

# MPEG Test Systems

## MTS415 Data Sheet



### Features & Benefits

- Industry's Fastest Analysis Engine enables Reduced Time to Insight, Rapid Development, Evaluation, Deployment, and Diagnostics of Next-generation DTV and IPTV Systems and Services
- A Wide Range of DTV Standards are Supported, including MPEG, DVB, ATSC, ISDB, and ISDB-TB (Brazil). Specific SI for Terrestrial, Cable, and Satellite, plus Regional Variations of these Standards are also Supported
- Range of Interfaces and Analysis Capabilities provide the Necessary Connectivity to Diagnose Problems Anywhere in the Network Environment, whether that be Transmission Links (RF or IP Layer) or Content Processing (TS Layer)
- Connect to both IP Version 4 and 6 Networks, including those using IGMP and MLD Multicast Protocols Respectively
- Analyze both Constant and Variable Bit Rate Streams (CBR and VBR)\*1
- Integrated Cross-layer Fault Analysis and Logging provides One-box Solution for Fault Diagnosis, Reducing Time to Insight when Troubleshooting
- Playout Functionality provides Stimulus with Parametric Capabilities and IP Multisession Replication to Characterize Behavior of Network or Device Under Test
- CaptureVu™ Technology Captures and Analyzes System Events in Real Time and Deferred Time to Debug the Intermittent and Complex Problems that Traditional Analyzers Miss
- Innovative Program-centric User Interface brings Expert Power to the Novice User
- H.264 Buffer Analysis, Multiplexing, and ES Compliance Checking provide the Most Powerful Suite of Tools for Creation and Analysis of Transport Streams containing H.264 Content
- Both Buffer Analysis and Multiplexing are Now Available for MPEG-4 AAC, a Mandatory ISDB-TB Audio CODEC. These compliment the existing MPEG-4 AAC ES Compliance Checking
- **Try Before You Buy:** Demo Versions of the TSCA, Multiplexer, and Buffer Analyzer are Available to Download

## Applications

### Equipment Manufacturers – Manufacturing Test

- Equipment Test is Simplified and Faster with CaptureVu™ and the High-speed Analysis Engine
- Multiplexer/Remultiplexer allows Custom Test Stream Creation for Fast and Flexible Equipment Stress Testing
- Stream Playout and Recording provides Repeatable Test Source with Seamless Looping and Continuous Time Stamping for Test and Alignment of STBs, IRDs, and Modulators
- Duplex Operation allows End-to-End Testing of System Network Elements\*2

### Broadcasters and Network Operators

- RF and IP Connectivity and Analysis provide Single-box Solution for Broadcast System Troubleshooting
- Integrated Cross-layer Fault Analysis and Logging for Network Fault Diagnosis Reduces Time to Insight when Troubleshooting and Removes the Need for Additional IP- or RF-specific Diagnostic Equipment
- CaptureVu™ Technology allows Isolation of Intermittent Network Problems that Other Analyzers would not be Capable of Isolating
- Tests Contribution Feeds or Encoder Outputs, Multiplexer Inputs/Outputs, Headend Modulators, and IP Encapsulators
- Tests PCR Insertion, Recovery, and Regeneration Equipment
- Encoder and Other Equipment Fault Diagnosis and Evaluation
- Analysis of Transport Streams to Confirm Correct System Operation and Isolate Faults during Installation and Commissioning

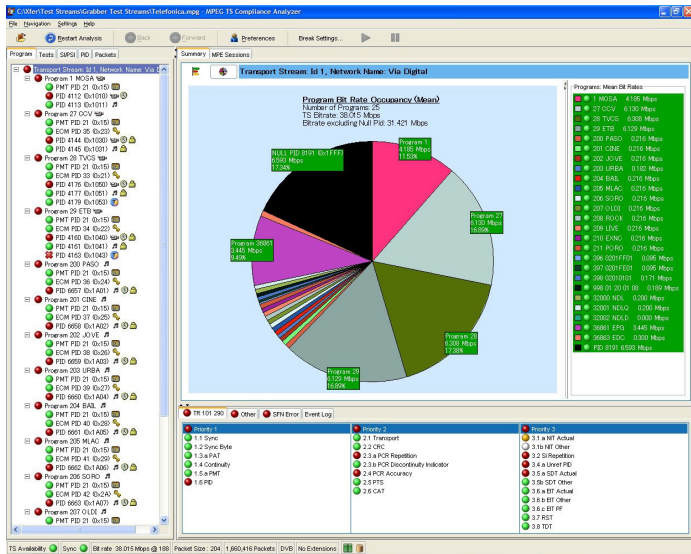
\*1 Some timing-related measurements are not possible with VBR streams.

\*2 Duplex is not available for Transport Streams over IP.

### Summary of Tools

| Standard Tools                                                      | Optional Tools                                           |
|---------------------------------------------------------------------|----------------------------------------------------------|
| Real- and Deferred-time Transport Stream Compliance Analyzer (TSCA) | Multiplexer                                              |
| Player                                                              | Carousel Analyzer                                        |
| T-STD Buffer Analyzer                                               | Carousel Generator                                       |
| PES Analyzer                                                        | MPEG-2 ES Analyzer                                       |
| MTS4CC ES Compliance Checker                                        | Additional software license with either TS or ES package |
| Tclips Test Streams                                                 |                                                          |
| TS Editor and Cutter                                                |                                                          |
| Standard Interfaces                                                 | Optional Interfaces                                      |
| ASI                                                                 | IP Video (10/100/1000BASE-T, 1000BASE-SX, LX, ZX)        |
| LVDS (DVP Parallel)                                                 | DVB-S: QPSK (L-Band) and Turbo 8PSK                      |
| SMPTE 310M                                                          | DVB-T: COFDM                                             |
| Ethernet IP (10/100/1000BASE-T)<br>Use with Player only             | DVB-C: QAM                                               |
|                                                                     | ATSC-T: 8VSB                                             |

Further details of individual tools are available within the Additional Resources.



