute
ATE—Automatic Test Equipment

B

BCD—Binary Coded Decimal

C

C—Celsius (Centigrade)
°C—Degrees Celsius
CDI—Collector diffusion isolation (semiconductor process)
cm—Centimeter
CMOS—Complementary metal oxide semiconductor
CW—Continuous wave (signal)
CMR—Common mode rejection
CMV—Common mode voltage

D

D—Depth
DAC—Digital to analog converter
dB—Decibel
dBc—Decibels below the carrier
dBm—Decibels referenced to 1 mW
dBv—Decibels referenced to 1 volt
DC—Direct current
DMM—Digital Multimeter
DVM—Digital Voltmeter

E

EAROM—Electrically alterable read only memory
ECM—Exchangeable calibration module
EEPROM—Eraseable EPROM
ELF—Extra low frequency (<3 kHz)
EMC—Electro-magnetic compatibility
EMI—Electro-magnetic interference (conducted or radiated)
EPROM—Electrically programmable read-only memory

F

f—Frequency
F—Farad
FM—Frequency modulation
FS—Full scale
FSD—Full scale deflection
FSK—Frequency shift keying

G

g—Gram
G—Giga
GΩ—Gigohm
GHz—Gigahertz
GPIB—General Purpose Interface Bus

H

H—Height
HEX—Hexadecimal
HF—High frequency (3-30 MHz)
HLL—High, low limit
HSD—High speed digitizer
Hz—Hertz

I

I—Current
IEEE—Institute of Electrical and Electronic Engineers
IEC—International Electro-Technical Commission
IF—Intermediate Frequency
ILS—Instrument landing system

J

K

k—Kilo
kg—Kilogram
kHz—Kilohertz
kΩ—Kilohm
kV—Kilovolt
kW—Kilowatt

L

LAH—Low, average, high
lb—Pound
LCD—Liquid crystal display
LED—Light emitting diode
LF—Low frequency, (30-300 kHz)
LSI—Large scale integration

M

m—Meters
m—Milli
M—Mega
mA—Milliampere
MAM—Maximum, average, minimum
max.—maximum
MEP—Microprocessor enhanced performance
mF—Millifarads
MF—Medium Frequency
mH—Millihenries
mHz—Millihertz
MHz—Megahertz
min.—minimum
mm—Millimeter
mΩ—Milliohm
MΩ—Megohm
MPU—Microprocessor Unit
mSec—Millisecond
MTBF—Mean time between failures
MTTR—Mean time to repair
mV—Millivolt
mW—Milliwatt

N

n—Nano
nA—Nanoampere
Ni-Cad—Nickel cadmium
nSec—Nanosecond
nV—Nanovolt

O

OEM—Original equipment manufacturer
Opt.—Optional

P

p—Pico or peak
pA—Picoampere
pF—Picofarad
PCM—Pulse coded modulation
p-p—Peak to peak
ppm—Parts per million
PRF—Pulse repetition frequency
pSec—Picosecond
Pin Diode—Current controlled RF resistor

Q

R

RAM—Random access memory
Ref.—Reference
RF—Radio Frequency
RFI—Radio frequency interference
RH—Relative Humidity
rms—Root mean square
ROM—Read only memory

S

Sec—Second
SHF—Super high frequency (>3 GHz)
SINAD—Signal to noise and distortion
S/N—Signal-to-noise ratio
SSB—Single side band
STD—Standard
SWR—Standing Wave Ratio

T

T.C.—Temperature Coefficient
TCXO—Temp. compensated XTAL oscillator
Temp.—Temperature
THD—Total harmonic distortion
TI—Time interval
True rms—rms value regardless of shape or form factor
TTL—Transistor-Transistor logic

U

μ—Micro
UCT—Universal Counter Timer
ULA—Universal logic array
UHF—Ultra high frequency (>300 MHz)

V

V—Volt
VA—Voltampere
VAC—AC Volts
VHF—Very high frequency (30-300 MHz)
VLF—Very low frequency (3-30 kHz)
Vp—Peak volts
Vp-p—Volts, peak-to-peak
VSW—Voltage standing wave
VSWR—Voltage Standing Wave Ratio

W

W—Width
W—Watts

X, Y, Z

XTAL—crystal
Z-Axis—(On oscilloscope) intensity modulation

Digital Multimeter

Autopolarity—The polarity of the applied DC voltage or current with respect to the common terminal is automatically indicated.

Autozero—Residual zero voltage, current, or resistance error is automatically detected and minimized.

Common Mode Rejection—CMR

Pure CMR—Ratio of common mode voltage and amount of CMV converted to normal-mode voltage (expressed in dB)

Effective CMR—Ratio of CMV and reading error produced (expressed in dB)

Common Mode Voltage—CMV Voltage common to both inputs (usually measured between inputs and chassis ground)

Crest Factor—Ratio of peak value of signal divided by rms value of signal. Symmetrical square waves equal 1:1 and sinewaves equal 1.4:1.

dB—Decibel. A unit used to express the magnitude of a change in, or ratio of, signals or sound levels.

dBm—Decibel referenced to one milliwatt. A power level equal to ten times the common logarithm of the ratio of a given power (Px), in watts, to 0.001 watt: dBm = 10 log (Px ÷ 0.001)

Four Terminal Ohms—A method for making accurate low resistance measurements. In the four-terminal method, the current source and voltage measurement terminals are separate. This eliminates the test lead resistance.

