User Manual

Tektronix

MTD200
MPEG Test Decoder

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General Safety Summary

Review the following safety precautions to avoid injury and prevent damage to this product or any products connected to it. To avoid potential hazards, use this product only as specified.

Only qualified personnel should perform service procedures.

To Avoid Fire or Personal Injury

Use Proper Power Cord. Use only the power cord specified for this product and certified for the country of use.

Use Proper Voltage Setting. Before applying power, ensure that the line selector is in the proper position for the power source being used.

Connect and Disconnect Properly. Do not connect or disconnect probes or test leads while they are connected to a voltage source.

Ground the Product. This product is grounded through the grounding conductor of the power cord. To avoid electric shock, the grounding conductor must be connected to earth ground. Before making connections to the input or output terminals of the product, ensure that the product is properly grounded.

Observe All Terminal Ratings. To avoid fire or shock hazard, observe all ratings and markings on the product. Consult the product manual for further ratings information before making connections to the product.

Do not apply a potential to any terminal, including the common terminal, that exceeds the maximum rating of that terminal.

Replace Batteries Properly. Replace batteries only with the proper type and rating specified.

Do Not Operate Without Covers. Do not operate this product with covers or panels removed.

Use Proper Fuse. Use only the fuse type and rating specified for this product.

Avoid Exposed Circuitry. Do not touch exposed connections and components when power is present.

Wear Eye Protection. Wear eye protection if exposure to high-intensity rays or laser radiation exists.

Do Not Operate With Suspected Failures. If you suspect there is damage to this product, have it inspected by qualified service personnel.

Do Not Operate in Wet/Damp Conditions.

Do Not Operate in an Explosive Atmosphere.

Keep Product Surfaces Clean and Dry.

Provide Proper Ventilation. Refer to the manual's installation instructions for details on installing the product so it has proper ventilation.

Symbols and Terms

Terms in this Manual. These terms may appear in this manual:

WARNING. *Warning statements identify conditions or practices that could result in injury or loss of life.*

CAUTION. *Caution statements identify conditions or practices that could result in damage to this product or other property.*

Terms on the Product. These terms may appear on the product:

DANGER indicates an injury hazard immediately accessible as you read the marking.

WARNING indicates an injury hazard not immediately accessible as you read the marking.

CAUTION indicates a hazard to property including the product.

Symbols on the Product. The following symbols may appear on the product:

WARNING
High Voltage

Protective Ground
(Earth) Terminal

CAUTION
Refer to Manual

Double
Insulated

Preface

This manual provides operating information for the MTD200 MPEG Test Decoder and supports firmware version 2.02 and up. The manual is divided into nine sections, containing the following information:

- Section 1 contains introductory information about the digital TV transmission technique. It discusses definitions and standards pertinent to using the MTD200 MPEG Test Decoder.
- Section 2 contains comprehensive descriptions of the measurement functions available with the MPEG test decoder. Also discussed is using the light-emitting diodes (LEDs), the liquid crystal display (LCD), and an external, on-screen display to view detected transport stream errors.
- Section 3 discusses preparing the MPEG test decoder for use. This section provides information about the front- and rear-panel controls and connectors. It also contains information, such as setting up the unit, connecting a monitor, configuring the unit, and a functional check.
- Section 4 describes the basic functions of MPEG test decoder. The section provides explanations of the controls in the cursor block and the menus.
- Section 5 provides the information you need to remotely control the MPEG test decoder. This section discusses topics such as the RS-232 interface and the command set, switching between manual and remote operation, and measurement parameters. The section also provides a sample program.
- Section 6 lists the basic maintenance procedures that an operator can perform and describes how to replace the battery.
- Section 7 contains the following appendices:
  - Appendix A, additional information about interfaces.
  - Appendix B, specifications, compliances, and certifications for the MPEG test decoder.
- Section 8 is the glossary.
- Section 9 is the index.

Contacting Tektronix

Product Support	For application-oriented questions about a Tektronix measurement product, call toll free in North America: 1-800-TEK-WIDE (1-800-835-9433 ext. 2400) 6:00 a.m. – 5:00 p.m. Pacific time Or contact us by e-mail: tm_app_supp@tek.com For product support outside of North America, contact your local Tektronix distributor or sales office.
Service Support	Contact your local Tektronix distributor or sales office. Or visit our web site for a listing of worldwide service locations. http://www.tek.com
For other information	In North America: 1-800-TEK-WIDE (1-800-835-9433) An operator will direct your call.
To write us	Tektronix, Inc. P.O. Box 1000 Wilsonville, OR 97070-1000

Introduction to Digital TV Transmission Technique

The MTD200 MPEG Test Decoder and the MTG200 MPEG Test Generator are based on a completely new transmission technique that is currently being phased in and has become known as the digital TV transmission technique. Not many users of the above units will have sufficient knowledge about this new technique. Therefore, this introductory chapter preceding the other sections of the manual is provided to give an outline of the subject matter and to inform in detail about the aspects relevant to the MPEG test generator and the MPEG test decoder.

The first section gives an overview of the relevant definitions and standards. The keywords MPEG and DVB are focused upon.

The second section presents a possible transmission scenario. The fields of application of the MPEG test generator and the MPEG test decoder are considered in particular.

The third section provides information about a special aspect of MPEG-2 (Part 1 / Systems), which is of special interest with regard to the operation of MPEG test generator and the MPEG test decoder.

Definitions and Standards

Digital TV transmission is understood to mean the transmission of moving pictures, sound and data from the source to the destination using digital methods. The goal is essentially to multiply the transmission capacity by minimizing the redundancy as well as to obtain flexibility in quality (transmission standards) and contents (any combination of vision, sound, and data).

Implementation is made in two steps: source coding and channel coding.

Source coding and multiplexing: First, data reduction for vision and sound is performed. Next, compressed data streams together with additional data (for example, teletext) have to be coded to a multiplex stream. Such multiplex streams are generated by the MPEG test generator and evaluated by the MPEG test decoder. The required methods are defined by MPEG-2. As for additional data, MPEG only defines the basic syntax. The European DVB project stipulates the additional data to be integrated into the multiplex stream and their form.

Channel coding and transmission: The transmission of compressed, almost redundancy-free data streams, requires a high transmission quality or a bit error rate approaching zero to ensure decoding. That is why a channel coding is performed before the digital modulation methods QPSK (Quadrature Phase Shift Keying for satellite transmission) and QAM (Quadrature Amplitude Modulation for transmission via cable). A certain number of bit errors can then be corrected at the end of the transmission link. The methods for channel coding and transmission are defined by the European DVB project.

MPEG-2

MPEG stands for Moving Pictures Experts Group. This standard committee works on the coding of moving pictures and the associated sound. MPEG-2 (ISO/IEC 13818) defines a corresponding standard documentation describing the compression of vision and sound data. Moreover, there is MPEG-1, which describes the recording of video on CD, or MPEG-4 for the transmission of pictures by means of very narrow band transmission channels. MPEG-3, which was to define the distribution of high-resolution TV pictures, has finally become a part of MPEG-2.

MPEG-2, which is subdivided into many sections, is exclusively relevant for this manual. The following MPEG-2 sections are applicable to the MPEG test generator and MPEG test decoder:

Part 1 / Systems ISO/IEC 13818–1	Multiplexing of several compressed vision and sound data streams as well as of additional data streams to a transport multiplex
Part 2 / Video ISO/IEC 13818–2	Compression of vision data
Part 3 / Audio ISO/IEC 13818–3	Compression of sound data
Part 4 / Conformance ISO/IEC 13818–4	Test procedure for compressed streams (encoder) and decoder
Part 9 / Real-Time Interface Specification for Low Jitter Applications	Elucidation regarding system-clock jitter during the distribution of transport streams

The interface for the MPEG test generator and the MPEG test decoder is the Transport Stream (TS). The composition and structure of this multiplex stream is described in *MPEG-2 Systems* on page 1–5.

DVB In addition to transmission methods based on the MPEG results, the European DVB project (Digital Video Broadcast) established a number of additional definitions that were stipulated as a standard by ETSI / CENELEC for standardization. The following standards are relevant for the MPEG test generator and the MPEG test decoder:

ETS 300 468:	Specification for Service Information (SI) in Digital Video Broadcast (DVB) Systems
ETS 300 472:	Specification for conveying ITU-R System B Teletext in Digital Video Broadcasting (DVB) Bit Streams
ETR 162:	Allocation of Service Information (SI) codes for Digital Video Broadcasting (DVB) Systems
ETR 211:	Guidelines on implementation and usage of service information
ETR 290:	Measurement Guidelines for DVB-Systems
DVB Technical Module:	
Document A010:	Interfaces for CATV / SMATV Headends and similar Professional Equipment
TM 1341	Common Interface Specification for Conditional Access and other Digital Video Broadcasting Decoder Applications

Transmission Scenario for DVB

Figure 1–1 illustrates a possible transmission scenario for DVB. ‘TS’ indicates the interfaces for the transport stream. The transport stream is the output and input interface of the MPEG test generator and the MPEG test decoder. At any of these interfaces, signals from the MPEG test generator can be fed in or applied to the MPEG test decoder for analysis and decoding. A TS analysis is of vital importance after every TS multiplexer. A program can run through several multiplexers if, for example, programs from different transmission paths are combined and sent on a new path.

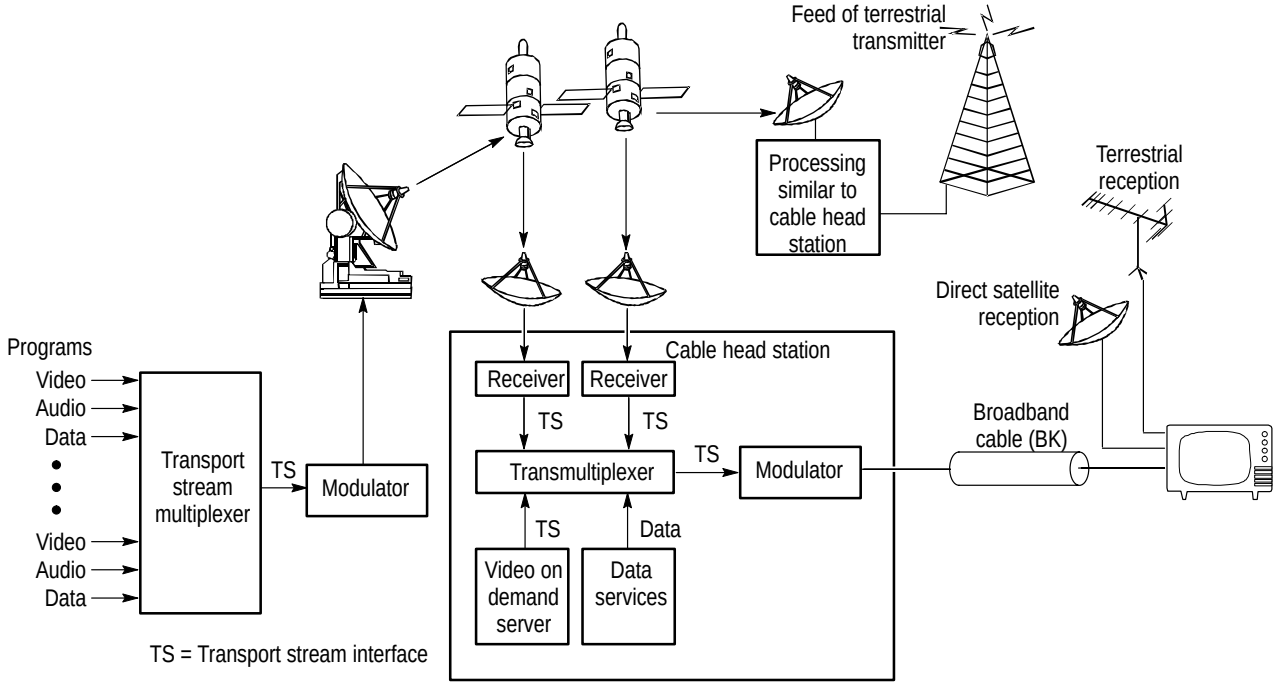


Figure 1–1: Scenario for a DVB distribution network

MPEG-2 Systems

This section describes the structure of a transport stream starting with decoding. The individual steps required for decoding a program are illustrated and the relevant elements of the data stream required are explained. Figure 1–2 presents an overview of the steps involved. The following subsections describe the decoding steps. The most important syntax elements are given in Figure 1–4 through Figure 1–10 starting on page 1–11.

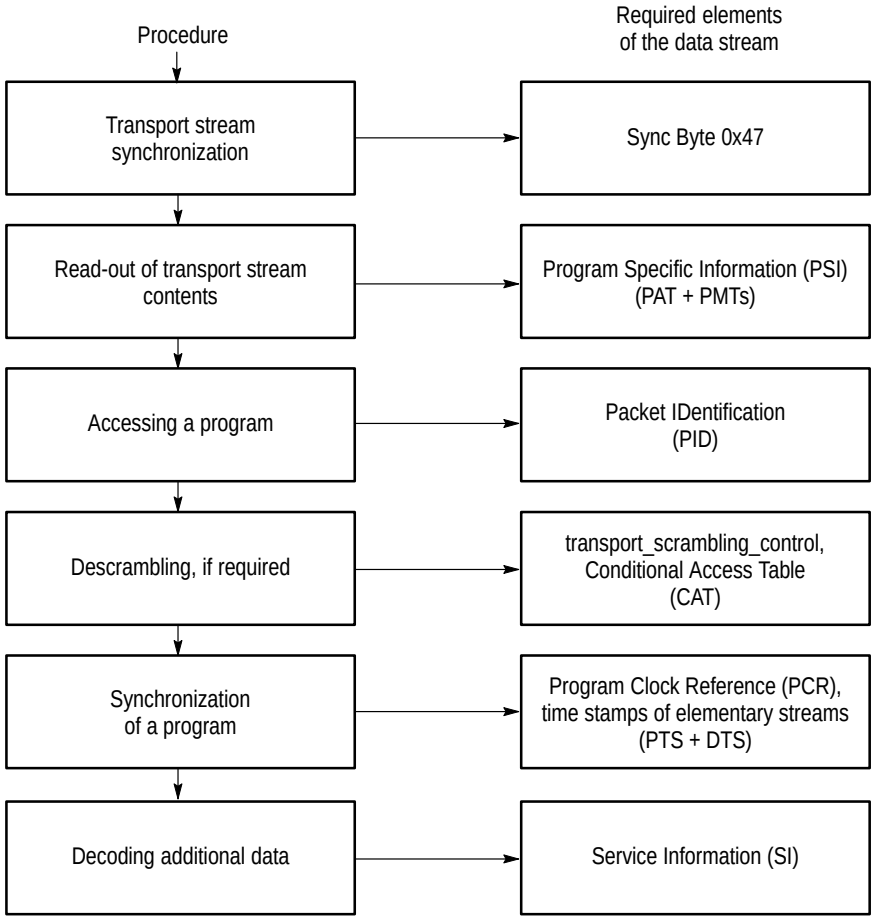


Figure 1–2: Functions of a transport stream demultiplexer

Transport Stream Synchronization and Packet Identification

The transport stream as a multiplex stream has to receive data from different elementary streams. The beginning of a new packet is marked by a sync byte 0x47. The packets of a transport stream have a fixed length of 188 bytes. The value 0x47 is not exclusively reserved for the beginning of a packet. Thus, this value does not always indicate a packet start.

To ensure stable synchronization, however, the repetitive occurrence of a sync byte at 188-byte intervals must be checked. The hysteresis parameters define how often the value 0x47 must occur at 188-byte intervals for the packet synchronization to be considered locked or how often the sync byte must be missing or the wrong for the packet synchronization to be declared lost.

The sync byte interval can also be 204 bytes (188 + 16 bytes). In this case, the last 16 bytes originate from the channel coding (Reed-Solomon error protection). Channel decoding has already taken place at the transport stream level so that the 16 bytes at the end of each packet do not carry any useful information. Only the clock conversion from 204 to 188 bytes per packet duration has not been performed.

A header with a length of four bytes precedes each transport stream packet. The first byte of the header is the sync byte, as described above. If not all the bit errors caused by transmission can be eliminated during channel decoding, the Transport Error Indicator is set in the header of the packet concerned.

Critical information for identifying a packet is the PID (Packet IDentification). The PID is a field of 13 bits. It can thus have 8196 different values. A PID is assigned to each substream such as a video or audio stream (not to a program). Some PID values are fixed, such as value 0x000 for the PAT (see *Contents of the Transport Stream* on page 1–6), value 0x0001 for the CAT (see *Descrambling* on page 1–8), and value 0x1FFF for the so-called zero packets that do not contain useful data but only dummy bytes.

Contents of the Transport Stream

The transport stream normally contains several programs consisting of several elementary streams. The contents of the transport stream is described in the Program Specific Information (PSI). Each transport stream contains a Program Association Table (PAT) as well as one or several Program Map Tables (PMTs).

The PAT is contained in the transport stream packets with the PID 0x0000. It refers to all the programs contained in the transport stream. The PAT indicates the program number and the corresponding PID for the Program Map Table (PMT).

The elementary streams (vision, sound, data) that belong to the individual programs are described in a PMT. A PMT consists of one or several sections, each describing a program.

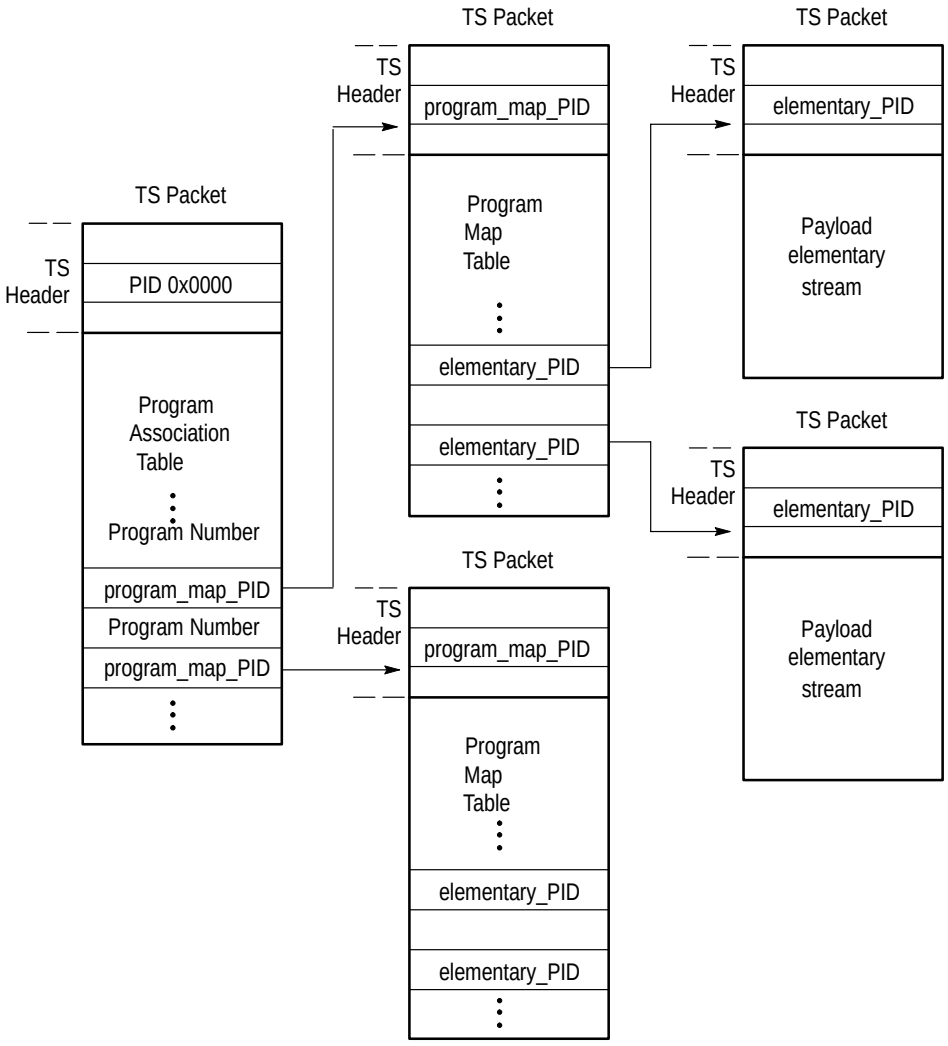


Figure 1–3: PAT and PMT describe the contents of a transport stream

Access to a Program

If the programs contain contending elementary streams, such as several audio streams, a selection must be made. The packets of the selected elementary streams identified by PID now must be conveyed from the demultiplexer to the associated decoders.

Analyzing the Continuity Counter in the packet header permits checking whether individual packets belonging to an elementary stream arrive completely and in the correct order. The Continuity Counter is represented by the four least significant bits of the last header bytes (bit 29 to bit 32 of each packet). The value (0–15) is incremented with each new packet. Value 15 is followed by a zero.

Two exceptions are permissible:

- The Discontinuity Indicator is set in the Adaptation Field (for example, during a program step). See Figure 1–5 on page 1–11. The Continuity Counter can then have any value.
- A packet may be transferred twice. The Continuity Counter must not be incremented.

Descrambling

The received data can be scrambled. Scrambling is performed at the level of the transport stream (TS) or of the packetized elementary stream (PES).

The corresponding header information (PES header or TS header) remains unscrambled. If scrambling is required at the transport stream level, this also includes the PES header, whereas the TS headers remain unscrambled in all cases.

If a packet (TS packet or PES packet) is scrambled, this is indicated by the first bit of the scrambling control field of the associated header (TS header or PES header). The second bit in the scrambling control field is required, since the scrambling code changes from time to time. This bit is set if a new scrambling code is valid for the packet in question.

To be able to perform descrambling, the decoder requires specific control data that are transmitted with the entitlement control messages (ECM) and the entitlement management messages (EMM). The ECM contain the scrambling codes and the EMM distribute the access authorizations for the receivers. ECM and EMM are included and referred to in the program specific information (CAT or PMT).

Descrambling is performed in a supplier-specific hardware, which can be connected to the decoder via a DVB-defined interface.

Program Synchronization

In general, a program comprises several elementary streams. A common clock reference is required to synchronize the decoding and display (or output) of the individual elementary streams. This clock reference for each program comes as Program Clock Reference (PCR) and is carried along in an elementary stream of the program. To this effect, every 40 ms at maximum, the 4-byte header of a transport packet is extended by an Adaptation Field (see Figure 1–5 on page 1–11) which contains not only a variety of other signaling information that cannot be dealt with here, but also the PCR. The Adaptation Field is always unscrambled.

The PCR value (42 bits long) corresponds to the state of a counter with a 27 MHz clock at the time of arrival of the first TS-packet byte containing the PCR value. It is used in the decoder for controlling the 27 MHz system clock PLL. Thus, the synchronization of the multiplexer at the transmitter end and of the demultiplexer at the receiver end is ensured.

The individual elementary streams contain time stamps, such as the Decoding Time Stamps (DTS) and the Presentation Time Stamps (PTS), for synchronizing the decoding and display of the individual elementary streams. The Packetized Elementary streams (PES) are transmitted in packets with up to a length of 64 kBytes (more for video streams), which define a certain display length (e.g., a picture in case of video streams). A header precedes each packet of an elementary stream (PES). The header also contains the DTS and PTS. If a transport packet contains the beginning of a PES packet, the 10th bit (Payload Unit Start Indicator) is set in the header of the transport packet.

The PTS / DTS value (33 bit) corresponds to the state of a 90 kHz counter and refers to the 33 most significant bits of the PCR. The ratio of 27 MHz (PCR) to 90 kHz (PTS / DTS) is 300 and is attained by the fact that the 9 least significant bits of PCR only count to 300 (instead of 512).

Two different time stamps (DTS and PTS) are provided, since the order of arrival of the PES packets and their decoding does not always correspond to the order of display (for instance during the transmission of difference pictures in video streams). In many cases, only one PTS is available.

Service Information

The tables defined by the DVB project (see ETS 300 468) are to be seen as service information. The information contained in these tables is not required for decoding, but provides convenient access for the end user: it might be program information for the viewer or control information for the decoder and units connected to it.

In many cases, PSI (Program Specific Information) is also mentioned in connection with SI (Service Information). PSI is already defined in MPEG-2 and contains the above-mentioned tables PAT (Program Association Table), PMT (Program Map Table), CAT (Conditional Access Table), and NIT (Network Information Table). The latter contains data provided by the network operator for tuning the receivers (for example, orbit positions or transponder numbers). The CAT and NIT contents are specified by the DVB project (and not by MPEG).

Tables additionally defined by the DVB project are as follows:

- BAT (Bouquet Association Table) contains information about the different programs of a broadcaster irrespective of their propagation paths.
- SDT (Service Description Table) describes the programs offered.
- EIT (Event Information table) supplies the data base for an electronic TV guide with information about the type of program and age classification for the viewer.
- RST (Running Status Table) contains status information about the individual programs and especially serves for controlling video recorders.

- TDT (Time and Date Table) provides information about date and current time (UTC).
- TOT (Time Offset Table) provides information about the local time offset in addition to date and time.
- ST (Stuffing Table) has no relevant contents. It is generated when invalid tables are overwritten during transmission (for example, at cable headends).

The PIDs for the tables are predefined. The PMTs whose PIDs are defined in the PAT are an exception. Each table has a table_id at the beginning of each table. This table_id is required to transmit different tables with a single PID. The interrelation of table type, PID and table_id is shown in Table 1–1.

Table 1–1: PID and Table_ID for PSI / SI

Table	PID	Table_ID
PAT	0x0000	0x00
PMT	0x0020 to 0x1FFE	0x02
CAT	0x0001	0x01
NIT	0x0010	0x40 to 0x41
BAT	0x0011	0x4A
SDT	0x0011	0x42, 0x46
EIT	0x0012	0x4E to 0x6F
RST	0x0013	0x71
TDT	0x0014	0x70
TOT	0x0014	0x73
ST	0x0010 to 0x0014	0x72

Syntax Diagrams

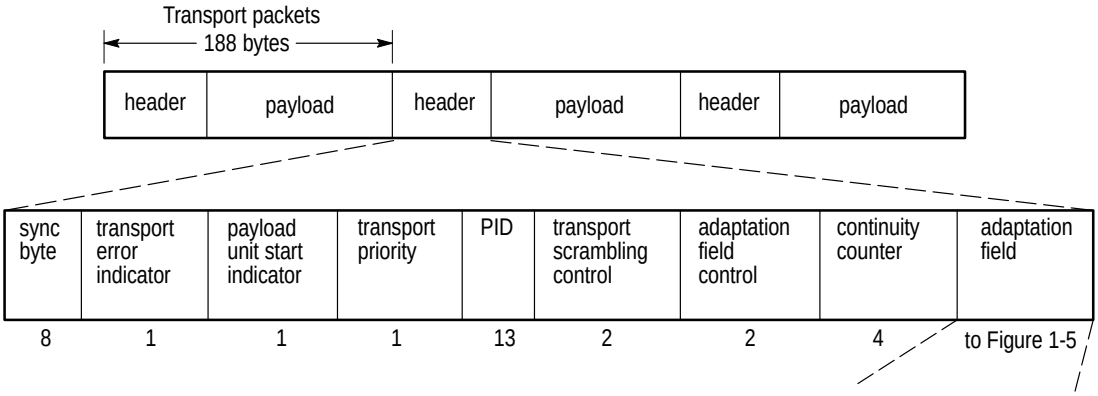


Figure 1–4: Transport packet

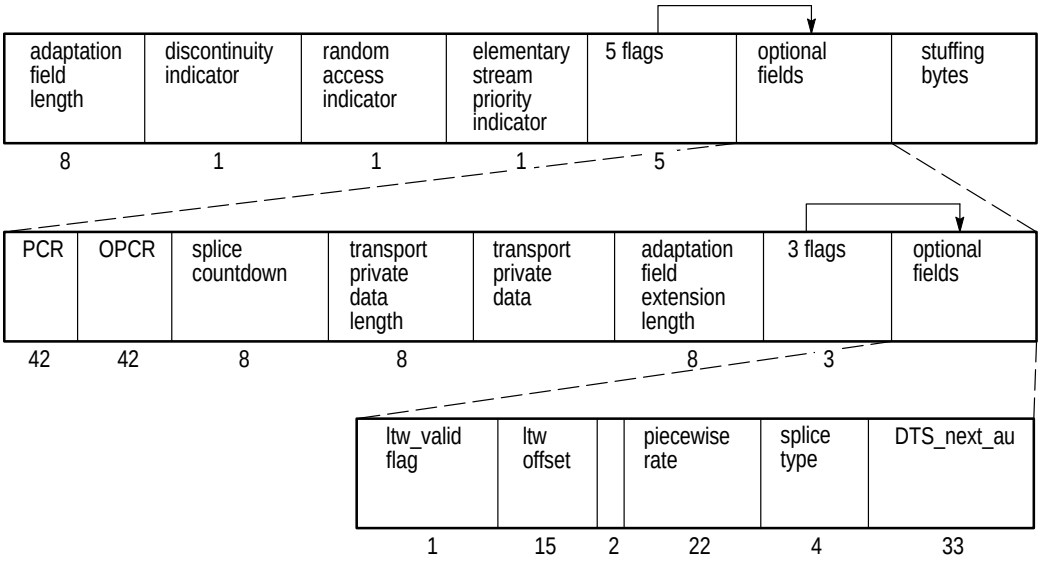


Figure 1–5: Adaptation field

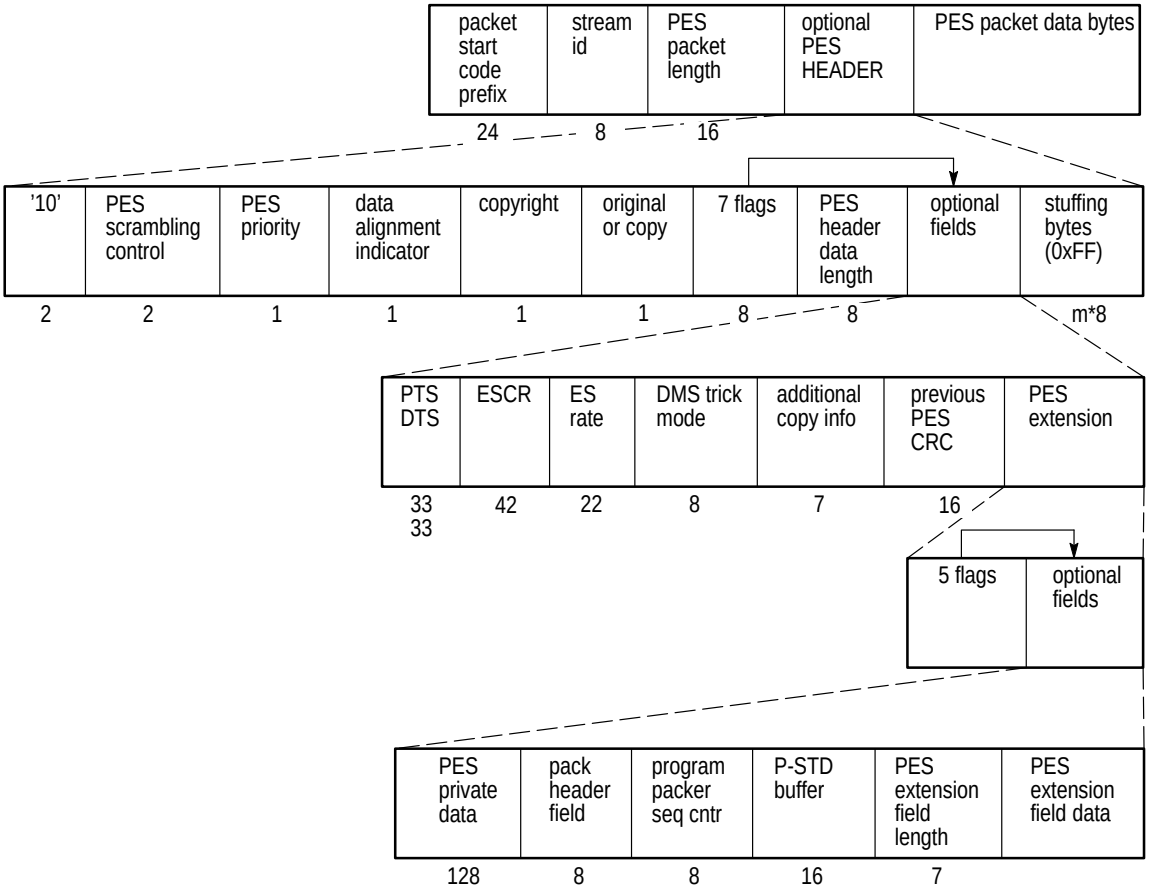


Figure 1–6: PES header

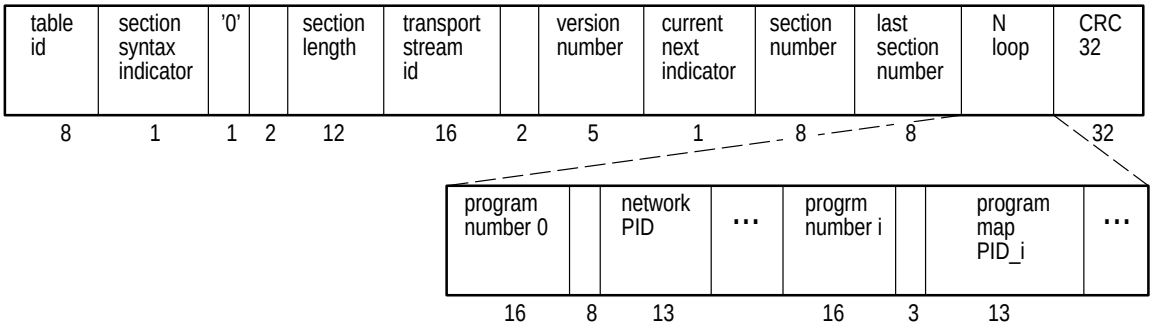


Figure 1–7: Program association section

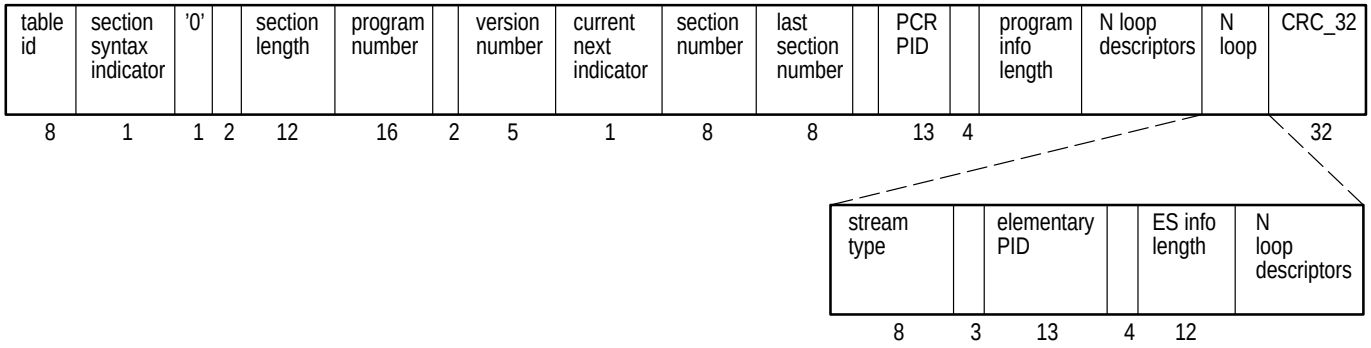


Figure 1–8: Program map section

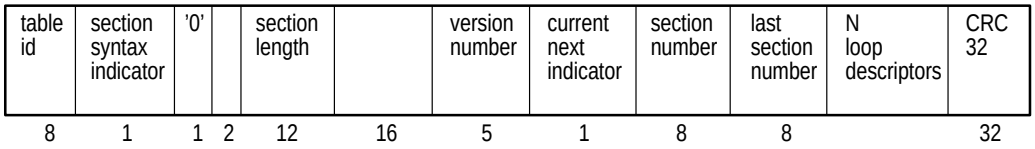


Figure 1–9: Conditional access section

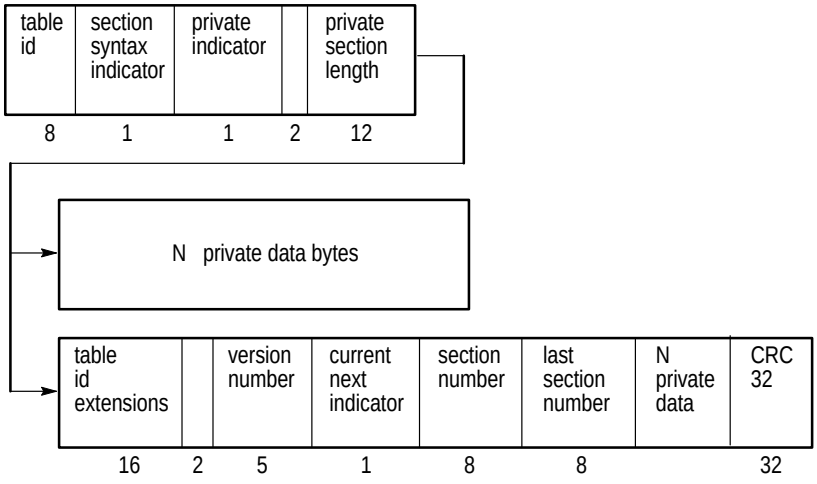


Figure 1–10: Private section

Measurement Functions

In this section you will find a comprehensive description of all measurement functions and error LEDs provided on the MTD200 MPEG Test Decoder to monitor an MPEG-2 transport stream. These measurement functions fully comply with the DVB guidelines for monitoring MPEG-2 transport stream syntax (DVB Measurement Guidelines ETR 290). Moreover, the MPEG test decoder calculates the total transport stream data rate as well as the data rates of all programs contained in the transport stream and their elementary streams.

