



Multi-Standard MPEG Test Systems MTS200 Series



MTS200 Series Product Family.

The MTS200 Series MPEG Test Systems provide innovative solutions to meet the challenges of designing and testing MPEG, DVB, and ATSC systems. The MTS200 Series products are based on an industry-standard computing platform that provides flexible and expandable test capabilities. The MTS200 Series provides three primary capabilities: real-time analysis, deferred-time analysis, and custom transport stream creation and generation.

Real-Time Analysis

The MTS200 Series' real-time analysis capabilities enable you to perform extensive protocol analysis in real-time. All tests conform to MPEG, ETR290 recommendations and ATSC standards so you

can verify that your designs meet established conformance criteria.

In addition, the MTS200 Series enables you to vary test parameters from established specifications so you can define and test the limits of your design or established system. You have control over the interval of each table, the timing relationship between related tables, as well as PCR interval and precision measurements.

To ease the analysis of test results, the MTS200 Series uses color in its various displays to indicate the status of each element under test within the transport stream. Green indicates that the element under test passes; Red indicates that there is a cur-

FEATURES AND BENEFITS

MPEG, DVB, ATSC and Dolby Digital™ Compliance Testing

Real-time Analysis of Transport Streams

Real-time Multiplexing of Transport Streams

On-line Storage of Captured Transport Streams

Create and Generate Custom MPEG, DVB and ATSC Compliant Transport Streams

Modular Concept – Purchase Only Performance Required Today (Real-time Analysis, Deferred-time Analysis, or Generator Capability) – Easily Upgrade in the Future as Your Needs Change

MPEG Video Compliance Bitstreams for Independent Certification of MPEG Interoperability

Synchronous Serial Interface Adapter "DVB and ATSC"

Rack Mount Configuration Available

rent error; and Orange indicates that an error has occurred but is no longer present. The Real-time Analyzer offers message logging that can be viewed either from the master log or on an individual PID basis.

A statistical view (see Figure 1) provides a status-at-a-glance display of the overall

bandwidth and efficiency of the transport stream under test. Graphic and dynamic displays show the data rates, percentage of use, and global data information for each program, PID, and the transport stream.

PCR Analysis

PCR Analysis with frequency offset and drift information (see Figure 2) are displayed in real-time. The real-time analyzer enables you to use MPEG, DVB or ATSC limits, or you can define your own. Once the limits have been defined, the system begins testing to that limit. Errors are graphically displayed in red and added to the message log with time of day and date information.

The real-time system also enables you to display multiple PCR views simultaneously to assist in identifying multiplexer or encoder problems.

Histograms for all timing graphs

The PCR, PTS/DTS and section rate analysis displays now include histograms. An example histogram can be seen in Figure 2.

PID Allocation

The PID Allocation view (see Figure 3) enables you to view all PIDs associated with either PSI/SI/PSIP or program tables and monitor their rates. High and low limits can be set to alert the user with error messages when these limits have been exceeded. This is especially important when monitoring the output of a statistical multiplexer and trying to identify a program that may be using too much bandwidth.

DVB Measurement Display

DVB ETR290 measurements can be monitored using two display types. The first display type is used strictly for monitoring while the second display type is a detailed view. Both views indicate the

three priorities of testing per ETR290 recommendation.

DVB-T for SFN (Single Frequency Network)

Mega-frame Initialization Packets (MIP), specified in the DVB TS 101 191 document, can be monitored using either the Real-time or Deferred-time analysis programs. MIP's carry information about the type of transmission that will be used to broadcast the transport stream. It is used to synchronize and to configure DVB-T transmitters (SFN adapters) using GPS-based time stamping.

IP Data Monitoring

Due to the increase in demand on accessing Internet services through cable and satellite communications, IP data monitoring has become an important issue. The MTS200 Real-time analyzer performs IP monitoring with detailed viewing of SI-DAT 360 (DVB Data Broadcasting) tables, syntactic control of the SI-DAT tables with error reporting and the ability to monitor data flow of the broadcast session.

Analyses performed are as follows:

- Intra-PSI analysis
- Inter SI/PSI analysis (data broadcast descriptors)
- Consistence of data carousel
- TCP/IP session monitoring

Several new tables are now available within the hierarchical display. Digital Storage Media Command and Control (DSM-CC) from ISO/IEC 13818-6 defines the following types: Multiprotocol encapsulation, U-N messages, and Stream descriptors. SI-DAT defines the following tables: 1-layer Data carousel, Multiprotocol encapsulation, 2-layer Data carousel, Data Piping, and Data Streaming. Figure 4 shows multiple DSM-CC elements along with their IP traffic sessions.

