VAROS 107

CATV measuring receiver
Manual

Contents

2 Contents

Chapter 1   **Release notes**

VERSION		NEW CONTENT (DESCRIPTION)
V12.0		Initial version
V12.1 **(Vxx.12f)**	DOCSIS 3.1	Best MER of the worst 2% of the subcarriers (M2P) and standard deviation (DEV)
	DVB-T2	MER echo-compensation
V12.2 **(Vxx.12g)**	WIFI-Interface	Hostnames of the device are shown (Figure 25-4)
	DOCSIS	Auto power-off delay
V12.3 **(Vxx.12h)**	OTA-Update	OTA-update (update via WiFi)

Chapter 2   Notes on Safety, Usage, Maintenance and Service

2.1   Safety notes

Please note the instructions and warnings contained in these operating instructions.

This instrument is built and tested according to EN61010-1 (protective measures for electronic measuring instruments).

Important!   This instrument may only be powered with the power supply originally delivered from the factory.

The instrument is in perfect working order upon leaving the factory. To maintain this condition and to ensure safe operation, the user must check the instrument and the power cord regularly for damage. A damaged power cord must be replaced immediately.

The instrument complies with the IP20 protection class according to EN60529.

Discharging via connectors may damage the instrument. Protect the instrument from electrostatic discharge when handling and operating it.

Make sure that no external voltages greater than 70 V_{eff} are applied to the measuring receiver's RF input since they may destroy the input circuits.

Do not cover the ventilation slots on the instrument. Doing so can lead to reduced air circulation in the instrument, causing heat to accumulate. The electronic components can overheat as a result.

Important!   Depending on the operating mode and the ambient temperature, overheating can occur when the instrument is operated for extended periods in its protective case and is on a flat surface. In this case, the instrument outputs a warning message and then switches off.

Lithium-Ion accumulators must not be exposed to high temperatures or fire. If battery is replaced incorrectly, there is a risk of explosion. Replace the batteries only with the original type (available from a salesman in your area, wholesaler, or the manufacturer of the instrument). Do not short-circuit the batteries.

Passage from the battery regulations (BattV)
This device contains a battery which incorporates hazardous substances. It must not be disposed of I domestic waste. At the end of its working life it should be disposed of only through the ESC customer service department or at a designated collection point.

2.2   Usage Notes

The guarantee for a new instrument ends 24 months after delivery.

The guarantee is invalidated if the instrument is opened!
Sharp tools (such as screwdrivers) can damage the plastic pane in front of the TFT display and thus ruin the TFT.

The contrast of the TFT deteriorates at ambient temperatures below 5°C.

The TFT display does not reach maximum brightness until several seconds after the instrument is cold-started.

The instrument reaches full measurement accuracy after about 5 minutes of operation.

Wireless DECT telephones and GSM mobile phones can cause malfunctions and incorrect measurements if they are operated in the immediate vicinity of the measuring receiver.

2.3   Maintenance

The instrument is maintenance-free.

2.4   Cleaning

Clean the case and the TFT display with a soft, lint-free dust cloth. Never use solvents such as diluents for cellulose lacquers, acetone or similar, since they may damage plastic parts or the coating on the front panel.

Remove dust from the ventilation slots regularly so that the air circulation provided by the integrated ventilator is not obstructed.

2.5   Calibration

The instrument should be recalibrated at least every two years. The instrument is automatically calibrated at the factory if returned for service.

2.6   Service

Service address: see back cover of operating manual.

Chapter 3   **Technical Data**

FREQUENCY RANGE		
TV		45 – 868 MHz
		868 – 1,050 MHz (Option)
		868 - 1,214 MHz (Option)
	Resolution	50 kHz
		Frequency input / Channel input
FM (VHF)		87.4 – 108.2 MHz
	Resolution	50 kHz
RC (Return channel)		5 – 65 MHz
	Resolution	50 kHz
EMI	Resolution	45 – 868 MHz
		50 kHz

OPERATION	
Input	Illuminated silicone keypad
Monitor	5.7" TFT, VGA resolution 640 x 480
User Prompting	via OSD (On Screen Display) german, english
Audio reproduction	Integrated loudspeaker

RF INPUT	IEC socket / 75 Ohm (DIN 45 325)
Return loss	> 12 dB (5 - 910 MHz)
RF sum power	max. 70 Veff (DC – 50 Hz)
External voltage	max. 500 mW

INPUT ATTENUATOR	0 – 60 dB in 2 dB increments

LEVEL RANGE		
Measuring ranges	TV	20 – 120 dBµV
	FM	20 – 120 dBµV
	RC	25 – 120 dBµV
	Resolution	0.1 dB
	Measuring accuracy	± 1.5 dB (at 20˚C) warm-up time > 5 min.
		± 2.0 dB (0˚C - 40˚C) warm-up time > 5 min.

LEVEL RANGE		
Measuring bandwidth	TV analog	Video carrier 200 kHz
		Sound carrier 200 kHz
	DVB-C	4 MHz, 1 MHz or 200 kHz depending on symbol rate
	FM	200 kHz
	RC	1 MHz, 200 kHz or 90 kHz
		depending on bandwidth symbol rate setting
	EMI	200 kHz
Acoustic level trend indicator		can be switched on / off

ANALYZER		
Measuring bandwidth	TV	4 MHz, 1 MHz, 200 kHz, 90 kHz
(RBW(-3dB))	FM	200 kHz, 90 kHz
	RC	200 kHz, 90 kHz
Span (frequency segment)	TV	Total range, 250 MHz, 100 MHz, 50 MHz, 256 MHz
	FM	Total range, 10 MHz
	RC	Total range, 20 MHz
MAX hold function		
Switch directly between analyzer mode and receiver mode		

TV ANALOG	
Television standards	B/G, D/K, L, I, M/N
Color standards	PAL, NTSC, SECAM
Sound demodulator	Sound carrier 1 and 2
	Decoding of MONO, STEREO and dual sound broadcasts
Sound carrier measurement	Sound carrier 1 and 2 relative to the video carrier, in dB
Resolution	0.1 dB
Measuring accuracy	± 1.5 dB

NICAM-DECODER	(Per ETS 300163)
Sound carrier	5.85 MHz (B/G, D/K, L) and 6.552 MHz (I) respectively
	Decoding of MONO, STEREO and dual sound broadcasts

S/N MEASURING	On analog video signals
	Evaluated measurement according to CCIR 569
Sources	TV analog
Measuring range	40 – 55 dB
Noise Margin (NM)	up to 10 dB
Resolution	0.1 dB
Measuring accuracy	± 1.5 dB

DVB-C AND EURO-DOCSIS

QAM demodulator	(Per ETS 300163)
Symbol rates	1.0 – 7.2 MSym/s
Modulation scheme	16, 32, 64,128 und 256 QAM

Measuring parameters		(Per ETR 290)
	BER	$1.00 \cdot 10^{-9}$
	MER	up to 40 dB
	Noise Margin (NM)	up to 29 dB (depends on modulation)
	Resolution	0.1 dB
	Measuring accuracy	± 1.5 dB
	PE (Packet Errors)	up to $4*10^9$
		counts packet errors from the beginning of the measurement
Scan function		

J83B (US-DOCSIS)

QAM demodulator	(Per ITU-T J83B)
Symbol rates	5.057, 5.361 MSym/s
Modulation scheme	64, 256 QAM
De-Interleaver depths	I=8 / J=16, 16/8, 32/4, 64/2, 128/1

Measuring parameters		(Per ETR 290)
	VBER (after Viterbi)	$1.00 \cdot 10^{-8}$
	MER	up to 40 dB
	Noise Margin (NM)	up to 17 dB (depends on modulation)
	Resolution	0.1 dB
	Measuring accuracy	± 1.5 dB
	PE (Packet Errors)	up to $4*10^9$
		counts packet errors from the beginning of the measurement
Scan function		

DOCSIS 3.0-ANALYZER

Downstream demodulator	USDOCSIS	See J83B
	EURODOCSIS	See DVB-C
	Frequency	111 MHz – 868 MHz
		111 MHz - 1002 MHz (Option 1.0GHz or 1.2GHz)
Upstream modulator	Modulation scheme	QPSK, 8QAM, 16QAM, 32QAM, 64QAM, 128QAM (only S-CDMA)
	Symbol rates	160, 320, 640, 1,280, 2,560, 5,120 kSym/s
	Access method	TDMA, A-TDMA, S-CDMA
	Frequency	5 MHz – 65 MHz
	Encryption	BPI/BPI+
Level	Receive level	minimum 50 dBµV
	Max. transmission	114 dBµV
	Measuring accuracy	± 1.5 dB (at 20°C)
		± 2.0 dB (0°C - 40°C)

Continuous ranging (synchronization with CMTS)
Continuous analysis of downstream/upstream level

Evaluation of the upstream equalizer parameters
Downstream channel utilization
IP synchronization
Scalable PING test
Time slice analysis
Graphical representation of channel bundling for downstream and upstream
Channel Bonding
8 x downstream (must be within 64 MHz)
4 x upstream (5 – 65 MHz)

Scan function

DOCSIS 3.1-ANALYZER

Downstream demodulator	USDOCSIS	See J83B (only Docsis3.0 and greater)
	EURODOCSIS	See DVB-C (only Docsis3.0 and greater)
	OFDM	4k or 8k FFT, Bandwidth up to 192MHz
	Frequency	111 MHz / 258MHz - 1218MHz
Upstream modulator	Modulation scheme	QPSK, 8QAM, 16QAM, 32QAM, 64QAM, 128QAM, 256QAM (only S-CDMA, OFDM (2k and 4k up to 96MHz)
	Symbol rates	160, 320, 640, 1,280, 2,560, 5,120 kSym/s
	Access method	TDMA, A-TDMA, S-CDMA, OFDMA
	Frequency	5 MHz – 85MHz / 204MHz
	Encryption	BPI/BPI+
Level	Receive level	minimum 50 dBµV
	Max. transmission	114 dBµV
	Measuring accuracy	± 1.5 dB (at 20°C)
		± 2.0 dB (0°C - 40°C)

Continuous ranging (synchronization with CMTS)
Continuous analysis of downstream/upstream level

Evaluation of the upstream equalizer parameters
Downstream channel utilization (only QAM)
IP synchronization
Scalable PING test
Speedtest with FTP Server at CMTS
Time slice analysis
Graphical representation of channel bundling for downstream and upstream
Channel Bonding:
32 x QAM downstream + 2x OFDM downstream
8 x QAM upstream + 2x OFDM upstream (5-85MHz/204MHz)

MER(f) at OFDM downstreams
Level(f) at OFDM downstreams
Evaluation of PLC parameters (OFDM downstreams)
Scan function

DVB-T

COFDM demodulator	(Per ETS 300744)
Bandwidth	6, 7, 8 MHz
FFT	2k, 8k
Modulation scheme	QPSK, 16QAM, 64QAM
Guard intervals	1/4, 1/8, 1/16, 1/32

Measuring parameters		(Per ETR 290)
	CBER (before Viterbi)	$1.00 \cdot 10^{-6}$
	VBER (after Viterbi)	$1.00 \cdot 10^{-8}$
	MER	up to 35 dB
	Noise Margin (NM)	up to 30 dB (depends on modulation)
	Resolution	0.1 dB
	Measuring accuracy	± 1.5 dB
	PE (Packet Errors)	up to $4*10^9$
		counts packet errors from the beginning of the measurement
	Impulse response	Attenuation relative to the primary impulse 0-40 dB
		Delay relative to the primary impulse in µs or km
Scan function		