There are ten LEDs on the front panel for displaying detected transport stream errors. A liquid crystal display (LCD) on the front panel and an on screen display (OSD) on an external video screen are also available for more informative error indication. The OSD information is overlaid on the decoded video signal at the video outputs as a measurement window (refer to *On Screen Display (OSD)* on page 4–32). All information on the display of the measurement parameters given in this section apply to the LCD as well as to the OSD.

Elements of Transport Stream Syntax

Figure 2–1 shows an overview of the basic structure of a transport stream. Elements of the transport stream syntax that are relevant for monitoring, such as packet header, adaptation field or PES (Packetized Elementary Stream) header, are shown in detail.

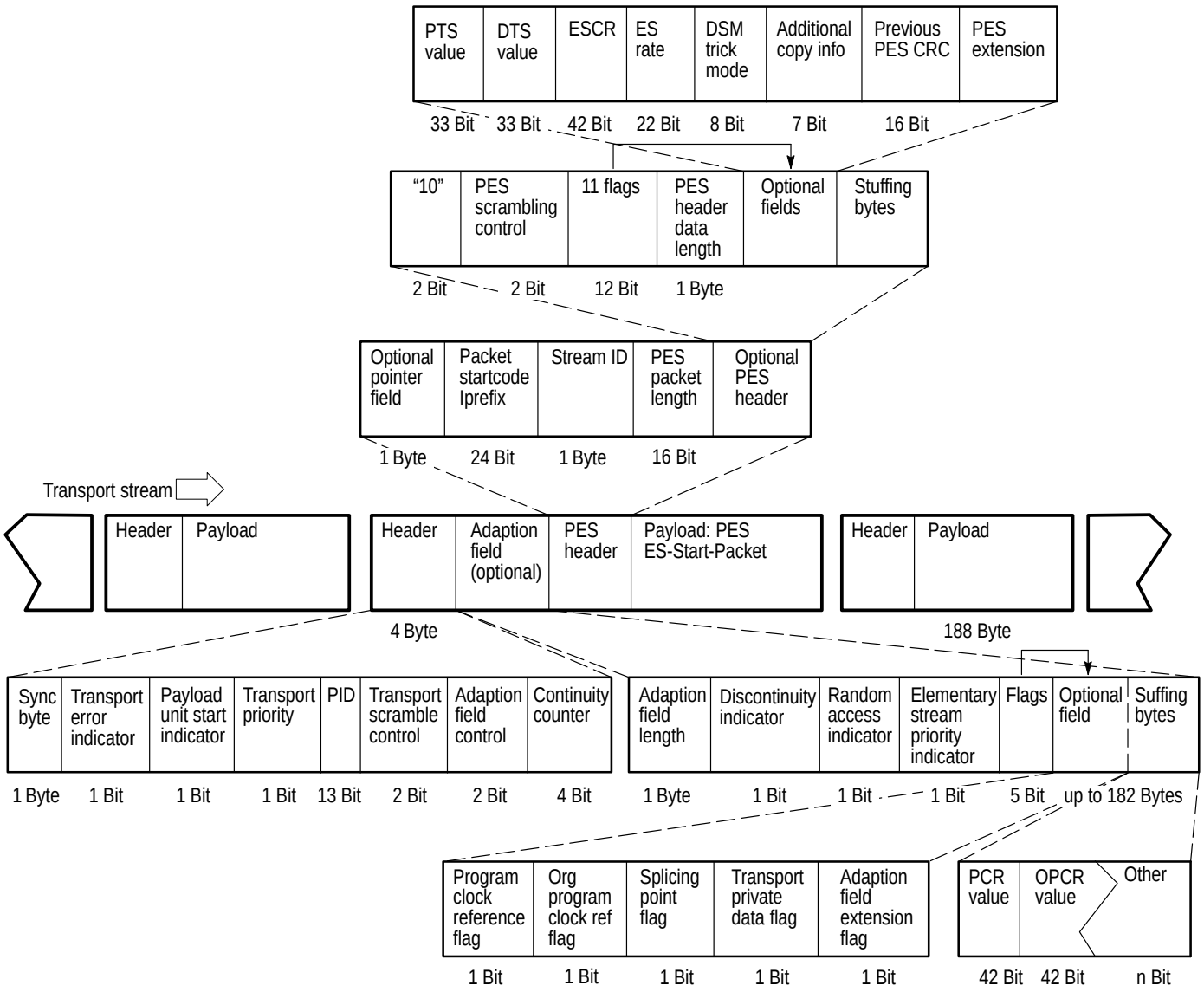


Figure 2–1: Elements of the transport stream syntax

Overview of All Measurement Functions

The measurement functions of the MPEG test decoder fully comply with the recommendations contained in the DVB Measurement Guidelines (ETR 290) for the analysis of MPEG-2 transport stream syntax.

Table 2–1 shows an overview of all measurement functions of the MPEG test decoder and information on error indication, either as a cumulative message (LED) or as a detailed error message in the Monitoring Statistic or the Monitoring Report menu on the LCD or OSD. Refer to *MONITORING / STATISTICS Menu* on page 4–12 and *MONITORING / REPORT Menu* on page 4–13.

In addition to the measurement functions shown in Table 2–1, the MPEG test decoder also calculates the following values from the transport stream multiplex:

- Total transport stream data rate [MBit/s]
- Data rates of all individual programs in the TS multiplex [Mbit/s]
- Data rates of all elementary streams of the individual programs in the TS multiplex [Mbit/s]
- Data rate for null packets
- Data rate for PSI/SI table

NOTE. *The data rates of programs and single streams calculated by the MTD200 are the gross rates of the programs and single streams. Packet headers and possible adaptation fields are considered in the measured value.*

The transport stream data rates measured are displayed on the LCD or OSD in the DECODER / SELECT PROGRAM menu (see page 4–21).

Table 2–1: Overview of measurement functions

Measurement	Priority (ETR 290)	Error display			PID Info	Trigger on error?	Error no. (ETR 290)
		LED	LCD / OSD	Error condition			
TS_sync_loss	1	⊙ TS	TS-Sync	Loss OK	— —	yes yes	1.1
Sync_byte_error	1	⊙ SYNC	Sync. Byte	Single Burst	no no	yes yes	1.2
PAT_error	1	⊙ PAT	PAT	Upper Distance Table ID Scrambled	yes yes yes	no yes yes	1.3
Continuity_count_error	1	⊙ COUNT	Cont. Cnt.	Packet Order More Than Twice Lost Packet	yes yes yes	yes yes yes	1.4

Table 2–1: Overview of measurement functions (cont.)

Measurement	Priority (ETR 290)	Error display			PID Info	Trigger on error?	Error no. (ETR 290)
		LED	LCD / OSD	Error condition			
PMT_error	1	⊙ PMT	PMT	Upper Distance Scrambled	yes yes	no yes	1.5
PID_error	1	⊙ PID	PID Missing		yes	no	1.6
Transport_error	2	⊙ TRANS	Transport		yes	yes	2.1
CRC_error	2	⊙ CRC	CRC	PAT CAT PMT NIT EIT BAT SDT TOT	yes yes yes yes yes yes yes yes	yes yes yes yes yes yes yes yes	2.2
PCR_error and PCR_accuracy_error	2 2	⊙ OTHER	PCR	Discontinuity Upper Distance	yes yes yes	yes no no	2.3 and 2.4
PTS_error	2	⊙ OTHER	PTS		yes	no	2.5
CAT_error	2	⊙ OTHER	CAT	Table ID Missing	yes yes	yes yes	2.6
SI_repetition_error	3	⊙ OTHER	SI REP.	PAT Upp/Low Dist. CAT Upp/Low Dist. PMT Upp/Low Dist. NIT Upp/Low Dist. SDT Upp/Low Dist. BAT Upp/Low Dist. EIT Upp/Low Dist. RST Upp Dist. TDT Upp/Low Dist. TOT Upp/Low Dist.	yes yes yes yes yes yes yes yes yes yes	no no no no no no no no no no	3.2
NIT_error	3	⊙ OTHER	NIT	Table ID NIT Upper Dist.	yes yes	yes no	3.1
SDT_error	3	⊙ OTHER	SDT	Table ID SDT Upper Dist.	yes yes	yes no	3.5
EIT_error	3	⊙ OTHER	EIT	Table ID EIT Upper Dist.	yes yes	yes no	3.6
RST_error	3	⊙ OTHER	RST	Table ID	yes	yes	3.7
TDT_error	3	⊙ OTHER	TDT	Table ID TDT Upper Dist.	yes yes	yes no	3.8
unreferenced_PID	3	⊙ OTHER	Unref. PID		yes	yes	3.4

TS_Sync_Loss (1st priority)

Each packet of the transport stream is preceded by a header consisting of four bytes. The first byte of the header is the synchronization byte (SyncByte), whose content is always the hexadecimal value 0x47. In the MPEG-2 decoder, the SyncByte serves for synchronization with the packetized transport stream. DVB recommendations define synchronism such that a sequence of at least five SyncBytes has to be detected by the MPEG-2 decoder. Synchronism is lost if the SyncBytes in a sequence of at least three TS packets are not detected according to the DVB recommendations. This status is referred to as TS_Sync_Loss. The synchronization hysteresis of 5/3 SyncBytes recommended in the DVB guidelines is also a basic setting in the MPEG test decoder, although it may be modified for synchronization tests (refer to *TS INPUT / SYNC CONDITION Menu* on page 4–28).

In the DVB Measurement Guidelines (ETR290), the preconditions for a TS_Sync_Loss message are set as follows:

TS_Sync_Loss is signaled if
■ the content of the synchronization bytes in a sequence of three TS packets does not equal 0×47 (hexadecimal)

Two LEDs labeled TS and located one above the other at the very left of the front panel serve to display the synchronization status. An error (no synchronism) is indicated by the yellow LED (top); synchronism is indicated by the green LED (bottom) lighting.

Sync_byte_error (1st priority)

Each packet of the transport stream is preceded by a header consisting of four bytes. The first byte of the header is the synchronization byte (SyncByte), whose content is always the hexadecimal value 0x47. In the MPEG-2 decoder the SyncByte serves for synchronization with the packetized transport stream. If the SyncByte is missing or contains errors too often, the decoder will not be able to synchronize to the transport stream.

The MPEG test decoder checks the SyncByte of every packet in the transport stream for correct contents.

In the DVB Measurement Guidelines (ETR290), the preconditions for a SyncByte_Error message are set as follows:

SyncByte ERROR is signaled if
■ the content of the synchronization byte in the TS header does not equal 0x47 (hexadecimal)

An error of this type is indicated by the LED labeled SYNC lighting (line of LEDs at front panel). Additional information on the fault triggering the SyncByte error message (SINGLE = single error or BURST = Burst error) can be obtained from the monitoring report.

PAT_error (1st priority)

The Program Association Table (PAT) contains a list of all programs and PIDs contained in the transport stream and of associated PMTs (Program Map Tables), which contain detailed program descriptions. The PAT is of key importance for decoding TV and audio programs. If the PAT is not available or contains an error, the MPEG-2 decoder will not be able to select and decode a program from the transport stream multiplex.

The syntactic structure of a PAT is comprehensively defined in MPEG-2 systems (ISO/IEC 13818–1). The PAT is exclusively transmitted in packets with 0x0000 as PID. The table may be divided into a maximum of 256 sections with the table index (table_id) of each section being 0x00.

In the DVB Measurement Guidelines (ETR290), the preconditions for a PAT_Error message are set as follows (abbreviated designations in parentheses are the text displayed in the monitoring report):

PAT ERROR is signaled if	
■ PAT table index does not equal 0x00 (TABLE ID)	or
■ PAT is transmitted in encrypted form (SCRAMBLED)	or
■ PAT is not transmitted at least every 0.5 second (UPPER DISTANCE)	

An error of this type (cumulative message) is indicated by the LED labeled PAT lighting (line of LEDs at front panel). Detailed information on the type of PAT error as defined in the above table can be obtained from the monitoring report.

PMT_error (1st priority)

The PMT (Program Map Table) is a table for detailed program descriptions referenced in the PAT. As essential information for the MPEG-2 decoder, it contains the PIDs of all packets of the individual TV, audio, and data streams (elementary-stream PIDs) as well as the PIDs of packets serving for the transmission of PCR values associated with the program. Like the PAT, the PMT is of key importance for decoding TV and audio programs. If PMT is not available or contains an error, the MPEG-2 decoder will not be able to select and decode a program from the transport stream multiplex.

The syntactic structure of a PMT is defined in MPEG-2 systems (ISO/IEC 13818-1). In contrast to the PAT, the PIDs of the individual PMTs are variable; MPEG-2 permits values ranging from 0x0010 to 0x1 FFE (compare to DVB ETS 300468: 0x0020 to 0x1 FFE). The table may be divided into a maximum of 256 sections with one section for each program. The table index (table_id) of each section must be 0x02.

In the DVB Measurement Guidelines (ETR290), the preconditions for a PMT_Error message are set as follows (abbreviated designations in parentheses are as text displayed in the monitoring report):

PMT ERROR is signaled if	
■ PMT table index does not equal 0x02 (TABLE ID)	or
■ PMT is transmitted in encrypted form (SCRAMBLED)	or
■ PMT is not transmitted at least every 0.5 second (UPPER DISTANCE)	

An error of this type (cumulative message) is indicated by the LED labeled PMT lighting (line of LEDs at front panel). Detailed information on the type of PMT error as defined in the above table can be obtained from the monitoring report.

Continuity_count_error (1st priority)

Each packet of the transport stream is preceded by a header consisting of four bytes. The fourth byte of the header contains the count of a four-bit continuity counter. The count must be increased by one for every packet of the transport stream that has the same PID. The count may consist of values ranging from 0 to 15; beyond 15, it will start from 0 again (modulo-16 counter). The continuity counter serves to recognize packets of a TV or audio program that are either missing or repeated more than once.

The MPEG-2 standard also tolerates counter discontinuity, provided this is indicated by a discontinuity indicator in the optional adaptation field (AF) of the same packet. This method is primarily used for the suppression of error messages when changing programs preceded by remultiplexing of the transport stream.

In the case of null packets (packets that do not contain any useful data but have a PID of 0x1FFF), continuity is not checked, since the value of the continuity counter in zero packets is not defined in the MPEG-2 standard.

In the DVB Measurement Guidelines (ETR 290), the preconditions for a Continuity_Count_Error message are set as follows (abbreviated designations in parentheses are the text displayed in the monitoring report):

Continuity Count ERROR is signaled if	
■ the same packet has been transmitted more than twice without discontinuity indicator (MORE THAN TWICE)	or
■ a packet is missing, (new count = old count + 2 without discontinuity indicator (LOST PACKET))	or
■ there is a wrong sequence of packets (discontinuity without discontinuity indicator, without any of the above conditions present (PACKET ORDER))	

An error of this type (cumulative fault) is indicated by the LED labeled CONT lighting (line of LEDs at front panel). More detailed information on the type of Continuity_Count Errors as listed in the above table can be obtained from the monitoring report.

PID_error (1st priority)

The PMT (Program Map Table) entries reveal the elementary-stream PIDs that are contained in the transport-stream multiplex. To decode a program with the corresponding PID, these packets must be contained in the transport stream, and for the MPEG-2 decoder to function error-free these packets also need to be transmitted at certain intervals. The DVB Measurement Guidelines (ETR 290) speak of a user specified period, which means that it can be freely selected by the user. The preset value for the MPEG test decoder is 0.5 s, but it can be modified in the MONITORING / LIMITS menu according to individual requirements (refer to *MONITORING / LIMITS Me*nu on page 4–15).

In the DVB Measurement Guidelines (ETR 290), the preconditions for a PID_Error message are set as follows:

PID ERROR is signaled if
■ the interval between two elementary-stream packets of the same PID is > 0.5 seconds

An error of this type (cumulative message) is indicated by the LED labeled PID lighting (line of LEDs at front panel). More detailed information on the type of PID error as listed in the above table can be obtained from the monitoring report.

Transport_error (2nd priority)

The second byte of every packet header in the transport stream contains the transport_error_indicator, which is a flag that serves to indicate bit errors in the following packet. This flag is generated and inserted by the Viterbi or Reed-Solomon decoder at the receiver end if the decoder is no longer capable of correcting all bit and byte errors in the transport stream.

Because it is not possible in case of a set transport_error_indicator to predict which bit or byte contains an error, this packet must not be evaluated by an MPEG-2 decoder. For this reason, the MPEG test decoder only indicates the Transport_Error, which means that the packet is not checked for further transport stream errors.

In the DVB Measurement Guidelines (ETR 290) the preconditions for a Transport_Error message are set as follows:

Transport ERROR is signaled if
■ a transport_error_indicator bit is set in the packet header

An error of this type (cumulative message) is indicated by the LED labeled TRANS lighting (line of LEDs at the front panel). As additional information, the PID of the packet containing the error can be obtained from the monitoring report.

***NOTE**. The PID information contained in the monitoring report may be wrong if a transport error is indicated and if the bit error concerns the PID information of the packet header.*

CRC_error (2nd priority)

If program-specific information (PSI tables), such as PAT, CAT, PMT, NIT, EIT, SDT, BAT and TOT, is transmitted, a value for checking the check sum of this section is inserted at the end of each table section. The so-called CRC (Cyclic Redundancy Check) is used for calculating the check sum at the transmitter and receiver end. Combined with the additionally transmitted CRC value, the check sum for each table section must be zero.

If the resulting check sum does not equal zero, the MPEG-2 decoder must reject the information contained in this table.

If a CRC_error is detected, it cannot be predicted which part of the information contained in the table is not correct. In this case, the MPEG test decoder signals the CRC_error, but the transport stream is not checked for further errors which are derived from the faulty content of this table (for example, a search for PMT PIDs from a PAT or ES PIDs from a PMT).

In the DVB Measurement Guidelines (ETR 290), the preconditions for a CRC_Error message are set as follows:

CRC ERROR is signaled if
■ a packet with PAT, CAT, PMT, NIT, EIT, BAT, SDT or TOT and CR check of a section does not equal zero

An error of this type (cumulative message) is indicated by the LED labeled CRC lighting (line of LEDs at front panel). As additional information, the PID of the packet containing the error can be obtained from the monitoring report.

PCR_error, PCR_accuracy_error (2nd priority)

In every transport stream, coded time values obtained from the system time are transmitted to enable the MPEG-2 decoder to link its own timing to the system timing of the coder to allow decoding (PLL). Each program contained in the transport stream may have its own independent program system timing (referenced in PMT). The program map table (PMT) reveals for all programs contained in the transport stream in which packets (PIDs) the PCR (Program Clock Reference) values are transmitted.

PCR values are transferred in the optional Adaptation Field with a width of 42 bits. The 42 bits contain two parts: a PCR base with 33 bits and the PCR extension with 9 bits. The following formulae hold for the bit structure :

PCR base (i) = (system clock frequency * t(i) DIV 300) % 2^{33}

PCR extension (i) = (system clock frequency * t(i) DIV 1) % 300

PCR (i) = (PCR base (i) * 300) + PCR extension (i)

A 42-bit PCR value coded this way starts again from count 0 after the elapse of 2^{33} * 300 clocks (corresponds to a time period of approximately 26.5 hours at 27 MHz).

The MPEG-2 standard also tolerates discontinuity of PCR values following one another, provided this is indicated by the discontinuity indicator in the optional adaptation field (AF) of the same packet. This method is primarily used for the suppression of PCR error messages when changing programs preceded by remultiplexing of the transport stream.

In the DVB Measurement Guidelines (ETR 290) the preconditions for a PCR_Error message are set as follows (abbreviated designations in parentheses are the text displayed in the monitoring report):

PCR ERROR is signaled if	
■ the difference of two consecutive PCR values of a program is > 100 ms and no discontinuity is indicated in the optional adaptation field (DISCONTINUITY)	or
■ the interval between two packets with PCR values of a program is > 40 ms (UPPER DISTANCE)	

The above mentioned intervals are given in the DVB Measurement Guidelines (ETR 290) and are preset in the MPEG test decoder, but they can also be modified according to individual requirements in the MONITORING / LIMITS menu (refer to *MONITORING / LIMITS Menu* on page 4–15).

The DVB Measurement Guidelines also recommend additional monitoring of the accuracy of the PCR values transmitted. Accuracy of PCR values may be impaired by inaccurate calculation of the 42-bit PCR word width or by errors during modification of PCR values in a remultiplex.

***NOTE**. The term accuracy in this case does not refer to absolute frequency accuracy of the 27 MHz system timing, but to the fluctuation width of the PCR values of a program, which is caused by the above mentioned errors.*

The MPEG-2 standard (ISO/IEC 13818–1) as well as the DVB Measurement Guidelines (ETR 290) prescribe a maximum tolerance of ± 500 ns for PCR values. The MPEG-2 standard (ISO/IEC 13818–4) also describes a method to be used for testing the so-called timing accuracy, which serves to monitor the compliance of these PCR tolerances. The description of this method contains an inequation, which must be fulfilled for all PCR values of a program. This inequation is as follows:

$$\frac{(i-i''-1)}{PCR(i)-PCR(i'') + \delta} \leq k \leq \frac{(i-i'' + 1)}{PCR(i)-PCR(i'')-\delta}$$

i being	index of the byte in which the current PCR value was transmitted
i'' being	index of the byte in which the previous PCR value was transmitted
δ being	27 + 810 * (PCR(i)–PCR(i'')) / 27E6;

If the above inequation is not fulfilled for any consecutive two pairs of PCR values, (maximum value of the left side and minimum values of the right side are stored) the precondition for a PCR_accuracy_error is fulfilled.

PCR Accuracy ERROR is signaled if
■ the PCR tolerance within a program is > ± 500 ns

A PCR_error and a PCR_accuracy_error are indicated in a cumulative message signaling several single errors by the LED labeled OTHER lighting (line of LEDs at front panel). More detailed information on the type of PCR error as listed in the above tables can be obtained from the monitoring report.

PTS_error (2nd priority)

Presentation Time Stamps (PTS values) in the PES headers are transmitted by transport stream packets of a program. They enable the MPEG-2 decoder to identify the exact time when a transmitted data block (TV picture for video streams and beginning of an audio sequence for audio streams) is to be presented. The time stamps are transmitted with a word width of 33 bits and relate to the 27 MHz system timing sequence transmitted in the transport stream together with the PCR values.

In the DVB Measurement Guidelines (ETR 290), the preconditions for a PTS_Error message are set as follows:

PTS ERROR is signaled if
■ magnitude of the difference of two consecutive PTS values following one another is > 700 ms

The above mentioned interval is given in the DVB Measurement Guidelines (ETR 290) and is preset in the MPEG test decoder, but it can also be modified according to individual requirements in the MONITORING / LIMITS menu (refer to *MONITORING / LIMITS Menu* on page 4–15).

An error of this type is indicated in a cumulative message signaling several single errors by the LED labeled OTHER lighting (line of LEDs at front panel). As additional information, the PID of the program containing the faulty PTS values can be obtained from the monitoring report.

CAT_error (2nd priority)

If encrypted data are contained in a packet of the transport stream, this must be indicated in the packet header (2nd byte) within the field that is two bits wide and is labeled transport_scrambling_control. The individual values indicate the following:

Value (binary)	Description
00	No encrypted data contained in the packet
01, 10, 11	Defined by user

If encrypted data are to be transmitted, the MPEG-2 standard recommends the additional transmission of the tables containing the encryption data (Conditional Access Table, CAT) in separate packets with (0x0001) as PID and 0x01 as table index.

The MPEG-2 standard prescribes that packet header including the optional adaptation fields must not be transmitted in encrypted form. According to DVB specifications (ETS 300 468), the same applies to tables containing service information (SI tables PAT, PMT, NIT, EIT, BAT, TDT, TOT and SDT). The only exception to this rule is the EIT (Event Information Table) when program overviews are transmitted.

In the DVB Measurement Guidelines (ETR 290) the preconditions for a CAT_Error message are set as follows (abbreviated designations in parentheses are the text displayed in the monitoring report):

CAT ERROR is signaled if	
■ a packet contains encrypted data, but no CAT is found (MISSING)	or
■ a packet with CAT-PID (0x0001) is found, but table index does not equal 0x01 (TABLE ID)	

An error of this type is indicated in a cumulative message indicating several single errors by the LED labeled OTHER lighting (line of LEDs at front panel). Additional information on the type of error as listed in the above table can be obtained from the monitoring report.

SI_repetition_error (3rd priority)

The DVB standard (ETR211) prescribes minimum and maximum intervals for the repetition of individual packets and has complete tables containing service information (SI). See Table 2–2. These values are preset in the MPEG test decoder, but each value can be modified according to individual requirements in the Monitoring/Limits menu. Refer to *MONITORING / LIMITS Menu* on page 4–15.

Table 2–2: Repetition rates for service information according to DVB

Service information	Maximum interval (complete table)	Minimum interval (individual sections)
PAT	0.5 s	25 ms
CAT	0.5 s[1]	25 ms[1]
PMT	0.5 s	25 ms
NIT	10 s	25 ms
SDT	2 s[2]	25 ms
BAT	10 s[1]	25 ms[1]
EIT	2 s[2]	25 ms
RST	—	25 ms
TDT	30 s	25 ms
TOT	30 s	25 ms

1 **If present.**

2 **For current transport stream multiplex.**

In the DVB Measurement Guidelines (ETS 300 468), the preconditions for a SI_repetition_error are set as follows:

SI_repetition_error is signaled if	
■ time difference between SI tables is too long (*** UPPER DISTANCE)	or
■ time difference between SI sections is too short (*** LOWER DISTANCE)	

The abbreviated designations in parentheses are the text displayed in the monitoring report. The series of asterisks (***) is replaced by the abbreviation used in the appropriate SI table (for example, NIT).

An error of this type is indicated in a cumulative message signaling several single errors by the LED labeled OTHER lighting (in the line of LEDs on the front panel). Additional information on the PID of the table, in which a repetition rate error was found, can be obtained from the monitoring report.

NIT, SDT, EIT, RST and TDT_error (3rd priority)

These types of service information (SI) are also inserted into the transport stream as additional data (multiplex) and contain items such as the current date, time, and description of the TV program. Each of these tables is transmitted in the form of packets with a given packet number (PID) and must be contained in the transport stream at certain intervals according to the DVB specification. However, not every SI has a different PID; packets for TDT and TOT as well as SDT and BAT have identical PIDs. These tables are differentiated by an entry in the table header, the so-called table index (table_id). This table_id enables an MPEG-2 decoder working in compliance with the DVB standard to identify the type of service information with which it is dealing.

Table 2–3 gives an overview of the service information according to the DVB guideline ETS 300 468.

Table 2–3: Overview of service information according to DVB guideline ETS 300468

Service Information	PID [hex]	Table_id [hex]	Max. interval [sec]
NIT	0x0010	0x40, 0x41, 0x42	10
SDT	0x0011	0x42, 0x46	2
BAT	0x0011	0x4A	10[1]
EIT	0x0012	0x4E to 0x4F, 0x50 to 0x6F	2[2]
RST	0x0013	0x71	—
TDT	0x0014	0x70	30
TOT	0x0014	0x73	30
Stuffing Table	0x0010 to 0x0013	0x72	—

1 **Only if present.**

2 **For the current transport stream multiplexer.**

In the DVB Measurement Guidelines (ETR 290), the preconditions for NIT_error, SDT_error, EIT_error, RST_error, or TDT_error messages are set as follows:

NIT_error, SDT_error, EIT_error, RST_error or TDT_error are signaled if	
■ a packet with the PID of an SI packet NIT, SDT, EIT, RST, TDT or TOT, but wrong table index is contained in the transport stream (TABLE ID)	or
■ time difference between SI sections of NIT, SDT, EIT, TDT or TOT is too long (*** UPPER DISTANCE)	

The abbreviated designations in parentheses are the text displayed in the monitoring report. The series of asterisks (***) is replaced by the abbreviation used in the appropriate SI table (for example, NIT).

An error of this type is indicated in a cumulative message signaling several single errors by the LED labeled OTHER lighting (in the line of LEDs at front panel). As additional information, the table_id of the packet containing the error or a possible repetition rate error can be obtained from the monitoring report.

Unreferenced PID (3rd priority)

The Program Map Table (PMT) contains a complete list of all program definitions contained in the transport stream. In turn, each program definition contains the information on all PIDs of the elementary stream packets of this program. This means that by evaluating the PMT one obtains the PIDs of all transport stream packets which are permitted to convey the useful data of the program. Besides these referenced packets, the transport stream multiplex is only permitted to contain packets with program-specific information (PSI tables) such as PAT, CAT, CA-PID, PMT, NIT, BAT, SDT, TDT, TOT, EIT, RST or having packet numbers reserved by the MPEG-2 standard.

If the program is changed (a new PMT), a nonreferenced PID may be contained in the transport stream during 0.5 s according to the DVB Measurement Guidelines (ETR 290). This interval of 0.5 s is preset in the MPEG test decoder to comply with DVB, but it can be modified according to individual requirements in the MONITORING / LIMITS menu (refer to *MONITORING / LIMITS Menu* on page 4–15).

In the DVB Measurement Guidelines (ETR 290) the preconditions for an Unreferenced_PID_Error message are set as follows:

Unreferenced PID ERROR is signaled if
■ the transport stream contains a packet with a PID which is not the PID of PAT, CAT, CA-PID, PMT, NIT, BAT, SDT, TDT, TOT, EIT or RST and which is not referenced in a PMT that is at least 0.5 second old (ES-PID or PCR-PID)

An error of this type is indicated in a cumulative message signaling several single errors by the LED labeled OTHER lighting (line of LEDs at front panel). As additional information, the PID of the packet containing the error can be obtained from the monitoring report.

Preparation for Use

This section discusses general instructions on the preparation for use and the operation of the MTD200 MPEG Test Decoder. It contains brief explanations of the controls and connectors on the front and rear panels. This chapter also provides step-by-step guidance to put the unit into operation.

Legend for Front and Rear View

The control elements of the unit are grouped together and color-coded according to their respective functions. The individual groups of control elements are described in Table 3–1 (front panel) on page 3–2 and Table 3–2 (rear panel) on page 3–4.

Front Panel

Front view of MTD200

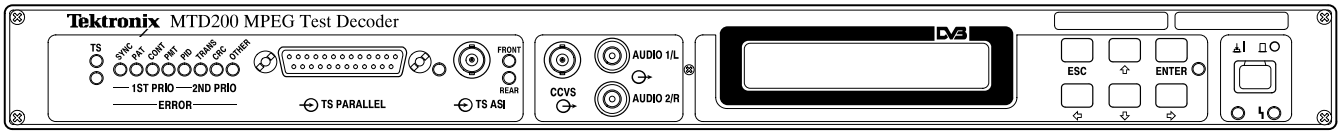


Table 3–1: Legend for front view

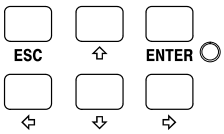
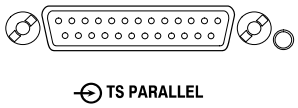
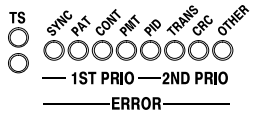
Control/Connector	Description	
	**POWER**	After the unit has been connected to the AC supply and powered on, the green LED lights signalling that the unit functions properly. The red LED signals a defect. The unit must be powered off and disconnected from AC supply to undergo repair. Quick flashing of the red LED when the unit is powered on or off does not indicate a defect.
	**KEYPAD**	The keypad comprises four CURSOR keys, the ENTER and the ESCAPE key. The CURSOR keys are used to select the desired menu item and for varying entered values. Pressing the ENTER key calls up a submenu or confirms the entered value. ESCAPE is used to quit a menu or to abort an entry procedure. The green LED lights when a value can be varied (CURSOR keys) or an entry made (ENTER).
	**LC DISPLAY**	Backlighted liquid crystal display (2 lines x 20 characters).
	**CCVS**	Analog video output. The decoded picture of a program in the MPEG transport stream is output. The output may be in PAL, SECAM or NTSC (refer to *DECODER/VIDEO OUTPUT Menu* on page 4–25). Depending on the instrument setting, measured data are inserted in the picture (refer to SETUP/ON SCREEN DISPLAY Menu page 4–32.).
	**SND 1 / L, SND 2 / R**	Analog audio outputs. A sound signal of a program in the MPEG transport stream is output.

Table 3–1: Legend for front view (cont.)

Control/Connector	Description	
	**TS ASI**	Input for an MPEG transport stream to DVB DOCUMENT A010: ASYNCHRONOUS SERIAL INTERFACE Another input of this type is provided at the rear of the unit. If one of the two inputs is selected, the respective LED lights.
	**TS PARALLEL**	Input for an MPEG transport stream to conforming to DVB DOCUMENT A010: SYNCHRONOUS PARALLEL INTERFACE If this input is selected, the LED is on.
	**ERROR INDICATION**	The two TS LEDs indicate whether the instrument identifies an MPEG transport stream at the selected input. The user-selectable hysteresis parameters are decisive (refer to *TS INPUT/SYNC CONDITION Menu* on page 4–28). If a transport stream is identified, the green LED (bottom) lights up, otherwise the yellow LED (top) is on. The other eight LEDs signal protocol errors in the transport stream in line with ETR 290. The following errors are signaled: SYNC Sync_byte_error PAT PAT_error CONT Continuity_count_error PMT PMT_error PID PID_error TRANS Transport_error CRC CRC_error OTHER PCR_error, PCR_accuracy_error, PTS_error, CAT_error, SI_repetition_error, NIT_error, SDT_error, EIT_error, RST_error, TDT_error, unreferenced PID The error messages are indicated at intervals of one second.

Rear Panel

Rear view of MTD200

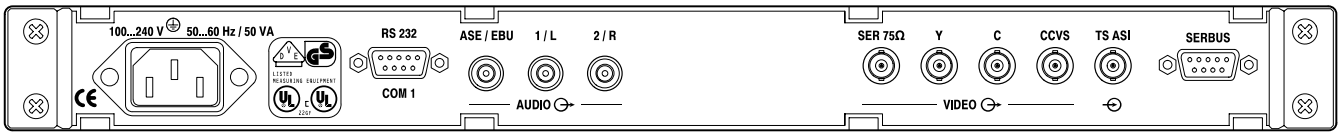
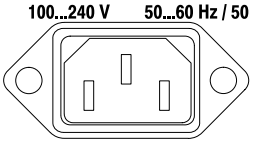
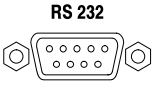
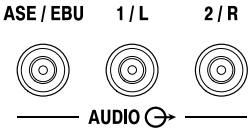
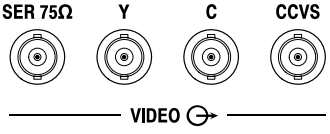


Table 3–2: Legend for rear view

Connector	Description	
	**POWER**	Power supply The attached flap may be used to prevent the power cable from becoming disconnected.
	**RS 232**	The serial interface is for remote control.
	**Audio outputs**	In addition to the analog outputs L and R, a digital AES/EBU interface is provided at the rear.
	**Video outputs**	The following outputs are available: SER 75 Ω : Digital serial interface to CCIR601 C : Chrominance signal, analog Y : Luminance signal, analog CCVS : CCVS signal, analog Depending on the instrument setup, measured data may be inserted in the picture (see *SETUP/ONSCREEN DISPLAY Menu* on page 4–32).
	**TS ASI**	Input for an MPEG transport stream to DVB DOCUMENT 010: ASYNCHRONOUS SERIAL INTERFACE When this input is selected, the front-panel LED marked TS ASI REAR lights.