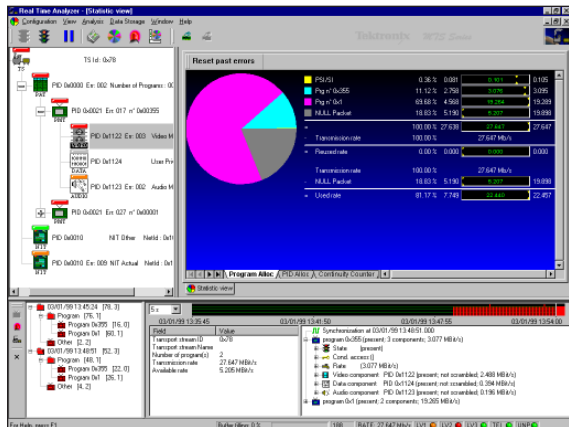


Figure 1 – Typical MTS200 Real-time Analyzer screen. This screen displays information and analysis results of the MPEG transport stream being monitored.

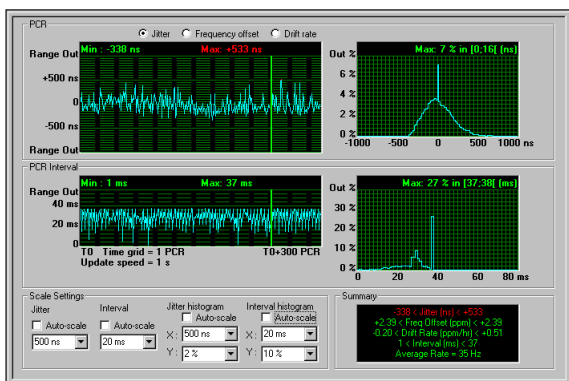


Figure 2 – PCR analysis view screen.

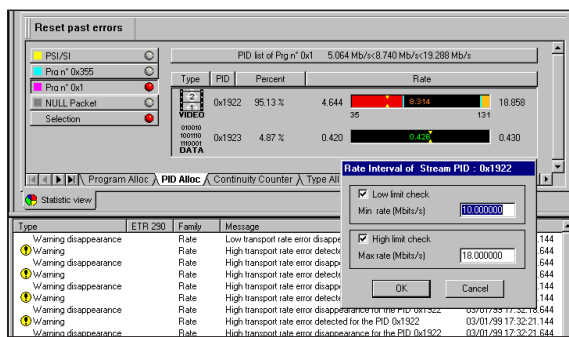


Figure 3 – PID-Allocation screen.

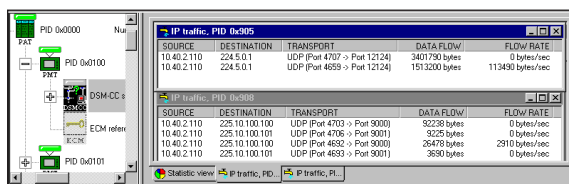


Figure 4 – IP Data Monitoring.

User Definable Parameters

The following parameters are user-definable:

- **Hardware** – Set the number of synchronization bytes before the system begins testing or synchronization is lost. Set the electrical input and output configuration of the Real-time Analyzer.
- **Analysis** – Select the type of testing to be performed (MPEG, DVB or ATSC). Select individual ETR290 tests. Select individual MPEG-2 programs for analysis.

- **Advanced Analysis** – Select packet ID and table inter-dependencies. Configure syntax, timing, and rate requirements.
- **View** – Enable NT Event logging. Configure message, hierarchical, and graphics displays.
- **Data Storage** – Configure trigger event, file name and size, and repetition mode.
- **Output Filtering** – Select MPEG-2 programs and PIDs to be removed from transport stream.

Private Syntax Table Editor

This program allows the user to describe the syntax of a private table. You can then use the table for testing the syntax of the incoming transport stream, validating the private table information.

Trigger/Capture

Intermittent problems are difficult to detect and capture. The MTS215 MPEG Test System addresses this by incorporating a trigger/capture function (see Figure 5) that enables you to specify an error or event to be monitored, start the process, and walk away. When the designated error or event occurs, the system automatically captures the event so that it can be analyzed at a later time. The system can capture a minimum of 35 minutes of data running at 60 Mb/s.