DVB-T2

COFDM demodulator	(Per ETS 302755)
Bandwidth	6, 7, 8 MHz
FFT	1k, 2k, 4k, 8k, 16k, 32k
Modulation scheme	QPSK, 16QAM, 64QAM, 256QAM
Guard intervals	1/4, 19/128, 1/8, 19/256, 1/16, 1/32, 1/128
Pilot pattern	PP1…PP8

Measuring parameters		(Per ETR 290)
	CBER (before LDPC)	$1.00 \cdot 10^{-6}$
	VBER (after LDPC)	$1.00 \cdot 10^{-8}$
	MER	up to 35 dB
	Noise Margin (NM)	up to 32 dB (depends on modulation)
	Resolution	0.1 dB
	Measuring Accuracy	± 1.5 dB
	PE (Packet Errors)	up to $4*10^9$
		counts packet errors from the beginning of the measurement
	Impulse response	Attenuation relative to the primary impulse 0-40 dB
		Delay relative to the primary impulse in µs or km
Scan function		

DTMB

Demodulator	(Per GB20600-2006)
Bandwidth	8MHz
Carrier mode	Single carrier modulation (C1)
	Multiple carrier modulation OFDM (C3780)
Modulation scheme	4QAM, 4QAM_NR, 16QAM, 32QAM, 64QAM
Guard intervals	PN420v, PN595c, PN945v, PN420c, PN945c
FEC	0,4, 0,6, 0,8
Time interleave	M_240, M_720
Measuring parameters	(Per ETR 290)
CBER (before DPC)	$1.00 \cdot 10^{-6}$
VBER (after DPC)	$1.00 \cdot 10^{-8}$
MER	up to 32 dB
Noise Margin (NM)	up to 27 dB (depends on modulation)
Resolution	0.1 dB
Measuring accuracy	± 1.5 dB
PE (Packet Errors)	To $4*10^{9}$
	Counts packet errors from the beginning of the measurement
Impulse response	Attenuation relative to the primary impulse 0-40 dB
	Delay relative to the primary impulse in µs or km
Scan function	

CONSTELLATION DIAGRAM	I/Q analysis of digitally modulated signals
Sources	DVB-C, J83B, DVB-T, DVBT2, DTMB
3-dimensional display	In color
(Status frequency)	
Zoom function	In all 4 quadrants (only DTMB)
Stop function	Freezes the diagram

FM (VHS)	
MONO-/STEREO indicator	
RDS (Radio Data System)	Station name, PI code
Scan function	

MPEG2, MPEG4 DECODER			NIT evaluation Display of MPEG video parameters Video bit rate measurement in Mbit/s
Video decoding		MPEG-2 MP@HL MPEG-4 AVC	ISO/IEC 13818-2 ISO/IEC 14496-10 ITU-T H.264
	Option	MPEG-H L5.1	ISO/IEC 23008-2 ITU-T H.265
	Option	AVS/AVS+	AVS1-P2 (Jizhun) AVS1-P16 (Guangbo)
Audio decoding		MPEG-1 Layer I/II MPEG-2 AAC MPEG-4 AAC Dolby Digital AC-3, Dolby Digital Plus	ISO/IEC 13818-3 ISO/IEC 13818-7 ISO/IEC 14496-3
Chinese character set			GB2312

CI (COMMON INTERFACE)	1 CI slot Presentation of card menu

INTERFACE	
DVI	As an alternative to the integrated TFT LCD display, the video and audio signal can be transmitted digitally to a TV device with a DVI/HDMI input. Output impedance 100 Ohm Difference output level typ. 1 V_{pp}
USB-A	USB-A socket for data logger and software update USB 2.0

TUNING MEMORY **Memory locations** **Memory protection function**	200

ELECTRO MAGNETIC **INTERFERENCE** **MEASUREMENT (EMI)**		
		Evaluation of the 13-digit identifier for the KFG 242 frequency identification generator and measurement of the interference field strength in connection with the bearing equipment, consisting of the EMI 240/Y Yagi antenna, EMI 240/V pre-amplifier and EMI 240/K adapter cable, or with the EMI 241 antenna. Other antenna sets can be user defined.
Measuring range		3 – 103 dBµV/m (EMI 241) 5 – 105 dBµV/m (EMI 240)
	Resolution	0.1 dB
	Measuring accuracy	± 1.5 dB (at 20°C) ± 2.0 dB (0°C – 40°C)

OPTICAL RECEIVER

Connector		SC/APC (with protective cap)
Wavelength (Lambda)		1,260 – 1,620 nm (no optical filter)
Max. optical input power		+8 dBm (continuous power)
Return loss		> 40 dB
Equivalent input noise (ON)		< 8 pA/$\sqrt{Hz}$
RF frequency range		5 – 2,150 MHz
Input power, nominal		-7…+3 dBm
Measuring parameters	Optical power	35 dBm…+9 dBm
	Wavelength (calibrated)	1,310 nm, 1,490 nm, 1,550 nm
	Resolution	0.1 dB
	Measuring accuracy	± 0.35 dB
Optical modulation index (OMI)		individual OMI and total OMI
	Resolution	0.1%
	Measuring accuracy	± 10% (of displayed value)

UPSTREAM SIGNAL GENERATOR (DOCSIS 3.0 ANALYZER)		
		Generating test signals feed in the return path to assess the quality of the return channel performance
Number of carriers		1 or 4 (all CW or all modulated)
Upstream modulator	Modulation scheme	OFF (CW), QPSK, 16QAM, 64QAM, 256QAM
	Symbol rates	320, 640, 1,280, 2,560, 5,120 kSymb/s
	Encryption	PRBS
Transmission		70 – 112 dBµV
	Resolution	1 dB
	Measuring accuracy	± 1 dB
Transmitting frequency		5 – 65 MHz
	Resolution	100 kHz
MER		≥ 43 dB

UPSTREAM SIGNAL GENERATOR (DOCSIS 3.1 ANALYZER)		
		Generating test signals feed in the return path to assess the quality of the return channel performance
Number of carriers		1 to 8 CW / QAM modulated or 1 OFDM (up to 96MHz bandwidth, free scaleable)
Upstream modulator (QAM)	Modulation scheme	OFF (CW), QPSK, 16QAM, 64QAM, 256QAM
	Symbol rates	320, 640, 1,280, 2,560, 5,120 kSymb/s
	Encryption	PRBS
Transmission		70 – 112 dBµV
	Resolution	1 dB
	Measuring accuracy	± 1 dB
Transmitting frequency		5 – 85/204 MHz
	Resolution	100 kHz
MER		≥ 43 dB

REMOTE SUPPLY	Per RF Input
Voltage	5 V
Power	up to 100 mA (short circuit-proof)
Short circuit message	Automatic switch-off
Power Supply	
External 12V	11 - 15 V DC max. 3.0 A
	or external primary power supply 12V/3A
	(included in delivery) via extra-low voltage jack
	according to DIN 45323
	Power consumption max. 36 W
Battery	Li-Ion battery package 7.2 V / 6.6 Ah or 10.35 Ah at Q1/2019
Operation time	approx. 3 hours or 4.5 hours (10.35Ah) (dependent upon the remote supply, keypad illumination and operating mode) automatic cutout as protectoin against exhaustive discharge
Charging time	approx. 4 hours or 6 hours
Battery management	Battery can be charged using 12 V external supply

ENVIRONMENTAL CONDITIONS	
Operating temperature	0°C - +45°C
Storage temperature	-10°C - +55°C
Battery charging temperature	+15°C - +35°C

ELECTROMAGNET COMPATIBILITY	See Declaration of Conformity

PROTECTION	See Declaration of Conformity

DIMENSIONS (W X H X D)	206mm x 297mm x 84mm

WEIGHT	Approx. 2.5kg with battery pack

QUANTITY OF DELIVERY	
Included in the delivery	Transport case
	IEC measuring cable 75 Ohm
	Fiber cable SC/APC to SC/APC (option fiber)
	Power supply and external power cable
	USB stick
	Protective case with carry strap (optional)
	Manual

107 V12.3

Chapter 4   **Control and connection elements, pin configurations**

4.1   Frontpanel

Loudpeaker

Loudspeaker

5.7" TFT

F1-F5
Function keys

Arrow keys Up/down

Arrow keys
Left/right

Remote supply 5V

Check light

On/Off

* Keypad assignments (Keypad backlit)

ANALYZ	-Analyzer function	0 - 9	-Numeric entry	MODE	-Special programs
RANGE	-Set range	ENTER	-Confirm entry/	PRINT	-Printer function
SAVE	-Save to memory		trigger function	OSD-VID	-On-screen display/
RECALL	-Recall from memory	HOME	-Start menue		video image
				AV-SET	-Audio (Volume)
					Video (Brightness)