Guard—An electrostatic shield which surrounds the active circuitry of a guarded instrument. It is used to reduce common mode currents and thereby increase the common mode rejection.

MTBF—Mean time between failure

Normal Mode Rejection—Ability to measure the DC component of a signal which contains both AC and DC

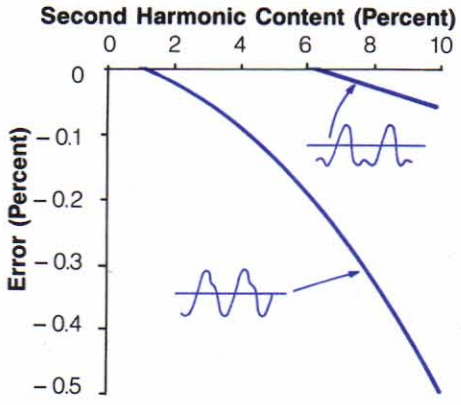
Offset Current—Current flowing into or out of the input terminals

Overrange—Capability to measure beyond a range of 1, 10, 100, 1000, etc. without having to change to the next higher range and thereby sacrifice resolution. For example, a voltmeter that can measure up to 1.2 volts on the 1V range has 20% overrange for that range.

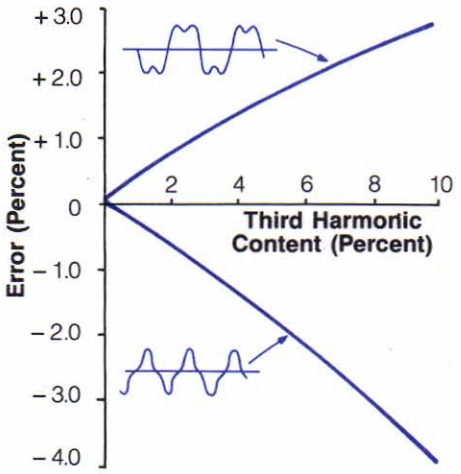
Resolution—The magnitude of input signal required to make one digit change in the least significant display numeral.

True rms—Capability of measuring AC signals to obtain the effective heating value. The rms value of an AC waveform is equivalent to the DC value which would produce the same heating in a purely resistive load. A True rms circuit makes accurate measurements even if the waveform is nonsinusoidal.

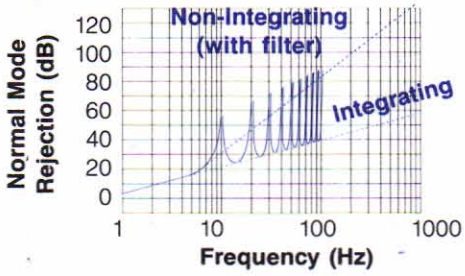
Voltage Burden—Voltage drop across the input terminals when measuring current. Caused by the finite input shunt resistance plus contact resistance.



Theoretical error in the output of an average-responding converter, produced by second-harmonic distortion.



Theoretical error in the output of an average-responding converter, produced by third-harmonic distortion.



Normal mode noise rejection for two DVMs, one using filtering and the other using integration.

Electronic Counters

Accuracy—In direct and prescaled counters, the accuracy is usually ±1 count + reference (timebase) error. Therefore, more digits in the display means better accuracy.

Timebase Error—Three factors affect the timebase error: aging rate, temperature stability, and voltage stability.

Aging Rate—The change in reference frequency over a period of time. This time is usually one day or one month.

1×10^7 per month means that the 10 MHz reference frequency will change 1 Hz in one month with constant line voltage and temperature.

Temperature stability—The change in frequency due to temperature. This may be expressed in Δ/°C or as change over a temperature range.

Voltage stability—The change in reference frequency due to changes in line voltage.

In order to establish the absolute accuracy of the counter you must know the accuracy of the frequency standard to which it was calibrated, temperature range over which it is to be used, line voltage from which it will operate, and time elapsed since last calibration. Worst case would be a summation of all these errors.

Sensitivity—Sensitivity is defined as the lowest input voltage on which the counter will trigger.

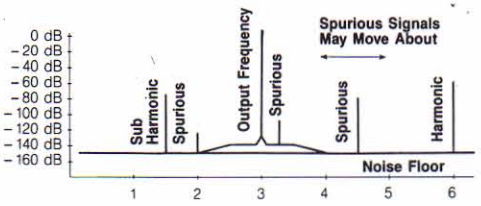
Time Interval Trigger Error—Trigger errors on time interval measurements are a function of the input wave shape, trigger level resolution and trigger level stability.

Signal Generators and Synthesizers

Noise Specifications—Noise specifications are broken into four separate types. Each type of noise can affect the output and your application differently.

Harmonic Signals—The amplitude of harmonics of the output frequency present on the output. Such harmonics are always in fixed relationship to the output frequency. They often fall outside the bandwidth of the circuitry being driven.

Spurious Signals (Non-Harmonic)—Technically both harmonic and non-harmonic signals may be called spurious noise. However, the term "Spurious signals" has come to refer to only the non-harmonically related spurious outputs. This type of noise is the most troublesome. Since it may appear anywhere in the spectrum, its frequency is not predictable and may be very close to the output frequency of the synthesizer. Since it may appear within the bandwidth of the equipment being driven by the synthesizer, most applications demand very low spurious signals.