Transport Stream Compliance Analyzer

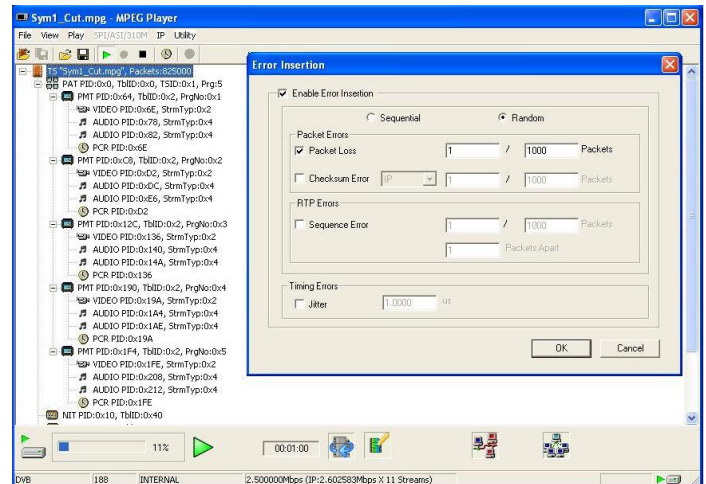
## Transport Stream Compliance Analyzer (TSCA)

The TSCA offers significant enhancements over traditional software-based deferred-time (stored streams) MPEG analyzers. The combination of an innovative high-speed analysis engine and built-in intelligence, allows ultrafast pinpointing and debugging of intermittent faults in MPEG Transport Streams used in next-generation DTV and IPTV systems and services.

The TSCA also provides real-time analysis of Transport Streams received through the MTS430's stream interfaces, including IP and RF. The real-time analysis includes cross-layer time-correlated IP and TS measurements, alarms, and error logging together with stream recording.

The TSCA includes the CaptureVu™ technology and PCR measurement and graphing capabilities. CaptureVu™ technology captures and analyzes system events in real time and deferred time to debug the intermittent and complex problems that traditional analyzers miss.

Standards compliance is ensured through built-in customizable scripting supporting the broadest ranges of ratified and evolving DTV standards, including ATSC, DVB-C, DVB-H, DVB-S, DVB-T, ISDB-S, ISDB-T, ISDB-TB, and MPEG. To maintain compatibility with the latest standards, flexibility is the key. New standards and proprietary tables can easily be catered for by loading Tektronix-supplied updates, or creating your own custom scripts.



MPEG Player

Users can configure the TSCA software to display stream information in user-selected fonts. This feature enables you to view stream information in your local language or to use custom fonts.

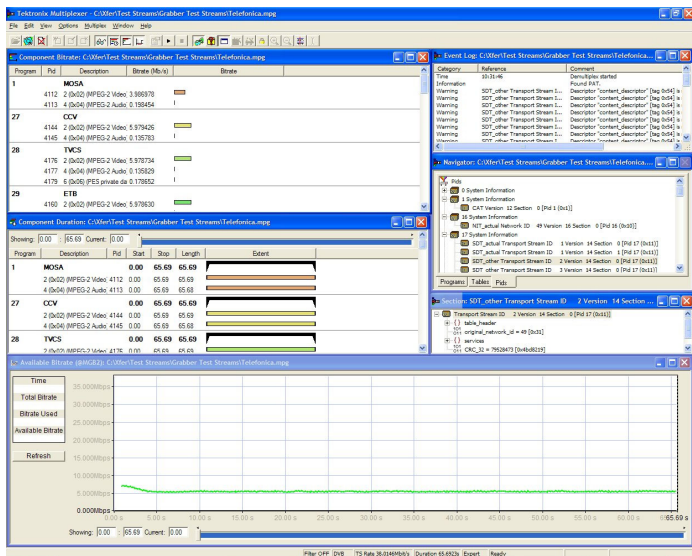
Duplex operation of the real-time TSCA and Player allows end-to-end system test (maximum aggregate bit rate is 214 Mb/s for simultaneous input and output operation)\*2.

## Playback (Transport Stream Generation) and Recording

The Player tool provides a Transport Stream stimulus for a device under test through the ASI, SMPTE310, LVDS (DVB Parallel) or IP stream interfaces. Continuous playback of looped streams is possible at up to maximum ASI rate of 214 Mb/s with automatic updating of time stamps. Playback rate can be automatically determined from file PCRs or manually set. Simultaneous playback and recording (duplex operation) for end-to-end system test is supported with the ASI/SMPTE310M and LVDS interfaces.

Playback through the IP interface provides stimulus with parametric capabilities and multisession replication to characterize behavior of a network or device under test. This capability enables equipment manufacturers developing hardware or software solutions for video distribution over IP and IPTV to ensure quality and performance of products, resulting in reduced development costs and accelerated rollout of next-generation IP broadcast services.

\*2 Duplex is not available for Transport Streams over IP.



Multiplexer

## Multiplexer and SI Table Editor

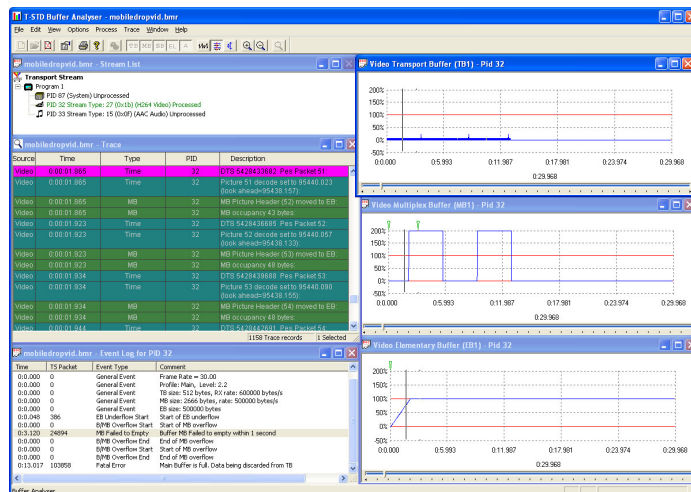
When testing network elements or set-top boxes, a Transport Stream of the representative type needed is often not available. Even if there is a similar one, vital components within it may be missing or suffer from a lack of SI (Service Information) or other tables, or are multiplexed to the incorrect Transport Stream rate for the application.

Use the Multiplexer/Remultiplexer/Demultiplexer application to create and modify multiprogram Transport Streams with custom SI/PSI/PSIP information for DVB, ATSC, ISDB\*3, and MPEG compliant Transport Streams.