Figure 4-1 Front panel

4.2   Rear panel
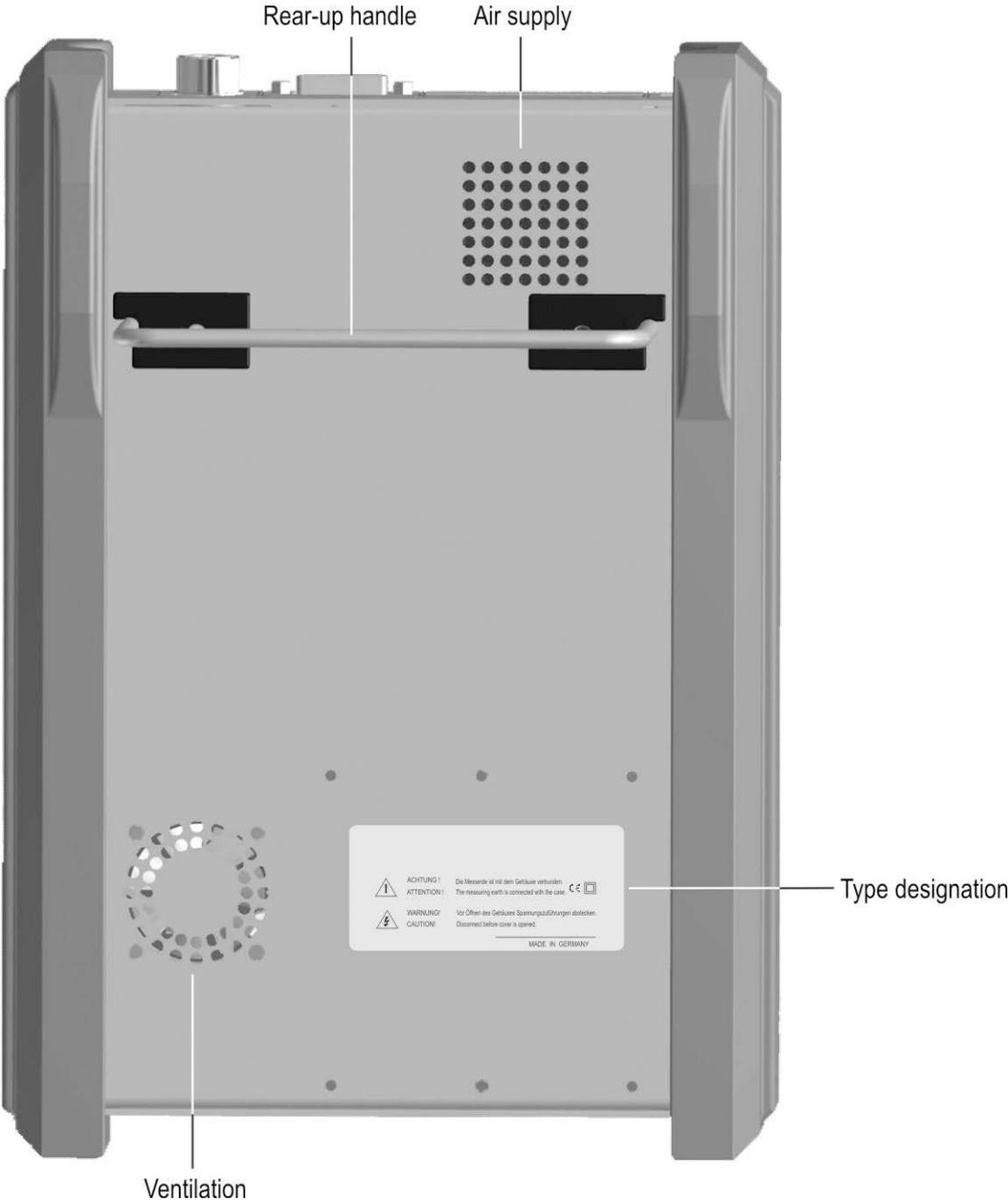
Figure 4-2 Rear panel

4.3   Top section of instrument
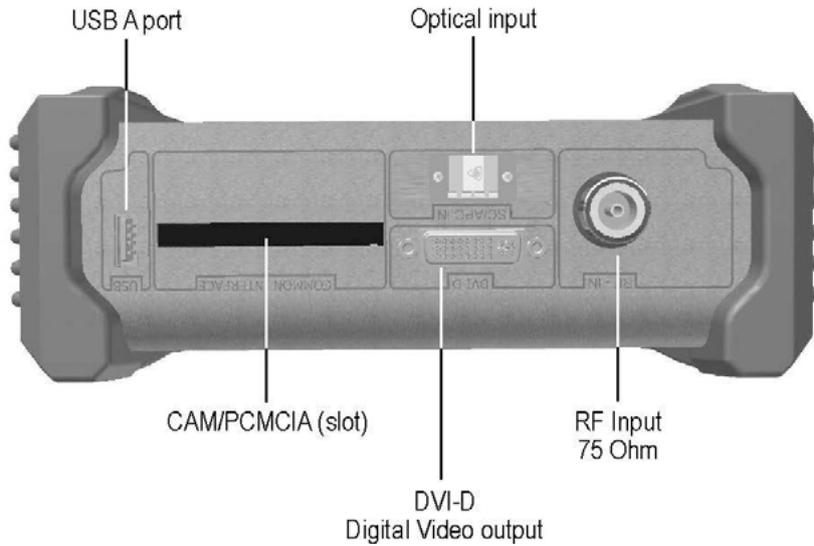
Figure 4-3 Top section of instrument

4.3.1   USB-A socket

Pin 1 = V_{CC} (+5V)
Pin 2 = Data D -
Pin 3 = Data D +
Pin 4 = GND

Socket A
Figure 4-4 USB-A socket

4.3.2   DVI output

According to DDWG (Digital Display Working Group) DVI (Digital Visual Interface) Revision 1.0

1 = T.M.D.S. Data 2-	11 = T.M.D.S. Data 1/3 Shield	21 = n.c.
2 = T.M.D.S. Data 2+	12 = n.c.	22 = T.M.D.S. Clock Shield
3 = T.M.D.S. Data 2/4 Shield	13 = n.c.	23 = T.M.D.S. Clock+
4 = n.c.	14 = +5V Power	24 = T.M.D.S. Clock-
5 = n.c.	15 = GND	
6 = DDC Clock	16 = Hot Plug Detect	C1 = n.c.
7 = DDC Data	17 = T.M.D.S. Data 0-	C2 = n.c.
8 = n.c.	18 = T.M.D.S. Data 0+	C3 = n.c.
9 = T.M.D.S. Data 1-	19 = T.M.D.S. Data 0/5 Shield	C4 = n.c.
10 = T.M.D.S. Data 1+	20 = n.c.	C5 = n.c.

Figure 4-5 DVI socket

4.4   Bottom section of instrument
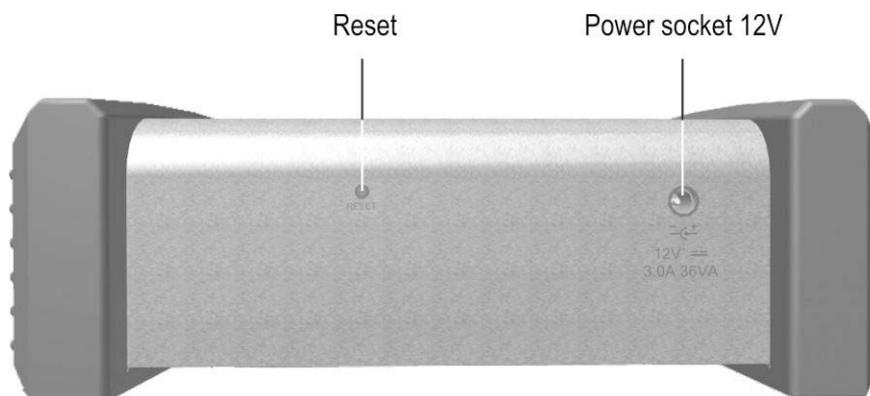
Figure 4-6 Bottom section of instrument

4.4.1   12V power supply

Extra-low voltage jack according to DIN 45 323

Figure 4-7 Extra-low voltage jack

Chapter 5   Startup

5.1   Mains operation

Only power the instrument from the mains using an external mains adapter connected to the 12 V extra-low voltage jack. A suitable adapter with connecting cable is included in delivery (see chapter 5.3 - Operation using an external power supply).

Important!   Always disconnect the instrument from the power supply when disassembling the instrument (e.g. replacing batteries).

5.2   Battery operation

5.2.1   Replacing the Li-Ion battery

The customer can replace the installed battery. It is strongly recommended to only use original batteries from the manufacturer.

To replace the battery, remove the three screws from the left side panel of the instrument, and remove the side panel. Unlock the battery plug using a screwdriver and remove the battery. The battery can then be replaced.

Important!   When reinstalling the battery, ensure that the cables are not squeeze.

Steps for replacing the batteries

① Remove the 3 screws on the left side panel and take off the panel.
② Unlock the battery connector.
③ Remove the battery pack.

The battery installation is carried out in the reverse order !

Figure 5-1 Replacing the battery

5.2.2   Battery management

The instrument has internal battery management, which optimizes the charging and discharging of the battery. The battery begins to charge as soon as the instrument is connected to the mains or an external voltage supply. The instrument starts in charging mode if it is not being used; during this time only the OSD window on the top left is shown with the text "Charging BATT" and the battery symbol. The display screen turns off after a minute. Pressing any button turns the display back on. If the instrument is operated in measuring mode, the charging current may be reduced somewhat depending on the operating status, causing the charging process to take longer. When the battery is being charged, the "charge" LED lights up red. Once the battery is fully charged, the internal battery management switches to maintenance charging and the "charge" LED turns green. The instrument also has a charge status indicator. A status bar in the frequency window indicates the remaining charge of the battery at all times. If the battery charge becomes critical, can still complete the current measurement, but the battery should then be recharged as soon as possible. The instrument shuts down automatically to prevent total discharge.

Storing the battery and operating the device at low temperatures
Because of the chemical reactions inside the battery the performance of the built in battery is somewhat reduced at low temperatures. It is not possible to charge the battery when the temperature is below 0°C!

5.3   Operation using an external power supply

In addition to using the battery, you can run the device on external direct current supplied by the mains adapter or the cigarette lighter adapter in a vehicle, for example. Direct current is fed via the extra-low voltage jack on the bottom section of the instrument. The external voltage supply must be in the range of 11 V to 15 V. The maximum current consumption is 3.0 A. When the instrument is supplied with appropriate voltage, the "charge" LED on the front side of the instrument lights up.

5.4   Ventilation control

A small, built-in fan ensures that the electronic components are well ventilated. This fan is controlled by the microprocessor using a temperature sensor.

5.5   Switching on

The instrument processor requires approx. 5 seconds to boot up. During this time, the "charge" LED lights up yellow. Afterwards, a display appears on the screen.

5.6   Setting volume, brightness, contrast and color saturation

A bar each for brightness and volume can be made to appear on the screen by pressing the **AV SET** key. These can then be set using the arrow keys. This function is not possible in some operating modes such as during level measurement. The **MODE** key can be used to change the function of the lower bar from brightness to contrast and then to color saturation. The color display on the screen can be optimized in this way and the set values are stored in the non-volatile memory. Pressing **AV SET** again makes the bars disappear and the arrow keys return to their original function. When the AV menu is selected again, the lower bar displays the set brightness again.

Chapter 6   **Menu structure**

The device functions can be controlled via the menu bar associated with the function keys **F1 – F5**. The menu bar is permanently displayed in most operating modes. It disappears after a few moments in analyzer and play mode and can be called up again by pressing one of the five function keys.

General settings can be made by pressing the **MODE** key. A drop-down menu with a list appears.

6.1   Menu bar

Individual fields are selected using the function keys (softkeys) **F1** - **F5**. A menu page can contain up to 5 menu items. The menu bar also contains additional menu pages. You can scroll back and forth in the menu using the menu items **>>>** or **<<<**. Press **BACK** to go to the previous menu. The menu items can be grouped into main and submenus.

Every measuring range has its own menu bar that is adapted to the respective operating mode. To make operation easier, the configuration of the range menu adjusts to the current operating status of the measuring receiver. This means different menus are displayed when it is in the default status and when it is tuned.

After you press the **RANGE** key, for example, additional independent main menus also appear that break down the functional range of the instrument further. If you press the corresponding key again (in this example the **RANGE** key), you will return to the main menu of the respective measuring range.

In the subsequent sections, the following notation is used to describe the menu navigation:

KEY -> | Menu item main menu | **->** | menu item submenu | …

6.2   Drop-down menu

This user interface is used for general settings when in default status and for lists.

Selecting main menu	Press **MODE** key
Leaving the menu	Press **MODE** or **HOME** key
Selecting a menu point	Select the desired menu item using the arrow keys (↑or ↓) and press **ENTER**
Back to previous menu level	Press **HOME** key
To change the page	In an extended menu you can switch between sides with the arrow keys ← / →
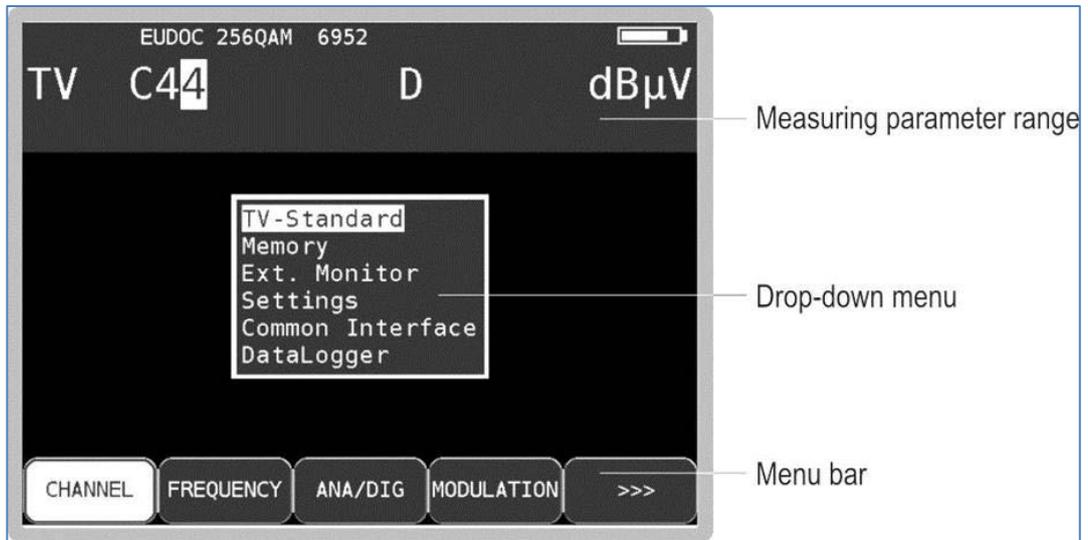
Figure 6-1 Default status with menu

Figure 6-1 Default status with menu, shows the instrument in default status, of the DVB-C range and the drop-down menu for general settings.