Simple Network Management Protocol (SNMP)

If you are using the MTS200 Series Real-time analyzer in an operational network environment you can take advantage of the SNMP agent that is a part of the Real-time system. This will allow you to control or capture analysis results from a remote location.

Deferred Time Analysis

The MTS200 Series' Deferred-time analysis capabilities provide four types of displays or views:

- **Hierarchical** – Displays the structure of the transport stream and identifies all of the components.
- **Interpreted** – Works as a tutorial on the MPEG structure. Double clicking on any of the fields in the display produces a definition of that field from the MPEG standard.
- **Graphical** – Uses graphs to show information about PCR (jitter analysis), MUX Allocation (rate analysis), and the PID Map (for viewing “burstiness” of data).
- **Numerical** – Shows decimal, hex, or binary versions of each display.

Tests performed in Deferred-time are listed below and determined by the user defined measurement environment.

- **Syntax** – Testing of the system layer (including PES) to ISO/IEC 13818-1.
- **Consistency** – Between the DVB SI and ATSC PSIP source information tables.
- **PSI/SI/PSIP Rates** – Frequency.
- **PTS/DTS** – Timing.
- **PCR** – Timing.
- **Semantic** – Value checks.
- **Mega-frame analysis for SFN**.
- **Dynamic** – Full T-STD (Transport stream System Target Decoder) including LTW (Legal Time Window) and Buffer Smoothing.

All of these tests can be performed automatically. You also have control of the buffer size in each of the T-STD buffers.

MPEG Audio and Video Stream Analysis (Option ES)

MPEG audio and video elementary stream analysis is also possible with the MTS210 and MTS215 systems. These programs allow you to perform syntax and semantic analysis of both audio and video elementary streams (see Figures 6 and 7).

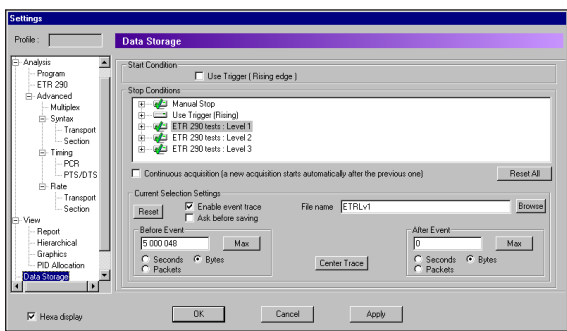


Figure 5 – Data Storage Trigger/Capture configuration display.

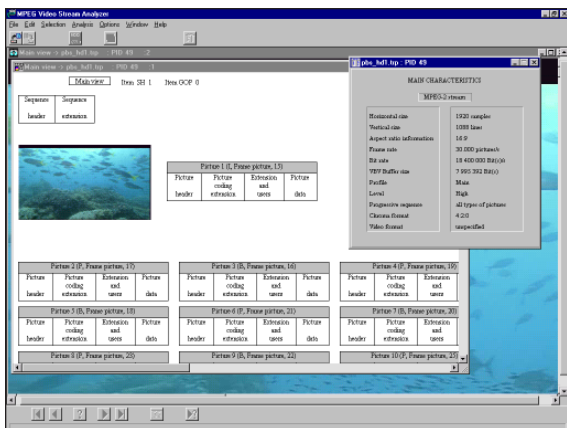


Figure 6 – MPEG video screen.

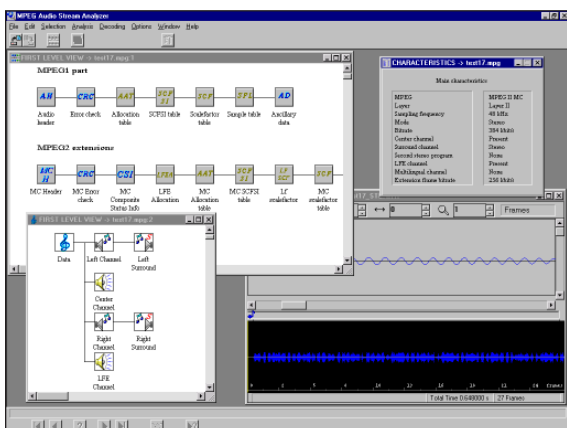


Figure 7 – MPEG audio screen.