Video and audio Elementary Streams, may also be multiplexed into a Transport Stream. H.264 streams, both with and without SEI timing messages, are supported. Bit rate and frame rate auto-detection features aid the import process.

This enables the user to create their own test streams that they can use to validate and debug their designs more quickly, and also to create errored streams to perform parametric stress testing and ensure robustness and quality of their MPEG-2 or H.264 implementation.

The **Make Seamless** wizard is provided with the Multiplexer. When looping a Transport Stream to simulate continuous playout, errors can be generated



Buffer Analyzer

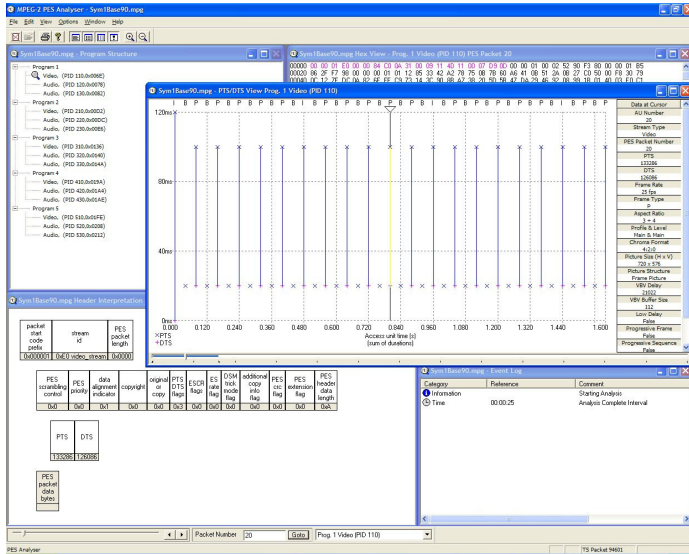
at the loop point caused by discontinuities in timing information. The Make Seamless wizard provides the opportunity of creating a seamless version of a Transport Stream file by adjusting SI and ES components within the stream.

## Buffer Analyzer

When developing professional and consumer equipment, particularly encoders and set-top boxes, the characteristics of the test streams being either generated or used as stimulus need to be ascertained. Of critical importance amongst these characteristics is adherence to the buffer model. That is, when the stream is processed by a receiver, will any of the internal buffers be caused to either under- or overflow. Consequences of these conditions will be freeze frames and receiver resets.

There are two types of buffer model; the one to use by the receiver is signaled within the Elementary Stream itself. The T-STD method is based upon the DTS values within the PES header and can be used for any contained CODEC type. Additionally, certain video CODECs such as MPEG-2 and H.264/AVC may contain buffer parameters within the ES itself. The Buffer Analyzer verifies conformance of a stream to the T-STD model. Verification of the H.264/AVC HRD method is covered by the MTS4EA product.

\*3 This includes ISDB-TB (Brazil) and Single Segment mode.



Packetized Elementary Stream Analyzer

## Packetized Elementary Stream (PES) Analyzer

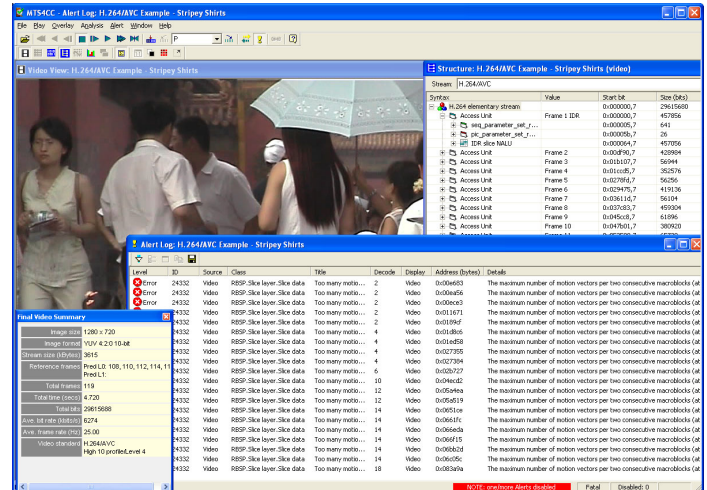
When developing professional and consumer equipment, particularly encoders and set-top boxes, the characteristics of the test streams being either generated or used as stimulus need to be ascertained. The header associated with each PES packet is of particular interest, as it contains the decode and presentation time stamps (DTS and PTS) for the contained Elementary Stream. Errors in these time stamps may cause resets or picture freeze problems at the receiver in extreme cases. They are more typically the cause of lip sync problems where the time stamps of associated video and audio streams are not synchronized. The PES Analyzer is designed to help address these problems as well as verify conformance of the PES header contents to the MPEG, DVB, and ATSC standards.

## Creating, Editing, and Resizing Transport Streams

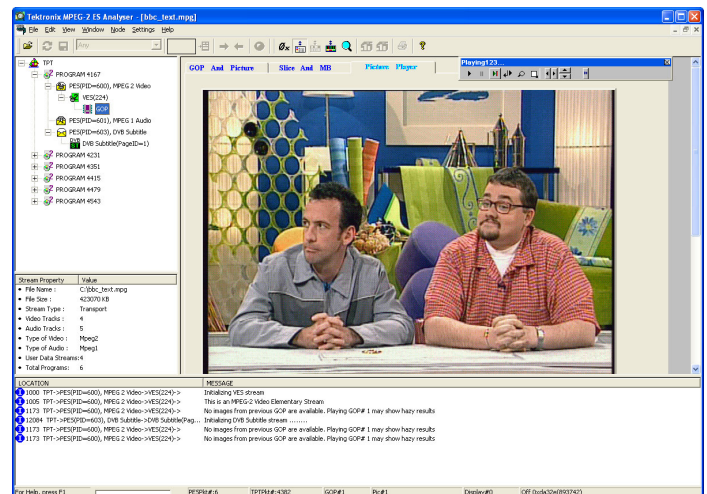
Two direct stream manipulation packages are supplied as standard with the MTS415. TS Cutter allows resizing of Transport Streams. TS Editor allows direct editing of Transport Streams using a hexadecimal view as well as a header interpretation guide.

