User Manual

Tektronix

DVT200
Digital Video Transmitter

070-9953-01

CE

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Tektronix, Inc., P.O. Box 1000, Wilsonville, OR 97070–1000

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To write us	Tektronix, Inc. P.O. Box 1000 Wilsonville, OR 97070-1000

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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.

The common terminal is at ground potential. Do not connect the common terminal to elevated voltages.

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 is divided into six sections. The sections contain the following information:

- Section 1 provides information about preparing the DVT200 Digital Video Transmitter for first-time use. The section contains descriptions of the front- and rear-panel controls and connectors. It also contains information about powering on the instrument.
- Section 2 describes the basic operation of the instrument using manual controls. This section also provides detailed descriptions of each of the menus and associated submenus.
- Section 3 has information about remotely operating the digital video transmitter. This section describes how to switch the instrument to remote operation and quickly set the basic functions. It also discusses the structure and syntax of bus messages, device-dependent messages, commands, responses, and queries. It also lists the commands associated with the various subsystems.
- Section 4 lists the basic maintenance that an operator can perform and describes how to replace the battery.
- Section 5 contains the following appendices:
  - Appendix A provides specifications, certifications, and compliances for the DVT200.
  - Appendix B contains information about the IEC/IEEE bus interface.
  - Appendix C lists the possible error messages that you may encounter while using the digital video transmitter.
  - Appendix D lists all the commands that can be used to remotely operate the digital video transmitter.
  - Appendix E provides example programs of remote operation.
- Section 6 is the index.

Preparation for Use

This section discusses general instructions on the preparation for use and the operation of the DVT200 Digital Video Transmitter. It contains brief explanations of the controls and connectors on the front and rear panels. This chapter also provides instructions on putting the digital video transmitter into use for the first time.

Legends for Front and Rear View

The controls and indicators of the DVT200 Digital Video Transmitter are combined into color-coded functional groups. The individual groups of control elements are described in Table 1–1 (front panel) on page 1–2 and Table 1–2 (rear panel) on page 1–4.

Front Panel

Front view of DTV 200

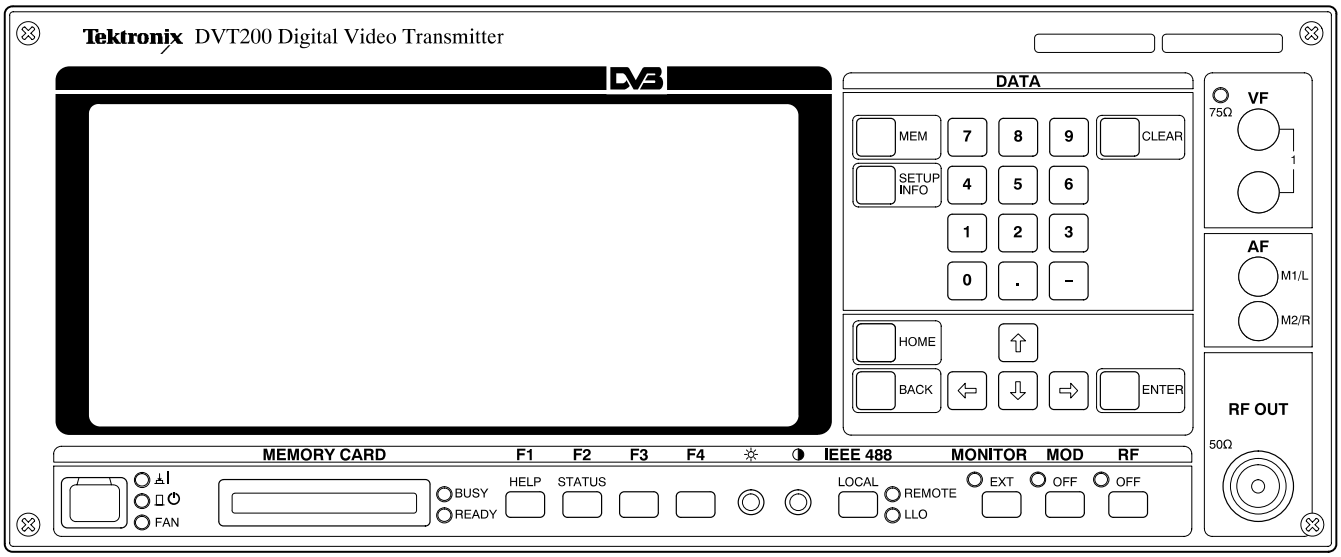


Table 1–1: Legend for front view

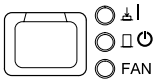
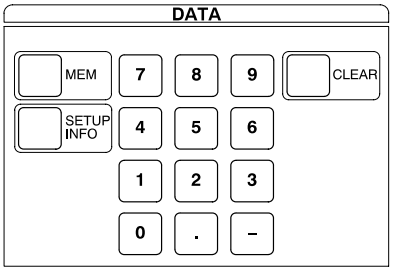
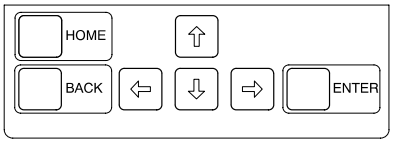
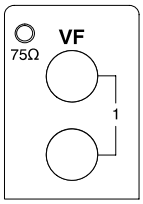
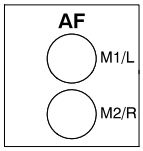
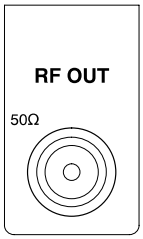
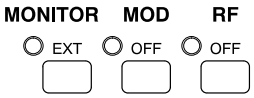
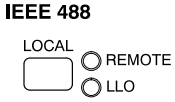
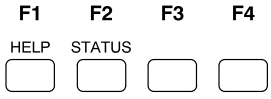
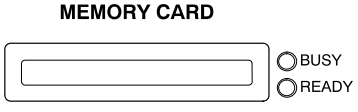
Controls/connectors	Description	
	**POWER**	Switching on the digital video transmitter ON — LED green; lights if digital video transmitter is switched on STANDBY — LED yellow; lights if digital video transmitter is in standby mode FAN — LED red; lights if fan is not running
	**DISPLAY**	The digital video transmitter has an LCD display with CGA mode for menu display with a resolution of 640 × 200 pixels.
	**DATA**	Keyboard for numeric data entry. Entry is terminated with the ENTER key. MEM — Operation of MEMORY CARD, memory management SETUP INFO — In the associated menu displayed on the screen basic settings can be made, (for example, the definition of interfaces). CLEAR — Reset of numeric entries.

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

Controls/connectors	Description	
	**CURSOR KEYS**	The cursor keys are used for menu-guided operation and for stepwise variation of data variables. An entry is terminated with the ENTER key.
	**VF**	These connector locations are for future use.
	**AF**	These connector locations are for future use.
	**RF OUT**	RF N female connector, 50 Ω
	**MONITOR** **MOD** **RF**	Switchover key for LCD display/external monitor Modulation ON/OFF key RF ON/OFF key
	**IEEE 488**	With IEEE-bus operation, the LOCAL key switches to local (front-panel) control unless this is inhibited by local lockout. Local lockout status is indicated by the LLO LED. IEEE-bus operation is indicated by the REMOTE LED.
	**F1 to F4**	F2 shows all the set values in a menu. F3 through F4 are function keys that are assigned to varying functions.
	MEMORY CARD	Memory to PCMCIA standard with 68-pin connector. The instrument settings can be stored on the MEMORY CARD and recalled.

Rear Panel

Rear view of DVT200

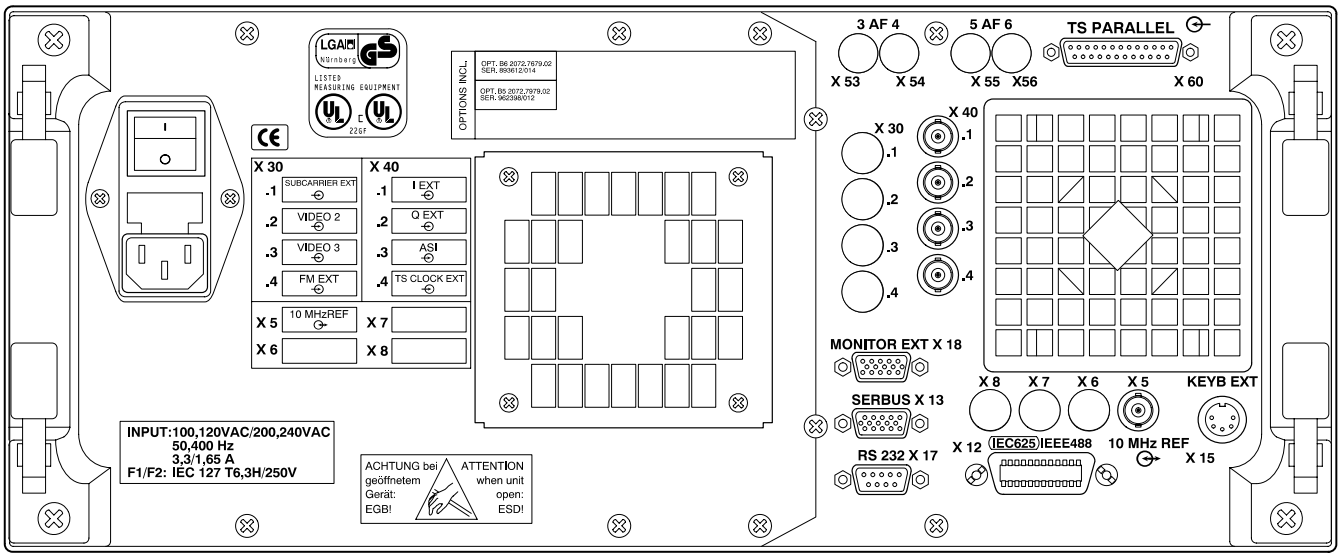
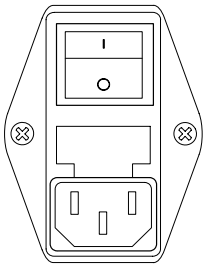
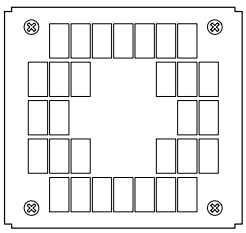
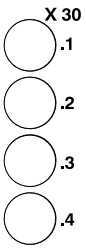
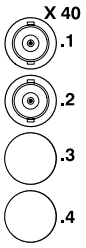
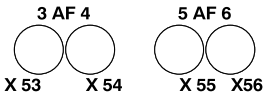
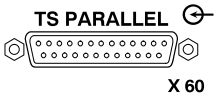
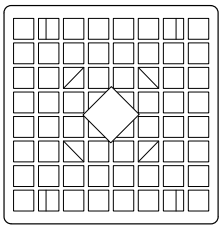


Table 1–2: Legend for rear view

Connectors	Description	
	**AC SUPPLY CONNECTION**	Power switch Fuses AC supply connector X1 100/120 V : IEC127-T3.15L / 250 V 220/230 V : IEC127-T1.6L / 250 V The correct AC supply voltage is selected automatically.
	**FAN 1**	Brings cooling air into the instrument

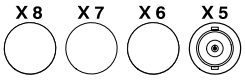
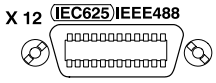
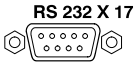
CAUTION. *To prevent overheating, do not block the airflow of the fan.*

Table 1–2: Legend for rear view (cont.)

Connectors	Description	
	**X 30**	These connector locations are for future use.
	**X 40**	.1 I EXT input for external signals .2 Q EXT input for external signals .3 If the INPUT INTERFACE option (Option B6) is fitted, this connector is used as an input for the ASI and ASI EXT. CLOCK transport streams. .4 If the INPUT INTERFACE option (Option B6) is fitted, this connector is used as an input for the ASI EXT. CLOCK and SPI EXT. CLOCK signals. If jumper X8 on the INPUT INTERFACE module is connected in position 1-2 (factory setting), the clock signal applied is the output bit clock of the module. If the jumper is connected in position 2-3, an output byte clock is applied.
	**AF**	These connector locations are for future use.
		X 60 Input for MPEG Parallel Transport Stream If fitted, the optional INPUT INTERFACE (option B6) serves as a transport stream input for SPI, SPI EXT. CLOCK, and TS PARALLEL (See *Synchronizing the Data Rate to an External Clock* on page 1–12 for more information.)
	FAN 2	Exhausts air

CAUTION. *To prevent overheating, do not block the airflow of the fan.*

Table 1–2: Legend for rear view (cont.)

Connectors	Description		
	**KEYB EXT**	An external keyboard allows for manual control of all instrument functions. In addition, any alphanumeric entries can be made in the appropriate menus.	
	**X 5 to X8**	X5	10-MHz reference, input/output
		X6	This connector location is for future use.
		X7	This connector location is for future use.
		X8	This connector location is for future use.
	**IEC625/IEEE488 X 12**	IEC/IEEE-bus connector (refer to *Remote Control)*	
	**MONITOR EXT X 18**	Monitor connector, female	
	**SERBUS X 13**	SERBUS connector, female	
	**RS 232 X 17**	RS-232 connector, female	

Accessories

The DVT200 Digital Video Transmitter is shipped with several standard accessories. These accessories and any recommended or optional accessories are described below.

Standard Accessories

The following accessories are included with this product:

- User manual, this manual (070–9953–01)
- Power cord: North America (161–0066–00)
- MS-DOS manual

Optional Accessories

The DVT200 has a number of optional accessories that you can order:

- Service maual (2072.6489.22–02)
- 50 Ω to 75 Ω type N matching pad (RAZ)
- 75 Ω type N (male) to type BNC (female) adaptor for use with matching pad (103–0413–00)
- 50 Ω type N (male) to type BNC (female) adapter (103–0045–00)
- 50 to 75 Ω type N (male) to type BNC (female) 10–1000 MHz transformer (120–1884–00)
- LVDS MPEG parallel shielded cable (174–3562–00)
- 75 Ω, RF BNC–BNC cable, 42 in (012–0074–00)
- 75 Ω, RF BNC–BNC cable, 72 in (012–0074–02)
- 50 Ω, RF N–N cable, 72 in (012–0114–00)
- 50 Ω, RF BNC–BNC cable, 42 in (012–0057–01)
- 50 Ω, RF BNC–BNC cable, 72 in, (012–0113–00)
- Rackmount adapter for a 19 in. rack (ZZA94)
- North American Power Cord, 250 V/10 A (161–0066–12)
- Swiss Power Cord, 240 V/6 A (161–0154–00)

Options

The following options are orderable when you purchase the DVT200:

- Option B5. Noise Generator
- Option B6 Input Interface
- Option 1R. Rackmount adapter for a 19 inch rack

Power Cord Options. If you do not specify a power cord option, the demodulator is shipped with a North American 125V power cord. The following power cord options are available when purchasing your DVT200 Digital Video Transmitter:

- Option A1. Power, Universal Europe, 220 V/16 A (Locking Power Cord) (161–0066–09)
- Option A2. Power, United Kingdom, 240 V/15 A (Power Cord)
- Option A3. Power, Australia, 240 V/10 A (Power Cord) (161–0066–11)

Putting into Operation

Refer also to Legends for *Front and Rear View* on page 1–1.

Prior to putting the instrument into operation, make sure that the following conditions are met:

- The instrument is connected to the correct AC supply voltage (refer to *AC Supply Connection on* page 1–4).
- The signal levels applied to the inputs do not exceed permissible limits.
- The instrument is operated within the permissible ambient temperature range (+5° C to +45° C).
- The fan at the rear of the instrument is not obstructed (to prevent overheating of the unit).
- The outputs of the instrument are not overloaded or connected incorrectly.

CAUTION. *To prevent damage to the instrument, do not exceed the specified input voltages or output load impedances (refer to the data sheet packaged with your instrument).*

Positioning the Instrument

The instrument is equipped with feet that can be folded out at the instrument front to facilitate operation. To do so, lift up the instrument at the front and swing down the feet.

The instrument is constructed so that its operating temperature remains sufficiently low even in continuous operation. When the unit is used as a benchtop, make sure that the air vents are not obstructed to prevent the instrument being overheated – especially during continuous operation. Sufficient ventilation must also be ensured when the unit is rackmounted.

EMC Safety Precautions

To prevent electromagnetic interference, the instrument must be operated closed and with all screening covers installed. Take the appropriate measures when calibrating the open instrument. Make sure that only suitable, screened IEC/IEEE-bus cables are used.

Connecting the Instrument

This section discusses the connectors you can use to interface the digital video transmitter to other equipment. For locations of these connectors, refer to Table 1–1 on page 1–2 for front-panel connectors or Table 1–2 on page 1–4 for rear panel connectors.

AC Supply Connection

The instrument may be operated at 90 to 132 V AC and 187 to 264 V AC at frequencies from 47 Hz to 440 Hz. The AC supply connector is at the rear of the unit. The instrument automatically sets itself to the applied voltage by selecting one of the two voltage ranges. Adjusting the instrument to a particular AC supply voltage is not required.

When the instrument is switched off, an “O” is visible above the power switch. The instrument need only be switched off when it is to be completely disconnected from the AC supply.

RF OUT Connector

The RF output provides signals between 0.3 MHz and 3.3 GHz.

In the SETUP/PRESET menu, the units dBm, dBµV or mV can be selected for RF LEVEL entry.

BNC Connectors X5 and X7

X5: 10 MHz REF input or output; X7: Q AUX 300 MHz, output.

External Monitor

Multisync VGA monitors with 32-kHz horizontal frequency are suitable for connection to this connector. The resolution of the display is CGA.

SERBUS Interface

In a system comprising a digital video transmitter system extension, the SERBUS connector and the mating connector of the extension are linked by a special cable. No extensions are currently available.

RS-232 Interface

For data transmission and remote control from a detached PC, the two RS-232 connectors are linked by a cable.

Keyboard Connector

A standard PC keyboard may be connected to the 5-contact keyboard connector.

The functions of the digital video transmitter front-panel keys correspond to those of an external keyboard with the exceptions indicated in Table 1–3.

Table 1–3: Keyboard equivalents

DVT200 Front panel key	External keyboard equivalent
HOME	Ctrl + B
BACK	Esc
MEM	Ctrl + M
SETUP INFO	Ctrl + F
CLEAR	Ctrl + E
RF OFF	Ctrl + G
MOD OFF	Ctrl + Y
MONITOR EXT	Ctrl + J
IEEE 488 LOCAL REMOTE LLO	Ctrl + L

Synchronizing the Data Rate to an External Clock

The data rate of MPEG2 transport stream packet can be presented in different ways using the DVT200 Digital Video Transmitter:

- The internal PRBS or NULL TS PACKETS are modulated and determine the clock and symbol rate. In this case, the internal free-running VCO is used for clock generation. Free-running does not necessarily imply high accuracy.
- An external MPEG2 data stream synchronizes the DVT200 clock via the TS PARALLEL interface. In this case, the data clock and symbol clock are as accurate as the applied signal.
- With its crystal-controlled clock, the INPUT INTERFACE (Option B6) determines the data rate of PRBS and NULL TS PACKETS.

Often, neither an MPEG2 data stream nor the INPUT INTERFACE is available. In order to guarantee the data and symbol rates for the internal PRBS and NULL TS PACKETS, use an external sinewave generator of acceptable accuracy, using the procedure described in the remainder of this section.

Firmware and Adapter Cable

If you are going to synchronize the data and symbol rates using an external sinewave generator, the firmware version of the DVT200 must be version 1.4 or higher. You must also use an adapter cable. Use the following procedure to create the adapter cable:

1. Solder the outer conductor of a 75 Ω BNC cable to pin 14 of a 25 pin, D-type connector as shown in Figure 1–1.

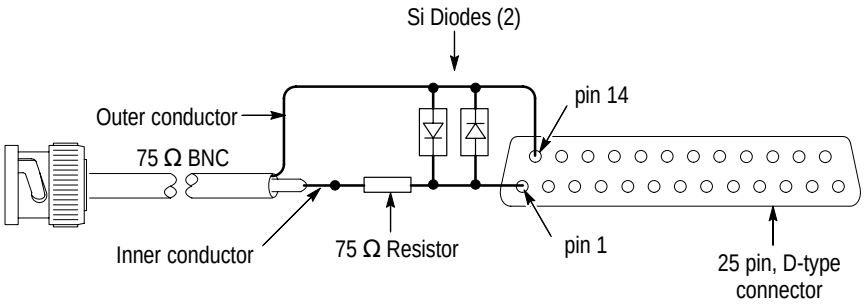


Figure 1–1: Adapter cable solder contacts

2. Solder a 75 Ω resistor to the inner conductor of the BNC cable, and then solder this to Pin 1 of the 25 pin, D-type connector. The resistor acts as a 75 Ω termination.

3. Create a bridge between Pin 1 and Pin 14 using two anti-parallel Si diodes (1N14448 or similar). See Figure 1–1. These two diodes limit input voltages to less than $1.4V_{p-p}$.

NOTE. *The sinewave amplitude from the sinewave generator should be within the limits* $1.4V < V_{p-p} < 3V$.

A DC voltage offset must not be present.

The adapter cable is then used to connect the output of the sinewave generator to the TS PARALLEL input on the rear-panel of the DVT200 (pin1 is clock input, pin 14 is grounded).

Calculating the TS Data Rate Frequency

Use the following equation to determine the external clock frequency so that the DVT200 can lock to the input.

$$f_{Generator} = f_c/8$$

Where: $f_{Generator}$ is the sinewave frequency, and
f_c is the cable clock rate

So, for a cable clock rate (f_c) of 38.152941 Mbit/sec (6.9 Msym/sec with 188 byte input packets), the sinewave setting needs to be

$$f_{Generator} = 38.152941/8 = 4.7691176\ Mbit/sec$$

After the DVT200 has synchronized to the applied clock, FRMERR (Frame Error) will be displayed in the status bar field. This message signifies that a clock is being applied to the TS PARALLEL interface but that the MPEG2 TS data are invalid or not packetized and not provided with the SYNC WORD. To modulate the TS packest with a valid sync word, use the following procedure:

1. Select the I/Q Coder menu.
2. Press F3 ACCEPT.
3. Select NULL TS PACKETS as the modulation source.

The DVT200 will now generate and modulate TS packets in QAM or QPSK with a valid sync word (47 hex) using the data rate determined by the sinewave generator.

Switching On

The instrument is switched on by pressing the power switch at the rear and the POWER key at the front panel.

For a temporary switch-off, the STANDBY mode is selected by pressing the POWER key.

Adjusting Screen Contrast and Brightness

The brightness is adjusted with the left control (***1***), and the screen contrast is adjusted with the right control knob (***2***).

Nonvolatile Memory

If the lithium battery in the instrument is discharged, settings can no longer be stored in the nonvolatile memory. To replace the battery refer to *Replacing the Lithium Battery* on page 4–3.

Memory Card

When using a memory card (PCMCIA or PC card refer to the same thing), observe the following precautions:

- Prevent dust from entering the connecter holes, since dust can damage the connectors or cause faulty contact with the spectrum analyzer.
- Do not insert anything into the memory card connector holes, such as a metal pin or needle, since this can cause damage from static electricity.
- Do not bend the memory card or subject the memory card to physical shock.
- Protect the memory card from moisture, extreme temperatures, and direct sunlight.

Plug in the memory card fully. After the memory card is installed, the green READY LED lights.

CAUTION. *To prevent loss of data, do not remove the memory card while the yellow BUSY LED is lighted.*

You can write protect most memory cards. This prevents someone from accidently losing your data by formatting the memory card or overwriting files that you want to save. If present, the write-protect switch is on the edge of the card opposite the connector (see Figure 1–2 on page 1–15).

To write protect a memory card, move the switch tab towards the edge of the card. When write protection is on, the digital video transmitter cannot write data to the memory card.

To turn off the write protection, move the switch tab towards the middle of the card. When the write protection is off, the digital video transmitter can write data to the memory card.

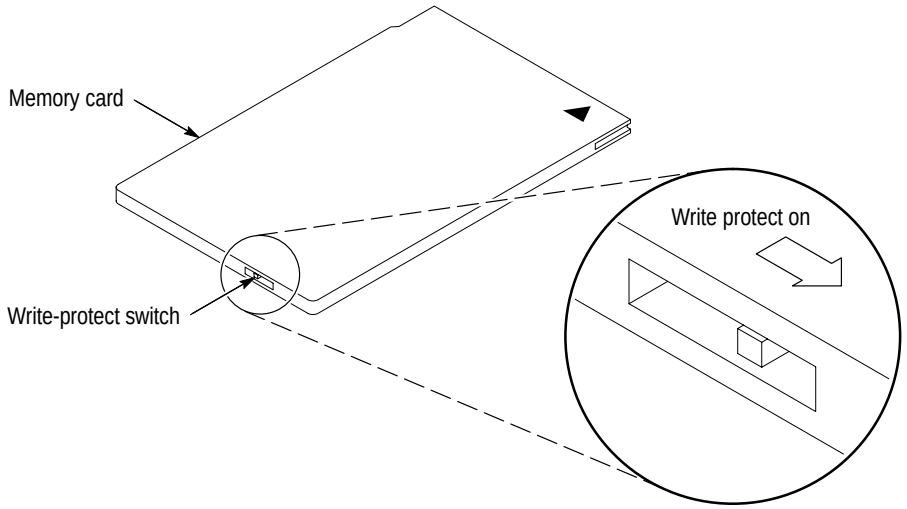


Figure 1–2: Write protect switch on memory card

The following types or memory cards may also be used:

Intel series1:	**AMD series A:**	**TI series I:**
iMC001FLKA	AmC001AFLKA	TMS28F010A 1MBIT
iMC002FLKA	AmC002AFLKA	
iMC004FLKA	AmC004AFLKA	
Intel series2:	**AMD series B:**	**SST flash chips:**
iMC004FLSA	AmC002BFLKA	
iMC010FLSA		
iMC020FLSA		
Intel series2+:	**AMD series C:**	**Atmel:**
iMC004FLSP	AmC002CFLKA	AT29C010
iMC020FLSP	AmC004CFLKA	AT 29C040
iMC040FLSP	AmC010CFLKA	
Intel ATA:		
iFD005P2SA		
iFD010P2SA		

Manual Control

Basic Operation

Front Panel

Operation of the DVT200 Digital Video Transmitter is started by selecting an opening menu with the cursor keys on the front panel and then pressing ENTER for confirmation.

Using these keys, you can display operating menus where you can make the required instrument settings. Submenus are used for more complex settings.

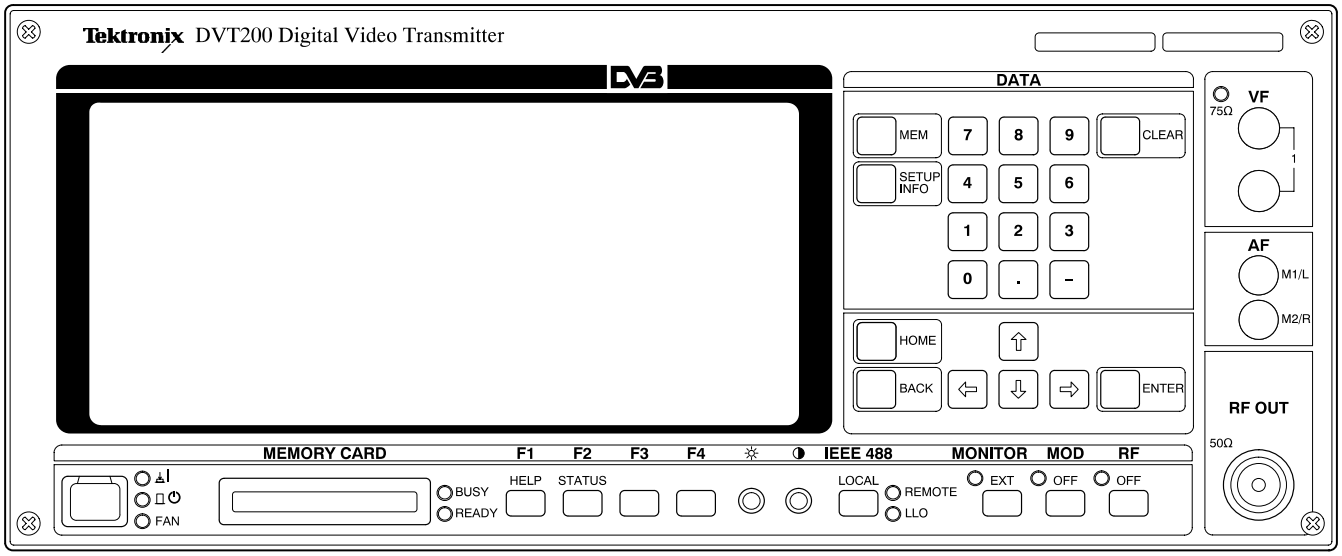
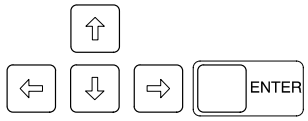


Figure 2–1: Front panel

Table 2–1: Front-panel interface elements

Graphic column	Text column
	Menu items can be selected and parameters varied using cursor keys ↑ and ↓. Numeric entries are confirmed with the ENTER key.
	The currently displayed menu can be quit by pressing the MEM key or the SETUP/INFO key, which opens up the corresponding menus.

External Keyboard

The instrument can also be operated from an external keyboard. Operating menus are displayed in the same way as on the front panel, using the cursor keys and the ENTER key. The ESC and HOME keys cause a return to the previous menu or to the initial menu. Numerals are entered via the numeric keypad or varied using the cursor keys.

Switch-On Procedure

Upon switch-on, a program is triggered for testing and initialization of the instrument. The program tests the hardware configuration and initializes the individual modules. Set parameters of the remote-control interface are displayed in bottom half of the screen. In the case of a fault, an error message is displayed with information about the defective unit.

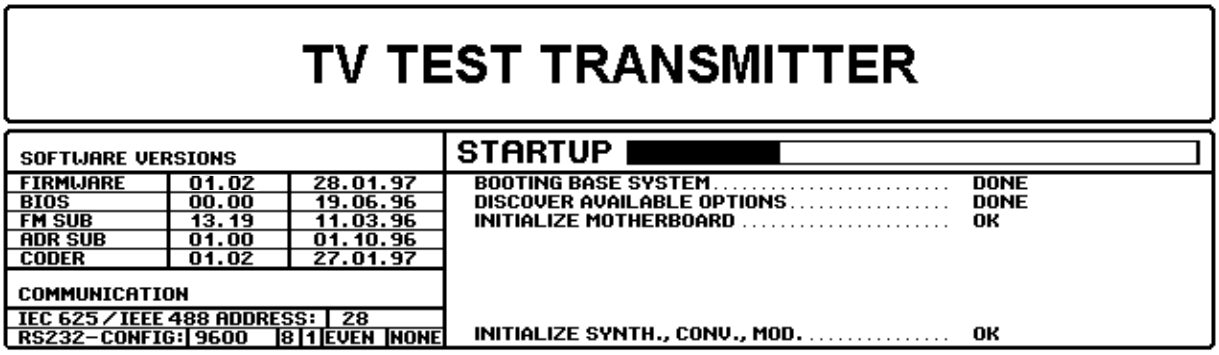


Figure 2–2: Startup menu

While the startup screen is displayed , default values can be called up using key F2 = RESET. See Figure 2–2.