Unpacking the Unit

After unpacking the unit check that the equipment supplied is complete as listed in *Standard Accessories*.

Check the unit carefully for any mechanical damage. If damage is found, immediately inform the carrier in charge of the delivery. Keep the cardboard box and the packing material in case you need to return the instrument.

Accessories

The MTD200 MPEG Test Decoder is shipped with several standard accessories. These accessories and any optional accessories are described below.

Standard Accessories

The following accessories are included with this product.

- MTD200 MPEG Test Decoder
- Power cable
- Dual LEMO/dual XLR adapter cable
- Null modem cable (RS-232)
- Locking device (used to prevent the power cable from being disconnected)
- This manual

Optional Accessories

You can order the following accessories for the MTD200 MPEG Test Decoder.

- LEMO/open adapter cable (part number 2067.7415.00)
- Dual LEMO/dual XLR cable (part number 2068.9187.00)

Installation

CAUTION. *To prevent damage to the instrument, ensure that the following conditions are met prior to operating the MPEG test decode:*

- *The earthing contact is connected to protective earth.*
- *The ventilation openings are not obstructed.*
- *The signal levels applied to the inputs are not above the permissible limits.*
- *The outputs of the instrument are not overloaded or improperly connected.*

Setting up the Unit

Desktop Model. The measurement decoder is intended for indoor use. The following site requirements must be met:

- The ambient temperature should be between + 5 and + 45 °C.
- The ventilation openings and the air outlet on top of the unit must be unobstructed.

For use in the lab or on a desk, fold down the feet at the bottom of the unit.

Accommodation in a 19-inch Rack.

CAUTION. *When mounting the unit in the rack, make sure that the air flow (air inlet and outlet at perforations) is not obstructed.*

To install a standard MPEG test decoder in a 19-inch rack, you can use Rack Adapter (part number ZZA91 or Option 1R). Mounting instructions are supplied with the adapter.

EMC Safety Precautions

To avoid electromagnetic interference, the unit should be closed when in use. Only suitable shielded signal and control cables may be used.

AC Supply Voltage

The MPEG test decoder can be operated on an AC supply from 100 to 240 V at frequencies of 47 to 63 Hz. The power connector is located at the rear of the unit (see Table 3–2 on page 3–4).

Connecting a Monitor

When a monitor is connected to one of the analog or digital video outputs, the MPEG test decoder can display characteristics and errors of the applied transport

stream clearly and in full detail. In this case, measurement results are displayed in the decoded video picture by means of the OSD (on screen display) function. If the MPEG test decoder is used as an operational decoder, the OSD function can be switched off.

Fitting a Key Card

Programs or elementary streams of a transport stream can be encrypted. When a key card valid for these programs is fitted in the unit, even encrypted programs can be decoded. A precondition is, however, that the descrambling method complies with DVB/TM1341. and that the key card has an interface compatible with the common interface (CI). The key card has to be bought from the broadcaster.

The data required for protocol analysis of a transport stream may not be encrypted, but encrypted program contents will not impair the measurement functions.

Open the unit to fit a key card.

Tools required	Phillips screwdriver, size 0 and 2

CAUTION. *The unit contains components that might be damaged by electrostatic discharges. Therefore, adequate measures for EMC protection have to be taken when work is carried out on the open unit.*

1. Opening the unit:
   - **a.** Disconnect power plug.
   - **b.** Loosen four screws in feet at rear panel.
   - **c.** Remove feet.
   - **d.** Withdraw top plate of enclosure towards rear.
   - **e.** Undo four screws at corner of front panel and screw in front panel.
   - **f.** Withdraw decoder board towards front.
2. Inserting or replacing the key card (see Figure 3–1):
   - **a.** If a key card is fitted already, remove it by pressing the ejection lever on the right.
   - **b.** Insert key card in the upper PCMCIA slot.
3. Closing the unit:
   - **a.** Proceed in the reverse order as for opening the unit.

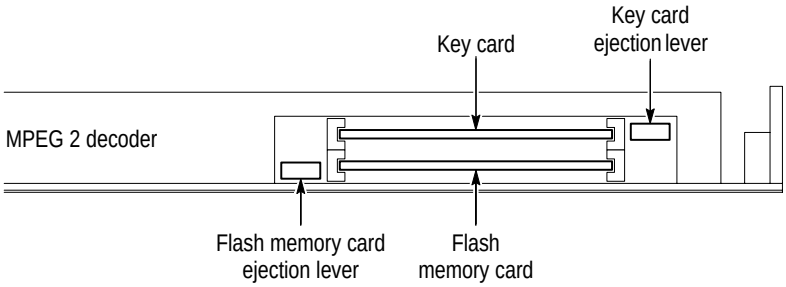


Figure 3–1: Slot for key card

Setting the Level of Analog Audio Outputs

The level is set with the aid of links on the MPEG decoder board.

The following output levels may be set:

- + 6 dBu
- + 9 dBu
- +12 dBu
- +15 dBu

The unit is factory-set to +6 dBu. To set another level the unit must be opened as described in *Fitting a Key Card* on page 3–7. In addition, the upper screen cover must be removed. To do so, loosen the 8 Phillips screws. The level can now be set for both “left” and “right” by positioning the links as shown on the screen cover (see Figure 3–2).

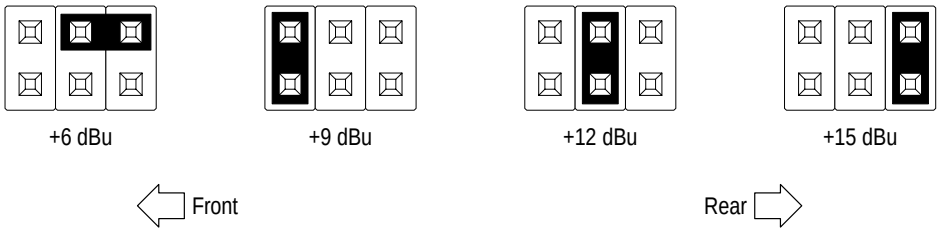


Figure 3–2: Setting the audio level

Function Test (Power-on Test)

The unit is powered on by pressing the POWER switch (see *Power* in Table 3–1 on page 3–2). The MPEG test decoder then performs a built-in test which is completed after a few seconds. When the boot phase is started, all LEDs on the front panel light up and a memory test is carried out. If a memory error occurs, all LEDs will be blinking. If there is no error, the LEDs are switched off and the boot phase is continued.

The individual steps of the boot phase are indicated by LEDs. The SYNC LED corresponds to the least significant bit, the PAT LED to the next higher bit, etc. If an error occurs during the boot phase, the current status indicated by the LED will be retained (see Table 3–3). Otherwise, the instrument is set to the previously used instrument status and the status menu is displayed.

Table 3–3: LED-Codes during booting of equipment

LED-Code	boot phase
0x01	Check Update
0x02	Loading of main program
0x03	Starting of main program
0x32	Reset of MPEG-2-Chipset
0x35, 0x36, 0x37	Setting-up loading of MPEG-2-Demultiplexer
0x38	Loading of MPEG-2-Audio Decoder
0x39	Loading of MPEG-2-Video Decoder
0x3A	Loading of Video-DAC
0x3B	Starting of MPEG-2-Demultiplexer and MPEG-2-Video Decoder
0x3C	Setting-up of ON Screen Display function
0x3D	Loading of FPGA for protocol analysis
0x3F	Loading of DSP for protocol analysis

The green LEDs next to the front-panel inputs indicate at which input the instrument expects a signal. See *Error Indication* in Table 3–1 on page 3–3. If a valid MPEG-2 signal is applied to the respective input, the instrument must synchronize to it. When synchronization is completed, the lower (below TS) green LED lights.

Manual Operation

This section describes the main operating functions of the MTD200 MPEG Test Decoder and familiarizes the user with the operation of the instrument.

When powered on for the first time, the new instrument is in a factory-set default state. Each change of instrument settings is permanently stored (even after instrument power-off) and available when the unit is powered on again.

Control Elements

This section describes the parts of the MTD200 that are used to control the instrument. A typical configuration is shown in Figure 4–1.

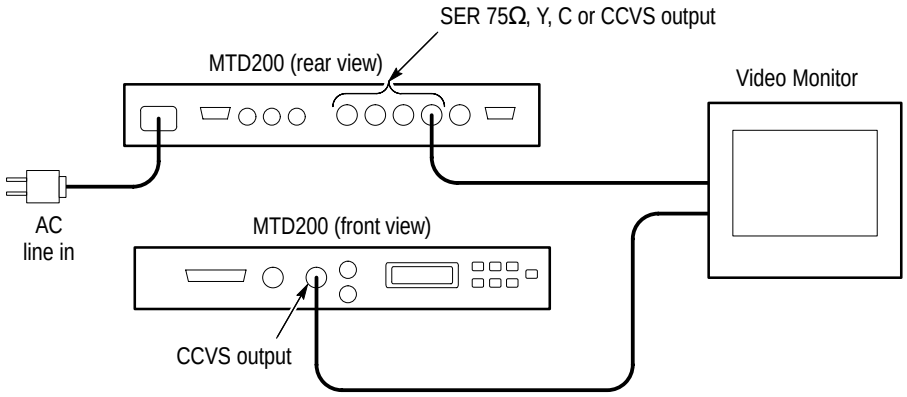


Figure 4–1: Overview of control elements

Keypad

Manual operation is performed by means of keys. See Figure 4–1 for the locations of the keys. Figure 4–2 shows the keypad itself.

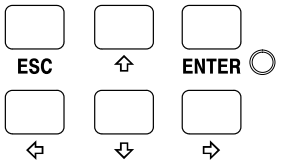


Figure 4–2: Keypad

The functions of the keys are as follows:

ESC Use the ESCAPE key to quit a submenu

ENTER Use the ENTER key to do one of the following:

- Call a submenu
- Start an entry
- Confirm an entry

LED The yellow LED lights when a parameter can be varied using the cursor keys, a selection can be made using ENTER, or a value can be entered using ENTER.

Use the cursor keys to select the desired menu item and to vary values to be entered.

LC Display

Operating steps and measurement results are displayed on a two-line liquid crystal display (LCD) with 20 characters per line. Depending on the entry and selection mode in use, the cursor is displayed in different ways (refer to *Basic Operating Procedures* on page 4–4).

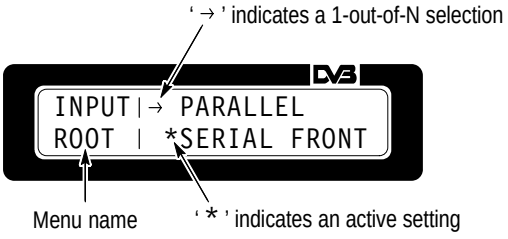


Figure 4–3: LC display

On Screen Display (OSD)

In addition to the information displayed on the LCD, a large menu picture (see Figure 4–4) is inserted into the decoded video signal and displayed on an external monitor. The menu in this on screen display (OSD) is displayed in parallel with the information in the LCD. In addition to the different cursor characters used (see *Basic Operating Procedures* on page 4–4), the cursor-selected menu item or field in the OSD is in reverse video.

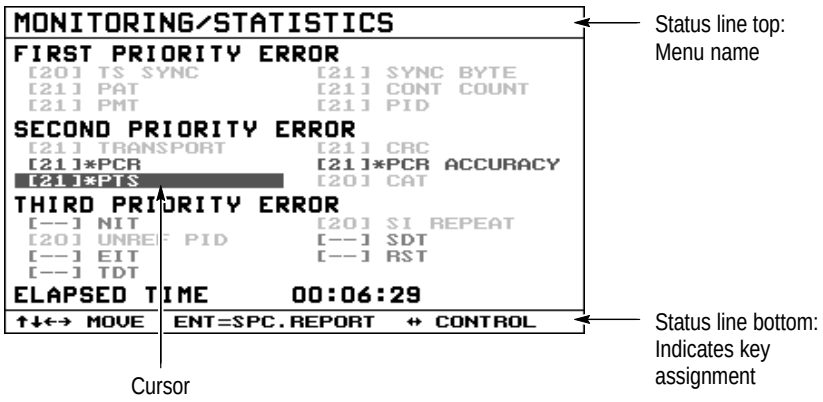


Figure 4–4: On screen display

Basic Operating Procedures

In this section, commonly used basic operating procedures are described. In the subsequent menu descriptions, these procedures are assumed to be known. In the menu descriptions, only operating procedures differing from basic operations will be explained.

Menu Selection

Menu selection is used to call up submenus in the MAIN menu. The possibility for a selection is indicated by the character ' → '. The cursor ' ← ' is set to the desired menu with the aid of the cursor keys (▲ ▼ ◀ ▶). The selected menu is called up with ENTER.

▲ ▼ ◀ ▶	Set cursor to desired submenu
Enter	Calls up the submenu
ESC	Returns to next higher menu

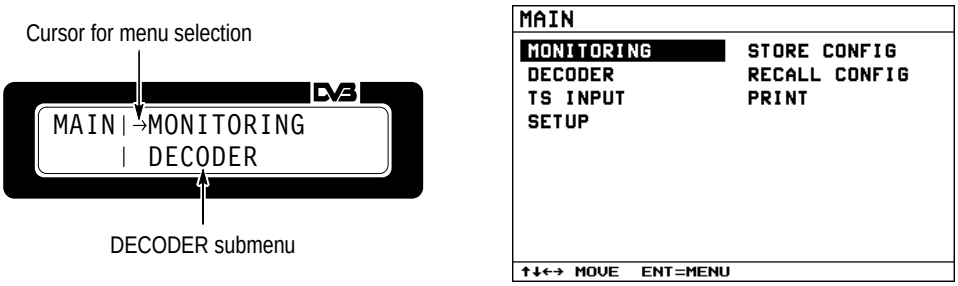


Figure 4–5: Menu selection

1-out-of-N Selection

The 1-out-of-N selection is used to switch the transport stream inputs in the TS INPUT/ROUTE menu. The user may select a setting from a list of N items. The selection mode is identified by the character → . Selection is made by moving the cursor → to the desired item (for example, PARALLEL) using the cursor keys ▲ ▼ ◀ ▶. The selected setting is activated with ENTER. In the LCD, active settings are marked with an asterisk (*).

▲ ▼ ◀ ▶	Set cursor to desired item
ENTER	Activates the selected setting which is marked with an asterisk (*)
ESC	Returns to the next higher menu

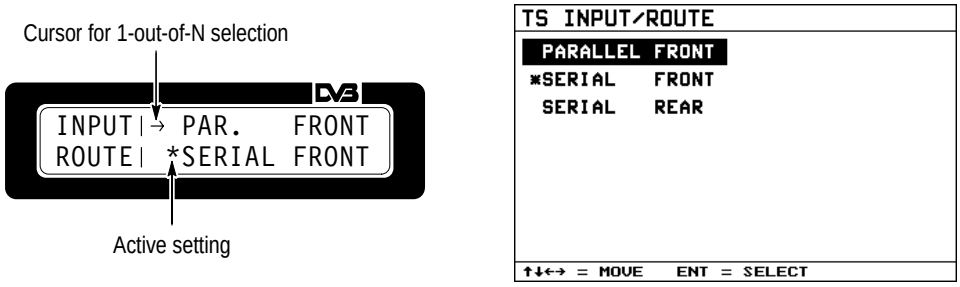


Figure 4–6: 1-out-of-N selection

M-out-of-N Selection

The M-out-of-N selection is explained using the MONITORING/PARAMETER GROUP menu as an example. The user may activate several items in a list of N items. The selection mode is identified by the cursor character →. Using the cursor keys (▲ ▼ ◀ ▶), the cursor → is set to the item to be changed (for example, TS_SYNC). The setting status is switched with ENTER (ON → OFF or OFF → ON). An active setting is marked with [X] (ON); an inactive setting is marked with [ ] (OFF).

▲ ▼ ◀ ▶	Set cursor to desired item.
ENTER	Switches the status of the selected item. Active items are marked with [X] for (ON); inactive items are marked with [ ] for (OFF).
ESC	Returns to next higher menu.

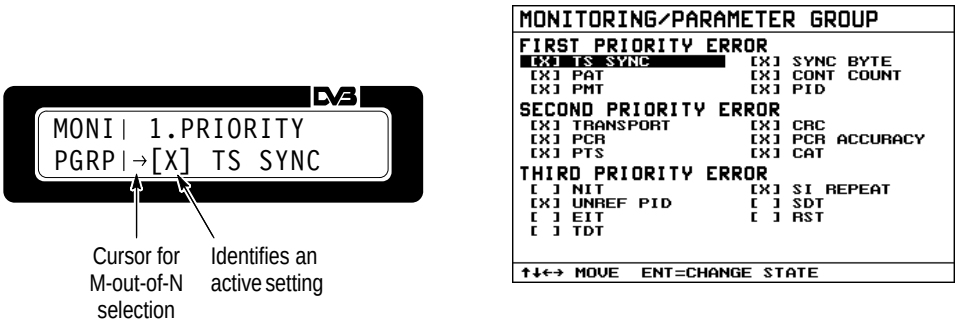


Figure 4–7: M-out-of-N selection

Entering Numerals

Numeric values must be entered for limit values in the MONITORING/LIMITS menu. Using the cursor keys (▲ ▼ ◀ ▶), the cursor → is positioned on the value to be changed (for example, the minimum PAT distance). ENTER activates the entry mode. This is indicated by > before and by < after the value to be changed. Set the cursor to the desired number or unit using keys ◀ ▶. The number or unit can be varied with keys ▲ ▼. After the entry, confirm and terminate with ENTER. The entry can be aborted with ESC. In the latter case, the previously set value is retained.

◀ ▶	Set cursor to desired numeral
▲ ▼	Increments/decrements the selected numeral
ENTER	Starts the entry, the value to be changed is marked with > ... <, or terminates the entry and sets the new value
ESC	Aborts the entry

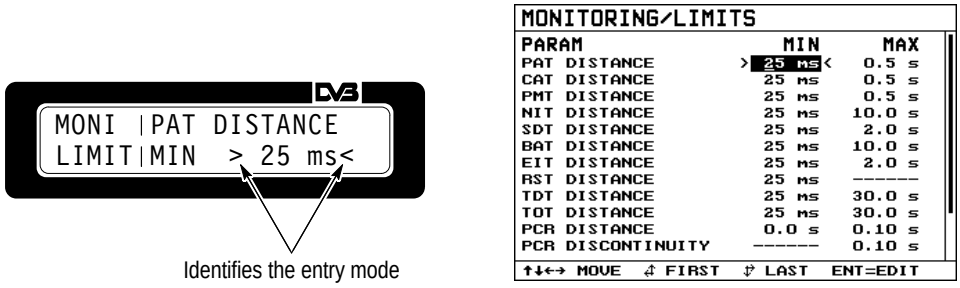


Figure 4–8: Entering numerals

Entering Text

The name and configuration in the STORE CONFIG and RECALL CONFIG menus must be entered in the form of text. Set the cursor to the text to be changed with the aid of keys ▲ ▼ ◀ ▶. ENTER activates the entry mode which is indicated by ‘ > ’ before and by ‘ < ’ after the text to be modified. Set the cursor to the desired character using keys ◀ ▶ . The selected character can now be changed with keys ▲ ▼ . ENTER confirms and terminates the entry. The entry can be aborted with ESC. In this case, the previous text is retained.

◀ ▶	Set cursor to the character to be changed
▲ ▼	Change the selected character
ENTER	Starts the entry for the item marked with > ... <, or terminates the entry and takes over the new text
ESC	Aborts the entered text

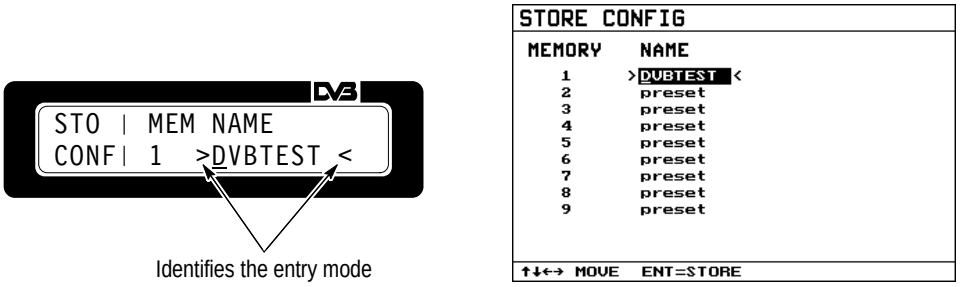


Figure 4–9: Entering text

Overview of Menus

This section describes the MPEG test decoder operating menus. Abbreviations or MPEG2-specific expressions are explained in the *Glossary.* A description of measurement parameters, measurements, and respective settings are given in *Measurement Functions* on page 2–3.

STATUS Menu

The STATUS menu provides information on the transport stream and the currently decoded program. It indicates the data rate and the ID of the transport stream, the number, name, and number of lines on program as well as information on encryption. On the OSD, the STATUS menu is displayed in the lower half of the screen.

▲ ▼ ◀ ▶	Call up MAIN menu
ENTER	Call up MAIN menu
ESC	Switches the STATUS menu display in the OSD on and off (see *SETUP/ON SCREEN DISPLAY Menu* on page 4–32).

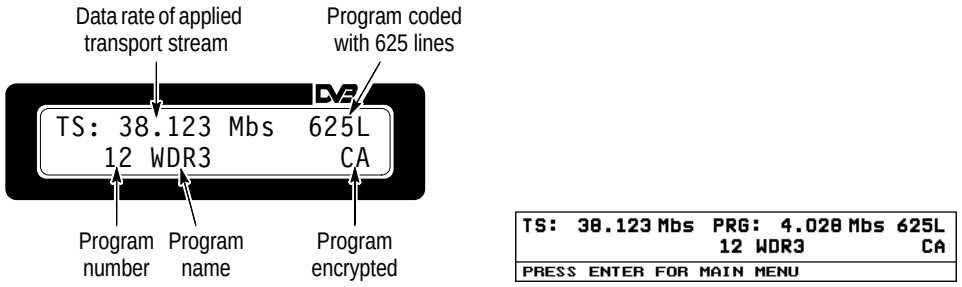


Figure 4–10: STATUS menu

If no transport stream is present at the selected input or if the MPEG test decoder is in the TS_SYNC LOSS state, an indication is made in the TS data rate field with "————" and using front–panel LEDs. If the name of the selected program is not in the transport stream, "————" is displayed in the field of the program name.

MAIN Menu

The MAIN menu (see Figure 4–11) contains all top-level operating functions. The relationship between functions is shown in Figure 4–12.

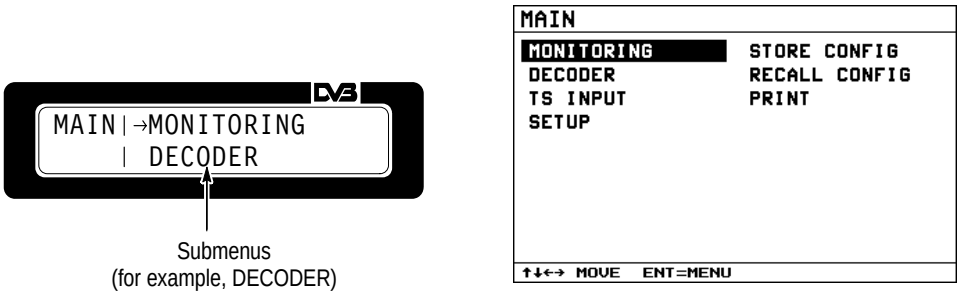


Figure 4–11: MAIN menu

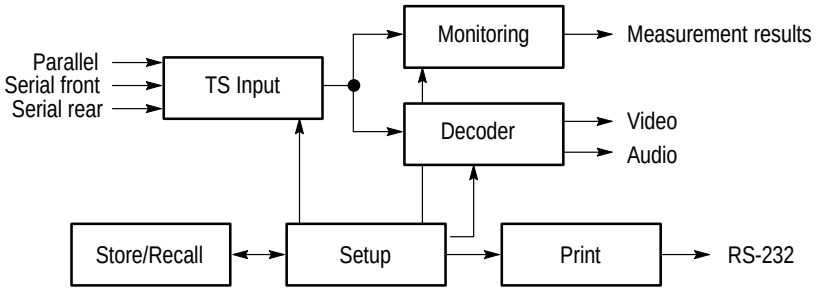


Figure 4–12: Overview of MAIN menu

▲ ▼ ◀ ▶	Set cursor to desired submenu
ENTER	Calls up the selected submenu
ESC	Returns to the STATUS menu

MONITORING Menu

The MONITORING menu provides the functions required for configuration of measurements on the MPEG2 transport stream and for presentation of the measurement results. See Figure 4–13.

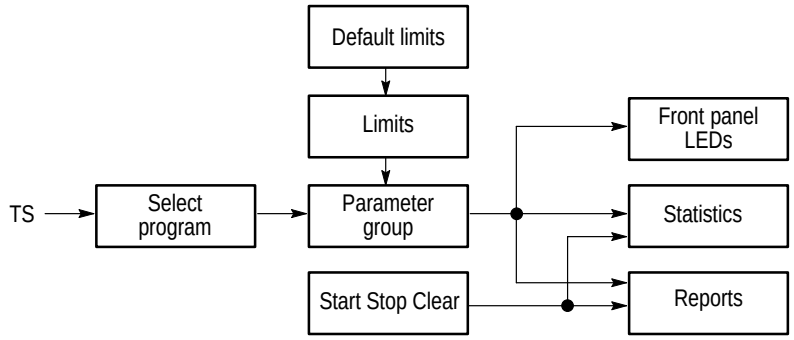


Figure 4–13: Functions of MONITORING menu

For monitoring the syntax of the transport stream, measurements are performed in line with the ‘Measurement guidelines for DVB systems (ETR 290). Refer to *Measurement Functions*.

All first-priority parameters and two second-priority parameters (Transport_error and CRC_error) are assigned an LED on the front panel. See Figure 4–14. All other second-priority and third-priority parameters are indicated by the OTHER LED. See Table 2–1 on page 2–3.

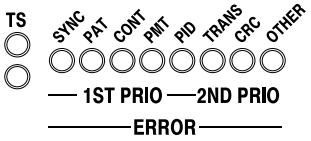
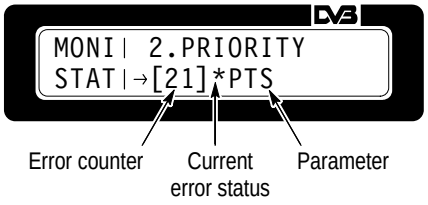


Figure 4–14: Front-panel LEDs indicating parameters

The parameters are cyclically checked. Any error detected is signaled by the respective LED on the front panel or indicated in the MONITORING/STATISTICS Menu or MONITORING/REPORT Menu. Individual parameters can be selected and deselected for monitoring in the MONITORING/PARAMETER GROUP menu. Limits for the PCR values and PSI and SI tables can be specified in the MONITORING/LIMITS menu. The limits with the standardized values for DVB and MPEG can be predefined in the MONITORING/DEFAULT menu.

MONITORING/STATISTICS Menu. Errors in the MPEG2 transport stream are indicated in the MONITORING/STATISTICS menu as specified by (ETR 290) (refer to *Measurement Functions*).

▲ ▼ ◀ ▶	Set cursor to parameter (for example, SECOND PRIORITY ERROR : PTS)
◀ ▶	Call up the MONITORING/CONTROL menu
ENTER	Displays the content of MONITORING/REPORT for this parameter
ESC	Returns to MONITORING menu



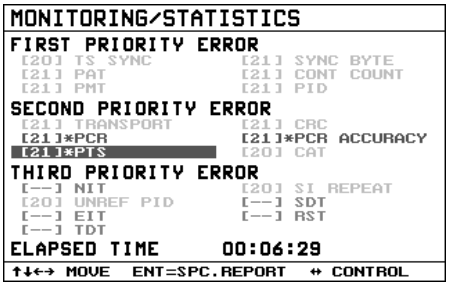


Figure 4–15: MONITORING/STATISTICS Menu

In the menu, a distinction is made between first-, second- and third-priority errors. The pertaining parameters are listed under the respective priority. Each parameter is preceded by an error counter.

Errors are indicated in error seconds; the counter is incremented by 1 for each second in which an error of the respective parameter occurs at least once. At a maximum of 99 error seconds, the counter stops until the monitoring is cleared (refer to *MONITORING/CONTROL Menu* on page 4–14).

If the monitoring of a parameter is switched off (see *MONITORING/REPORT Menu* on page 4–13), the respective error counter in the LCD indicates [—]. In the OSD, the deactivated parameter is marked in a darker color (for example, gray instead of white).

If an error occurs for a monitored parameter, the pertaining front-panel LED comes on for 1 second and an asterisk (*) is displayed in front of the parameter name. In the OSD the error counter is displayed in red. If error conditions are no longer met after one second has expired, the counter is displayed in yellow and the asterisk in front of the parameter name is cleared.

In the '**ELAPSED TIME**' field of the OSD, the monitoring time is displayed in days, hours, minutes, and seconds.

After selecting a parameter by means of the cursor key, the content of MONITORING/STATISTICS menu for the respective parameter only is displayed when the ENTER key is pressed.

MONITORING/REPORT Menu. The MPEG test decoder is able to record errors that occurred in the transport stream. A nonvolatile memory that accepts 1000 entries is provided for this purpose. If all 1000 memory locations are occupied, the next entry clears the first one, and the other 999 entries are shifted by one position. Entry No. 1 becomes No. 0, No. 2 becomes No. 1, etc. The new entry is written into the now empty position 999. The data in this report memory is retained even after instrument power-off.

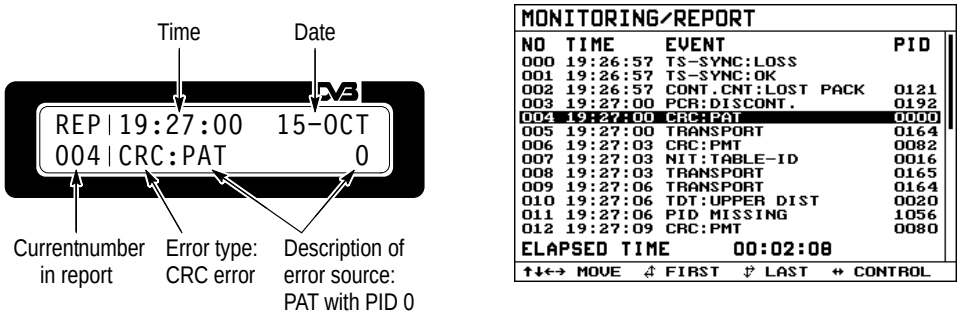


Figure 4–16: MONITORING/REPORT Menu

▲ ▼ ◀ ▶	Set cursor to desired entry in the report
▼ ▶	Set cursor to last entry in the report
◀ ▼	Set cursor to first entry in the report
◀ ▶	Call up the MONITORING/CONTROL menu
ENTER	Displays a detailed description of error conditions for this report entry in the OSD
ESC	Returns to MONITORING menu

The report in the OSD is divided into four columns. The column ‘NO’ lists the current numbers of report entries. Under ‘TIME’ the time when the error or operating event occurred is recorded. Under ‘EVENT’ the type of the event, (for example, CRC error of PAT), is indicated. If the event refers to a specific PID, this is indicated in the column ‘PID’.

In the ‘ELAPSED TIME’ field of the MONITORING/STATISTICS Menu, the monitoring time is displayed in days, hours, minutes and seconds.

MONITORING/CONTROL Menu. In the MONITORING/CONTROL menu, monitoring of the transport stream can be controlled. This control influences the display in the MONITORING/STATISTICS Menu and in the MONITORING/REPORT Menu.

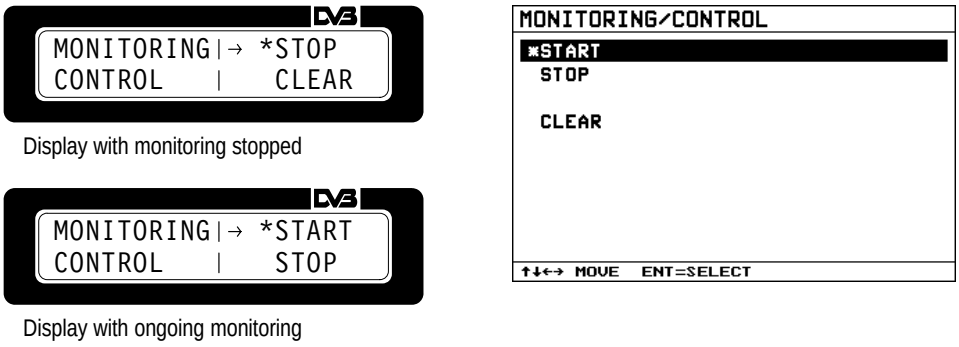


Figure 4–17: MONITORING/CONTROL menu

▲ ▼ ◀ ▶	Set cursor to desired action (for example, START)
ENTER	Executes the selected action (for example, starts monitoring)
ESC	Returns to the MONITORING menu

Actions available for monitoring:

START — Starts monitoring of transport stream. The error seconds are determined and the detected errors recorded in the report. The START action is entered in the report.

STOP — Stops monitoring of transport stream. Error seconds are no longer determined nor the report updated. The STOP action is entered in the report and only available during an ongoing measurement. An interrupted measurement can be continued with START.

CLEAR — Resets the display of error seconds in the MONITORING/STATISTICS Menu to 0, and clears the content of the report. Clearing does not affect the status of an ongoing measurement; the measurement is not stopped nor is an interrupted measurement restarted. The error seconds counters are reset. The content of the report is cleared and the time in the 'ELAPSED TIME' field is reset to 0:00:00.

MONITORING/PARAMETER GROUP Menu. For monitoring the transport stream, the measurement parameters (see Table 2–1 on page 2–3) can be activated individually in an M-out-of-N selection. Only error seconds for active parameters are signaled to LEDs, indicated in the MONITORING/STATISTICS Menu and entered in the report (refer to *MONITORING/REPORT Menu* on page 4–13).

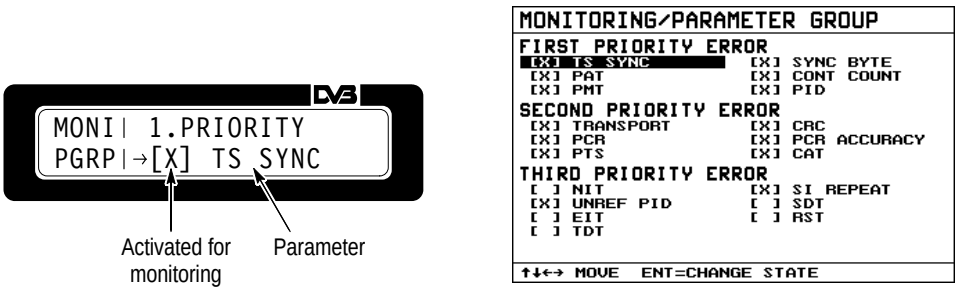


Figure 4–18: MONITORING/PARAMETER GROUP menu

▲ ▼ ◀ ▶	Set cursor to desired parameter (for example, FIRST PRIORITY ERROR: TS SYNC)
ENTER	Switches monitoring for the selected parameter on '[X]' or off '[ ]'
ESC	Returns to the MONITORING menu

The structure of this menu is identical to that of the MONITORING/STATISTICS Menu. Instead of the error counter, the marker for parameter monitoring on '**[X]**' or off '**[ ]**' is displayed in front of each parameter.

MONITORING/LIMITS Menu. In addition to active state of individual parameters, the limits for the distances of PCR values and PSI and SI tables can be indicated (see Table 4–1). When a limit is exceeded, the error condition is considered fulfilled and an error is entered in the report and error seconds in the statistics for active parameters.