## MTS4CC ES Compliance Checker

Whether developing a new CODEC chip, integrating a CODEC into professional or consumer equipment, or integrating different vendor's equipment when rolling out new services, the ability to verify the compliance of an Elementary Stream to either next-generation VC-1, AVC/H.264, and MPEG-4 standards, or legacy MPEG-2 and H.263. Audio decode and waveform display of MPEG-2 audio (ISO/IEC 13818 parts 3 and 7), AC-3, and MPEG-4 AAC are also supported.



MTS4CC



MPEG-2 ES Analyzer

Frame-by-frame and block-by-block displays allow for ease of CODEC comparison. Synchronized displays allow the user to quickly ascertain the effects of each reported error. A Batch mode allows the tool to be integrated into an automated test system.

## Elementary Stream (ES) Analyzer

The ES Analyzer is intended for CODEC design, optimization, and conformance purposes. It provides the ability to view the moving picture from within a PES stream and carry out a whole range of sophisticated tests on the lower layers of an Elementary Stream within a Transport Stream. In addition, it both analyzes and displays a range of extended media formats, including ATSC Closed Captions, DVB Subtitles, and Teletext associated with video Elementary Streams.

For analysis of MPEG-4, AVC/H.264, and VC-1, as well as MPEG-2 Elementary Streams, please refer to the MTS4EA.



When developing either data or object carousels for interactive applications, designers not only need to verify the content of carousels, but also whether they are compliant with the relevant standards, and to optimize the settings between transmission bandwidth and responsiveness of the user experience. These settings are mainly concerned with the repetition rates of the various carousel groups. The Carousel Analyzer is designed to address all of these needs for a Transport Stream file containing carousel components. It analyzes carousels compliant with MPEG-2 DSM-CC, DVB (including MHP), DTT (MHEG-5), or ARIB standards.



The Carousel Generator product is used for creating object carousel contents within an output Transport Stream. This is particularly useful in test situations where the effects of varying parameters, such as individual repetition intervals, may be quickly ascertained. The generator will create object carousels conforming to the MPEG-2 DSM-CC, DVB, DTT (MHEG-5), or MHP standards.

Depend on Tektronix to provide you with performance you can count on. In addition to industry-leading service and support, this product comes backed by a one-year warranty as standard.

## Characteristics

### Platform Characteristics

| Characteristic                                              | Description                                                                                     |
|-------------------------------------------------------------|-------------------------------------------------------------------------------------------------|
| Operating System                                            | Microsoft Windows XP Pro                                                                        |
| Processor                                                   | Intel Pentium P4, 2.8 GHz minimum                                                               |
| Disk Storage for Operating System and Software Applications | 250 GB, Ultra ATA100 IDE Hard Drive                                                             |
| Disk Storage for Captured Video Streams                     | 144 GB (Two × 72 GB SCSI Hard Disk Drives)                                                      |
| Video Stream Storage                                        | SCSI-3 (Ultra 160), Micro D68 connector, 68 pin                                                 |
| Disk I/O Port                                               |                                                                                                 |
| RAM                                                         | 1 GB (One SIM of DDRS memory)                                                                   |
| Optical Storage Drive                                       | CD-R/W, DVD-R/RW, DVD+R/RW                                                                      |
| Display                                                     | LCD, 1024 × 768, 10.4 inch                                                                      |
| External VGA Output                                         | 15-pin, High-density, D-Sub. Resolution needs to be set to the same as the integral LCD display |
| Ethernet                                                    | One 10/100BASE-T RJ45 connector<br>One 10/100/1000BASE-T RJ45 connector                         |
| Keyboard Port                                               | Mini DIN, PS-2, one at the rear and one at left front side (Not hot pluggable)                  |
| Mouse Port                                                  | Mini DIN, PS-2, one at the rear and one at left front side (Not hot pluggable)                  |
| Printer Port                                                | IEEE P1284                                                                                      |
| COM Port                                                    | RS-232                                                                                          |
| USB Port                                                    | 2 × USB 2.0                                                                                     |

### Instrument Characteristics

#### External Reference/Clock Input

| Characteristic       | Description                                                              |
|----------------------|--------------------------------------------------------------------------|
| Input Connector Type | 50 $\Omega$ , BNC, AC coupled                                            |
| Frequency            | 8.12698 MHz, 10 MHz, 27 MHz<br>(<1 ppm recommended)                      |
| Amplitude            | 0 $\pm$ 6 dBm (Peak-to-Peak, Sine Wave),<br>0.5 V to 3.0 V (Square Wave) |
| Clock Inputs         |                                                                          |
| Frequency            | 160 kHz to 25 MHz (Parallel Clock)<br>1.28 MHz to 32 MHz (Serial Clock)  |
| Amplitude            | 0.5 V to 3.0 V (Square Wave)                                             |

### External Trigger Input

| Characteristic       | Description                               |
|----------------------|-------------------------------------------|
| Input Connector Type | 1 k $\Omega$ , BNC                        |
| Threshold Level      | Rising/Falling edge programmable          |
| High Level           | >3.5 V (The maximum limit voltage is 7 V) |
| Low Level            | <0.8 V                                    |

### SPI I/O

| Characteristic           | Description                                                       |
|--------------------------|-------------------------------------------------------------------|
| SPI Input Connector Type | D-sub 25 pin                                                      |
| Output Amplitude         | 240 mV to 550 mV BUS LVDS with 100 $\Omega$ termination           |
| Data Rate                | 250 Kb/s to 108 Mb/s<br>(in accordance DVB specification maximum) |
| Output Impedance         | 100 $\Omega$ between differential outputs with "Output Off"       |
| Data Delay               | $\pm$ 5 ns from DCLK rising edge                                  |
| Input Level              | >200 mV <sub>P-P</sub> (RI+)-(RI-) with 100 $\Omega$ termination  |
| Input Impedance          | 100 $\Omega$ between differential inputs                          |

### ASI

| Characteristic | Description                                                                                                                                                                                                                                                   |
|----------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Connector      | BNC (uses a common connector with the SMPTE 310M interface)<br>75 $\Omega$ transformer-coupled input and output<br>800 mV $\pm$ 10% into 75 $\Omega$ load output<br>200 mV to 880 mV input<br>Return loss < -17 dB (5 MHz to 270 MHz) into a 75 $\Omega$ load |
| Bit Rate       | 250 Kb/s to 214 Mb/s<br>(in accordance DVB specification maximum)<br>Input and output aggregate bit rate<br>(simplex or duplex operation)                                                                                                                     |