***NOTE**. If the external monitor is selected (see page 1–3), the* STARTUP *screen on the DVT200 Digital Video Transmitter will be blank during the power up sequence.*

When the menu for selecting individual parameters is opened, a status field with the main parameters is displayed at the top of the menu. Below the status field, the menu displays the selection fields for instrument settings: FREQUENCY, RF LEVEL, MODULATION, I/Q CODER, *BASEBAND* and SPECIAL. See Figure 2–3. These fields comprise areas for the display of important operating states. Selection of one of the setting fields opens up a submenu holding further parameters to be entered, either in an EDIT window or selected from an additional list.

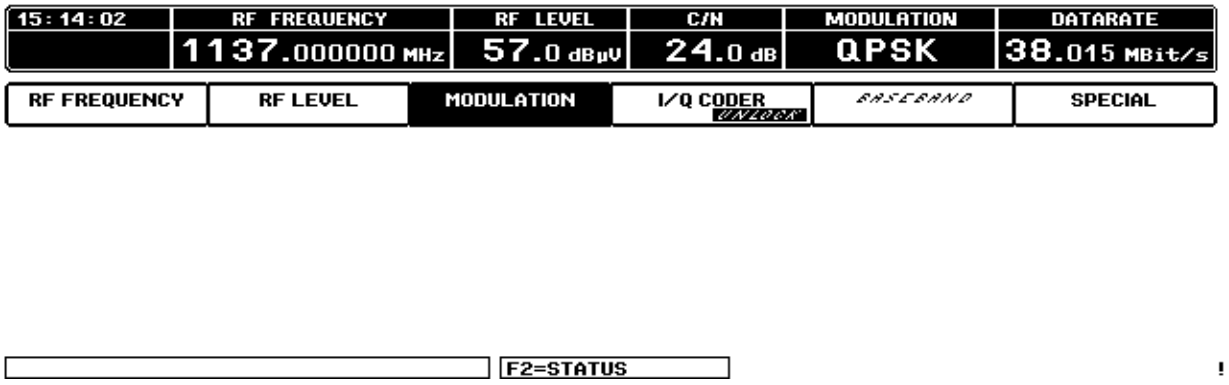


Figure 2–3: Menu selection

NOTE*. While the DVT200 Digital Video Transmitter has an internal symbol clock generator (used when an external MPEG transport stream is not present), this internal symbol clock generator has high jitter and should not be used when testing receivers. Therefore, always use an MPEG transport stream generator, such as the MTS100/200 series or the MTG200.*

To ensure that the DVT200 locks to an acceptable signal, always use the following procedure as part of the switch-on procedure:

4. Select the I/Q Coder menu.

- **a.** Press the right arrow cursor key until IQ CODER is selected.
- **b.** Press ENTER.

5. Select the Input Data Rate submenu.

- **a.** Press the down arrow cursor key until INPUT DATA RATE is selected.
- **b.** Press ENTER. The display should look similar to Figure 2–4.

6. Press F3 = ACCEPT.

The DVT200 will lock to the measured data rate of the incoming signal.

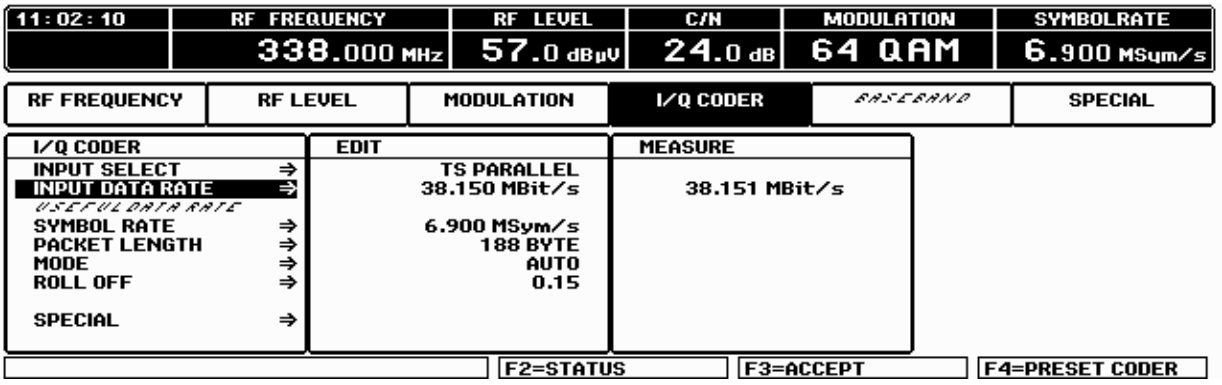


Figure 2–4: I/Q Coder menu at switch-on

Fundamentals of Operation

Operating menus resemble pull-down menus,in that the submenus do not obscure parent menus. This way, the complete path and all menu items are visible and accessible from the top level of the menu heirarchy down.

Selection within a menu or submenu is made by using the cursor keys. The selected field is either marked by a dark background or an arrow. The selection is confirmed with the ENTER key. After this, the operator is in the submenu, where he proceeds in the same way, or in the final EDIT window.

In the EDIT window numerals can be entered via the numeric keypad. To ensure fast operation, the physical unit is preset and, except for the level, it cannot be changed.

Entry of numerals is also confirmed with the ENTER key, irrespective of the set unit. Entered numbers can be cancelled using the CLEAR key.

In the EDIT field, values can also be modified using the cursor keys. To do so, set the cursor to the digit to be varied and increment or decrement using the cursor keys. This operation can also be carried out repetitively by pressing the cursor key continuously. The parameter takes on the entered value immediately. The number entered is limited by corresponding minimum and maximum values.

Table 2–2 shows the controls used to move between menus or to return to the normal operating menu.

Table 2–2: Menu controls

Control	Action
BACK	Pressing the BACK key causes a return to the previous menu level.
HOME	Pressing the HOME key causes a return to the initial menu, irrespective of how many submenus are open.
MEM SETUP INFO	Further selection menus can be called up directly by pressing the MEM key, SETUP/INFO, or STATUS (**F2**), provided the operator is not in an EDIT window. Pressing HOME causes a return to the normal operating menu.

Menu Operation

RF FREQUENCY Menu

The RF FREQUENCY menu has three choices; each of these is discussed in the following text.

FREQUENCY. In this menu (see Figure 2–5), the digital video transmitter output frequency can be set. The unit of the set frequency is always [MHz].

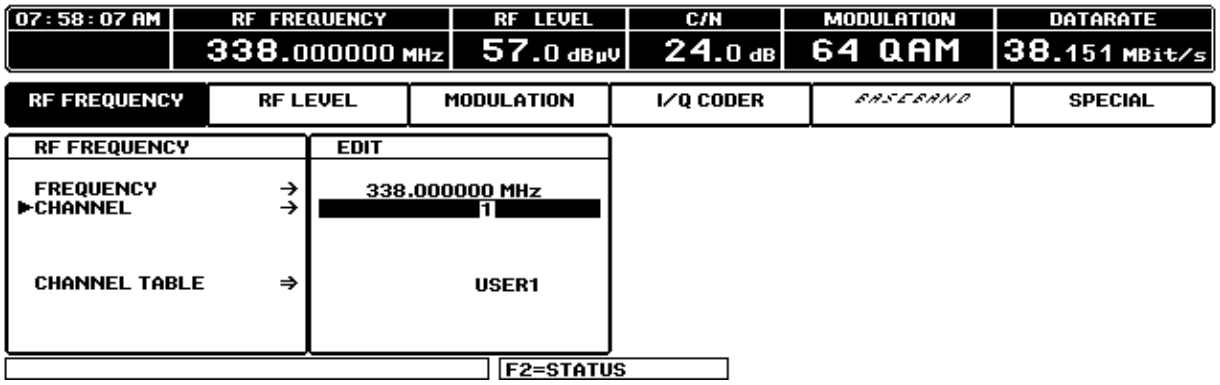


Figure 2–5: RF frequency menu

The frequency can be entered by using the cursor keys to select FREQUENCY and then pressing ENTER. The operator is then in the EDIT window where the frequency value can be entered directly using the numeric keypad. When the entered value is confirmed with ENTER, the frequency change is immediately effected. The frequency in the EDIT window can also be varied using the cursor keys. In this case, the new value is set after each stroke of the cursor key.

Frequencies between 0.300 and 3300.000 MHz can be set.

The resolution of the frequency entry can be increased to 1 Hz in the setup menu (from .000 MHz to .000000 MHz).

CHANNEL. The frequency can be set indirectly using a channel table. In this case, the channel number is entered directly or the channels are selected one after the other with the aid of the cursor keys. The channels of the selected table are used.

A table contains a maximum of 100 channels (1 to 100).

Only channels to which a frequency has been assigned can be selected (refer to *SETUP / INFO Menu* on page 2–37).

CHANNEL TABLE. In this menu (see Figure 2–6), the channel table associated with the channel entry is selected. Either NONE or one of five available tables can chosen (USER1 to USER5). Tables can be prepared by the user in the SETUP menu and assigned a name with a maximum length of six characters.

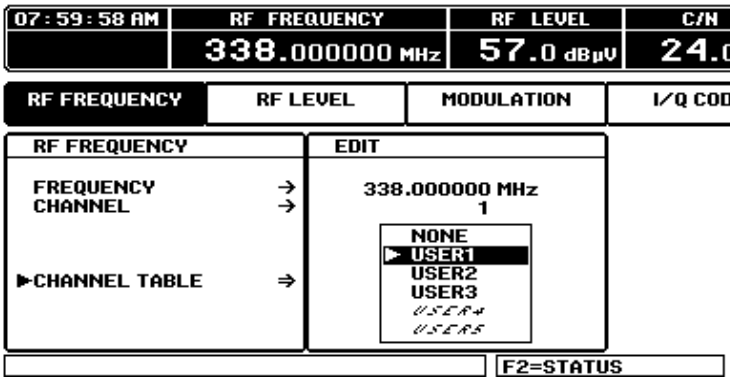


Figure 2–6: Channel table menu

RF LEVEL Menu

In the RF LEVEL menu (Figure 2–7), the following parameters can be selected and set:

- RF LEVEL
- RF LEVEL MODE
- RF ALC MODE

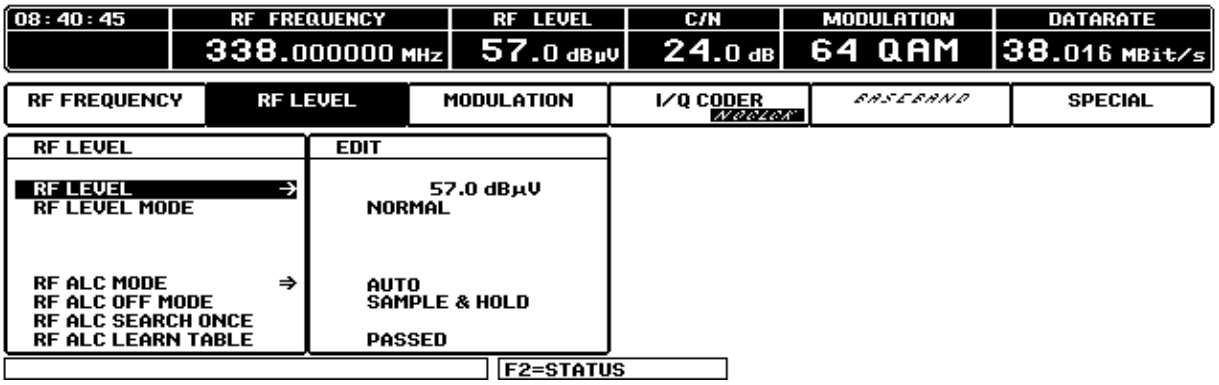


Figure 2–7: RF LEVEL menu

RF LEVEL. When **RF LEVEL** is selected, the new level can be set in the EDIT window by using the numeric keypad and then pressing the ENTER key.

It is also possible to place the cursor in the EDIT window on a digit of the currently set level and to vary the value using the up and down keys. The level change is immediately effective.

NOTE. *The level unit dBm, dBu V or mV is preselected in the SETUP menu. The RF OFF status is indicated in the selection field below RF LEVEL.*

- RF LEVEL MODE. See Figure 2–8. With RF LEVEL MODE selected (Figure 2–8), switchover between the NORMAL and CONTINUOUS operating modes is possible using the ENTER key.

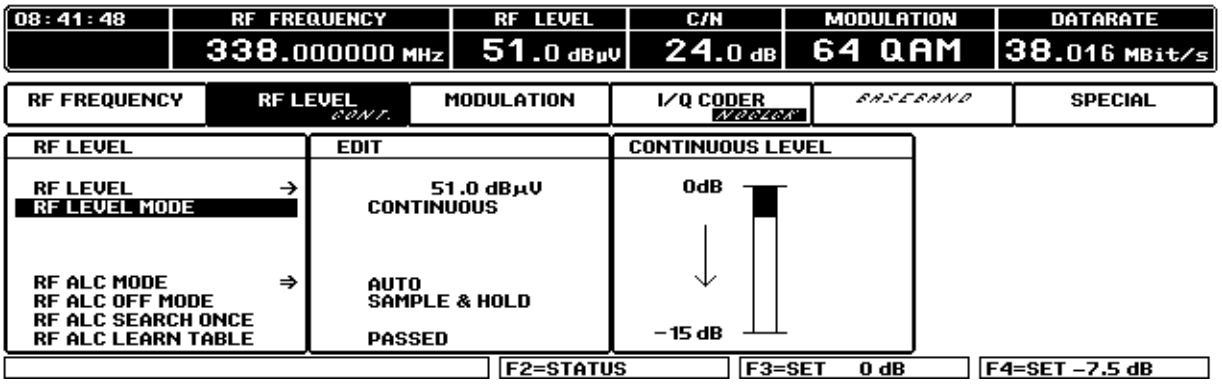


Figure 2–8: RF LEVEL MODE menu

NORMAL. In the NORMAL mode the RF level is set using an internal attenuator and electronic setting circuits. The attenuator setting is in 5 dB steps.

CONTINUOUS (uninterrupted level setting). In the CONTINUOUS mode, the RF LEVEL is set without a break in a 15 dB range. Electronic setting is used instead of the switching attenuator. The current RF LEVEL can be set to a starting value using key F3 = SET 0 dB from which the RF level can be reduced.

Using key F4 = SET –7.5 dB, the RF LEVEL can be set to the center of the CONTINUOUS LEVEL range (– 7.5 dB).

RF ALC MODE (switching internal ALC on/off). See Figure 2–9. In the RF ALC MODE menu, ALC can be switched off for certain applications. With CW, ALC is normally switched on. For vector and digital modulation, ALC must be switched off. In this case, a selection can be made between SAMPLE & HOLD and TABLE.

ALC is preset to AUTO. In this mode, level control is automatically adapted to the operating conditions. For certain applications, ALC can be fixed to the OFF or ON condition. OFF (level control off) should be selected when the intermodulation suppression is to be improved in the CW mode. ON (level control on) should be selected in case of vector or digital modulation with constant envelope. See Figure 2–9.

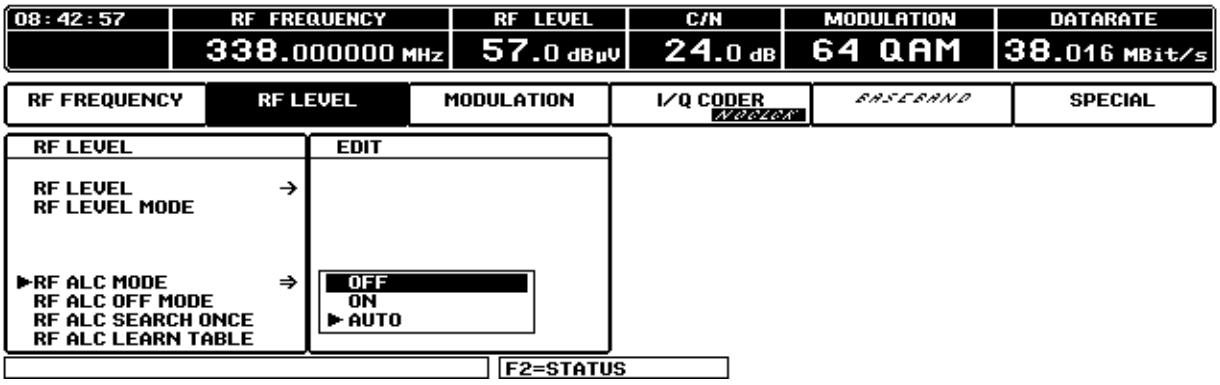


Figure 2–9: RF ALC MODE menu

In the SAMPLE & HOLD mode, the level is recalibrated after each level and frequency setting. To do this, the CW mode is selected for a brief period, ALC is switched on and the level control element is set to the value obtained. When this calibration is disturbing, the TABLE mode can be selected (level control voltage selected from a table). In this mode, level correction values are taken from a table each time the frequency or level is changed. The table can be regenerated with the aid of the LEARN TABLE function without using additional measuring instruments.

Menu items: RF ALC MODE	
RF ALC MODE –>	
OFF	Internal level control switched set to SAMPLE & HOLD or TABLE by the RF ALC OFF MODE selection.
ON	Internal level control permanently switched on.
AUTO	Normal mode. Level control is automatically adapted to operating conditions.
RF ALC OFF MODE	
SAMPLE&HOLD	Level recalibration in the ALC OFF mode after each level or frequency change.
TABLE	Correction values for level setting are taken from a table in the ALC OFF mode.
RF ALC SEARCH ONCE–>	Brief manual switch-on of level control for level calibration in the ALC OFF SAMPLE & HOLD mode.

Menu items: RF ALC MODE	
RF ALC LEARN TABLE –>	Regeneration of correction values for function ALC OFF MODE –TABLE (level control voltage taken from table).
RF OFF	The RF output signal is switched on and off with the RF ON / OFF key. This has no effect on the current menu. When the output signal is switched off, *RF OFF* is displayed in the RF LEVEL window. The off state is also signaled by an LED.

Resetting the overload protection. The DVT200 Digital Video Transmitter is protected against overloading through an externally applied RF signal. If the external signal is too high, the overload protection responds. This status is signalled by *RF OFF* displayed in the status line of the RF LEVEL selection window and by an LED.

The overload protection can be reset by pressing the RF ON /OFF key.

The RF output of the digital video transmitter is also protected against external DC by a DC BLOCK of up to 50 V.

MODULATION Menu

In the DVT200 Digital Video Transmitter, vector modulation can be selected for QPSK, QAM, and I/I/Q EXTERNAL. See Figure 2–10.

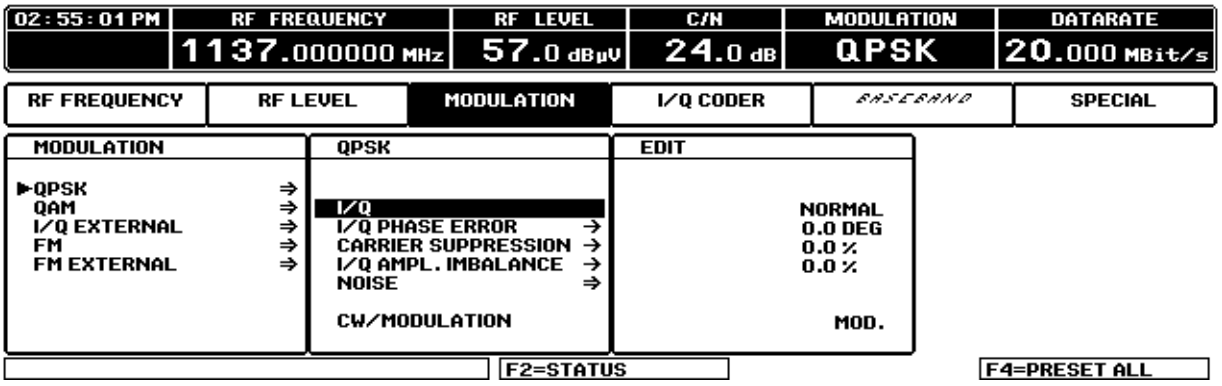


Figure 2–10: Modulation menu

MODULATION. External modulation sources. An external parallel input for the connection of an external data source, such as an MTG 200 MPEG Test Generator, is provided for I/Q vector modulation QPSK and QAM**.**

- I/Q inputs. The nominal voltage for external vector modulation at the I/Q inputs is V = 0.5 V_{peak}. The input impedance is 50 Ω (for more details refer to *I/Q Vector Modulation* on page 2–11).

External broadband AM is possible via the I input. The input sensitivity is 0.35 V for 100% AM.

- [MOD ON/OFF] key. The different types of modulation can be switched directly using the MOD ON/OFF key or via the modulation menus. Modulation off is indicated by *OFF* in the status line in the MODULATION selection window and also by an LED.

I/Q Vector Modulation. In the QPSK and QAM modulation modes the modulation signals for complex RF carrier modulation are applied by the internal I/Q coder to the I and Q inputs of the vector modulator.

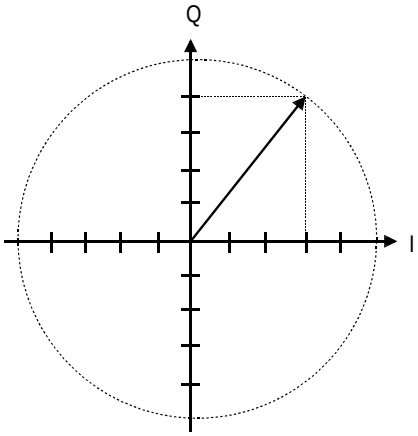


Figure 2–11: Vector modulation.

- External modulation signals. In the I/Q EXTERNAL mode the modulation signals are applied via the rear I and Q inputs.
- Vector modulation. The vector sum of

  $$\sqrt{I^2+Q^2} = 0.5\,V_{peak}$$

  corresponds to the modulation level. To avoid overdriving of the I/Q modulator, the vector sum should not exceed 0.5 V.

***NOTE**. The selectable auto calibration of the I/Q modulator allows accurate and reproducible measurements to be made. The calibration routine should be called up before measurements or after temperature variations of more than five degrees. Select the routine in the SETUP-HARDWARE CALIBRATION menu.*

Menu items: QPSK	
I/Q	Selection of normal or changed I/Q modulation. Change of I and Q signals causes the modulation sidebands to be inverted.
NORMAL	Normal I/Q modulation
CHANGED	I and Q signals changed
I/Q PHASE ERROR →	Entry of phase error
CARRIER SUPPRESSION →	Entry of residual carrier
I/Q AMPL. IMBALANCE →	Entry for unequal modulation of I and Q vectors
NOISE	Entry for C/N, Bandwidth, and Noise Generator option

Noise. If you have Option B5 installed (Noise Generator) this submenu is available. Use the submenu shown in Figure 2–12 to set the C/N and bandwidth values, and to turn the noise generator on or off.

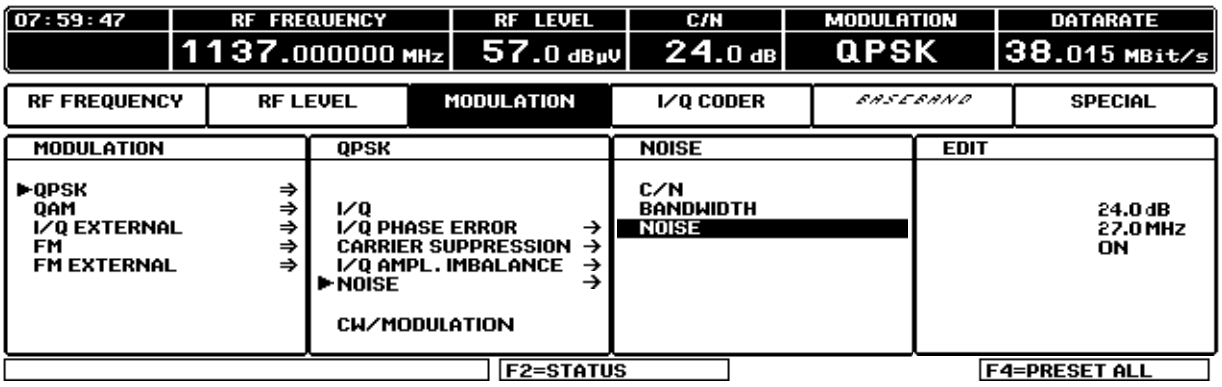


Figure 2–12: QPSK: Noise submenu

- **C/N.** This menu item is used to set the carrier-to-noise ratio. The unit is dB, with a resolution of 0.1 dB.

  The effective power of the I/Q-modulated carrier is taken as the carrier power. The noise power is determined by the given noise power density, the bandwidth depends on the set receiver bandwidth. (To limit the bandwidth of hte noise power, filters are switched in the DVT200.)

  The set receiver bandwidth is used for calculating the C/N ratio.

  Since the bandwidth of the noise signal generated by the DVT200 is in any case wider than the set receiver bandwidth, realistic conditions can be simulated.

The C/N ratio is calculated using the following formula:

$$\frac{C}{N} = C - N$$

$$N = Noise\ marker \cdot 10log(BW)$$

Where:

C = rms carrier power in dBm

N = rms noise power in dBm

Noise marker = rms noise power density in dBm/Hz

BW = equivalent noise bandwidth of receiver in Hz

C/N in dB

- **Bandwidth.** The equivalent noise bandwidth of the receiver is set in MHz. Values between 1.0 MHz and 60.0 MHz are available.

  The set receiver bandwidth will be used for calculating C/N ratio.

NOTE. *The noise generator is witched off upon every change of the modulation mode. Also, when the noise generator is switched on, the RF ALC OFF MODE is preset to TABLE.*

- **Noise.** Turn the noise generator on or off.

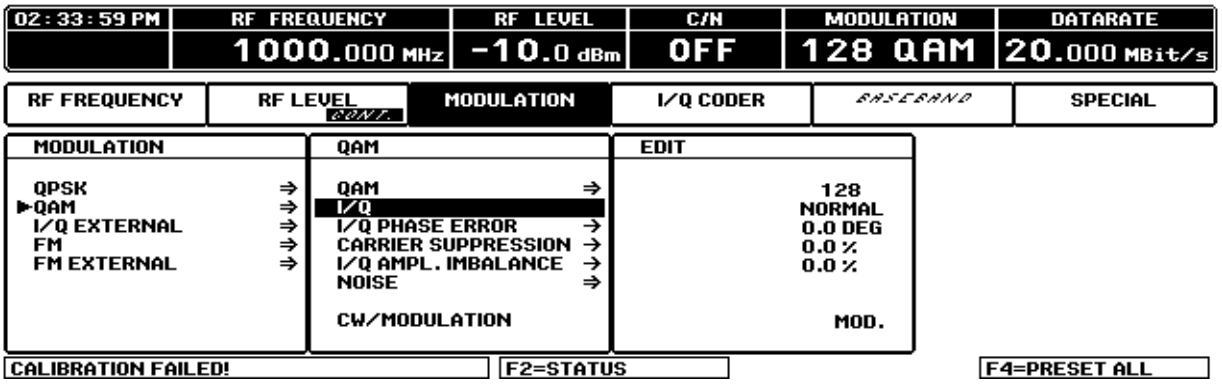


Figure 2–13: QAM modulation menu

Menu items: QAM	
QAM	Entry for selecting QAM16, 32, 64, 128, 256
I/Q	Selection of normal or changed I/Q modulation. Change of I and Q signals causes the modulation sidebands to be inverted.
NORMAL	Normal I/Q modulation
CHANGED	I and Q signals changed
I/Q PHASE ERROR →	Entry of phase error
CARRIER SUPPRESSION →	Entry of residual carrier
I/Q AMPL. IMBALANCE →	Entry for unequal modulation of I and Q vectors.

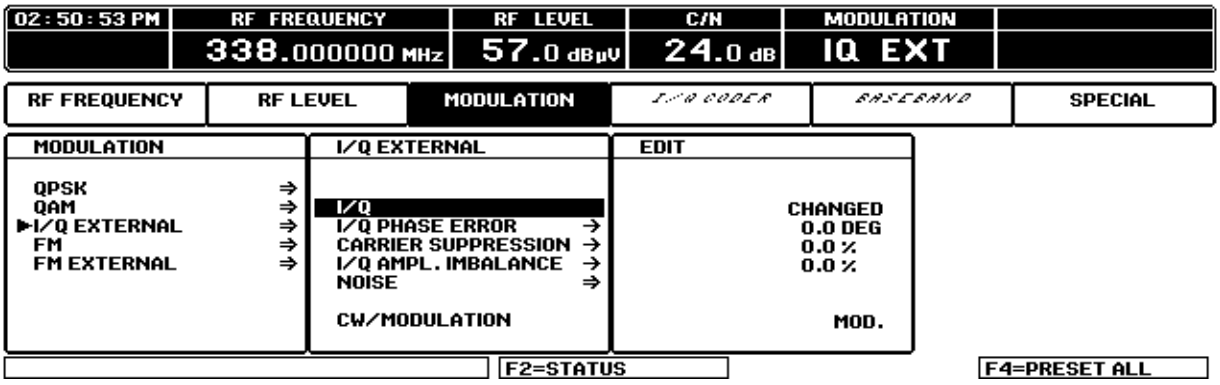


Figure 2–14: I/Q external menu

Menu items: I/Q EXTERNAL	
I/Q	Selection of normal or changed I/Q modulation. Change of I and Q signals causes the modulation sidebands to be inverted.
NORMAL	Normal I/Q modulation
CHANGED	I and Q signals changed
I/Q PHASE ERROR →	Entry of phase error
CARRIER SUPPRESSION →	Entry of residual carrier
I/Q AMPL. IMBALANCE →	Entry for unequal modulation of I and Q vectors.

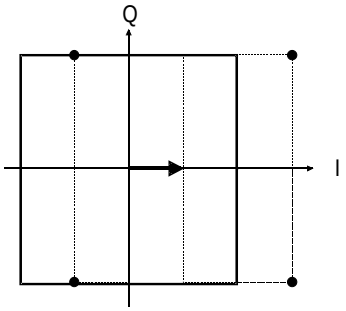
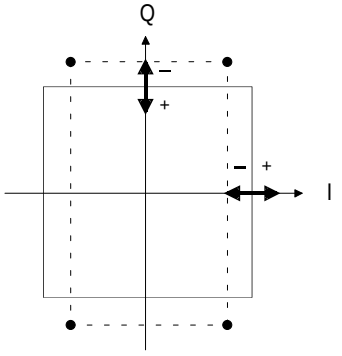
NOTE. *The BNC inputs for the I and Q signals are at the rear of the DVT200 Digital Video Transmitter (X40.1 = I, X40.2 = Q). The input impedance is 50 Ω, and the nominal voltage for external vector modulation at the I and Q inputs is:* $V = 0.5\ V_{peak}$.