Table 4–1: Limit values for parameters

	Adjustable limits		According to DVB		According to MPEG	
Parameter name	**MIN**	**MAX**	**MIN**	**MAX**	**MIN**	**MAX**
PAT Distance	0 ms – 100 ms	0.1 s – 60.0 s	25 ms	0.5 s	25 ms	0.5 s
CAT Distance	0 ms – 100 ms	0.1 s – 60.0 s	25 ms	0.5 s	25 ms	0.5 s
PMT Distance	0 ms – 100 ms	0.1 s – 60.0 s	25 ms	0.5 s	25 ms	0.5 s
NIT Distance	0 ms – 100 ms	0.1 s – 60.0 s	25 ms	10 s	—	—
SDT Distance	0 ms – 100 ms	0.1 s – 60.0 s	25 ms	2 s	—	—
BAT Distance	0 ms – 100 ms	0.1 s – 60.0 s	25 ms	10 s	—	—
EIT Distance	0 ms – 100 ms	0.1 s – 60.0 s	25 ms	2 s	—	—
RST Distance	0 ms – 100 ms	—	25 ms	—	—	—
TDT Distance	0 ms – 100 ms	0.1 s – 60.0 s	25 ms	30 s	—	—
TOT Distance	0 ms – 100 ms	0.1 s – 60.0 s	25 ms	30 s	—	—
PCR Distance	0 ms – 10 ms	0.01 s – 1.00 s	0 ms	0.04 s	0 ms	0.1 s
PCR Discontinuity	—	0.01 s – 1.00 s	—	0.1 s	—	—
PTS Distance	—	0.1 s – 60.0 s	—	0.7 s	—	—
PID Distance	—	0.1 s – 60.0 s	—	0.5 s	—	—
PID unref. Duration	—	0.1 s – 60.0 s	—	0.5 s	—	—

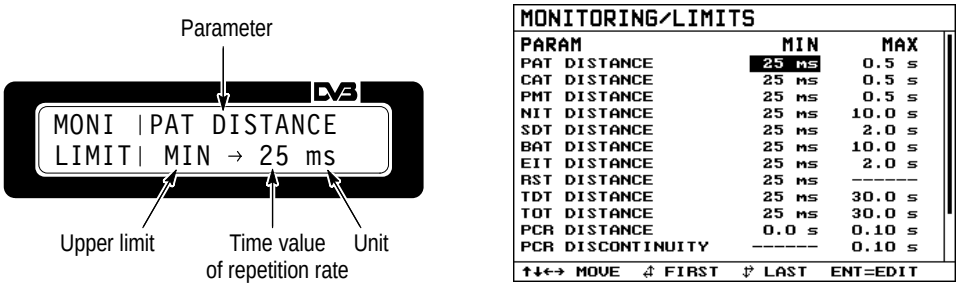


Figure 4–19: MONITORING/LIMITS menu

▲ ▼	Set cursor to desired parameter (for example, PAT DISTANCE)
◀ ▶	Switch between MIN and MAX value of parameter
ENTER	Starts entry of numerals and enters value (refer to *Entering Numerals* on page 4–7)
ESC	Returns to MONITORING menu

MONITORING/DEFAULT LIMITS Menu. In this menu the limits with the values stipulated for DVB or MPEG can be predefined.

The two following standards are provided:

- MPEG ISO/IEC 13818-1, dated 13 November 1994
- DVB ETR 290, dated 28 June 1996

Only the limit values stipulated in the corresponding standard are predefined. The values marked with '—' in Table 4–1 on page 4–16 are not influenced by this setting.

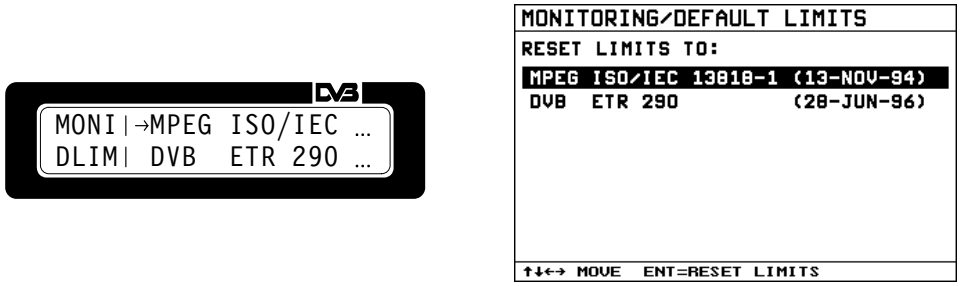


Figure 4–20: MONITORING/DEFAULT LIMITS menu

▲ ▼ ◀ ▶	Set cursor to desired standard
ENTER	Predefines limit values with the standard values (see Table Table 4–1 on page 4–16)
ESC	Returns to the MONITORING menu

MONITORING/SELECT PROGRAM Menu. In this menu, you can be define whether the programs to be monitored are to be selected manually or automatically by the decoder.

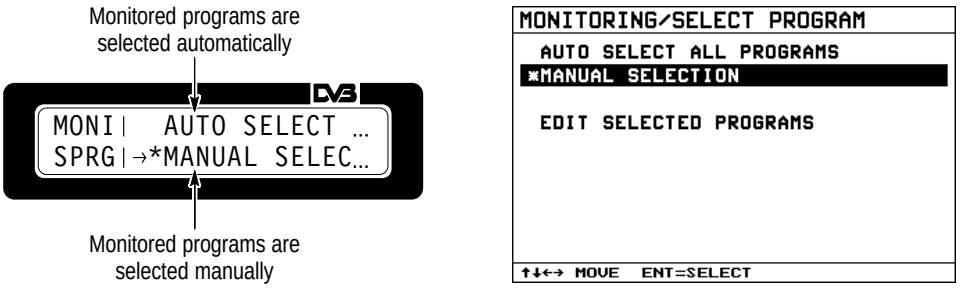


Figure 4–21: MONITORING/SELECT PROGRAM Menu

▲ ▼ ◀ ▶	Set cursor to the desired function
ENTER	Cursor is set to: AUTO SELECT ALL PROGRAMS: The programs to be monitored are selected automatically. MANUAL SELECTION: The programs to be monitored can be selected in MONITORING/ SELECTED PROGRAMS EDIT / VIEW SELECTED PROGRAMS Calls up the MONITORING/SELECTED PROGRAMS menu
ESC	Returns to the MONITORING menu

AUTO SELECT ALL PROGRAMS:

After creating a new transport stream, all the programs are selected for monitoring, if possible. If more than 10 PMTs or more than 64 programs are in the stream, only the first 10 PMTs and a maximum of 64 programs referenced in the tables are monitored.

MANUAL SELECTION:

After applying a new transport stream, it is first checked to see if at least one of the programs selected in the MONITORING/SELECTED PROGRAMS menu for monitoring is contained in the transport stream. If not, the AUTO SELECT ALL PROGRAMS mode is enabled and the programs are selected automatically.

MONITORING/SELECTED PROGRAMS Menu. In the MANUAL SELECTION mode, the programs to be monitored can be selected in this menu. Up to 64 programs, referenced in a maximum of 10 PMTs, can be monitored.

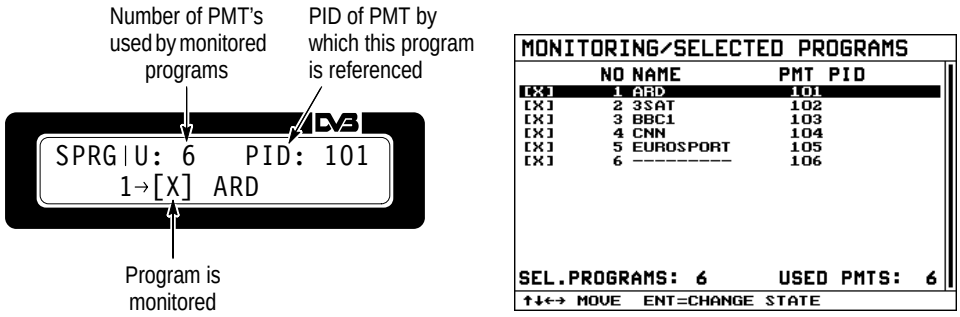


Figure 4–22: MONITORING/SELECTED PROGRAMS Menu

▲ ▼ ◀ ▶	Set cursor to the desired program
◀ ▶	In MANUAL SELECTION mode: switching monitoring of all programs off.
ENTER	In MANUAL SELECTION mode: switching monitoring for the desired program on [X] or off [ ]
ESC	Returns to the MONITORING/SELECT PROGRAM Menu

On the OSD, a list with all the programs available in the transport stream is output. Field 'SEL.PROGRAMS' indicates how many programs are currently monitored. Display 'USED PMTS' indicates in how many different PMTs the programs are referenced.

There are some restrictions when monitoring single programs:

PMT ERROR	only determined for the PMTs used by the monitored programs
PID ERROR	only determined for the PIDs used by the monitored programs
CRC ERROR	only determined for the PMTs used by the monitored programs for the PMTs
PCR ERROR	only determined for the PCR values of the monitored programs
PCR ACCURACY	only determined for the PCR values of the monitored programs

PTS ERROR	only determined for the PCR values of the monitored programs
SI REPEAT ERROR	only determined for the PMTs used by the monitored programs for the PMTs
UNREF PID	no longer determined

DECODER Menu

With the decoder section of the MPEG test decoder, a program can be decoded independently and in parallel to the monitoring functions selected in the MONITORING menu. See Figure 4–23.

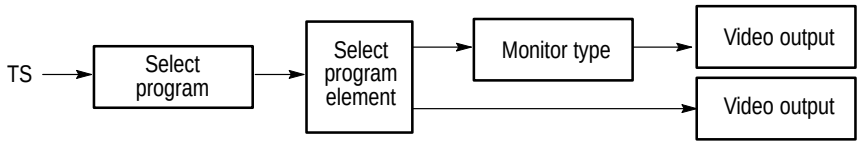


Figure 4–23: Interaction of DECODER functions

The program to be decoded is selected from the programs of the applied data stream in the DECODER/SELECT PROGRAM menu.

If the selected program consists of more than one video, audio and data stream, a detailed selection of program elements can be made in the DECODER/SELECT PROGRAM ELEMENT menu.

The video standard for the analog video output is set in the DECODER/VIDEO OUTPUT menu. The audio output can be muted in the DECODER/AUDIO OUTPUT menu.

The aspect ratio of the connected monitor can be selected in the DECODER/ MONITOR TYPE menu.

DECODER/SELECT PROGRAM Menu. In the DECODER/SELECT PROGRAM menu, a decoding program can be selected. For the selection, the PAT, PMT, and SDT tables in the MPEG2 data stream are evaluated and the programs in the transport stream displayed on the LDC and the OSD (see Figure 4–24). Also, the total data rate of the SI tables as well as the data rate of the null packets are displayed.

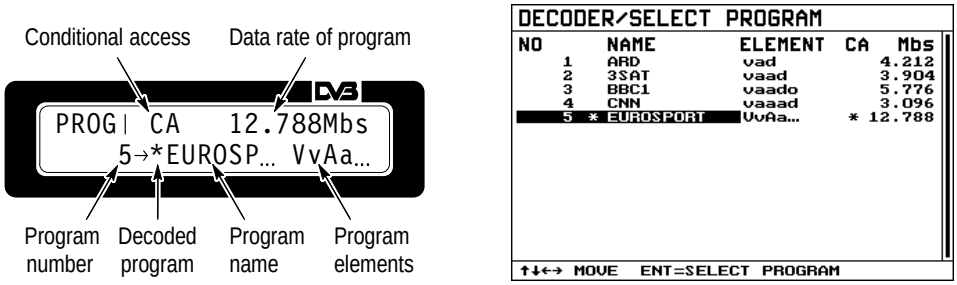


Figure 4–24: DECODER/SELECT PROGRAM menu: Selecting a program via its name

◆ ◆	Set cursor to column containing program name or program elements
▲ ▼	Set cursor to the desired entry in the respective column
ENTER	With the cursor in the column Program name: Decodes the selected program and marks it with an asterisk (*). Program element: Calls up the DECODER/SELECT PROGRAM ELEMENT menu.
ESC	Returns to the DECODER menu

The menu in the OSD has five columns. The first three can be selected with cursor keys ◆ ◆ . The two last columns contain only program-specific information and cannot be selected.

NO	Program number
NAME	Program name
ELEMENT	Program elements indicated in the following form: **V** = video **A** = audio **D** = data **O** = others The currently decoded elements are represented by capital letters, for example, '**VaAad**' means that the program consists of a video, three audio, and one data stream. The video stream and the second audio stream are decoded.
CA	Conditional access An asterisk (*) indicates that at least one program element is encrypted
Mbs	Data rate of program in MBits/s, specified for monitored programs only (see *MONITORING/SELECT PROGRAM Menu* on page 4–18)

The program to be decoded is selected via the name in the program list.

Program selection via name:

1. Set the cursor to the name of the desired program
2. Activate decoding of this program with ENTER.

   Take care that the program list is displayed after the MPEG2 data stream has been applied.

   If the transport stream does not contain a description of the program names (for example, there is no SDT-table or service descriptor), "————" is output for the name.

DECODER/SELECT PROGRAM ELEMENT Menu. For selecting program elements, set the cursor to the element display of the desired program in the DECODER/SELECT PROGRAM menu and press ENTER. The program elements are displayed with PID, type, code, conditional access, and data rate in the subsequently opened DECODER/SELECT PROGRAM ELEMENT menu.

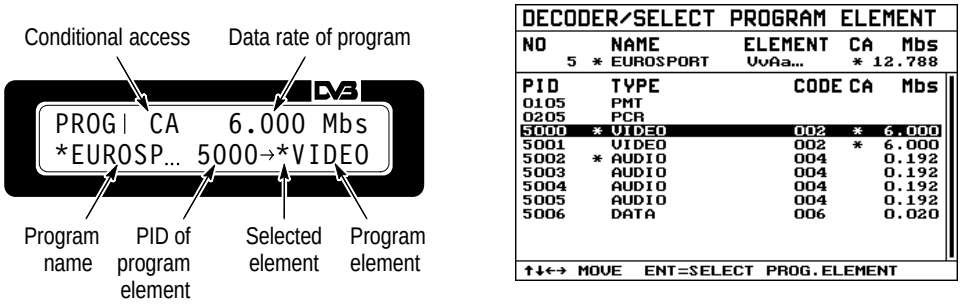


Figure 4–25: DECODER/SELECT PROGRAM ELEMENT menu

◆ ◆	Set cursor to the desired program element
▲	Sets cursor to the first program element
▼	Sets cursor to last program element
ENTER	Selects the desired program element to be decoded. The selected element is marked with an asterisk (*). A selection is only possible if more than one element of a type are available
ESC	Returns to the DECODER/SELECT PROGRAM menu

The program with number, name and brief information on elements, conditional access, and total data rate is displayed in the first line of the OSD. Below this line, the respective program elements are listed.

The five columns of the list provide the following information:

PID	PID of program element
TYPE	Type of program element (for example, VIDEO). The first element is the PMT providing detailed program information; the second element is the PID of the PCR values
CODE	Type of program element as number as stipulated in standard IEC/ISO 13818
CA	Conditional access, an asterisk (*) indicates that the program is encrypted
Mbs	Data rate of program element in MBit/s, specified for elements of monitored programs only (refer to *MONITORING/SELECT PROGRAM Menu* on page 4–18)

A video and an audio stream can be selected from this list. If the selected program is being decoded, element settings immediately affect the decoding procedure. If the program is not decoded at present, settings of the program elements become effective when the program is selected in the DECODER/SELECT PROGRAM menu.

Settings of program elements are assigned to the transport stream currently applied to the MPEG test decoder and remain in the memory until either the content of the transport stream changes, another transport stream is applied or another input is selected.

DECODER/SI TABLES Menu. The data rates of the SI tables are displayed in detail in this menu.

▲ ▼ ◀ ▶	Sets cursor in the list
ESC	Returns to DECODER/SELECT PROGRAM menu

The complete data rate of the SI tables is displayed in the first line of OSD. The individual tables are listed below. The three columns have the following meaning:

PID	PID of SI table
TABLE	Name of SI table
Kbs	Indication of data rate of an SI table in KBit/s, for PMTs only indicated for those tables whose programs are monitored (see section 4.3.3.7)

DECODER/VIDEO OUTPUT Menu. For a program coded with 525 lines, the MPEG test decoder provides the video standard M/NTSC at the analog video outputs CCVS and Y/C. If the program is coded with 625 lines, a selection can be made between standards B/G PAL and SECAM. Switchover between 625 and 525 lines depends on the decoded program and is automatic.

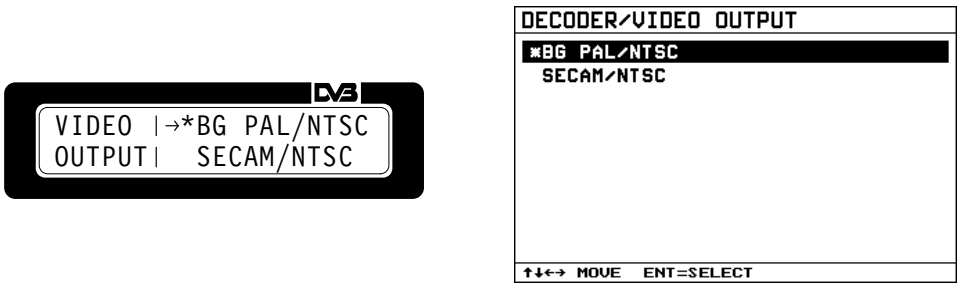


Figure 4–26: DECODER/VIDEO OUTPUT menu

▲ ▼ ◀ ▶	Set cursor to desired video standard for 625 lines
ENTER	Selects the desired video standard. The selected standard is marked with an asterisk (*).
ESC	Returns to DECODER menu

Table 4–2: Selectable video standards

Setting in DECODER/VIDEO OUTPUT menu	Video standard for program with 625 lines	Video standard for program with 525 lines
PAL/NTSC	B/G PAL	M/NTSC
SECAM/NTSC	SECAM	M/NTSC

DECODER/AUDIO OUTPUT Menu. In this menu, the two audio channels can be switched on and off.

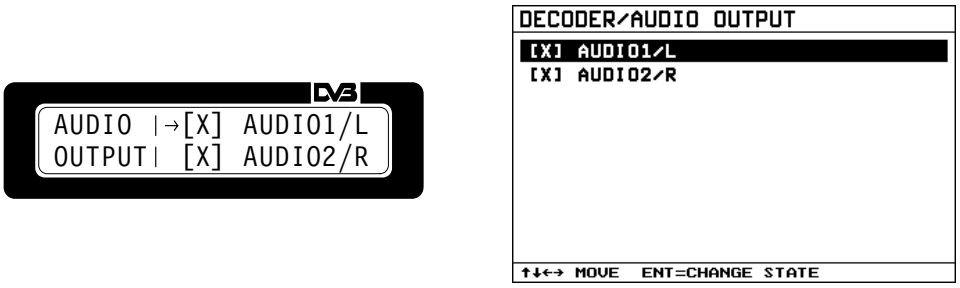


Figure 4–27: DECODER/AUDIO OUTPUT menu

▲ ▼ ◀ ▶	Set cursor to desired item
ENTER	Switches AUDIO1/L or AUDIO2/R on-[X] or off [ ]
ESC	Returns to DECODER menu

DECODER/MONITOR TYPE Menu. In this menu, the aspect ratio of the connected monitor can be selected. The output format of the program to be decoded is adapted to the set aspect ratio.

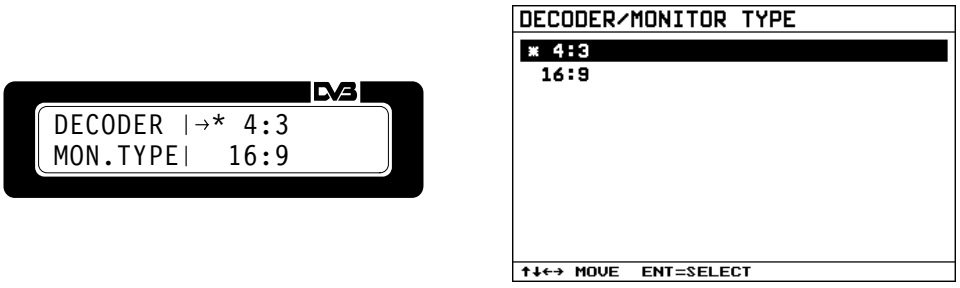


Figure 4–28: DECODER/MONITOR TYPE menu

▲ ▼ ◀ ▶	Set cursor to desired aspect ratio
ENTER	Selection of desired aspect ratio, the selected aspect ratio is marked with an asterisk (*)
ESC	Returns to the DECODER menu

TS INPUT ROUTE Menu

The TS INPUT menu provides the functions required for selecting the input for the MPEG2 transport stream and for configuring synchronization to the transport stream.

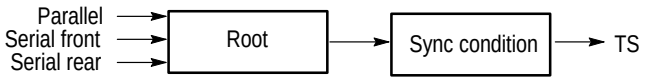


Figure 4–29: Interaction of functions in the TS INPUT menu

TS INPUT/ROUTE Menu. In the TS INPUT/ROUTE menu, the input for the transport stream can be selected.

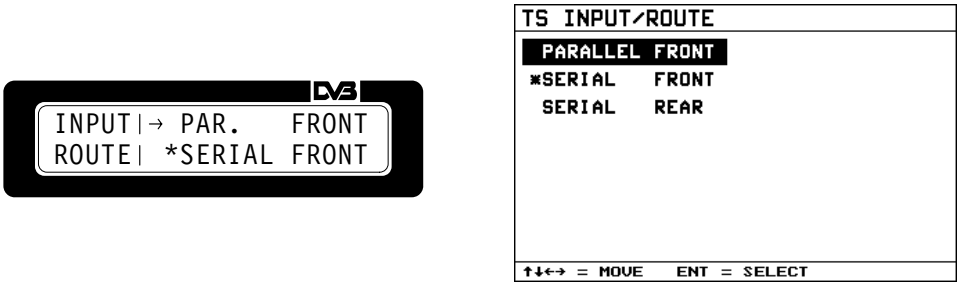


Figure 4–30: TS INPUT/ROUTE menu

▲ ▼ ◀ ▶	Set cursor to desired transport stream input
ENTER	Selects the desired input, and marks it with an asterisk (*).
ESC	Returns to the TS INPUT menu

The following three inputs are provided on the MPEG test decoder for the MPEG2 data stream:

- PARALLEL parallel input (LVDS) at front panel
- SERIAL FRONT serial, asynchronous input (BNC) on front panel
- SERIAL REAR serial, asynchronous input (BNC) at the rear.

CAUTION. *The maximum data rate may be 54 Mbit/s. A packet may have a length of 188 Byte or 204 Byte (188 data bytes + 16 error-correction bytes).*

TS INPUT/SYNC CONDITION Menu. The sync lock and sync loss is monitored from the TS INPUT/SYNC CONDITION menu.

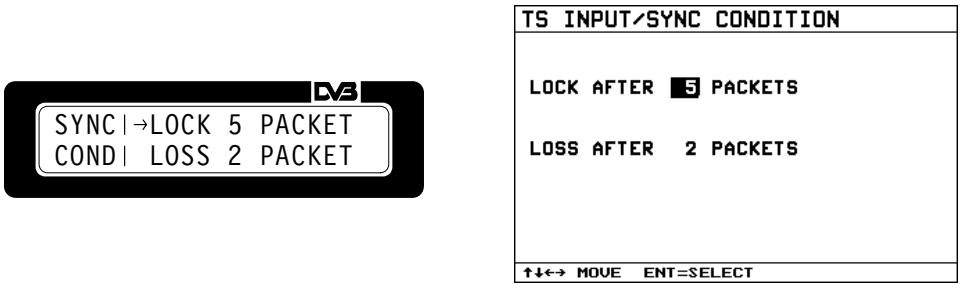


Figure 4–31: TS INPUT/SYNC CONDITION menu

▲ ▼ ◀ ▶	Set cursor to LOCK or LOSS
ENTER	Calls up the entry of numerals (refer to *Entering Numerals* on page 4–7) and enters the number of sync bytes.
ESC	Returns to TS INPUT menu

For monitoring synchronization to the MPEG2 transport stream, a sync hysteresis can be generated separately for sync lock and sync loss. The sync hysteresis specifies the number of successive valid/invalid sync words received before the measurement decoder identifies a sync lock (TS SYNC LOCK) or sync loss (TS SYNC LOSS).

LOCK Number of valid sync words before TS SYNC LOCK is recognized, selectable between 1 and 31

LOSS Number of invalid sync words before a TS SYNC LOSS is recognized, selectable between 1 and 7

PRINT Menu. The PRINT menu provides all functions required for the output of test reports, program contents and device settings to a printer. The output is in the form of ASCII text via the RS–232 interface (see *Set up RS232 Menu* on page 4–33). Only common control characters are used. The page length is fixed to 60 lines. At the end of each line a <carriage return> (0Dhex) and a <line feed > (0Ahex) is sent, and at the end of the page <form feed> (0Chex). With this configuration any printer equipped with a serial interface can be used.

Figure 4–32: PRINT menu

▲ ▼ ◀ ▶	Set cursor to required item
ENTER	The submenu for starting or stopping the desired printout is called up.
ESC	Returns to MAIN menu

The following information can be printed:

STATISTICS	Hardcopy of currently displayed MONITORING/STATISTICS menu
REPORT	Content of MONITORING/REPORT Menu. The range to be printed is selectable. The range added to the report since the last printout is preset.
PROGRAM INFO	List of detailed contents of applied data stream.
CONFIG	Current settings of MPEG2 Measurement Decoder DVMD.

PRINT/STATISTICS, REPORT, PROGRAM INFO, CONFIG Menu. The submenus for starting the printing for the four different contents are identical. The PRINT/REPORT menu is given as an example. This menu allows the selection of the range to be printed.

▲ ▼ ◀ ▶	Set cursor to required function
ENTER	Cursor is set to: SELECT LINES: Calls up the menu for selecting the report entries to be printed. This entry is only available in PRINT/REPORT menu. START PRINTING: Starts printing CANCEL PRINTING: Cancels the current printing process
ESC	Returns to PRINT menu

PRINT/REPORT/SELECT LINE Menu. This menu allows the selection of the range of the report to be printed. The selected range on OSD is displayed in white. The entries that are not selected are displayed in a darker color. On the LC display, the selected entries are marked with an asterisk (*).

When these menus are displayed, the report entries added since the last report printout are preselected.

▲ ▼ ◀ ▶	Marker mode on: The range to be printed can be marked by means of the cursor. Marker mode off: Moving through the report is possible with the cursor.
▼ ▶	Set cursor to last entry in report
◀ ▲	Set cursor to first entry of report
ENTER	Switch on/off marker mode When switching on the marker mode an existing marking is deleted.
ESC	Returns to PRINT/REPORT menu

STORE CONFIG and RECALL CONFIG Menu

The MPEG test decoder has nine memory locations for storing complete instrument setups. When setups are stored, a name is assigned to each of the nine configurations. One of the nine stored setups (or a 10th setup) can be called up again. Memory location 10 (PRESET) holds the factory-set configuration and cannot be changed.

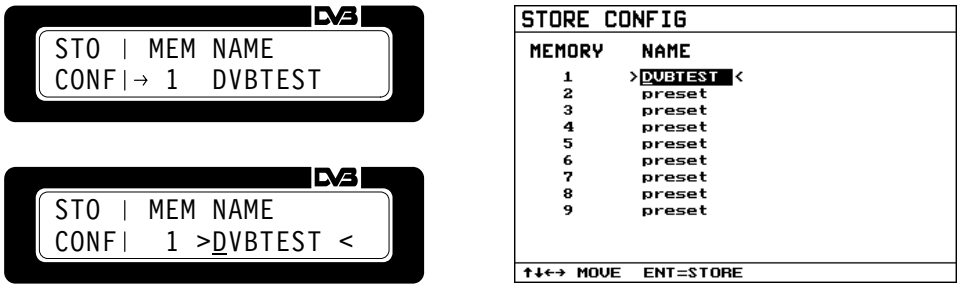


Figure 4–33: STORE CONFIG and RECALL CONFIG menu

▲ ▼ ◀ ▶	Set cursor to desired memory location
ENTER	RECALL CONFIG: Loads the selected instrument setup. STORE CONFIG: Stores current settings in the selected memory. First the text editor is called up for entering a name. When the entry is confirmed with ENTER the settings are stored.
ESC	Returns to the MAIN menu

CAUTION. *The following settings and data are not stored with the STORE CONFIG function and are reloaded unvaried when a stored setup is called up:*

- *Content of error counter in the MONITORING/STATISTICS menu*
- *Content of report in the MONITORING/REPORT menu*
- *Content of program list in the DECODER/SELECT PROGRAM menu*
- *Settings of program elements in the DECODER/SELECT PROGRAM ELEMENT menu, except those for the currently decoded program*

SETUP Menu

The SETUP menu provides all general functions for configuring the OSD, the serial interface, and the internal clock.

SETUP/ON SCREEN DISPLAY Menu. In the menu, the OSD can be switched on and off.

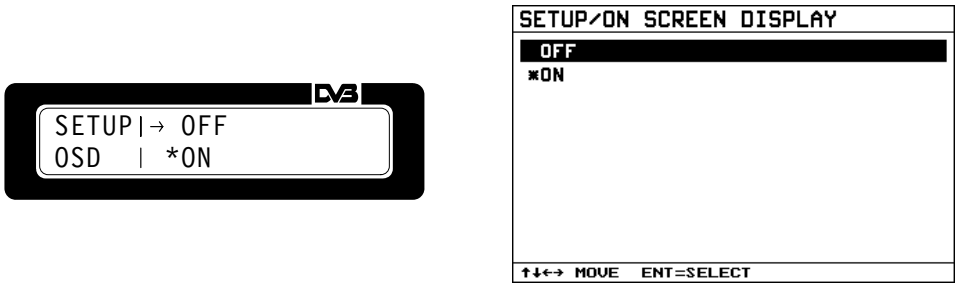


Figure 4–34: SETUP/ON SCREEN DISPLAY menu

▲ ▼ ◀ ▶	Set cursor to 'ON' or 'OFF'
ENTER	Switches the OSD on or off
ESC	Returns to SETUP menu

DISPLAY OFF — Menus are displayed on LCD only.

DISPLAY ON — Menus are displayed on LCD and OSD simultaneously. In the STATUS menu, the OSD can be switched off with ESC. The OSD is switched on again by pressing any key.

SETUP/RS-232 Menu. In this menu, the operating parameters of the serial interface can be configured.

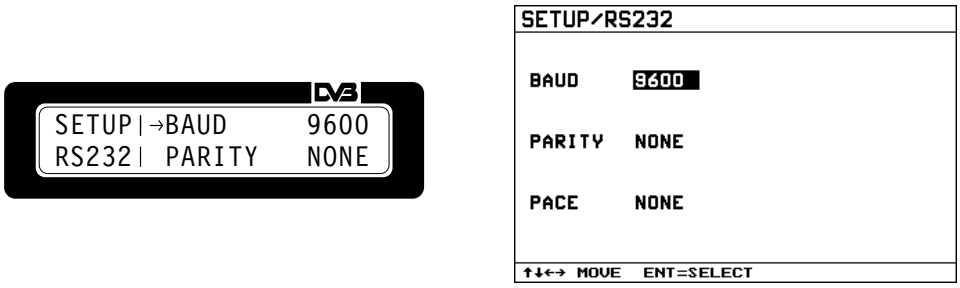


Figure 4–35: SETUP/RS-232 menu

▲ ▼	Set cursor to the item to be changed (for example, PARITY)
ENTER	Calls up the entry mode: Select setting (for example, parity NONE, with cursor keys ▲ ▼). The new setting is stored with ENTER or cleared with ESC.
ESC	Returns to SETUP menu

BAUD — Selectable baud rates for data transmission:
1200, 2400, 4800, 9600, 19200

PARITY — Selectable parity for data transmission:

NONE	No parity
EVEN	Even parity
ODD	Uneven parity

PACE — Selectable handshake for data transmission:

NONE	No handshake used.
XON/XOFF	Handshake with XON and XOFF.
RTS/CTS	Handshake with RTS and CTS.

Data transmission uses 8 data bits and one stop bit.

***NOTE**. Hardware handshake must be used for transmitting block data via the RS-232 interface, since control characters (XON / XOFF) are not recognized. The latter may be part of the block data stream.*

SETUP/DATE+TIME Menu. In this menu, the date and time for the clock is set.

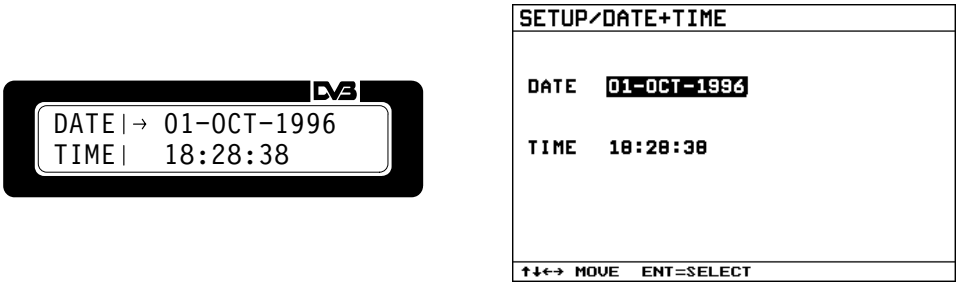


Figure 4–36: SETUP/DATE+TIME menu

▲ ▼	Set cursor to date or time
ENTER	Calls up the entry mode: The new date or time are entered in the same way as numerals. Set the cursor to the digit or month to be varied using keys ◀ ▶. The selected digit is varied with cursor keys ▲ ▼ and the entered value is stored with ENTER. The entry is aborted with ESC.
ESC	Returns to SETUP menu

Remote Control

The MTD200 MPEG Test Decoder is fitted with an RS-232-C interface as standard. The connector is located at the rear of the instrument and permits an external controller to be connected. The instrument supports the Standard Commands for Programmable Instruments (SCPI), version 1995.0. The SCPI standard is based on the IEEE 488.2 standard and aims at a standardization of device-specific commands, error handling, and status registers (refer to *SCPI Introduction* on page 5–4).

Basic knowledge of SCPI programming and operation of the controller is required for a clear understanding of this chapter.

The requirements of the SCPI standard on the command syntax, error handling and configuration of the status registers are described in detail in the relevant sections. Tables provide a quick overview of the commands implemented in the instrument and the assignment of the bits in the status registers. The tables are supplemented by a detailed description of commands and status registers. For the description of the commands, a basic knowledge of the MPEG test decoder manual operation is assumed.

All program examples for control via RS-232 are written in C for the program package V24.Tools Plus from Langner.

Brief Instructions

The following brief operating instructions allow you to quickly put the instrument into operation and to set the basic functions:

1. Connect the MPEG test decoder to the controller via a null-modem cable.
2. Set the MPEG test decoder (menu item SETUP/RS232) to 9600 baud, 8 bits, parity NONE, 1 stop bit, and the protocol PACE.
3. Start a terminal program on the controller, and set it to the same protocol as the MPEG test decoder.
4. Enter the following command sequence:
   a. DISP:OSD:MODE ON
   b. SYST:DISP:CONT STAT
   c. CONF:MON:CONT CLEA
   d. CONF:MON:CONT START

The MONITORING REPORT is cleared and monitoring restarted. On the OSD (On Screen Display), the MONITORING/STATISTICS menu is displayed.

5. To return to manual operation:

   a. Press any key on the front panel.

      The menu for switchover to LOCAL is opened on the display.

   b. Set the cursor to LOCAL and confirm with ENTER.

Starting Remote Control

On power up, the MPEG test decoder is automatically set to in the manual mode (LOCAL) and can be operated from the front panel. Starting remote control (REMOTE) is made as soon as a character is received via the RS-232 interface. The MPEG test decoder remains in the REMOTE state until it is switched back to the manual mode, either manually or via the RS-232 interface (refer to *Return to Manual Operation* on page 5–3). Switching from the manual mode to remote control and vice versa has no effect on the instrument settings.

Setting the Transmission Parameters

To ensure error-free data transmission, the same transmission parameters must be set on the MPEG test decoder and the controller. The parameters can be varied either manually in the SETUP/RS232 menu or via remote control using the SYSTem:COMMunicate:SERial:... commands.

The following transmission parameters are the factory default settings:

- Baud rate = 9600
- Bits = 8, stop bits = 1
- Parity = NONE
- Protocol = NONE

Indications in Remote Control

In remote control, REMOTE is indicated in the STATUS menu. The MPEG test decoder features four different display modes for the OSD which must be switched on with command DISPlay:OSD:MODE ON. The display modes are selected my means of command SYSTem:DISPlay:CONTents STATistic | ... and are as follows:

- STATistic MONITORING\STATISTICS menu displayed on the OSD
- REPort MONITORING\REPORT menu displayed on the OSD

- PROGram DECODER/PROGRAM menu displayed on the OSD
- INFO STATUS menu displayed on the OSD

Return to Manual Operation

If the MPEG test decoder is in the remote-control mode, press any key on the front panel to call up the menu for switchover to LOCAL mode. Set the cursor to LOCAL, and confirm with ENTER.