### SMPTE310M

| Characteristic | Description                                                                                                                                                                                                                                              |
|----------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Connector      | BNC (uses a common connector with the ASI interface)<br>75 $\Omega$ transformer-coupled input and output<br>800 mV $\pm$ 10% into 75 $\Omega$ load output<br>200 mV to 880 mV input<br>Return loss < -17 dB (5 MHz to 38.785316 MHz) at 75 $\Omega$ load |
| Bit Rate       | 19,392,658.5 b/s                                                                                                                                                                                                                                         |

## Interface Options Characteristics

### IP Video Interface (Option IPTVD)

| Characteristic                                                                       | Description                                                                                                                                                                                                                                                     |
|--------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Ethernet Ports                                                                       | 10/100/1000BASE-T, 1000BASE-SX, LX, ZX                                                                                                                                                                                                                          |
| Port Options                                                                         |                                                                                                                                                                                                                                                                 |
| Opt. IPTVD                                                                           | Gigabit Ethernet Interface with 10/100/1000BASE-T RJ45 electrical port                                                                                                                                                                                          |
| Optical SFP modules which plug into IP Video Card GE to provide optical connectivity |                                                                                                                                                                                                                                                                 |
| Opt. SX                                                                              | 1000BASE-SX Short-wavelength optical port with LC connector for Gigabit Ethernet Interface (Multi Mode 850 nm)                                                                                                                                                  |
| Opt. LX                                                                              | 1000BASE-LX Long-wavelength optical port with LC connector for Gigabit Ethernet Interface (Single Mode 1310 nm)                                                                                                                                                 |
| Opt. ZX                                                                              | 1000BASE-ZX Optical port with LC connector for Gigabit Ethernet Interface (Single Mode 1550 nm)                                                                                                                                                                 |
| Maximum Data Rate                                                                    | Line rate                                                                                                                                                                                                                                                       |
| ASI Output                                                                           | ASI-compliant with specification EN 50083-9<br>ASI smoothing can be activated to compensate for bursty IP traffic                                                                                                                                               |
| Protocol Stack Support                                                               | IPv4 and v6 support<br>UDP/IP/Ethernet<br>UDP/IP/VLAN/Ethernet<br>RTP/UDP/IP/Ethernet<br>RTP/UDP/IP/VLAN/Ethernet                                                                                                                                               |
| Multicast and Control Support                                                        | IGMP v2 and v3<br>MLD v1 and v2<br>ARP<br>ICMP (Inbound and Outbound ping)                                                                                                                                                                                      |
| IP Packet Support                                                                    | 7 Transport Stream packets per IP packet (188 byte packets)<br>FEC (FEC is parsed but is not processed)                                                                                                                                                         |
| IP Video Metrics                                                                     | Session Support Discovery of up to 500 IP sessions<br>Simultaneous monitoring of key parameters including Continuity Count and Sync Byte<br>Packet Interarrival Time (PIT) for all sessions.<br>RTP sessions are monitored for Out-of-Order and Dropped Packets |

### COFDM Interface Characteristics (Option CF)

| Characteristic                              | Description                                                                                                                                                                                                                                                                                         |
|---------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Input Frequency Range                       | 50 MHz to 858 MHz                                                                                                                                                                                                                                                                                   |
| Channel Bandwidth                           | 6 MHz, 7 MHz, and 8 MHz (SW selectable)                                                                                                                                                                                                                                                             |
| Connector Style                             | F Type with BNC adaptor                                                                                                                                                                                                                                                                             |
| Input Termination Impedance                 | 75 $\Omega$ nominal                                                                                                                                                                                                                                                                                 |
| Input Return Loss                           | 7 dB typical 50 MHz to 858 MHz                                                                                                                                                                                                                                                                      |
| Rx Lock Status                              | Indicated by LED on rear panel and by the UI                                                                                                                                                                                                                                                        |
| Modulation Scheme Supported                 | QPSK (4QAM), 16QAM, and 64QAM modulation                                                                                                                                                                                                                                                            |
| Transmission Modes                          | 2K carriers and 8K carriers                                                                                                                                                                                                                                                                         |
| Hierarchical Modes                          | All hierarchies are supported, including no hierarchy, and alpha = 1, 2, and 4                                                                                                                                                                                                                      |
| Viterbi Puncture Rates                      | 1/2, 2/3, 3/4, 5/6, 7/8                                                                                                                                                                                                                                                                             |
| Guard Interval                              | 1/32, 1/16, 1/8, 1/4                                                                                                                                                                                                                                                                                |
| Spectrum Polarity                           | The receiver will operate with both inverted and normal spectral polarity                                                                                                                                                                                                                           |
| Input Signal Amplitude Range*4              | QPSK (4QAM): -85 dBm to -15 dBm (24 dBuV to 94 dBuV) typical<br>16QAM: -80 dBm to -15 dBm (29 dBuV to 94 dBuV) typical<br>64QAM: -72 dBm to -15 dBm (37 dBuV to 94 dBuV) typical                                                                                                                    |
| <b>RF Measurements</b>                      |                                                                                                                                                                                                                                                                                                     |
| Carrier Offset                              | Carrier offset is measured from the tuned channel frequency to an accuracy of $\pm 50$ ppm typical                                                                                                                                                                                                  |
| Signal to Noise Ratio (SNR)                 | Display Range:<br>6 dB to 40 dB for QPSK (4QAM)<br>11 dB to 40 dB for 16QAM<br>16 dB to 40 dB for 64QAM<br>Resolution: 1 dB<br>Accuracy: $\pm 1$ dB to 30 dB SNR (measured at -30 dBm in high-resolution mode) typical                                                                              |
| Error Vector Magnitude (EVM)                | Display Range:<br>1% to 30% RMS, for QPSK<br>1% to 20% RMS, 16QAM<br>1% to 8.5% RMS, 64QAM<br>Resolution: 0.1%                                                                                                                                                                                      |
| Modulation Error Ratio (MER) with Equalizer | Both MER Peak and MER Average are displayed as measured across all carriers<br>Display Range:<br>6 dB to 37 dB for QPSK (4QAM)<br>11 dB to 37 dB for 16QAM<br>16 dB to 37 dB for 64QAM<br>Resolution: 0.1 dB<br>Accuracy: $\pm 1$ dB to 30 dB (measured at -30 dBm in high-resolution mode) typical |
| Constellation                               | The RF constellation is displayed on the UI                                                                                                                                                                                                                                                         |
| Channel Impulse Response                    | Measurement of channel impulse response and SFN delay                                                                                                                                                                                                                                               |
| Channel Spectral Response                   | Active receive channel spectrum, RF level vs. frequency                                                                                                                                                                                                                                             |
| Bit Error Ratio (BER)                       | Pre FEC, BER, and Error Sec BER values are displayed                                                                                                                                                                                                                                                |
| Post Reed Solomon BER                       | Post RS BER (Uncorrectable Error Count) displayed                                                                                                                                                                                                                                                   |
| Transport Error Flag (TEF)                  | Alarm generated on detection of a TEF                                                                                                                                                                                                                                                               |