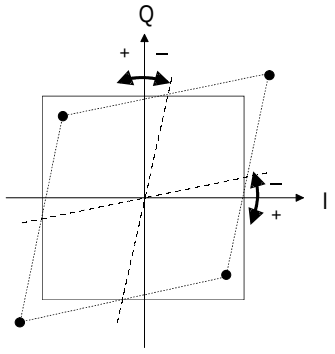
I/Q Detuning. To simulate an impairment of the vector modulation, the parameters residual carrier (carrier suppression), unequal I and Q modulation (amplitude imbalance), and phase error (quadrature error) can be entered.

Parameter tuning ranges:

Parameter	Tuning range	Resolution
Carrier suppression	0 to 50 %	0.5 %
Ampl. imbalance	–25 to +25 %	0.1 %
Phase error	–10 to +10 °	0.1 °

Effect of I/Q detuning:

Parameter	Effect
CARRIER SUPPRESSION	
AMPL. IMBALANCE	

Parameter	Effect
PHASE ERROR	

I/Q CODER Menu

All settings concerning coding and error protection of the MPEG2 transport stream can be made using the menu shown in Figure 2–15. The submenus differ only slightly, depending on the selected I/Q modulation mode. The description below indicates when a menu item is available in one mode only or setting ranges are different. If no specific information is given, the description applies to both QAM (quadrature amplitude modulation) and QPSK (quadrature phase shift keying).

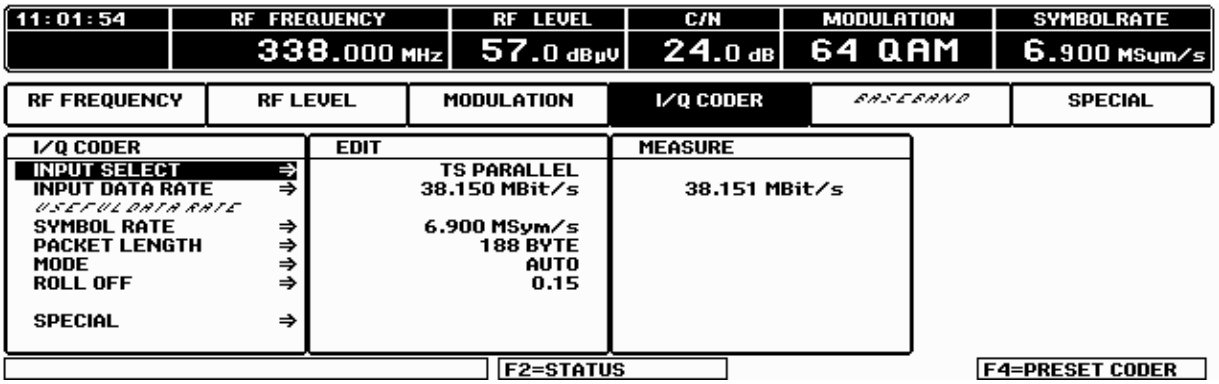


Figure 2–15: Input select menu

For QPSK (satellite transmission), coding and error protection are in line with ETS 300421. For QAM (cable transmission), coding and error protection are in line with ETS 300429.

This means that the incoming transport stream is scrambled (energy dispersal); sync words are not scrambled but the scrambler continues to run. The polynominal 1 + x(14) + x(15) is used. The scrambler is initialized (100 101 010 000 000) with a sync word. The synchronization is repeated every 8 transport frames. The first of 8 sync words is inverted in addition (47(hex) –> B8(hex)) which indicates the beginning of a scrambler sequence.

After energy dispersal and sync word inversion, a Reed Solomon code (204, 188, t=8) is provided for outer error protection. That is, 16 bytes containing the redundancy for correcting 8 errored bytes of the frame are added to the incoming 188 data bytes of the frame.

Subsequently, a convolutional interleaver with a depth of l = 12 and a base delay of M = 17 ensures that the inverted and the noninverted sync words are always transmitted in path 0 without delay.

Data coding up to this point is the same for QAM and QPSK.

With QAM, the following is carried out after the convolutional interleaver:

- A symbol word conversion (byte-to-m-tuple conversion) is performed. The data bits are combined to symbols depending on the selected QAM mode.
- The two MSBs (most significant bits) of each symbol are difference-coded.
- Pulse filtering with a square root cosine factor of alpha = 0.15 is performed for QAM; factors of 0.1, 0.125, 0.175 and 0.2 can also be set.

With QPSK, the following is carried out after the convolutional interleaver:

- Coding is performed by a convolutional encoder with a rate of 1/2, a constrained length of K=7 and the generator polynominals 171 (octal) and 133 (octal). A puncturing rate of 1/2 (not punctured), 2/3, 3/4, 5/6 and 7/8 can be set next.
- Pulse filtering is performed with the square root cosine factor of alpha = 0.35; factors of 0.25, 0.30, 0.40 and 0.45 can also be set.

I/Q CODER Menu Warnings. The following warnings are displayed in the I/Q CODER field under the conditions described:

FRMERR. The warning *FRMERR* is displayed if the received MPEG2 transport stream is not valid

MODIFY. The warning *MODIFY* is displayed if settings are not in conformance with standard coding procedures, . When the PRESET CODER key (F4) is pressed, all nonstandard settings are replaced by standard values.

NO CLK. The warning *NO CLK* is displayed in the absence of clock signals at the input.

NO DAT. The warning *NO DAT* is displayed in the absence of input data, or when the clock signals at the input are missing.

UNLOCK. The warning *UNLOCK* is displayed if the received input data rate deviates by more than 10% from the set data rate. After the cursor has been placed on the INPUT DATA RATE field, the measured input data rate can be taken as the setting rate using key F3 = ACCEPT.

The currently set status is displayed when the STATUS key (F2) is pressed. The status information is displayed below the submenu items and the setting windows.

With the INPUT INTERFACE option fitted, the DVT200 has two different input interfaces: an *Asynchronous Serial Interface* (ASI) and a *Synchronous Parallel Interface* (SPI). The interfaces comply with DVB specifications and cover most of the applications. The interfaces are given equal priority by the INPUT INTERFACE option, which converts the serial ASI data into parallel data like the SPI interface.

To this end, the input data rate and the packet length of the transport stream are measured and displayed. Then an internal output data stream is generated from the input data stream. The data rate of the internal output data stream is linked to the output symbol rate of DVT200. To effect this conversion of data rate, any null packets contained in the data stream are removed. The data rate thus obtained is the minimum output data rate of the module. The desired output data rate is obtained by adding null packets. The added null packets contain as a payload a pseudo random binary sequence (PRBS) in line with ITU–T O.151 (223 – 1), which can be used for measuring the bit error rate. In the TS PARALLEL mode, data rate conversion is disabled and the DVT200 operates as if the INPUT INTERFACE was not fitted.

If a transport stream is modified by removing and adding null packets, the position of the MPEG2 packets relative to each other changes as well because the positions of the null packets in the transport stream change. This means that the program clock reference (PCR) values in the data stream are no longer correct. However, the PCR values are corrected by the INPUT INTERFACE. The jitter produced by the correction is far below the specified DVB limit value.

I/Q CODER Submenu Items. The following submenus are found within the I/Q CODER menu.

INPUT SELECT: The TS PARALLEL (synchronous parallel MPEG2 transport stream) input interface in LVDS (low voltage differential signaling) format is available. This interface is described in DVB–PI–154. The corresponding 25-contact, sub-D type connector is available at the rear of the instrument.

If the INPUT INTERFACE option is fitted (Option B6), you can choose from among several input interfaces, including the TS PARALLEL input. See Figure 2–16.

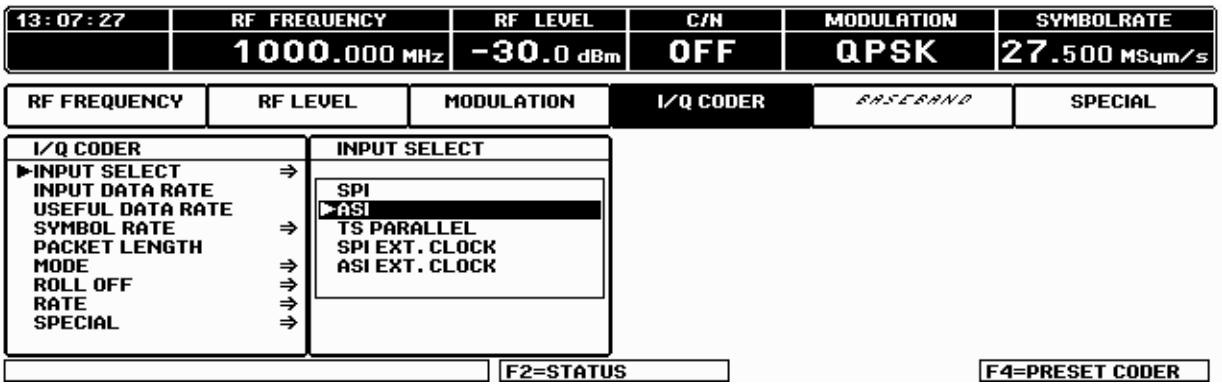


Figure 2–16: I/Q Coder submenu items showing INPUT INTERFACE options

Unlike the other interfaces available with the INPUT INTERFACE option, the TS PARALLEL interface does not change the input data stream. If one of the other available interfaces described in this section is chosen, the clock rate of the data stream is changed, which means that the output symbol rate of the DVT200 can be selected independently of the input rate. The required corrections are performed by the INPUT INTERFACE.

The following list describes the alternative input options enabled by the INPUT INTERFACE option (Option B6):

- SPI. The *Synchronous Parallel Interface* (SPI) is provided by the TS PARALLEL, 25-pin, D-type connector on the rear panel. The clock rate of the data stream is changed. The output data rate is determined by an internal clock generator which can be set in the SYMBOL RATE menu.
- ASI. The *Asynchronous Serial Interface* (ASI) is provided by the ASI BNC connector on the rear panel. The clock rate of the data stream is changed. The output data rate is determined by an internal clock generator which can be set in the SYMBOL RATE menu.

- SPI EXT. CLOCK. This synchronous parallel external interface is provided by the TS PARALLEL, 25-pin, D-type connector on the rear panel. The clock rate of the data stream is changed. The output data rate is determined by a clock signal applied to the TS CLOCK EXT BNC connector on the rear panel. If jumper X8 on the INPUT INTERFACE module is connected in position 1–2 (factory setting), the clock signal applied is the output bit clock of the module. If the jumper is connected in position 2–3, an output byte clock is applied.
- ASI EXT. CLOCK. This asynchronous serial external interface is provided by the ASI BNC connector on the rear panel. The clock rate of the data stream is changed. The output data rate is determined by a clock signal applied to the TS CLOCK EXT BNC connector on the rear panel. If jumper X8 on the INPUT INTERFACE module is connected in position 1–2 (factory setting), the clock signal applied is the output bit clock of the module. If the jumper is connected in position 2–3, an output byte clock is applied.

INPUT DATA RATE: An input data rate between 2.000 and 60.000 Mbit/s can be set. It refers to the transport stream applied to the coder. See Figure 2–17.

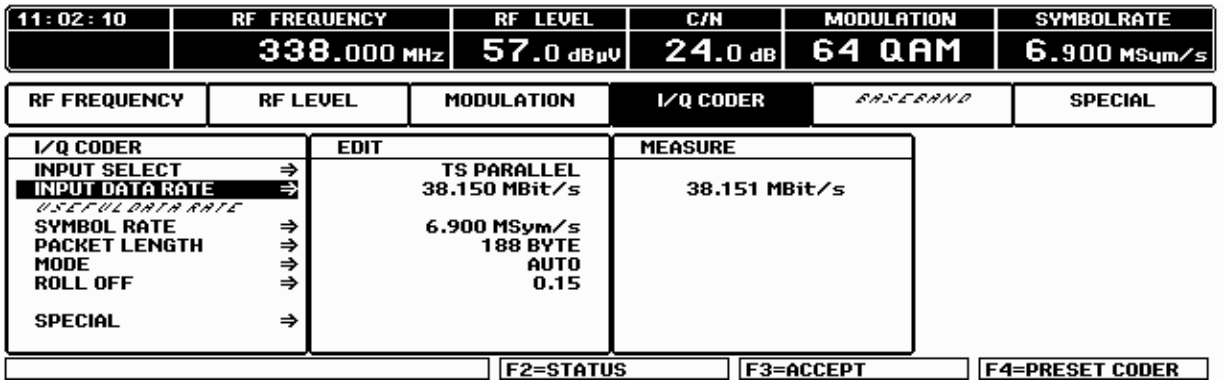


Figure 2–17: Input data rate menu

If the ASI or the SPI input interface is selected (with an internal or external clock), the INPUT DATA RATE is measured and displayed and setting the input data rate is not possible. The INPUT DATA RATE is understood to be the (gross) data rate comprising all bits received.

In the TS PARALLEL mode, an input data rate between 2.000 and 60.000 Mbit/s can be set. The input data rate refers to the transport stream applied to the coder. In this mode, if the instrument is not locked to an external clock, a clock is generated, at the approximate frequency, but it is not very accurate and has high jitter—most instruments will not be able to lock to the generated clock.

With menu item INPUT DATA RATE selected, the measured input data rate is displayed in the window at the right of the set data rate. If a new transport stream is applied to the TS Parallel input, the displayed measured value can be accepted as the set value by pressing key F3 = ACCEPT.

If the measured data rate is not within the permissible setting range, only underscores will be displayed (_ _ _ _).

Since setting means only a preselection of oscillator ranges and considering that the oscillators synchronize to the incoming signal, the set input data rate need not correspond exactly to the received data rate. If a deviation of more than 10% is measured, the warning UNLOCK is displayed in the I/Q CODER selection field. The warning disappears as soon as the deviation becomes smaller.

When in AUTO mode, if no data stream is received the digital video transmitter automatically switches to an internal data rate generator and generates a clock signal that corresponds to the set data rate. The warning NO CLK is displayed in the I/Q CODER selection field. A measured value of 0.000 Mbit/s is displayed when the cursor is placed on the INPUT DATA RATE field. A newly applied data stream is identified by the digital video transmitter, which then switches back to normal operation.

***NOTE**. The standard internal clock generator is intended merely to keep the signal alive for the DVT200 Digital Video Transmitter. This clock generator typically has more jitter than many receivers can lock to. Be sure to use either an external clock or the B6 option, rather than the TS Parallel mode. See also the switch-on procedure on page 2–2.*

At the bottom of the INFO window the calculated symbol rate is displayed. It is calculated with respect to the set INPUT DATA RATE and other settings and is indicated in Msymb/s (Mega symbols per second).

USEFUL DATA RATE. If the ASI or SPI interfaces are selected (with internal or external clock), The USEFUL DATA RATE field indicated the data rate or the payload; that is, without stuffing bytes or null packets.

SYMBOL RATE. The symbol rate is calculated from the input data rate, the modulation type and the coder settings and is displayed in the header line in the top right corner of the display.

The desired symbol rate can also be entered directly in Megasymbols per second. The DVT200 then calculates the required input data rate as a function of the other parameters. If the limits of the permissible input data rate (2 to 60 Mbit/s) are exceeded, the user is warned and the minimum or maximum possible symbol rate indicated.

The user has to make sure the calculated input data rate is applied to the DVT200.

Since setting means only a preselection of oscillator ranges and considering that the oscillators synchronize to the incoming signal, the set input data rate need not correspond exactly to the received data rate. If a deviation of more than 10% is measured, the warning UNLOCK is displayed in the I/Q CODER selection field. The warning disappears as soon as the deviation becomes smaller.

If no data stream is received,the DVT200 automatically switches to internal data rate tuning and generates a clock signal which corresponds to the set data rate. The warning NO CLK is displayed in the I/Q CODER selection field. A measured value of 0.000 Mbit/s is displayed when the cursor is placed on the INPUT DATA RATE field. A newly applied data stream is identified by the DVT200 which then switches back to normal operation.

At the bottom of the STATUS window the calculated symbol rate is displayed. It is calculated with respect to the set INPUT DATA RATE and other settings and is indicated in Msymb/s (Mega symbols per second).

The symbol rate is a function of the input data rate as shown by the following equation:

$$TS\_data\ rate\ =\ symbol\ rate\ \frac{PL}{204}\ rate\ q$$

$$Symbol\ rate\ =\ TS\_data\ rate\ \frac{204}{PL}\ \frac{1}{rate}\ \frac{1}{q}$$

where

TS_data rate corresponds to the input data rate in [Mbit/s]

PL is the packet length, which may be 188 or 204 [Byte]

Rate corresponds to the rate of the convolutional encoder. A rate of 1/2, 2/3, 3/4, 5/6 or 7/8 can be selected for QPSK. Since no convolutional encoder is used with QAM, the rate is set to 1.

Symbol rate is given in [Msymb/s]

q corresponds to the order of I/Q modulation (see table below)

Modulation:	q
QPSK	2
16QAM	4
32QAM	5
64QAM	6
128QAM	7
256QAM	8

The symbol data rate of 7.000 Msymb/s for QAM should not be exceeded. The minimum rate for QAM should be greater than 1.5 Msymb/s. Lower symbol rates can be used with restrictions.

With QPSK, symbol rates between 2 and 45 Msymb/s are useful. With certain restrictions, higher or lower rates can also be set.

A table showing the relationship between TS-input data rate and symbol rate is enclosed at the end of the manual.

If ASI or SPI is selected as input interface with an external clock, the SYMBOL RATE is measured and can be adopted by pressing F3 = ACCEPT.

USEFUL DATA RATE: If the INPUT INTERFACE option is available, the USEFUL DATA RATE is measured and displayed. USEFUL DATA RATE is

understood to mean the total data rate of all transport–stream packets carrying information. It is measured after the null packets have been eliminated.

PACKET LENGTH: A packet length of 188 or 204 bytes can be selected (toggle function). See Figure 2–18.

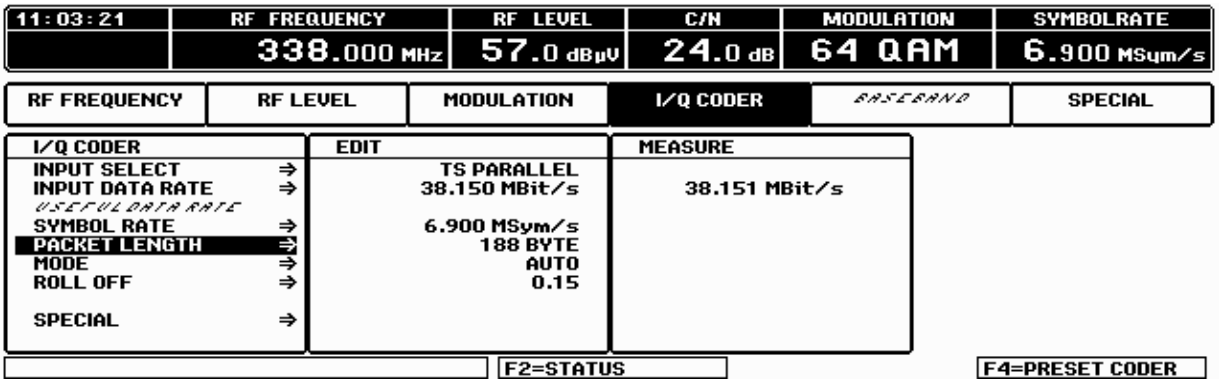


Figure 2–18: Packet length

The packet length corresponds to the frame length of the applied transport stream. Normally a 188-byte frame is applied and a 204-byte frame is obtained in the coder after the Reed Solomon error protection.

When a frame length of 188 byte is set, the digital video transmitter expects a sync word in the first byte of each frame (47 hexadecimal).

When a frame length of 204 bytes is set, the first byte must again be a sync word. The last 16 bytes of the frame are overwritten by the Reed Solomon encoder. If this is not desired, the Reed Solomon encoder should be switched off in the SPECIAL submenu.

If the INPUT INTERFACE (Option B6) is fitted, the PACKET LENGTH is measured and setting the PACKET LENGTH is not possible when the ASI/SPI input interfaces are used. You can still set the PACKET LENGTH is you use the TS PARALLEL interface.

MODE: Under this menu item one of several operating modes can be selected. See Figure 2–19.

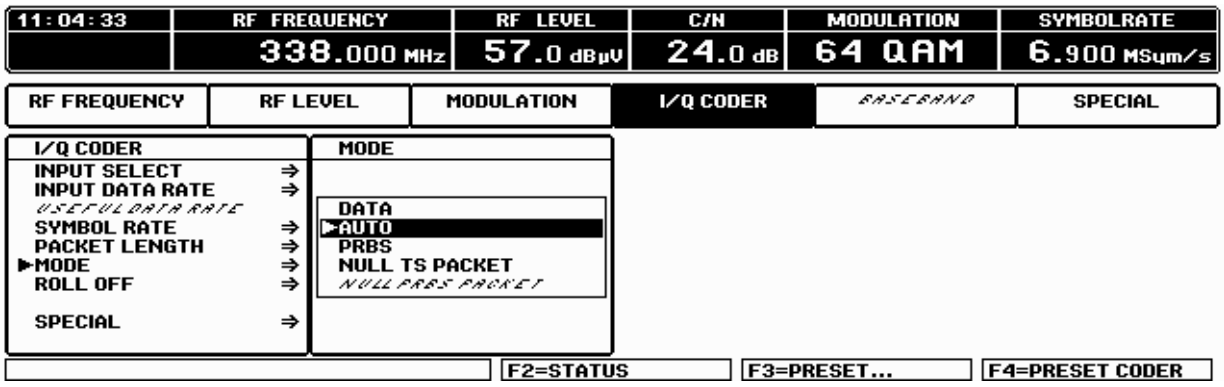


Figure 2–19: I/Q coder mode menu

DATA: In this mode, the externally applied transport stream is conditioned. If invalid data are received or no data at all, the data (or zeros in the case of no data) are forwarded unmodified to the error protection coder, interleaver, and so on, and finally to the modulator.

AUTO: This mode is identical with the DATA mode as long as a transport stream is received. In the absence of a transport stream, when the frame is faulty or other faults have occurred, the digital video transmitter automatically switches to an internal PRBS sequence. When a valid transport stream is identified again, the received data are conditioned.

PRBS: In this mode, an internal PRBS sequence is automatically selected irrespective of whether a transport stream is received or not.

NULL TS PACKET: In this mode, a test transport stream consisting of a sync word, identification bytes, and zeros as a payload is generated in the digital video transmitter and transmitted. This test transport stream is described in the DVB Measurement Guidelines (MG 66 Rev. 5). The null transport stream packets are conditioned like any externally applied transport stream.

NULL PRBS PACKET: When set to NULL PRBS PACKET, which is only possible if the input interface option (Option B6) is available, the DVT200 generates null packets (PID 1FFFhex), whose payloads are filled with a pseudo random binary sequence (PRBS) according to ITU–T O.151 ($2^{23} – 1$). The PRBS is transmitted in the transport stream byte by byte (MSB first).

NOTE. *If the signals used have been generated internally, for example, when you use NULL TS PACKET, applying an external clock using the synchronous parallel interface is still useful—the DVT200 oscillator will lock to it. If the INPUT INTERFACE option (Option B6) is used, this is not necessary.*

ROLL OFF: Under this menu item (see Figure 2–20), pulse shaping can be set. The selectable roll-off factors differ, depending on the selected modulation mode. A square root cosine roll-off factor is used.

The following roll-off factors may be selected for QAM:

0.1 / 0.13 / 0.15 (standard value for DVB-C) / 0.175 / 0.2

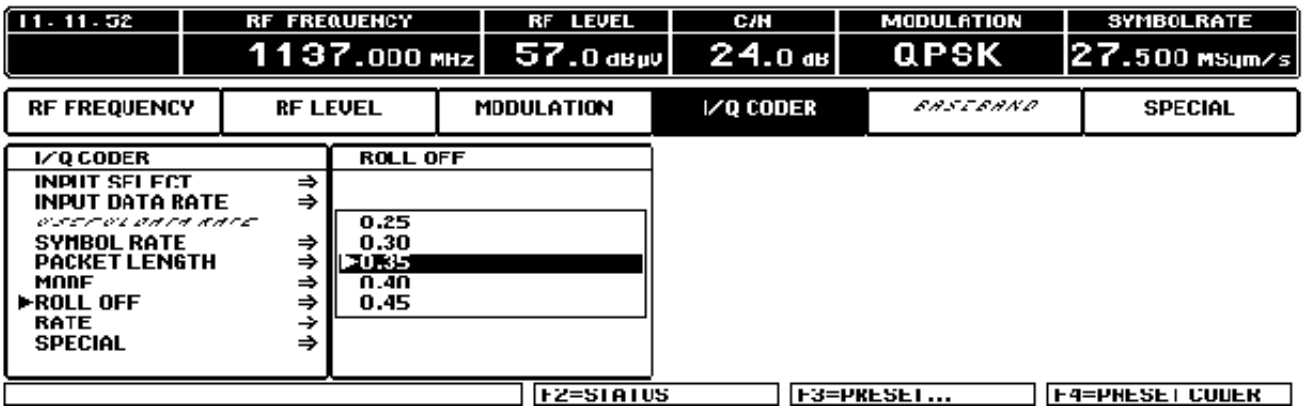


Figure 2–20: I/Q coder roll off menu

The following roll-off factors may be selected for QPSK:

0.25 / 0.3 / 0.35 (standard value for DVB–S) / 0.4 / 0.45

RATE: This menu item is only available with QPSK; the item is not displayed in the QAM mode. See Figure 2–21.

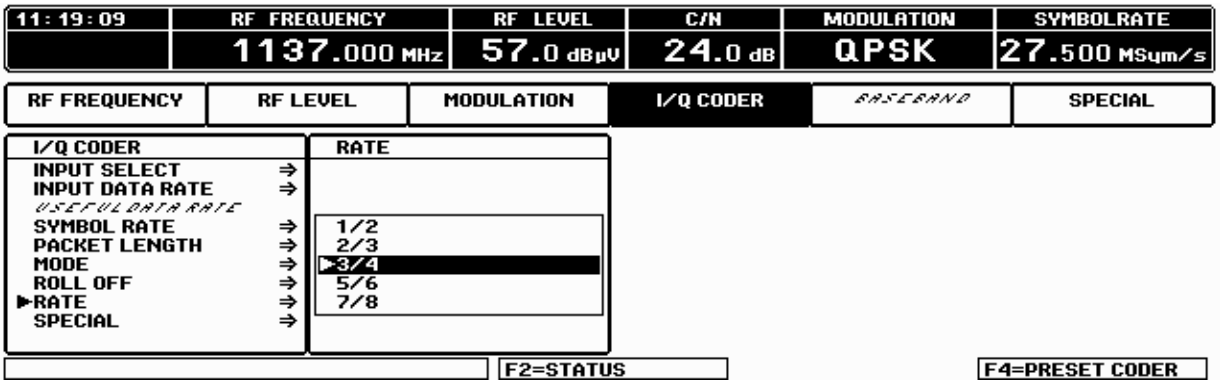


Figure 2–21: I/Q coder rate menu (QPSK only)

In the case of satellite transmission (QPSK), convolutional encoding with subsequent puncturing is performed after the convolutional interleaver. The rate 1/2 means that puncturing is not performed.

The following puncturing rates can be selected:

1/2, 2/3, 3/4, 5/6, 7/8

SPECIAL: Under this menu item (see Figure 2–22), some parts of the encoder and the error protection facilities can be disabled. However disabling error protection impairs transmission and should be used for testing purposes only. If some of the functions are switched off, the warning MODIFY is displayed in the I/Q CODER selection field.

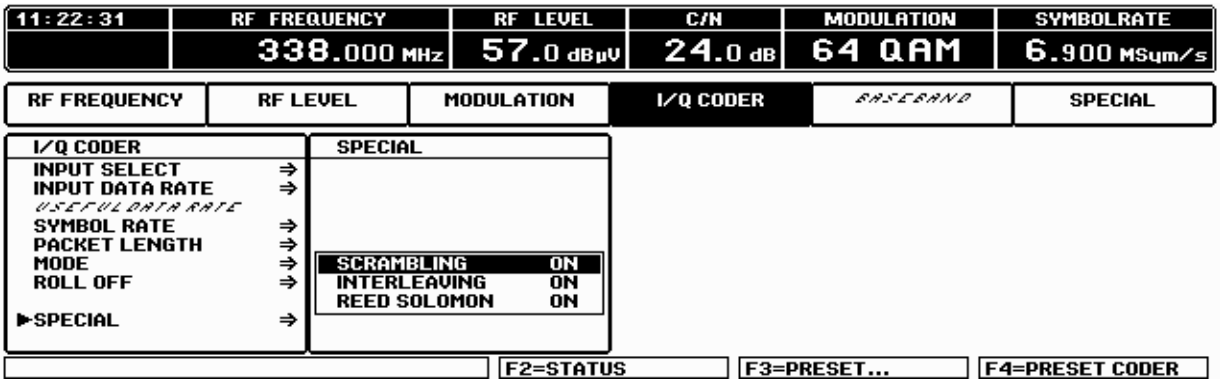


Figure 2–22: I/Q coder special menu

The following functions can be switched off in the DVT200 Digital Video Transmitter (toggle function):

- SCRAMBLING: Energy dispersal is disabled but the sync inversion remains active.
- INTERLEAVING: With the interleaver switched off, data are directly transmitted.
- REED SOLOMON: With the Reed Solomon encoder switched off, the frame length is extended to 204 bytes.

***NOTE**. If PACKET LENGTH: 188 BYTE is selected (see the discussion of PACKET LENGTH on page 2–25), the 16 bytes added when REED SOLOMON is switched off are invalid.*

SPECIAL Menu

The sweep function allows the DVT200 Digital Video Transmitter to sweep the RF frequency. When the sweep function is activated, modulation is not switched off. If a sweep is to be performed in the CW mode, I/Q modulation can be switched off using the MOD OFF hardkey.

In the SWEEP START/STOP, Figure 2–23, and the SWEEP CENTER/SPAN modes, the sweep is started and stopped with key F4.

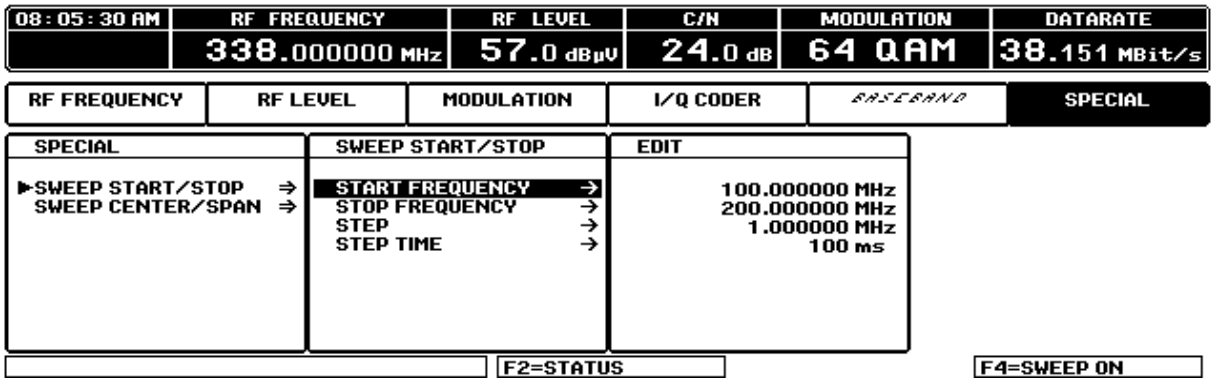


Figure 2–23: SWEEP START/STOP Submenu

SWEEP START/STOP Submenu.