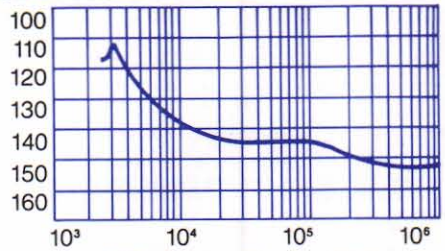


Technical Information
Terms and Definitions

Phase Noise—Phase noise is associated with the short-term stability of a frequency source and is the phase modulation due to random noise. The agreed convention for specifying phase noise is the single sideband (SSB) noise measured in a bandwidth of 1 Hz at various offsets from the carrier frequency. These offsets are usually represented on a log scale on the horizontal axis with the amount of noise specified in dB relative to the level of the carrier. Figure 101 shows the phase noise of the Racal-Dana Model 9084 Signal Generator versus offset from output frequency.

Typical SSB Phase Noise at 10 MHz Carrier Frequency

SSB Phase Noise dB/Hz



Offset from Carrier (Hz)
Figure 101

In applications requiring precise phase control and short-term stability, this can be an important specification.

AM Noise—The effect of amplitude modulation of the output signal. This creates sideband noise on both sides of the output frequency. It is non-harmonic and within a narrow bandwidth around the output frequency.

Settling Time—Settling time is defined as the time it takes the output to move from a previous output frequency to a newly selected frequency.

Modulation—The ability to modulate the frequency synthesizer creates a synthesized signal generator. There are four types of modulation.

1. Phase—Carrier phase is modulated by audio or digital signal
2. Frequency—Carrier frequency is modulated by audio or digital signal
3. Amplitude—Carrier amplitude is modulated by audio signal
4. Pulse—Carrier amplitude is modulated on and off by a pulse signal.

Stabilities—Instabilities are changes in output due to time, temperature, or line voltage changes.

Frequency Stabilities—Frequency stabilities are directly dependent upon the reference oscillator and are specified exactly as those used in counters.

Phase Stabilities—Phase stabilities are a measure of phase change with a constant frequency and are generally specified as peak or RMS Phase jitter in degrees or radians.

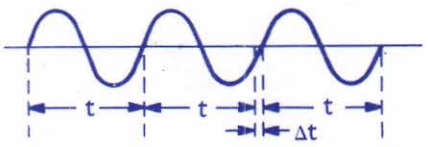


Figure 105

Figure 105 shows an exaggerated example of phase instability. Cycle 1 is used as a reference cycle to establish t. Note that the second cycle took t + Δt time. The total time of 3 cycles was 3t, so the frequency had not changed (long-term), only the phase at the 4th zero crossing.

Amplitude—Amplitude instabilities are of little importance in frequency synthesizers unless of a rate high enough to be considered AM noise.

More important is the frequency response of the output. This may cause major changes in the output voltage as the frequency is programmed over its range.

VSWR Conversions

This table is made up of seven columns as follows:

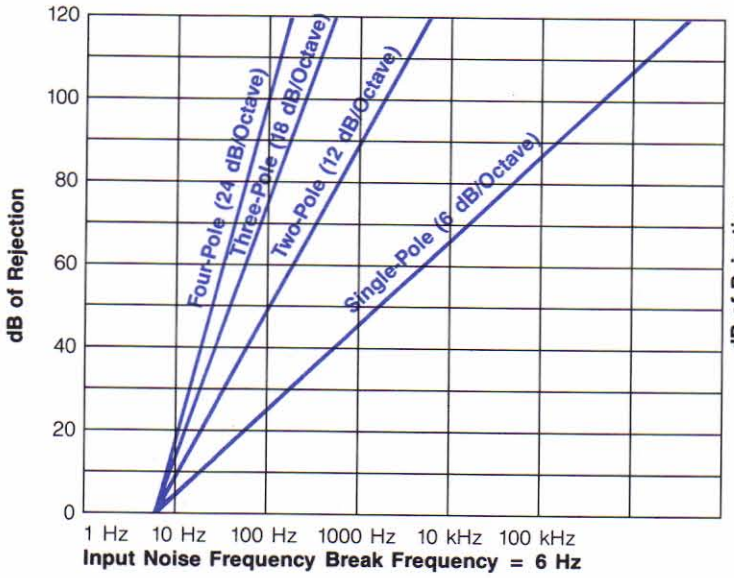
1. VSWR is voltage standing wave ratio coefficient:
2. VSWR (dB) = $20 \log_{10}$ (VSWR).
3. K is the absolute value of the reflection

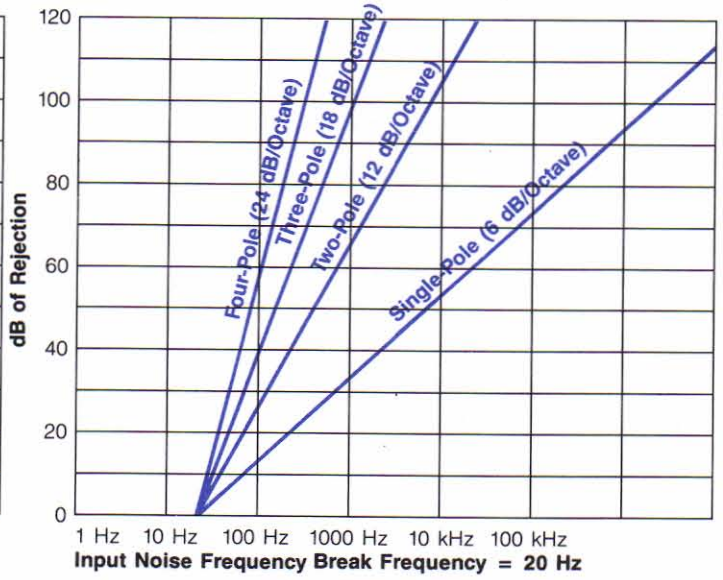
$$K = \frac{VSWR - 1}{VSWR + 1}$$

4. Return loss, K (dB) = $20 \log_{10}$ (1/K).
5. K^2 is the power reflection coefficient (fraction of power reflected).
6. $1 - K^2$ is the fraction of power transmitted.
7. $1 - K^2$ (dB) = $10 \log_{10} (1 - K^2)$.