\*4 For compliance with IEC61000-4-3 (Immunity) the Input Signal Amplitude must be  $\geq -40$  dBm.

**8VSB Interface Characteristics (Option VS)**

| Characteristic                          | Description                                                                                                                                                                                                               |
|-----------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Input Frequency Range                   | 54 MHz to 860 MHz, VHF/UHF channels 2 to 69 (to include low VHF frequencies)                                                                                                                                              |
| Input Signal Level                      | –72 dBm to –6 dBm (–23 dBmV to +43 dBmV) typical                                                                                                                                                                          |
| Modulation Format                       | 8VSB in accordance with ATSC A/53B                                                                                                                                                                                        |
| Receiver Bandwidth                      | 6 MHz                                                                                                                                                                                                                     |
| Input Termination Impedance             | 75 $\Omega$ nominal                                                                                                                                                                                                       |
| Connector Type                          | F Type Connector                                                                                                                                                                                                          |
| Input Return Loss                       | 5 dB typical                                                                                                                                                                                                              |
| <b>RF Measurements</b>                  |                                                                                                                                                                                                                           |
| RF Lock                                 | RF lock is indicated by a LED on the rear panel and a status indicator on the UI                                                                                                                                          |
| Input Level                             | Range:<br>–72 dBm to –2 dBm<br>–23 dBmV to +47 dBmV relative to 75 $\Omega$<br>Resolution: 1 dB<br>Accuracy: $\pm 3$ dB up to –6 dBm input level typical<br>$\geq -50$ dBm to ensure compliance to IEC 61000-4-3 immunity |
| Error Vector Magnitude (EVM)            | Display Range: 3% to 12.5% RMS<br>Resolution: 0.1% typical                                                                                                                                                                |
| Equivalent Modulation Error Ratio (MER) | Display Range: 15 dB to 36 dB<br>Resolution: 1 dB<br>Accuracy:<br>$\pm 1$ dB for MER <25 dB typical<br>$\pm 3$ dB for MER 25 dB to 31 dB typical                                                                          |
| Signal to Noise Ratio (SNR)             | Display Range: 15 dB to 35 dB<br>Resolution: 1 dB<br>Accuracy:<br>$\pm 1$ dB for SNR <25 dB<br>$\pm 3$ dB for SNR 25 dB to 35 dB typical                                                                                  |
| Bit Error Ratio (BER)                   | Pre FEC, SER, and Error Sec BER values displayed on UI                                                                                                                                                                    |

Interface Option EP provides both QPSK (L-Band) and Turbo 8PSK interface and measurement capability.

**QPSK (L-Band) and Turbo 8PSK Interface Card (Option EP)**

| Characteristic                              | Description                                                                                                          |
|---------------------------------------------|----------------------------------------------------------------------------------------------------------------------|
| Input Frequency Range                       | 950 MHz to 2150 MHz, step size of 1 MHz                                                                              |
| Input Signal Amplitude Range                | –60 dBm to –30 dBm for CBER < $1e^{-6}$                                                                              |
| Modulation Format                           | QPSK in accordance with ETSI EN 300 421                                                                              |
| Modulated Baud Rate                         | 1 MBaud min, 30 MBaud max                                                                                            |
| Viterbi Values Supported                    | 1/2, 2/3, 3/4, 5/6, 6/7, 7/8                                                                                         |
| FEC                                         | In accordance with ETSI EN 300 421                                                                                   |
| Turbo Viterbi Values Supported              | 1/2, 2/3, 3/4, 5/6, 7/8                                                                                              |
| Turbo FEC                                   | Turbo Code                                                                                                           |
| Connector Style                             | F Style                                                                                                              |
| Input Termination Impedance                 | 75 $\Omega$ nominal                                                                                                  |
| LNB Supply Voltage                          | Selectable; 13.0 V $\pm 1.5$ V or 18.0 V $\pm 1.5$ V                                                                 |
| LNB Supply Maximum Current                  | 200 mA maximum                                                                                                       |
| LNB 22 kHz Signaling Frequency              | 17.6 kHz min, 26.4 kHz max (22 kHz $\pm 20\%$ )                                                                      |
| LNB 22 kHz Signaling Amplitude              | 600 mV <sub>rms</sub> nominal with 100 $\Omega$ load                                                                 |
| Modes Supported                             | Turbo QPSK, QPSK DSS, QPSK DCII, QPSK DVB                                                                            |
| <b>RF Measurements</b>                      |                                                                                                                      |
| RF Lock                                     | RF lock is indicated to the user by an LED on the rear panel and a status icon on the UI                             |
| Input Level (Signal strength)               | Range: –60 dBm to –30 dBm<br>Resolution: 1 dBm<br>Accuracy: $\pm 5$ dBm typical                                      |
| Error Vector Magnitude (EVM)                | Display Range: $\leq 4.0\%$ to $\geq 30.0\%$ RMS<br>Resolution: 0.1%                                                 |
| Modulation Error Ratio (MER) with Equalizer | Display Range: 10 to 26 dB with Equalizer<br>Resolution: 1 dB<br>Accuracy: $\pm 2$ dB typical for range 10 to 20 dB  |
| Signal to Noise Ratio (SNR)                 | Display Range: 5 to 35 dB<br>Resolution: 1 dB<br>Accuracy: $\pm 2$ dB typical for range from 5 to 30 dB              |
| Pre Reed Solomon (RS) BER                   | Pre-RS BER is displayed on the UI                                                                                    |
| Post RS BER and TEF (Transport Error Flag)  | Post Reed Solomon BER (TEF ratio), TEF rate, and number of Transport Error Flags (TEF count) are displayed on the UI |
| Constellation                               | The RF constellation is displayed on the UI                                                                          |