START FREQUENCY: The start frequency is entered here in [MHz]. The lowest start frequency is 0.300 MHz; the highest start frequency is 3300.000 MHz.

If a start frequency higher than the stop frequency is entered, the user is informed accordingly.

STOP FREQUENCY: The stop frequency is entered here in [MHz]. The lowest stop frequency is 0.300 MHz; the highest stop frequency is 3300.000 MHz.

If a stop frequency lower than the start frequency is entered, the user if informed. In addition, the stop frequency must be at least one step higher than the start frequency.

STEP: The frequency step width is entered here in [MHz]. The minimum step width that can be entered is 1 Hz. The maximum step width depends on the start and stop frequency. The step width must not be greater than the stop frequency less the start frequency so that at least one sweep step can be performed.

STEP TIME: The time required for a frequency step during a SWEEP is entered here in [ms]. A minimum step time of 10 ms can be entered; the maximum step time is 1000 ms.

CENTER FREQUENCY: The center frequency can be entered here in [MHz]. A center frequency between 0.300 MHz and 3300.000 MHz can be chosen.

SPAN: The frequency range swept around the center frequency is entered. A sweep is performed over one half of the span at both sides of the center frequency. The unit is [MHz]. The minimum SPAN that can be entered is 1 Hz, the maximum span is limited by the overall frequency range of 0.300 to 3300.000 MHz. The set span must not exceed this range and must not be smaller than the set step width. It must be wide enough so that at least one sweep step can be performed. The user is informed if incorrect settings are made.

STEP: The frequency step is entered here in [MHz]. A minimum step width of 1 Hz can be set. The maximum step width depends on the set span. A step must not be wider than the set span so that at least one step can be performed.

STEP TIME: The duration of a frequency step for SWEEP is entered here in [ms]. The minimum STEP TIME is 10 ms; the maximum STEP TIME is 1000 ms.

STATUS Menu

The menu is called up with the STATUS key (F2). The menu is quit when the F2 key is pressed again (EXIT).

The status display, Figure 2–24, comprises a menu selection line where QPSK and QAM can be called up separately. The following illustration shows the parameters in the QPSK status display.

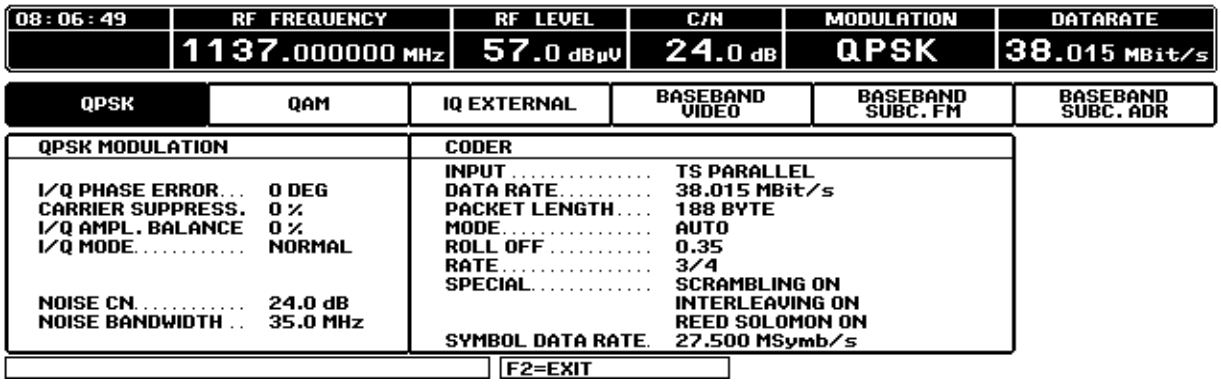


Figure 2–24: Status menu (QPSK)

In the left column, QPSK modulator settings are displayed:

I/Q PHASE ERROR	[DEG]	Phase error of I/Q signal
CARRIER SUPPRESS.	[%]	Carrier suppression
I/Q AMPL. BALANCE	[%]	I/Q amplitude imbalance
I/Q MODE	[NORMAL/CHANGED]	I and Q not inverted/inverted (normal/changed)

In the right column, I/Q CODER settings are displayed:

INPUT	[TS PARALLEL]	Selected transport stream input
DATA RATE	[Mbit/s]	Set MPEG2 transport stream input data rate
MODE	[DATA, AUTO, PRBS, NULL TS PACKET, CW]	Selected operating mode
ROLL OFF	[0.25, 0.30, 0.35, 0.40, 0.45]	Alpha factor of roll-off filtering
SPECIAL	SCRAMBLING [ON, OFF]	Energy dispersal
	INTERLEAVING [ON, OFF]	Convolutional interleaver
	REED SOLOMON [ON, OFF]	Reed Solomon encoder
SYMBOL DATA RATE	[MSymb/s]	Set symbol data rate

Figure 2–25 shows the parameters in the QAM status display:

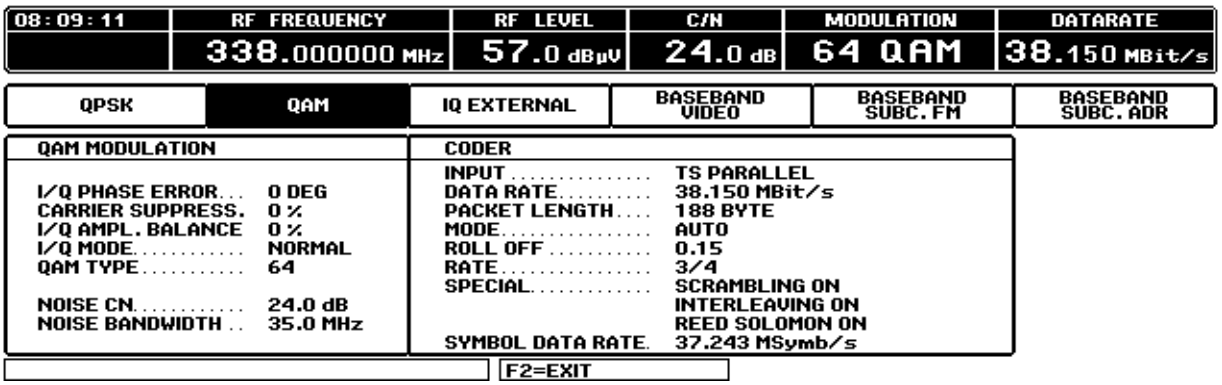


Figure 2–25: Status menu (QAM)

In the left column QAM modulator settings are displayed:

I/Q PHASE ERROR	[DEG]	Phase error of I/Q signal
CARRIER SUPPRESS.	[%]	Carrier suppression
I/Q AMPL. BALANCE	[%]	I/Q amplitude imbalance
MODE	[NORMAL/CHANGED]	I and Q not inverted/inverted (normal/changed)
QAM TYPE	[16, 32, 64, 128, 256]	QAM modulation modes

In the right column I/Q CODER settings are displayed:

INPUT	[TS PARALLEL]	Selected transport stream input
DATA RATE	[Mbit/s]	Set MPEG2 transport stream input data rate
MODE	[DATA, AUTO, PRBS, NULL TS PACKET, CW]	Selected operating mode
ROLL OFF	[0.1, 0.13, 0.15, 0.175, 0.2]	Alpha factor of roll-off filtering
RATE	[1/2, 2/3, 3/4, 5/6, 7/8]	Puncturing rate
SPECIAL	SCRAMBLING [ON, OFF]	Energy dispersal
	INTERLEAVING [ON, OFF]	Convolutional interleaver
	REED SOLOMON [ON, OFF]	Reed Solomon encoder
SYMBOL DATA RATE	[MSymb/s]	Set symbol data rate

MEMORY Menu

In the MEMORY CARDS menu, the following functions can be selected and performed. See Figure 2–26.

- STORE INTERNAL
- RECALL INTERNAL
- STORE EXTERNAL
- RECALL EXTERNAL
- SPECIAL FUNCTIONS
- SOFTWARE UPDATE

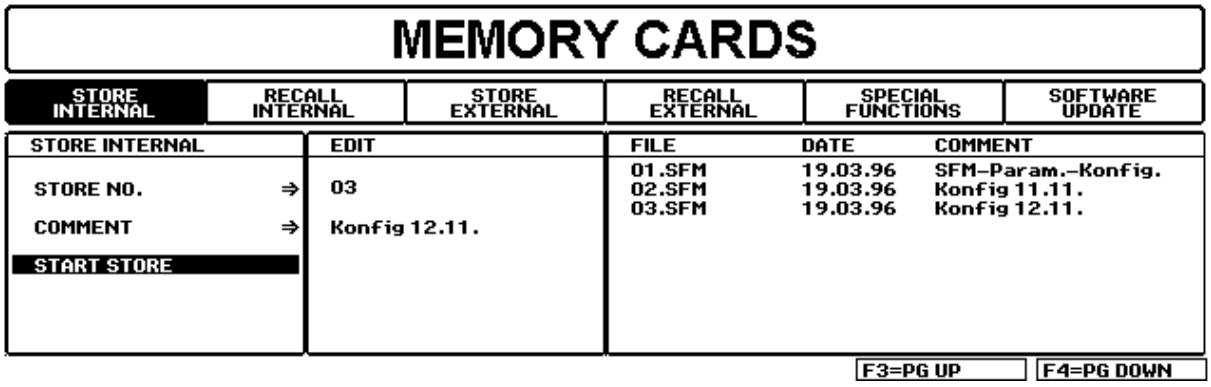


Figure 2–26: Memory cards menu

Storing and Recalling Instrument Settings. After selecting STORE INTERNAL/EXTERNAL or RECALL INTERNAL/EXTERNAL, a list of occupied memory locations is displayed. A maximum of 99 locations is available.

If a location is assigned for STORE, a brief comment (of up to 15 characters) can be entered using the editor, which is operated via the cursor keys or via a PC keyboard. Each file is assigned a file name, a location identification code, and the date of storage. If the selected memory location is occupied, a query is displayed asking whether the location content should be overwritten. All instrument settings are stored.

When using an external memory card, the following should be observed:

- When the memory card is inserted, the green READY LED lights up.
- After selection of a item, confirmation with ENTER triggers the copying procedure. During copying the yellow BUSY LED flashes.

CAUTION. *To prevent loss of data, do not remove the memory card while the yellow BUSY LED flashes.*

Special Functions. See Figure 2–27. The following special functions are available:

- DIR EXTERNAL — Display of content of an external memory card
- CHKDSK EXTERNAL — Testing an external memory card
- FORMAT 1 MB — Formatting an external 1-Mbyte memory card
- FORMAT 2 MB — Formatting an external 2-Mbyte memory card
- FORMAT 4 MB — Formatting an external 4-Mbyte memory card
- FORMAT 10 MB — Formatting an external 10-Mbyte memory card
- FORMAT 20 MB — Formatting an external 20-Mbyte memory card
- COMMAND LINE — Intermediate limited operation at the DOS level In this case an external keyboard has to be connected. Return to normal instrument operation with <EXIT>.

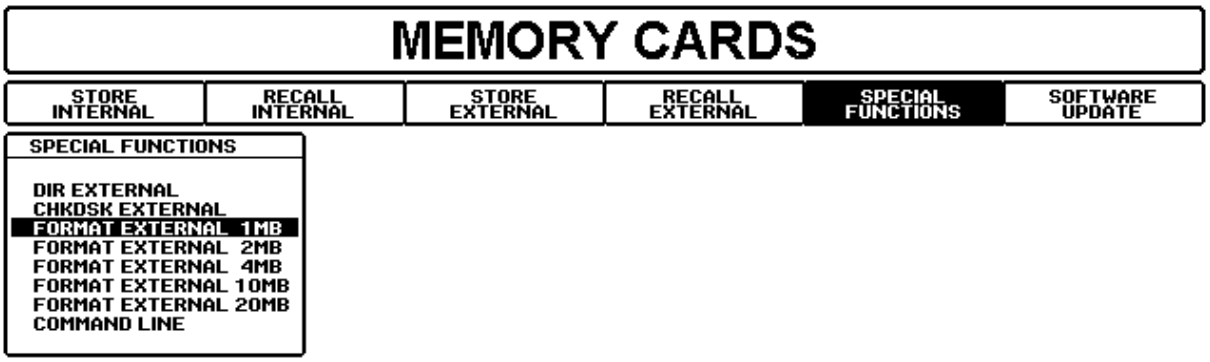


Figure 2–27: Memory cards special function menu

Software Update. You can use an external memory card to update your software with the Software Update function. See Figure 2–28. Insert memory card holding the new program routines in the slot on the front panel and call up the Software Update menu.

During this procedure the yellow BUSY LED flashes.

CAUTION. *To prevent loss of data, do not remove the memory card while the yellow BUSY LED flashes.*

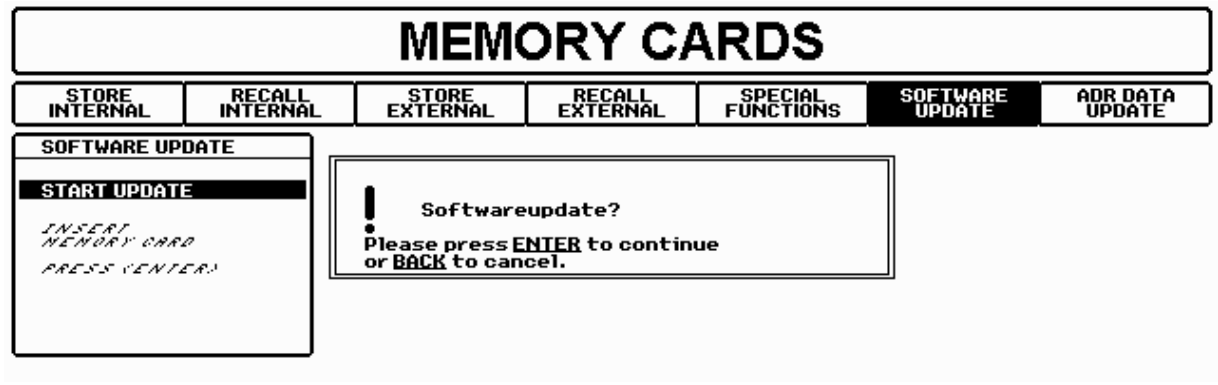


Figure 2–28: Software update menu

Use the following procedure to update your software via the serial interface and a separate PC:

1. Using a null-modem cable, connect the PC to the RS-232 port on the DVT200. The cable you use should have the pin assignments indicated in Figures 2–29 and 2–30.

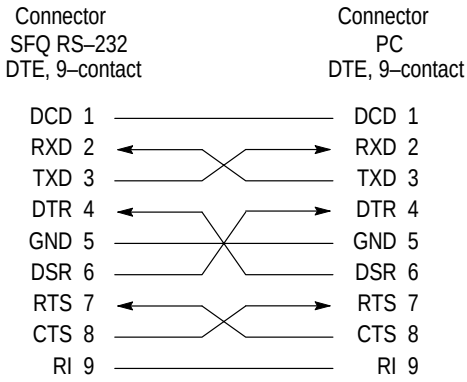


Figure 2–29: Pin assignments for PCs with a 9-pin connector

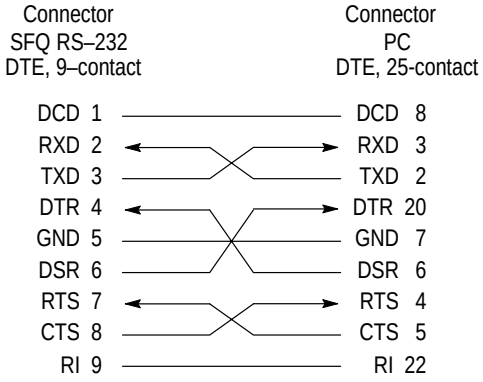


Figure 2–30: Pin assignments for PCs with a 25-pin connector

NOTE. *Since the cable has to support a 115200 baud transmission standard, cable length is limited to a few meters.*

2. Power off the DVT200 and insert the update disk into the appropriate drive on your PC.

3. Type: A:>UPDATE COM1 (or COM2).
4. Power on the digital video transmitter when the prompt appears.
5. If necessary, follow the prompts on the PC until the update is completed.

SETUP / INFO Menu

The SETUP / INFO menu is called up with the respective hardkey. The following data can be queried in the SETUP menu:

- HARDWARE. In this menu system configurations can be queried.
- INFO FIRMWARE. In this menu, the instrument firmware version is displayed.
- TIME / DATE, COMMUNICATION and PRESET. In this menu, instrument parameters and interface states can be preset.
- CANNEL TABLE. In this menu, customized channel and frequency tables can be edited.
- SERVICE. In this menu the system configuration and device data can be entered. The SERVICE submenu is password protected and is accessible only to qualified service personnel.

HARDWARE Submenu. In the HARDWARE submenu, Figure 2–31, system configurations can be queried.

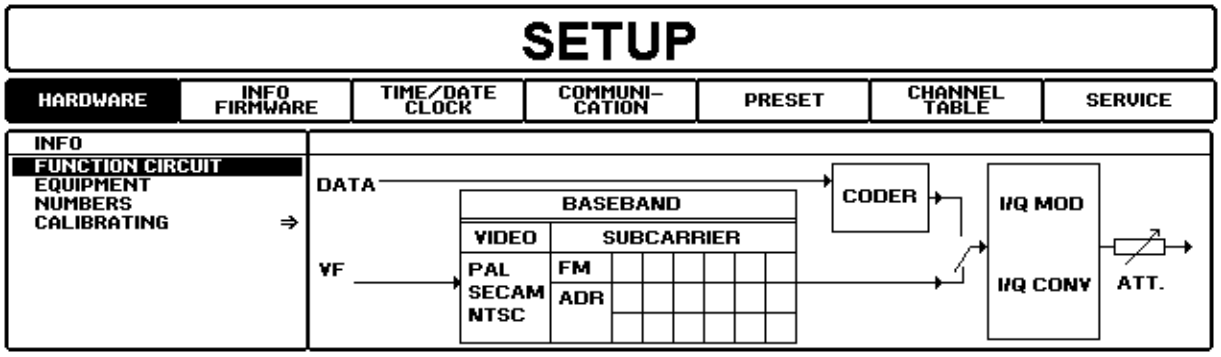


Figure 2–31: Hardware menu

Figure 2–31 shows model .10 with the BB FM/NOISE option.

- FUNCTION CIRCUIT: With FUNCTION CIRCUIT, the block diagram of the models can be called up.
- EQUIPMENT: Under EQUIPMENT, all modules are listed with identification numbers.
- CALIBRATING: With CALIBRATING, an internal calibration can be called up.

NOTE. *Allow the instrument to warm up for at least one hour before calibration. This is particularly important for the I/Q modulator.*

INFO FIRMWARE Submenu. In the INFO FIRMWARE submenu, Figure 2–32, the software versions are displayed.

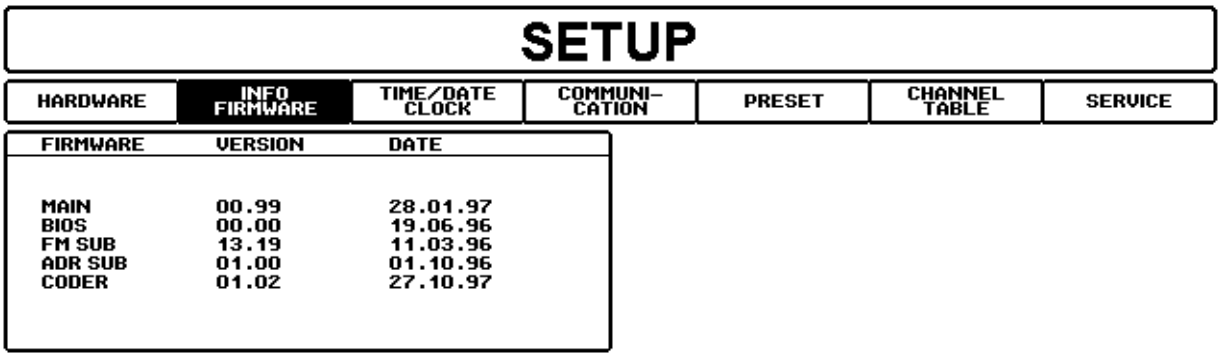


Figure 2–32: Info firmware menu

TIME / DATE / CLOCK Submenu. In the TIME / DATE / CLOCK submenu, Figure 2–33, time and date and the type of display can be selected.

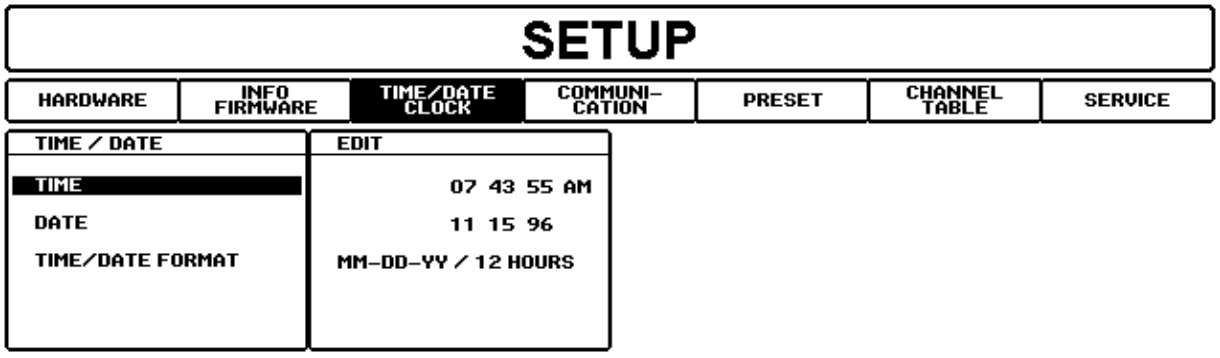


Figure 2–33: Time/Date/Clock menu

COMMUNICATION Submenu. In the COMMUNICATION submenu, Figure 2–34, the IEC/IEEE-bus address can be set and data of the serial interface and the remote-control interface selected.

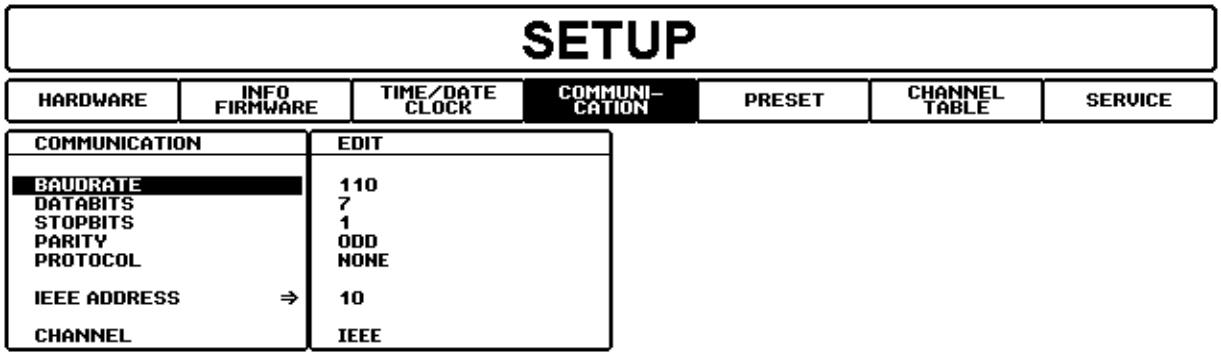


Figure 2–34: Communications menu

Available ranges:

BAUDRATE:	100; 300; 600; 1200; 2400; 9600; 19200
DATABITS:	7/8
STOPBITS:	1/2
PARITY:	NONE; ODD; EVEN; SPACE; MARK
PROTOCOL:	NONE; XON; RTS/CTS
IEEE ADDRESS:	1 to 30

PRESET Submenu. In the PRESET submenu, Figure 2–35, various settings can be made.

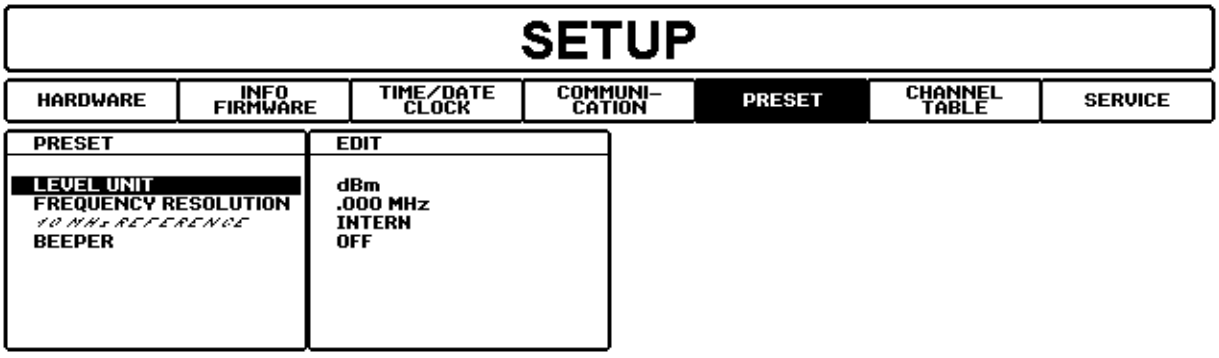


Figure 2–35: Preset menu

- LEVEL UNIT: Here the unit for the level can be preset depending on the application: dBm, dB, or dBμV
- FREQUENCY RESOLUTION: Here a 3-digit or 6-digit resolution for frequency setting can be preset.
- 10 MHz REFERENCE: Permits the selection of an internal or external 10 MHz reference oscillator.
- BEEPER: With BEEPER ON, the built-in loudspeaker can be switched on for information on errors or incorrect entries; the loudspeaker is switched off with BEEPER OFF.

CHANNEL TABLE Submenu. In the CHANNEL TABLE submenu, Figure 2–36, 5 frequency tables with a maximum of 99 entries can be set up. A name of up to 5 characters can be assigned to each table. The user-defined channel tables can be selected in the RF FREQUENCY menu.

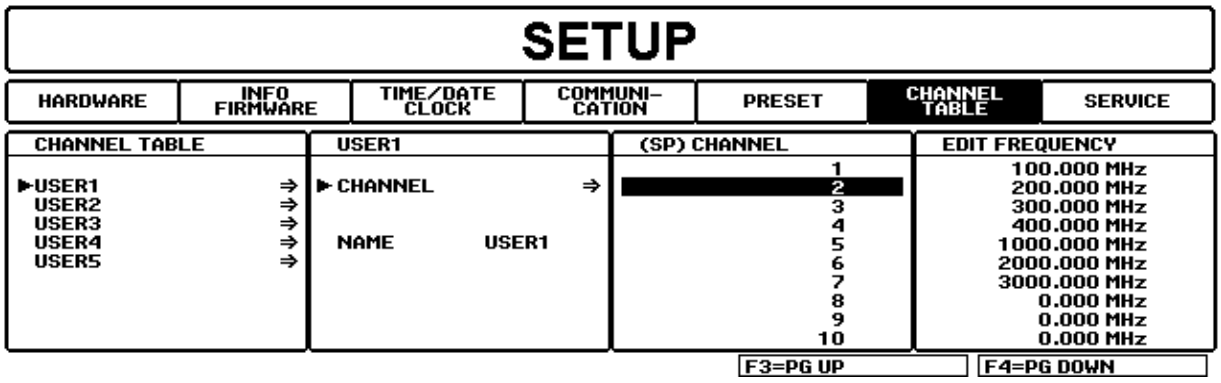


Figure 2–36: Setup channel table menu

SERVICE Submenu. The SERVICE submenu is password protected and only accessible to service personnel. Here the system configuration and device data can be entered.

These data can then be called up in the INFO HARDWARE submenu.

Special Keys. The following table lists the special keys and their functions:

RF OFF	With the **RF** OFF key the RF output signal is switched off.
MOD OFF	With the **MOD** OFF key all modulation signals of the currently used system are switched off and the vector-modulated RF carrier is set to CW (continuous wave).
MONITOR EXT	With the **MONITOR** EXT key the display is switched to the monitor output. At the same time the built-in LC display is blanked and the yellow MONITOR EXT LED lights.

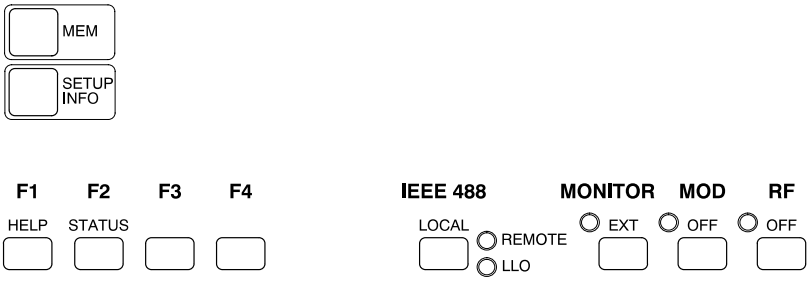
Menu Tree

Use the cursor keys to control the operation of the menus and to increment or decrement data variables.

The HOME key is used for calling up the following opening menus:

- RF FREQUENCY
- RF LEVEL
- MODULATION
- I/Q CODEDR
- *BASEBAND*
- SPECIAL

Additional selections can be made with the following hardkeys, depending on the display:



An overview of the menus is shown on pages 2–44 through 2–48.