***NOTE**. Prior to the switchover all commands must have been fully processed; otherwise, remote control is immediately switched on again.*

Switchover to LOCAL mode lockout can be disabled by the command SYSTem:KLOC ON. This command prevents inadvertent switchover.

Cancel LOCAL switchover lockout by using the command SYSTem:KLOC OFF.

Device-Dependent Messages (Commands and Responses)

Device-dependent messages are transmitted on the data lines of the remote-control interface using the ASCII/ISO code. Device-dependent messages are differentiated according to the direction in which they are sent via the interface:

Commands are messages sent by the controller to the device. They control the device functions and request information. The commands are differentiated by two criteria:

1. The effect they have on the device.

   Setting commands trigger device settings (for example, resetting of the instrument).

   Queries cause data to be provided for output via the IEC/IEEE bus (for example, for device identification or query of the active input).

2. Their definition in the IEEE 488.2 standard.

   Common commands are precisely defined in their function and notation in the IEEE 488.2 standard. They concern functions, such as the management of the standardized status registers, resetting, and self test.

   Device-specific commands relate to functions that depend on device characteristics, such as the frequency setting. Part of these commands are standardized by the SCPI Consortium (refer to *SCPI Introduction* page 5–4).

Responses are messages sent by the device to the controller following a query. They may contain results, device settings, or information about the device status (refer to *Responses to Queries* on page 5–8).

Structure and syntax of the device-dependent messages are described on page 5–4. Commands are listed and explained on page 5–12. The description of the commands requires basic knowledge of the manual operation of the MPEG test decoder.

Structure and Syntax of Device-Dependent Messages

SCPI Introduction

Standard Commands for Programmable Instruments (SCPI) describes a standardized command set for the programming of instruments, regardless of the type of instrument or manufacturer. The objective of the SCPI Consortium is to standardize device-specific commands to a large extent. For this purpose, an instrument model has been developed which defines identical functions within an instrument or of different instruments. Command systems have been generated and assigned to these functions so that it is possible to address identical functions by the same commands. The command systems have a hierarchical structure. Figure 5–1 shows this tree structure, using a detail from the SYSTem command system for controlling parts of the instrument setup. The other examples of syntax and structure of the commands are taken from this command system.

SCPI is based on the IEEE 488.2 standard; it uses the same syntax elements as well as the common commands defined therein. The syntax of the responses is partly subjected to stricter rules than laid down in the IEEE 488.2 standard (refer to *Responses to Queries* on page 5–8).

Command Structure

The commands consist of a so-called header and usually one or more parameters. Header and parameters are separated by a white space with an ASCII code of 0 to 9 or 11 to 32 decimal (for example, a space). The headers may be composed of several keywords. The query form is generated by appending a question mark directly to the header.

NOTE. *The commands used in the examples below are not necessarily implemented in the instrument.*

Common commands. Common commands consist of a header to which an asterisk (*) is prefixed and one or more parameters.

Examples:

```
*RST
```
RESET (resets the device)

```
*ESE 235
```
EVENT STATUS ENABLE (sets the bits of the Event Status Enable Register)

```
*ESR?
```
EVENT STATUS QUERY (queries the contents of the Event Status Register)

Device-specific commands.

- Hierarchy:
  Device-specific commands have a hierarchical structure (see Figure 5–1).

  The various levels are represented by compound headers. Headers of the highest level (root level) have one keyword only. This keyword stands for a whole command system.

  Example:

  ```
  SYSTem
  ```
  This keyword denotes the command system SYSTem.

  For lower-level commands, the full path has to be specified, starting with the highest level in the left-most position. The individual keywords are separated by a colon (:).

  Example:

  ```
  SYSTem:COMMunicate:SERial:RECeive:BAUD 9600
  ```
  This command is at the fifth level of the system SYSTem and sets the baud rate to 9600.

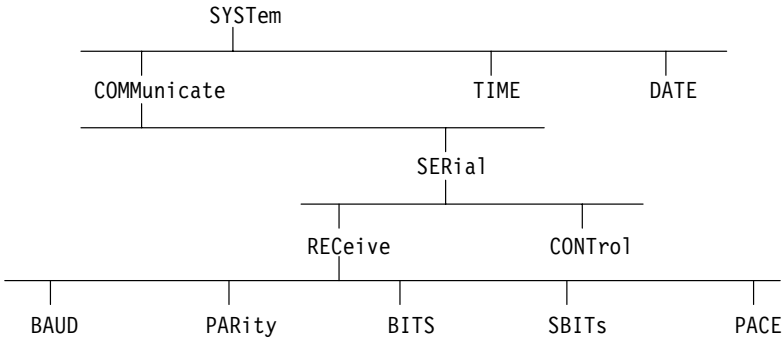


Figure 5–1: Tree structure of SCPI command systems (SYSTem shown as an example)

- Long and short form:
  The keywords have a long and a short form. They may be entered in the short or the long form; other abbreviations are not allowed.

  Example:

  ```
  SYSTem:COMMunicate:SERial:BAUD 9600
  ```

  The following command has the same effect.

  ```
  SYST:COMM:SER:BAUD 9600
  ```

NOTE. *The short form uses uppercase characters, the long form gives the whole keyword. Uppercase and lowercase letters are only used for identification in the instrument manual; the instrument itself does not differentiate between uppercase and lowercase characters.*

- Parameter:
  The parameter must be separated from the header by a white space. If a command contains several parameters, these must be separated by a comma (,). Some of the queries allow the specification of the parameters MINimum, MAXimum and DEFault. For a description of the various types of parameters, refer to *Parameters* on page 5–9.

  Example:

  ```
  SYSTem:COMM:SER:REC:BAUD? MAXimum Response: 19200
  ```
  This query returns the maximum value for the baud rate.

- Numeric suffix:
  If an instrument has several identical functions or features (such as inputs), the desired function can be selected by a suffix to the command. Commands given without suffix are interpreted as having suffix 1.

Example:

SYSTem:COMMunicate:SERial2:BAUD 4800
This command sets the baud rate of the serial interface SERial2 to 4800 Baud.

- Optional keywords:
  In some command systems, it is possible to insert or to omit certain keywords. These keywords are shown in the instrument manual in square brackets. For compatibility with the SCPI standard, the instrument must be able to recognize the full command length. Some of the commands become considerably shorter when the optional keywords are omitted.

  Example:

  SYSTem:COMMunicate:SERial[:RECeive]:BAUD 4800
  This command sets the baud rate of the serial interface SERial to 4800 baud. The following command has the same effect.

  Example:

  SYSTem:COMMunicate:SERial:BAUD 4800
  An optional keyword may not be omitted if its effect is specified in more detail by a numeric suffix.

Structure of a Command Line

A command line may contain one or several commands. Via the RS-232 interface; it is terminated by a <Carriage Return><New Line>.

Several commands in a command line are separated by a semicolon (;). If the next command belongs to a different command system, the semicolon is followed by a colon.

Example:

SYSTem:TIME 20,30,00;:SENSe:PROGram 10
This command line contains two commands. The first command belongs to the SYSTem system and is used to set the time of the system clock. The second command belongs to the SENSe system, and selects the program to be decoded.

If the successive commands belong to the same system and therefore have one or more common levels, the command line may be shortened. The second command following the semicolon then starts at the level that is below the common levels (see also Figure 5–1 on page 5–6). The colon after the semicolon has to be omitted.

Example:

```
SYSTem:COMM:SERial:BAUD 4800;:SYSTem:COMM:SERial:BITS 8
```

This command line contains two commands separated by a semicolon. Both commands belong to the SYSTem system COMMunicate:SERial subsystem; they have three common levels.

In the shortened command line the second command starts at the level below SYSTem:COMMunicate:SERial. The colon after the semicolon has to be omitted.

The shortened form of the command line is:

```
SYST:COMM:SER:BAUD 4800;BITS 8
```

A new command line always starts with the full path however.

Example:

```
SYSTem:COMMunicate:SERial:BAUD 4800
SYSTem:COMMunicate:SERial:BITS 8
```

Responses to Queries

Unless otherwise expressly specified, a query is defined for each setting command. The query is generated by appending a question mark to the associated setting command. The SCPI rules imposed on the query responses are somewhat stricter than those of the IEEE 488.2 standard:

1. The required parameter is sent without header.

Example: `SYSTem:COMMunicate:SERial:BAUD?`
Response: `4800`

2. Maximum and minimum values can be requested by a special text parameter.

Example: `SYSTem:COMMunicate:SERial:BAUD? MINimum`
Response: `1200`

3. Numeric values are output without unit. Physical quantities refer to the basic units.

Example: `READ:TS:BITRate?`
Response: `38E6 for 38 MBit/s`

4. Boolean values are returned as 0 (for OFF) and 1 (for ON).

   Example: `ROUTe:AUDio:RIGHt?`
   Response: `1`

5. Character data used for a parameter are returned in short form (see also *Parameters* on page 5–9).

   Example: `ROUTe:VIDeo?`
   Response: `PALN`

Parameters

Most commands require the specification of a parameter. The parameters must be separated from the header by a white space. Parameters may be specified as numeric values, Boolean parameters, character data, character strings and block data. The type of parameter required for the specific command as well as the permitted range of values are described together with the commands (see page 5–12).

Numeric values. Numeric values may be entered in any customary form (that is, with a sign, decimal point and exponent). If the values exceed the resolution of the instrument, they will be rounded off. The mantissa may comprise up to 255 characters, the exponent must be in the range between –32000 and 32000. The exponent is denoted by an “E” or “e.” The exponent alone must not be used. Physical quantities may be stated with the unit. Permissible prefixes for the unit are G (Giga), MA (Mega, MOHM and MHZ are also allowed), K (kilo), M (milli), U (micro) and N (nano). If no unit is specified, the basic unit will be used.

Example:

```
SOURce:FREQuency 1.5 kHz
SOURce:FREQuency 1.5E3
```

Special numeric values. The parameters MINimum, MAXimum, DEFault, and NAN are interpreted as special numeric values.

Upon a query, the numeric value will be returned.

Example:

```
Setting command:    SYST:COMM:SER:BAUD MAX
Query:              SYST:COMM:SER:BAUD?
Response:           19200
```

- MIN/MAX
  MINimum and MAXimum denote the minimum and maximum value.
- DEF
  DEFault denotes a preset value stored in the EPROM. This value coincides with the basic setting called up by the *RST command.
- NAN
  Not A Number (NAN) is represented as 9.91E37. NAN is only sent as a response. This value is not defined. NAN is typically returned when dividing by zero, subtracting infinity from infinity and representing missing data.

Boolean parameters. Boolean parameters represent two states. The ON state (true condition) is represented by ON or a nonzero numeric value. The OFF state (false condition) is represented by OFF or the value of 0. Queries always return 0 or 1.

Example:

```
Setting command:    ROUTe:AUDio:RIGHt ON
Query:              ROUTe:AUDio:RIGHt?
Response:           1
```

Character data. Character data follow the syntax rules for keywords and have a short and a long form. Like any other parameters, they must be separated from the header by a white space. A query returns the short form of the character data.

Example:

```
Setting command:    ROUTe:VIDeo PALNtsc
Query:              ROUTe:VIDeo?
Response:           PALN
```

Character strings. Strings must always be given in single or double quotes.

Example:

```
SYSTem:            LANGuage "SCPI" or
SYSTem:            LANGuage 'SCPI'
```

Block data. Block data is a format suitable for the transmission of large data volumes. A command with a block data parameter has the following structure:

Example:

```
HEADer:HEADer #45168xxxxxxxx
```

The ASCII character # denotes the beginning of the data block. The next number specifies the number of subsequent digits defining the length of the data block. In the example above, the four digits specify a length of 5168 bytes. The 5168 data bytes follow next. During the transmission of these data bytes, all terminators and other control characters are ignored until all 5168 bytes have been transmitted.

If block data are returned upon a query, they will always be sent in the above format (<DEFINITE LENGTH ARBITRARY RESPONSE DATA>).

In the MPEG test decoder, block data are always transmitted as byte stream. Special formats are either fixed to the respective command or described in the data stream. Formatting of the commands is described together with the commands (refer to *Description of Commands* on page 5–12).

NOTE. *The transmission of block data via the RS-232 interface is subject to certain restrictions (refer to* Appendix A: Interfaces*).*

Overview of Syntax Elements

The following list provides an overview of the syntax elements.

‘ : ’ The colon separates the keywords of a command. In a command line, the colon following a semicolon identifies the highest command level.

‘ ; ’ The semicolon separates two commands in a command line.

‘ , ’ The comma separates several parameters of a command.

‘ ? ’ The question mark forms a query.

‘ * ’ The asterisk identifies a common command.

‘ ” ’ Quotation marks denote the beginning of a character string and terminate it.

‘ # ’ The double cross (pound symbol) denotes the beginning of block data.

‘ ’ A white space (ASCII code 0 to 9 and 11 to 32 decimal), such as a space, separates header and parameters.

Description of Commands

Notation

In the following sections, all commands implemented in the MPEG 200 test decoder are tabulated according to the operating mode and the command system, and are described in detail. The notation is largely in line with the SCPI standard. The SCPI conformity information is given in Table 5–13 on page 5–60.

In Table 5–13 on page 5–60, all commands implemented in the device are tabulated.

Command table.

- Command:
  In the command column the table shows an overview of the commands and their hierarchical relationships (refer to *Indentations* on page 5–12).
- Parameter:
  In the parameter column the required parameters and their range of values are stated.
- Unit:
  The unit column shows the basic unit of the physical parameters.
- Notes:
  In the notes column it is stated,
  - whether the command has a query form,
  - whether the command is only in the form of a query,
  - whether the command is implemented in a certain instrument option only.

Indentations. The various levels of the SCPI command hierarchy are shown in the table by indentations to the right. The lower the level, the greater the indentation to the right. It should be noted that the complete notation of the command always includes the higher levels too.

In the command description the hierarchy of the commands is shown. This means that for each command all keywords listed above the command through to the left-hand margin have to be considered too.

Upper/lower case. Uppercase/lowercase characters are used to differentiate between the long form and the short form of the keywords of a command in the command description (refer to *Command Structure* on page 5–4). The instrument itself does not differentiate between uppercase and lowercase letters.

Special characters.

| A vertical bar in the notation of the parameters is used to separate alternative options and is to be seen as “or”. The effect of the command differs according to the parameter stated.

Example:
Selection of parameters for the command

```
SYSTem:COMM:SER:PAR        NONE | EVEN | ODD
```

[ ] Keywords in square brackets may be omitted in compound headers (refer to *Optional Keywords* on page 5–7). For compatibility with the SCPI standard, the instrument must be able to recognize the full length of the command.

Parameters in square brackets may also be optionally inserted into the command or omitted.

{ } Parameters in curly brackets may be included in the command zero, one or more times.

< > A name given in angle brackets is a summarized description of character data that due to their volume have been combined in a table.

Example:

```
CONFigure:MONITORING:PARameter <parameter name>
```

Common Commands

The common commands are based on the IEEE 488.2 (IEC 625.2) standard. A specific command has the same effect in different instruments. The headers of these commands consist of an asterisk (*) followed by three letters. Many common commands refer to the status reporting system described in detail in *Status Reporting System* on page 5–49.

Command	Parameter	Unit	Notes
*CLS			No query
*ESE	0 to 255		
*ESR?			Query only
*IDN?			Query only
*OPC			

Command	Parameter	Unit	Notes
*PSC	0 | 1		
*RST			Query only
*SRE	0 to 255		
*STB?			Query only
*TST?			Query only
*WAI			

*CLS — CLEAR STATUS sets the status byte (STB), the Standard Event Register (ESR) and the EVENt part of the QUEStionable and of the OPERation Register to zero. The command has no effect on the mask and transition parts of the register. It clears the output buffer.

*ESE 0 to 255 — EVENT STATUS ENABLE sets the Event Status Enable Register to the defined value. The query *ESE? returns the contents of the Event Status Enable Register in decimal form.

*ESR? — STANDARD EVENT STATUS QUERY returns the contents of the Event Status Register in decimal form (0 to 255) and then clears the register.

*IDN? — IDENTIFICATION QUERY for identification of the instrument.

The response is for example:
`"Rohde&Schwarz, DVMD,0,2.02"`

0 = serial number
2.02 = firmware version number

*OPC — OPERATION COMPLETE sets bit 0 in the Event Status Register if all preceding commands have been executed. This bit may be used to assert a Service Request.

*OPC? — OPERATION COMPLETE QUERY places an ASCII character 1 into the output buffer as soon as all preceding commands have been executed.

*PSC 0 | 1 — POWER ON STATUS CLEAR determines whether on power up the contents of the ENABle Register is retained or cleared.

- *PSC = 0 — causes the status register to retain its contents. With a corresponding configuration of the status registers ESE and SRE, a Service Request may be asserted upon power up.
- *PSC =| 0 — clears the register.
  The query *PSC? reads out the contents of the power-on-status-clear flags. The response may be 0 or 1.

*RST — RESET sets the device to a defined default state. The default setting is given together with the description of the commands.

*SRE 0 to 255 — SERVICE REQUEST ENABLE sets the Service Request Enable Register to the defined value. This command determines the conditions under which a Service Request will be asserted. The query *SRE? outputs the contents of the Service Request Enable Register in decimal form. The value of the unused bit 6 (MSS mask bit) is always 0.

*STB? — READ STATUS BYTE QUERY outputs the contents of the status byte in decimal form.

*TST? — SELF TEST QUERY triggers all self tests of the device and outputs an error code in decimal form.

*WAI — WAIT-to-CONTINUE allows processing of commands only after all preceding commands have been executed and all signals are settled (see also **OPC*.

Setting the Operating Modes

In the remote-control mode the decoder features two additional operating modes.

Command	Parameter	Unit	Notes
SENSe :FUNCtion [:ON][?]	MONitoring | TRERror | DUMP		Setting the operating mode

SENSe :FUNCtion [:ON][?] MONitoring | TRERror | DUMP

*RST value: MONitoring

Selects one of the three decoder modes:

MONitoring	Activates the monitoring mode. An applied transport stream is monitored.
TRERror	Activates the 'Trigger on Error' function (refer to *Commands for the 'Trigger on Error' Function* on page 5–35). If the error condition set with CONFigure:TRERor:TRIGger has occurred, a maximum of 800 transport stream packets can be read with READ:TRERor?.
DUMP	Activates the 'Dump' function (refer to *Commands for the 'Dump' Function* on page 5–36). If the filter condition set with CONFigure:DUMP:STATe and ...:TRIGger:PID has occurred, a maximum of 1394 transport stream packets can be read with READ:DUMP?.
Example:	SENS:FUNC MON

***NOTE**. The TRERror and DUMP modes can only be activated by remote control. Upon switchover from MONitoring to TRERror or DUMP, monitoring of the transport stream is stopped (corresponds to command CONF:MON:CONT STOP). When a switchover is performed from remote to manual control (refer to* Return to Manual Operation *on page 5–3), the MONitoring mode is automatically selected. If monitoring was active before the switchover to TRERror or DUMP, monitoring will be continued when the MONitoring mode is selected again.*

On power up, the MPEG test decoder is always in the MONitoring mode.

Commands of MONITORING Menu

Enable the MONITORING operating mode by using the command SENSe:FUNCtion:MONitoring

Command	Parameter	Unit	Notes
READ [:SCALar] :MONitoring?	<parameter name> / Year, month, day, hour, minute, second, parameter status		Reads the current parameter status, –1 = parameter not active 0 = okay. 1 = error
:ALL?	– / Year, month, day, hour, minute, second, parameter status 1, ... , parameter status 19		Reads all parameter states –1 = parameter not active 0 = okay. 1 = error
:ERRSeconds?	<parameter name> / Year, month, day, hour, minute, second, error seconds		Reads error seconds of a parameter –1 = parameter not active 0 = okay. 1 to 99 = number of error seconds
:ALL?	– / Year, month, day, hour, minute, second, error seconds 1, ... , error seconds 19		Reads error seconds of all parameters –1 = parameter not active 0 = okay. 1 to 99 = number of error seconds
:REPort?	– / 0 | 1, Year, month, day, ... | –1, Year, month, day, ...		Reads one line of the test report; the read cursor is incremented, 0 = read cursor == write cursor 1 = line in test report –1 = entries overwritten
:LINE?	0 to 999 / 0 | 1, Year, month, day, ... | –1, Year, month, day, ...		Reads one line of the test report. 0 = last line 1 = last but one line, etc. Response: 0 = line not in the report 1 = line in the test report –1 = entries overwritten
:MOMent?	<parameter name> 1900 to 2100, 1 to 12, 1 to 31, 0 to 23, 0 to 59, 0 to 59 / 0 | 1, <error number>, PID {, ... } | –1, <error number>, PID {, ... }		Reads an entry in the test report for a specific parameter at a specific time. Response: 0 = no entry in the test report. 1 = line in the test report –1 = entries overwritten

Command	Parameter	Unit	Notes
:DURation?	0, day, hours, minutes, seconds | 1, day, hours, minutes, seconds		Evaluated period 0 = measurement stopped 1 = measurement on
CONFigure :MONitoring :CONTrol[?]	STARt | STOP | CLEar		Starts and stops monitoring, clears measured values
:PARameter[?]	<parameter name>, ON | OFF		Includes specific parameters in or excludes them from monitoring, see page 5–42
:ALL	ON | OFF		Includes all parameters in the monitoring or clears all, no query
:LIMit :UPPer[?]	<parameter name>,100 to 60000ms	S	Sets upper limit value, see page 5–46
:LOWer[?]	<parameter name>, 1 to 100 ms	S	Sets lower limit value, see page 5–46
:PROGram :MODE[?]	AUTO | PRESelected		Configuration of program monitoring
:LIST1..10[?]	1 to 65535		Configuration of program list for the PRESelected mode
:CLEAr			Clears the configuration of the whole program list

READ [:SCALar] :MONitoring? <parameter name>

This command queries the current status of a parameter in the MONitoring mode. In the TRERror and DUMP modes, NAN is returned.

Parameter name: See *Parameter Names for Monitoring* on page 5–42.

Response: year, month, day,
hour, minute, second,
parameter status

Parameter status : –1 parameter not active
0 okay., no error occurred
1 an error has occurred

Example: READ:MON? CCNT

Response: 1996,05,06,20,15,00,1

READ [:SCALar] :MONitoring :ALL?

Queries the current status of all parameters in the MONitoring mode. In the TRERror and DUMP modes, NAN is returned.

Response: year, month, day,
hour, minute, second,
parameter status of

TSSL,	SBE,	PATE,	CCOE,	PMTE,	PIDE,
TPEE,	CRCE,	PCRE,	PCRA,	PTSE,	CATE,
NITE,	SIRE,	PIDU,	SDTE,	EITE,	RSTE,
TDTE					

Parameter status :

–1	parameter not active
0	okay., no error occurred
1	an error has occurred

Example: READ:MON:ALL?

Response: 1996,05,06,20,15,00,1,0,0...,0

READ [:SCALar] :MONitoring :ERRSeconds? <parameter name>

Queries the error seconds of a parameter.

Parameter name: See *Parameter Names for Monitoring* on page 5–42.

Response: year month day,
hour, minute, second,
error seconds

Error seconds :

–1	parameter not active
0	okay., no error occurred
1 to 99	number of error seconds

Example: READ:MON:ERRS? CCNT

Response: 1996,05,06,20,15,00,17

READ [:SCALar] :MONitoring :ERRSeconds :ALL?

Queries the error seconds of all parameters.

Response: year month day,
hour, minute, second,
error seconds of

TSSL,	SBE,	PATE,	CCOE,	PMTE,	PIDE,
TPEE,	CRCE,	PCRE,	PCRA,	PTSE,	CATE,

	NITE, SIRE, PIDU, SDTE, EITE, RSTE, TDTE	
Error seconds :	–1	parameter not active
	0	okay., no errors found
	1 to 99	number of error seconds

Example: READ:MON:ERRS:ALL?

Response: 1996,05,06,20,15,00,17,3,0,...,0,11

READ [:SCALar] :MONitoring :REPort?

Reads an entry in the MONITORING/REPORT and sets the corresponding read cursor to the next entry in the report.

Response: Report status,
year, month, day,
hour, minute, second,
<error number>, PID

Report status :	0	No new entry in the report. Read cursor == write cursor. Only the report status is output.
	1	There are entries in the report.
	–1	Entries in the report not read with READ:MONitoring:REPort? were overwritten.

Error number : Refer to Table 5–1 on page 5–42

PID: PID at which the error occurred

Example: READ:MON:REP?

Response: 1,1996,05,06,20,15,00,101,1250

READ [:SCALar] :MONitoring :REPort :LINE? 0 to 999

Reads a specific entry in the MONITORING/REPORT. The location of the entry is given with respect to the last entry.

Response: Report status,
year, month, day,
hour, minute, second,
<error number>, PID

Report status :	0	The desired entry is not in the report. Only the report status is output.
	1	The desired entry is in the report.

	–1	Entries not read in the report were overwritten by READ:MONitoring:REPort?
Error number :		Refer to Table 5–1 on page 5–42
PID:	PID at which an error occurred	
Example:	READ:MON:REP:LINE 5	
Response:	1,1996,05,06,20,15,00,101,1250	

READ [:SCALar] :MONitoring :REPort :MOMent?
<parameter name>, year, month, day, hour, minute, second

Reads the entries in the MONITORING/REPORT for the desired parameter and time.

Parameter name:	See *Parameter Names for Monitoring* on page 5–42.	
Response:	Report status, <error number>, PID {, <error number> , PID }	
Report status :	0	No entry in the report for the desired parameter and time. Only the report status is output.
	1	The desired entry is in the report.
	–1	Entries in the report not read with READ:MONitoring:REPort? were overwritten.
Error number :	Refer to Table 5–1 on page 5–42	
PID:	PID at which the error occurred	
Example:	READ:MON:REP:MOM? CCNT,1996,05,07,20,15,20	
Response:	1,101,1250	

READ [:SCALar] :MONitoring :DURation?

Reads the monitoring period (value in the ELAPSED TIME field in the OSD)

Response:	Monitoring status, day, hours, minutes, seconds	
Monitoring status:	0	monitoring disabled
	1	monitoring active
Example:	READ:MON:DUR?	
Response:	1,0,5,45,06	

CONFigure :MONitoring

This node defines the commands for configuration and control of MPEG2 transport stream monitoring.

CONFigure :MONitoring :CONTrol STARt | STOP | CLEAR

*RST value: STARt

This command controls monitoring.

STARt starts monitoring

STOP stops monitoring

CLEAR clears error report and error seconds

Example: CONF:MON:CONT STOP

CONFigure :MONitoring :PARameter <parameter name>, ON | OFF

Parameter name: See *Parameter Names for Monitoring* on page 5–42.

*RST value: <parameter name>, ON

Switches monitoring of the specified parameter on or off.

Example: CONF:MON:PAR CCNT,ON

CONFigure :MONitoring :PARameter :ALL ON | OFF

Switches monitoring of all parameters on or off.

Example: CONF:MON:PAR:ALL? ON

CONFigure :MONitoring :LIMit :UPPer <parameter name>, 100 to 60000 ms

Sets the upper limit for the specified parameter.

(For limit values, refer to Table 5–5 on page 5–46.)

Parameter name: See *Parameter Names for Monitor Limits* on page 5–46.

Example: CONF:MON:LIM:UPP PATR, 600 s

CONFigure :MONitoring :LIMit :LOWer <parameter name>, 1 to 1000 ms

Sets the lower limit for the specified parameter.

(For limit values, refer to Table 5–5 on page 5–46.)

Parameter name: See *Parameter Names for Monitor Limits* on page 5–46.

Example: CONF:MON:LIM:LOW PATR, 30 ms

CONFigure :MONitoring :PROGram:MODE[?] AUTO | MANual

This command determines whether the program to be monitored is selected automatically (AUTO) or manually (MANual).

Example: CONF:MON:PROG:MODE MAN

CONFigure :MONitoring :PROGram:SELect[?] 1 to 65535, ON | OFF

This command selects one of the programs to be monitored in the MANual operating mode. If the program selected is not within the transport stream, or if the AUTO monitoring mode is enabled, an SCPI error is generated.

Example: CONF:MON:PROG:SEL 9001, ON

Commands of DECODER Menu

Command	Parameter	Unit	Notes
SENSe :PROGram[?]	1 to 65535		Selects the program. PCR, video, audio and data elements are selected from PSI tables.
:PCR[?]	32 to 8191		Selects the PCR element.
:VIDeo[?]	32 to 8191		Selects the video element.
:AUDio[?]	32 to 8191		Selects the audio element.
READ [:SCALar] :TS :BITRate?	– / 0.00 to 99.999 E 6	 bit/s	Queries the bit rate of the transport stream.
:PROGram :NAMe?	1 to 65535 / 'name'		Queries a program name.
:BITRate?	1 to 65535 / 0.0 to 99.999E6	 bit/s	Queries the bit rate of a program
:CONDaccess?	1 to 65535 / 1 | 0		Queries whether a program is encrypted.

Command	Parameter	Unit	Notes
READ :ARRay :PROGram?	 – / 1 to 65535 {, 1 to 65535}		Reads the number of the programs in the transport stream.
:PID?	1 to 65535 / 0 to 8191 {,0 to 8191}		Queries the PID numbers of all program elements. The first number is the PID of the PMT, the second is the PCR PID.
READ [:SCALar] :PID :TYPE?	 0 to 8191 / VIDeo | AUDio | DATA | PSI | SI		Queries the type of an element.
:BITRate?	0 to 8191 / 0.0 to 99.999E6	 bit/s	Queries the bit rate of an element
:CONDaccess?	0 to 8191 / 1 | 0		Queries whether an element is encrypted.
ROUTe :VIDeo[?]	 PALNtsc | SECamntsc		Sets the video standard for a 625-line signal
:AUDio :RIGHt[?]	 ON | OFF		Audio output 1/right off/on
:LEFT[?]	ON | OFF		Audio output 2/left off/on

SENSe :PROGram 1 to 65535

This command selects the program to be decoded via the program number. PID values for PCR, video, audio and data are taken from the PMT.

Example: SENS:PROG 1

SENSe :PROGram :PCR 32 to 8191

Sets the PID for the PCR values of the decoded streams. This setting is only required when the PMT is faulty.

Example: SENS:PROG:PCR 100

SENSe :PROGram :VIDeo 32 to 8191

Sets the PID for the video stream to be decoded. This is only required if the program contains more than one video stream or if the PMT is faulty.

Example: SENS:PROG:VID 100

SENSe :PROGram :AUDio 32 to 8191

Sets the PID for the audio stream to be decoded. This is only required if the program contains more than one audio stream or if the PMT is faulty.

Example: SENS:PROG:AUD 101

READ [:SCALar] :TS :BITRate?

Queries the bit rate of the transport stream in the MONitoring mode. In the TRERror and DUMP modes, NAN is returned.

Example: READ:TS:BITR?

Response: 38.014e6

The response is 38.014 Mbit/s

READ [:SCALar] :PROGram :NAMe? 1 to 65535

Queries the program name.

Example: READ:PROG:NAM? 1

Response: ARD

READ [:SCALar] :PROGram :BITRate? 1 to 65535

Queries the bit rate of a program in the MONitoring mode. In the TRERror and DUMP modes, NAN is returned.

Example: READ:PROG:BITR? 1

Response: 5.3e6

The response is 5.3 Mbit/s

READ [:SCALar] :PROGram :CONDaccess? 1 to 65535

Queries whether the program is encrypted.

Example: READ:PROG:COND? 1

Response: 0

READ :ARRay :PROGram?

Queries the program numbers in the transport stream.

Example: READ:ARR:PROG?

Response: 1,2,3,5,7

READ :ARRay :PROGram :PID? 1 to 65535

Queries the PIDs of the program elements. The first PID identifies the PMT to which the program is referred; the second PID indentifies the stream containing the PCR values. The following PIDs identify the program elements.

Example: READ:ARR:PROG:PID?

Response: 90,100,101,102

READ [:SCALar] :PID

If the PID is not contained in the transport stream or if operating mode TRERror or DUMP set, NAN is returned.

READ [:SCALar] :PID :TYPE? 0 to 8191

Queries the type of PID.

xx.VIDeo	PID contains video stream of type xx (ISO/IEC 13818–1)
xx.AUDio	PID contains audio stream of type xx (ISO/IEC 13818–1)
xx.OTHer	PID contains data or teletext of type xx (ISO/IEC 13818–1)
–1.PSI	PID contains PSI tables
–1.SI	PID contains SI tables
–1.UNDef	PID contains unknown data

Example: READ:PID:TYPE? 100

Response: 2.VIDEo

READ [:SCALar] :PID :BITRate? 0 to 8191

Queries the bit rate of an element in the MONitoring mode.

Example: READ:PID:BITR? 100

Response: 4.0e6

The response is 4.0 Mbit/s.

READ [:SCALar] :PID :CONDaccess? 0 to 8191

Queries whether the element is encrypted.

Example: READ:PID:COND? 100

Response: 1

ROUTe :VIDeo PALNtsc | SECamntsc

*RST value: PALNtsc

Sets the standard at the analog video output for 625-line programs. 525-line programs are always coded to M/NTSC standard.

PALNtsc 625-line program coded to B/G PAL

SECamntsc 625-line program coded to SECAM

Example: ROUT:VID PALN

ROUTe :AUDio :RIGHt ON | OFF

*RST value: ON

Switches the audio outputs for AUDIO1/R on and off.

Example: ROUT:AUD:RIGH ON

ROUTe :AUDio :LEFT ON | OFF

*RST value: ON

Switches the audio outputs for AUDIO2/L on and off.

Example: ROUT:AUD:LEFT ON

Commands of TS INPUT Menu

In the TS INPUT menu, the input is selected and the hysteresis for synchronization of the MPEG test decoder is set.

Command	Parameter	Unit	Notes
ROUTe :INPut[?]	RSERial|FSERial|FPARallel		Selects signal input
SENSe :SCONdition :LOCK[?]	1 to 31		Number of consecutive valid sync words received before synchronization is detected.
:DROP[?]	1 to 7		Number of consecutive invalid sync words received before unlocking is detected.

ROUTe :INPut RSERial | FSERial | FPARallel

*RST value: FSERial

The command selects the signal input for the transport stream.

RSERial	serial, asynchronous input (T link) at the rear
FSERial	serial, asynchronous input (T link) at the front
FPARallel	parallel input (LVDS) at the front

Example: ROUT:INP FSER

SENSe :SCONdition

This node provides the commands for setting the hysteresis for synchronization to the MPEG2 transport stream.

SENSe :SCONdition :LOCK 1 to 31

*RST value: 5

This command sets the number of consecutive valid data words required before the decoder detects synchronization.

Example: SENS:SCON:LOCK 5

SENSe :SCONdition :DROP 1 to 7

*RST value: 2

Sets the number of consecutive invalid data words required before the decoder detects a drop-out.

Example: SENS:SCON:DROP 2

Commands of the PRINT Menu

Command	Parameter	Unit	Notes
HCOPy :MONitoring :DATA?			Prints the contents of the MONITORING/ STATISTICS menu in the form of block data
:REPort :DATA?			Prints the lines of the MONITORING/RE-PORT menu that have been added since the last report print in the form of block data
:LINes :DATA?	0 to 999, 0 to 999		Prints from line n to line m of the MONITORING/REPORT menu in the form of block data
:SETTings :DATA			Prints the current unit settings in the form of block data.
:PROGram :DATA?			Prints the contents of the applied transport stream in the form of block data.

HCOPy

This node provides the commands for reading data as they are sent. In manual operation these commands are sent to the printer using the functions of the PRINT menu. The commands come as block data of defined length. After removing the block data header and the end character, the data can be sent directly to the printer.

HCOPy :MONitoring :DATA?

This command reads the displayed MONITORING/STATISTICS menu in the form of block data.

Example: HCOP:MON:DATA?

Response: #41345DVMD...

HCOPy :REPort

With all commands under this node, the report entries are read in the form of block data.

HCOPy :REPort :DATA?

This command reads out the print data report for the MONITORING/REPORT menu lines in the form of block data

Example: HCOP:REP:DATA?

Response: #512345DVMD...

HCOPy :REPort :LINes :DATA? 0 to 999, 0 to 999

This command reads out the print data for the specified range of the MONITORING/REPORT menu in the form of block data.

Example: HCOP:REP:LINE:DATA? 15,45

Response: #512345DVMD...

HCOPy :SETTings:DATA

This command reads out the print data of the current device setting in the form of block data.