VSWR	VSWR (dB)	K	K (dB)	K^2	$1-K^2$	$1-K^2$ (dB)
1.000	0.000	0.0000	∞	0.00000	1.00000	0.0000
1.001	.008361	.000490	66.20	.0000002	.9999998	.000089
1.002	.017077	.000999	60.01	.0000010	.9999990	.000089
1.003	.025793	.001498	56.49	.0000022	.9999978	.000089
1.004	.034332	.001996	54.00	.0000040	.9999960	.000089
1.005	.043049	.002494	52.06	.0000062	.9999938	.000089
1.006	.051765	.002991	50.48	.0000090	.9999910	.000089
1.007	.060304	.003488	49.15	.0000122	.9999872	.000089
1.008	.069020	.003984	47.99	.0000159	.9999841	.000089
1.009	.077559	.004480	46.97	.0000201	.9999799	.000089
1.010	.086	.0050	46.02	.00003	.99997	.0001
1.020	.173	.0099	40.09	.00010	.99990	.0004
1.030	.256	.0148	36.60	.00022	.99978	.001
1.040	.340	.0196	34.15	.00038	.99962	.002
1.050	.424	.0244	32.25	.00060	.99940	.003
1.060	.506	.0291	30.72	.00085	.99915	.004
1.070	.588	.0338	29.42	.00114	.99886	.005
1.080	.668	.0385	28.29	.00148	.99852	.006
1.090	.749	.0431	27.31	.00186	.99814	.008
1.100	.828	.0476	26.45	.00227	.99773	.010
1.110	.906	.0521	25.68	.00271	.99729	.012
1.120	.984	.0566	24.94	.00320	.99680	.014
1.130	1.062	.0610	24.29	.00372	.99628	.017
1.140	1.138	.0654	23.69	.00428	.99572	.019
1.150	1.214	.0698	23.12	.00487	.99513	.021
1.160	1.289	.0741	22.60	.00549	.99451	.024
1.170	1.364	.0783	22.12	.00613	.99387	.027
1.180	1.438	.0826	21.66	.00682	.99318	.030
1.190	1.511	.0868	21.23	.00753	.99247	.033
1.200	1.584	.0909	20.83	.00826	.99174	.036
1.210	1.656	.0950	20.44	.00903	.99097	.039
1.220	1.727	.0991	20.08	.00982	.99018	.043
1.230	1.798	.1031	19.73	.01063	.98937	.046
1.240	1.868	.1071	19.40	.01147	.98853	.050
1.250	1.938	.1111	19.09	.01234	.98766	.054
1.260	2.007	.1150	18.78	.01323	.98677	.058
1.270	2.076	.1189	18.49	.01414	.98586	.062
1.280	2.144	.1228	18.22	.01508	.98492	.066
1.290	2.212	.1266	17.51	.01603	.98397	.070
1.300	2.278	.1304	17.70	.01700	.98300	.074
1.310	2.345	.1342	17.44	.01801	.98199	.079
1.320	2.411	.1379	17.21	.01902	.98098	.083
1.330	2.477	.1416	16.98	.02005	.97995	.088
1.340	2.542	.1453	16.76	.02111	.97889	.093
1.350	2.607	.1489	16.54	.02217	.97783	.097