RF FREQUENCY

```
|–RF FREQUENCY                <value>
|–CHANNEL                     <value>
|–CHANNEL TABLE - - - - - - - - - - |– NONE
|                                   |– USER1
|                                   |– USER2
|                                   |– USER3
|                                   |– USER4
|                                   |– USER5
```

RF LEVEL

```
|–RF LEVEL                    <value>
|–RF LEVEL OFFSET             <value>
|–RF AMPLITUDE                <value>
|–RF LEVEL MODE - - - - - - - - - - |– NORMAL
|                                   |– CONTINUOUS
|
|–RF LEVEL ALC MODE  - - - - - - |– AUTO
|                                |– OFF
|                                |– ON
|
|–RF LEVEL ALC OFF MODE - - - |– TABLE
|                             |– SAMPLE&HOLD
|
|– RF LEVEL ALC SEARCH ONCE      <function call>
|– RF LEVEL ALC LEARN TABLE      <function call using WAIT>
```

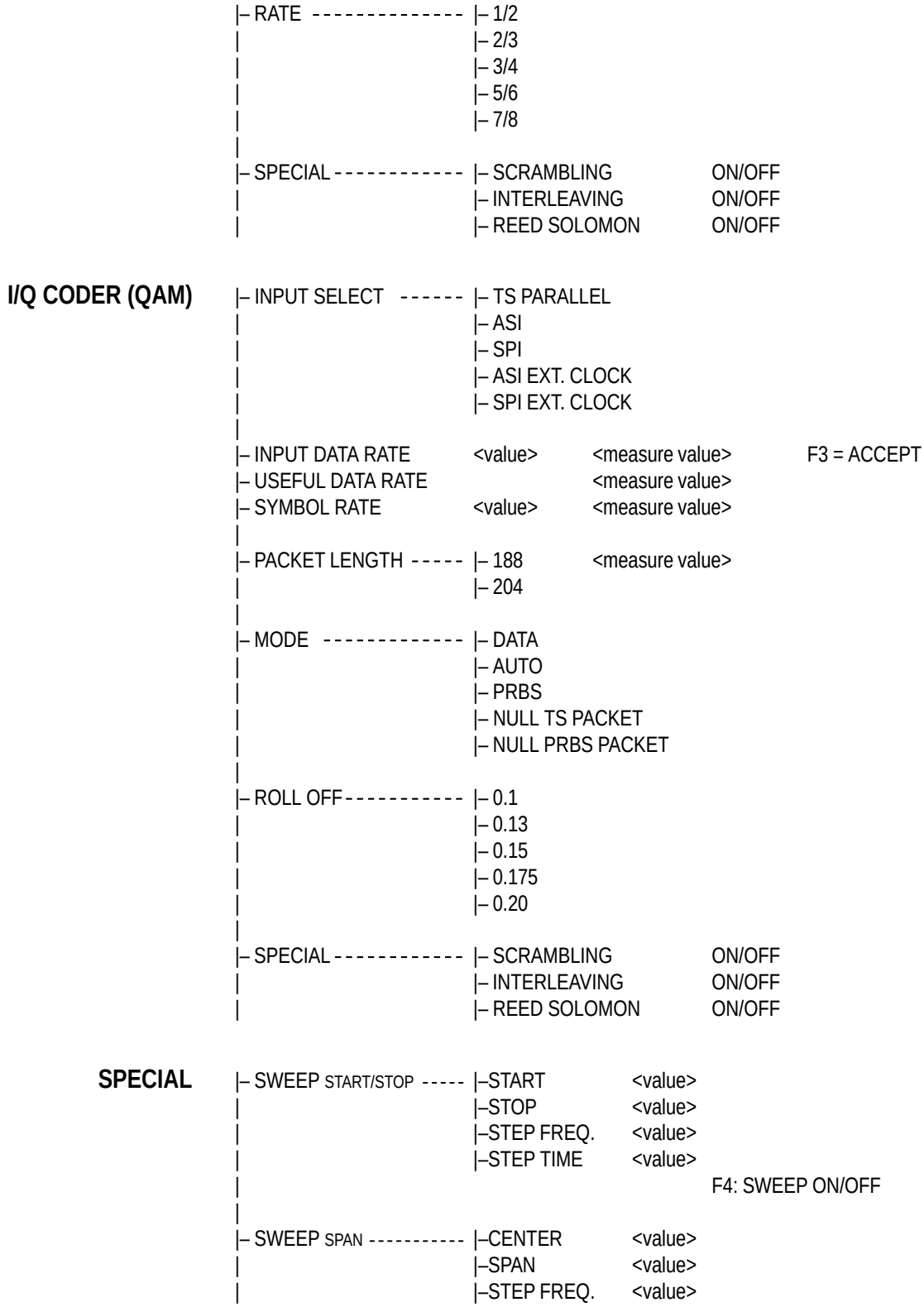
MODULATION

```
|– QPSK - - - - - - - - - - - - - - |– I/Q - - - - - - - - - - - - - - - - - |– NORMAL
|                                   |                                       |–CHANGED
|                                   |– I/Q PHASE ERROR                                  <value>
|                                   |– CARRIER SUPRESSION                               <value>
|                                   |– I/Q AMPL:IMBALANCE                               <value>
|                                   |– NOISE  - - - - - - - - - - - - - |– C / N          <value>
|                                   |                                   |– BANDWIDTH    <value>
|                                   |                                   |– NOISE ON/OFF
|                                   |
|                                   |– CW / MODULATION                  |– CW (RF ONLY)
|                                   |                                   |– MODULATION
|– QAM - - - - - - - - - - - - - - - |– QAM  - - - - - - - - - - - - - - - |– 16 QAM
|                                   |                                   |– 32 QAM
|                                   |                                   |– 64 QAM
|                                   |                                   |– 128 QAM
|                                   |                                   |– 256 QAM
|                                   |
|                                   |– I/Q - - - - - - - - - - - - - - - - - |– NORMAL
|                                   |                                       |–CHANGED
|                                   |– I/Q PHASE ERROR                                  <value>
|                                   |– CARRIER SUPRESSION                               <value>
|                                   |– I/QAMPL. IMBALANCE                               <value>
|                                   |
|                                   |– NOISE - - - - - - - - - - - - - - |– C / N          <value>
```

```
|                          |                              |– BANDWIDTH     <value>
|                          |                              |– NOISE ON/OFF
|                          |
|                          |– CW / MODULATION . . . .     |– CW (RF ONLY)
|                          |                              |– MODULATION
|
|– I/Q EXTERNAL            |– I/Q - - - - - - - - - - - - - - - - |– NORMAL
|                          |                              |–CHANGED
|                          |
|                          |– I/Q PHASE ERROR                                <value>
|                          |– CARRIER SUPRESSION                             <value>
|                          |– I/Q AMPL. IMBALANCE                            <value>
|                          |
|                          |– I/Q - - - - - - - - - - - - - - - - |– NORMAL
|                          |                              |–CHANGED
|                          |
|                          |– NOISE  - - - - - - - - - - - - |– C / N         <value>
|                          |                              |– BANDWIDTH     <value>
|                          |                              |– NOISE ON/OFF
|                          |
|                          |– CW / MODULATION - - - -     |– CW (RF ONLY)
|                          |                              |– MODULATION
|– FM INTERNAL
|– FM EXTERNAL  - - - - - - -  (Reserved for future use)
```

I/Q CODER (QPSK)

```
|– INPUT SELECT - - - - - - -  |– TS PARALLEL
|                              |– ASI
|                              |– SPI
|                              |– ASI EXT. CLOCK
|                              |– SPI EXT. CLOCK
|
|– INPUT DATA RATE             <value>      <measure value>      F3 = ACCEPT
|– USEFUL DATA RATE                         <measure value>
|– SYMBOL RATE                 <value>      <measure value>
|
|– PACKET LENGTH  - - - - -    |– 188         <measure value>
|                              |– 204
|
|– MODE  - - - - - - - - - - - - |– DATA
|                              |– AUTO
|                              |– PRBS
|                              |– NULL TS PACKET
|                              |– NULL PRBS PACKET
|
|– ROLL OFF - - - - - - - - - - |– 0.25
|                              |– 0.30
|                              |– 0.35
|                              |– 0.40
|                              |– 0.45
|
```


|– RATE
|– 1/2
|– 2/3
|– 3/4
|– 5/6
|– 7/8
|– SPECIAL
|– SCRAMBLING ON/OFF
|– INTERLEAVING ON/OFF
|– REED SOLOMON ON/OFF
I/Q CODER (QAM)
|– INPUT SELECT
|– TS PARALLEL
|– ASI
|– SPI
|– ASI EXT. CLOCK
|– SPI EXT. CLOCK
|– INPUT DATA RATE <value> <measure value> F3 = ACCEPT
|– USEFUL DATA RATE <measure value>
|– SYMBOL RATE <value> <measure value>
|– PACKET LENGTH
|– 188 <measure value>
|– 204
|– MODE
|– DATA
|– AUTO
|– PRBS
|– NULL TS PACKET
|– NULL PRBS PACKET
|– ROLL OFF
|– 0.1
|– 0.13
|– 0.15
|– 0.175
|– 0.20
|– SPECIAL
|– SCRAMBLING ON/OFF
|– INTERLEAVING ON/OFF
|– REED SOLOMON ON/OFF
SPECIAL
|– SWEEP START/STOP
|–START <value>
|–STOP <value>
|–STEP FREQ. <value>
|–STEP TIME <value>
F4: SWEEP ON/OFF
|– SWEEP SPAN
|–CENTER <value>
|–SPAN <value>
|–STEP FREQ. <value>

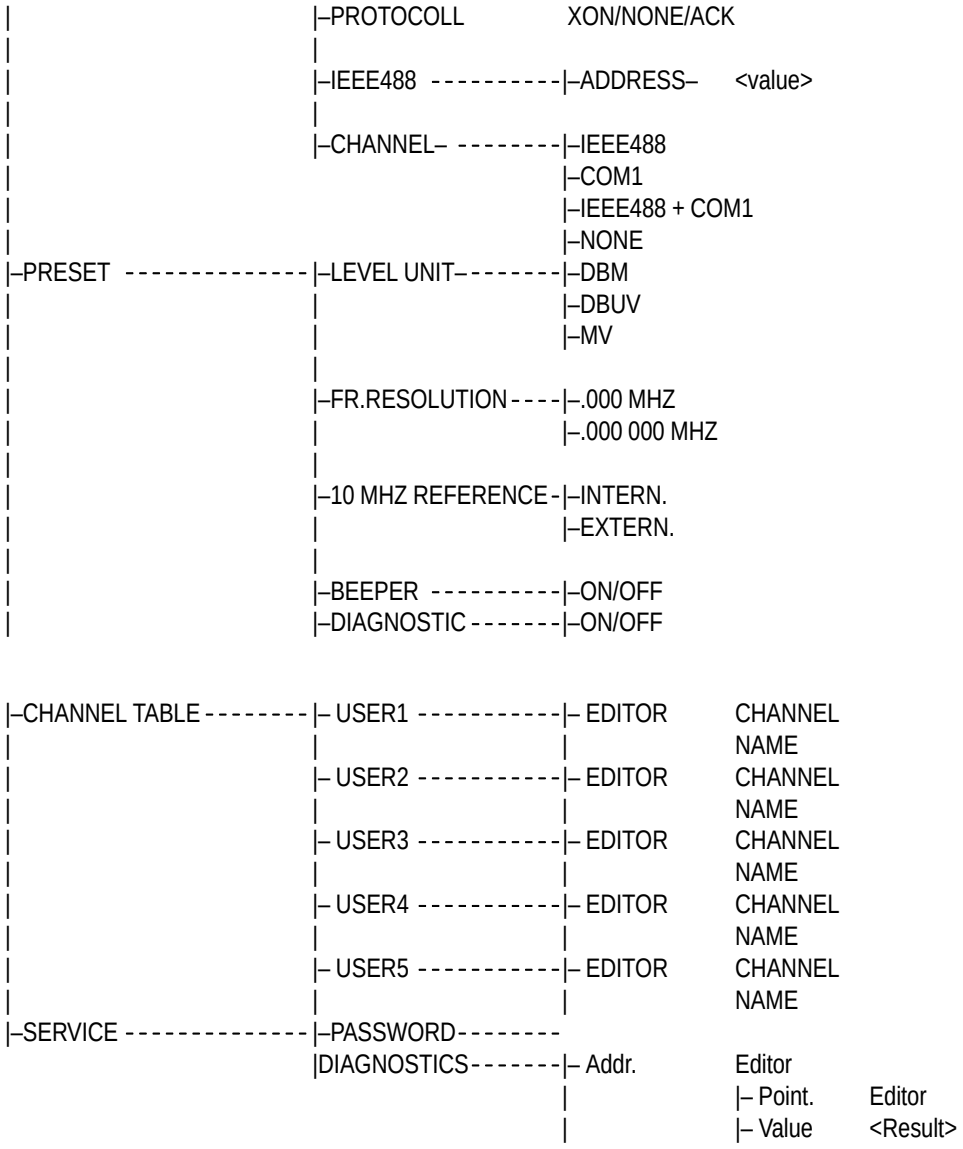
```
|                          |–STEP TIME       <value>
|                                                    F4: SWEEP ON/OFF
```

MEMORY

```
|–STORE INT. - - - - -  |– STORE NO.      1...99
|                       |– COMMENT
|                       |– START STORE
|
|–RECALL INT - - - - -  |– RECALL NO      1...99
|                       |– START RECALL
|
|–STORE EXT.- - - - -   |– STORE NO.      1...99
|                       |– COMMENT
|                       |– START STORE
|
|–RECALL EXT. - - - -   |– RECALL NO.     1...99
|                       |– START RECALL
|
|–SPECIAL FUNCTIONS - - - - - - - - - - - -|– FORMAT EXTERNAL   |– 1, 2, 4, 10, 20 MB
|
|–SW UPDATE  - - - - - - - - - - - - - - - -|– START UPDATE
|
|– ADR DATA UPDATE- - - - - - - - - - - - - |– START UPDATE DATA1
|                                           |– START UPDATE DATA2
|                                           |– START UPDATE DATA3
|                                           |– START UPDATE DATA4
```

SETUP

```
|–INFO HARDWARE / INFO - -|– FUNCTION. CIRCUIT  |        Display of block diagram
|                         |
|                         |– EQUIPMENT          |        Display of equipment list
                                                           with “OK / failed status”
|                         |
|                         |– NUMBERS  - - - - - - - -|     Display of Order Nos.
|                         |
|                         |– CALIBRATING - - - - - -|– VCO SYTHESE          <Result>
|                                                   |
|                                                   |– RF LEVEL             <Result>
|                                                   |
|                                                   |– I/Q MOD.             <Result>
|–INFO FIRMWARE - - - - - - - -|                    –        Display: versions
|–TIME/DATE/CLOCK  - - - - - -|–TIME– - - - - - - - - - - - -|– 08:37:00 AM
|                             |–DATE–                        |– 03.28.94
|                             |–TIME/DATE                    |– dd-mm-yy (24 HOURS)
|                                                            |– mm-dd-yy (12 HOURS)
|–COMMUNICATION - - - - - - -|–BAUDRATE                     <value>
|                             |–BITS                                 <value>
|                             |–STOPBIT                      <value>
|                             |–PARITY                       ODD/EVEN/ZERO/
                                                                     ONE/NONE
|                             |
```


|–PROTOCOLL XON/NONE/ACK
|–IEEE488 |–ADDRESS– <value>
|–CHANNEL– |–IEEE488
|–COM1
|–IEEE488 + COM1
|–NONE
|–PRESET |–LEVEL UNIT– |–DBM
|–DBUV
|–MV
|–FR.RESOLUTION |–.000 MHZ
|–.000 000 MHZ
|–10 MHZ REFERENCE |–INTERN.
|–EXTERN.
|–BEEPER |–ON/OFF
|–DIAGNOSTIC |–ON/OFF
|–CHANNEL TABLE |– USER1 |– EDITOR CHANNEL NAME
|– USER2 |– EDITOR CHANNEL NAME
|– USER3 |– EDITOR CHANNEL NAME
|– USER4 |– EDITOR CHANNEL NAME
|– USER5 |– EDITOR CHANNEL NAME
|–SERVICE |–PASSWORD
|DIAGNOSTICS |– Addr. Editor
|– Point. Editor
|– Value <Result>

Remote Control

The standard DVT200 Digital Video Transmitter has an IEC/IEEE-bus interface that complies with the IEC 625.1/IEEE 488.2 standard. The connector is located on the rear panel. A controller can be connected for remote control. The digital video transmitter supports the Standard Commands for Programmable Instruments version 1995.0 (SCPI). The SCPI standard is based on the IEEE 488.2 standard, and its goal is a standardization of the device-specific commands, error handling, and status registers (refer to *SCPI Introduction* on page 3–5).

Basic knowledge of IEC/IEEE-bus programming and operation of the controller is required for a clear understanding of this section. A description of the interface commands is to be taken from the relevant manuals.

The requirements of the SCPI standard for 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 the commands and the status registers.

Brief Instructions

The following brief operating instructions allow the instrument to be quickly put into operation and to set the basic functions. It is assumed that the IEC/IEEE-bus address, which is set at the factory to 20, has not been changed.

1. Connect the digital video transmitter and controller using the IEC/IEEE-bus cable.
2. Generate and start the following program on the controller:

```
CALL IBDEV(0, 28, 12, 0, 0x100a, generator%)    Open channel to device
CALL IBPAD(generator%, 28)                      Send device address to
                                                controller
CALL IBWRT(generator%, "*rst;*cls")             Reset device
CALL IBWRT(generator%, "sour:freq:chan 2")      Select user-defined
                                                TV channel 2
CALL IBWRT(generator%, "sour:pow -10 dBm")      Select output power
```

   A German-standard TV signal on channel 2 is available at the output of the digital video transmitter with an output power of –10 dBm.

3. Press the [LOCAL] key on the front panel to return to manual operation.

Switching to Remote Control

On power up, the digital video transmitter is always in the manual control mode (LOCAL state) and can be operated from the front panel. Switch over to remote control (REMOTE state) is effected as soon as the digital video transmitter receives an addressed command from a controller. In the remote-control mode, operation from the front panel is inhibited. The digital video transmitter remains in the REMOTE state until it is switched back to the manual control mode, either from the front panel or via the IEC/IEEE bus (refer to *Return to Manual Control* on page 3–3). Switch over from the manual mode to remote control and vice versa has no effect on the device settings.

Setting the Device Address

The factory-set IEC/IEEE-bus address is 20. The address can be changed manually in the SETUP menu or via the IEC/IEEE bus. Addresses between 0 and 30 can be selected.

To manually change the bus address, do the following steps:

1. Press the [SETUP / INFO] key.
2. Select the COMMUNICATION menu.
3. Select the IEEE ADDRESS.
4. Press [ENTER] key.
5. Enter the desired address.
6. Terminate the entry with the [ENTER] key.

To change the bus address via IEC/IEEE bus, execute the following commands:

```
CALL IBFIND("DEV1", generator%)                    Open channel to device
CALL IBPAD (generator%, 28)                        Send old address to
                                                   controller
CALL IBWRT(generator%, "SYST:COMM:GPIB:ADDR 17")   Set device to new
                                                   address
CALL IBPAD(generator%, 17)                         Send new address to
                                                   controller
```

Displays in Remote-Control Mode

The remote-control status is indicated on the front panel by the LEDs labeled REMOTE and LLO. In the REMOTE status, a REMOTE message is indicated on the display and the REMOTE LED lights. The LLO LED lights if the instrument is in the local lockout state and does not respond to the [LOCAL] key.

***NOTE**. If the main parameters and the display of special messages is to be updated on the display with each remote-control command, command SYSTem:DISPlay:UPDate[:STATe] ON must be entered first.*

Return to Manual Control

Return to manual control can be made via the front panel or via the IEC/IEEE bus. To return manually, press the [LOCAL] key.

***NOTE**. Prior to the switch over, the commands must have been fully processed. If not, the remote control is immediately switched on again.*

The [LOCAL] key can be locked by the universal command LLO (refer to Common Commands *on page B–4) to prevent inadvertent switch over. Then it is only possible to switch to manual control via the IEC/IEEE bus.*

Locking of the [LOCAL] key can be cancelled by deactivating the "REN" line of the IEC/IEEE bus (refer to Bus Lines *on page B–2).*

To return to manual control via the IEC/IEEE bus, execute the following command:

```
CALL IBLOC(generator%)        Set instrument to manual control
```

IEC/IEEE-Bus Messages

The messages transmitted on the data lines of the IEC/IEEE bus (refer to *Appendix B: IEC/IEEE Bus Interface*) can be subdivided into two groups:

- Interface messages
- Device-dependent messages

Interface Messages

Interface messages are transmitted on the data lines of the IEC/IEEE bus when the control line "ATN" is active. They are used for communication between the controller and the instrument and can only be sent by a controller with controller function on the IEC/IEEE bus.

There are two groups of interface messages:

- Common commands
- Addressed commands

Common commands affect all devices connected to the IEC/IEEE bus without any addressing required; addressed commands only affect devices addressed as a listener. The relevant interface messages are listed in *Appendix B: IEC/IEEE Bus Interface*.

Device-Dependent Messages (Commands and Responses)

The device-dependent messages are transmitted on the data lines of the IEC/IEEE bus when the control line "ATN" is not active. The ASCII code is used for data transmission. Device-dependent messages are differentiated according to the direction in which they are sent via the IEC/IEEE bus.

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:

- The effect they have on the device:

  Setting commands trigger device settings; for instance, resetting of the instrument or setting the output level to 1 Volt.

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

- 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 refer to functions such as the management of the standardized status registers, resetting, and self test.

Device-specific commands refer to functions that depend on the device characteristics, such as frequency setting. A large number of these commands has also been standardized by the SCPI Consortium (refer to *SCPI Introduction* below).

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 3–9).

Structure and syntax of the device-dependent messages are described in the following topic. The commands are listed and explained in *Descriptions of Commands* on page 3–13.

Structure and Syntax of Device-Dependent Messages

SCPI Introduction

Standard Commands for Programmable Instruments (SCPI) describes a standardized command set for the programming of devices regardless of the type of instrument or manufacturer. The goal of the SCPI Consortium is to standardize device-specific commands. 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 3–1 shows this tree structure, using a detail from the SOURce command system for controlling the signal sources of the instrument. The other examples of syntax and structure of the commands are mainly 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 defined in the IEEE 488.2 standard (refer to *Responses to Queries* on page 3–9).

Command Structure

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

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

Example:

*RST
RESET (resets the device)

*ESE 253
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 3–1). 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:

SOURce
This keyword denotes the command system SOURce.

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

Example:

SOURce:MODulator:STATe OFF
This command is at the third level of the SOURce system. It switches the RF output off.

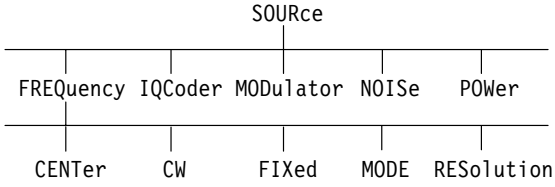


Figure 3–1: Tree structure of SCPI command system (SOURce is shown as an example)

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 reasons of 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:

```
SOURce:MODulator[:STATe] ON
```

The following command has the same effect:

```
SOURce:MODulator ON
```

NOTE. *An optional keyword may not be omitted if its effect is specified in more detail by a numeric suffix.*

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

Example:

```
STATus:QUEStionable:ENABle 1= STAT:QUES:ENAB 1
```

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

Parameter:
The parameter must be separated from the header by a white space. If a command contains several parameters, these have to 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 parameter, refer to *Parameters* on page 3–9.

Example**:**

```
SOURce:POWer:LEVel? MINimum
```

Response:

```
-9,900000e+01
```

This query returns the maximum value for the attenuation.

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

  Example:

  ```
  SOURce:FM:SUBCarrier:FM1:PREemphasis:STATe ON
  ```
  This command switches on the pre-emphasis of FM subcarrier 1.

Structure of a Command Line

A command line may contain one or more commands. It is terminated by a <New Line>, a <New Line> with EOI or an EOI together with the last data byte. QuickBASIC automatically generates an EOI together with the last data byte.

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:

```
CALL IBWRT(generator%,"SOURce:POWer MAXimum;
:OUTPut:STATe ON")
```

This command line contains two commands. The first command belongs to the SOURce system and is used to set the output line to maximum value. The second command belongs to the OUTPut system and through-connects the output signal to the output connector.

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 3–1 on page 3–6). The colon after the semicolon must be omitted.

Example:

```
CALL IBWRT(generator%, "SOURce:IQCoder:QPSK:RATE R3_4;
:SOURce:IQCoder:QPSK:ROLLoff 0.35")
```

This command line is shown in full length and contains two commands separated by a semicolon. Both commands belong to the SOURce command system, IQCoder:QPSK subsystem (that is, they have two common levels).

In the shortened command line the second command starts at the level below SOURce: IQCoder:QPSK. The colon after the semicolon must be omitted.

The shortened form of the command line is:

```
CALL IBWRT(generator%," SOURce:IQCoder:QPSK:RATE R3_4;
ROLLoff 0.35")
```

A new command line always starts with the full path.

Example:

```
CALL IBWRT(generator%, "SOURce:IQCoder:QPSK:RATE R3_4")
CALL IBWRT(generator%, "SOURce:IQCoder:QPSK:ROLLoff 0.35")
```

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:FREQency:RESolution?`
Response: `LOW`

2. Maximum and minimum values as well as all further quantities requested by a special text parameter are returned as numeric values.

Example: `SOURCe:FREQuency? MAX`
Response: `3.300000e+09`

3. Maximum and minimum values as well as all further quantities requested by a special text parameter are returned as numeric values.

Example: `SOURce:FREQuency?`
Response: `1.000000e+07 for 10 MHz`

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

Example: `SOURce:POWer:STATe?`
Response: 1

5. Character data are returned in short form.

Example: `ROUTe:REFerence:CLOCk?`
Response: `INT`

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 and the permitted range of values are described together with the commands (refer to *Description of Commands* on page 3–13).

Numeric values. Numeric values may be entered in any customary form (with 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 –32 000 and 32 000. 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 E (Exa), P (Peta), T (Tera), G (Giga), MA (Mega, MOHM and MHZ are also allowed), K (Kilo), M (Milli; do not use with OHM and HZ, where M means Mega), U (Micro), N (Nano), P (Pico), F (Femto) and A (Atto). If no unit is specified, the basic unit will be used. No prefix is allowed for the units DBM and DB. For voltages, additional logarithmic units in the form of dB<prefix>V are supported.

Normally, numeric values are inadmissible for queries of the digital video transmitter. This does not apply, however, to the special numeric values described below.

Example:

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

Special numeric values. The parameters MINimum, MAXimum, DEFault, UP and DOWN are interpreted as special numeric values. MINimum and MAXimum are allowed for all device-specific commands; DEFault, UP, and DOWN are allowed for a few commands only (see the description of the specific command).

Upon a query, the numeric value will be returned.

Example:

Setting command:	`SOURce:POWer:LEVel MINimum`
Query:	`SOURce:POWer:LEVel?`
Response:	`-9.900000e+01`

- 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.
- UP/DOWN
  UP and DOWN increments or decrements the numeric value by one step. The step size can be adjusted for each parameter set via UP, DOWN with the aid of the associated step command (refer to *Appendix D: List of Commands with SCPI Conformity Information).*

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:	SOURce:POWer:STATe ON
Query:	SOURce:POWer:STATe?
Response:	1

Text. Character data follow the syntax rules for keywords; they 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:	SOURce:SIDeband UPPer
Query:	SOURce:SIDeband?
Response:	UPP

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

Example:

```
"character string" or
'character string'
```

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 data bytes follow next. During the transmission of these data bytes all terminators and other control characters are ignored until all bytes have been transmitted. In case of data elements comprising more than one byte, the byte defined by the SCPI command “FORMat:BORDer” will be transmitted first.

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. It does not change the path.

‘ , ’ 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 denotes the beginning of block data.
‘ ’	A white space (ASCII code 0 to 9, 11 to 32 decimal) separates header and parameters.

Description of Commands

Notation

In the following sections, all commands implemented in the digital video transmitter are tabulated according to the command system and described in detail. The notation is largely in line with the SCPI standard. The SCPI conformity information is given in Table D–1 on page D–1.

Command table.

- Command:
  In the command column, the table shows an overview of the commands and their hierarchical relationships (see indentations).
- 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, the following information is listed:+
  – whether the command has a query form
  – whether the command is only in the form of a query
  – whether this command is implemented in a certain instrument option only

  In the individual command description, the hierarchy is represented accordingly. This means that for each command all keywords above up to the left-most position have to be considered too. An example is given at the end of the individual description for each command.

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 *Long and short form* on page 3–7). The instrument itself does not differentiate between uppercase and lowercase letters.

Special characters.

| For some commands there is a choice of keywords having the same effect. These keywords are stated in the same line and separated by a vertical bar. Only one of these keywords need to be stated in the header of the command. The effect of the command is independent of the keyword selected.

Example:

```
SOURce
:FREQuency
    :CW|:FIXed
```

The following two commands having the same effect can be generated. They both set the frequency of continuous-wave signal to 10 MHz:

```
SOURce:FREQuency:CW 1E7 = SOURce:FREQuency:FIXed 1E7
```

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

```
SOURce:FREQency:RESolution HIGH | LOW
```

[ ] Keywords in square brackets may be omitted in compound headers (see *Optional keywords* on page 3–7). For reasons of 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.

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 devices. 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 3–33.

Command	Parameter	Unit	Notes
*CLS			no query
*ESE	0 to 255		
*ESR?			query only
*IDN?			query only
*IST?			query only
*OPC			
*OPT?			query only
*PRE	0 to 255		
*PSC	0 | 1		
*RST			no query
*SRE	0 to 255		
*STB?			query only
*TST?			query only
*WAI			
*RCL	0 to 99 and 101 to 199		no query
*SAV	0 to 99 and 101 to 199		no query

*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. The output buffer is cleared.

*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, SFQ,0,1.00"`

0 = serial number
1.00 = firmware version

*IST? INDIVIDUAL STATUS QUERY returns the contents of the IST flag in decimal form (0 | 1).

The IST flag is the status bit sent during a parallel poll (refer to *IST Flag and Parallel Poll Enable Register (PPE)* on page 3–39).

*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 (refer to *Device Model and Command Processing* on page 3–31).

*OPC? OPERATION COMPLETE QUERY places an ASCII character 1 into the output buffer as soon as all preceding commands have been executed (refer to *Device Model and Command Processing* on page 3–31).

*****OPT? OPTION IDENTIFICATION QUERY requests identification of the device options and returns a list of the installed options. The options of systems 1 to 6 are separated by commas.

Example of a device response:
`"2072.5501.10","844355/001"`

The device returns order number and serial number.

*PRE 0 to 255 PARALLEL POLL RegISTER ENABLE sets the Parallel Poll Enable Register to the defined value. The query *PRE? returns the contents of the Parallel Poll Enable Register in decimal form.

*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 = 1 Clears the register. The query *PSC? reads out the contents of the power-on-status-clear flags. The response may be 0 or 1.
*RCL	RECALL Recalling internal (1 to 99) and external (101 to 199) instrument settings, which corresponds to commands RECALL INTERNAL and RECALL EXTERNAL.
*RST	RESET sets the device to a defined default state. Table D–1 on page D–1 shows the reset values.
*SAV	SAVE Storing internal (1 to 99) and external (101 to 199) instrument settings, which corresponds to commands STORE INTERNAL and STORE EXTERNAL.
*SRE 0 to 255	SERVICE REQUEST ENABLE sets the Service Request Enable Register to the defined value. Bit 6 (MSS mask bit) remains 0. 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. Bit 6 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 implemented in the digital video transmitter 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 (refer also to **OPC* on page 3–16 and *Device Model and Command Processing* on page 3–31).

CALibrate Subsystem

These commands cause a calibration and have no parameters or units. The individual commands have the following effect:

:CALibrate:RF_Level Calibrates the RF level. PASS or FAIL is returned in response to a query.

:CALibrate:MODulation Calibrates the I/Q modulation. PASS or FAIL is returned in response to a query.

:CALibrate:SYNThesis Calibrates the VCO synthesizer. PASS or FAIL is returned in response to a query.

DIAGnostic Subsystem

The DIAGNOSTIC subsystem is used for a diagnosis within the digital video transmitter.