Example: HCOP:SETT:DATA?

Response: #512345DVMD...

HCOPy :PROGram:DATA?

This command reads out the print data of the contents of the applied transport stream in the form of block data.

Example: HCOP:PROG:DATA?

Response: #512345DVMD...

Commands of the STORE and RECALL CONFIG Menus

Command	Parameter	Unit	Notes
MEMory :SETTings1..9 :STORe	'name' (max. 8 characters)		Stores the instrument configuration in memory locations 1 to 9 No query
MEMory :SETTings1..10 :RECall			Calls up an instrument configuration from memory locations 1 to 10. Memory location 10 contains the PRESET setting. No query
:NAME?	'name'		Queries the name of the stored settings.

MEMory :SETTings1..9 :STORe 'NAME'

This command stores the configuration under 'name' in the memory locations 1 to 9.

Example: MEM:SETT1:STOR 'DVMDTEST'

MEMory :SETTings1..10 :RECall

Calls up the configuration from memory locations 1 to 10

Memory location 10 comprises the PRESET setting.

Example: MEM:SETT1:REC

MEMory :SETTings1..10 :NAME?

Queries the name of a configuration.

Example: MEM:SETT1:NAME?

Response: DVMDTEST

Commands of SETUP Menu

In the SETUP menu the operating parameters (serial interface, system clock, On Screen Display, etc) are set for the MPEG test decoder.

Command	Parameter	Unit	Notes
SYSTem :COMMunicate :SERial [:RECEIVE]			Sets the serial interface
:BAUD[?]	1200 | 2400 | 4800 | 9600 | 19200 | 38400 | 57600 | 115200		Data rate
:PARity[?] [:TYPE[?]]	EVEN | ODD | NONE		Type of parity
:BITS[?]	8		Number of data bits
:SBITs[?]	1		Number of stop bits
:PACE[?]	XON | ACK | NONE		Protocol
:DATE[?]	1900 to 2099, 1 to 12, 1 to 31		Date
:TIME[?]	0 to 23, 0 to 59, 0 to 59		Time
:ERROR?			Queries the error queue
:DISPlay :CONTents[?]	STATistic | REPort | PROGram | INFO		Selects the display on the OSD in the remote-control mode
KLOCk	ON | OFF		Disable/enable front panel keyboard.
DISPlay :OSD :MODE[?]	ON | OFF		On Screen Display: Sets operating mode

SYSTem :COMMunicate :SERial

This node provides the commands for setting the communication parameters of the RS-232-C interface.

SYSTem :COMMunicate :SERial [:RECeive] :BAUD 1200 | 2400 | 4800 | 9600 | 19200

*RST value: 9600

This command sets the baud rate.

Example: SYST:COMM:SER:BAUD 9600

SYSTem :COMMunicate :SERial [:RECeive] :PARity [:TYPE] EVEN | ODD | NONE

*RST value: NONE

This command sets the parity bit.

Example: SYST:COMM:SER:PAR ODD

SYSTem :COMMunicate :SERial [:RECeive] :BITS 8

*RST value: 8

This command sets the number of data bits.

Example: SYST:COMM:SER:BITS 8

SYSTem :COMMunicate :SERial [:RECeive] :SBITs 1

*RST value: 1

This command sets the number of stop bits.

Example: SYST:COMM:SER:SBIT 1

SYSTem :COMMunicate :SERial [:RECeive] :PACE NONE | XON | ACK

*RST value: NONE

This command sets the transmission protocol.

NONE	no handshake
XON	software handshake
ACK	hardware handshake RTS/CTS

Example: SYST:COMM:SER:PACE NONE

SYSTem :DATE 1900 to 2099, 1 to 12, 1 to 31

Sets the data of the system clock.

Example: SYST:DATE 1996,08,01

SYSTem :TIME 0 to 23, 0 to 59, 0 to 59

Sets the time of the system clock.

Example: SYST:TIME 10,20,00

SYSTem :ERRor?

Queries the oldest entry in the error queue. Positive error numbers denote device-specific errors; negative error numbers denote error messages specified by SCPI (refer to *SCPI-Specific Error Messages* on page 5–63)

Example: SYST:ERRor? =

Response: –221, “Settings conflict”

SYSTem :VERSion?

Queries the number of the SCPI version supported by the device.

Example: SYST:VERS?

Response: 1995.0

SYSTem :DISPlay :CONTents STATistic | REPort | PROGram | INFO

*RST value: INFO

This command selects the display on the OSD in the remote-control mode:

STATistic	selects the MONITORING\STATISTICS menu
REPort	selects the MONITORING\REPORT menu
PROGram	selects the DECODER\PROGRAM menu
INFO	selects the STATUS menu

Example: SYST:DISP:CONT REP

SYSTem :KLOCk[?] ON | OFF

This command locks the front panel keyboard or enables the switchover to LOCAL mode.

Example: SYST:KLOCk ON

DISPlay :OSD

This node provides the commands for setting the OSD.

DISPlay :OSD :MODE ON | OFF

*RST value: ON

This command selects the operating mode for the OSD:

OFF	The menus are only displayed on the LCD.
ON	The menus are displayed simultaneously on the LCD and OSD.

Example: DISP:OSD:MODE ON

Commands for the 'Trigger on Error' Function

With the 'Trigger on Error' mode the faulty part of the transport stream can be read from the internal memory via the remote-control interface if one or several of the settable trigger conditions occur (refer to *Measurement Parameters* on page 5–42).

This mode is switched on using the command SENSe:FUNCtion:TRERror.

Command	Parameter	Unit	Notes
CONFigure :TRERror :STATe[?]	 ON | OFF		Starts a 'Trigger on Error'
:TRIGger[?]	<parameter name>, ON | OFF		Enters or clears individual parameters of the trigger condition.
:ALL	ON | OFF		Enters or clears all trigger condition parameters.
READ [:SCALar] :TRERor?	 –400 to +400		Reads a packet, 0 = packet in which the error occurred

CONFigure :TRERor :STATe[?] ON | OFF

The command activates and deactivates the trigger for the conditions set with CONFigure:TRERror:TRIGer. When the trigger condition occurs, bit 5 is set in the OPERation:STATus register and, if desired, a service request is initiated. In addition, the setting for CONFigure:TRERror:STATe is reset to OFF. If the Trigger on Error mode is not set, an error message will be generated.

Example: CONF:TRER:STAT ON

CONFigure :TRERor :TRIGger[?] <parameter name>, ON | OFF

This command includes the parameter in the trigger condition or clears it.

Example: CONF:TRER:TRIG CCNT, ON

CONFigure :TRERor :TRIGger[?] :ALL ON | OFF

This command includes all parameters in the trigger condition or clears them.

Example: CONF:TRER:TRIG:ALL ON

READ [:SCALar] :TRERor? –400 to +400

After the trigger conditions have occurred, the data of one of the stored transport stream packets are read. They are output as a block data with a constant length of 188 bytes. If the trigger condition has not occurred or if the MONitoring or the DUMP mode is set, NAN is returned.

Example: READ:TRER 5

Response: #3188G...

Commands for the 'Dump' Function

With the aid of the 'Dump' function a selectable number of transport stream packets corresponding to a set filter condition can be stored in the unit and read out via the remote-control interface.

Command	Parameter	Unit	Notes
CONFigure :DUMP			
:STATe[?]	PID | AFPID | AF | PUSPid | PUS | HEADer | ALL | OFF		– Reads packet with PID – Packet with PID and adaption fields – Reads all packets with adaption field – Reads packet with Payload Unit Start indicator and packet PID – Reads all packets with PUS – Reads all packet headers – Reads all packets Stops read-in
:TRIGger			Sets PID for.:STATe PID and AF
:PID[?]	0 to 8191		
:COUNt[?]	1 to 1394		Number of packets to be read into the trace buffer
READ [:SCALar]			Reads a transport packet from the trace buffer
:DUMP?	1 to 1394		With HEADer a packet is made up of 47 headers
:COUNt?	1 to 1394		Reads the number of transport packets currently read in.

CONFigure :DUMP :STATe[?] PID | AF | AF_All | HEADer | ALL | OFF

This command activates and deactivates the trigger with the specified filter condition:

PID — Only transport packets with a PID set with CONFigure:TRIGger:PID are read.

AFPID	Only transport packets with an adaptation field and a PID set with CONFigure:TRIGger:PID are read.
AF	All transport packets with an adaptation field are read.
PUSPID	Transport packets with payload unit start indicator and PID set with CONFigure:TRIGger:PID are read.
PUS	All transport packets with with payload unit start indicator are read.
HEADer	The header (4 bytes) of each transport packet is read.
ALL	All transport packets are read.
OFF	The trigger is disabled.

After the number of transport packets set with CONFigure:DUMP:COUNt has been read into the dump memory, bit 5 is set in the OPERation:STATus register and, if desired, a service request is activated. In addition, the setting for CONFigure:DUMP:STATe is reset to OFF. If function DUMP is not set, an error message is generated.

Example: CONF:TRER:STAT PID

CONFigure :DUMP :TRIGger :PID[?] 0 to 8191

*RST value: 0

The commands determines the PID for the filter conditions PID and AF.

Example: CONF:DUMP:TRIG:PID 100

CONFigure :DUMP :COUNt[?] 1 to 1394

*RST value: 1394

This command determines the number of transport packets to be read, which correspond to the filter condition set with CONFigure:DUMP:STATe. With CONFigure:DUMP:STATe HEADer, 47 packet headers of 4 bytes each are read for each unit of :COUNt. The query reads the number of transport packets currently read in. With mode MONitoring and TRERror set, NAN is returned.

Example: CONF:DUMP:COUN 250

READ [:SCALar] :DUMP? 1 to 1394

This commands reads the data of a transport stream packet once the number of the transport packets set with CONFigure:DUMP:COUNt is available in the dump memory. The data are output in the form of block data with a constant

length of 188 bytes each. With CONFigure:DUMP:STATe HEADer, 47 4-byte packet headers are read per unit. If the desired packet is not in the memory (for example, packet 124 should be read but the set :COUNt was 120 only), or if triggering was switched off with command CONF:DUMP:STAT OFF before the desired number of packets could be read into the memory, NAN is returned. NAN is also returned when the MONitoring or the DUMP mode is active.

Example: READ:DUMP 5

Response: #3188G...

Commands of the SCPI Registers

The following table lists the commands for controlling SCPI-defined and device-specific STATus registers. The function of the individual registers is described in detail in *Status Reporting System* on page 5–49.

Command	Parameter	Unit	Notes
STATus			Queries the error/event queue
:QUEue [:NEXT]?			
:OPERation [:EVENt]?			Query only
:CONDition?			Query only
:ENABle	0 to 32767		
:PTRansition	0 to 32767		
:NTRansition	0 to 32767		
:QUEStionable [:EVENt]?			Query only
:CONDition?			Query only
:ENABle	0 to 32767		
:PTRansition	0 to 32767		
:NTRansition	0 to 32767		
:QUEStionable :DVMD [:EVENt]?			Query only
:CONDition?			Query only
:ENABle	0 to 32767		
:PTRansition	0 to 32767		
:NTRansition	0 to 32767		

STATus :QUEue [:NEXT]?

This query returns the next item from the error/event queue and removes it from the queue. Error numbers denote device-specific errors, negative error numbers denote error messages defined by SCPI (refer to *SCPI-Specific Error Messages* on page 5–63). If the queue is empty, the MPEG test decoder returns 0 (“No error”). If the queue has overflown, the MPEG test decoder returns –350 (“Too many errors”).

Example: STAT:QUE?

Response: 0, “No Error”

STATus :OPERation

This node provides the commands for controlling the SCPI-STATus:OPERation registers.

STATus :OPERation [:EVENt]?

Queries the contents of the EVENt register of the STATus:OPERation register. Reading the EVENt register clears it.

Example: STAT:OPER?

STATus :OPERation :CONDition?

This query returns the contents the CONDition register of the STATus:OPERation register. Reading the CONDition register is nondestructive.

Example: STAT:OPER:COND?

STATus :OPERation :ENABle 0 to 32767

Sets the bits in the ENABle register of the STATus:OPERation register. This register selects and enables the individual bits of the EVENt register for the summary bit in the status byte. The numeric response after loading the initial state (PRESET) is 0.

Example: STAT:OPER:ENAB 32

STATus :OPERation :PTRansition 0 to 32767

Sets the positive transition filters of the CONDition bits of the STATus:OPERation register. If a PTRansition bit is 1, the associated bit in the EVENt register is set upon transition of the CONDition bits from 0 to 1.

The numeric response after loading the initial state (PRESET) is 32767.

Example: STAT:OPER:PTR 32

STATus :OPERation :NTRansition 0 to 32767

Sets the negative transition filters of the CONDition bits of the STATus:OPERation register. If an NTRansition bit is 1, the associated bit in the EVENt register is set upon transition of the CONDition bit from 1 to 0.

The numeric response after loading the initial state (PRESET) is 0.

Example: STAT:OPER:NTR 0

STATus :QUEStionable

This note provides the commands for controlling the SCPI-STATus:QUEStionable register.

STATus :QUEStionable [:EVENt]?

This query returns the contents of the EVENt register of the STATus:QUEStionable register. Reading the EVENt register clears it.

Example: STAT:QUES?

STATus :QUEStionable :CONDition?

Returns the contents of the CONDition register of the STATus:QUEStionable register. Reading the CONDition register is nondestructive.

Example: STAT:QUES:COND?

STATus :QUEStionable :ENABle 0 to 32767

This command sets the bits of the ENABle registers of the STATus:QUEStionable register. This register selects and enables the individual bits of the EVENt register for the summary bit of the status byte. The numeric response after loading the initial state (PRESET) is 32767.

Example: STAT:QUES:ENAB 128

STATus :QUEStionable :PTRansition 0 to 32767

Sets the positive transition filters of the CONDition bits of the STATus:QUEStionable register. If a PTRansition bit is 1, the associated bit in the EVENt register is set upon transition of the CONDition bit from 0 to 1.

The numeric response after loading the initial state (PRESET) is 32767.

Example: STAT:QUES:PTR 128

STATus :QUEStionable :NTRansition 0 to 32767

Sets the negative transition filters of the CONDition bits of the STATus:QUEStionable register. If an NTRansition bit is 1, the associated bit in the EVENt register is set upon transition of the CONDition bit from 1 to 0.

The numeric response after loading the initial state (PRESET) is 0.

Example: STAT:QUES:NTR 0

STATus :QUEStionable :DVMD

This node provides the commands for controlling the device-specific STATus:QUEStionable:DVMD register. This register shows questionable device states in the MPEG test decoder.

STATus :QUEStionable :DVMD [:EVENt]?

This query returns the contents of the EVENt register of the STATus:QUEStionable:DVMD register. Reading the EVENt register clears it.

Example: STAT:QUES:DVMD?

STATus :QUEStionable :DVMD :CONDition?

Returns the contents of the CONDition register of the STATus:QUEStionable:DVMD register. Reading the CONDition register is nondestructive.

Example: STAT:QUES:DVMD:COND?

STATus :QUEStionable :DVMD :ENABle 0 to 32767

This command sets the bits in the ENABle register of the STATus:QUEStionable:DVMD register. This register selects and enables the individual bits of the EVENt register for the summary bit of the STATus:QUEStionable register.

The numeric response after loading the initial state (PRESET) is 32767.

Example: STAT:QUES:DVMD:ENAB 128

STATus :QUEStionable :DVMD :PTRansition 0 to 32767

Sets the positive transition filters of the CONDition bits of the STATus:QUEStionable:DVMD register. If a PTRansition bit is 1, the associated bit in the EVENt register is set upon transition of the CONDition bit from 0 to 1.

The numeric response after loading the initial state (PRESET) is 32767.

Example: STAT:QUES:DVMD:PTR 128

STATus :QUEStionable :DVMD :NTRansition 0 to 32767

Sets the negative transition filters of the CONDition bits of the STATus:QUESTionable:DVMD register. If an NTRansition bit is 1, the associated bit in the EVENt register is set upon transition of the CONDition bit from 1 to 0.

The numeric response after loading the initial state (PRESET) is 0.

Example: STAT:QUES:DVMD:NTR 0

Measurement Parameters

Parameter Names for Monitoring

The parameter names apply to the queries:

- READ:MONitoring?
- READ:MONitoring:ERRSeconds?
- CONFigure:MONitoring:PARameter[?]
- CONFigure:TRERror:TRIGger[?]
  (only the parameters marked in the column TRIGGER ON ERROR)

Table 5–1: Parameter Names of 1st Priority

Parameter name	Parameter	ON SCREEN DISPLAY: MONITORING\STATISTICS MONITORING\REPORT	Reason	PID info	TRIGGER ON ERROR	Error number
TSSL	TS_sync_loss	TS SYNC	Loss		X	100
			OK		X	101
SBE	Sync_byte_error	SYNC BYTE	Single		X	110
			Multib		X	111
PATE	PAT_error	PAT	Upper Dist.	X		120
			Tab_id	X	X	121
			Scrambled	X	X	122
CCOE	Continuity_count_error	CONT COUNT	Pack_order	X	X	130
			More_than_twice	X	X	131
			Lost_packt	X	X	132

Table 5–1: Parameter Names of 1st Priority (cont.)

Parameter name	Parameter	ON SCREEN DISPLAY: MONITORING\STATISTICS MONITORING\REPORT	Reason	PID info	TRIGGER ON ERROR	Error number
PMTE	PMT_error	PMT	Upper Dist.	X		140
			Scrambled	X	X	141
PIDE	PID_error	PID		X		150

Table 5–2: Parameter Names of 2nd Priority

Parameter name	Parameter	ON SCREEN DISPLAY: MONITORING\STATISTICS MONITORING\REPORT	Reason	PID info	TRIGGER ON ERROR	Error number
TPEE	Transport_error	TRANSPORT		X	X	200
CRCE	CRC_error	CRC	PAT	X	X	210
			PMT	X	X	211
			CAT	X	X	212
			NIT	X	X	213
			EIT	X	X	214
			BAT	X	X	215
			SDT	X	X	216
			TOT	X	X	217
PCRE	PCR_error	PCR	Discont	X	X	220
			PCR_U	X		221
			PCR_L	X		222
PCRA	PCR_accuracy_error	PCR ACCURACY		X		230
PTSE	PTS_error	PTS		X		240
CATE	CAT_error	CAT	Tab_id	X	X	250
			Scrambling without CAT	X	X	251

Table 5–3: Parameter Names of 3rd Priority

Parameter name	Parameter	ON SCREEN DISPLAY: MONITORING\STATISTICS MONITORING\REPORT	Reason	PID info	TRIGGER ON ERROR	Error number
NITE	NIT_error	NIT	Tab_id	X	X	300
			NIT_U	X		301
SIRE	SI_repetition_error	SI REPEAT	PAT_U	X		310
			PAT_L	X		311
			CAT_U	X		312
			CAT_L	X		313
			PMT_U	X		314
			PMT_L	X		315
			NIT_U	X		316
			NIT_L	X		317
			SDT_U	X		318
			SDT_L	X		319
			BAT_U	X		320
			BAT_L	X		321
			EIT_U	X		322
			EIT_L	X		323
			RST_L	X		324
			TDT_U	X		325
			TDT_L	X		326
			TOT_U	X		327
			TOT_L	X		328
PIDU	unreferenced_PID	UNREF PID		X		340
SDTE	SDT_error	SDT	Tab_id	X	X	350
			SDT_U	X		351
EITE	EIT_error	EIT	Tab_id	X	X	360
			EIT_U	X		361
RSTE	RST_error	RST	Tab_id	X	X	370
TDTE	TDT_error	TDT	Tab_id	X	X	380
			TDT_U	X		381

Error Numbers for Device-Internal Actions. In addition to the errors detected, changes of device settings affecting subsequent report entries are also entered in the MONITORING/REPORT menu (for example, monitoring of CRCE was enabled).

Table 5–4: Error Numbers for Device-Internal Actions

ON SCREEN DISPLAY: MONITORING\REPORT	Reason	Error number
POWER	OFF	400
	ON	401
CONTROL	START	410
	STOP	411
	CLEAr	412
INPUT CHANGED	RSERial	420
	FSERial	421
	FPARallel	422
PARAMETER GROUP	<parameter name> ON | OFF	430
PROG MODE : SET PROG	Program number	440
PROG MODE	AUTO	450
	PRESelected	451
SENSe	MONitoring	460
	TRERror	461
	DUMP	462

Parameter Names for Monitoring Limits

The parameter names are valid for commands:

- CONFigure:MONitoring:LIMit:UPPer[?] (see column MAX)
- CONFigure:MONitoring:LIMit:LOWer[?] (see column MIN)

Table 5–5: Parameter Names for Monitor Limits

Parameter name	ON-SCREEN DISPLAY: MONITORING\STATISTICS MONITORING\REPORT	LIMit :LOWer	LIMit :UPPer	Adjustable limits		Acc to ETR 290	
				MIN	MAX	MIN	MAX
PATR	PAT Distance	X	X	0 ms to 100 ms	0.1 s to 60.0 s	25 ms	0.5 s
CATR	CAT Distance	X	X	0 ms to 100 ms	0.1 s to 60.0 s	25 ms	0.5 s
PMTR	PMT Distance	X	X	0 ms to 100 ms	0.1 s to 60.0 s	25 ms	0.5 s
NITR	NIT Distance	X	X	0 ms to 100 ms	0.1 s to 60.0 s	25 ms	10 s
SDTR	SDT Distance	X	X	0 ms to 100 ms	0.1 s to 60.0 s	25 ms	2 s
BATR	BAT Distance	X	X	0 ms to 100 ms	0.1 s to 60.0 s	25 ms	10 s
EITR	EIT Distance	X	X	0 ms to 100 ms	0.1 s to 60.0 s	25 ms	2 s
RSTR	RST Distance	X	—	0 ms to 100 ms	—	25 ms	—
TDTR	TDT Distance	X	X	0 ms to 100 ms	0.1 s to 60.0 s	25 ms	30 s
TOTR	TOT Distance	X	X	0 ms to 100 ms	0.1 s to 60.0 s	25 ms	30 s
PCRR	PCR Distance	X	X	0 ms to 10 ms	0.01 s to 1.00 s	0 ms	0.04 s
PCRD	PCR Discontinuity	—	X	—	0.01 s to 1.00 s	—	0.1 s
PTSR	PTS Distance	—	X	—	0.1 s to 60.0 s	—	0.7 s
PIDR	PID Distance	—	X	—	0.1 s to 60.0 s	—	0.5 s
PDUD	PID unref. Duration	—	X	—	0.1 s to 60.0 s	—	0.5 s

Instrument Model and Command Processing

The instrument model shown in Figure 5–2 has been configured under the aspect of processing remote-control commands. The individual components operate independently of each other and simultaneously. They communicate with each other by means of messages.

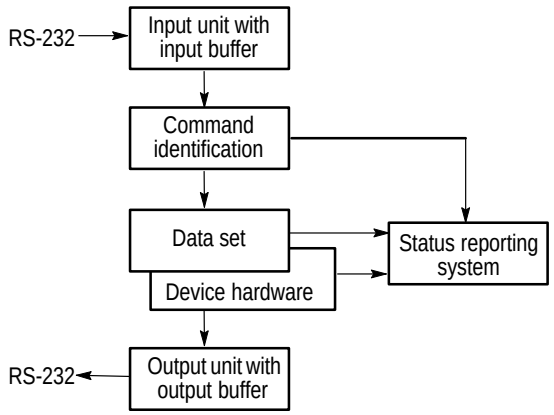


Figure 5–2: Instrument model with remote control via RS-232 interface

Input Unit

The input unit receives the commands in the form of characters from the remote-control interface and collects them in the input buffer. The input buffer has a capacity of 220 characters. The input unit sends a message to the command identification as soon as the input buffer is full or as soon as it receives a terminator as defined by IEEE 488.2.

If the input buffer is full or a terminator is received, data reception is stopped and the data received so far are processed. Data reception is then continued.

Command Identification

The command identification analyzes the data received from the input unit, proceeding in the order in which the data are received. Syntax errors in the command are recognized and passed on to the status reporting system. Following the syntax test, the range of values of the data is verified and the setting made accordingly. Only when the command has been completely executed will the next command be processed by the command identification.

Data Set and Device Hardware

The term “device hardware” refers to that part of the device which performs the measurement function.

The data set contains all parameters required for setting the device hardware.

Setting commands causes a modification in the data set. Before the data are entered in the data set, they are verified for compatibility both with the other data and with the device hardware. If the setting is not possible, an "execution error" message will be sent to the status reporting system and the setting ignored. After successful completion of the verification, setting will immediately be performed. Prior to the hardware setting, the SETTling bit is set in the STATus:OPERation register (refer to Table 5–9 on page 5–55). The hardware carries out the settings and as soon as the settled state is reached, the bit is reset. The SETTling bit is only set if hardware settings take more time than processing by the command identification. This bit may be used for synchronization of the command processing.

Queries cause the data-set management to send the desired data to the output unit.

Status Reporting System

The status reporting system collects information about the device status and makes it available to the output unit on request. Structure and function are described in *Status Reporting System* on page 5–49.

Output Unit

The output unit collects the information requested by the controller from the data set management. It processes such information in line with the SCPI rules and makes it available in the output buffer. The output buffer has a capacity of 1024 characters. If the requested information is longer, it is made available in portions in a way that is not noticeable to the controller.

Command Sequence and Command Synchronization

All commands are immediately executed. There is no overlapping command processing. The user therefore can determine the sequence of execution. The *WAI command has no effect on the sequence of the command execution.

If a longer command line is terminated by one of two commands (*OPC or *OPC?), the end of the command processing will be signalled to the controller by a suitably programmed message.

Table 5–6: Synchronization with *OPC and *OPC?

Command	Action after hardware setting	Programming of controller
*OPC	Setting the Operation Complete bits in the ESR	– Setting bit 0 in the ESE – Setting bit 5 in the SRE – Waiting for service request (SRQ)
*OPC?	Writing a "1" into the buffer amplifier	Addressing the device as a talker

An example for command synchronization is given in *Program Examples* on page 5–68.

Status Reporting System

The status reporting system (see Figure 5–4 on page 5–52) stores all information on the current operating status of the instrument and on errors. The information is stored in the status register and in the error queue. The contents of the status registers and of the error queue can be queried via remote control.

The information is hierarchically structured. The topmost level is formed by the Status Byte Register (STB) defined by IEEE 488.2 and the associated mask register Service Request Enable (SRE). The STB receives its information from the Standard Event Status Register (ESR), which is also defined in IEEE 488.2, and the associated mask register Standard Event Status Enable (ESE) as well as from the SCPI–defined STATus:OPERation and STATus:QUEStionable registers, which contain detailed information on the instrument.

The output buffer contains the messages returned by the device to the controller. It is not part of the status reporting system, but since it determines the value of the MAV bits in the STB, it is also shown in Figure 5–4 on page 5–52.

Structure of an SCPI Status Register

Each SCPI register consists of five registers of 16 bit each and with different functions (see Figure 5–3). The individual bits are independent of each other. Each hardware status is assigned a bit number which is the same for all five registers. Bit 4 of the STATus:OPERation register, for instance, is assigned in all five registers to the “MEASuring” action. Bit 15 (the most-significant bit) is set to zero in all SCPI status registers. Thus the contents of the registers can be processed by the controller program as a positive integer.

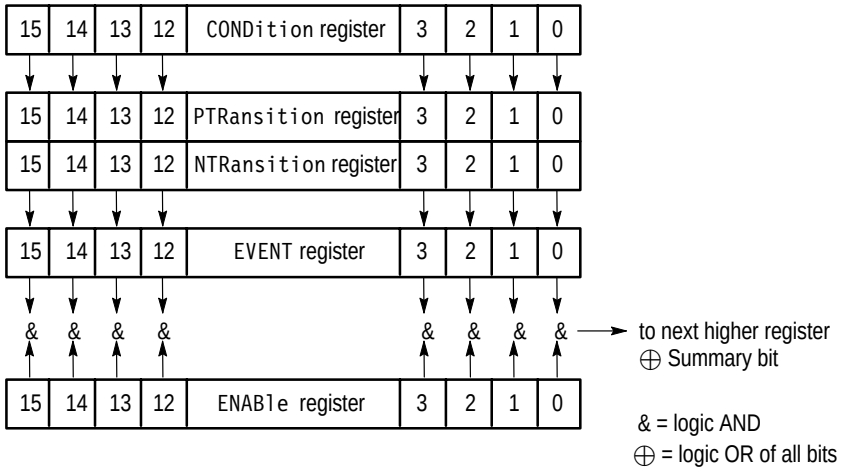


Figure 5–3: Status Register model

CONDition register. The CONDition register is directly written to by the hardware or the summary bit of the next lower register. Its contents reflects the current device status. This register can only be read, but neither written nor cleared. Reading the register does not change its contents.

PTRansition register. The Positive TRansition register acts as a transition filter. Upon transition of a bit of the CONDition register from 0 to 1, the associated PTR bit decides whether the EVENt bit will be set to 1.

PTR bit = 1: the EVENt bit is set.
PTR bit = 0: the EVENt bit is not set.

This register can be written and read. Reading the register does not change its contents.

NTRansition register. The Negative TRansition register also acts as a transition filter. Upon transition of a bit of the CONDition register from 1 to 0, the associated NTR bit decides whether the EVENt bit is set to 1.

NTR bit = 1: the EVENt bit is set.
NTR bit = 0: the EVENt bit is not set.

This register can be written and read. Reading the register does not change its contents.

With the aid of these two transition filter registers the user can define the status change of the CONDition register (none, 0 to 1, 1 to 0 or both) that is to be reported in the EVENt register.

EVENt register. The EVENt register reports whether an event has occurred since its last reading; it is the “memory” of the CONDition register. It only registers events that have been reported by the transition filters. The EVENt register is continuously updated by the instrument. It can only be read by the user. Reading this register clears its contents. This register is frequently referred to as the overall register.

ENABle register. The ENABle register determines whether the EVENt bit affects the summary bit (see below). Each bit of the EVENt register is ANDed (symbol '&') with the associated ENABle bit. The events of all logical operations of this register are ORed (symbol '+') and passed on to the summary bit.

ENAB bit = 0: the associated EVENt bit does not affect the summary bit.
ENAB bit = 1: if the associated EVENt is "1", the summary bit is also set to "1".

This register can be written and read by the user. Reading the register does not change its contents.

Summary bit. As stated above, the summary bit for each register is derived from the EVENt and the ENABle registers. The result is entered into a bit of the CONDition register of the next higher register.

The instrument automatically generates the summary bit for each register. An event (for example, a missing input signal) may thus cause a service request through all hierarchical levels.

Overview of Status Registers

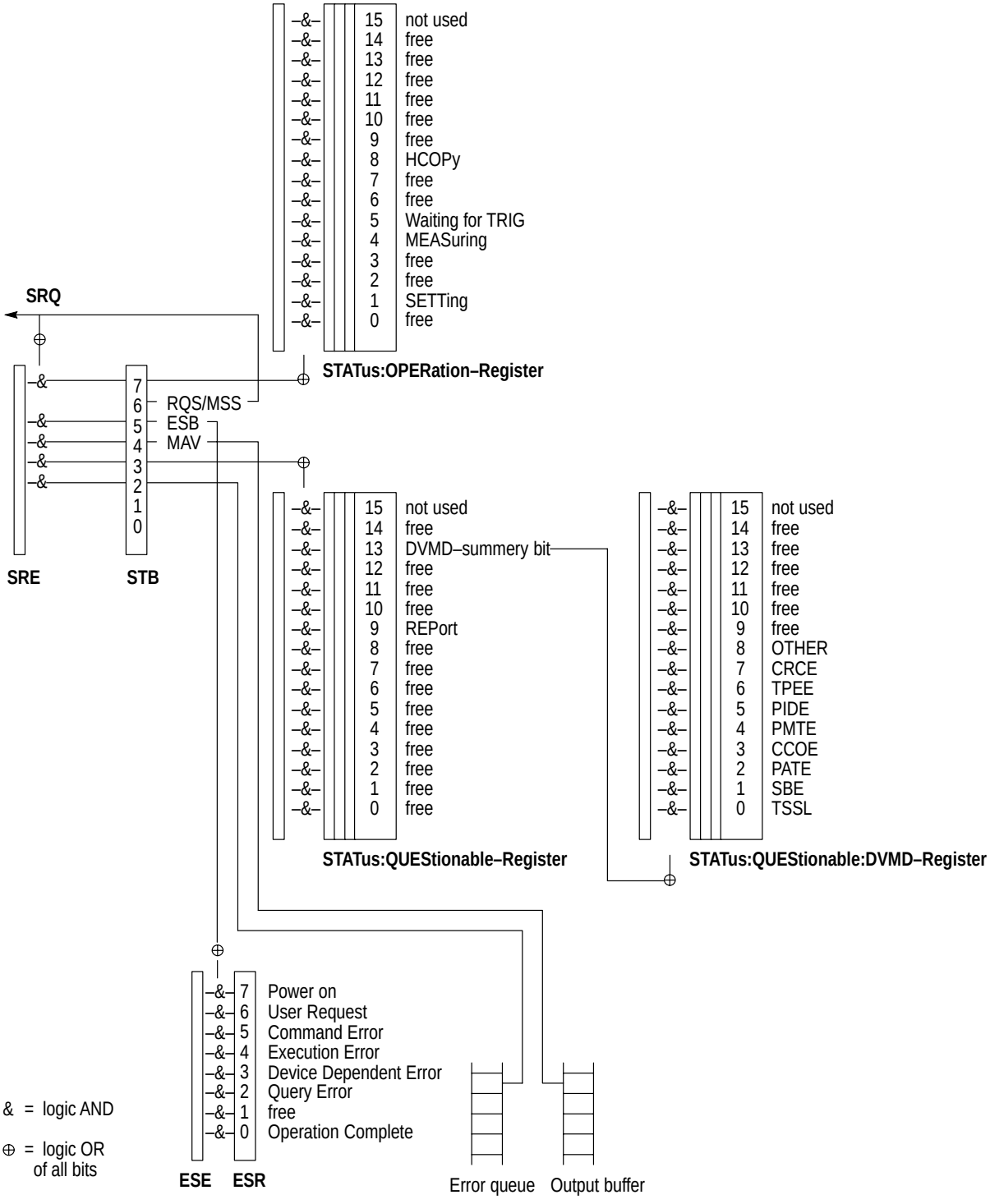


Figure 5–4: Overview of Status Registers

Description of Status Registers

Status Byte (STB) and Service Request Enable Register (SRE). The Status Byte Register is defined in IEEE 488.2. It is the root of the SCPI status register tree. The previously defined bits of the IEEE 488.2 standard have remained unchanged. Bits 3 and 7 are new. These are the summary bits of the QUEStionable and OPERationable status registers. Although the STB is integrated into the SCPI hierarchy, there are some historical differences.

The function of the Service Request Enable Register SRE corresponds to that of the ENABle register of STB. The summary bit of the STB is its own bit 6. The STB has no EVENt register; it directly represents the device status in the CONDition register.

PTRansition and NTRansition registers have no significance and are not defined.

Each bit of the STB is assigned a bit in the SRE. Bit 6 of the SRE is ignored. If a bit is set in the SRE and the associated bit in the STB changes from 0 to 1, a Service Request (SRQ) will be generated which triggers an interrupt in the controller, provided that the controller has been configured accordingly and can be further processed by the controller.

The Status Byte Register is read out by the query *STB?. The SRE can be set by the command *SRE and read out by the query *SRE?.

Table 5–7: Definition of bits in the Status Byte Register

Bit No.	Definition
2	Error Queue not empty This bit is set when the Error Queue receives an entry. If this bit is enabled by the SRE, each entry of the Error Queue will generate a Service Request. An error can thus be recognized and specified in detail by querying the Error Queue. The query returns a conclusive error message.
3	QUEStionable Status summary bit This bit is set if in the QUEStionable Status Register an EVENt bit is set and the associated ENABle bit is set to 1. A set bit denotes a questionable device status which can be specified in greater detail by querying the QUEStionable Status Register.
4	MAV bit (Message available) This bit is set if a readable message is in the output buffer.

Table 5–7: Definition of bits in the Status Byte Register (cont.)