MPEG Video Stream Analyzer analyzes MPEG1 or MPEG2 video streams at different levels (i.e., MP@ML, MP@HL, 4:2:2) as well as the decoding of I-pictures. The video analyzer provides multiple levels of analysis:

- Video sequence
- Sequence
- Pictures
- Group of pictures

Both syntactic and semantic (coherence between all components in the stream) analysis are available. An extraction routine allows the user to select and save either the whole stream or a part of the stream.

The MPEG Audio Stream Analyzer analyzes MPEG Audio Layer I and II specification streams. It allows analysis of an MPEG audio stream at different levels as well as the ability to decode them.

The audio analyzer provides the following levels of analysis:

- Audio Header (AH)
- Audio Allocation Table (AAT)
- Scalefactor Table (SCF)
- Scalefactor Selection Information (SCFSI)
- Sample Table (SPL)
- Ancillary Data (AD)

At each of these levels, syntactic, semantic and CRC analysis can be performed.

An extraction routine allows the user to select and save either the whole stream or a part of the stream. The decoded stream can be saved in a WAV file format.

AC-3™ Analysis (Option AC)

The technology on which Dolby Digital sound is based is Dolby AC-3, a proprietary audio coding technique Dolby Laboratories developed for storing and transmitting multiple channels of digital sound more efficiently. The analysis of Dolby AC-3 streams can be performed on MPEG-2 transport streams, program streams, packetized elementary streams (PES), as well as elementary streams. Analysis functions include CRC checking, syntactic analysis, and semantic analysis. Graphs can be plotted for the following fields to observe trends in these values over different sections of the stream:

- Dialog normalization
- Heavy compression
- Dynamic range

The interpreted display shows the actual data along with each parameter field-name. Double-clicking on the field-name produces a definition of that field as defined by the AC-3 standard. Figure 8 shows the Dolby AC-3 analysis application along with two characteristics views.

All or part of an AC-3 stream can be saved on a frame or time basis.

Custom Transport Stream Generation

The MTS200 Series' generation capabilities allow you to create custom transport streams with complete control over many of the parameters. User-definable parameters include:

- Timing offsets
- Data rates
- PES packet size
- Jitter and channel coding
- DVB SI table information
- ATSC PSIP Table information (Terrestrial or Cable)

These parameters can be easily modified using the included DVB or ATSC Table Editor or Jitter Programs.

Using a "known good" transport stream, you can test performance of the entire system or an individual component under ideal conditions. Because you have control over the user-definable parameters, you can create a custom transport stream with variations to stress performance at or near operational limits. For example, Figures 9a and 9b show custom transport stream creation.

CD-ROMs with elementary streams are included with all MTS200 Series systems having generation capability. The video elementary streams contain both motion sequences and traditional television test patterns. The STRM102 product is included and contains MPEG video elements from the Sarnoff Corporation for independent certification of MPEG interoperability. These "known good" MPEG streams

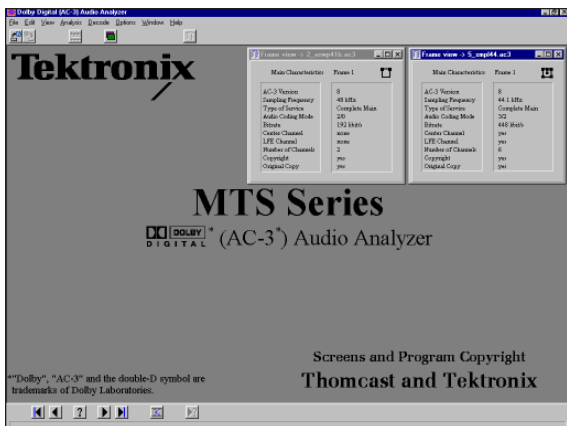


Figure 8 – The Dolby AC-3 analysis application with two Main Characteristics displays.

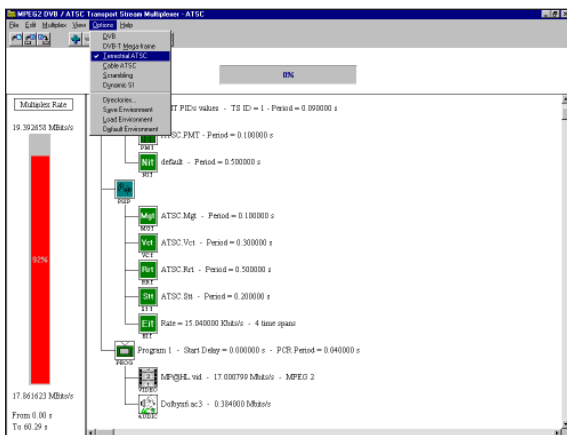


Figure 9a – Example Custom ATSC Transport Stream with PSIP Tables, High-Level MPEG-2 video, and Dolby AC-3 audio.