Command	Parameter	Unit	Notes
:DIAGnostic:POSition	<value> | MINimum | MAXimum, <value> | MINimum | MAXimum		query only 1st parameter: address 2nd parameter: test point

:DIAGnostic:POSition

This command determines a voltage at a specific test point of a module. The first parameter selects the module address the second the test point within the module. This command is used in servicing.

OUTPut Subsystem

The OUTPUT is used to switch off the RF output.

Command	Parameter	Unit	Notes
:OUTPut[:STATe]	<value> | OFF | ON		

:OUTPut[:STATE]

Switches the output signal of the instrument on and off.

READ Subsystem

The READ subsystem is used to query values calculated or generated by the digital video transmitter.

Command	Parameter	Unit	Notes
:READ:IQCoder:DATarate			query only
:READ:IQCoder:SYMBols[:RATE]			query only
:READ:IQCoder:USEFul[:RATE]			query only
:READ:IQCoder:PACKetlength			query only

:READ:IQCoder:DATarate

This command queries the measured data rate for QAM or QPSK.

:READ:IQCoder:SYMBols[:RATE]

Query of the symbol rate which results from the measurement of the external ASI or SPI clock in case of QAM or QPSK. Only possible if the optional Input Interface is fitted.

:READ:IQCoder:USEFul[:RATE]
Query of the program data contained in the applied transport stream in case of QAM or QPSK. Only possible if the optional Input Interface is fitted.

:READ:IQCoder:PACKetlength
Query of the packet length of the transport stream applied via ASI or SPI in case of QAM or QPSK. Only possible if the optional Input Interface is fitted.

ROUTe Subsystem

The ROUTE subsystem is provided to establish logical and electrical connections within the instrument.

Command	Parameter	Unit	Notes
:ROUTe:MONitor	INTernal | EXTernal		
:ROUTe:REFerence:CLOCk	INTernal | EXTernal		

:ROUTe:MONitor
Selects the to display output mode INTERNAL / EXTERNAL

:ROUTe:REFerence:CLOCk
This command defines the reference clock of the instrument. An internal (INTernal) or an external reference clock (EXTernal) can be used.

SOURce:DM Subsystem

The SOURCE:DM subsystem provides the commands for digital modulation. Digital modulation includes QPSK, QAM, and the externally applied I/Q signal.

Command	Parameter	Unit	Notes
[:SOURce]:DM:CW:STATe	<value> | OFF | ON		
[:SOURce]:DM:FORMat	QPSK | QAM16 | QAM32 | QAM64 | QAM128 | QAM256		
[:SOURce]:DM:IQRatio[:MAGNitude]	<value> [ONE | PCT] | MINimum | MAXimum		
[:SOURce]:DM:MODulation:OFFSet	<value> [ONE | PCT] | MINimum | MAXimum		
[:SOURce]:DM:POLarity[:ALL]	NORMal | INVerted		
[:SOURce]:DM:QUADrature:ANGLe	<value> [Deg] | MINimum | MAXimum		
[:SOURce]:DM:SOURce	EXTernal | INTernal		
[:SOURce]:DM:STATe	<value> | OFF | ON		

[:SOURce]:DM:CW:STATe
Switches digital modulation (continuous wave) on and off.

[:SOURce]:DM:FORMat
Selects the type of modulation.

[:SOURce]:DM:IQRatio[:MAGNitude]
Sets the I/Q modulation imbalance in percent for the currently selected digital modulation mode.

[:SOURce]:DM:MODulation:OFFSet
Sets the residual carrier in percent for the currently selected digital modulation mode.

[:SOURce]:DM:POLarity[:ALL]
Selects the I/Q modulation (normal / changed) for the currently selected digital modulation mode.

[:SOURce]:DM:QUADrature:ANGLe
Sets the quadrature offset for the currently selected digital modulation mode.

[:SOURce]:DM: SOURce
Switches between EXTernal / INTernal digital modulation source (for example, QAM/QPSK versus external analog I/Q).

[:SOURce]:DM:STATe
This command switches digital modulation (QPSK, QAM, I/Q external) on and off. On power-up, the digital modulation used last is selected. Upon switch-off, the FM modulation used last is selected.

SOURce:FREQuency Subsystem

The SOURCE:FREQUENCY subsystem provides commands for setting the frequency.

Command	Parameter	Unit	Notes
[:SOURce]:FREQuency:CENTer	<value> | MAXimum | MINimum	[HZ]	
[:SOURce]:FREQuency:CHANnel	<value> | MAXimum | MINimum | UP | DOWN		
[:SOURce]:FREQuency:CHANnel:TABLe	NONE | USER1 | USER2 | USER3 | USER4 | USER5		
[:SOURce]:FREQuency[:CW]	<value> | MAXimum | MINimum	[HZ]	
[:SOURce]:FREQuency:FIXed	<value> | MAXimum | MINimum	[HZ]	
[:SOURce]:FREQuency:MODE	CW | FIXed | SWEep		
[:SOURce]:FREQuency:RESolution	<value> | MAXimum | MINimum	[HZ]	
[:SOURce]:FREQuency:SPAN	<value> | MAXimum | MINimum	[HZ]	
[:SOURce]:FREQuency:STARt	<value> | MAXimum | MINimum	[HZ]	
[:SOURce]:FREQuency:STOP	<value> | MAXimum | MINimum	[HZ]	

[:SOURce]:FREQuency:CENTer
Sets the center frequency for a sweep.

[:SOURce]:FREQuency:CHANnel
Selects the channel from a selected, user-defined channel table.

[:SOURce]:FREQuency:CHANnel:TABLe
This command selects a user-defined channel table. The user can generate up to five tables and assign a name to them.

[:SOURce]:FREQuency[:CW]
[:SOURce]:FREQuency:FIXed
These two commands have the same function. They set a fixed carrier frequency.

[:SOURce]:FREQuency:MODE
Selects the frequency mode for normal (CW or FIXed) and sweep operation (SWEep).

[:SOURce]:FREQuency:RESolution
Set the frequency steps for a sweep.

[:SOURce]:FREQuency:SPAN
Sets the frequency range for a sweep.

[:SOURce]:FREQuency:STARt
Sets the start frequency for a sweep.

[:SOURce]:FREQuency:STOP
Sets the stop frequency for a sweep.

SOURce:IQCoder Subsystem

The SOURCE: IQCODER subsystem provides commands for QAM and QPSK modulation.

Command	Parameter	Unit	Notes
[:SOURce]:IQCoder:QAM:DATarate	<value> [MB] | MAXimum | MINimum		
[:SOURce]:IQCoder:QAM:INPut	TSP | ASI | SPI | ASX | SPX		
[:SOURce]:IQCoder:QAM:MODE	DATA | AUTO | PRBS | NTSP | PTSP		
[:SOURce]:IQCoder:QAM:PACKetlength	P188 | P204		
[:SOURce]:IQCoder:QAM:SYMBols[:RATe]			query only
[:SOURce]:IQCoder:QAM:LOCKed			query only
[:SOURce]:IQCoder:QAM:ROLLoff	<value> | MAXimum | MINimum		
[:SOURce]:IQCoder:QAM[:SPECial]:INTerleave	<value> | OFF | ON		
[:SOURce]:IQCoder:QAM[:SPECial]:REEDsolomon	<value> | OFF | ON		
[:SOURce]:IQCoder:QAM[:SPECial]:SCRamble	<value> | OFF | ON		

Command	Parameter	Unit	Notes
[:SOURce]:IQCoder:QPSK:DATarate	<value> [MB] | MAXimum | MINimum		
[:SOURce]:IQCoder:QPSK:INPut	TSP | ASI | SPI | ASX | SPX		
[:SOURce]:IQCoder:QPSK:MODE	DATA | AUTO | PRBS | NTSP | PTSP		
[:SOURce]:IQCoder:QPSK:PACKetlength	P188 | P204		
[:SOURce]:IQCoder:QPSK:SYMBols[:RATe]			query only
[:SOURce]:IQCoder:QPSK:LOCKed			query only
[:SOURce]:IQCoder:QPSK:RATE	R1_2 | R2_3 | R3_4 | R5_6 | R7_8		
[:SOURce]:IQCoder:QPSK:ROLLoff	<value> | MAXimum | MINimum		
[:SOURce]:IQCoder:QPSK[:SPECial]:INTerleave	<value> | OFF | ON		
[:SOURce]:IQCoder:QPSK[:SPECial]:REEDsolomon	<value> | OFF | ON		
[:SOURce]:IQCoder:QPSK[:SPECial]:SCRamble	<value> | OFF | ON		

[:SOURce]:IQCoder:QAM:DATarate
Sets the data rate for QAM.

[:SOURce]:IQCoder:QAM:INPut
Selects the input interface for QAM. The INPUT INTERFACE option is required for all inputs except the TS Parallel input.

[:SOURce]:IQCoder:QAM:MODE
Selects the mode for the data generated by the I/Q coder for QAM. NTSP is used for null packet transport stream, and PTSP is used for packetized PRBS.

[:SOURce]:IQCoder:QAM:PACKetlength
Selects the data packet length for QAM.

[:SOURce]:IQCoder:QAM:SYMBols[:RATe]
Queries the symbol rate for QAM.

[:SOURce]:IQCoder:QAM:LOCKed
Queries the synchronization of the I/Q coder to the applied data stream for QAM. The following states are possible: LOCK for locked, UNL for unlocked, NOCL for no clock signal present, NOD for no data received and FRER for frame error.

[:SOURce]:IQCoder:QAM:ROLLoff
Sets the rolloff factor for square root cosine bandpass filtering for QAM.

[:SOURce]:IQCoder:QAM[:SPECial]:INTerleave
Switches the convolutional interleaver for QAM on and off.

[:SOURce]:IQCoder:QAM[:SPECial]:REEDsolomon
Switches the Reed Solomon encoder for QAM on and off.

[:SOURce]:IQCoder:QAM[:SPECial]:SCRamble
Switches the scramblers for QAM on and off.

[:SOURce]:IQCoder:QPSK:DATarate
Sets the data rate for QPSK.

[:SOURce]:IQCoder:QPSK:INPut
Selects the input interface for QPSK. The INPUT INTERFACE option is required for all inputs except the TS Parallel input.

[:SOURce]:IQCoder:QPSK:MODE
Selects the mode for the data generated by the I/Q coder for QPSK. NTSP is used for null packet transport stream, and PTSP is used for packetized PRBS.

[:SOURce]:IQCoder:QPSK:PACKetlength
Selects the data packet length for QPSK.

[:SOURce]:IQCoder:QPSK:SYMBols[:RATe]
Queries the symbol rate for QPSK.

[:SOURce]:IQCoder:QPSK:LOCKed
Queries synchronization of the I/Q coder to the applied data stream for QPSK. The following states are possible: LOCK for locked, UNL for unlocked, NOCL for no clock received, NOD for no data received and FRER for frame error.

[:SOURce]:IQCoder:QPSK:RATE
Puncturing rate for QPSK.

[:SOURce]:IQCoder:QPSK:ROLLoff
Sets the rolloff factor for square root cosine bandpass filtering for QPSK.

[:SOURce]:IQCoder:QPSK[:SPECial]:INTerleave
Switches the convolutional interleaver for QPSK on and off.

[:SOURce]:IQCoder:QPSK[:SPECial]:REEDsolomon
Switches the Reed Solomon encoders for QPSK on and off.

[:SOURce]:IQCoder:QPSK[:SPECial]:SCRamble
Switches the scrambler for QPSK on and off.

SOURce:MODulator Subsystem

The SOURCE:MODULATOR subsystem provides the command for switching the modulation on and off.

Command	Parameter	Unit	Notes
[:SOURce]:MODulator[:STATe]	<value> | OFF | ON		

SOURce:NOISe Subsystem

The SOURCE:NOISe subsystem provides the command for the noise generator.

Command	Parameter	Unit	Notes
[:SOURce]:NOISe:BANDwidth	<value> [HZ | AHZ | FHZ | PHZ | NHZ | UHZ | KHZ | MHZ | GHZ | THZ | PEHZ | EXHZ] | MAXimum | MINimum		
[:SOURce]:NOISe:CN	<value> [DB] | MAXimum | MINimum		
[:SOURce]:NOISe[:STATe]	<value> | OFF | ON		

[:SOURce]:NOISe:BANDwidth
Sets the noise generator bandwidth.

[:SOURce]:NOISe:CN
Sets the C/N ratio of the noise generator.

[:SOURce]:NOISe[:STATe]
Switches the noise generator on and off.

SOURce:POWer Subsystem

The SOURCE:POWER subsystem provides commands for setting the power at the output and within the instrument.

Command	Parameter	Unit	Notes
[:SOURce]:POWer[:LEVel]:MODE	NORMal | CONTinuous		
[:SOURce]:POWer[:LEVel][:IMMediate][:AMPLitude]	<value> [DBM] | MAXimum | MINimum		
SOURce:POWer:ALC:MODE	OFF | ON | AUTO		
SOURce:POWer:ALC:OFFMode	TABLe | HOLD		
SOURce:POWer:ALC:SEARch			
SOURce:POWer:ALC:LEARn			

[:SOURce]:POWer[:LEVel]:MODE
Selects the attenuator operating mode.

In the NORMal mode attenuator switches at any level to obtain the desired level setting.

In the CONTinuous mode, the attenuator is set so that the level can be reduced by up to 15 dB below the current value without any switching procedure required. Each time the mode is switched from NORMal to CONTinuous, the current level is set as the maximum for the continuous level range.

[:SOURce]:POWer[:LEVel][:IMMediate][:AMPLitude]
Sets the output level.

[:SOURce]:POWer:ALC:MODE
Switches ALC on and off. In the AUTO mode ALC is switched off during QPSK, QAM and I/Q external modulation. ALC is on with FM and FM external modulation.

[:SOURce]:POWer:ALC:OFFMode
With ALC switched off, set level values can be obtained either by a temporary switch-on of ALC (sample & hold) or by using a previously determined correction table (Table).

[:SOURce]:POWer:ALC:SEARCH
Selects manual sample & hold for optimum level adjustment at current setting.

[:SOURce]:POWer:ALC:LEARn
Starts generation of a new ALC table for current ambient conditions.

SOURce:SWEep Subsystem

Command	Parameter	Unit	Notes
[:SOURce]:SWEep:STEP	<value> | MAXimum | MINimum		HZ | AHZ | FHZ | PHZ | NHZ | UHZ | KHZ | MHZ | GHZ | THZ | PEHZ | EXHZ
[:SOURce]:SWEep:DWELL	<value> [S | AS | FS | PS | NS | US | MS | KS | MAS | GS | TS | PES | EXS] | MAXimum | MINimum		

[:SOURce]:SWEep:STEP
Sets frequency steps for sweep operation.

[:SOURce]:SWEep:DWELL
Sets the time for a frequency step for sweep operation.

SOURce:VOLTage Subsystem

The SOURCE:VOLTAGE subsystem provides one command only.

Command	Parameter	Unit	Notes
[:SOURce]:VOLTage[:LEVel][:IMMediate][:AMPLitude]	<value> [DBM | AV | FV | PV | NV | UV | MV | V | KV | MAV | GV | TV | PEV | EXV | DBAV | DBFV | DBPV | DBNV | DBUV | DBMV | DBV | DBKV | DBMAV | DBGV | DBTV | DBPEV | DBEXV] | MAXimum | MINimum		

[:SOURce]:VOLTage[:LEVel][:IMMediate][:AMPLitude]
Sets the output level. When queried the level is output with the unit set with UNIT:VOLTage.

STATus Subsystem

The STATUS subsystem controls the SCPI-defined status reporting system. Refer also to *Status Reporting System* on page 3–33.

Command	Parameter	Unit	Notes
:STATus:OPERation[:EVENt]?			query only
:STATus:OPERation:CONDition?			query only
:STATus:OPERation:ENABle	0 to 32767		
:STATus:PRESet			no query
:STATus:QUEStionable [:EVENt]?			query only
:STATus:QUEStionable:CONDition?			query only
:STATus:QUEStionable:ENABle	0 to 32767		
:STATus:QUEue[:NEXT]?			query only

:STATus:OPERation[:EVENt]?
Reads the contents of the event register of the STATus:OPERation Register.

:STATus:OPERation:CONDition?
Reads the contents of the condition register of the STATus:OPERation Register.

:STATus:OPERation:ENABle
Writes or reads the contents of the enable register of the STATus:OPERation Register.

:STATus:PRESet
Partly resets the SCPI status.

:STATus:QUEStionable [:EVENt]?
Reads the contents of the event register of the STATus:QUEStionable Register.

:STATus:QUEStionable:CONDition?

Reads the contents of the condition register of the STATus:QUEStionable Register.

:STATus:QUEStionable:ENABle

Writes or reads the contents of the enable register of the STATus:QUEStionable Register.

:STATus:QUEue[:NEXT]?

Reads out and clears the first-in entry from the error queue.

NOTE. *Status Operation Register and Status Questionable Register are not yet assigned.*

SYSTem Subsystem

Command	Parameter	Unit	Notes
:SYSTem:BEEPer:STATe	<value> | OFF | ON		
:SYSTem:CODer:PRESet			
:SYSTem:COMMunicate:GPIB[:SELF]:ADDRess	<value> | MAXimum | MINimum		
:SYSTem:COMMunicate:REMote	OFF | GPIB | SERial | BOTH		
:SYSTem:COMMunicate:SERial[:RECeive]:BAUD	<value> | MAXimum | MINimum		
:SYSTem:COMMunicate:SERial[:RECeive]:BITS	<value> | MAXimum | MINimum		7 | 8
:SYSTem:COMMunicate:SERial[:RECeive]:PACE	NONE | XON | ACK		
:SYSTem:COMMunicate:SERial[:RECeive]:PARity[:TYPE]	ODD | EVEN | ZERO | ONE | NONE		
:SYSTem:COMMunicate:SERial[:RECeive]:SBITs	<value> | MAXimum | MINimum		1 | 2
:SYSTem:DATE	<value> | MAXimum | MINimum, <value> | MAXimum | MINimum, <value> | MAXimum | MINimum		Year, Month, Day
:SYSTem:DISPlay:UPDate[:STATe]	<value> | OFF | ON		
:SYSTem:ERRor			query only
:SYSTem:FREQuency:RESolution	LOW | HIGH		
:SYSTem:INFormation			query only
:SYSTem:MODulation:PRESet			
:SYSTem:TIME	<value> | MAXimum | MINimum, <value> | MAXimum | MINimum, <value> | MAXimum | MINimum		Hour, Minute, Second
:SYSTem:VERSion			query only

:SYSTem:BEEPer:STATe
Switches the loudspeaker on and off.

:SYSTem:CODer:PRESet
Sets the preset values for parameters of the I/Q CODER menu (refer to *Menu Operation* on page 2–5).

:SYSTem:COMMunicate:GPIB[:SELF]:ADDRess
Sets the device address on the IEEE 488 bus.

:SYSTem:COMMunicate:REMote
Sets the active remote-control channel. The remote control is switched off by OFF, the IEEE 488 bus activated by GPIB and the RS-232 interface by SERial. BOTH enables communication via the IEEE 488 bus and the RS-232 interface.

:SYSTem:COMMunicate:SERial[:RECeive]:BAUD
Sets the baud rate for remote control via serial interface.

:SYSTem:COMMunicate:SERial[:RECeive]:BITS
Sets the number of data bits per byte for remote control via serial interface.

:SYSTem:COMMunicate:SERial[:RECeive]:PACE
Sets the handshake for remote control via serial interface. OFF means no handshake, XON means handshake with XON and XOFF, ACK means handshake with the handshake lines RTS and CTS.

:SYSTem:COMMunicate:SERial[:RECeive]:PARity[:TYPE]
Sets the parity bit. NONE means that no parity bit is transmitted, ZERO or ONE assigns a constant value to the parity bit, 0 or 1. EVEN or ODD means even or odd parity.

:SYSTem:COMMunicate:SERial[:RECeive]:SBITs
Sets the number of stop bits.

:SYSTem:DATE
Sets the date. The first number represents the year, the second the month and the third the day.

:SYSTem:DISPlay:UPDate[:STATe]
Activates or deactivates the status line on the screen.

NOTE. *When the status line is active, the processing speed is reduced.*

:SYSTem:ERRor?
Reads out and clears the first-in entry from the error queue. The effect is the same as of :STATus:QUEue[:NEXT].

:SYSTem:FREQuency:RESolution?
Permits the frequency resolution in the display for front-panel operation to be changed. HIGH means a resolution of 1 Hz, LOW means a resolution of 1 kHz.

:SYSTem:INFormation?
Query for hardware installed. A variable string formatted as follows is returned:

<Bios version>, <Bios subversion>, <program version>, <program subversion>, <coder version>, <coder subversion>, <DSP FM version>, <DSP FM subversion>, <DSP ADR version>, <DSP ADR subversion>, <module name>, <module version>, <Order No. of module>
{, <module name>, <module version>, <Order No. of module>}*

The following abbreviations are used for the modules:

MBO	Motherboard
COD	I/Q coder
IQC	I/Q converter
IQM	I/Q modulator
SYN	Synthesizer
BAS	Baseband
FM1 ... FM6	FM subcarrier 1 to 6
AD1 ... AD12	ADR subcarrier 1 to 12
NGEN	BB FM / noise
INPS	Input interface
ATT	Attenuator

:SYSTem:MODulation:PRESet
Sets the preset values for parameters of the modulation menu (refer to *Menu Operation* on page 2–5).

:SYSTem:TIME
Sets the time. The first number is the hour (24-hour clock), the second the minute, the third the second.

:SYSTem:VERSion?
Queries the SCPI version used.

UNIT Subsystem

The UNIT subsystem consists of a single command only.

Command	Parameter	Unit	Notes
:UNIT:VOLTAGE	AV | FV | PV | NV | UV | MV | V | KV | MAV | GV | TV | PEV | EV | DBAV | DBFV | DBPV | DBNV | DBUV | DBMV | DBV | DBKV | DBMAv | DBGV | DBTV | DBPEv | DBEV		

:UNIT:VOLTage
Sets the default unit for voltages. The default unit defines the unit to be used in responses to voltage queries and the unit to be used in voltage setting commands when no particular unit is specified.

The default unit is V.

Device Model and Command Processing

The device model shown in Figure 3–2 has been configured under the aspect of processing IEC/IEEE-bus commands. The individual components operate independently of each other and simultaneously. They communicate with each other by means of so-called messages.

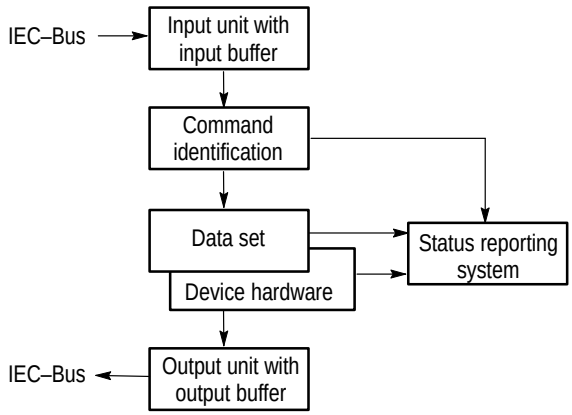


Figure 3–2: Device model with remote control via IEC/IEEE bus

Input Unit

The input unit receives commands in the form of characters via the IEC/IEEE bus and collects them in the input buffer. The input buffer has a capacity of 1024 characters. The input unit sends a message to the command identification as soon as one of the following conditions occurs:

- The input buffer is full
- It receives a terminator (<PROGRAM MESSAGE TERMINATOR> as defined by IEEE 488.2)
- It receives the interface message DCL

If the input buffer is full, data transfer on the IEC/IEEE bus is stopped and the data received so far are processed. Data transfer is then continued. If the input buffer is not full when a terminator is received, the input unit can receive the next command during command identification and processing. Receiving a DCL message clears the input buffer and immediately causes a message to be sent to the command identification.

Command Identification

The command identification analyzes the data received from the input unit, proceeding in the order in which the data are received. Only a DCL is given priority; a GET (Group Execute Trigger), for instance, is processed only after the previously received commands are executed. Any identified command is forwarded immediately to the data set but not immediately executed.

Syntax errors in the command are recognized and passed on to the status reporting system. The rest of a command line received after a syntax error is analyzed and processed as far as possible.

If the command identification receives a terminator or DCL, it requests the data set to execute the command in the device hardware. After this request further commands can be executed. This means that further commands can be executed while hardware setting is taking place (overlapping execution).

Data Set and Device Hardware

The term “device hardware” refers to that part of the device which performs the actual device functions — signal generation, measurements, and so on. The controller is not included.

The data set is an exact representation of the device hardware in the software.

IEC/IEEE-bus commands cause a modification in the data set. The new values (for example, frequency) are entered in the data set but forwarded to the hardware only after a request to do so from the command identification. Since this request is only sent at the end of a command line, the sequence of commands in a line is irrelevant.

Immediately before the data are forwarded to the device hardware, they are verified for compatibility with other data and with the device hardware. If it turns out that the setting is not possible, the message execution error is sent to the status reporting system. Modifications of the data set are ignored and the hardware is not set. Because of the delayed verification and hardware setting it may happen that illegal device states are set briefly within a command line without an error message being issued. However, a legal device status must be obtained at the end of a command line.

Prior to handing the data to the hardware, the settling bit is set in the STATus:OPERation Register (refer to *STATus:OPERation Register* on page 3–41). The hardware carries out the settings and as soon as a settled state is reached the bit is reset. This bit may be used for synchronization of the command processing.

IEC/IEEE-bus queries cause the data set management to send the desired data to the output unit.

Status Reporting System

The status reporting system collects information on the device status and makes it available to the output unit on request. Structure and function are described in detail in *Status Reporting System* on page 3–33.

Output Unit

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

If the device is addressed as a talker and the output buffer does not contain any data or expect data from the data set management, the output unit sends the error message “Query UNTERMINATED” to the status reporting system. No data will be sent on the IEC/IEEE interface and the controller waits until its time limit is reached. This procedure is prescribed by SCPI.

Command Sequence and Command Synchronization

The description above shows that overlapping command processing is permissible. Likewise, setting commands of a command line need not be executed in the sequence of their arrival.

To ensure that commands are executed in a desired sequence, each command has to be sent in a separate line with its own IBWRT() call.

To prevent an overlapping execution of commands, *OPC, *OPC?, or *WAI must be sent. All three commands have the effect that a certain action is triggered only after the hardware has been set and is settled. The controller can be forced by suitable programming to wait for an action (see Table 3–1).

Table 3–1: Synchronization with *OPC, *OPC? and *WAI

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 a service request (SRQ)
*OPC?	Writing “1” into the output buffer	Addressing the device as a talker
*WAI	Continuing the IEC/IEEE-bus handshake	Sending the next command

An example of command synchronization is given in *Appendix E:Program Examples*.

Status Reporting System

The status reporting system (see Figure 3–3) stores all information on the current operating status of the device and on errors that occurred. The information is stored in the status registers and in the error queue. The status registers and the error queue can be queried via the IEC/IEEE bus.

The information is hierarchically structured. The highest 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) 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 device.

The status reporting system also includes the Individual STatus (ST) flag and the Parallel Poll Enable Register (PPE) assigned to it. The IST flag, just as SRQ, combines the complete device status in a single bit. The PPE has an analog function for the IST flag like the SRE for the service request.

The output buffer contains the messages returned by the device to the controller. It is not part of the status reporting system but it determines the value of the MAV bit in the STB so that it is also shown in Figure 3–3.

Each SCPI register consists of five 16-bit registers which assume different functions (see Figure 3–3). 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 3 of the STATus:OPERation Registers, for instance, is assigned in all five registers to the hardware status “Wait for trigger”. Bit 15 (the most significant bit) is set to zero in all status registers. Thus the contents of the registers can be processed by the controller as a positive integer.

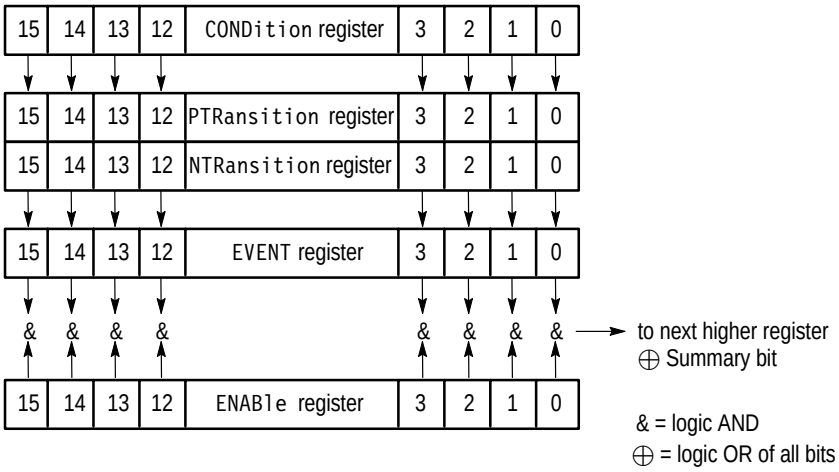


Figure 3–3: Status register model

CONDition Register

The CONDition register is directly written by the hardware or the summary bit of the next lower register. Its content reflects the current device status. This register can only be read; it cannot be written or cleared. Reading the register does not change its content.

PTRansition Register

The positive transition register (PTR) 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 content.

NTRansition Register

The negative transition register (NTR) 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 content.

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 readout, 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 device. It can only be read by the user. Reading the register clears its content. The 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 = 1: the associated EVENt bit does not affect the summary bit.
ENAB bit = 0: if the associated EVENT bit 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 content.

Summary Bit

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

The device automatically generates the summary bit for each register. An event, for example, an unlocked PPL, may thus cause a service request through all hierarchical levels.

NOTE. *The Service Request Enable Register (SRE) defined by IEEE 488.2 can be used as the ENABle register for STB, provided the structure of STB is follows the SCPI rules. Similarly, the ESE can be used as the ENABle register for ESR.*

Overview of Status Registers

Figure 3–4 provides an illustration of the status registers.