Bit No.	Definition
5	ESB bit Summary bit of the Event Status Register. This bit is set if one of the bits in the Event Status Register is set and enabled in the Event Status Enable Register (ENABle bit set to '1'). Setting of this bit denotes a serious error, which can be specified in greater detail by querying the Event Status Register.
6	MSS bit (Master Status Summary Bit) This bit is set if the instrument causes a service request. This is the case if one of the other bits of this register is set together with its mask bit in the Service Request Enable Register (SRE).
7	OPERation Status Register summary bit This bit is set if an EVENt bit is set in the OPERation Status Register and the associated ENABle bit is set to 1. A set bit denotes that an action is just being performed by the instrument. Information on the type of action can be obtained by querying the OPERation Status Register.

Event Status Register (ESR) and Event Status Enable Register (ESE)

Although the ESR is already defined in the IEEE 488.2 standard, it fits quite well into the SCPI register mode. It is comparable to the EVENt register of an SCPI register. The ESE forms the associated ENABle register. All PTRansition bits are fixed to logic '1' and all NTRansition bits to logic '0'. The Event Status Register can be read out by the query *ESR?. The ESE can be set by the command *ESE and read out by the query *ESE?.

Table 5–8: Definition of bits used in the Event Status Register

Bit No.	Definition
0	Operation Complete Upon reception of the *OPC command, this bit is set exactly then when all previous commands have been executed.
2	Query Error This bit is set if the controller wants to read data from the instrument but has not sent a data request command. A frequent cause is a faulty query which cannot be executed.
3	Device-dependent Error This bit is set if a device-dependent error occurs. An error message with a number between –300 and –399 or a positive error number denoting the error in greater detail (see *Error Messages of Remote-Control Interface* on page 5–63) will be entered into the Error Queue.

Table 5–8: Definition of bits used in the Event Status Register (cont.)

Bit No.	Definition
4	Execution Error This bit is set if the syntax of the command received is not correct but the command cannot be executed due to various marginal conditions. An error message with a number between –200 and –300 describing the error in greater detail (refer to *Error Messages of Remote-Control Interface* on page 5–63) will be entered into the Error Queue.
5	Command Error This bit is set if an undefined command or a command with incorrect syntax is received. An error message with a number between –100 and –200 describing the error in greater detail (refer to *Error Messages of Remote-Control Interface* on page 5–63) will be entered into the Error Queue.
6	User Request This bit is set upon switchover from [REMOTE] to [LOCAL] (that is, when the instrument is switched to manual operation by means of the LOCAL key).
7	Power On (AC supply on) This bit is set upon power on of the instrument.

STATus:OPERation Register. The OPERation Status Register contains information on the operations currently performed by the instrument.

It can be read by the queries STATus:OPERation:CONDition? or STATus:OPERation[:EVENt]?.

Table 5–9: Definition of bits used in the STATus:OPERation Register

Bit No.	Definition
1	SETTling This bit is set as long as settling takes place following a new setting command. The bit is only set if the settling time is longer than the command processing time.
4	MEASuring This bit is set while the instrument is performing a measurements and the results are not yet stable.
5	Waiting for TRIG This bit is set if the instrument is active in the Trigger on Error and DUMP mode.
8	HCOPy This bit is set when the print function is active.

STATus:QUEStionable Register. This register contains information on questionable device states. These may for instance occur if the instrument is operated out of specifications. The register can be read by the queries STATus:QUEStionable:CONDition? or STATus:QUEStionable[:EVENt]?.

Table 5–10: Definition of bits used in the STATus:QUEStionable Register

Bit No.	Definition
9	REPOrt This bit is set if the MONITORING/REPORT contains entries that have not yet been read with READ:MONitoring:REPort?.
13	DVMD summary bit This summary bit is set if an EVENt bit is set in the QUEStionable:DVMD Register and the associated ENABle bit is set to 1.

STATus:QUEStionable:DVMD Register

This register contains information on questionable MPEG test decoder-specific device states.

It can be read with the queries STATus:QUEStionable:DVMD:CONDition? or STATus:QUEStionable:DVMD[:EVENt]?.

The bit assignment corresponds to the LED display on the front panel.

Table 5–11: Definition of bits used in the STATus:QUEStionable:DVMD Register

Bit No.	Definition
0	TSSL This bit is set if a TS SYNC error is indicated in the MONITORING/STATISTICS menu.
1	SBE This bit is set if a SYNC BYTE error is indicated in the MONITORING/STATISTICS menu.
2	PATE This bit is set if a PAT error is indicated in the MONITORING/STATISTICS menu.
3	CCOE This bit is set if a CONT_COUNT error is indicated in the MONITORING/STATISTICS menu.
4	PMTE This bit is set if a PMT error is indicated in the MONITORING/STATISTICS menu.

Table 5–11: Definition of bits used in the STATus:QUEStionable:DVMD Register (cont.)

Bit No.	Definition
5	PIDE This bit is set if a PID error is indicated in the MONITORING/STATISTICS menu.
6	TPEE This bit is set if a TRANSPORT error is indicated in the MONITORING/STATISTICS menu.
7	CRCE This bit is set if a CRC error is indicated in the MONITORING/STATISTICS menu.
8	OTHER This bit is set if an error is indicated in the MONITORING/STATISTICS menu for the parameters not mentioned above.

Use of the Status Reporting System

For an efficient use of the status reporting system, the information contained therein has to be transferred to the controller program and further processed. There are various methods which are described in the following. Detailed program examples are given in *Program Examples* on page 5–68.

Service Request and Use of Hierarchical Structure. Under certain conditions, the instrument may send a service request (SRQ) to the controller. This service request usually causes an interrupt at the controller to which the controller program can respond by suitable action. As shown in Figure 5–4 on page 5–52, an SRQ will always be triggered if one or several of the bits 2, 3, 4, 5, or 7 have been set in the Status Byte Register and enabled in the SRE. Each of these bits combines the information from a further status register, from the error queue, or the output buffer. By setting the ENABle registers of the status registers accordingly, it is possible that any bit in any status register will be able to trigger a SRQ. To utilize the possibilities of the service request, the corresponding bits in the enable registers must be set to “1”.

The use of baud rates of less that 9600 requires special measures to avoid loss of data.

- The RS-232 interface with the controller needs to be rated for these baud rates.
- The controller must be able to process the received data in time.
- To synchronize data transmission, hardware handshaking must be used.

- The connection between the MTD200 and the controller must be made using a null modem cable.
- Follow the instructions that are supplied with your RS-232 control program.

Examples (see also Figure 5–3 on page 5–49 and *Program Examples* on page 5–68):

1. Using the command *OPC to generate an SRQs:

a. Set bit 0 (Operation Complete) in the ESE.

b. Set bit 5 (ESB) in the SRE.

The instrument generates an SRQ upon completion of its settings.

2. Indicating the end of a measurement by an SRQ on the controller

a. Set bit 7 (summary bit of the STATus:OPERation register) in the SRE.

b. Set bit 4 (MEASuring) in the STATus:OPERation:ENABle register.

c. Set bit 4 in the STATus:OPERation:NTRansition register so that the transition of the MEASuring bit from 1 to 0 (measure end) will also be noted in the EVENt register.

After having provided a stable measured value, the instrument generates an SRQ.

The SRQ is the only way for the instrument to become active on its own. A controller program should set the instrument so that a service request will be generated in case of malfunctions. The program should suitably respond to the service request.

Queries. Each individual register of a status register can be read out by queries. The individual queries are discussed in *Description of Status Registers* on page 5–53. The queries always return a number representing the bit pattern of the queried register. This number is evaluated by the controller program.

Queries to read out the status registers are mainly used after an SRQ to obtain detailed information on the cause for the SRQ.

Error Queue Query. Each error condition in the instrument causes an entry in the error queue. The entries in the error queue are detailed error messages in plain text which can be read out via remote control by the query SYSTem:ERRor?. Each query SYSTem:ERRor? returns an entry from the error queue. If there are no more error messages in the error queue, 0 = “No error” is returned by the instrument.

The error queue should be queried in the controller program whenever after a SRQ a precise description of the error cause is required. In particular in the test phase of a controller program the entries in the error queue provide a valuable support, since they also register faulty commands from the controller to the instrument.

Resetting the Status Reporting System

Table 5–12 contains the various commands and events causing a reset of the status reporting system. None of the commands, with the exception of *RST, affects the functional device settings..

Table 5–12: Resetting the device functions

Event	Switching on AC supply voltages			
	Power On Status Clear			
Effect	0	1	*RST	*CLS
Clears STB, ESR		yes		yes
Clears SRE, ESE		yes		
Clears EVENt registers		yes		yes
Clears ENABle registers of all OPERation and QUESTionable registers, fills ENABle registers of all other registers with “1”.		yes		
Fills PTRansition registers with “1”, clears NTRansition registers		yes		
Clears error queue	yes	yes		yes
Clears output buffer	yes	yes	1)	1)
Clears command processing and input buffer	yes	yes		yes

1) **Any command that is the first one in a command line (that is, one that immediately follows a <PROGRAM MESSAGE TERMINATOR>) clears the output buffer.**

Set of Commands

The instrument supports the SCPI version 1995.0.

The list shows all commands of the MPEG test decoder in alphabetical order. SCPI-defined commands are identified by “SCPI” in the SCPI info.

Table 5–13: Set of commands

Command	Parameter	SCPI Info	Page
*CLS		SCPI	5–14
*ESE[?]	0 to 255	SCPI	5–14
*ESR?		SCPI	5–14
*IDN?		SCPI	5–14
*OPC[?]		SCPI	5–14
*PSC	0 | 1	SCPI	5–15
*RST		SCPI	5–15
*SRE[?]	0 to 255	SCPI	5–15
*STB?		SCPI	5–15
*TST?		SCPI	5–15
*WAI		SCPI	5–15
CONFigure:DUMP:COUNt[?]	1 to 1394		5–37
CONFigure:DUMP:STATe[?]	PID | AF | AF_ALL | HEADer | ALL | OFF		5–36
CONFigure:DUMP:TRIGger:PID[?]	0 to 8191		5–37
CONFigure:MONitoring:CONTrol[?]	STARt | STOP | CLEar		5–22
CONFigure:MONitoring:LIMit:LOWer[?]	<parameter name>, 0 to 100 ms		5–22
CONFigure:MONitoring:LIMit:UPPer[?]	<parameter name>, 100 to 60000 ms		5–22
CONFigure:MONitoring:PARameter:ALL	ON | OFF		5–22
CONFigure:MONitoring:PARameter[?]	<parameter name>, ON | OFF		5–22
CONFigure:TRERor:STATe[?]	ON | OFF		5–35
CONFigure:TRERor:TRIGger:ALL	ON | OFF		5–35
CONFigure:TRERor:TRIGger[?]	<parameter name>, ON | OFF		5–35
DISPlay:OSD:MODE[?]	ON | OFF		5–34
HCOPy:MONitoring:DATA?			5–29
HCOPy:REPort:LINES:DATA?	0 to 999, 0 to 999		5–30
MEMory:SETTing1...10:NAME?			5–31
MEMory:SETTing1...10:RECall			5–31

Table 5–13: Set of commands (cont.)

Command	Parameter	SCPI Info	Page
MEMory:SETTing1...9:STORe	'NAME'		5–31
READ:ARRay:PROGram:PID?	1 to 65535		5–26
READ:ARRay:PROGram?			5–25
READ[:SCALar]:DUMP?	1 to 1394		5–37
READ[:SCALar]:MONitoring:ALL?			5–19
READ[:SCALar]:MONitoring:DURation?			5–21
READ[:SCALar]:MONitoring:ERRSeconds:ALL?			5–19
READ[:SCALar]:MONitoring:ERRSeconds?	<parameter name>		5–19
READ[:SCALar]:MONitoring:REPort:LINE?	0 to 999		5–20
READ[:SCALar]:MONitoring:REPort:MOMent?	<parameter name>, 1900 to 2100, 1 to 12, 1 to 31, 0 to 23, 0 to 59, 0 to 59		5–21
READ[:SCALar]:MONitoring:REPort?			5–20
READ[:SCALar]:MONitoring?	<parameter name>		5–18
READ[:SCALar]:PID:BITRate?	0 to 8191		5–26
READ[:SCALar]:PID:CONDaccess?	0 to 8191		5–26
READ[:SCALar]:PID:TYPE?	0 to 8191		5–26
READ[:SCALar]:PROGram:BITRate?	1 to 65535		5–25
READ[:SCALar]:PROGram:CONDaccess?	1 to 65535		5–25
READ[:SCALar]:PROGram:NAMe?	1 to 65535		5–25
READ[:SCALar]:TRERor?	–400 to +400		5–36
READ[:SCALar]:TS:BITRate?			5–25
ROUTe:AUDio:LEFt[?]	ON | OFF		5–27
ROUTe:AUDio:RIGHt[?]	ON | OFF		5–27
ROUTe:INPut[?]	RSERial | FSERial | FPARallel		5–28
ROUTe:VIDeo[?]	PALNtsc | SECamntsc		5–27
SENSe:FUNCtion[:ON][?]	MONitoring | TRERor | DUMP		5–15
SENSe:PROGram:AUDio[?]	32 to 8191		5–25
SENSe:PROGram:PCR[?]	32 to 8191		5–24
SENSe:PROGram:VIDeo[?]	32 to 8191		5–24
SENSe:PROGram[?]	1 to 65535		5–24
SENSe:SCONdition:DROP[?]	1 to 7		5–28
SENSe:SCONdition:LOCK[?]	1 to 31		5–28
STATus:OPERation:CONDition?		SCPI	5–39
STATus:OPERation:ENABle[?]	0 to 32767	SCPI	5–39

Table 5–13: Set of commands (cont.)

Command	Parameter	SCPI Info	Page
STATus:OPERation:NTRansition[?]	0 to 32767	SCPI	5–40
STATus:OPERation:PTRansition[?]	0 to 32767	SCPI	5–39
STATus:OPERation[:EVENt]?		SCPI	5–39
STATus:QUEStionable:CONDition?		SCPI	5–40
STATus:QUEStionable:DVMD:CONDition?		SCPI	5–41
STATus:QUEStionable:DVMD:ENABle[?]	0 to 32767	SCPI	5–41
STATus:QUEStionable:DVMD:NTRansition[?]	0 to 32767	SCPI	5–42
STATus:QUEStionable:DVMD:PTRansition[?]	0 to 32767	SCPI	5–41
STATus:QUEStionable:DVMD[:EVENt]?		SCPI	5–41
STATus:QUEStionable:ENABle[?]	0 to 32767	SCPI	5–40
STATus:QUEStionable:NTRansition[?]	0 to 32767	SCPI	5–41
STATus:QUEStionable:PTRansition[?]	0 to 32767	SCPI	5–40
STATus:QUEStionable[:EVENt]?		SCPI	5–40
STATus:QUEue[:NEXT]?		SCPI	5–39
SYSTem:COMMunicate:SERial[:RECeive]:BAUD[?]	1200 | 2400 | 4800 | 9600 | 19200	SCPI	5–32
SYSTem:COMMunicate:SERial[:RECeive]:BITS[?]	8	SCPI	5–33
SYSTem:COMMunicate:SERial[:RECeive]:PACE[?]	XON | ACK | NONE	SCPI	5–33
SYSTem:COMMunicate:SERial[:RECeive]:PARity[:TYPE][?]	EVEN | ODD NONE	SCPI	5–32
SYSTem:COMMunicate:SERial[:RECeive]:SBITs[?]	1	SCPI	5–33
SYSTem:DATE[?]	1900 to 2099, 1 to 12, 1 to 31	SCPI	5–33
SYSTem:DISPlay:CONTents[?]	STATistic | REPort | PROGram | INFO		5–34
SYSTem:ERRor?		SCPI	5–33
SYSTem:TIME[?]	0 to 23, 0 to 59, 0 to 59	SCPI	5–33
SYSTem:VERSion?		SCPI	5–34

Error Messages of Remote-Control Interface

The list below contains all error messages that may occur in the instrument. Negative error numbers are defined in the SCPI standard, positive error numbers identify device-specific errors.

The error code is queried with **SYSTem:ERR?**

The left column of the table below gives the error code. In the right column, the text of the error message entered in the error queue is printed in bold. An additional explanation is given below this text.

SCPI-Specific Error Messages

No error.

Table 5–14: No error

Error number	Error text returned upon queue query Explanations
0	No error This message is displayed when there are no entries in the error queue.

Command Errors (cause bit 5 in the ESR register to be set).

Table 5–15: Command errors

Error number	Error text returned upon queue query Explanations
–100	**Command Error** Command faulty or invalid.
–101	**Invalid Character** The command comprises a character which is invalid for that type. Example: a header contains an ampersand, “SENS&”.
–102	**Syntax error** Command invalid. Example: the command contains block data which the device does not accept.
–103	**Invalid separator** Command contains an illegal character where a separator is expected. Example: the semicolon after the command omitted.
–104	**Data type error** Command contains an illegal data element. Example: numeric data were expected and ON was encountered.
–105	**GET not allowed** A Group Execute Trigger (GET) was received within a program message.

Table 5–15: Command errors (cont.)

Error number	Error text returned upon queue query Explanations
–108	**Parameter not allowed** More parameters than expected were received in the data section of the command. Example: the command SENSe:PROGram allows only one program number.
–109	**Missing parameter** Command contains fewer parameters than required. Example: command SENSe:PROGram:VIDeo requires a PID to be specified.
–111	**Header separator error** Header contains a character which is not a legal separator. Example: no “White Space”, “*ESE255” between header and data section.
–112	**Program mnemonic too long** Header contains more than 12 characters.
–113	**Undefined header** The header is undefined for this specific device. Example: *XYZ is not defined for any device.
–114	**Header suffix out of range** The header contains a numeric suffix which makes the header invalid. Example: CONFigure:MONitoring:PROGram:LIST30 does not exist in the device.
–120	**Numeric data error** Command contains an erroneous numeric parameter.
–121	**Invalid character in number** A numeric contains an invalid character. Example: “A” in a decimal numeric or “9” in an octal data.
–123	**Exponent too large** The magnitude of the exponent was larger than 32000.
–124	**Too many digits** Numeric contains too many digits.
–128	**Numeric data not allowed** A legal numeric element was received but the device expects character data in this position.
–131	**Invalid suffix** The entered suffix is inappropriate for this device. Example: nHz is not defined.
–134	**Suffix too long** Suffix contains more than 12 characters.
–138	**Suffix not allowed** A suffix was encountered which is not allowed for this command or at this position in the command. Example: command SENSe:PROGram does not allow a suffix to be specified.

Table 5–15: Command errors (cont.)

Error number	Error text returned upon queue query Explanations
–141	**Invalid character data** Either the character data element contains an invalid character or the element received is not valid for this command. Example: spelling mistake in parameter specification.
–144	**Character data too long** The character data element contains more than 12 characters.
–148	**Character data not allowed** A legal character data element encountered was not allowed for this command or at this position of the command. Example: command SENSe:PROGram requires a numeral to be specified.
–151	**Invalid string data** Command contains invalid string data. Example: an END message was received before the terminal quote character.
–158	**String data not allowed** The command contains a legal string data element at a position where it is not allowed. Example: character data in quotation marks.
–168	**Block data not allowed** The command contains legal block data at a position where they are not allowed.
–171	I**nvalid expression** Command contains an invalid expression data element. Example: the expression contains unmatched parentheses.
–178	**Expression data not allowed** A legal expression data was encountered at a position where it is not allowed.

Execution Error (error encountered during command execution that causes bit 4 in the ESR register to be set).

Table 5–16: Execution error

Error number	Error text returned upon queue query Explanations
–200	**Execution error** Error encountered upon command execution (eg printer has run out of paper).
–221	**Settings conflict** There is a setting conflict between two parameters. Example: In the DUMP mode, monitoring cannot be started when MONITORING is selected.
–222	**Data out of range** The data element was outside the legal range as defined by the device. Example: command SENSe:PROGram allows entries only in the range 1 to 65535.

Table 5–16: Execution error (cont.)

Error number	Error text returned upon queue query Explanations
–223	**Too much data** The command contains more data than the device can handle. Example: insufficient memory.
–224	**Illegal parameter value** The parameter value is illegal. Example: The parameter value does not correspond to the list is possible values.
–230	**Data corrupt or stale** Data incomplete or invalid. Example: a measurement was aborted by the device.
–240	**Hardware error** A legal program command could not be executed because of hardware problems in the device.
–241	**Hardware missing** A legal program command could not be executed because of missing device hardware. Example: an option is not fitted.

Device-Specific Error (causes bit 3 in the ESR register to be set).

Table 5–17: Device-Specific error

Error number	Error text returned upon queue query Explanations
–300	**Device-specific error** Device-specific error that cannot be defined more precisely.
–310	**System error** Indicates that some error termed system error has occurred. Please contact the R&S service center.
–311	**Memory error** An error was detected in the device's memory.
–313	**Calibration memory lost**
–314	**Save/recall memory lost**
–315	**Configuration memory lost**
–330	**Self test failed**
–350	**Queue overflow** Error code entered in the queue in lieu of the code that caused the error. This code indicates that there is no room in the queue and that the error occurred but was not recorded. Five of these codes are accepted in the queue.

Query Error (error upon data query that causes bit 2 to be set in the ESR register).

Table 5–18: Query error

Error number	Error text returned upon queue query Explanations
–400	**Query error** Generic query error that cannot be defined more precisely.
–410	**Query INTERRUPTED** The query was interrupted. Example: a query is followed by new data before the response was completely sent.
–420	**Query UNTERMINATED** The query is incomplete. Example: the device receives incomplete data.
–430	**Query DEADLOCKED** The query cannot be processed. Example: both input buffer and output buffer are full and the device cannot continue.

Program Example

The example illustrates programming of the device and may be used as a basis for solving more complex programming problems.

The use of baud rates of less that 9600 requires special measures to avoid loss of data.

- The RS-232 interface with the controller needs to be rated for these baud rates.
- The controller must be able to process the received data in time.
- To synchronize data transmission, hardware handshaking must be used.
- The connection between the MTD200 and the controller must be made using a null modem cable.
- Follow the instructions that are supplied with your RS-232 control program.

General

The programming language is Borland C. The serial interface is supported by the program packet “V.24 Tools Plus” from Langner GmbH.

Definitions of Library Calls Supporting the V24 Interface

Table 5–19: Definitions of Library Calls

Function	Definitions
v24open v24setparams v24sethandshake v24settimeout v24setbuffer v24flush	These functions initialize the serial interface.
v24puts	This function outputs a string to the serial interface. This string is not automatically terminated with CR/LF.
v24gets	This function reads a string from the serial interface.
v24read	This function reads an array of defined length from the serial interface.

Example 1 This example illustrates a routine in which the connection to the MTD200 is made, the MTD200 signal is input, and the presence of a transport stream is checked. Then two routines are provided to read out error statistics (mode MONITORING) and transport stream data (mode DUMP).

```
int main(int argc, char *argv[])
{
 #define SETTLING 400  /* settling time = 10 * 40 ms = 400 ms*/
 int port;
 char answer[256];
 /* Preparations... */
  clrscr();
  /* open port COM1 */
  port = v24open("COM1");
  /* set protocol for COM1: 9600 baud, 8 data bits, no paritiy, 1
stop bit */
  v24setparams(port, 9600, 8, N, 1);
  /* select handshake: RTS/CTS */
  v24sethandshake(port, V24RTSCTS);
  /* set default-timeout: maximum time to wait for a character
from COM1 = 1 s */
  v24settimeout(port, 18);
  /* reserve 10 K bytes of receive buffer for COM1*/
  v24setbuffer(port, RCV, 1024 * 10);
  /* clear receive buffer */
  v24flush(port, RCV);
  /* Adjust the DVMD... */
  /* set  */
  v24puts(port, "disp:osd:on");
  /* set  */
  v24puts(port, "syst:disp:cont stat");
  /* close port COM1 */
  v24close(port);
  return(0);  /* return ERRORLEVEL 0 */
}  /* main */
```

Maintenance and Checking

This section discusses the basic maintenance and checks that an operator can perform on the MTD200 MPEG Test Decoder,

Maintenance

The instrument requires no regular maintenance. Generally, maintenance is confined to cleaning the instrument and changing the battery. Make sure that air inlets and outlets are not blocked and clean them at regular intervals.

Cleaning the Outside

The outside of the instrument can be cleaned with a soft, lint–free cloth or a brush. For heavier contamination, use spirit or mild soap suds for cleaning.

CAUTION. *To prevent damage to front-panel labels or plastic parts, do not use solvents such as nitro thinners or acetone.*

Any dust collected inside the instrument should be removed at regular intervals to ensure unimpaired cooling (approximately every 1 to 2 years, depending on the daily on–time of the equipment and the amount of dust in the environment).

Storage

Storage temperature of instrument:

– 40 to +70 °C**.**

When stored for an extended period of time, protect the instrument from dust.

Replacing the Battery

These instructions are for personnel who are familiar with servicing the product. If you need further details for disassembling or reassembling the product, contact your nearest Tektronix, Inc., Service Center or Tektronix Factory Service for installation assistance.

WARNING. *To prevent injury, avoid short circuiting or charging the battery, since this can cause the battery to explode. Do not open discharged batteries; dispose of them as hazardous waste.*

The instrument uses a lithium battery for storing the selected status and for operation of the real–time clock. The battery has a lifetime of approximately five years and should be replaced as required (for example, after a long storage period at high temperatures). Replace the discharged battery by one of the same type.

CAUTION. *The instrument contains electrostatic–sensitive components. To prevent damage to these components, any repair work should done on a grounded work position.*

The instrument must be opened to replace the battery.

Tools required:	Phillips screwdrivers, sizes 0, 1 and 2 Soldering iron
Material required:	Lithium battery, 3 V. Order No. 0565.1687.00 Cable tie (width 2 mm)

WARNING. *To prevent electric shock, disconnect the power plug from the power source before opening the instrument.*

1. Opening the instrument:

a. Switch off the instrument and disconnect the power plug.

b. Unscrew and remove the two rear–panel feet (two Phillips screws each).

c. Remove the top and bottom covers towards the rear (see Figure 6–1).

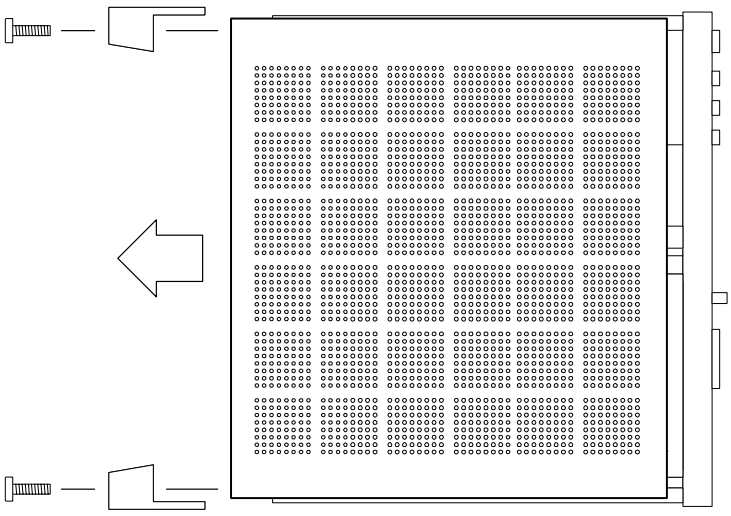


Figure 6–1: Removing covers

2. Removing the front panel:

a. Undo the two trim screws on the front panel.

b. Undo the four attaching screws.

c. Remove the front panel.

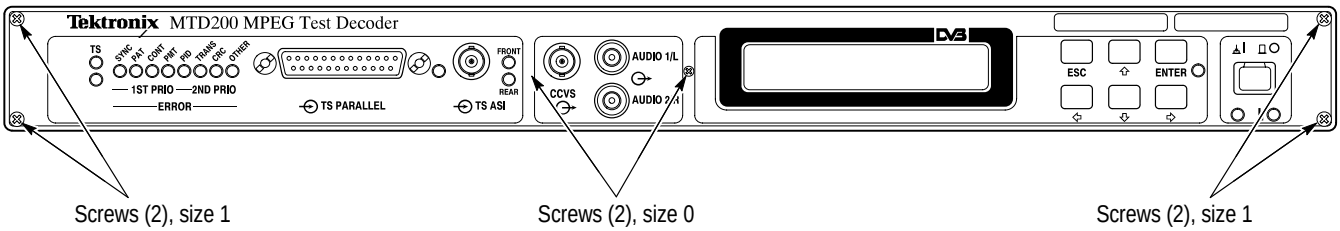


Figure 6–2: Front–panel screws

3. Withdrawing the module:

a. Withdraw the module (Decoder board) towards the front. See Figure 6–3.

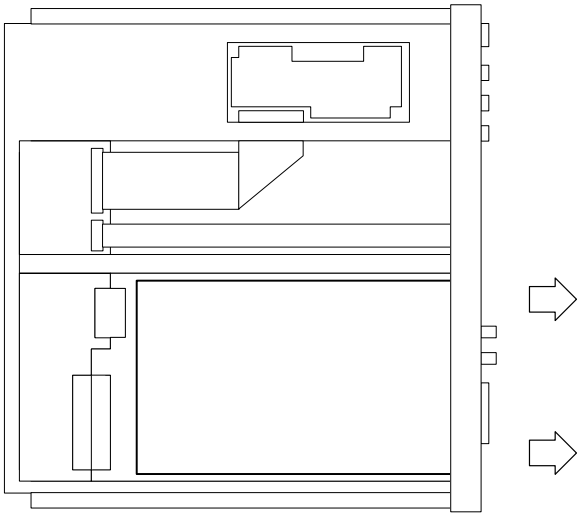


Figure 6–3: Withdrawing the module (Decoder board)

4. Opening the module:

a. Unscrew the top RF cover of decoder board.

b. Turn the instrument upside down.

c. Unscrew the lower RF cover of decoder board.

d. Turn the instrument upright again.

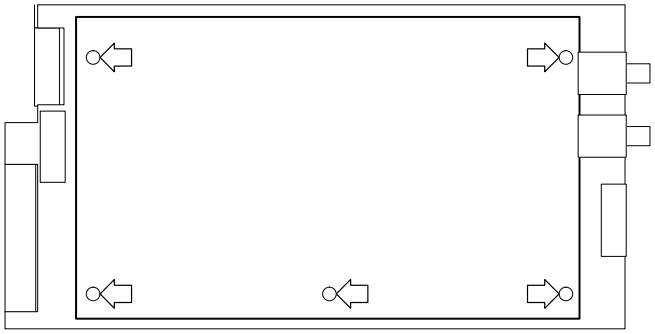


Figure 6–4: Fixing RF cover

5. Replacing the battery:

Replace the battery properly (use solder lugs and fasten with a cable tie). Make sure that the poles are correctly connected. They are marked on the battery with "+" and "–". For the location and polarity of the battery on the decoder board, see Figure 6–5.

a. Open the cable tie holding the battery using side cutters.

b. Unsolder battery terminals (negative pole first).

c. Cut terminals of the new battery as required and solder them (positive pole first).

d. Insert new cable tie through openings and tighten.

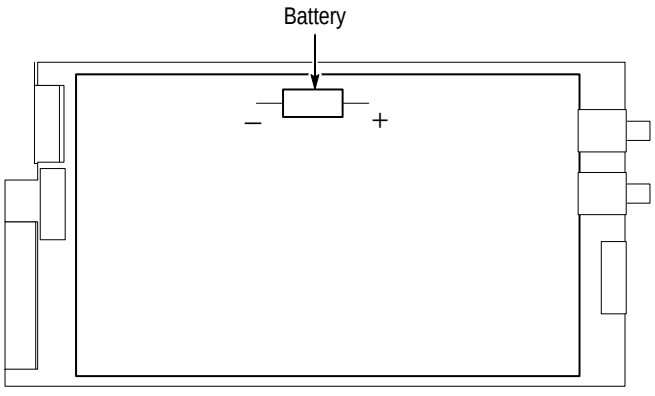


Figure 6–5: Location and poles of battery

6. Closing the instrument:

a. Put upper RF cover onto decoder board and screw it on.

b. Slide on top cover from the rear.

c. Put instrument upside down.

d. Put lower RF cover onto decoder board and screw it on.

e. Slide on bottom cover from the rear.

f. Put back feet on rear panel and screw them on.

After this date and time have to be newly set.

g. Switch on instrument.

h. Set date and time in the SETUP menu.

▼ ▲	selecting DATE and TIME
◗ ◖	selecting individual elements
ENT	entry mode
ESC	return to main menu

Checking

Upon power on, the instrument starts a BOOT procedure with a memory and hardware check. If a fault is detected, a message is displayed on the LCD.

In the case of a total failure, send the instrument to your local service center.

Appendix A: Interfaces

This appendix contains information about the MTD200 MPEG Test Decoder interfaces.

Synchronous Parallel Transport Stream Input – TS Parallel (LVDS)

A 25-pin D-type connector with the designation TS PARALLEL is provided on the front panel of the unit for connecting an MPEG2 transport stream with synchronous parallel data transmission (8-bit parallel).

Pin Assignment of TS PARALLEL Connector

The pin assignment corresponds to the DVB DOCUMENT A010 (synchronous parallel interface):

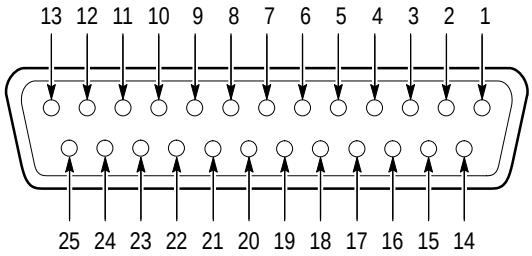


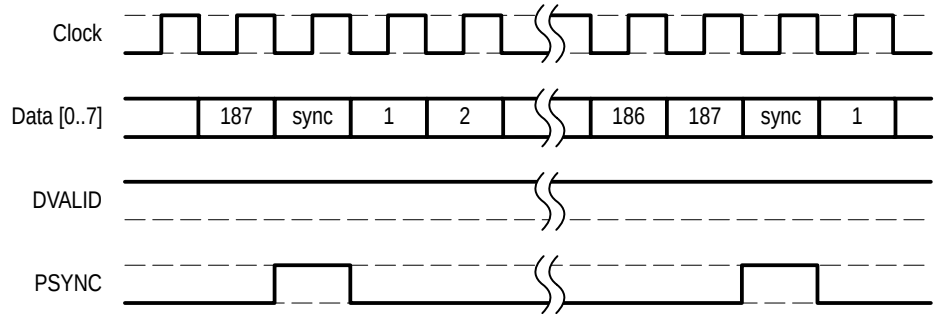
Table A–1: Pin assignment of TS PARALLEL connector (corresponding to DVB Document A010)

Pin	Signal	Description	Pin	Signal	Description
1	CLOCK A	Clock for data word	14	Clock B	Clock for data word, inverted
2	GND	Ground	15	GND	Ground
3	DATA BIT 7 A (MSB)	Data bit 7 (most significant bit)	16	DATA BIT 7 B (MSB)	Data bit 7, inverted (most significant bit)
4	DATA BIT 6 A	Data bit 6	17	DATA BIT 6 B	Data bit 6, inverted
5	DATA BIT 5 A	Data bit 5	18	DATA BIT 5 B	Data bit 5, inverted
6	DATA BIT 4 A	Data bit 4	19	DATA BIT 4 B	Data bit 4, inverted
7	DATA BIT 3 A	Data bit 3	20	DATA BIT 3 B	Data bit 3, inverted
8	DATA BIT 2 A	Data bit 2	21	DATA BIT 2 B	Data bit 2, inverted

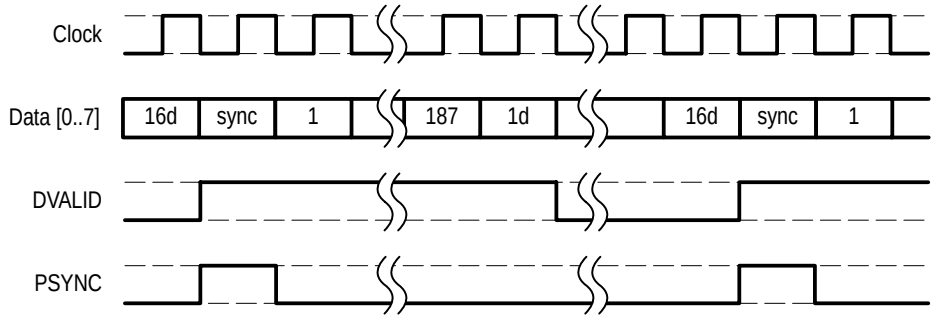
Table A–1: Pin assignment of TS PARALLEL connector (corresponding to DVB Document A010) (cont.)