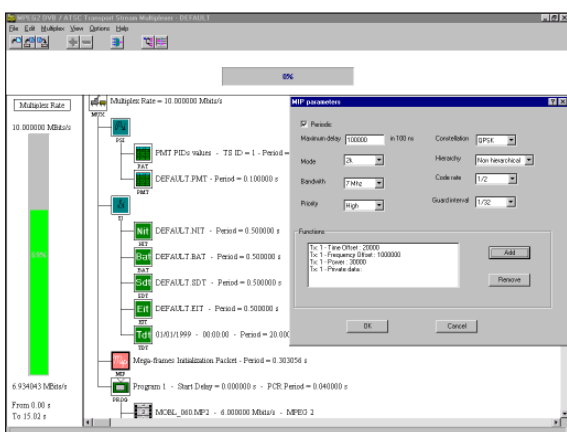


Figure 9b – Example custom transport stream with Mega-frame.

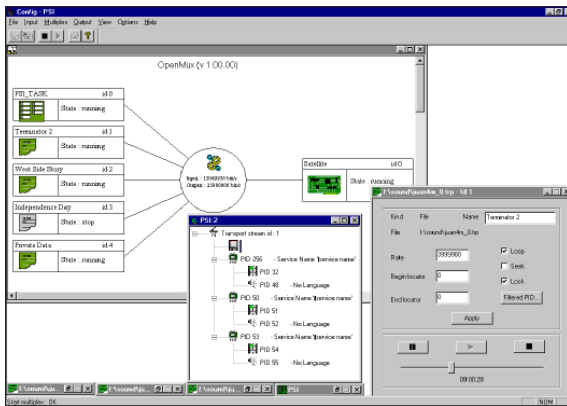


Figure 10 – Real-time Multiplexing screen.

can be used as ideal test signals or they can be used as the basis for creating your own MPEG transport streams.

Real-time Multiplexing (Option OM)

The purpose of the Real-time multiplexing application is to provide an easy way to multiplex MPEG-2 Transport Streams in real time. The heart of the application is a transport packet multiplexer task that can quickly process many input streams and outputs a valid MPEG-2 stream. The input transport streams can represent a single-program transport stream (SPTS) or multi-program transport streams (MPTS), elementary streams, private data, PSI tables, DVB-SI tables or ATSC-PSIP tables.

The main characteristics are as follows :

- Dynamic management of MPEG2 PSI, DVB SI and ATSC PSIP tables.
- SPTS and MPTS file multiplexing.
- Allocation and dynamic filtering of PIDs.
- Re-stamping of PCRs.

I/O for Acquisition and Generation

The MTS200 Series provides rear panel I/O connectors for external acquisition and generation. The exact connector configuration depends upon the system ordered.

SMPTE 310M and DVB SSI Adapter (Option SS)

The Synchronous Serial Interface (SSI) adapter accepts MPEG-2 transport streams at 19.39 and 38.78 Mb/s meeting the SMPTE 310M standard. The SSI adapter will also accept SSI streams that meet the DVB standard over a frequency range of 10 Mb/s to 50 Mb/s. An automatic detection circuit allows the adapter to act as either an input or output device.

Modular System Design

The MTS200 Series is based on a modular design so you can purchase only the capa-

bilities you need now. Later, you can purchase field upgrades to expand the functionality of your system as your needs change or as new tests and technologies emerge. The MTS200 Series is based on Windows NT™ and runs on a high-end PC platform for maximum flexibility and upgradeability. The MTS200 Series consists of the following systems:

- MTS205 Real-time Analysis System. Designed for fast, time-critical system analysis.
- MTS210 Deferred-time Analysis System. Designed for out-of-service (off-line) analysis. The MTS210 requires one of the three options: option 1A provides acquisition and analysis only, option 1G provides custom transport stream generation only, option AG provides both analysis and transport stream generation capabilities. Other MTS210 options include: 1R, OM, ES, AC, PS, CA, and SS.
- MTS215 MPEG Test System. Combines both the MTS205 and MTS210 capabilities into a single system.