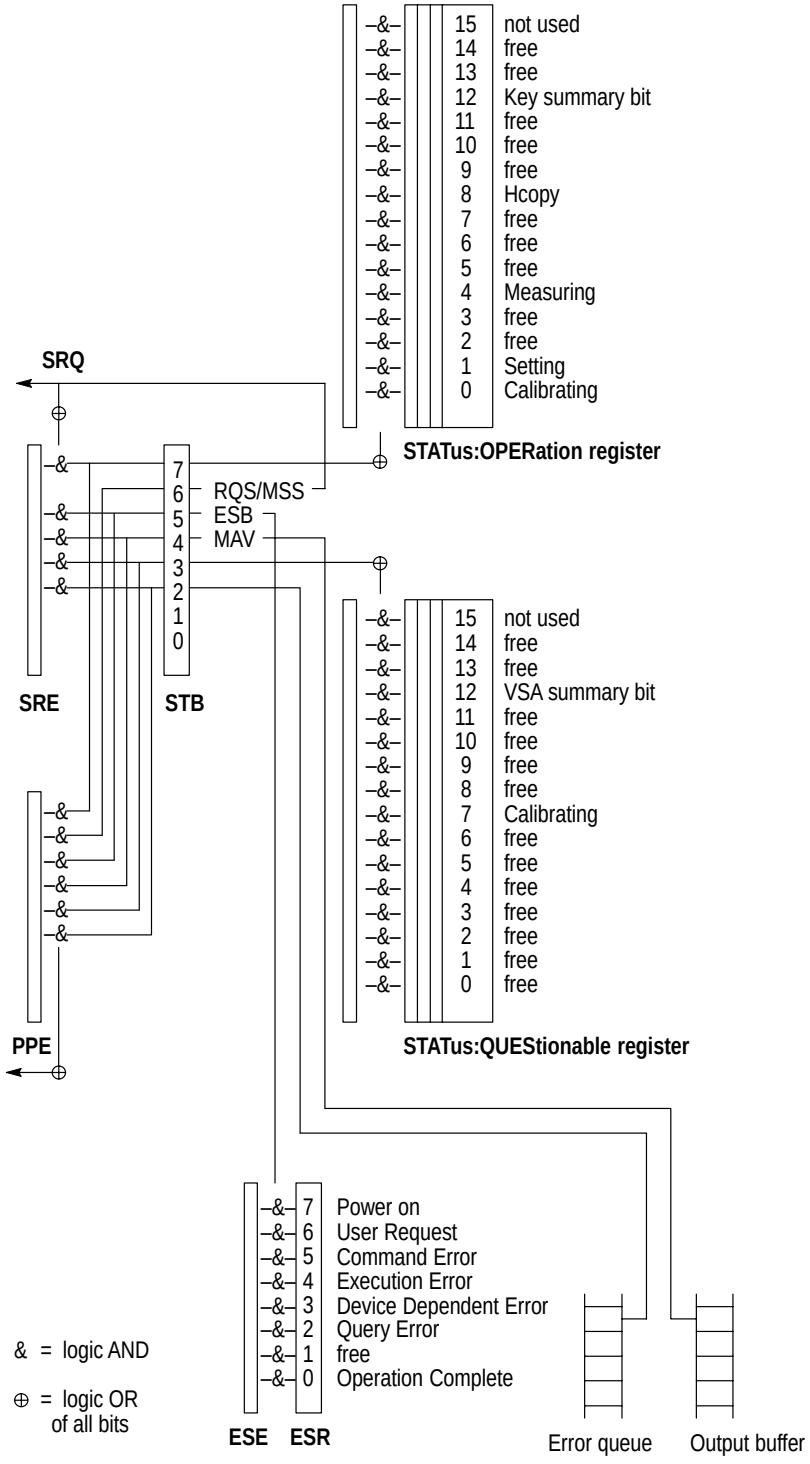


Figure 3–4: Status registers diagram

Description of Status Registers

The Status Byte Register is already defined in IEEE 488.2. Since it collects all the information of the other lower-order registers, it gives a rough overview on the device status. Its function corresponds to that of the CONDition register of a SCPI register and assumes the highest level in the SCPI hierarchy. A special characteristic is that bit 6 is used as summary bit for all other bits of the Status Byte.

The Status Byte is read with command *STB? or by a serial poll.

SRE is associated with the STB. Its function corresponds to that of the ENABle register of the SCPI register. 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 on the IEC/IEEE bus, which triggers an interrupt in the controller, provided the controller has been configured accordingly, and can be further processed by the controller.

The SRE can be set with *SRE and read by the query *SRE?.

Table 3–2 provides a definition of the bits in the status byte register.

Table 3–2: 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 be recognized and specified in detail by querying the error queue. The query returns an informative error message. This procedure is recommended, since it considerably reduces the problems of IEC/IEEE-bus control.
3	QUEStionable Status summary bit This bit is set if an EVENt bit is set in the QUEStionable Status Register 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. This bit may be used to automate reading of data from the device into the controller (refer to *Appendix E: Program Examples*)

Table 3–2: 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. 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 device issues 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 device. Information on the type of action can be obtained by querying the OPERation Status Register.

IST Flag and Parallel Poll Enable Register (PPE). Similar to the SRQ, the IST flag combines the complete status information in a single bit. It can be queried by a parallel poll (refer to *Parallel Poll* on page 3–43) or by the query *IST?.

The Parallel Poll Enable Register (PPE) determines which bits of the STB affect the IST flag. The bits of the STB are ANDed with the corresponding bits of the PPE, bit 6 being used too – in contrast to the SRE. The IST flag is obtained by ORing all results together. The PPE can be set by the command *PRE and read by the query *PRE?.

Event Status Register (ESR) and Event Status Enable Register (ESE). The ESR is already defined in the IEEE 488.2 standard. It is comparable to the EVENt register of an SCPI register. The Event Status Register can be read out by the query *ESR?. See Table 3–3.

The ESE forms the associated ENABle register. It can be set by the command *ESE and read by the query *ESE?.

Table 3–3: Definition of bits in the Event Status Register

Bit No.	Definition
0	Operation Complete Upon reception of the *OPC command this bit is set exactly when all previous commands have been executed.
2	Query Error This bit is set if the controller wants to read data from the device but has not sent a data request command or has not read requested data and sends new commands to the device instead. A frequent cause is an incorrect 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 will be entered into the error queue (refer to *Appendix C: List of Error Messages*).
4	Execution Error This bit is set if the syntax of the command received is 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 will be entered into the error queue (refer to *Appendix C: List of Error Messages*).
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 will be entered into the error queue (refer to *Appendix C: List of Error Messages*).
6	User Request This bit is set when the [LOCAL] key is pressed; that is, when the device is switched to manual operation.
7	Power On This bit is set upon power on of the device.

STATus:OPERation Register. The STATus:OPERation register, Table 3–4, contains information in the CONDition register on operations currently performed by the device or in the EVENt register on operations performed by the device since the last readout. It can be set by the commands STATus:OPERation:CONDition or STATus:OPERation[:EVENt] and read by the queries STATus:OPERation:CONDition? or STATus:OPERation[:EVENt]?.

Table 3–4: Definition of bits used in the STATus:OPERation Register

Bit No.	Definition
0	CALibrating This bit is set as long as a calibration is being performed by the device.
1	SETTling This bit is set as long as settling goes on after a setting command. It is set only if the settling time is longer than the time required for command execution.
3	SWEeping This bit is set as long as a sweep is being performed by the device.
4	MEASuring This bit is set as long as a measurement is being performed by the device.
5	WAIT for TRIGGER This bit is set as long as the device waits for a trigger event.

STATus:QUEStionable-Register. The STATus:QUEStionable register, Table 3–5 contains information on questionable device states. These may for instance occur if the device is operated out of specifications. The register can be read by the queries STATus:QUEStionable:CONDition or STATus:QUEStionable[:EVENt] and queried by the commands STATus:QUEStionable:CONDition? or STATus:QUEStionable[:EVENt]?.

Table 3–5: Definition of bits used in the STATus:QUEStionable Register

Bit No.	Definition
0	VOLTage This bit is set when a questionable voltage occurs.
4	FREQuency This bit is set when a questionable frequency occurs.
5	PHASe This bit is set when a questionable phase value occurs.
6	MODulation This bit is set when a questionable modulation is performed.
7	CALibration This bit is set when a calibration procedure is not properly performed.

Use of Status Reporting Systems

For an efficient use of the status reporting system, the information it contains must be transferred to the controller and further processed. There are various transfer methods, which are described in the following subtopics. Refer to *Appendix E: Program Examples* for detailed program examples.

Service Request, Use of Hierarchical Structure. Under certain conditions, the device may send a service request (SRQ) to the controller. This service request usually causes an interrupt at the controller to which the control program can respond by suitable action. As shown in Figure 3–4 on page 3–37, an SRQ will always be triggered if one or more of 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 suitably setting the ENABle registers of the status registers, it is possible for any bit in any status register to trigger an SRQ. To utilize the possibilities of the service request, all bits in the enable registers SRE and in the ESE must be set to “1”.

Example (refer also to *Overview of Status Registers* on page 3–37 and *Appendix E: Program Examples*):

Using the *OPC command to generate an SRQ:

1. Set bit 0 (Operation Complete) in the ESE.
2. Set bit 5 (ESB) in the SRE.

   The device generates an SRQ upon completion of its settings.

Indicating the end of a sweep by an SRQ on the controller:

1. Set bit 7 (summary bit of the STATus:OPERation Register) in the SRE.
2. Set bit 3 (sweeping) of the STATus:OPERation:ENABle register.
3. Set bit 3 in the STATus:OPERation:NTRansition register so that the transition of sweeping bit 3 from 1 to 0 (sweep end) will also be recorded in the EVENt register.

   After termination of the sweep the device generates an SRQ.

The SRQ is thus the only way for the device to become active of its own. A controller program should set the device so that a service request will be generated in case of malfunctions. The program should suitably respond to the service request. A detailed example of a service request routine is given in *Appendix E: Program Examples*.

Serial Poll. Same as the command *STB, serial poll is used to query the contents of the status byte register. However, since the query is performed via interface commands, it is considerably faster. The serial poll method has already been

defined in the IEEE 488.1 standard and was previously the sole comprehensive means for querying the status byte. This method functions also with devices that do not comply with SCPI or with IEEE 488.2.

The QuickBASIC command IBRSP () is used for a serial poll. The serial poll is mostly used to obtain a fast overview of the states of devices connected to the IEC/IEEE bus.

Parallel Poll. In the parallel poll mode, each of up to eight devices is requested simultaneously by a single command from the controller to transmit 1 information bit on the data lines (that is, to pull the data line assigned to it to logic 0 or 1). Similar to the SRE register, which defines the conditions under which an SRQ will be generated, there is a Parallel Poll Enable Register (PPE), which is also ANDed bit by bit with the STB taking into account bit 6. The result is ORed and returned (if required in inverted form) as a reply to a parallel poll of the controller. The result can also be read out by the command *IST without a parallel poll.

First the device must be set for the parallel poll by the QuickBASIC command IBPPC (). This command assigns a data line to the device and determines whether the response should be inverted or not. The parallel poll itself is made by IBRPP ().

The parallel poll mode is mainly used to find out quickly which of the devices connected to the IEC/IEEE bus has raised an SRQ. To do this SRE and PPE must be set to the same value. A detailed example on parallel poll is given in *Appendix E: Program Examples*.

Queries. Each individual register of a status register can be read out by queries. The individual queries are given in the detailed description of the registers on page 3–38. The queries always return a number representing the bit pattern of the queried register. This number is evaluated by the controller program.

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

Error Queue Query. Each error condition in the device 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 of the ERROR menu manually or via the IEC/IEEE bus 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 queue, 0 = “No error” is returned.

The error queue should be queried in the controller program after each SRQ since the entries provide more detailed information on the error source than the status registers. Particularly in the test phase of a controller program the error

queue should be queried regularly, since it also registers erroneous commands from the controller to the device.

Resetting the Status Reporting System

Table 3–6 contains the various commands and events causing a reset of the status reporting system. None of the commands (with the exception of *RST and SYSTem:PRESet) affects the functional device settings. In particular, DCL does not clear the device settings.

Table 3–6: Resetting the device functions

Event / Effect	Switching on AC supply voltages – Power On Status Clear 0	Switching on AC supply voltages – Power On Status Clear 1	DCL, SDC (Device Clear, Selected Device Clear)	*RST or SYSTem :PRESet	STATus :PRESet	*CLS
Clears STB, ESR		yes				yes
Clears SRE, ESE		yes				
Clears PPE		yes				
Clears EVENt registers		yes				yes
Clears ENABle registers of all OPERation and QUESTionable Registers, fills the ENABle registers of all other registers with “1”.		yes			yes	
Fills PTRansition registers with “1”, clears NTRansition registers		yes			yes	
Clears error queue	yes	yes				yes
Clears output buffer	yes	yes	yes	(1)	(1)	(1)
Clears command processing and input buffer	yes	yes	yes			yes

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

Maintenance and Troubleshooting

This section describes basic maintenance and troubleshooting procedures and should be be used only by qualified technicians. For more complete servicing information see the service manual.

Maintenance

The instrument requires no regular maintenance. Generally, maintenance is confined to cleaning the instrument.

Cleaning the outside

The outside of the instrument should be cleaned with a soft, lint-free cloth or a brush. In the case of heavier contamination, use mild soap suds for cleaning. To avoid damaging the front-panel labels or plastic parts, do not use solvents such as acetone.

Dust within the instrument should be removed regularly to ensure effective cooling (approximately every 1 to 2 years depending on operating hours per day and amount of dust in the rooms).

Cleaning the inside

For cleaning the inside, remove the instrument from the cabinet or rack. Remove the dust by means of a brush or grease-free, compressed air.

Storage

The storage temperature range of the instrument is:

– 40 to +70° C**.**

Protect the instrument against dust when it is stored for an extended period of time.

Functional Check

The rated specifications should be checked from time to time. Data and tolerances are specified in the data sheet. In most cases, slight deviations can be corrected by means of tuning elements.

Mechanical Check

When the instrument is open (for example, for cleaning the inside), check whether the PC boards are seated properly.

Also check the mechanical function of all control elements such as potentiometers and switches.

Replacement of Modules

WARNING. *Disconnect the power cord from the rear-panel before attempting to open the instrument. Failure to disconnect the power cord first could cause injury or death.*

Opening the instrument

1. Switch off the instrument and disconnect power plug.
2. Disconnect all cables.
3. Unscrew and remove the two rear-panel feet (two Phillips screws each).
4. Unscrew rear cover and loosen the bottom rails.
5. If required, remove the upper and lower panelling (proceed carefully because of braided cord).

Closing the instrument

For closing the instrument proceed in the reverse order. When putting the cover back, take care that it fits properly into the grooves. While attaching the feet, press on the cover so that it locks into the spigots provided.

WARNING. *Disconnect the power cord from the rear-panel before attempting to remove the power supply. Failure to disconnect the power cord first could cause injury or death.*

Removing the power supply

To remove the power supply undo the four screws of the two rear-panel feet. Withdraw the upper and lower panelling towards the rear.

Replacing the Lithium 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.

CAUTION. *The battery in the instrument is a high–power lithium cell. To prevent injury, avoid short circuiting and charging the battery, since these actions can cause the battery to explode. Do not open discharged batteries; dispose them as hazardous waste.*

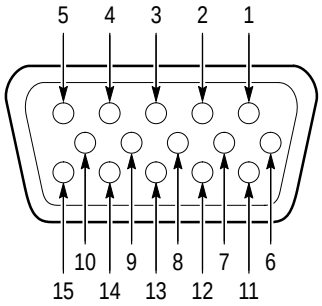
The instrument uses a lithium battery for storing the selected device status. The lifetime of the battery depends on the operating conditions. The battery should be replaced as required (for example, after a long storage period at high temperatures). Replace the discharged battery by one of the same type.

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

WARNING. *Disconnect the power cord from the rear-panel before attempting to open the instrument. Failure to do so could cause injury or death.*

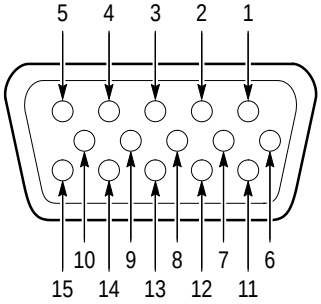
To replace the battery, open the instrument and replace the discharged battery properly, using solder lugs and cable ties.

MONITOR Connector



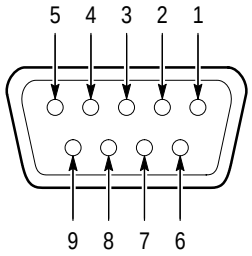
Pin assignment X18:	
1	red
2	green
3	blue
4	GND
5	Intens./N.C.
6 ... 11	GND
12	N.C.
13	H SYNC
14	V SYNC
15	N.C.

SERBUS Connector



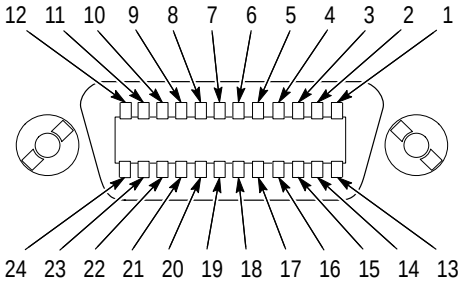
Pin assignment X13:	
1	GND
2	SYSRESET
3	RESET
4	GND
5	RESERVE1
6	DATA
7	SERCLOCK
8	GND
9	I^2C-CLK
10	I^2C-DATA
11	GND
12	SYNC
13	INT/EXT
14	GND
15	N.C.

RS-232 Connector



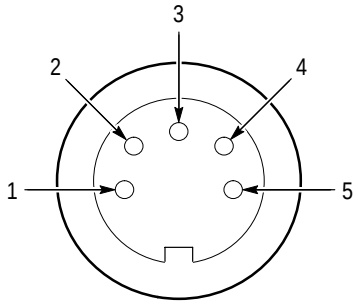
Pin assignment X18:	
1	DCD
2	RXD
3	TXD
4	DTR
5	GND
6	DSR
7	RTS
8	CTS
9	RI

IEC/IEEE-Bus Connector



Pin assignment X12:	
1	DIO 1
2	DIO 2
3	DIO 3
4	DIO 4
5	EOI
7	NRFD
8	NDAC
9	IFC
10	SRQ
11	ATN
12	SHIELD
13	DIO 5
14	DIO 6
15	DIO 7
16	DIO 8
17	REN
18	GND (6)
19	GND (7)
20	GND (8)
21	GND (9)
22	GND (10)
23	GND (11)
24	LOGIC GND

KEYBOARD Connector



Pin assignment X15:	
1	CLK
2	DATA
3	RESET
4	GND
5	+5V

Appendix A: Specifications

This section contains the specifications for the DVT200 Digital Video Transmitter. All specifications are guaranteed unless labeled "typical." Typical specifications are provided for your convenience and are not guaranteed. Specifications labeled with the ✓ symbol are checked in the Performance Test (PT) procedure in the service manual.

NOTE. *Performance requirements are valid provided that the instruments are operating within environmental parameters and have warmed up for at least one hour.*

Table A–1: Electrical characteristics

Characteristics	Requirements	Supplemental information
Overvoltage category		CAT II
Main Carrier Frequency		
✓ Range	0.3 MHz to 3.3 GHz	
Resolution	1 Hz	
Reference Frequency		
Accuracy	± 1 ppm	
Aging	± 1 ppm/year	After 30 days of operation
Drift	<± 0.2 dB	For temperature range of 20–26° C, within one day of the measurement, after the instrument has warmed up for 1 hour.
Temperature effect, typical	2 ppm	0 to 50° C
Reference Output		
Frequency, typical	10 MHz	
Level, typical	1 V_{RMS}	Sinewave
Reference Input		
✓ Frequency	5 or 10 MHz	
Level, typical	0.1 to 0.2 V_{RMS}	
Resistance, typical	200 Ω	
Locking range, typical	3 ppm	
Spectral Purity: Spurious Signals		
✓ Harmonics	< –30 dBc	Up to 5 GHz
✓ Non-harmonics, CW	< –70 dBc	
✓ Non-harmonics, I/Q	< –56 dBc	Referenced to CW

Table A–1: Electrical characteristics (cont.)

Characteristics	Requirements	Supplemental information
✓ Single side band phase noise	< –108 dBc/Hz	Offset from carrier 20 kHz
✓ Spurious FM (RMS f=1 GHz)	< 8 Hz	0.3 to 3 kHz (CCITT)
Level		
Range		
CW	–99 to + 13 dBm	
I/Q, digital modulation	–99 to + 4 dBm	
Resolution	0.1 dB	
Total level error	< ± 1.5 dB	
✓ Frequency response	≤ 1 dB	At 0 dBm; ≤ 0.5 dB, typical
Level, Interruption-free level setting, typical	0 to –15 dB	
Output		
Impedance, typical	50 Ω	Connector: Front-panel type N, female
VSWR		
RF level		
✓ +13 to 0 dBm	< 2	
< 0 to –99 dBm, typical	1.4	
Overvoltage protection, typical		Resettable signal path interrupt
DC block to 50 V DC		
I/Q Modulation		
Frequency response		
DVB–C		Up to 7 MS/s
✓ DC to 2.975 MHz	< ± 0.2 dB	Flatness measured up to ± 2.975 MHz, RF 0.3 to 1000 MHz
DC to 2.975 Mhz, typical	< ± 0.3 dB	Flatness measured up to ± 2.975 MHz, RF 0.3 to 3.3 GHz
✓ DC to 3.5 MHz	3 dB ± 1 dB	Bandwidth measured at ± 3.5 MHz, RF 0.3 to 1000 MHz
DVB–S		Up to 45 Msymb/s, RF 0.3 to 3300 MHz
✓ DC to 14.625 MHz	< ± 1.0 dB	Flatness measured at ± 14.625 MHz
✓ DC to 22.5 MHz	3 dB ± 1 dB	Bandwidth measured at ± 22.5 MHz
✓ Signal/Noise ratio	> 35 dB	QAM, 6.9 MS/s, roll-off = 0.15, measured with DDS200
✓ Residual carrier	< –50 dBc	At input voltage of 0 V, 50 Ω I/Q source, referred to full range
✓ I/Q amplitude balance	< 1%	At 0% I/Q amplitude balance
✓ Quadrature offset (phase error)	< 1°	At 0° quadrature offset

Table A–1: Electrical characteristics (cont.)

Characteristics	Requirements	Supplemental information
External I and Q inputs		Connector: Rear-panel BNC (2)
Input impedance, typical	50Ω	
VSWR (DC to 30 MHz)	< 1.4	
Input voltage, typical	0.5 V	For full range $(I^2 + Q^2)^{1/2} \leq 0.5$ V
I/Q Impairments		Data input for MPEG2 data stream
Carrier suppression		
Range	0 to 50%	
Resolution	0.1 %	
Amplitude imbalance		
Range	–25 to +25%	
Resolution	0.1%	
Quadrature offset (phase error)		
Range	–10° to +10°	
Resolution	0.1°	
Modulation Signals		
MPEG input		Synchronous parallel MPEG2 transport stream (LVDS, to DVB–A010), Connector: Rear-panel 25-pin female, shielded
Resistance, typical	100Ω	
Level, typical	100 mV_{pp} to 2.0 V_{pp}	
Data rate	2.5 to 60 Mbit/s	
Internal PRBS generator		External MPEG clock recommended
Data rate	2.5 to 60 Mbit/s	
Sequence length	$2^{23}-1$	To CCITT Rec. O.151
Mode		Continuous or upon loss of MPEG stream
Internal null packet generator		As defined by DVB measurement guidelines, External MPEG clock recommended
Data rate	2.5 to 60 Mbit/s	
QPSK encoder		
QPSK coding and error protection		To ETS 300 421 (DVB–S)
Symbol rate	2 to 45 MSym/s	
Energy dispersal	On/Off	
Reed-Solomon encoder	On/Off	204, 188, t=8
Convolutional interleaver	On/Off	
Pulse filtering	0.25, 0.3, 0.35, 0.4, 0.45 roll off	

Table A–1: Electrical characteristics (cont.)

Characteristics	Requirements	Supplemental information
Puncturing rate	1/2, 2/3, 3/4, 5/6, 7/8	
QAM encoder		
QAM coding and error protection		To ETS 300 429
Symbol Rate, typical	2.0 to 7.0 MSym/s	When setting symbol rate value, the accuracy should be to three decimal places.
Symbol rate	6.9 MSym/s	
Energy dispersal	On/Off	
Reed-Solomon encoder	On/Off	204, 188, t=8
Convolutional interleaver	On/Off	
Pulse filtering	0.1, 0.13, 0.15, 0.175, 0.2 roll off	
Mapping	16, 32, 64, 128[1], 256[1] QAM	
Noise Generator (Opt. B5)		
Receiver bandwidth (B/W) setting range	1 to 60 MHz	
Carrier-to-Noise (C/N)		
Setting range	60 dB	Limits vary with receiver B/W setting. For example: For BW = 6.9 MHz, limits are from 0.6 to 60.6 dB For BW = 27.5 MHz, limits are from 1.2 to 61.2 dB
Resolution	0.1 dB	
Accuracy		For QPSK: < 25 dB C/N For QAM: < 35 dB C/N Accuracy degrades progressively at higher C/N values.
5–45° C	<± 1 dB	
20–26° C	<± 0.5 dB	
Drift at 20–26° C	<± 0.2 dB	Within one day

1 **Operation at 128 and 256 QAM is not specified.**

Table A–2: Certifications and compliances

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 55011 Class A Radiated and Conducted Emissions EN 55011 Class B Radiated and Conducted Emissions EN 50081-1 Emissions: EN 55022 Class B 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
EMC Compliance	Meets the intent of Directive 89/336/EEC for Electromagnetic Compatibility when it is used with the product(s) stated in the specifications table. Refer to the EMC specification published for the stated products. May not meet the intent of the Directive if used with other products.
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, Amended by 93/68/EEC EN 61010-1:1993 Safety requirements for electrical equipment for measurement, control, and laboratory use
Approvals	UL3111-1 – Standard for electrical measuring and test equipment CAN/CSA C22.2 No. 1010.1 – Safety requirements for electrical equipment for measurement, control and laboratory use
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 A–3: Power characteristics

Characteristic	Description
Line Voltage	85 to 132 VAC and 187 to 264 VAC
Line Frequency	47 to 440 Hz
Power Consumption	< 170 VA

Table A–4: Physical characteristics

Dimension	mm	in
Height	192	7.6
Width	435	17.1
Depth	460	18.1
Weight	**kg**	**lb**
Net	17.5	38.6

Table A–5: Environmental characteristics

Characteristic	Description
Operating temperature range	0° C to +50° C
Rated temperature range	+5° C to +45° C
Storage temperature range	–40° C to +70° C

Appendix B: IEC/IEEE Bus Interface

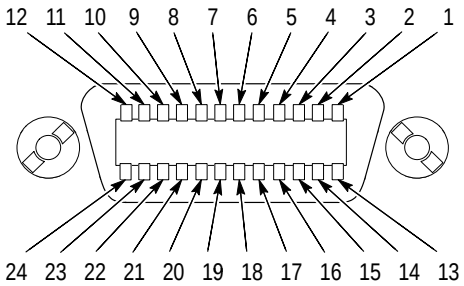
The DVT200 Digital Video Transmitter is equipped with an IEC/IEEE-bus interface as standard. The IEEE 488 connector, Table B–1, is located at the rear. For remote control of the device, a controller may be connected via this interface by means of a screened cable.

Interface Characteristics

The following is a list of the interface characteristics:

- 8-bit parallel data transmission
- Bidirectional data transmission
- Three-wire handshake
- High transmission rate, maximum of 350 Kbyte/s
- Up to 15 external devices connectible
- Maximum length of connecting cables: 15 m (length of single cable: 2 m)
- Wired OR links when several devices are parallel-connected.

Table B–1: Bus Lines

IEC/IEEE 488 Connector	Pin No.	Bus Line	Pin No.	Bus Line
	1	DIO1	13	DIO5
	2	DIO2	14	DIO6
	3	DIO3	15	DIO7
	4	DIO4	16	DIO8
	5	EOI	17	REN
	6	DAV	18	GND(6)
	7	NRFD	19	GND(7)
	8	NDAC	20	GND(8)
	9	IFC	21	GND(9)
	10	SRQ	22	GND(10)
	11	ATN	23	GND(11)
	12	Shield	24	Logic GND

Bus Lines

1. Data bus with 8 lines DIO 1 to DIO 8

   Transmission is bit-parallel and byte-serial in ASCII/ISO code. DIO 1 is the least-significant and DIO 8 the most-significant bit.

2. Control bus with 5 lines

   IFC (Interface Clear),
   active LOW resets the interfaces of connected devices to a defined initial condition.

   ATN
   (Attention), active LOW signals the transmission of interface messages.
   inactive HIGH signals the transmission of device messages.

   SRQ (Service Request),
   active LOW enables a device to send a service request to the controller.

   REN (Remote Enable),
   active LOW allows switchover to the remote control mode.

   EOI (End or Identify),
   in connection with ATN has two functions:
   ATN = HIGH active LOW signals the end of a data transmission.
   ATN = LOW active LOW triggers a parallel poll.

3. Handshake bus with three lines

   DAV (Data Valid),
   active LOW signals that a valid data byte is on the bus.

   NRFD (Not Ready For Data),
   active LOW signals that one of the connected devices is not ready to accept data.

   NDAC (Not Data Accepted),
   active LOW, until the connected device has accepted the data on the bus.

Interface Functions

Devices controlled via IEC/IEEE bus may be provided with different interface functions. The interface functions of FSQ are listed in Table B–2.

Table B–2: Interface functions

Control character	Interface function
SH1	Source handshake
AH1	Acceptor handshake
L3..L4/LE3..LE4	Listener
T5..T8/TE5..TE8	Talker, capability to answer serial poll
SR1	Service request
PP1	Parallel poll
RL1	Remote/local switchover
DC1	Device clear
DT1	Device trigger
C1...C27	Controller

Interface Messages

Interface messages are sent to the device on data lines when the ATN line is active LOW. They are used for communication between device and controller.

Common Commands

Common commands are in the code range 10 to 1F hex. They affect all devices on the bus without any addressing being required.

Table B–3: Common commands

Command	QuickBASIC command	Function in the device
DCL (Device Clear)	IBCMD (controller%, CHR$(20))	Interrupts processing of received commands and sets the command processing software to a defined initial state. The device setup remains unchanged.
IFC (Interface Clear)	IBSIC (controller%)	Resets the interfaces to their initial condition.
LLO (Local Lockout)	IBCMD (controller%, CHR$(17))	The LOC/IEC ADDR key is disabled.
SPE (Serial Poll Enable)	IBCMD (controller%, CHR$(24))	Ready for serial poll
SPD (Serial Poll Disable)	IBCMD (controller%, CHR$(25))	End of serial poll
PPU (Parallel Poll Unconfigure)	IBCMD (controller%, CHR$(21))	End of parallel poll query status

Addressed Commands

The addressed commands are in the code range 00 to 0F hexadecimal. They only affect devices addressed as a listener.

Table B–4: Addressed commands

Command	QuickBASIC command	Function in the device
SDC (Selected Device Clear)	IBCLR (device%)	Interrupts processing of received commands and sets the command processing software to a defined initial state. The device setup remains unchanged.
GTL (Go to Local)	IBLOC (device%)	Change to local mode (manual control)
PPC (Parallel Poll Configure)	IBPPC (device%, data%)	Configures device for parallel poll. The Quick BASIC command executes PPE / PPD in addition.

Appendix C: List of Error Messages

Tables C–1 through C–6 list all error messages for the DVT200 Digital Video Transmitter during remote control. The meaning of negative error codes is specified by SCPI; positive error codes identify device-specific errors.

The left column in the table below states the error code. In the right column, the text of the error message entered in the error/event queue (and displayed) is in bold type. Below this text, an explanation is given.

SCPI-Specific Error Messages

No error.

Table C–1: No error

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

Command errors – faulty command, causes bit 5 in the ESR register to be set.