Chapter 7   **TV Measuring Range**

You access the TV range via **RANGE** -> TV.
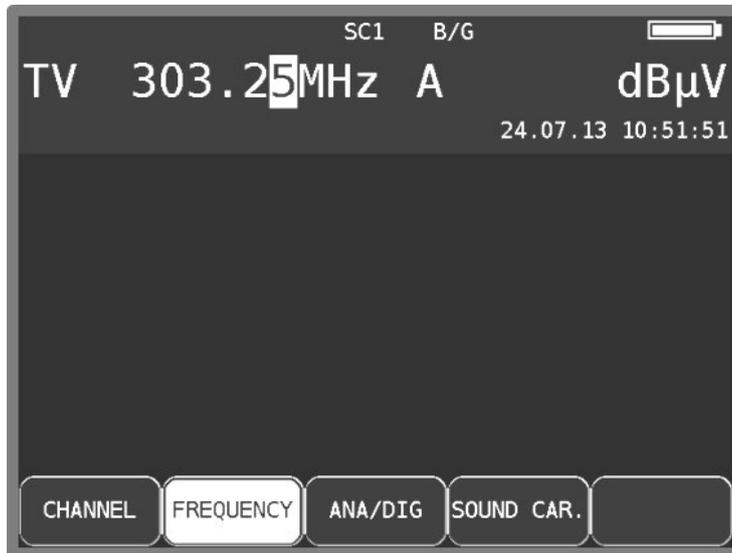
Figure 7-1 TV measuring range

7.1   Switching between frequency and channel input

The instrument can be tuned by entering the channel center frequency (DVB-C und DOCSIS), the video carrier frequency (ATV) or by entering the channel. You switch between modes using the menu items CHANNEL or FREQUENCY. After selection, the corresponding menu item is displayed inverted.

7.1.1   Channel input

The basis for the channel input is a channel table stored in the instrument. It corresponds to the TV standard that has been set (BG, I, L, etc.). The table contains the center frequency and the video carrier frequency (ATV) for every channel. Within the channel table, there are "common" channels (C channels) and special channels (S channels). You can switch the instrument from C to S channel input by pressing the **F1** key (CHANNEL).

You can enter the desired channel number using the numeric keypad or the arrow keys. Invalid entries are limited to the respective minimum or maximum value.

7.1.2   Frequency input

You can enter the frequency within a range of 4MHz and 868.00 MHz using the numeric keypad or the arrow keys. Here, the smallest frequency resolution is 0.05 MHz (50 kHz).
The decimal place of the current cursor position can be changed from 0-9 by pressing the arrow key ↑/↓. The cursor can be moved to the left and right using the ←/→keys. You use the **ENTER** key to confirm the entry. If the value entered is beyond the valid range it is limited to the corresponding minimum and/or maximum value. After that, the receiver is tuned and the actual measured values are displayed.

Use the **HOME**, **Arrow** or the **Number keys** to end the measurement procedure. A new frequency can be set as described above.

7.2   Selecting of the operating mode

Using the ANA/DIG menu item you can select the operating mode of the measuring instrument in the TV range. An "A" on the display stands for analog mode, while a "D" indicates digital operating mode.

7.2.1   Analog (ATV) operating mode

Analog-modulated TV signals can be received and measured here.
The instrument supports the B/G, M/N, I, D/K and L TV standards as well as the PAL, SECAM and NTSC color standards.

7.2.1.1   Selecting the TV standard

You can set a new TV standard via **MODE** -> **TV-NORM** -> **B/G**, **M/N**, **I**, **D/K** or **L**. The setting is stored in non-volatile memory.
The TV standard is also incorporated in the tuning memory. The default setting is B/G.
The TV standard that is currently set is shown in the top line of the display.
The channel table is also changed when the instrument is switched to another TV standard.

7.2.1.2   Sound carrier

Audio signals are transmitted on modulated sound carriers. Depending on the TV standard, the two sound carriers have different frequency distances from the video carrier frequency.
The sound information can transmit MONO, STEREO or DUAL SOUND (bilingual). The instrument can demodulate both sound carriers at the same time. The type of source signal transmission (MONO, STEREO or DUAL SOUND) is shown on the display.

Figure 7-2 Display sound carrier

You can select the desired sound carrier with SOUND CAR. -> SC1 or SC2. The sound carrier level that is measured relative to the video carrier is displayed in dB. At the same time, the loudspeaker outputs the demodulated sound signal of the set sound carrier.

7.2.1.3   Scan

You can use this function to scan the entire TV range for analog TV signals. For this, the instrument must operate in channel input mode.

In this operating mode, the arrow keys have a dual function. After entry of a new channel, the menu item **2.FUNCTION** is inverted. That means that the measurement parameter area can be hidden or shown using the arrow keys. To start the scan, first press the **F5** key in order to activate the first function of the arrow keys.

You start the scan by first tuning the measuring receiver to a channel at which the scan should begin. Press the ↑ key to start the scan in the positive direction. Press the ↓ key to do the same in the negative direction. When the band limit is reached, the scan continues at the other end of the range. You can end the scan at any time by pressing **ENTER**.

7.2.1.4   Picture and sound check

As soon as the measuring receiver is tuned, the TFT screen shows the demodulated video image. At the same time, the internal loudspeakers of the instrument outputs the demodulated audio signal. Picture and audio reproduction can be interrupted or restarted using **OSD/VID**.

This is necessary, for example, for a hardcopy of the measured values.

7.2.1.5   S/N measurement (Option)
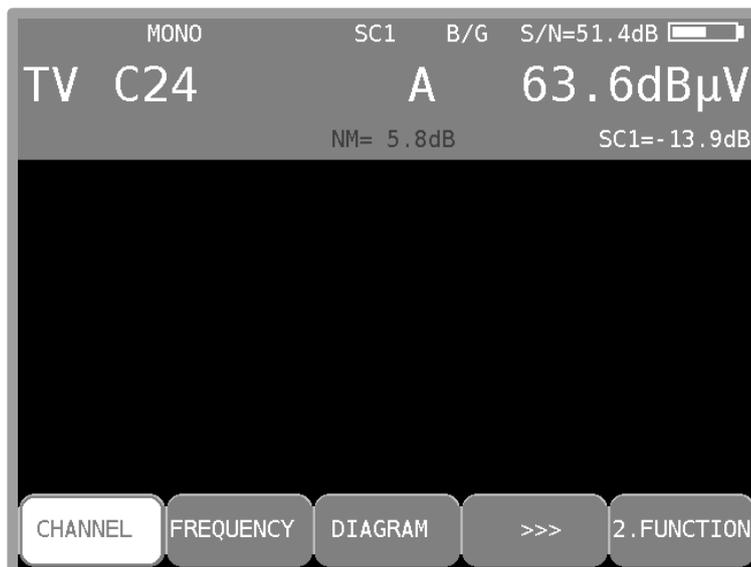
Figure 7-3 S/N measurement display

The S/N (Signal/Noise) measurement (see Figure 7-3) is used with analog television for quality assessment of the video signal received. The measuring receiver measures the assessed signal to noise ratio of the demodulated video signal. For this, the noise signal of an empty video line is fed through an evaluation filter written in CCIR569. The displayed S/N value is calculated from the ratio of the nominal video signal limit (700 mVpp) to the assessed noise level. The measuring range spans from 40 to 55 dB with a resolution of 0.1 dB. A video signal with an assessed S/N of more than 46.5 dB can be considered noise-free.

Video line 6 is permanently set to measure the noise signal.

7.2.1.6   Noise Margin (NM)

In contrast to digital signals there is no fixed point here at which the image display is disturbed, but a continuous deterioration of the image.

Therefore here the value S/N = 45 dB for the minimum quality at the BK socket according to EN500083-7 is taken as reference value. The difference of S/N to this limit value corresponds to the system reserve NM (noise margin). Just as S/N it is displayed in dB with the resolution 0.1 dB. For an easier assessment of the signal quality NM is displayed in the colors red for bad, yellow for limited and green for good signal quality.

7.2.2   DIGITAL (DVB-C, DOCSIS) operating mode

Here you can receive the digitally modulated DVB-C or DOCSIS signals and measure their signal quality.

7.2.2.1   DVB-C

The DVB-C receiver of the measuring instrument is activated via the menu item MODULATION -> DVB-C.
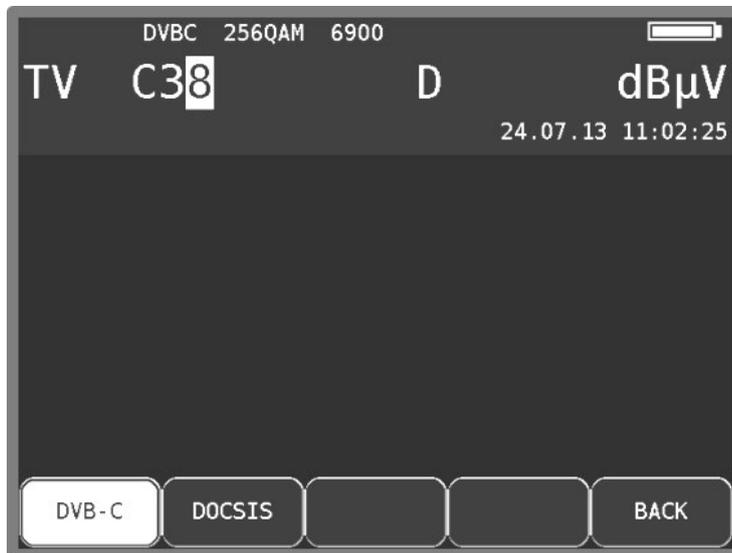
Figure 7-4 DVB-C mode

You enter the modulation scheme for DVB-C in another menu.
The selections 16QAM, 32QAM, 64QAM, 128QAM and 256QAM are also available.
QAM means Quadrature Amplitude Modulation. That is the modulation method with DVB-C.

Automatic detection of the modulation schemes:

The measuring receiver uses the modulation scheme that was just selected as the starting point for automatic detection of the modulation scheme. As soon as you enter a channel, the receiver attempts to demodulate the signal that is present. If that is not successful with the set modulation scheme, the receiver attempts additionally with 64QAM, 128QAM and 256QAM. The modulation scheme of the DVB-C signal received is shown on the display.

7.2.2.1.1   Symbol rate input

You must set the corresponding symbol rate before a DVB-C (QAM) signal can be received.
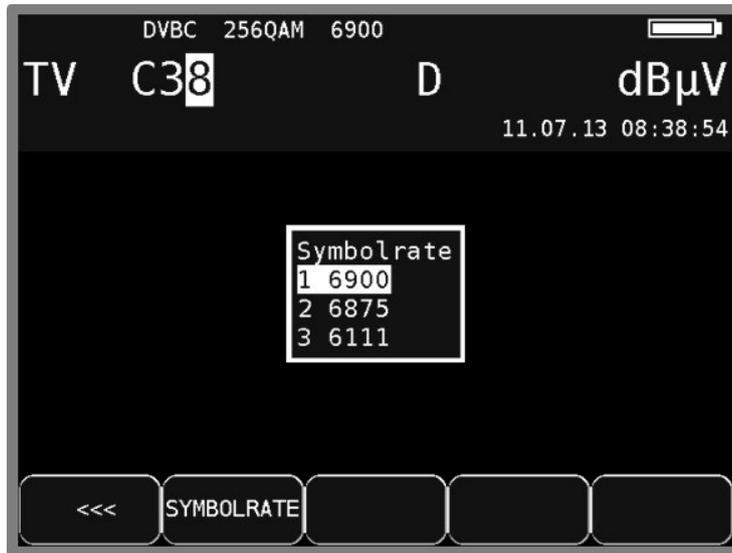
Figure 7-5 Symbol rate setting

First select menu item **SYMBOLRATE**. A drop-down menu with three symbol rates then appears. Select the desired symbol rate using the ↑/↓arrow keys. Activate it by pressing **ENTER** or select the → arrow key to access an input menu. You can now enter the new symbol rate in kBd using the numeric keypad or with the arrow keys. Press **ENTER** to store this setting.