**Turbo 8PSK Interface Characteristics (Option EP)**

| Characteristic                 | Description                                          |
|--------------------------------|------------------------------------------------------|
| Input Frequency Range          | 950 MHz to 2150 MHz in 100 kHz steps                 |
| Modulation Format              | Turbo 8PSK* <sup>5</sup>                             |
| Modulated Baud Rate            | 1 MBaud min, 30 MBaud max                            |
| Turbo Viterbi Values Supported | 2/3, 3/4 (2.05), 3/4 (2.1), 5/6, 8/9                 |
| Turbo FEC                      | Turbo Code                                           |
| Connector Style                | F Style                                              |
| Input Termination Impedance    | 75 $\Omega$ nominal                                  |
| LNB Supply Voltage             | Selectable; 13.0 V $\pm$ 1.5 V or 18.0 V $\pm$ 1.5 V |
| LNB Supply Maximum Current     | 200 mA maximum                                       |
| LNB 22 kHz Signaling Frequency | 17.6 kHz min, 26.4 kHz max (22 kHz $\pm$ 20%)        |
| LNB 22 kHz Signaling Amplitude | 600 mV <sub>p-p</sub> with 100 $\Omega$ load         |
| Modes Supported                | Turbo 8PSK                                           |

**RF Measurements**

|                                             |                                                                                                                      |
|---------------------------------------------|----------------------------------------------------------------------------------------------------------------------|
| RF Lock                                     | RF lock is indicated to the user by an LED on the rear panel and a status icon on the UI                             |
| Input Level (Signal strength)               | Range: -60 dBm to -30 dBm<br>Resolution: 1 dBm<br>Accuracy: $\pm$ 5 dBm typical                                      |
| Error Vector Magnitude (EVM)                | Display Range: $\leq$ 4.0% to $\geq$ 30.0% RMS<br>Resolution: 0.1%                                                   |
| Modulation Error Ratio (MER) with Equalizer | Display Range: 10 to 26 dB with Equalizer<br>Resolution: 1 dB<br>Accuracy: $\pm$ 2 dB typical for range 10 to 20 dB  |
| Signal to Noise Ratio (SNR)                 | Display Range: 5 to 35 dB<br>Resolution: 1 dB<br>Accuracy: $\pm$ 2 dB typical for range from 5 to 30 dB              |
| Pre Reed Solomon (RS) BER                   | Pre-RS BER is displayed on the UI                                                                                    |
| Post RS BER and TEF (Transport Error Flag)  | Post Reed Solomon BER (TEF ratio), TEF rate, and number of Transport Error Flags (TEF count) are displayed on the UI |
| Constellation                               | The RF constellation is displayed on the UI                                                                          |

\*<sup>5</sup> Please note that the Turbo 8PSK option does not support nonturbo 8PSK (DVB-DSNG), or DVB-S2. For information, please contact Tektronix.

**QAM Interface Characteristics (Option QB2)**

| Characteristic                  | Description                                                                                          |
|---------------------------------|------------------------------------------------------------------------------------------------------|
| Input Frequency Range           | 88 MHz to 858 MHz, 62.5 kHz steps                                                                    |
| Modulation Format               | 64QAM, 256QAM compliant with ITU J-83* <sup>6</sup><br>SCTE07 compliant                              |
| Modulation Baud Rate            | 5.057 Mbaud/s and 5.360 Mbaud/s                                                                      |
| Input Signal Level              | -64 dBm to -19 dBm (45 dBuV to 90 dBuV relative to 75 $\Omega$ ) with a 64 and 256 QAM input typical |
| Ultimate Modulation Error Ratio | 37 dB typical                                                                                        |
| Receiver Bandwidth              | 6 MHz nominal                                                                                        |
| Input Termination Impedance     | 75 $\Omega$ nominal                                                                                  |
| Input Return Loss               | -6 dB min, -10 dB typical, 51 MHz to 858 MHz                                                         |

**RF Measurements**

|                                             |                                                                                                                                                                                                    |
|---------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| RF Lock                                     | RF lock is indicated by a LED on the rear panel and a status icon on UI                                                                                                                            |
| Input Level (Signal strength)               | Range: -64 dBm to -19 dBm<br>Resolution: 1 dBm<br>Accuracy: $\pm$ 3 dBm typical                                                                                                                    |
| Error Vector Magnitude (EVM)                | Display Range for 64 QAM: $\leq$ 1% to $\geq$ 5% RMS<br>Display Range for 256 QAM: $\leq$ 1% to $\geq$ 2.5% RMS<br>Resolution: 0.1%<br>Accuracy: Within 20% of reading for S/N >25 dB typical      |
| Modulation Error Ratio (MER) with Equalizer | Display Range for 64 QAM: 22 dB to 37 dB<br>Display Range for 256 QAM: 28 dB to 37 dB<br>Resolution: 0.1 dB<br>Accuracy:<br>$\pm$ 1 dB for MER <25 dB<br>$\pm$ 3 dB for MER 25 dB to 34 dB typical |
| SNR                                         | Display Range for 64 QAM: 22 dB to 37 dB<br>Display Range for 256 QAM: 28 dB to 37 dB<br>Resolution: 1 dB<br>Accuracy:<br>$\pm$ 1 dB for MER <25 dB<br>$\pm$ 3 dB for MER 25 dB to 34 dB typical   |
| BER                                         | Pre FEC, SER, and Error Sec BER values are displayed                                                                                                                                               |
| Post RS BER and TEF (Transport Error Flag)  | Post Reed Solomon BER (Uncorrectable Error Count) and number of Transport Error Flags are displayed on the UI                                                                                      |
| Constellation                               | The RF constellation is displayed on the UI                                                                                                                                                        |

\*<sup>6</sup> Level 1 and Level 2 interleaving support compliant with all ITU J-83 Annex B, excluding I, J = 128, 7 and 128, 8 for 64QAM and in 256QAM excluding I, J = 8, 16 and 16, 8.