MTS200 Characteristics

G.703 8.448 AND 34.368 MB/S

Standards Conformance – ITU-T G.703, G.823.

Connector – 50 Ω SMB.

Line Encoding – HDB3.

Serial Bit Rate – 8.448 Mb/s ±10 ppm. 34.368 Mb/s ±20 ppm.

Required Receiver Termination – 75 Ω nominal resistive.

Connector – 50 Ω SMB male.

ECL PARALLEL, SERIAL, AND CONTROL PORTS

Connectors –

Parallel: 25-pin D connector.

Serial: 25-pin D connector.

Control: 9-pin D connector.

Maximum Data Rate – 60 Mb/s.

Minimum Data Rate – 1 Mb/s.

Maximum Serial Data Rate – 55 Mb/s.

Signal Level Amplitude – Differential ECL (compliant with 100K ECL levels).

Required Receiver Termination – 100 Ω line-to-line.

10 MBIT SERIAL (RS-422 LEVEL I/O)

Connector – 9-pin D connector.

Maximum Data Rate (typical) – 10 Mb/s.

50 Ω TTL I/O

Connectors – Two 50 Ω male SMBs (one for data I/O, one for clock I/O).

Maximum Data Rate – 45 Mb/s.

Minimum Data Rate – 1 Mb/s.

Termination (input) – 50 Ω nominal resistive.

CLOCK PORT (INPUT)

Voltage Levels – TTL.

Low: <0.8 V.

High: >2.0 V.

Termination – 50 Ω nominal resistive.

Frequency Range – 125 kHz to 45 MHz (typical).

MTS200
Characteristics
Continued

PLL

Range (typical) – 125 kHz to 60 MHz.
Resolution (typical) – 1 Hz.
Jitter Resolution – 0.2 UI peak-to-peak over a 1000 UI delay.
Settling Time – 3 seconds after frequency change.
Frequency Accuracy (typical) – 10 ppm ± resolution.

REAL TIME ANALYSIS

Parallel Input Port –
 Connector: D25.
 Input Data Rate:
 Maximum: 60 Mbits/s.
 Minimum: 1 Mbit/s.
 Signal Amplitude (auto selects ECL, RS-422, or LVDS):
 Maximum: 2.0 V_{p-p}.
 Minimum: 100 mV_{p-p}.
 Signal Common-Mode Range: –1.8 V to +2.5 V.
 Termination: 100 Ω resistive nominal, line-to-line.
 Timing Reference: Rising edge of clock.
 Clock-to-Data Timing: Data must be stable ±5 ns of rising clock edge.

Parallel Output Port – Connector: D25.
 Signal Amplitude (software selectable to LVDS or ECL-modified level):
 LVDS: 454 mV_{p-p} maximum, 247 mV_{p-p} minimum.
 ECL (modified): 400 mV_{p-p} nominal.
 Termination: 100 Ω line-to-line.
 Signal Common-Mode Range:
 LVDS: 1.125 V to 1.375 V.
 ECL: –1.65 V nominal.

ASI Input Port –
 Connector: BNC.
 Input Bit Rate: 270 Mbps ±100 ppm.
 Transport Stream Data rate up to 60 Mb/s.
 Signal Amplitude:
 Maximum: 800 mV_{p-p}.
 Minimum: 200 mV_{p-p}.
 Termination: 75 Ω nominal.
 Return Loss: +17 dB minimum, 27 MHz to 270 MHz.

ASI Output Port (output follows the input) –
 Connector: BNC.
 Output Bit Rate: 270 Mbps ±100 ppm.
 Signal Amplitude: 880 mV maximum, 500 mV minimum into 75 Ω load.
 Rise and Fall Times: 1.2 ns maximum (20% to 80%).

MTS200
Optional
Synchronous
Serial Interface
Adapter
Characteristics

SSI INPUT

Connector – BNC.
Input Bit Rate – 10 Mb/s to 50 Mb/s.
Data Format – Compliant with SMPTE 310M and DVB SSI.
Packet Length – 188 or 204 bytes

SSI OUTPUT

Connector – BNC.
Data Format – Compliant with SMPTE 310M and DVB SSI.
Output Bit Rate –
 For SMPTE 310M: settable to 19,392,658 b/s for 8 VSB, and 38,785,316 b/s for 16 VSB.
 For DVB: adjustable between 10 Mb/s and 50 Mb/s.