Technical Information
Digital Multimeter Filters
Noise Rejection Characteristics

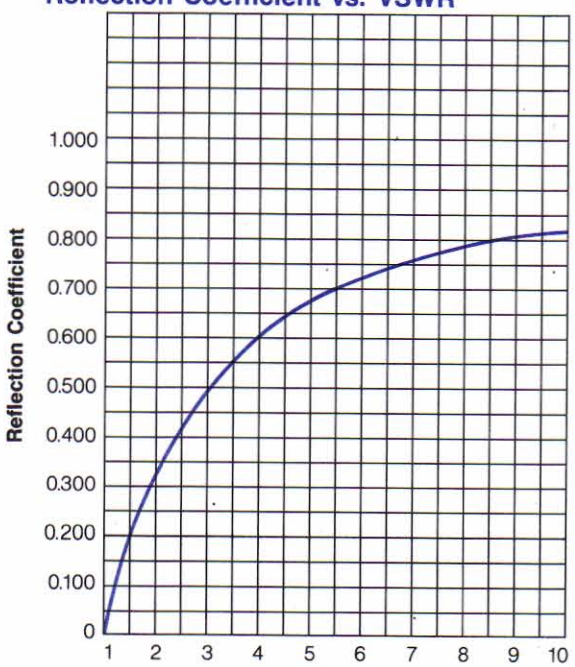




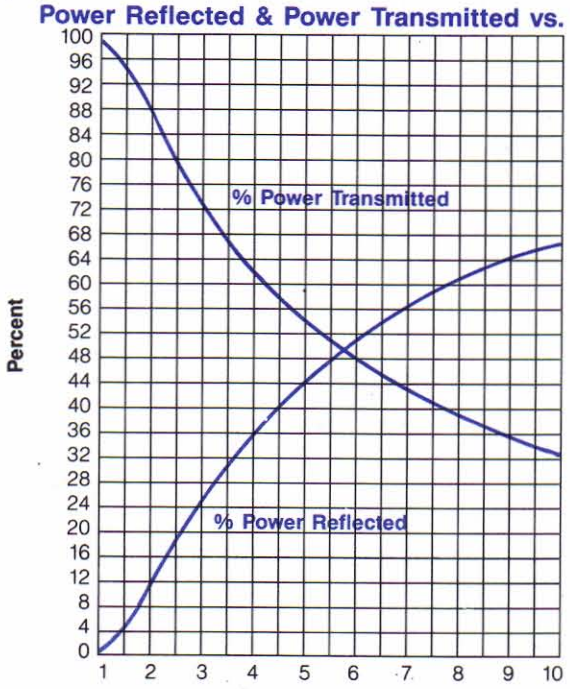
VSWR as a Function of Power Loss

VSWR Conversions

Reflection Coefficient vs. VSWR



Power Reflected & Power Transmitted vs. VSWR



Technical Information
Voltage and Power Ratios to Decibels

The basic chart below indicates the number of decibels (dB) corresponding to the listed ratios of voltage or power over the range of −20 to +20 dB. For voltage or power ratios greater than those included in the chart, the ratio can be broken down into a product of two numbers, the value in dB for each found separately, and the two results added.

In the lower right-hand corner of the chart dB values for voltage and power ratios of integral powers of 10 are given.