Pin	Signal	Description	Pin	Signal	Description
9	DATA BIT 1 A	Data bit 1	22	DATA BIT 1 B	Data bit 1, inverted
10	DATA BIT 0 A (LSB)	Data bit 0 (least significant bit)	23	DATA BIT 0 B (LSB)	Data bit 0, inverted (least significant bit)
11	DVALID A	Data word valid	24	DVALID B	Data word valid, inverted
12	PSYNC A	Packet sync	25	PSYNC B	Packet sync inverted
13	GND	Ground	----	----------	----------

Transmission Formats - TS PARALLEL



Transmission format with packets of 188 bytes



Transmission format with packets of 188 bytes and 16 dummy bytes (= 204 bytes)

Asynchronous Serial Transport Stream Input – TS ASI

A BNC connector with the designation TS ASI corresponding to the DVB DOCUMENT A010 (asynchronous serial interface) is provided on the front and rear panel of the unit for connecting an MPEG2 transport stream with asynchronous serial data transmission.

The asynchronous serial transport stream interface operates with a constant bit rate of 270 Mbit/s. Data bytes (8 bit) of max. 27 Mbyte/s are transmitted via this interface. According to a standard table, two additional bits are added to each byte for making non-relevant data bytes (dummy bytes) required to fill up the 27-Mbyte/s data rate and also to prevent DC component in the serial signal.

The BNC connector has an input impedance of 75 Ω. The input level of a standardized signal is 800 mV (10%).

Video Outputs

A TV program can be selected from the transport stream multiplex. This program is then decoded and available as a video signal at the BNC connectors described below.

Digital/Serial Video Output to CCIR601 – SER 75

The BNC connector for this video output is provided at the rear of the unit and is designated SER 75 Ω. The connector has an output impedance of 75 Ω, the output level is 800 mV (10%).

Analog Video Outputs for CCVS

A BNC connector each with the designation CCVS is provided at the front and rear of the unit for the output of a CCVS signal. The connectors have an output impedance of 75 Ω, the output level is 1 V (±10%).

Analog Video Outputs for Luminance/Chrominance – Y/C

A BNC connector each with the designation Y and C is provided at the rear of the unit for the output of the luminance signal (Y) and the chrominance signal (C). The connectors have an output impedance of 75 Ω, the output level is 1 V (10%) for the Y signal and 700 mVpp (±10%) for the C signal.

Audio Outputs

An audio program can be selected from the transport stream multiplex. This program is then decoded and made available as an audio signal at the LEMO connectors mentioned below. A digital/serial signal to AES/EBU as well as two analog signals L and R are available.

Digital/Serial Audio Output – AES/EBU

The LEMO connector for this audio output is provided at the rear of the unit and is designated AES/EBU. The connector has an output impedance of 110 Ω, the output level is 4 Vpp (±10%).

Analog Audio Outputs – Audio1/L , Audio2/R

The two LEMO connectors for the output of the audio channels are provided at the front and rear of the unit ('Audio1/L' = tone 1/left channel and 'Audio2/R' = tone 2/right channel). The connectors have an output impedance of < 50 Ω, the output level is +6 dBu (default) and can be increased after opening the unit by repositioning two jumpers to +9/12/15 dBU (refer to *Setting the Level of Analog Audio Outputs* on page 3–9).

RS232 Interface – COM1

The serial interface COM1 of the MPEG test decoder is either used for remote control or for the printer.

Pin assignment

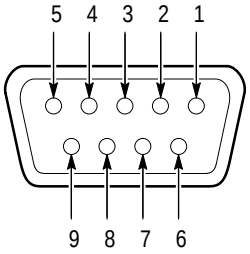


Table A–2: Pin assignment COM1

Pin	Signal	Description
1	CD	Carrier Detect
2	RXD	Receive Data
3	TXD	Transmit Data
4	DTR	Data Terminal Ready
5	GND	Ground
6	DSR	Data Set Ready
7	RTS	Request To Send
8	CTS	Clear To Send
9	—	not assigned

Transmission Parameters

The transmission parameters are set in the SETUP/RS232 menu (refer to *SETUP/RS-232 Menu* on page 4–33).

The following interface parameters can be selected:

Table A–3: Transmission speed settings COM1

Transmission speed (Baud)
1200
2400
4800
9600
19200

Table A–4: Parity settings COM1

Value for PARITY	Meaning
none	no parity check
even	even parity
odd	odd parity
one	Parity bit logic 1
zero	Parity bit logic 0

Table A–5: Data bit setting COM1 (fixed)

Number of data bits
8

Table A–6: Stop bit setting COM1 (fixed)

Number of stop bits
1

Table A–7: Pace settings COM1

Value for PACE	Meaning
none	No special interface protocol
XON/XOFF	XON/XOFF protocol
RTS/CTS	Hardware handshake

Interface Functions

To control the interface, some control characters are taken from the ASCII code range from 0 to 20 hexadecimal. The control characters are transmitted via the interface.

Table A–8: Control characters of the RS-232 interface

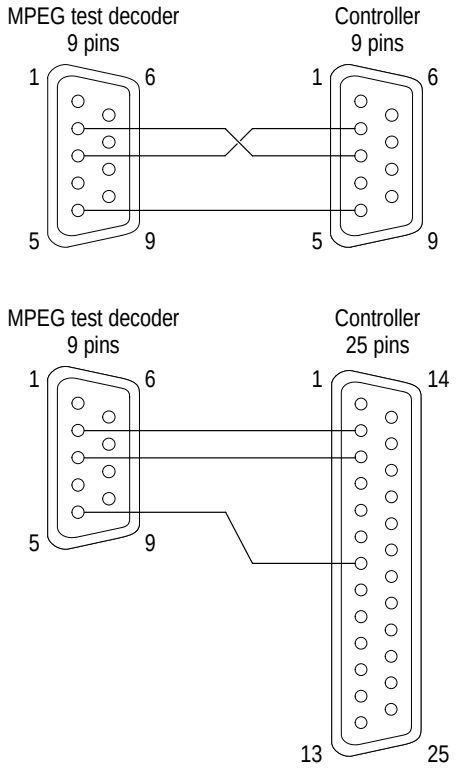
Name	Control character	Function
SRQ_char	<Ctrl B> 02 hexadecimal	Service request function (SRQ) If bit 6 of status byte is set, this character will be sent. The receipt of the character SRQ_char is ignored.
XON_char	<Ctrl Q> 11 hexadecimal	Enable character output The XON_char character informs the remote station that it may again transmit data.
XOFF_char	<Ctrl S> 13 hexadecimal	Stop character output The XOFF_char character informs the remote station not to send further data.
END_char	0D hexadecimal, 0A hexadecimal	Delimiter <CR><LF>

Handshake

Software handshake. In case of a software handshake, data transmission is controlled via the two control characters XON_char / XOFF_char. The MPEG test decoder signals its ready-to-receive state via the control character XON_char. If the receive buffer is full, the MPEG test decoder informs the controller by means of control character XOFF_char not to send further data. The controller thus interrupts the data output as long as it receives another XON_char from the MPEG test decoder. The controller signals its ready-to-receive state to the MPEG test decoder in the same way.

During the transmission of block data the software handshake is not possible because of the above-mentioned reasons.

Interconnections with local controller in case of software handshake. In case of software handshake, the MPEG test decoder is connected with a controller according to the following wiring diagram. The wiring diagram applies to a controller with a 9-pin or 25-pin connector. See Figure A–1.



MPEG test decoder pin	Signal	Controller pin
2	RxD / TxD	3
3	TxD / RxD	2
5	GND / GND	5

MPEG test decoder pin	Signal	Controller pin
2	RxD / TxD	3
3	TxD / RxD	2
5	GND / GND	7

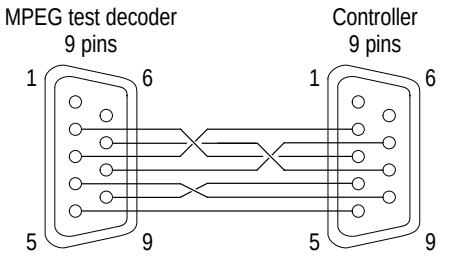
Figure A–1: Wiring Diagram for software handshake

Hardware handshake. In case of a hardware handshake, the MPEG test decoder signals its ready-to-receive state via the RTS lines. A logic ‘0’ (active) means “ready” and a logic ‘1’ means “not ready”.

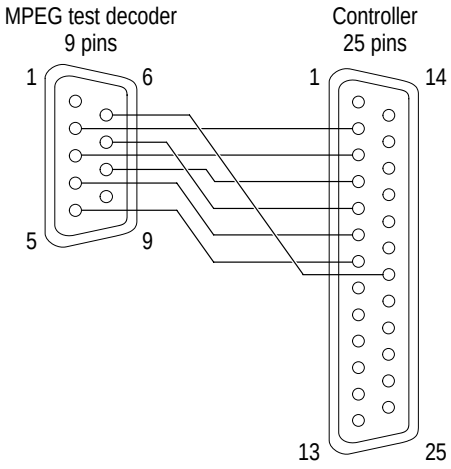
The MPEG test decoder is informed about the ready-to-receive state of the remote station via the CTS line. A logic ‘0’ activates the data output, a logic ‘1’ informs the MPEG test decoder to stop sending further data. The DTR line remains active (logic ‘0’) as long as the serial interface is switched on as a remote-control interface.

Interconnections with local controller in case of hardware handshake.

The MPEG test decoder is connected with a controller by means of a null-modem cable. When this cable is used, the data, control and signalling lines have to be crossed. The following wiring diagram applies to a controller with a 9-pin or 25-pin connector.



MPEG test decoder pin	Signal	Controller pin
2	RxD / TxD	3
3	TxD / RxD	2
4	DTR / DSR	6
5	GND / GND	5
6	DSR / DTR	4
7	RTS / CTS	8
8	CTS / RTS	7



MPEG test decoder pin	Signal	Controller pin
2	RxD / TxD	2
3	TxD / RxD	3
4	DTR / DSR	6
5	GND / GND	7
6	DSR / DTR	20
7	RTS / CTS	5
8	CTS / RTS	4

Figure A–2: Wiring diagram for hardware handshake

Interfaces for Descrambling and Flash ROM card

These two interfaces can be accessed by opening the unit. The bottom of the two interface slots positioned on top of each other is always equipped with a flash ROM card which accommodates the complete firmware of the MPEG test decoder. The top descrambling card is optional. The programs or elementary streams contained in a transport stream may be scrambled. After installation of the descrambling card valid for these programs the unit can decode the scrambled programs and provide them at the corresponding video outputs. The interfaces for the descrambling and flash ROM card are in line with the Personal Computer Memory Card International Association (PCMCIA) Standard.

Table A–9: Pin assignment of flash ROM card

Pin	Signal	Description
1	GND	Ground
2	D3	Data Bit 3
3	D4	Data Bit 4
4	D5	Data Bit 5
5	D6	Data Bit 6
6	D7	Data bit 7
7	CE1	Card Enable 1
8	A10	Address Bit 10
9	OE	Output Enable
10	A11	Address Bit 11
11	A9	Address Bit 9
12	A8	Address Bit 8
13	A13	Address Bit 13
14	A14	Address Bit 14
15	WE/PGM	Write Enable
16	RDY/BSY	Ready/Bus (EEPROM)
17	VCC	Supply voltage +5V
18	VPP1	Programming voltage 1
19	A16	Address Bit 16
20	A15	Address Bit 15
21	A12	Address Bit 12
22	A7	Address Bit 7
23	A6	Address Bit 6

Table A–9: Pin assignment of flash ROM card(cont.)

Pin	Signal	Description
24	A5	Address Bit 5
25	A4	Address Bit 4
26	A3	Address Bit 3
27	A2	Address Bit 2
28	A1	Address Bit 1
29	A0	Address Bit 0
30	D0	Data Bit 0
31	D1	Data Bit 1
32	D2	Data Bit 2
33	WP	Write Protect
34	GND	Ground
35	GND	Ground
36	CD1	Card Detect 1
37	D11	Data Bit 11
38	D12	Data Bit 12
39	D13	Data Bit 13
40	D14	Data Bit 14
41	D15	Data Bit 15
42	CE2	Card Enable 2
43	RFSH	Refresh (DRAM)
44	RFU	Spare
45	RFU	Spare
46	A17	Address Bit 17
47	A18	Address Bit 18
48	A19	Address Bit 19
49	A20	Address Bit 20
50	A21	Address Bit 21
51	VCC	Supply voltage +5V
52	VPP2	Programming voltage 2
53	A22	Address Bit 22
54	A23	Address Bit 23
55	A24	Address Bit 24
56	A25	Address Bit 25

Table A–9: Pin assignment of flash ROM card(cont.)

Pin	Signal	Description
57	RFU	Spare
58	RFU	Spare
59	RFU	Spare
60	RFU	Spare
61	REG	Register Select
62	BVD2	Battery Voltage Detect 2
63	BVD1	Battery Voltage Detect 1
64	D8	Data Bit 8
65	D9	Data Bit 9
66	D10	Data Bit 10
67	CD2	Card Detect 2
68	GND	Ground

Table A–10: Pin assignment of Descrambling card

Pin	Signal	Description
1	GND	Ground
2	D3	Data Bit 3
3	D4	Data Bit 4
4	D5	Data Bit 5
5	D6	Data Bit 6
6	D7	Data bit 7
7	CE1	Card Enable 1
8	A10	Address Bit 10
9	OE	Output Enable
10	A11	Address Bit 11
11	A9	Address Bit 9
12	A8	Address Bit 8
13	A13	Address Bit 13
14	A14	Address Bit 14
15	WE/PGM	Write Enable
16	IREQ	Interrupt Request

Table A–10: Pin assignment of Descrambling card (cont.)

Pin	Signal	Description
17	VCC	Supply voltage +5V
18	VPP1	Programming voltage 1
19	MIVAL	MPEG Input Data Valid
20	A15	Address Bit 15
21	A12	Address Bit 12
22	A7	Address Bit 7
23	A6	Address Bit 6
24	A5	Address Bit 5
25	A4	Address Bit 4
26	A3	Address Bit 3
27	A2	Address Bit 2
28	A1	Address Bit 1
29	A0	Address Bit 0
30	D0	Data Bit 0
31	D1	Data Bit 1
32	D2	Data Bit 2
33	RFU	Spare
34	GND	Ground
35	GND	Ground
36	CD1	Card Detect 1
37	MDO3	MPEG Data Out Bit 3
38	MDO4	MPEG Data Out Bit 4
39	MDO5	MPEG Data Out Bit 5
40	MDO6	MPEG Data Out Bit 6
41	MDO7	MPEG Data Out Bit 7
42	CE2	Card Enable 2
43	MCLK	MPEG Clock
44	IORD	I/O Read
45	IOWR	I/O Write
46	MISTRT	MPEG Input Data Start
47	MDI0	MPEG Data In Bit 0
48	MDI1	MPEG Data In Bit 1
49	MDI2	MPEG Data In Bit 2

Table A–10: Pin assignment of Descrambling card (cont.)

Pin	Signal	Description
50	MDI3	MPEG Data In Bit 3
51	VCC	Supply voltage +5V
52	VPP2	Programming voltage 2
53	MDI4	MPEG Data In Bit 4
54	MDI5	MPEG Data In Bit 5
55	MDI6	MPEG Data In Bit 6
56	MDI7	MPEG Data In Bit 7
57	RFU	Spare
58	RESET	Card Reset
59	WAIT	Lengthening of bus cycles
60	INPACK	Input Port Acknowledge
61	REG	Register Select
62	MOVAL	MPEG Data Out Valid
63	MOSTRT	MPEG Data Out Start
64	MDO0	MPEG Data Out Bit 0
65	MDO1	MPEG Data Out Bit 1
66	MDO2	MPEG Data Out Bit 2
67	CD2	Card Detect 2
68	GND	Ground

Appendix B: Specifications

Table B–1: Input Signals

Characteristic	Performance requirement	Supplemental information
Transport Stream		To ISO/IEC 1-13818
Data Rate of Transport Stream	Up to 54 Mbit/s	
Length of Data Packets	188 or 204 bytes	

Table B–2: Signal Inputs

Characteristic	Performance requirement	Supplemental information
Synchronous Parallel MPEG2 Transport Stream (LVDS, to DVB-A010)	Level: 100 mV_{p-p} to 2 V_{p-p} Impedance: 100 Ω	Connector: Front-panel 25-pin connector
Asynchronous Serial MPEG2 Transport Stream, 270 Mbit/s (ASI, to DVB-A010)	Level: 200 mV_{p-p} to 1 V_{p-p} Impedance: 75 Ω	Connector: Front- and rear-panel BNC

Table B–3: Signal Outputs

Characteristic	Performance requirement	Supplemental information
Composite Video (PAL, SECAM, NTSC)	Level: 1 V_{p-p} ± 1% Impedance: 75 Ω	Connector: Front- and rear-panel BNC
Luminance (Y)	Level: 1.0 V_{p-p} ± 1% Impedance: 75 Ω	Connector: Front- and rear-panel BNC
Chrominance (C)	Level: 0.7 V_{p-p} ± 1% Impedance: 75 Ω	Connector: Front- and rear-panel BNC
C/L Gain	± 2%	
C/L Delay	± 30 ns	
Return Loss (0 to 6 MHz)	34 dB	At front-panel CCVS connector: 30 dB
Frequency Response (typ)	0 to 3 MHz: +1%/ -2% <4 MHz : +1%/ -5% <5 MHz: +1%/ -15%	

Table B–3: Signal Outputs (cont.)

Characteristic	Performance requirement	Supplemental information
Serial Digital Video (ITU-R 601)	Level: 800 mV_{p-p} Impedance: 75 Ω	Connector: Rear-panel BNC
Analog Audio (Left, Right)	Level (full scale): 6/9/12/15 dBu ± 0.5 dB Impedance: 50 Ω Frequency response (40 Hz to 15 kHz): ± 0.5 dB S/N ratio: > 70 dB, unweighted THD: > 70 dB	Connector: Front- and rear-panel LEMO Triax Relative to 1 kHz
Digital Audio (AES/EBU)	Level: 4 V_{p-p} Impedance: 110 Ω	Connector: Rear-panel LEMO Triax
Remote Control/Printer Interface		RS-232 serial interface

Table B–4: Environmental Characteristics

Characteristic	Performance requirement	Supplemental information
Temperature Range	Operating: +5 to +50° C Storage: -40 to +70° C Climactic Stressing: +25/ +40° C	Rated from 0 to ±50° C Cyclically at 95% RH
Humidity		To IEC 68-2-30
Vibration	Sinewave: 5 to 150 Hz, maximum 2 g at 55 Hz, 0.5 g from 55 to 150 Hz Random: 10 to 300 Hz, 1.2 g_{rms}	Complies with IEC 68-2-6, IEC 1010-1, Mil-T-28800 D class 5
Shock	40 g shock spectrum	Complies with MIL-STD-810 C and MIL-T-28800 D class 3 and 5

Table B–5: Certifications and compliances

Certification	Compliance
EC Declaration of Conformity – EMC	Meets intent of Directive 89/336/EEC for Electromagnetic Compatibility. Compliance was demonstrated to the following specifications as listed in the Official Journal of the European Communities: EN 50081-1 Emissions: EN 55022 Class A Radiated and Conducted Emissions EN 60555-2 AC Power Line Harmonic Emissions EN 50082-1 Immunity: IEC 801-2 Electrostatic Discharge Immunity IEC 801-3 RF Electromagnetic Field Immunity IEC 801-4 Electrical Fast Transient/Burst Immunity IEC 801-5 Power Line Surge Immunity
FCC Compliance	Emissions comply with FCC Code of Federal Regulations 47, Part 15, Subpart B, Class A Limits
EC Declaration of Conformity – Low Voltage	Compliance was demonstrated to the following specification as listed in the Official Journal of the European Communities: Low Voltage Directive 73/23/EEC EN 60950/A1: 1993 Safety of Information Technology Equipment, Including Electrical Business Equipment (Second Edition)
Approvals	
U.S. Nationally Recognized Testing Laboratory Listing	UL1950 Safety of Information Technology Equipment, Including Electrical Busines Equipment
Canadian Certification	CAN/CSA C22.2 No. 950 M89 Safety of Information Technology Equipment, Including Electrical Business Equipment
European Union Compliance	Low Voltage Directive 73/23/EEC, Amended by 93/68/EEC EN60950 Safety of Information Technology Equipment, Including Electrical Business Equipment
Conditions for Safety Certification	Operating temperature: +5° C to +40° C Max. operating altitude: 2000 m Safety class: Class I, gounded product Pollution degree: Pollution Degree 2, rated for indoor use only
Installation Category Descriptions	Terminals on this product may have different installation category designations. The installation categories are: CAT III Distribution-level mains (usually permanently connected). Equipment at this level is typically in a fixed industrial location CAT II Local-level mains (wall sockets). Equipment at this level includes appliances, portable tools, and similar products. Equipment is usually cord-connected CAT I Secondary (signal level) or battery operated circuits of electronic equipment

Table B–6: Power Characteristics

Characteristic	Performance requirement
Line Voltage	88 to 264 VAC
Line Frequency	47 to 63 Hz
Power Consumption	50 W

Table B–7: Physical Characteristics

Dimensions	mm	in
Height	43	1.75
Width	434	17.1
Depth	460	18.1
Weight	**kg**	**lb**
Net	4.9	10.8

Glossary

Definition of Terms

Acronym	Definition
ASI	Asynchronous Serial Interface
BAT	Bouquet Association Table
CA	Conditional Access
CAT	Conditional Access Table
CI	Common Interface
CRC	Cyclic Redundancy Check
DTS	Decoding Time Stamp
DVB	Digital Video Broadcasting
ECM	Entitlement Control Messages
EIT	Event Information Table
EMM	Entitlement Management Messages
ES	Elementary Stream
IRD	Integrated Receiver/Decoder
LVDS	Low Voltage Differential Signalling
NP@ML	Main Profile @ Main Level
NIT	Network Information Table
PAT	Program Association Table
PCR	Program Clock Reference
PCMCIA	Personal Computer Memory International Association
PES	Packetized Elementary Stream
PID	Packet Identity
PMT	Program Map Table
PS	Program Stream
PSI	Program Specific Information
PTS	Presentation Time Stamp
QAM	Quadrature Amplitude Modulation
QPSK	Quadrature Phase Shift Keying
SDT	Service Description Table
SI	Service Information
ST	Stuffing Table

Definition of Terms (Cont.)

Acronym	Definition
TDT	Time and Date Table
TOT	Time Offset Table
TS	Transport Stream

Adaptation Field

The adaptation field is an extension of the *TS header* and contains ancillary data for a program. The *program clock reference (PCR)* is of special importance. The adaptation field must never be scrambled when it is to be transmitted (see *Conditional Access*).

Asynchronous Serial Interface (ASI)

The ASI is an interface for the t*ransport stream.* Each byte of the transport stream is expanded to 10 bits (energy dispersal) and is transmitted with a fixed bit clock of 270 MHz (asynchronous) irrespective of the data rate of the transport stream. The fixed data rate is obtained by adding dummy data without information content. Useful data is integrated into the serial data stream either as individual bytes or as whole *TS packets.* This is necessary to avoid *PCR jitter.* A variable buffer memory at the transmitter end is therefore not permissible.

Bouquet Association Table (BAT)

The BAT is an *SI* table. It contains information about the different programs (bouquet) of a broadcaster. It is transmitted in *TS packets* with *PID* 0x11 and indicated by *table_ID* 0x4A.

Common Interface (CI)

The CI is an interface at the receiver end for a broadcaster–specific exchangeable *CA* plug–in card. This interface allows scrambled programs from different broadcasters to be descrambled with the same hardware despite differences in CA systems.

Conditional Access (CA)

The CA is a system allowing to scramble programs and to provide access to these programs at the receiver end only to authorized users. Broadcasters can thus charge fees for programs or individual broadcasts. Scrambling can be performed at one of the two levels provided by an MP*EG2* multiplex stream, ie the t*ransport stream* or the *packetized elementary stream* level. The relevant headers remain unscrambled. The *PSI* and *SI* tables also remain unscrambled except for the *EIT.*

Conditional Access Table (CAT)

The CAT is a *PSI* table and comprises information required for descrambling programs. It is transmitted in *TS packets* with *PID* 0x0002 and indicated by *table_ID* 0x01.

Continuity Counter

A continuity counter for each e*lementary stream (ES)* is provided as a four–bit counter in the fourth and last byte of each *TS header*. It counts the *TS packets* of a *PES*, determines the correct order and checks whether the packets of a PES are complete. The counter (15 is followed by zero) is incremented with each new packet of the PES. Under certain circumstances, exceptions are permissible (see Access to a Program on page 1–7).

Cyclic Redundancy Check (CRC)

The CRC serves for verifying whether data transmission was error–free. To this effect, a bit pattern is calculated in the transmitter based on the data to be monitored. This bit pattern is added to the corresponding data in such a way that an equivalent computation in the receiver yields a fixed bit pattern in case of error–free transmission after processing the data. Every *transport stream* contains a CRC for the *PSI tables (PAT, PMT, CAT, NIT)* as well as for some *SI tables (EIT, BAT, SDT, TOT)*.

Decoding Time Stamp (DTS)

The DTS is a 33–bit value in the *PES header* and represents the decoding time of the corresponding PES packet. The value refers to the 33 most significant bits of the associated program clock reference. A DTS is only available if it differs from the *presentation time stamp (PTS)*. For video streams this is the case if differential pictures are transmitted and if the order of decoding does not correspond to that of output.

Digital Video Broadcasting (DVB)

The European DVB project stipulates methods and regulations for the digital transmission of TV signals. Abbreviations such as DVB–C (for transmission via cable), DVB–S (for transmission via satellite) and DVB–T (for terrestrial transmission) are used as well.

Elementary Stream (ES)

The elementary stream is a ‘continuous’ data stream for vision, sound or user–specific data. The data originating from the digitization of vision and sound are compressed by means of methods defined in *MPEG2*–Video and *MPEG2*–Audio.

Entitlement Control Messages (ECM)

ECM contain information for the descrambler in the receiver of a CA system providing further details about the descrambling method.

Entitlement Management Messages (EMM)

EMM comprise information for the descrambler in the receiver of a CA system providing further details about the access rights of the customer to specific scrambled programs or broadcasts.

Event Information Table (EIT)

The EIT is an *SI* table. It provides information about program contents like a TV guide. The EIT is transmitted in *TS packets* with *PID* 0x0012 and indicated by a *table_ID* from 0x4E to 0x6F.

Integrated Receiver/Decoder (IRD)

The IRD is a receiver with integrated MPEG2 decoder. A more colloquial expression would be set–top box.

Channel Coding

The channel coding is performed prior to the modulation and transmission of a transport stream. The channel coding is mainly used for a forward error correction (FEC) allowing to correct bit errors occurring in the receiver during transmission.

Low Voltage Differential Signaling (LVDS)

LVDS is used for the parallel interface of the transport stream. It is a positive differential logic. The difference voltage is 330 mV into 100 Ω.

MP@ML

MP@ML stands for Main Profile / Main Level and is a type of source coding for video signals. The profile determines the source coding methods that may be used while the level defines the picture resolution.

Moving Picture Experts Group (MPEG)

MPEG is an international standardization committee working on the coding, transmission and recording of (moving) pictures and sound.

MPEG-2

MPEG-2 is a standard consisting of three main parts and written by the *Moving Picture Experts Group*. It describes the coding and compression of video (Part 2) and audio (Part 3) to obtain the corresponding *elementary stream* as well as the multiplexing of elementary streams to a *transport stream* (Part 1).

Network Information Table (NIT)

The NIT is a *PSI* table. It comprises technical data about the transmission network (eg orbit positions of satellites and transponder numbers). The NIT is transmitted in *TS packets* with *PID* 0x0010 and indicated by t*able_ID* 0x40 or 0x41.

Null Packet

Null packets are *TS packets* by which the *transport stream* can be filled to obtain a specific data rate. Null packets do not contain any useful data and have the *packet identity* 0x1FFF. The *continuity counter* is undefined.

Packet Identity (PID)

The PID is a 13–bit value in the *TS header.* It shows that a *TS packet* belongs to a substream of the *transport stream.* A substream may contain a *packetized elementary stream (PES)*, user–specific data, *program specific information (PSI)* or *service information (SI)*. For some PSI and SI tables the associated PID values are predefined (see 1.3.6.). All other PID values are defined in the PSI tables of the transport stream.

Packetized Elementary Stream (PES)

For transmission, the ”continuous” *elementary stream* is subdivided into packets. In case of video streams one picture constitutes the PES, whereas with audio streams an audio frame which may represent an audio signal between 16 ms and 72 ms is the PES. Each *PES packet* is preceded by a *PES header.*

Payload

Payload signifies useful data in general. With reference to the t*ransport stream* all data except for the *TS header* and the adaptation field is payload. With reference to an *elementary stream (ES)* only the useful data of the corresponding ES without the *PES–header* is payload.

Payload Unit Start Indicator

The payload unit start indicator is a 1–bit flag in the second byte of a *TS header.* It indicates the beginning of a *PES packet* or of a section of *PSI* or *SI* tables in the corresponding TS packet.

PCMCIA

PCMCIA is a physical interface standardized by the Personal Computer Memory Card International Association for the data exchange between computers and peripherals. A model of this interface is used for the *common interface.*

PCR Jitter

The value of a *PCR* exactly refers to the beginning of a *TS packet* in which it is located. The reference to the 27–MHz system clock yields an accuracy of approx. 20 ns. If the difference of the transferred values deviates from the actual difference of the beginning of the corresponding packets, this is called a PCR jitter. It can be caused, for example, by an inaccurate PCR calculation during *transport stream* multiplexing or by the subsequent integration of *null packets* on the transmission path without PCR correction.

PES Header

Each *PES packet* in the transport stream starts with a *PES header.* The *PES header* contains information for decoding the e*lementary stream*. The *presentation time stamp (PTS)* and *decoding time stamp (DTS)* are of vital importance. The beginning of a PES header and thus also the beginning of a PES packet is indicated in the associated *TS packet* by means of the set *payload unit start indicator.* If the PES header is to be scrambled, it is scrambled at the transport–stream level. It is not affected by scrambling at the elementary–stream level (see *Conditional Access*).

PES Packet

The PES packet (not to be mixed up with *TS packet*) contains a *packetized elementary stream (PES)* as transmission unit. In a video stream, for example, this is a *source–coded* picture. The length of a PES packet is normally reduced to 64 Kbytes. Only if a video picture requires more capacity may a PES packet be longer than 64 Kbytes. A *PES header* precedes each PES packet.

Presentation Time Stamp (PTS)

The PTS is a 33–bit value in the *PES header* and represents the output time of the content of a PES packet. The value refers to the 33 most significant bits of the associated program clock reference. If the order of output does not correspond to the order of decoding, a decoding time stamp (DTS) is additionally transmitted. This is the case for video streams containing differential pictures.

Program Association Table (PAT)

The PAT is a *PSI T*able. It lists all the programs contained in a *transport stream* and refers to the associated *PMT*s containing further information about the programs. The PAT is transmitted in *TS packets* with *PID* 0x0000 and indicated by t*able_ID* 0x00.

Program Clock Reference (PCR)

The PCR is a 42–bit value contained in an *adaptation field* and helps the decoder to synchronize its system clock (27 MHz) to the clock of the encoder or TS multiplexer by means of PLL. In this case, the 33 most significant bits refer to a 90–kHz clock while the 9 least significant bits count from 0 to 299 and thus represent a clock of 300 × 90 kHz (= 27 MHz). Each program of a transport stream relates to a PCR which is transmitted in the adaptation field by *TS packets* with a specific PID. The *presentation time stamps (PTS)* and *decoding time stamps (DTS)* of all the *elementary streams* of a program refer to the 33 most significant bits of the PCR. According to *MPEG2* PCRs have to be transmitted at intervals of max. 100 ms, according to the *DVB* regulations at intervals of max. 40 ms.

Program Map Table (PMT)
The PMT is a *PSI* table. The *elementary streams* (vision, sound, data) belonging to the individual programs are described in a PMT. A PMT consists of one or several *sections* each containing information about a program. The PMT is transmitted in *TS packets* with a *PID* from 0x0020 to 0x1FFE (referenced in the *PAT*) and indicated in *table_ID* 0x02.

Program Stream (PS)
Like the *transport stream*, the program stream is a multiplex stream but can only contain elementary streams for a program and is only suitable for the transmission in 'undisturbed' channels (eg recording in storage media).

Program Specific Information (PSI)
The four tables below defined by *MPEG2* are summed up as program specific information:

Program Association Table (PAT),
Program Map Table (PMT),
Conditional Access Table (CAT),
Network Information Table (NIT).

Quadrature Amplitude Modulation (QAM)
QAM is the modulation method used for transmitting a *transport stream* via cable. The *channel coding* is performed prior to QAM.

Quadrature Phase Shift Keying (QPSK)
QPSK is the modulation method used for transmitting a *transport stream* via satellite. The *channel coding* is performed prior to QPSK.

Source Coding
The aim of source coding is data reduction by eliminating redundancy to the greatest possible extent and by affecting the relevance in a video or audio signal as little as possible. The methods to be applied are defined in *MPEG2*. They are the precondition that the bandwidth required for the transmission of digital signals is narrower than that for the transmission of analog signals.

Running Status Table (RST)
The RST is an *SI table* and contains status information about the individual broadcasts. It is transmitted in *TS packets* with *PID* 0x0013 and indicated by *table_ID* 0x71.

Section
Each table (*PSI* and *SI*) may comprise one or several sections. A section may have a length of up to 1 Kbyte (for *EIT* and *ST* up to 4 Kbytes). For most of the tables, 4 bytes at the end of each section are available for the *CRC*.

Service Description Table (SDT)
The SDT is an *SI* table and contains the names of programs and broadcasters. It is transmitted in *TS packets* with *PID* 0x0011 and indicated by t*able_ID* 0x42 or 0x46.

Service Information (SI)
The following tables defined by *DVB* are called service information:

Bouquet Association Table (BAT),
Service Description Table (SDT),
Event Information Table (EIT),
Running Status Table (RST),
Time and Date Table (TDT),

Time Offset Table (TOT)
Sometimes, the *program specific information (PSI)* is also included.

Stuffing Table (ST)
The ST is an *SI* table. It has no relevant content and is obtained by overwriting tables that are no longer valid on the transmission path (eg at cable headends). It is transmitted in *TS packets* with a *PID of* 0x0010 to 0x0014 and indicated by *table_ID* 0x72.

Sync byte
The sync byte is the first byte in the *TS header* and thus also the first byte of each *TS packet*. Its value is 0x47.

Table_ID
The table_identity defines the type of table (eg *PAT, NIT, SDT*, etc.) and is always located at the beginning of a s*ection* of the corresponding table. The table_id is necessary especially because different tables can be transmitted with a *PID* (eg *BAT* and *SDT* with PID 0x0011, see 1.3.6) in one substream.

Time and Date Table (TDT)
The TDT is an *SI* table and contains date and time (UTC). It is transmitted in *TS packets* with *PID* 0x0014 and indicated by *table_ID* 0x70.

Time Offset Table (TOT)
The TOT is an *SI* table and contains information about the local time offset in addition to date and time (UTC). It is transmitted in *TS packets* with *PID* 0x0014 and indicated by *table_ID* 0x73.

Transport Error Indicator
The transport error indicator is contained in the *TS header* and is the first bit after the s*ync byte* (MSB of the second byte). It is set during *channel decoding* if channel decoding could not correct all the bit errors generated in the corresponding TS packet on the transmission path. As it is basically not possible to find the incorrect bits (eg the PID could also be affected), the errored packet must not be processed any further.

The occurrence frequency of a set transport error indicator is no measure for the bit error rate on the transmission path. The set transport error indicator shows that the quality of the transmission path is not sufficient for an error–free transmission despite error control coding. A slight drop in transmission quality will already quickly increase the occurrence frequency of a set transport error indicator and transmission will not take place.

Transport Stream (TS)

The transport stream is a multiplex data stream defined by *MPEG2* which may contain several programs that may consist of several e*lementary streams.* A program clock reference *(PCR)* is carried along for each program. Multiplexing is by forming *TS packets* for each elementary stream and by stringing together these TS packets originating from different elementary streams.

TS Header

The TS header is provided at the beginning of each *TS packet* and has a length of four bytes. The TS header always begins with the *sync byte* 0x47. Further important elements are the *PID* and the *continuity counter.* The TS header must never be scrambled when it is to be transmitted (see *Conditional Access*).

TS Packet

The *transport stream* is transmitted in packets of 188 bytes (after *channel coding* 204 bytes). The first four bytes form the *TS header* which is followed by the 184 useful bytes.

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