For reference: 6,900 kBd = 6,900 kSym/s = 6.9 MBd = 6. 9MSym/s

The symbol rate can be set in the range 500 kBd to 7,200 kBd.

Automatic symbol rate detection:

The measuring receiver uses the set symbol rate as the starting point for automatic detection. As soon as you enter a new channel, the receiver attempts to use the set symbol rate to demodulate the signal that is present. If this is not successful, it uses the symbol rates 6,111 kBd, 6,875 kBd or 6,900 kBd for additional attempts.

7.2.2.1.2   Scan

You can use this function to scan the entire TV range for DVB-C signals.
For this, you must switch the instrument to channel input mode.
The scan function includes automatic detection of modulation schemes and symbol rates.
That means that the instrument scans every channel with 64QAM, 128QAM and 256QAM and the symbol rates 6,111 kBd, 6,875 kBd and 6,900 kBd.
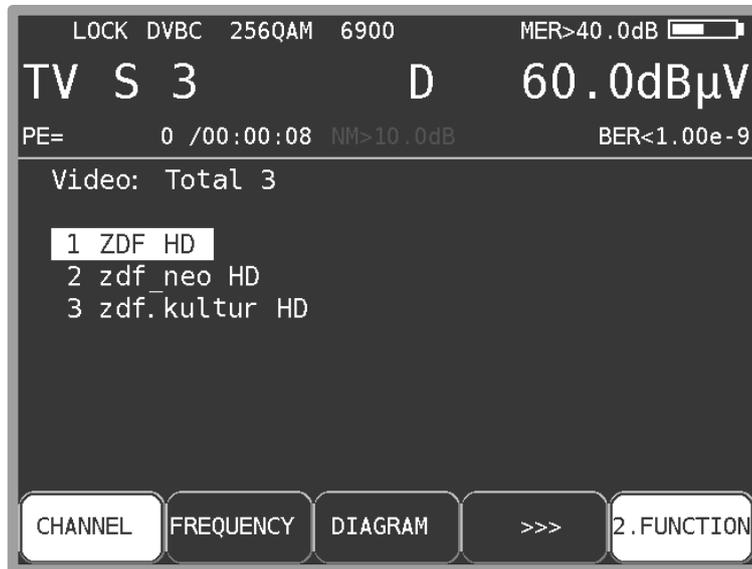
Figure 7-6 DVB-C select service

In this operating mode, the arrow keys have a dual function. After entry of a new channel, the menu item 2.FUNCTION is inverted. That means that the program list can be operated with the arrow keys. To start the scan, first press the F5 key in order to activate the first function of the arrow keys. The scan is then started by first tuning the measuring receiver to a channel at which the scan should begin. Press the ↑ key to start the scan in the positive direction. Press the ↓ key to do the same in the negative direction. When the band limit is reached, the scan continues at the other end of the range. You can end the scan at any time by pressing **HOME**. "SCAN" is shown on the display while the scan takes place.

7.2.2.1.3   DVB-C parameters

As soon as the receiver has completed the synchronization process, several parameters are shown on the display. When LOCK appears, it means that the digital receiver is receiving a valid data stream.
In contrast, UNLK means that either the quality of the signal that is present is insufficient, or that the parameters of the receiver do not match, or that no DVB-C signal can be received at this frequency.
Once the receiver has synchronized, the set modulation scheme and the associated symbol rate are shown on the display.

7.2.2.1.4   BER measurement (Bit Error Rate)

The measurement of the bit error rate aids in the determination of the quality of a DVB signal. To determine the bit error rate, the error correction mechanisms in the digital receiver are used. The data stream is compared before and after correction and the number of corrected bits is determined from that. This number is placed in a ratio to the total throughput of bits and the BER is calculated based on that. For DVB-C, there is only one error protection mechanism (Reed-Solomon), i.e., there is only one bit error rate (BER) here.
The BER is shown on the display in exponential form.
The measuring depth can be shifted between $1 \cdot 10^8$ and $1 \cdot 10^9$ bits. For changing the measuring depth at first the key **HOME** has to be pressed. Then the depth of the bit error rate measurement can be set to $1 \cdot 10^9$ (1 billion) bits via the menu item **BER** -> **e-9**.

Via the menu item **e-8** the measuring depth can be set back to the default setting $1 \cdot 10^8$. This setting is non-volatile. In the operating mode DATAGRABBER and DATALOGGER the measurement of the bit error rate generally operates with a depth of $1 \cdot 10^8$ bits.

7.2.2.1.5   MER measurement (Modulation Error Rate)

In addition to measurement of the bit error rate, it is established practice within digital transmission also measures the MER. It is defined in ETR290. MER is calculated from the constellation points.
It is the counterpart to S/N measurement with analog transmission methods. The measuring range goes up to 40 dB with a resolution of 0.1 dB.

7.2.2.1.6   Noise Margin (NM)

In case of white noise a limit value of MER for the minimum signal quality (QEF) can be determined which depends on the modulation.
The difference of MER to this limit value corresponds to the system reserve NM (noise margin). Just as MER it is displayed in dB with a resolution of 0.1 dB. For an easier assessment of the signal quality the NM is shown in the colors red for bad, yellow for limited and green for good signal quality. The limit values for the BER (>2e-4 for bad and <1e-6 for good) will also be included in this assessment.

7.2.2.1.7   PE measurement (Packet Error)

Short interruptions in the DVB-C signal usually cannot be detected using MER and BER measurement.
They can make entire packets in the transport stream unusable for the MPEG decoder, however. This can lead to short picture freezes or sound that crackles.
The extent of this depends largely on the receiver hardware.
The measuring receiver has a function with which corrupt transport stream packets are summed from the point in time of entry of a new channel.

The number of packet errors (PE = Packet Error) and the amount of time that has passed since the last tuning process is displayed in the measurement parameter area in the bottom left.

7.2.2.1.8   Picture and sound check

For digital television, picture and sound decoding take place in the MPEG decoder. See Chapter 13 MPEG decoder

7.2.2.1.9   Constellation diagram

As soon as the measurement receiver is adjusted, the constellation diagram can be called up by choosing the menu item **CONST**. Further information can be taken from chapter 13 - Constellation diagram.

7.2.2.2   ScQAM-DOCSIS (downstream)

DOCSIS (Data over Cable Service Interface Specification) is the standard for the transmission of data in interactive cable networks. DOCSIS includes a downstream and an upstream.
DOCSIS differentiates between US-DOCSIS (transmission in 6 MHz channels) and Euro-DOCSIS (transmission in 8 MHz channels). From the beginning of DOCSIS-standard 3.1 OFDM as additional modulation type is used. See also chapter 12.5 - DOCSIS3.1-Analyzer.

Similarities and differences in the downstream:

	US-DOCSIS	EURO-DOCSIS
Modulation type	64QAM, 256QAM	64QAM, 256QAM
Symbol rate	5,057 and 5,361	6,952
FEC	J.83/B	DVB-C
Channel bandwidth	6 MHz	8 MHz
Transmission frequency range	50…862 MHz	112…862 MHz

Differences in the upstream:

	US-DOCSIS	EURO-DOCSIS
Transmission frequency range	0…42 MHz	5…65 MHz

As you can see in the comparison, you can use a DVB-C receiver for the reception of a Euro-DOCSIS downstream signal. It is only necessary to set the symbol rate to 6,952kBd. For US-DOCSIS, a receiver according to ITU J.83/B is required.

The measuring receiver has a common receiver for both DOCSIS variants.

You can activate the DOCSIS receiver of the measuring instrument via the menu item MODULATION -> DOCSIS.
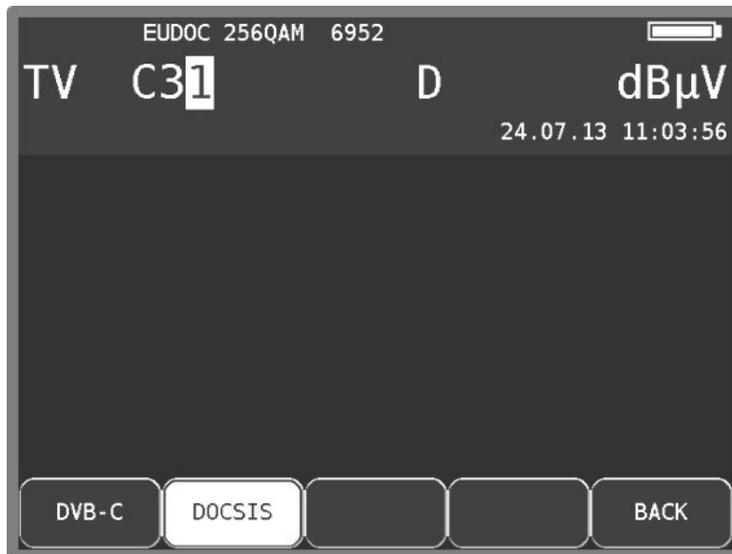
Figure 7-7 DOCSIS mode

You can select the modulation scheme for the DOCSIS variant in another menu.
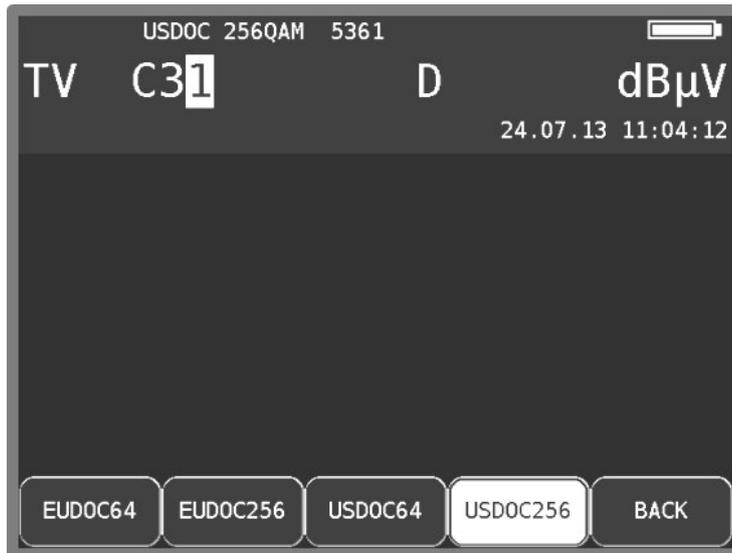
Figure 7-8 DOCSIS modulation type

The associated symbol rate is automatically set.

Automatic scan with DOCSIS:

If you enter a new channel, the receiver attempts to synchronize with the current settings (DOCSIS variants, modulation schemes). If this is not successful, the instrument alternatively uses the other settings EUDOC64 , EUDOC256 , USDOC64 or USDOC256 to receive the signal that is present.