Table C–2: Command errors

Error number	Test displayed upon an error queue query Explanations
–100	**Command Error** Command faulty or invalid
–101	**Invalid Character** Command contains a character which is invalid for that type. Example: a header containing an ampersand “SOURCE&”.
–102	**Syntax error** Command invalid Example: a string is received when the device does not accept strings.
–103	**Invalid separator** Command contains an illegal character where a separator is expected. Example: the semicolon was omitted after the command.
–104	**Data type error** Command contains an invalid data element. Example: numeric data for frequency setting were expected and ON was encountered.

Table C–2: Command errors (Cont.)

Error number	Test displayed upon an error queue query Explanations
–105	**GET not allowed** A Group Execute Trigger (GET) was received within a program message.
–108	**Parameter not allowed** More parameters were received than expected. Example: The command SOURce:FM:INTernal:FREQuency accepts one frequency parameter.
–109	**Missing parameter** Fewer parameters were received than required. Example: The command SOURce:FM:INTernal:FREQuency requires a frequency parameter to be specified.
–110	**Command header error** An error was detected in the header.
–111	**Header separator error** Header contains a character which is not a legal separator. Example: There is 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** He header contains a numeric suffix which makes the header invalid. Example: SOURce3 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 does not expect one in this position. Example: The command SOURce:FREQuency:MODE requires character data to be specified.
–130	**Suffix error** The command contains a faulty suffix.

Table C–2: Command errors (Cont.)

Error number	Test displayed upon an error queue query Explanations
–131	**Invalid suffix** The suffix is illegal 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 *RCL does not accept a suffix.
–140	**Character data error** Command contains faulty character data.
–141	**Invalid character data** Either the character data element contains an invalid character or the element received is not valid for this command. Example: Writing error when entering a parameter: SOURce:FREQuency:MODE FIKSed.
–144	**Character data too long** The character data element contains more than 12 characters.
–148	**Character data not allowed** A legal character data element was encountered where prohibited by the device. Example: Command *RCL required numeric data to be specified.
–150	**String data error** Command contains faulty string data.
–151	**Invalid string data** Command contains an invalid string data element. Example: an END message was received before the terminal quote character.
–158	**String data not allowed** A string data element was encountered but was not allowed by the device at this point. Example: a character data element is market by quotes, SOURce:FREQuency:MODE “FIXed”
–160	**Block data error** Command contains faulty block data.
–161	**Invalid block data** A block data element was expected but was illegal for some reason. Example: an END message was received before the length was satisfied.
–168	**Block data not allowed** A legal block data element was encountered but was not allowed at this point.
–170	**Expression error** The command contains an invalid expression data element.

Table C–2: Command errors (Cont.)

Error number	Test displayed upon an error queue query Explanations
–171	**Invalid expression** Command contains an invalid expression data element. Example: unmatched parentheses
–178	**Expression data not allowed** A legal expression data was encountered but was not allowed at this point.
–180	**Macro error** Error generated when defining a macro or executing a macro.
–181	**Invalid outside macro definition** A macro parameter placeholder was encountered outside the macro definition.
–183	**Invalid inside macro definition** The program message unit sequence is syntactically invalid.
–184	**Macro parameter error** A command inside the macro definition had the wrong number or type of parameter.

Execution errors – error encountered upon command execution, causes bit 4 in the ESR register to be set.

Table C–3: Execution errors

Error number	Test displayed upon an error queue query Explanations
–200	**Execution error** Error encountered upon command execution
–201	**Invalid while in local** The command is not executable while the device is in local due to a hard local control element. Example: a device with a rotary switch receives a message which would change the switch state, but since the device is in local the message cannot be executed.
–202	**Settings lost due to rtl** A setting associated with a hard local control was lost when the device changed from LOCS to REMS or from LWLS to RWLS.
–210	**Trigger error** Error upon device trigger
–211	**Trigger ignored** A GET, *TRG or trigger signal was received and recognized but was ignored. Example: device was not ready to respond.
–212	**Arm ignored** An arming signal was received and recognized but was ignored.

Table C–3: Execution errors (Cont.)

Error number	Test displayed upon an error queue query Explanations
–213	**Init ignored** A request for a measurement initiation was ignored as another measurement was already in progress.
–214	**Trigger deadlock** The trigger signal cannot be executed. (The trigger source for the initiation of a measurement is set to GET and a subsequent measurement query is received. The measurement cannot be started until a GET is received but the GET would cause an INTERRUPTED error.)
–215	**Arm deadlock** The arming signal cannot be executed.
–220	**Parameter error** Command contains a faulty or invalid parameter.
–221	**Settings conflict** A legal program data element was received but could not be executed due to the current device state. Example: FM1 and PM1 cannot be switched on simultaneously.
–222	**Data out of range** A legal program data element was received but could not be executed because the value was outside the legal range. Example: command *RCL allows only values between 0 to 50 to be specified.
–223	**Too much data** Command contains more data than the device can handle. Example: the device has not enough memory capacity.
–224	**Illegal parameter value** The parameter is invalid. Example: an illegal parameter is given: TRIGger:SWEep:SOURce TASTe
–230	**Data corrupt or stale** Data are incomplete or invalid. Example: a measurement was aborted by the device.
–231	**Data questionable** The measurement accuracy is suspect.
–240	**Hardware error** A command cannot be executed because of a hardware problem in the device.
–241	**Hardware missing** The command cannot be executed because of a missing device hardware. Example: an option is not installed.
–250	**Mass storage error** Error in the mass memory.
–251	**Missing mass storage** Command cannot be executed because of missing mass memory. Example: an option is not installed.

Table C–3: Execution errors (Cont.)

Error number	Test displayed upon an error queue query Explanations
–252	**Missing media** Command could not be executed because of a missing media. Example: no disk in the drive.
–253	**Corrupt media** The media is faulty. Example: disk has the wrong format.
–254	**Media full** The media was full. Example: disk out of space.
–255	**Directory full** The media directory was full.
–256	**File name not found** The file name could not be found on the device media.
–257	**File name error** The file name on the device media was in error. Example: an attempt was made to copy to a duplicate file name.
–258	**Media protected** The media was protected. Example: the write-protect tab on a disk was present.
–260	**Expression error** Command contains an error related to an expression program data element.
–261	**Math error in expression** The expression contains a math error. Example: division by zero.
–270	**Macro error** A macro-related execution error occurred.
–271	**Macro syntax error** A syntactically legal macro program data sequence cannot be executed due to a syntax error.
–272	**Macro execution error** A syntactically legal macro program data sequence cannot be execution due to an error in the macro definition.
–273	**Illegal macro label** The macro label defined in the DMC* command was a legal string syntax but could not be accepted by the device. Example: the label was too long, the same as a common command header or contained invalid header syntax.
–274	**Macro parameter error** The macro definition improperly used a macro parameter placeholder.

Table C–3: Execution errors (Cont.)

Error number	Test displayed upon an error queue query Explanations
–275	**Macro definition too long** The macro program data sequence could not be executed because the string or block contents were too long for the device to handle.
–276	**Macro recursion error** A macro program data sequence could not be executed because the device found it to be recurrent. Example: the event causing the recurrence to stop is not received.
–277	**Macro redefinition not allowed** The macro label in the *DMC command could not be executed because it was already defined.
–278	**Macro header not found** A legal macro label in the *GMC? query could not be executed because the header was not previously defined.
–280	**Program error** A downloaded program-related execution error occurred.
–281	**Cannot create program** An attempt to create a program was unsuccessful.
–282	**Illegal program name** The program name was invalid. Example: the name refers to a nonexistent program.
–283	**Illegal variable name** The entered variable is nonexistent in the program.
–284	**Program currently running** The operation is illegal while the program is running.
–285	**Program syntax error** The downloaded program contains a syntax error.
–286	**Program runtime error**

Device-specific error – causes bit 3 in the ESR register to be set.

Table C–4: Device-specific error

Error number	Test displayed upon an error queue query Explanations
–300	**Device-specific error** SM3-specific error that cannot be defined more precisely.
–310	**System error** A system internal error has occurred. Please inform the R&S service team.
–311	**Memory error** An error was detected in the device memory.
–312	**PUD memory lost** The protected user data saved by the *PUD command has been lost.
–313	**Calibration memory lost** The nonvolatile calibration data used by the *CAL? command has been lost.
–314	**Save/recall memory lost** The nonvolatile calibration data used by the *SAV? command has been lost.
–315	**Configuration memory lost** The nonvolatile calibration data saved by the device has been lost.
–330	**Self-test failed** The self test could not be performed.
–350	**Queue overflow** Error code entered in the queue instead of the code that caused the error. This code indicates that there is no room in the queue and an error occurred but was not recorded. Five of these entries can be made in the queue.

Query errors – error upon data query, causes bit 2 in the ESR register to be set.

Table C–5: Query errors

Error number	Test displayed upon an error queue query Explanations
–400	**Query error** Generic query error for devices that cannot detect more specific error.
–410	**Query INTERRUPTED** The query was interrupted. Example: a query is followed by new data before a response was completely sent.
–420	**Query UNTERMINATED** An incomplete query error was received. Example: the device was addressed to talk and an incomplete program message was received.

Table C–5: Query errors (Cont.)

Error number	Test displayed upon an error queue query Explanations
–430	**Query DEADLOCKED** The query cannot be processed. Example: both input and output buffer are full and the device cannot continue.
–440	**Query UNTERMINATED after indefinite response** A query is received in the same program message after a query requesting an indefinite response.

Device-Dependent Error Messages

Device-dependent errors – device-dependent error, causes bit 3 in the ESR register to be set.

Table C–6: Device-dependent errors

Error number	Test displayed upon an error queue query Explanations
105	**Frequency underrange** Frequency below the guaranteed limit value.
110	**Output unlevelled** Level control loop out of function.
115	**Level overrange** Level above the guaranteed limit value.
130	**FM modulator VCO unlocked** FM modulator VCO not synchronized.
131	**AM modulation frequency out of range** AM modulation frequency outside permissible range.
132	**PM modulation frequency out of range** PM modulation frequency outside permissible range.
147	**A/D converter not responding** Device unable to address the diagnosis converter on the controller module.

Appendix D: List of Commands with SCPI Conformity Information

The DVT200 Digital Video Transmitter supports SCPI version 1995.0.

Commands specified or accepted by this SCPI version are mostly used for remote control. Commands not specified by SCPI are marked “nonSCPI” in the SCPI information column.

Table D–1: List of commands

Command	Parameter	SCPI information	to *RST
*CLS			
*ESE	<numeric>		
*ESR?			
*IDN?			
*IST?			
*OPC			
*OPC?			
*OPT?			
*PRE	<numeric>		
*PSC	<numeric>		
*RST			
*SRE	<numeric>		
*STB?			
*TST?			
*WAI			
*RCL	1 to 99 101 to 199		
*SAV	1 to 99 101 to 199		
CALibration:LEVel		nonSCPI	
CALibration:MODulation		nonSCPI	
CALibration:SYNThesis		nonSCPI	
DIAGnostic:POSition?	<numeric> | MAXimum | MINimum, <numeric> | MAXimum | MINimum	nonSCPI	
OUTPut[:STATe]	<numeric> | OFF | ON		ON
READ:IQCoder:DATarate?		nonSCPI	
ROUTe:MONitor	INTernal | EXTernal	nonSCPI	INTernal

Table D–1: List of commands (Cont.)

Command	Parameter	SCPI information	to *RST
ROUTe:REFerence:CLOCk	INTernal | EXTernal	nonSCPI	INTernal
[SOURce:]DM:CW:STATe	<numeric> | OFF | ON	nonSCPI	ON
[SOURce:]DM:FORMat	QPSK | QAM16 | QAM32 | QAM64 | QAM128 | QAM256		QPSK
[SOURce:]DM:IQRatio[:MAGNitude]	<numeric> [ONE | PCT] | MAXimum | MINimum		0%
[SOURce:]DM:MODulation:OFFSet	<numeric> [ONE | PCT] | MAXimum | MINimum	nonSCPI	0%
[SOURce:]DM:POLarity[:ALL]	NORMal | INVerted		NORMAL
[SOURce:]DM:QUADrature:ANGLe	<numeric> [DEG] | MAXimum | MINimum	nonSCPI	0 DEG
[SOURce:]DM:SOURce	EXTernal | PRBS		PRBS
[SOURce:]DM:STATe	<numeric> | OFF | ON		ON
[SOURce:]FREQuency:CENTer	<numeric> [HZ | AHZ | FHZ | PHZ | NHZ | UHZ | KHZ | MHZ | GHZ | THZ | PEHZ | EXHZ] | MAXimum | MINimum		150 MHZ
[SOURce:]FREQuency:CHANnel:TABLe	NONE | USR1 | USR2 | USR3 | USR4 | USR5 | USER1 | USER2 | USER3 | USER4 | USER5	nonSCPI	NONE
[SOURce:]FREQuency:CHANnel	<numeric> | MAXimum | MINimum | UP | DOWN	nonSCPI	
[SOURce:]FREQuency:CW	<numeric> [HZ | AHZ | FHZ | PHZ | NHZ | UHZ | KHZ | MHZ | GHZ | THZ | PEHZ | EXHZ] | MAXimum | MINimum		1000 MHZ
[SOURce:]FREQuency:FIXed	<numeric> [HZ | AHZ | FHZ | PHZ | NHZ | UHZ | KHZ | MHZ | GHZ | THZ | PEHZ | EXHZ] | MAXimum | MINimum		1000 MHZ
[SOURce:]FREQuency:MODE	CW | FIXed | SWEep		CW
[SOURce:]FREQuency:RESolution	<numeric> [HZ | AHZ | FHZ | PHZ | NHZ | UHZ | KHZ | MHZ | GHZ | THZ | PEHZ | EXHZ] | MAXimum | MINimum		
[SOURce:]FREQuency:SPAN	<numeric> [HZ | AHZ | FHZ | PHZ | NHZ | UHZ | KHZ | MHZ | GHZ | THZ | PEHZ | EXHZ] | MAXimum | MINimum		100 MHZ
[SOURce:]FREQuency:STARt	<numeric> [HZ | AHZ | FHZ | PHZ | NHZ | UHZ | KHZ | MHZ | GHZ | THZ | PEHZ | EXHZ] | MAXimum | MINimum		100 MHZ
[SOURce:]FREQuency:STOP	<numeric> [HZ | AHZ | FHZ | PHZ | NHZ | UHZ | KHZ | MHZ | GHZ | THZ | PEHZ | EXHZ] | MAXimum | MINimum		200 MHZ
[SOURce:]IQCoder:QAM:DATarate	<numeric> [MB] | MAXimum | MINimum	nonSCPI	38.015 MB

Table D–1: List of commands (Cont.)

Command	Parameter	SCPI information	to *RST
[SOURce:]IQCoder:QAM:INPut	TSParallel | SYNCserial | ASYNcserial | TLINk	nonSCPI	TSParallel
[SOURce:]IQCoder:QAM:LOCKed?	LOCK | UNL | NOCL | NOD | FRER	nonSCPI	
[SOURce:]IQCoder:QAM:MODE	DATA | AUTO | PRBS | NTSP | PTSP	nonSCPI	AUTO
[SOURce:]IQCoder:QAM:PACKetlength	P188 | P204	nonSCPI	P188
[SOURce:]IQCoder:QAM:ROLLoff	<numeric> | MAXimum | MINimum	nonSCPI	0.15
[SOURce:]IQCoder:QAM:SYMBols[:RATE]?	<numeric>	nonSCPI	
[SOURce:]IQCoder:QAM[:SPECial]:INTerleave	<numeric> | OFF | ON	nonSCPI	ON
[SOURce:]IQCoder:QAM[:SPECial]:REEDsolomon	<numeric> | OFF | ON	nonSCPI	ON
[SOURce:]IQCoder:QAM[:SPECial]:SCRamble	<numeric> | OFF | ON	nonSCPI	ON
[SOURce:]IQCoder:QPSK:DATarate	<numeric> [MB] | MAXimum | MINimum	nonSCPI	38.015 MB
[SOURce:]IQCoder:QPSK:INPut	TSP | ASI | SPI | ASX | SPX	nonSCPI	TSParallel
[SOURce:]IQCoder:QPSK:LOCKed?	LOCK | UNL | NOCL | NOD | FRER	nonSCPI	
[SOURce:]IQCoder:QPSK:MODE	DATA | AUTO | PRBS | NTSP | PTSP	nonSCPI	AUTO
[SOURce:]IQCoder:QPSK:PACKetlength	P188 | P204	nonSCPI	P188
[SOURce:]IQCoder:QPSK:RATE	R1_2 | R2_3 | R3_4 | R5_6 | R7_8	nonSCPI	R3_4
[SOURce:]IQCoder:QPSK:ROLLoff	<numeric> | MAXimum | MINimum	nonSCPI	0.35
[SOURce:]IQCoder:QPSK:SYMBols[:RATE]?	<numeric>	nonSCPI	
[SOURce:]IQCoder:QPSK[:SPECial]:INTerleave	<numeric> | OFF | ON	nonSCPI	ON
[SOURce:]IQCoder:QPSK[:SPECial]:REEDsolomon	<numeric> | OFF | ON	nonSCPI	ON
[SOURce:]IQCoder:QPSK[:SPECial]:SCRamble	<numeric> | OFF | ON	nonSCPI	ON
[SOURce:]MODulator[:STATe]	<numeric> | OFF | ON	nonSCPI	OFF
[SOURce:]NOISe:BANDwidth	<numeric> [HZ | AHZ | FHZ | PHZ | NHZ | UHZ | KHZ | MHZ | GHZ | THZ | PEHZ | EXHZ] | MAXimum | MINimum	non–SCPI	35 MHZ
[SOURce:]NOISe:CN	<numeric> [DB] | MAXimum | MINimum	non–SCPI	60 DB
[SOURce:]NOISe[:STATe]	<numeric> | OFF | ON	non–SCPI	OFF
[SOURce:]POWer:ALC:LEARn		nonSCPI	
[SOURce:]POWer:ALC:MODE	OFF | ON | AUTO	nonSCPI	AUTO
[SOURce:]POWer:ALC:OFFMode	TABLe | HOLD	nonSCPI	HOLD

Table D–1: List of commands (Cont.)

Command	Parameter	SCPI information	to *RST
[SOURce:]POWer:ALC:SEARch			
[SOURce:]POWer[:LEVel]:MODE	NORMal | CONTinuous		NORMAL
[SOURce:]POWer[:LEVel][:IMMediate][:AMPLitude]	<numeric> [DBM] | MAXimum | MINimum		–99 dBm
[SOURce:]SWEep:STEP	<numeric> [HZ | AHZ | FHZ | PHZ | NHZ | UHZ | KHZ | MHZ | GHZ | THZ | PEHZ | EXHZ] | MAXimum | MINimum		1 MHZ
[SOURce:]SWEep:WDELL	<numeric> [S | AS | FS | PS | NS | US | MS | KS | MAS | GS | TS | PES | EXS] | MAXimum | MINimum		100 MS
[SOURce:]VOLTage[:LEVel][:IMMediate][:AMPLitude]	<numeric> [DBM | AV | FV | PV | NV | UV | MV | V | KV | MAV | GV | TV | PEV | EXV | DBAV | DBFV | DBPV | DBNV | DBUV | DBMV | DBV | DBKV | DBMAV | DBGV | DBTV | DBPEV | DBEXV] | MAXimum | MINimum		–99 dBm
STATus:OPERation:CONDition?			
STATus:OPERation:ENABle	<numeric>		
STATus:OPERation[:EVENt]?			
STATus:PRESet		nonSCPI	
STATus:QUEStionable:CONDition?			
STATus:QUEStionable:ENABle	<numeric>		
STATus:QUEStionable[:EVENt]?			
STATus:QUEue[:NEXT]?			
SYSTem:BEEPer:STATe	<numeric> | OFF | ON		
SYSTem:CODer:PRESet		nonSCPI	
SYSTem:COMMunicate:GPIB[:SELF]:ADDRess	<numeric> | MAXimum | MINimum		
SYSTem:COMMunicate:REMote	OFF | GPIB | SERial | BOTH		
SYSTem:COMMunicate:SERial[:RECeive]:BAUD	<numeric> | MAXimum | MINimum		
SYSTem:COMMunicate:SERial[:RECeive]:BITS	<numeric> | MAXimum | MINimum		
SYSTem:COMMunicate:SERial[:RECeive]:PACE	NONE | XON | ACK		
SYSTem:COMMunicate:SERial[:RECeive]:PARity[:TYPE]	ODD | EVEN | ZERO | ONE | NONE		
SYSTem:COMMunicate:SERial[:RECeive]:SBITs	<numeric> | MAXimum | MINimum		

Table D–1: List of commands (Cont.)

Command	Parameter	SCPI information	to *RST
SYSTem:DATE	<numeric> | MAXimum | MINimum, <numeric> | MAXimum | MINimum, <numeric> | MAXimum | MINimum		
SYSTem:DISPlay:UPDate[:STATe]	<numeric> | OFF | ON	nonSCPI	
SYSTem:ERRor?			
SYSTem:FREQuency:RESolution	LOW | HIGH	nonSCPI	
SYSTem:INFormation?		nonSCPI	
SYSTem:MODulation:PRESet		nonSCPI	
SYSTem:TIME	<numeric> | MAXimum | MINimum, <numeric> | MAXimum | MINimum, <numeric> | MAXimum | MINimum		
SYSTem:VERSion?			
UNIT:VOLTage	AV | FV | PV | NV | UV | MV | V | KV | MAV | GV | TV | PEV | EXV | DBAV | DBFV | DBPV | DBNV | DBUV | DBMV | DBV | DBKV | DBMav | DBGV | DBTV | DBPev | DBEXv | DBM		

Appendix E: Program Examples

The examples in this appendix illustrate programming of the DVT200 Digital Video Transmitter and may be used as a basis for solving complex programming examples.

The programming language is QuickBASIC, but the programs may be converted to other languages if required.

Integration of IEC/IEEE–Bus Library for QuickBASIC

```
REM ------ Integrating IEC/IEEE-bus library for QuickBASIC -------
'$INCLUDE: 'c:\qbasic\qbdecl4.bas'
```

Initialization and Default State

Before a program is started, the IEC/IEEE bus and the device setup are reset to a defined initial state. This is done by means of subroutines “InitController” and “InitDevice”.

Initialization of Controller

```
REM ------------ Initializing the controller -----------
REM InitController
iecaddress% = 28                        'IEC/IEEE-bus addresse of the DVT200
CALL IBFIND("DEV1", generator%)         'Opens channel to DVT200
CALL IBPAD(generator%, iecaddress%)     'Informs controller on DVT200
                                         address
CALL IBTMO(generator%, 11)              'Sets response time to 1 s
REM ***************************************************************
```

Initialization of Device

The IEC/IEEE–bus status registers and DVT200 settings are reset to a defined initial state.

```
REM ------------ Initializing the instrument --------------
REM InitDevice
CALL IBWRT(generator%, "*CLS")          'Resets the status register
CALL IBWRT(generator%, "*RST")          'Resets DVT200
CALL IBWRT(generator%, "OUTPUT ON")     'Switches on RF output
REM***************************************************************
```

Sending Device Setting Commands

This example shows setting of output frequency, output level and AM. The settings correspond to the examples given in the section for manual operation by a first-time user. In addition to setting the step widths of the spinwheel, the step width for varying the RF frequency with UP and DOWN is set.

```
REM -------- Device setting commands -------------
CALL IBWRT(generator%, "FREQUENCY 250E6")  'RF frequency 250 MHz
CALL IBWRT(generator%, "POWER 3")          'Output power 3 dBm
CALL IBWRT(generator%, "DM:FORMAT QAM64")  'QAM modulation of the order 64
REM ***************************************************************
```

Switch over to Manual Control

```
REM -------- Switching the instrument to manual control -----------
CALL IBLOC(generator%)        'Sets DVT200 to local
REM ***************************************************************
```

Readout of Device Settings

The settings shown in *Sending Device Setting Commands* are called up again using the short form of the commands.

```
REM --------- Readout of device settings ---------
RFfrequenz$ = SPACE$(20)           'Provides character string
                                    (20 characters)
CALL IBWRT(generator%, "FREQ?")    'Requests frequency setting
CALL IBRD(generator%, RFfrequenz$) 'Reads value
RFpegel$ = SPACE$(20)              'Provides character string
                                    (20 characters)
CALL IBWRT(generator%, "POW?")     'Requests level setting
CALL IBRD(generator%, RFpegel$)    'Reads value
DMFormat$ = SPACE$(20)             'Provides text string (20 characters)
CALL IBWRT(generator%, "DM:FORM?") 'Queries format for digital modulation
CALL IBRD(generator%, DMFormat$)   'Reads value

REM -------- Display of values -----------
PRINT "RF frequency:      "; RFfrequenz$,
PRINT "RF level:          "; RFpegel$,
PRINT "DM format:         "; DMFormat$,
REM*************************************************************************
```

Command Synchronization

The synchronization procedures in the example below are described in *Command Sequence and Command Synchronization* on page 3–33.

```
REM -------- Examples for command synchronization ---------
REM Command CAL:MOD requires a relatively long time for execution.
REM It must be ensured that results are only queried
REM after calibration has been completed.

REM -------- First option: use of *WAI -------------------
CALL IBWRT(generator%, "CAL:MOD; *WAI; CAL:MOD?")

REM -------- Second option: use of *OPC? ---------------
OpcOk$ = SPACE$(2)                    'Space for *OPC? - Provides response
CALL IBWRT(generator%, " CAL:MOD; *OPC?")
REM -------- Here the controller may serve other devices ----------
CALL IBRD(generator%, OpcOk$)         'Wait for "1" from *OPC?

REM -------- Third option: use of *OPC
CALL IBWRT(generator%, "*SRE 32")     'Enables service request for ESR
CALL IBWRT(generator%, "*ESE 1")      'Sets the Event Enable bit for the
                                      Operation Complete bit
ON PEN GOSUB OpcReady                 'Initializes the service request
                                       routine.
PEN ON
CALL IBWRT(generator%, " CAL:MOD; *OPC")

OpcReady:
REM As soon as the reference oscillator has settled, the program branches
to this subroutine
REM to program an appropriate response to the OPC service request.
RETURN
REM ************************************************************************
```

Service Request

The service request routine requires a further initialization of the device, in the course of which the appropriate bits in the transition and enable registers are set.

```
REM ---- Example for initializing SRQ in the case of errors ------
CALL IBWRT(generator%,"*SRE 168")     'Enables a service request for
                                      STAT:OPER,STAT:QUES and ESR registers
CALL IBWRT(generator%,"*ESE 60")      'Sets event-enable bit for command,
                                      execution, device-specific and query
                                      errors.
CALL IBWRT(generator%,"STAT:OPER:ENAB 32767") 'Sets OPERation Enable bit
                                               for all events
CALL IBWRT(generator%,"STAT:OPER:PTR 32767")  'Sets associated OPERation
                                               Ptransition bits
CALL IBWRT(generator%,"STAT:OPER:ENAB 32767") 'Sets Questionable Enable
```

```
                                                bits for all events
CALL IBWRT(generator%,"STAT:OPER:PTR 32767")  'Sets associated Questionable
                                                Ptransition bits
ON PEN GOSUB Srq                              'Initializes the service
                                                request routine
PEN ON
```

A service request is handled in the service request routine.

```
Srq:
REM ------------ Service request routine -----------
DO
    SRQFOUND% = 0
        FOR I% = TeilnehmerN% TO TeilnehmerM%    'Sends a service request
                                                 to all bus users
        ON ERROR GOTO noTeilnehmer               'No bus user found
        CALL IBRSP(I%, STB%)                     'Serial poll, read status
                                                 byte
        IF (STB% AND 64) > 0 THEN                'The instrument has set
                                                 bits in STB
            SRQFOUND% = 1
            IF (STB% AND 16)  > 0 THEN GOSUB Outputqueue
            IF (STB% AND 4)   > 0 THEN GOSUB Failure
            IF (STB% AND 8)   > 0 THEN GOSUB Questionablestatus
            IF (STB% AND 128) > 0 THEN GOSUB Operationstatus
            IF (STB% AND 32)  > 0 THEN GOSUB Esrread
        END IF
noTeilnehmer:
    NEXT I%
LOOP UNTIL SRQFOUND% = 0
ON ERROR GOTO Fehlerbehandlung
ON PEN GOSUB Srq: RETURN                         'Reactivates SRQ routine;
                                                 'Terminates SRQ routine
PEN ON
```

Readout of event status register, output buffer and error/event queue in subroutine.

```
REM -------- Subroutine for individual STB bits ------
Outputqueue:                                  'Reads the output buffer
Nachricht$ = SPACE$(100)                      'Provides space for response
CALL IBRD(generator%, Nachricht$)
PRINT "Nachricht im Ausgabepuffer :"; Nachricht$
RETURN

Failure:                                      'Reads error queue
ERROR$ = SPACE$(100)                          'Provides space for error
                                               variable
CALL IBWRT(generator%, "SYSTEM:ERROR?")
CALL IBRD(generator%, ERROR$)
PRINT "Fehlertext :"; ERROR$
RETURN
```

```
Questionablestatus:                    'Reads questionable status register
Ques$ = SPACE$(20)                     'Defines character variable with
                                        space

CALL IBWRT(generator%, "STATus:QUEStionable:EVENt?")
CALL IBRD(generator%, Ques$)
IF (VAL(Ques$) AND 128) > 0 THEN PRINT "Calibration ?"   'Calibration
                                                          questionable
IF (VAL(Ques$) AND 1) > 0 THEN PRINT "Voltage ?"         'Output level
                                                          questionable
RETURN

Operationstatus:                       'Reads operation status register
Oper$ = SPACE$(20)                     'Defines text variable with space
CALL IBWRT(generator%, "STATus:OPERation:EVENt?")
CALL IBRD(generator%, Oper$)
IF (VAL(Oper$) AND 1) > 0 THEN PRINT "Calibration"
IF (VAL(Oper$) AND 2) > 0 THEN PRINT "Settling"
IF (VAL(Oper$) AND 4) > 0 THEN PRINT "Ranging"
IF (VAL(Oper$) AND 8) > 0 THEN PRINT "Sweeping"
IF (VAL(Oper$) AND 32) > 0 THEN PRINT "Wait for trigger"
RETURN

Esrread:                               'Reads event status register
Esr$ = SPACE$(20)                      'Defines text variable with space
CALL IBWRT(generator%, "*ESR?")        'Reads ESR
CALL IBRD(generator%, Esr$)
IF (VAL(Esr$) AND 1) > 0 THEN PRINT "Operation complete"
IF (VAL(Esr$) AND 4) > 0 THEN GOTO Failure
IF (VAL(Esr$) AND 8) > 0 THEN PRINT "Device-dependent error"
IF (VAL(Esr$) AND 16) > 0 THEN GOTO Failure
IF (VAL(Esr$) AND 32) > 0 THEN GOTO Failure
IF (VAL(Esr$) AND 64) > 0 THEN PRINT "User request"
IF (VAL(Esr$) AND 128) > 0 THEN PRINT "Power on"
RETURN
REM ***************************************************************

REM ------------- Error routine ----------------
Fehlerbehandlung:
PRINT "ERROR"                  ' Displays error message
STOP                           ' Stops software
```

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