PARALLEL INPUT/OUTPUT

Connector – 25 Contact Sub-D, female
Input Bit Rate – 10 Mb/s to 50 Mb/s.
Data Format – SPI, but at ECL logic levels.
Signal Amplitude –
 Differential ECL, Compliant with ECL 100 K levels
 Logic high : – 0.9V typical,
 Logic low : – 1.7 V typical

MTS200
General
Characteristics

ENVIRONMENTAL, EMC, SAFETY

Temperature – Operating: +10°C to +35°C.
 Non-operating: –20°C to +60°C.
Humidity – Operating: 20% to 80% (maximum 10% change/hour). Non-operating: 5% to 90% non-condensing.
Altitude – Operating: To 4,572 m (15,000 ft.).
Electromagnetic Compatibility – CISPR 22A Radiated and Conducted.
 Emissions:
 IEC 801-2 Electrostatic Discharge.
 IEC 801-3 Radiated RF Immunity.
 IEC 801-4 Electrical Fast Transients.
 IEC 801-5 Power-line Surge.
Safety –
 CAN/CSA C22.2 No. 950 M89.
 UL 1950.

POWER

Source Power –
 Voltage Ranges: 100 to 120 VAC or 220 to 240 VAC.
 Line Frequency: 60 Hz or 50 Hz.
Power Consumption (not including monitor) –
 Maximum: 240 W.
 Typical: 160 W.

PHYSICAL CHARACTERISTICS

Dimensions*1	cm	in.
	Height	45.52
Width	22.43	8.83
Depth	57.58	22.67
Weight	kg	lb.
	Net	29.54
Shipping*1	47.17	100

*1 Not including monitor (shipped separately).

WARRANTY

One year.

**MTS200
Hardware
Products
Ordering
Information**

MTS205

Real-time Analyzer
Option SS – Synchronous Serial Interface Adapter (DVB SSI and ATSC SMPTE 310M).
Option 1R – Rackmount kit.

MTS210

Deferred-time Analysis System and Transport Stream Generator
MTS210 OPTIONS (OPTION 1A, 1G, OR AG REQUIRED)
Option 1A – Deferred-Time Analysis System only.
Option 1G – Custom MPEG Transport Stream Generation only.
Option AG – Deferred-Time Analysis System with Custom MPEG Transport Stream Generation.
Option AC – Dolby Digital (AC-3) Analyzer.
Option CA – ViAccess Conditional Access.
Option ES – MPEG Audio/Video Elementary Stream Analyzer.
Option OM – Real-time Multiplexing.
Option PS – Program Stream Analyzer.
Option SS – Synchronous Serial Interface Adapter (DVB SSI and ATSC SMPTE 310M).
Option 1R – Rackmount kit.

MTS215 MPEG Test System

MTS215 OPTIONS
Option AC – Dolby Digital (AC-3) Analyzer.
Option CA – ViAccess Conditional Access.
Option ES – MPEG Audio/Video Elementary Stream Analyzer.
Option PS – Program Stream Analyzer.
Option OM – Real-time Multiplexing.
Option SS – Synchronous Serial Interface Adapter (DVB SSI and ATSC SMPTE 310M).
Option 1R – Rackmount kit.

MTS200 Series International Power Cord Options

Option A1 – Universal Euro 220 V, 50 Hz.
Option A2 – UK 240 V, 50 Hz.
Option A3 – Australian 240 V, 50 Hz.
Option A5 – Switzerland 220 V, 50 Hz.

MTS200 Series Upgrade Kits (all kits require running MTS2Wiz.Zip available from www.tektronix.com)

MTS1F03 – Updates existing MTS100 to MTS210 Opt. AG features and functionality.
MTS1F05 – Updates existing MTS100 to MTS215 features and functionality.
MTS2F01 – Updates MTS205 to MTS215 features and functionality.
MTS2F04 – Updates MTS210 to MTS215 features and functionality.
MTS2F06 – Updates MTS210 Opt. 1G or MTS210 Opt. 1A to MTS210 Opt. AG features and functionality.
MTS2F07 – Adds MPEG Audio/Video elementary stream capability to existing systems (same as Option ES).
MTS2F08 – Adds ViAccess conditional access capability to existing systems (same as Option CA).

MTS2F1R – Adds rack mount capability (computer only).