## Ordering Information

### MTS415 (Network Operators) Base System

#### MTS415 MPEG Test System

**Includes:** Real- and deferred-time Transport Stream Compliance Analyzer with CaptureVu™ technology, Simultaneous Play/Record on one channel, PES and T-STD Buffer Analysis, MTS4CC ES Compliance Checker, TcIps test streams, TS Editor, TS Cutter Applications, and one-year warranty.

#### MTS415 Options

| Option     | Description                                                                                                                               |
|------------|-------------------------------------------------------------------------------------------------------------------------------------------|
| Opt. IPTVD | IP Video Gigabit Ethernet Interface with 10/100/1000BASE-T RJ45 electrical port. For optical interface, SFP required (Options SX, LX, ZX) |
| Opt. MX    | Multiplexer                                                                                                                               |
| Opt. ES    | ES Analyzer                                                                                                                               |
| Opt. DB    | Carousel Analyzer                                                                                                                         |
| Opt. CG    | Carousel Generator                                                                                                                        |
| Opt. DBCG  | Carousel Analyzer and Carousel Generator                                                                                                  |
| Opt. VS    | 8VSB Interface                                                                                                                            |
| Opt. QB2   | QAM Annex B Interface                                                                                                                     |
| Opt. CF    | COFDM DVB-T Interface                                                                                                                     |
| Opt. EP    | QPSK/8PSK Interface                                                                                                                       |
| Opt. LX    | 1000BASE-LX Long-wavelength optical port with LC connector for Gigabit Ethernet Interface (Single Mode 1310 nm)                           |
| Opt. SX    | 1000BASE-SX Short-wavelength optical port with LC connector for Gigabit Ethernet Interface (Multi Mode 850 nm)                            |
| Opt. ZX    | 1000BASE-ZX Optical port with LC connector for Gigabit Ethernet Interface (Single Mode 1550 nm)                                           |

#### MTS415 Package Options

|                |                                                                                                                                                   |
|----------------|---------------------------------------------------------------------------------------------------------------------------------------------------|
| MTS4USB P415TS | Additional TS package license. Contains real- and deferred-time TS Compliance Analyzer, PES Analyzer, Buffer Analyzer, and TS Editor applications |
| MTS4USB P415ES | Additional ES package license. Contains MTS4CC with all options                                                                                   |

#### Service

| Option  | Description            |
|---------|------------------------|
| Opt. R3 | Repair Service 3 Years |
| Opt. R5 | Repair Service 5 Years |

#### Documentation

| Option  | Description     |
|---------|-----------------|
| Opt. L0 | English Manual  |
| Opt. L5 | Japanese Manual |

#### Power Cord/Adapter

| Option   | Description                 |
|----------|-----------------------------|
| Opt. A0  | North America power         |
| Opt. A1  | Universal Euro power        |
| Opt. A2  | United Kingdom power        |
| Opt. A3  | Australia power             |
| Opt. A4  | 240 V, North America power  |
| Opt. A5  | Switzerland power           |
| Opt. A6  | Japan power                 |
| Opt. A10 | China power                 |
| Opt. A11 | India power                 |
| Opt. A12 | Brazil power                |
| Opt. A99 | No power cord or AC adapter |

#### Upgrade or Add Standard Options after Initial Purchase of MTS415

| Item                  | Option    | Description                                               |
|-----------------------|-----------|-----------------------------------------------------------|
| MTS4UP                |           | MTS400 Series Field Upgrade Kit                           |
| <b>Upgrade to add</b> |           |                                                           |
| MTS4UP                | Opt. MX   | Deferred-time Multiplexer                                 |
| MTS4UP                | Opt. ES   | ES Analyzer to MTS400 Series                              |
| MTS4UP                | Opt. DB   | Carousel Analyzer to MTS400 Series                        |
| MTS4UP                | Opt. CG   | Carousel Generator to MTS400 Series                       |
| MTS4UP                | Opt. DBCG | Carousel Analyzer and Carousel Generator to MTS400 Series |

#### Upgrade kit to add

|        |            |                                                                                                                                           |
|--------|------------|-------------------------------------------------------------------------------------------------------------------------------------------|
| MTS4UP | Opt. IPTVD | IP Video Gigabit Ethernet Interface with 10/100/1000BASE-T RJ45 electrical port. For optical interface, SFP required (Options SX, LX, ZX) |
| MTS4UP | Opt. LX    | 1000BASE-LX Long-wavelength optical port with LC connector for Gigabit Ethernet Interface (Single Mode 1310 nm)                           |
| MTS4UP | Opt. SX    | 1000BASE-SX Short-wavelength optical port with LC connector for Gigabit Ethernet Interface (Multi Mode 850 nm)                            |
| MTS4UP | Opt. ZX    | 1000BASE-ZX Optical port with LC connector for Gigabit Ethernet Interface (Single Mode 1550 nm)                                           |
| MTS4UP | Opt. VS    | 8VSB Interface. Includes upgrade to latest software                                                                                       |
| MTS4UP | Opt. QB2   | QAM Annex B Interface<br>Includes upgrade to latest software                                                                              |
| MTS4UP | Opt. CF    | COFDM DVB-T Interface<br>Includes upgrade to latest software                                                                              |
| MTS4UP | Opt. EP    | QPSK/8PSK Interface<br>Includes upgrade to latest software                                                                                |

#### Other

|          |          |                                                                                                                                                       |
|----------|----------|-------------------------------------------------------------------------------------------------------------------------------------------------------|
| MTS4UP   | Opt. UPG | Upgrade to latest version of MTS400 Series base software and installed options. Includes CD and manual (does not include upgrades to MTS4CC software) |
| MTS4UP   | Opt. IF  | Return to Depot installation of MTS4UP on an MTS415                                                                                                   |
| MTS4CCUP | Opt. UPG | Upgrade to latest version of MTS4CC ES Compliance Checker software                                                                                    |



Tektronix is registered to ISO 9001 and ISO 14001 by SRI Quality System Registrar.

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**For Further Information.** Tektronix maintains a comprehensive, constantly expanding collection of application notes, technical briefs and other resources to help engineers working on the cutting edge of technology. Please visit [www.tektronix.com](http://www.tektronix.com)



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