Voltage Ratio	Power Ratio	−dB+	Voltage Ratio	Power Ratio	Voltage Ratio	Power Ratio	−dB+	Voltage Ratio	Power Ratio	Voltage Ratio	Power Ratio	−dB+	Voltage Ratio	Power Ratio
1.000	1.000	0	1.000	1.000	.447	.200	7.0	2.239	5.012	.200	.0398	14.0	5.012	25.12
.989	.977	0.1	1.012	1.023	.442	.195	7.1	2.265	5.129	.197	.0389	14.1	5.070	25.70
.977	.955	0.2	1.023	1.047	.437	.191	7.2	2.291	5.248	.195	.0380	14.2	5.129	26.30
.966	.933	0.3	1.035	1.072	.432	.186	7.3	2.317	5.370	.193	.0372	14.3	5.188	26.92
.955	.912	0.4	1.047	1.096	.427	.182	7.4	2.344	5.495	.191	.0363	14.4	5.248	27.54
.944	.891	0.5	1.059	1.122	.422	.178	7.5	2.371	5.623	.188	.0355	14.5	5.309	28.18
.933	.871	0.6	1.072	1.148	.417	.174	7.6	2.399	5.754	.186	.0347	14.6	5.370	28.84
.923	.851	0.7	1.084	1.175	.412	.170	7.7	2.427	5.888	.184	.0339	14.7	5.433	29.51
.912	.832	0.8	1.096	1.202	.407	.166	7.8	2.455	6.026	.182	.0331	14.8	5.495	30.20
.902	.813	0.9	1.109	1.230	.403	.162	7.9	2.483	6.166	.180	.0324	14.9	5.559	30.90
.891	.794	1.0	1.122	1.259	.398	.159	8.0	2.512	6.310	.178	.0316	15.0	5.623	31.62
.881	.776	1.1	1.135	1.288	.394	.155	8.1	2.541	6.457	.176	.0309	15.1	5.689	32.36
.871	.759	1.2	1.148	1.318	.389	.151	8.2	2.570	6.607	.174	.0302	15.2	5.754	33.11
.861	.741	1.3	1.161	1.349	.385	.148	8.3	2.600	6.761	.172	.0295	15.3	5.821	33.88
.851	.724	1.4	1.175	1.380	.380	.145	8.4	2.630	6.918	.170	.0288	15.4	5.888	34.67
.841	.708	1.5	1.189	1.413	.376	.141	8.5	2.661	7.079	.168	.0282	15.5	5.957	35.48
.832	.692	1.6	1.202	1.445	.372	.138	8.6	2.692	7.244	.166	.0275	15.6	6.026	36.31
.822	.676	1.7	1.216	1.479	.367	.135	8.7	2.723	7.413	.164	.0269	15.7	6.095	37.15
.813	.661	1.8	1.230	1.514	.363	.132	8.8	2.754	7.586	.162	.0263	15.8	6.166	38.02
.804	.646	1.9	1.245	1.549	.359	.129	8.9	2.786	7.762	.160	.0257	15.9	6.237	38.90
.794	.631	2.0	1.259	1.585	.355	.126	9.0	2.818	7.943	.159	.0251	16.0	6.310	39.81
.785	.617	2.1	1.274	1.622	.351	.123	9.1	2.851	8.128	.157	.0246	16.1	6.383	40.74
.776	.603	2.2	1.288	1.660	.347	.120	9.2	2.884	8.318	.155	.0240	16.2	6.457	41.69
.767	.589	2.3	1.303	1.698	.343	.118	9.3	2.917	8.511	.153	.0234	16.3	6.531	42.66
.759	.575	2.4	1.318	1.738	.339	.115	9.4	2.951	8.710	.151	.0229	16.4	6.607	43.65
.750	.562	2.5	1.334	1.778	.335	.112	9.5	2.985	8.913	.150	.0224	16.5	6.683	44.67
.741	.550	2.6	1.349	1.820	.331	.110	9.6	3.020	9.120	.148	.0219	16.6	6.761	45.71
.733	.537	2.7	1.365	1.862	.327	.107	9.7	3.055	9.333	.146	.0214	16.7	6.839	46.77
.724	.525	2.8	1.380	1.905	.324	.105	9.8	3.090	9.550	.145	.0209	16.8	6.918	47.86
.716	.513	2.9	1.396	1.950	.320	.102	9.9	3.126	9.772	.143	.0204	16.9	6.998	48.98
.708	.501	3.0	1.413	1.995	.316	.100	10.0	3.162	10.00	.141	.0200	17.0	7.079	50.12
.700	.490	3.1	1.429	2.042	.313	.0977	10.1	3.199	10.23	.140	.0195	17.1	7.151	51.29
.692	.479	3.2	1.445	2.089	.309	.0955	10.2	3.236	10.47	.138	.0191	17.2	7.244	52.48
.684	.468	3.3	1.462	2.138	.306	.0933	10.3	3.273	10.72	.137	.0186	17.3	7.328	53.70
.676	.457	3.4	1.479	2.188	.302	.0912	10.4	3.311	10.96	.135	.0182	17.4	7.413	54.95
.668	.447	3.5	1.496	2.239	.299	.0891	10.5	3.350	11.22	.133	.0178	17.5	7.499	56.23
.661	.437	3.6	1.514	2.291	.295	.0871	10.6	3.388	11.48	.132	.0174	17.6	7.586	57.54
.653	.427	3.7	1.531	2.344	.292	.0851	10.7	3.428	11.75	.130	.0170	17.7	7.674	58.88
.646	.417	3.8	1.549	2.399	.288	.0832	10.8	3.467	12.02	.129	.0166	17.8	7.762	60.26
.638	.407	3.9	1.567	2.455	.285	.0813	10.9	3.508	12.30	.127	.0162	17.9	7.852	61.66
.631	.398	4.0	1.585	2.512	.282	.0794	11.0	3.548	12.59	.126	.0159	18.0	7.943	63.10
.624	.389	4.1	1.603	2.570	.279	.0776	11.1	3.589	12.88	.125	.0155	18.1	8.035	64.57
.617	.380	4.2	1.622	2.630	.275	.0759	11.2	3.631	13.18	.123	.0151	18.2	8.128	66.07
.610	.372	4.3	1.641	2.692	.272	.0741	11.3	3.673	13.49	.122	.0148	18.3	8.222	67.61
.603	.363	4.4	1.660	2.754	.269	.0724	11.4	3.715	13.80	.120	.0145	18.4	8.318	69.18
.596	.355	4.5	1.679	2.818	.266	.0708	11.5	3.758	14.13	.119	.0141	18.5	8.414	70.79
.589	.347	4.6	1.698	2.884	.263	.0692	11.6	3.802	14.45	.118	.0138	18.6	8.511	72.44
.582	.339	4.7	1.718	2.951	.260	.0676	11.7	3.845	14.79	.116	.0135	18.7	8.610	74.13
.575	.331	4.8	1.738	3.020	.257	.0661	11.8	3.890	15.14	.115	.0132	18.8	8.710	75.86
.569	.324	4.9	1.758	3.090	.254	.0646	11.9	3.936	15.49	.114	.0129	18.9	8.811	77.62
.562	.316	5.0	1.778	3.162	.251	.0631	12.0	3.981	15.85	.112	.0126	19.0	8.913	79.43
.556	.309	5.1	1.799	3.236	.248	.0617	12.1	4.027	16.22	.111	.0123	19.1	9.016	81.28
.550	.302	5.2	1.820	3.311	.246	.0603	12.2	4.074	16.60	.110	.0120	19.2	9.120	83.18
.543	.295	5.3	1.841	3.388	.243	.0589	12.3	4.121	16.98	.108	.0118	19.3	9.226	85.11
.537	.288	5.4	1.862	3.467	.240	.0575	12.4	4.169	17.38	.107	.0115	19.4	9.333	87.10
.531	.282	5.5	1.884	3.548	.237	.0562	12.5	4.217	17.78	.106	.0112	19.5	9.441	89.13
.525	.275	5.6	1.905	3.631	.234	.0550	12.6	4.266	18.20	.105	.0110	19.6	9.550	91.20
.519	.269	5.7	1.928	3.715	.232	.0537	12.7	4.315	18.62	.104	.0107	19.7	9.661	93.33
.513	.263	5.8	1.950	3.802	.229	.0525	12.8	4.365	19.05	.102	.0105	19.8	9.772	95.50
.507	.257	5.9	1.972	3.890	.227	.0513	12.9	4.416	19.50	.101	.0102	19.9	9.886	97.72
.501	.251	6.0	1.995	3.981	.224	.0501	13.0	4.467	19.95	.100	.0100	20.0	10.000	100.00
.496	.246	6.1	2.018	4.074	.221	.0490	13.1	4.519	20.42					
.490	.240	6.2	2.042	4.169	.219	.0479	13.2	4.571	20.89		10^{-3}	30		10^{3}
.484	.234	6.3	2.065	4.266	.216	.0468	13.3	4.624	21.38	10^{-2}	10^{-4}	40	10^{2}	10^{4}
.479	.229	6.4	2.089	4.365	.214	.0457	13.4	4.677	21.88					
.473	.224	6.5	2.113	4.467	.211	.0447	13.5	4.732	22.39		10^{-5}	50		10^{5}
.468	.219	6.6	2.138	4.571	.209	.0437	13.6	4.786	22.91	10^{-3}	10^{-6}	60	10^{3}	10^{6}
.462	.214	6.7	2.163	4.677	.207	.0427	13.7	4.842	23.44		10^{-7}	70		10^{7}
.457	.209	6.8	2.188	4.786	.204	.0417	13.8	4.898	23.99	10^{-4}	10^{-8}	80	10^{4}	10^{8}
.452	.204	6.9	2.213	4.898	.202	.0407	13.9	4.955	24.55		10^{-9}	90		10^{9}
										10^{-5}	10^{-10}	100	10^{5}	10^{10}
											10^{-11}	110		10^{11}
										10^{-6}	10^{-12}	120	10^{6}	10^{12}