MTS2F25 – Upgrade MTS200 Series Products from Version 2.2 software to Version 3.0.

MTS2F30 – Upgrade MTS200 Series Products from Version 2.5 to Version 3.0 Software.

MTS2FPS – Adds Program Stream Analysis to MTS products.

MTSFAC3 – Upgrades current MTS 3.0 systems with Dolby Digital (AC-3) Analysis capability.

MTSF0MX – Upgrade existing MTS210/215 Series systems with Real-time multiplexing capability.

MTSFSSI – Upgrade MTS200 Series system (Proliant Platforms Only) with Synchronous Serial input or output capability.

Service Assurance Options

Option R3 – Extends the repair warranty to cover three years from product shipment.

Software-Only Products (Requires Windows NT)

All software provided on CD.

MTS2AN Deferred-time Analysis Software – Option CA, ES, and AC.

MTS2CR Multiplexer Software – Option CA and ES.

MTS2ES MPEG Audio/Video Elementary Stream Analysis Software

MTS2TS Deferred-time Software – Option CA, ES, and AC

MTS2AC3 Dolby Digital (AC-3) Analysis Software

Minimum System Requirements

- Windows NT 4.0
- Service Pack 1
- 150 MHz Processor
- 32 MB Memory
- CD-Rom Drive
- 140 MB free space on Hard Drive
- 1024 x 768, 256 Color Video

Other Related Products

DVBPI Physical Interface Adapter – Converts either ECL Parallel or DVB LVDS or ASI to the other format. 19-in. rack mount.

PQA200 Picture Quality Analysis System – Provides fast, accurate, and repeatable objective measurements of picture quality against a reference.

PSA200 Program Stream Analysis Software –

Option ES and AC.

Analyze MPEG-1 system streams and MPEG-2 program streams down to the PES level. Option ES provides MPEG analysis down to the video and audio elementary stream level. Option AC provides Dolby AC-3 audio elementary stream analysis.

MTS200 Series Configuration Guide	System Nomenclature	Real-Time Analysis per MPEG, DVB and ATSC	Deferred-Time Analysis per MPEG, DVB and ATSC	Custom MPEG Transport Stream Generation per MPEG, DVB and ATSC	I/O
	MTS205	X			
MTS210	Option 1A		X		G.703, ECL serial and parallel, TTL 50 Ω , 10 Mbit serial port (RS-422), and CLOCK
	Option 1G			X	G.703, ECL serial and parallel, TTL 50 Ω , 10 Mbit serial port (RS-422), and CLOCK
	Option AG		X	X	G.703, ECL serial and parallel, TTL 50 Ω , 10 Mbit serial port (RS-422), and CLOCK
MTS215	X	X	X	X	All of above

For further information, contact Tektronix:

Worldwide Web: for the most up-to-date product information visit our web site at: www.tektronix.com

ASEAN Countries (65) 356-3900; **Australia & New Zealand** 61 (2) 9888-0100; **Austria, Central Eastern Europe, Greece, Turkey, Malta, & Cyprus** +43 2236 8092 0; **Belgium** +32 (2) 715 89 70; **Brazil and South America** 55 (11) 3741-8360; **Canada** 1 (800) 661-5625; **Denmark** +45 (44) 850 700; **Finland** +358 (9) 4783 400; **France & North Africa** +33 1 69 86 81 81; **Germany** + 49 (221) 94 77 400; **Hong Kong** (852) 2585-6688; **India** (91) 80-2275577; **Italy** +39 (2) 25086 501; **Japan (Sony/Tektronix Corporation)** 81 (3) 3448-3111; **Mexico, Central America, & Caribbean** 52 (5) 666-6333; **The Netherlands** +31 23 56 95555; **Norway** +47 22 07 07 00; **People's Republic of China** 86 (10) 6235 1230; **Republic of Korea** 82 (2) 528-5299; **South Africa** (27 11)651-5222; **Spain & Portugal** +34 91 372 6000; **Sweden** +46 8 477 65 00; **Switzerland** +41 (41) 729 36 40; **Taiwan** 886 (2) 2722-9622; **United Kingdom & Eire** +44 (0)1628 403300; **USA** 1 (800) 426-2200.

From other areas, contact: Tektronix, Inc. Export Sales, P.O. Box 500, M/S 50-255, Beaverton, Oregon 97077-0001, USA 1 (503) 627-6877.



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