7.2.2.2.1   Downstream-Measurement without DOCSIS-Analyzer

It is possible to measure a single QAM- Downstream without starting the DOCSIS-Modem and lock to CMTS. This can be done via the menu item +US . If the menu item is invers the device will try to lock to the CMTS after entering a new Channel/Frequency. Otherwise only a downstream measurement will be done. This setting is also considered in the station memory.
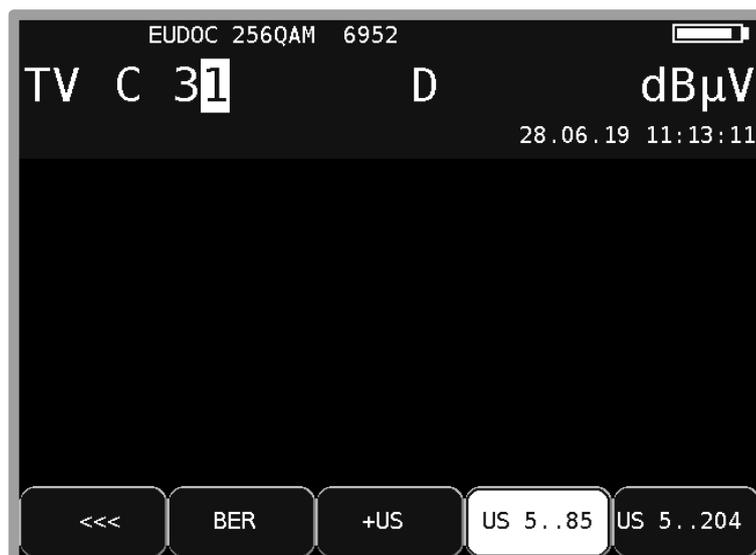
Figure 7-9 Mode +US QAM-Downstream

7.2.2.2.2   DOCSIS parameters

As soon as the receiver has completed the synchronization process, several parameters are shown on the display. When LOCK appears, it means that the digital receiver is receiving a valid data stream.

In contrast, UNLK means that either the quality of the signal that is present is insufficient, or that the parameters of the receiver do not agree, or that no DOCSIS signal can be received at this frequency.

Once the receiver has synchronized, the set modulation scheme and the associated symbol rate is shown on the display.

In the case of a US-DOCSIS signal, the automatically detected de-interleaver depths are also shown in the display. The variable de-interleaver is part of the J83B specification (in the case of DVB-C and EURO-DOCSIS, the de-interleaver is fixed with I = 12 / J = 17).

```
LOCK USDOC 256QAM  5361        MER>40.0dB ▭
TV C31            D      54.9dBu
PE=       0 /00:00:57  I=128,J=1      VBER<1.00e-8
 System:
  Stack-State:       Operational
  Downstream: valid
    80 ┌─────────────────────────────────┐
       │                                 │
  dBµV │                                 │
       │                                 │
    40 └───────────────────■─────────────┘
       522            f/MHz            586
  Upstream: valid
   110 ┌─────────────────────────────────┐
       │                                 │
  dBµV │                 █               │
       │                 █               │
    70 └─────────────────█───────────────┘
        5             f/MHz            65
```
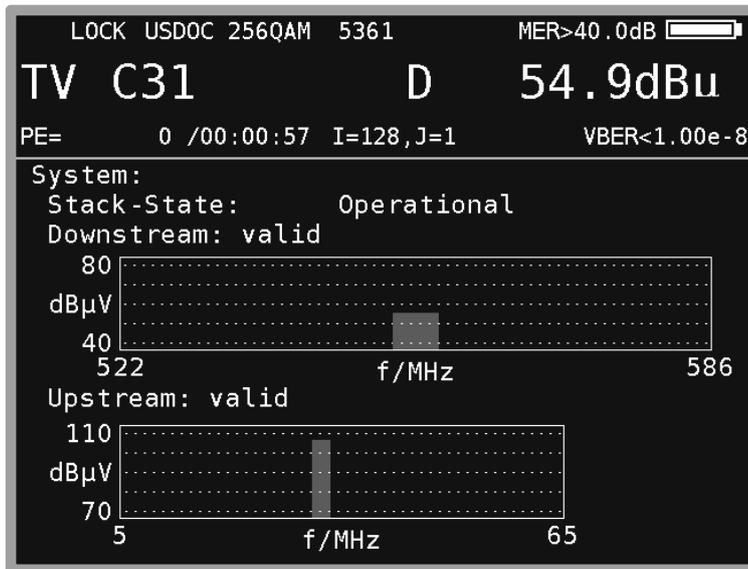
Figure 7-10 DOCSIS ranging display

7.2.2.2.3   Scan

With this function, you can scan the entire TV range for DOCSIS signals.
For this, you must switch the instrument to channel input mode.

The scan function includes the automatic scan of the DOCSIS variants as described above. That means that the instrument scans every channel with EUDOC64, EUDOC256, USDOC64 and USDOC256.

The arrow keys have a dual function. After entry of a new channel, the menu item **2.FUNCTION** is inverted. That means that the Program list decoder can be operated with the arrow keys. To start the scan, first press the F5 key in order to activate the first function of the arrow keys. The scan is then started by first tuning the measuring receiver to a channel at which the scan should begin.
Press the ↑ key to start the scan in the positive direction. Press the ↓ key to do the same in the negative direction. When the band limit is reached, the scan continues at the other end of the range. You can end the scan at any time by pressing **ENTER**. "SCAN" is shown on the display while the scan takes place.

7.2.2.2.4   BER measurement (Bit Error Rate)

The measurement of the bit error rate aids in the determination of the quality of a DVB signal. To determine the bit error rate, the error correction mechanisms in the digital receiver are used. The

data stream is compared before and after correction and the number of corrected bits is determined from that.

This number is placed in a ratio to the total throughput of bits and the BER is calculated based on that. With Euro-DOCSIS, there is only one error protection mechanism (Reed-Solomon). That means that there is only one bit error rate (BER) here.

With US-DOCSIS, in contrast, there is an internal error protection (Viterbi) and an external error protection (Reed-Solomon) as same as in DVB-S and DVB-T. For technical reasons, the measuring instrument can measure only the bit error rate according to Viterbi (VBER) with US-DOCSIS.

The BER is shown on the display in exponential form.

The measuring depth can be shifted between $1 \cdot 10^8$ and $1 \cdot 10^9$ bits. For changing the measuring depth at first the key **HOME** has to be pressed. Then the depth of the bit error rate measurement can be set to $1 \cdot 10^9$ (1 billion) bits via the menu item $\boxed{\text{BER}}$ **->** $\boxed{\text{e-9}}$.

Via the menu item $\boxed{\text{e-8}}$ the measuring depth can be set back to the default setting $1 \cdot 10^8$. This setting is non-volatile. In the operating mode DATAGRABBER and DATALOGGER the measurement of the bit error rate generally operates with a depth of $1 \cdot 10^8$ bits.

7.2.2.2.5   MER measurement (Modulation Error Rate)

In addition to measurement of the bit error rate, it is established practice within digital transmission also measures the MER. It is defined in ETR290. MER is calculated from the constellation points.

It is the counterpart to S/N measurement with analog transmission methods. The measuring range goes up to 40 dB with a resolution of 0.1 dB.

7.2.2.2.6   Noise Margin (NM)

In case of white noise a limit value of MER for the minimum signal quality (QEF) can be determined which depends on the modulation.

The difference of MER to this limit value corresponds to the system reserve NM (noise margin). Just as MER it is displayed in dB with a resolution of 0.1 dB. For an easier assessment of the signal quality the NM is shown in the colors red for bad, yellow for limited and green for good signal quality. The limit values for the BER (>2e-4 for bad and <1e-6 for good) will also be included in this assessment.

7.2.2.2.7   PE measurement (Packet Error)

Short interruptions in the DOCSIS signal usually cannot be detected using MER and BER measurement. They can make entire packets in the transport stream unusable, however. The measuring receiver has a function with which corrupt transport stream packets are summed from the point in time of entry of a new channel.

The number of packet errors (PE = Packet Error) and the amount of time that has passed since the last tuning process is displayed.

7.2.2.2.8   Constellation diagram

The constellation diagram can be called via the menu item $\boxed{\text{CONST}}$, if the measurement receiver is tuned. For further information see Chapter 14 Constellation diagram.

7.2.2.3   OFDM-DOCSIS (downstream)

From the beginning of DOCSIS-standard 3.1 the modulation type OFDM is used additionally to ScQAM (single carrier QAM). The next table gives an overview of the different parameters.

	OFDM-DOCSIS
Modulation (Single Carrier)	Up to 4kQAM
Channel bandwidth	24..192MHz
FEC	LDPC/BCH
FFT-order	4k oder 8k
Downstream frequency range	108…1218 MHz

The device is set to mode OFDM-downstream via the menu item **MODULATION** -> **DOCSIS** -> **OFDM** .

Figure 7-11 OFDM-DOCSIS-Mode

Further settings are not necessary here. The remaining parameters are automatically recognized by the device after the frequency entry. Either the center frequency or the PLC frequency of the OFDM channel can be entered. By using a custom channel table, OFDM downstream channels can also be input via channel input.

7.2.2.3.1   Downstream-Measurement without DOCSIS-Analyzer

It is possible to measure a single OFDM downstream without the modem beginning the log in process. This can be achieved via the menu item **+US**.

If the menu item is displayed in inverse (default), the log-on process is started simultaneously after the frequency / channel input. Otherwise, only one downstream measurement will be performed. This setting is also taken into account in the station memory.
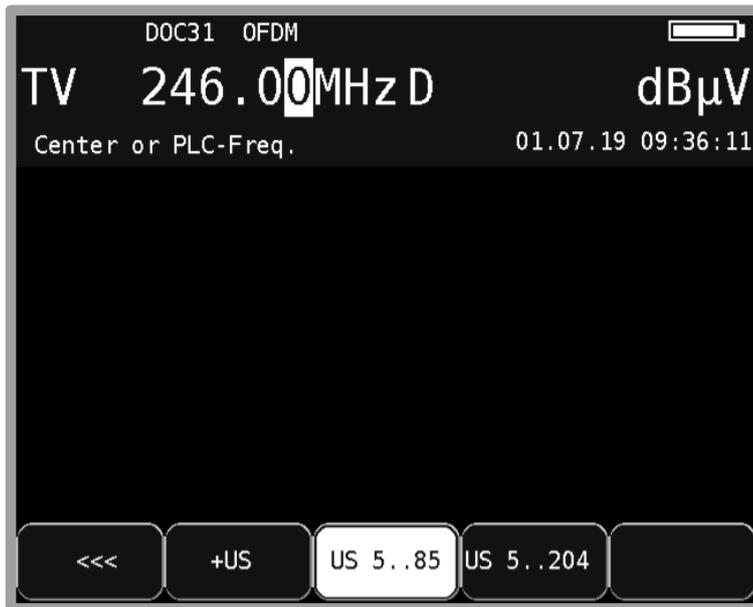
Figure 7-12 Mode +US OFDM-Downstream

This has a speed advantage if only a certain downstream is to be measured.

If the downstream to be measured is secondary, it is possible to perform the measurement via "+US" off, or the device can be logged in to the CMTS via another downstream and measure the OFDM downstream in the DOCSIS analyzer.