Assistance

Racal-Dana is committed to providing convenient local support and individual attention to customer needs on a worldwide basis. Therefore, your primary access to the resources of our company is through your local Racal-Dana sales office or representative.

The salesmen and field engineers in your local office are trained and equipped to provide you with pre-sale assistance in product selection, as well as information regarding current product availability and price at your location. Demonstration at your facility of a particular instrument may be conveniently arranged. Moreover, technical assistance in selecting equipment and preparing orders is available from personnel at these local offices who are backed by a highly qualified staff of application engineers at our factory locations.

Placing Your Order

We want to be sure the product delivered to you is exactly the one you want. When placing your order, please specify the complete model, option, accessory, or part number as well as the products name. Be sure to include full information on all desired options and accessories. You may list options as separate items on your purchase order, or you may combine the basic model and option numbers as a single item. Please be sure in either case to provide a complete description of the product and options desired.

U.S.A.

All orders should be made out to:

Racal-Dana Instruments Inc.
P.O. Box C-19541
Irvine, California 92713 U.S.A.
Phone: (714) 859-8999
TWX: 910-595-1136
Telex: 678341

You may mail your order direct to our factory or to your local Racal-Dana sales office or representative.

United Kingdom

All orders should be addressed to:

Racal-Dana Instruments Ltd.
Duke Street
Windsor, Berkshire SL4 1SB
United Kingdom
Phone: Windsor (07535) 68101
Telex: 847013

France

All orders should be addressed to:

Racal-Dana Instruments S.A.
18 Avenue Dutartre
78150 Le Chesnay
France
Phone: (3) 955 8888
Telex: 697 215

Germany

All orders should be addressed to:

Racal-Dana Instruments GmbH
Hermannstrasse 29
D-6078 Neu Isenburg
Federal Republic of Germany
Phone: (06102) 2861/2
Telex: 412896

Italy

All orders should be addressed to:

Racal-Dana Instruments Italia srl
20138 Milano MI, Via Mecenate 84/A, Italy
Phone: (02) 5062767/5052686/503444.
Telex: 315697

Other Countries

Please place your orders through your local Racal-Dana representative. He is equipped to supply the details of your local ordering procedures.

If you wish to contact Racal-Dana directly you may contact either of our manufacturing locations below.

Racal-Dana Instruments Inc.
4 Goodyear Street
P.O. Box C-19541
Irvine, California 92713
U.S.A.
Phone: (714) 859-8999
TWX: 910-595-1136
Telex: 678341

Racal Dana Instruments Ltd.
Duke Street
Windsor, Berkshire SL4 1SB
England
Phone: Windsor (07535) 68101
Telex: 847013

Special Instruments

Many Racal-Dana instruments can be supplied with special paint, altered specifications, non-standard connectors, or other special features. Contact your local Racal-Dana sales office with details of your specific requirements.

Product and Specifications Changes

Product information and illustrations in this catalog are current at the time of printing. Racal-Dana's policy is one of continuous development, and consequently the company reserves the right to vary from the descriptions and specifications in this publication.

Ordering Information

Calibration Certification

Calibration certificates and test data traceable to national standards are available on special request. Racal-Dana products are traceable to the National Bureau of Standards per MIL-C-45662A.

Warranty

Racal-Dana products are warranteed against defects in materials and workmanship. Most products are warranteed for one year. 99 Hundred Series products have a 2-year warranty on all components and a lifetime warranty on the CDI/LSI chip.

Racal-Dana Instruments will, at our option, repair or replace your instrument during its warranty period if it is in any way defective in material or workmanship. All parts and labor charges will be paid by Racal-Dana Instruments. Just call Product Service for assistance. We will advise the proper shipping address for your prepaid shipment.

Shipping Methods

Unless otherwise specified, most products will be shipped by land transportation.

For your convenience, we suggest that you specify shipping method when entering your order. Since many of our products are lightweight, you may wish to authorize air shipments.

Terms—U.S.A., U.K., France, Germany, Italy

Racal-Dana's terms are Net 30 days upon approved credit. Unless credit has already been established, shipments will be made C.O.D. or on receipt of cash in advance.

Other Countries

Contact your local Racal-Dana representative for local terms. For orders placed directly to Racal-Dana, terms are an irrevocable letter of credit or cash in advance unless other terms have been previously arranged.

Prices

Any price information supplied with this catalog is for budgetary guidance and is subject to change without notice. Contact your local Racal-Dana sales office, or representative, for current price and delivery information.

For budgetary purposes, request a Racal-Dana price list from your local sales office.