The following figure shows a measurement screen when an OFDM downstream is measured without logging in to CMTS.
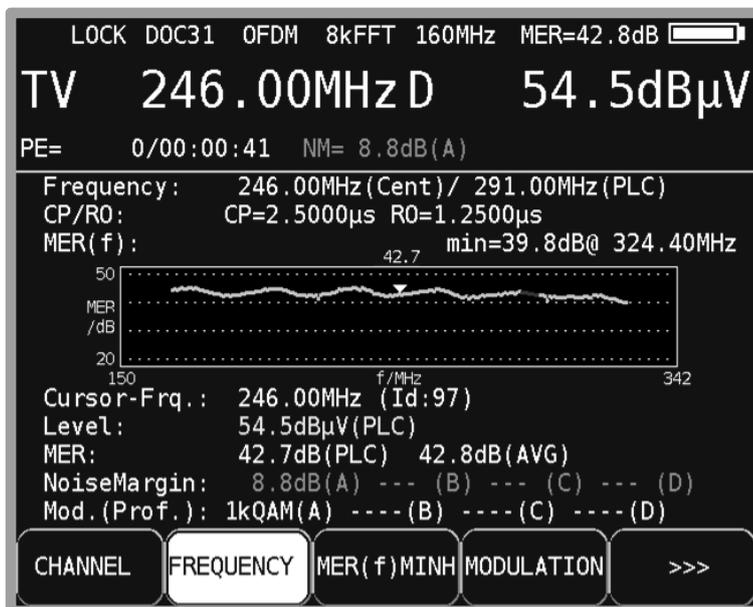
Figure 7-13 OFDM-Downstream-Measurement

7.2.2.3.2   Downstream-Measurement with DOCSIS-Analyzer

See chapter 12.5 - DOCSIS3.1-Analyzer.

7.2.2.3.3   OFDM-Parameters

As soon as the receiver has finished the synchronization process (SCAN), some parameters are shown in the display.
The hint LOCK means that the digital receiver is receiving a valid data stream. In contrast, UNLK states that the quality of the applied signal is insufficient, the parameters of the receiver do not match, or no DOCSIS-OFDM signal is to be received at that frequency. If the receiver has synchronized, the ascertained FFT order and the channel bandwidth are shown in the top line of the display.
Below, the meter will display the cyclic prefix and roll-off of the OFDM signal.

7.2.2.3.4   MER measurement (Modulation Error Rate)

The MER is calculated from the constellation points. Here, the mean MER is measured over all individual carriers and displayed next to the battery symbol.

7.2.2.3.5   Noise Margin (NM)

The measurement receiver uses the measured MER and the modulation scheme to determine a Noise Margin in dB. The limits considered are defined in the DOCSIS specification. The indication in brackets e.g. (A) denotes the profile with the most significant modulation scheme. That always the most critical case is considered.

7.2.2.3.6   PE measurement (Packet Error)

Short disturbances in the DOCSIS signal can usually not be detected by the MER measurement. Therefore, the meter counts the number of packet errors, or code word errors.
In the measurement parameter area at the bottom left, the number of packet errors (PE: = Packet Error) and the elapsed time after the last tuning process are displayed.

7.2.2.4   DVB-T

The DVB-T receiver of the measuring instrument is activated via the menu item MODULATION ->
DVB-T .
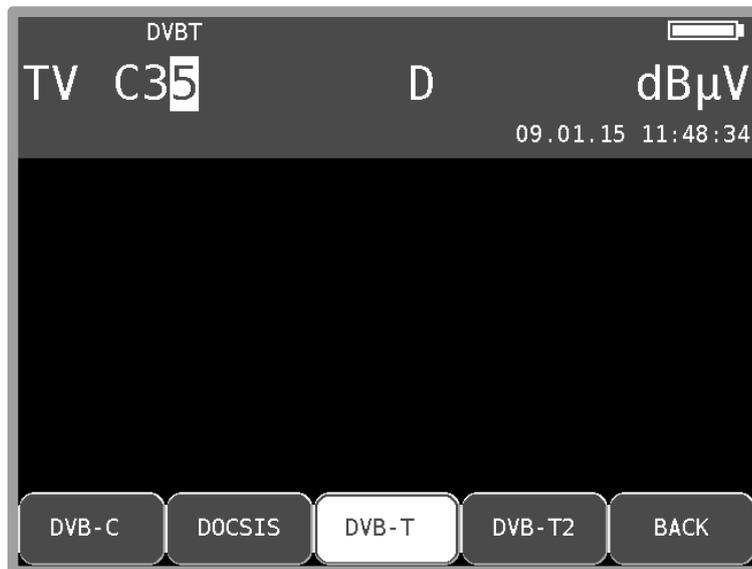
Figure 7-14 DVB-T modulation

The modulation method with DVB-T is COFDM (Coded Orthogonal Frequency Division Multiplex).
It involves a very robust digital transmission method that is optimized in particular for transmission
channels with multipath reception.

7.2.2.4.1   Selection of the COFDM bandwidth (channel bandwidth)

The DVB-T standard provides for transmission in 6, 7 or 8 MHz channels.

Figure 7-15 DVB-T selection bandwidth

The bandwidth of the COFDM signal is set via BANDWIDTH -> AUTO, 8MHz, 7MHz or 6MHz. In
the AUTO setting, which is also the default setting, the measuring instrument uses the channel
bandwidth that is stored in the respective channel table.

This setting is non-volatile and is also incorporated in the tuning memory.

7.2.2.4.2 Scan

You can use this function to scan the entire TV range for DVB-T signals.

You must switch the instrument to channel input mode to use the scan function.

In the digital operating mode, the arrow keys have a dual function. After entry of a new channel, the menu item 2.FUNCTION is inverted. That means that the MPEG decoder can be operated with the arrow keys. To start the scan, first press the **F5** key in order to activate the first function of the arrow keys.

The scan is then started by first tuning the measuring receiver to a channel at which the scan should begin. Press the ↑ key to start the scan in the positive direction. Press the ↓ key to do the same in the negative direction. When the band limit is reached, the scan continues at the other end of the range. You can end the scan at any time by pressing **ENTER**. "SCAN" is shown on the display while the scan takes place

7.2.2.4.3 DVB-T parameters

As soon as the receiver has completed the synchronization process, several parameters are shown on the display. When LOCK appears, it means that the digital receiver is receiving a valid data stream. In contrast, UNLK means that either the quality of the signal that is present is insufficient, or that the parameters of the receiver do not agree, or that no DVB-T signal can be received at this frequency.

```
 LOCK  DVBT   16QAM   8kFFT          MER=28.2dB ▭▭

TV C35            D        48.4dBμV
GI=1/4    FEC=2/3  NM>10.0dB VBER<1.00e-8  CBER=3.62e-5

   Video:  Total 4


    1 ZDF
    2 3sat
    3 ZDFinfo
    4 neo/KiKA




  CHANNEL  FREQUENCY  DIAGRAM    >>>    2.FUNCTION
```
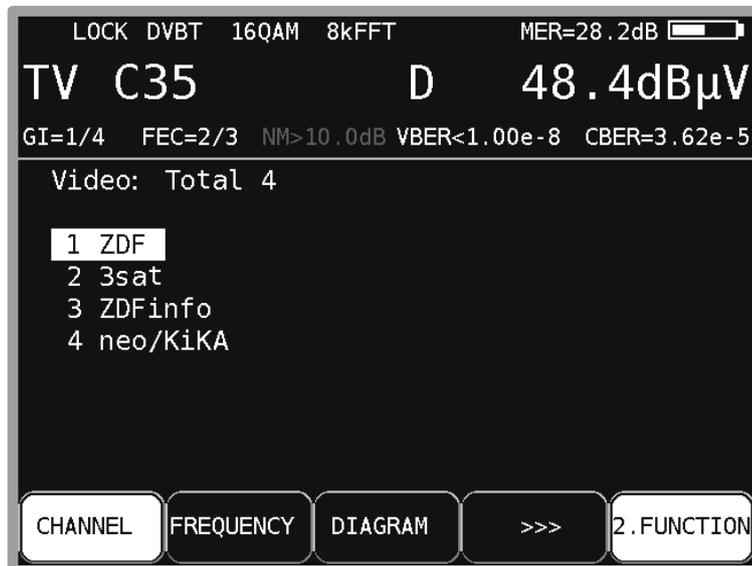
Figure 7-16 DVB-T parameters

Once the receiver is synchronized, additional parameters are shown on the display. The DVB-T receiver determines these automatically.

With COFDM, a multi-carrier method is involved. The single carriers within the DVB-T signal are QPSK, 16QAM or 64QAM modulated. Figure 7-16 shows transmission with the modulation scheme 16QAM.

The DVB-T standard specified two FFT modes (2k or 8k). In the top line, you can see the currently determined FFT mode.

Additional parameters are the Guard Interval (GI), FEC (Forward Error Correction) and the network identification number (ID). These are displayed in the line above the menu bar.

The DVB-T standard is suitable for transmission in single frequency networks (SFN). In a single frequency network, the involved stations operate synchronously on the same frequency. In order to take into account differing transit times with simultaneous effect on the receiving location, the DVB-T signal contains a so-called "guard interval". The size of the guard interval tells you something about the maximum station distance within a single frequency network.

The FEC value expresses the ratio between usable bits and transmitted bits. In this example, there are two usable bits for every three transmitted bits.

7.2.2.4.4   Further DVB-T parameters

The menu item PARAMETERS opens a sub menu with further DVB-T parameters.
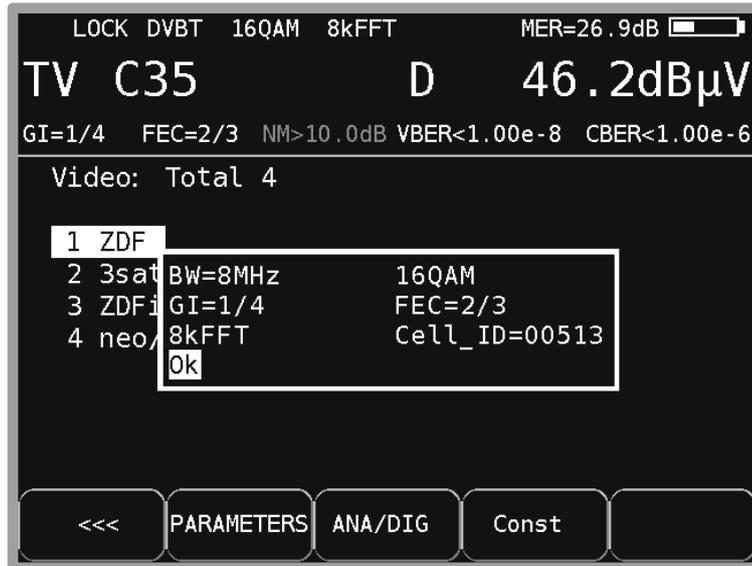
Figure 7-17 DVB-T parameter information

One of the parameters, the Cell ID, uniquely identifies the cell of the transmitter.

7.2.2.4.5   BER measurement (Bit Error Rate)

The measurement of the bit error rate aids in the determination of the quality of a DVB signal.

To determine the bit error rate, the error correction mechanisms in the digital receiver are used. The data stream is compared before and after correction and the number of corrected bits is determined from that. This number is placed in a ratio to the total throughput of bits and the BER is calculated based on that.

For DVB-T, two independent error protection mechanisms work together. So-called internal error protection (after the demodulator) is called Viterbi (named after the Viterbi algorithm) with DVB-T.

External error protection operates after that. With DVB-T, it is called Reed-Solomon.

For DVB-T, the bit error rates are measured before Viterbi (CBER) and after Viterbi (VBER).
Both values are shown on the display in exponential form.

The depth of measurement for the CBER is $1 \cdot 10^6$ bits, for the VBER is $1 \cdot 10^8$ bits.

7.2.2.4.6   MER measurement (Modulation Error Rate)

In addition to measurement of the bit error rate, it is established practice with digital transmission to also measure MER. It is defined in ETR290. MER is calculated from the constellation points.
It is the counterpart to S/N measurement with analogue transmission methods. The measuring range goes up to 35 dB with a resolution of 0.1 dB.