U.S. Government Sales

Most instruments in this catalog are available on General Services Administration Contracts in FSC Group 66, Part II, Sections I and J, FSC Clas 6625, Item #66-14; 66-15 (a); 66-15 (b); 66-15 (f); 66-15 (h).

Customers authorized to purchase against GSA contracts should request copies of our GSA Catalog and Authorized Federal Supply Schedule Price List.

Government and Military Customers

Many of the Racal-Dana products carry NATO stock numbers, National Stock numbers, and other government or military designations. Many products are designed to meet MIL, BS, IEC, and VDE Specifications. Contact your local Racal-Dana Sales office for details. Full provisioning, nomenclature, and replacement-by-model information is available on request.

Racal
The Electronics Group

RACAL

Racal-Dana is the specialist test instrument and systems company within the Racal Electronics Group, one of the fastest-growing electronics groups anywhere in the world.

Racal was formed in 1950 when two men, Raymond Brown and Calder Cunningham set up a consultancy service for planning radio communications systems.

Since then the company has expanded into a large international organization employing some 19,000 people worldwide. The Group's principal areas of activity include data communications, radio communications, marine electronics, defence radar and avionics, and energy resources. In addition the Group is actively involved in communications security, acoustics, antennas, data and communications recording, intruder detection, test instrumentation and computer aided engineering.

Racal is continuing to expand into new areas. The Group has been granted a 25 year licence to operate a nationwide public telephone service based on cellular radio technology. The licence enables Racal to set up and operate a system – Vodafone – providing instant communications, both portable and mobile, for people constantly on the move.

The Group is also involved in pay television, assisting operators in the U.K. and Europe to develop their services. As well as supplying domestic and program operator equipment, the company provides the important business and control software necessary to operate pay television profitably.

Racal is the only major electronics company to emerge since the second world war and is already established as a world leader in many key areas with some 70% of sales being outside the United Kingdom.

Racal Recorders Limited

Racal Recorders is one of the world's premier producers of top quality magnetic recording instruments, being specialists in the field for over 35 years. The Company has established marketing and sales bases throughout the world. Backed by heavy investment, Racal Recorders has pioneered many of the considerable advances that have been made in both mechanical and electronic areas of recording and playback instruments. In a program of continuous development, specialist engineers bring together electronic and mechanical expertise to supply highly reliable voice logging and instrumentation recording equipment to a discerning and specialized market.

Storehorse

Storehorse sets a new standard of excellence in the design of multichannel, IRIG/ISO compatible, wideband instrumentation tape recorders. Extensive use of microprocessor technology has permitted complete automatic calibration and equalization (ACE) which dramatically reduces the time and expertise required to set up the signal channel characteristics prior to record or replay. Available in various configurations to suit customers' needs, Storehorse is manufactured in 14, 28 and 42-channel versions and utilizes a co-axial tape transport accommodating reels of up to 15 inches in diameter. Signal electronics channels are available in DR, FM intermediate/wideband 1 and wideband 2 standards with an HDDR wrap-around option available.

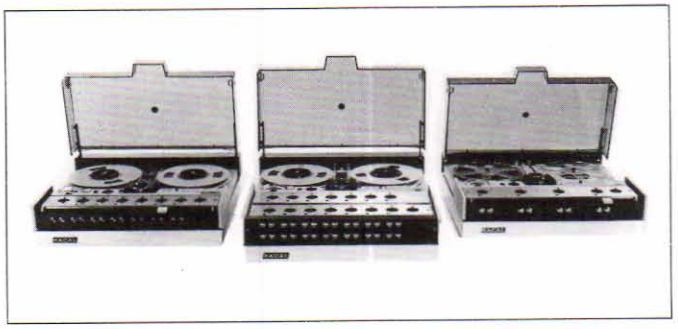
GRA 011

Racal Recorders model GRA 011 is a magnetic tape time encoder specifically designed to provide all the functions required for reliable tape search at a price that is attractive to the user of even low-cost instrumentation recorders. This compact and portable instrument generates and reads time code and will search for a pre-set time bi-directionally. The performance specification for these three functions equals or exceeds that of individual instruments costing more than the GRA 011 combination. Other features include a real-time alarm, dual-displays and the capability to switch on peripheral equipment.

Transiscope TS900

The Transiscope TS9000 brings flexible transient recording data processing and high resolution display into a single instrument. It has been carefully designed to maximize operator convenience using menu programming and soft key control. High processing power and standard interfaces allow the Transiscope to be used as a Single Instrument Measuring System (SIMS) with interactive or automatic data processing, as a high speed front end system for a computer, or as an intelligent pre-processing and data-reducing device.

Store Recorders



The family of precision instrumentation recorders has the ability to record and reproduce vital analogue information on up to 14 independent channels. With data supplied from strategically placed sensors engineers involved in the safety and reliability of tomorrow's technology can analyze the results of test programs in such areas as the aerospace and automotive industries, medical science and oceanographic survey. Signal electronics channels are available in DR intermediate band and FM wideband 1 and intermediate bands. With tape sizes of ¼, ½ and 1 inch width available and speeds between 15/16 up to 60 in/s, on various sizes of spools, the versatile Store range covers the entire spectrum of small portable instrumentation recording requirements. Powered by mains AC or capable of operating over an 11-32V DC range, there recorders are particularly suited to both field and laboratory work.

Racal Recorders Ltd., Hythe, Southampton, Hants., S04 6ZH, England. Tel: (0703) 843265. Telex: 47600.

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