7.2.2.4.7   Noise Margin (NM)

In case of white noise a limit value of MER for the minimum signal quality (QEF) can be determined dependent on the modulation type and the FEC.The difference of MER to this limit value corresponds to the system reserve NM (noise margin). Just as MER it is displayed in dB with a resolution of 0.1 dB. For an easier assessment of the signal quality the NM is shown in the colors red for bad, yellow for limited and green for good signal quality. This assessment also considers the limit values of VBER (>2e-4 for bad and <1e-6 for good).

Important!   The noise margin cannot be shown in DVB-T during active PE-measurement.

7.2.2.4.8   Impulse response

It is helpful to measure the impulse response for DVB-T for setting up a receiving antenna - especially in situations where reception is difficult and signals are received simultaneously from several stations in the SFN. If a receiving antenna receives the DVB-T signal from multiple directions with differing transit times and differing field strengths, the individual signals superimpose upon each other to form a sum signal.
Because DVB-T is made up of several narrow-band single carriers (COFDM), individual carriers may occasionally be notably attenuated through superimposition. Because information is distributed among all carriers with respect to time, the DVB-T system can process this to a certain degree without any problem. However, the impulse response can be used to detect this scenario before it causes problems in reception. The basis for measuring the impulse response is information in the channel transmission function.
The DVB-T channel decoder acquires this from the pilot carriers that are transmitted with DVB-T. Through calculation of the Inverse FFT, the   impulse response can be obtained from the channel transmission function.
The measuring receiver must receive a DVB-T signal in order to display the impulse response. The instrument should be tuned to an appropriate channel to do this.

To show the impulse response on the TFT of the measuring instrument, select the menu item IMPULSERES . A menu for additional settings will then appear.
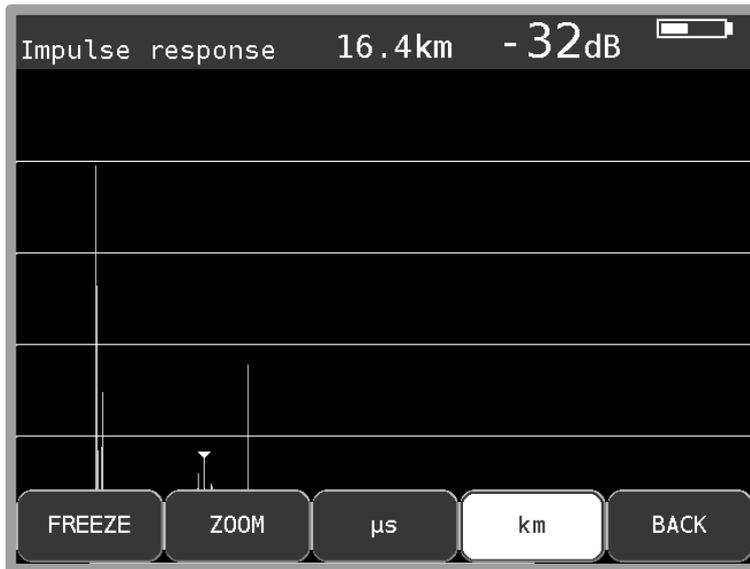
Figure 7-18 DVB-T Impulse response menu options

You can "freeze" the picture using FREEZE . You can expand the impulse response in the horizontal direction using ZOOM . You can then see more details near the primary impulse. You can define the unit of the x-axis with µs or km . Time and length are related via the speed of light, c: =3•10^8 m/s. You can end the display of the impulse response via the menu item BACK .
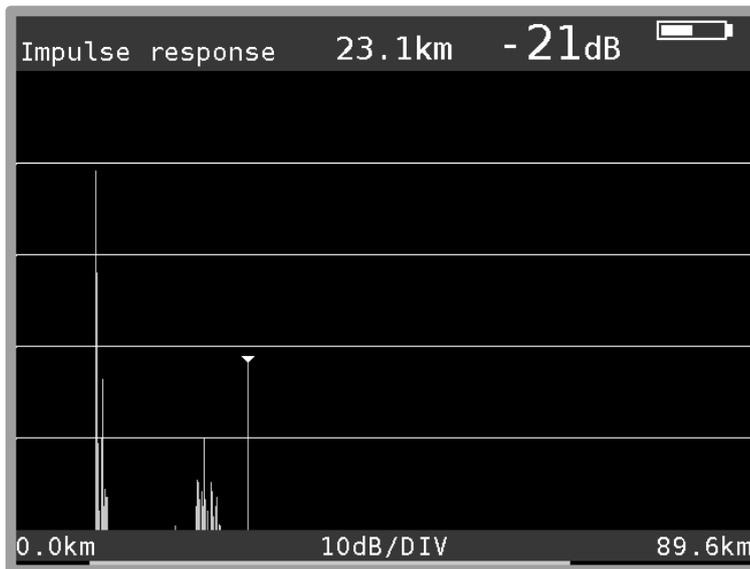
Figure 7-19 DVB-T Impulse response

Figure 7-19 shows an impulse response with a primary impulse (left picture edge) and several secondary impulses at a distance of approximately 23 km from the primary impulse.

You can move the cursor (small triangle) left and right using the ←/→keys. At the top area of the screen, the distance of the secondary impulses and their attenuation (-21 dB) in relation to the primary impulse is displayed.

Peak-Search Function

While the impulse response is built up, the instrument determines the four highest secondary impulses apart from the main impulse. If there are echoes, the cursor moves to the highest secondary impulse after the second cycle. By pressing the keys ↑ and ↓ the cursor may be moved to further echoes cyclically one after the other. The distance and/or the delay as compared to the main impulse may be taking taken from the readings in the header of the diagram.

7.2.2.4.9   PE measurement (Packet Error)

Short interruptions in the DVB-T signal usually cannot be detected using MER and BER measurement. They can make entire packets in the transport stream unusable for the MPEG decoder, however. This can lead to short picture freezes or sound that crackles.

The extent of this depends largely on the receiver hardware.

The measuring receiver has a function were corrupt transport stream packets can be summed from the point in time of entry of a new channel. This function runs in the background constantly. An additional window can be shown on the display using the menu item PE-INFO . The number of packet errors (PE = Packet Error) and the amount of time that has passed since the last tuning process is displayed. Press **ENTER** to close the window again.
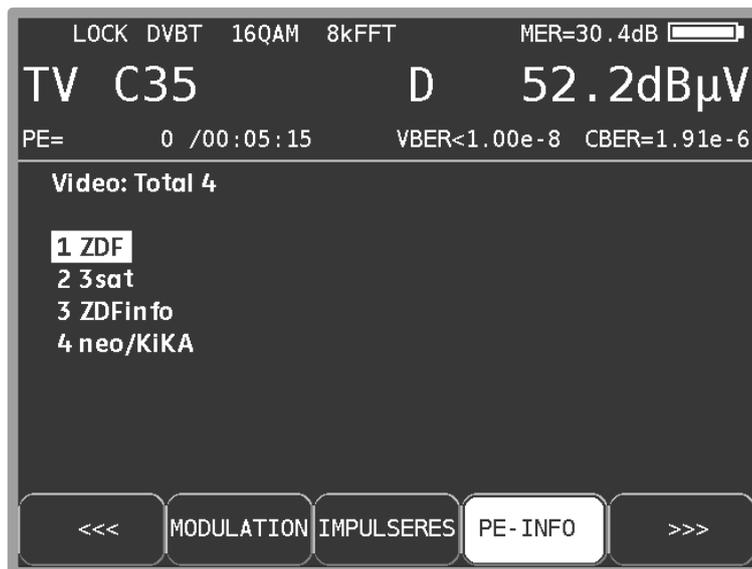
Figure 7-20 DVB-T packet error

7.2.2.4.10   Picture and sound check

For digital television, picture and sound decoding take place in the MPEG decoder.
For more information see Chapter 13 - MPEG decoder section.

7.2.2.4.11   Remote supply

The measuring receiver can provide a remote power supply via the RF input socket for an active receiving antenna (see also chapter 10.9 - Remote supply).

7.2.2.4.12   Constellation diagram

As soon as the measurement receiver is adjusted, the constellation diagram can be called up by choosing the menu item CONST . Further information can be found in Chapter 14 Constellation diagram.

7.2.2.5   DVB-T2

The DVB-T2 receiver of the measuring instrument is activated via the menu item MODULATION ->
DVB-T2.
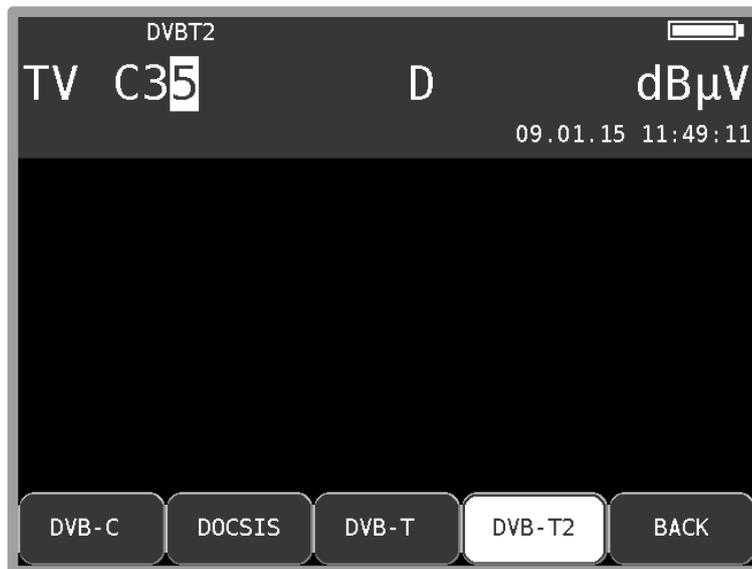
Figure 7-21 Modulation mode DVB-T2

The modulation method for DVB-T2 is COFDM (Coded Orthogonal Frequency Division Multiplex). It
involves a very robust digital transmission method that is optimized in particular for transmission
channels with multipath reception. DVB-T2 is a very flexible standard for terrestrial transmission of
digital TV. OFDM transmission parameters can be optimally adapted to the topographic conditions.
The main improvement compared to DVB-T is a higher transmission capacity up to 30% at the
same channel quality.

7.2.2.5.1   Selecting the COFDM bandwidth (channel bandwidth)

The DVB-T2 standard provides for transmission in 1.7, 5, 6, 7 or 8 MHz channels.
The bandwidths 1.7 MHz and 5 MHz are not supported by the instrument.

The bandwidth of the COFDM signal is set via BANDWIDTH -> AUTO, 8MHz, 7MHz or 6MHz. In
the AUTO setting, which is also the default setting, the measuring instrument uses the channel
bandwidth that is stored in the respective channel table.
This setting is non-volatile and is also incorporated in the tuning memory.

7.2.2.5.2   Scan

You can use this function to scan the entire TV range for DVB-T2 signals.
To do this, you must switch the instrument to channel input mode.

In the digital operating mode, the arrow keys have a dual function. After entry of a new channel, the menu item 2.FUNCTION is inverted.

That means that the MPEG decoder can be operated with the arrow keys. To start the scan, first press the F5 key in order to activate the first function of the arrow keys.
The scan is then started by first tuning the measuring receiver to a channel at which the scan should begin. Press the ↑ key to start the scan in the positive direction. Press the ↓ key to do the same in the negative direction. When the band limit is reached, the scan continues at the other end of the range. You can end the scan at any time by pressing **ENTER**. "SCAN" is shown on the display while the scan takes place.

7.2.2.5.3   DVB-T2 parameters

As soon as the receiver has completed the synchronization process, several parameters are shown on the display. When LOCK appears, it means that the digital receiver is receiving a valid data stream.

In contrast, **UNLK** means that either the quality of the signal that is present is insufficient, or that the parameters of the receiver do not match, or that no DVB-T2 signal can be received at this frequency.
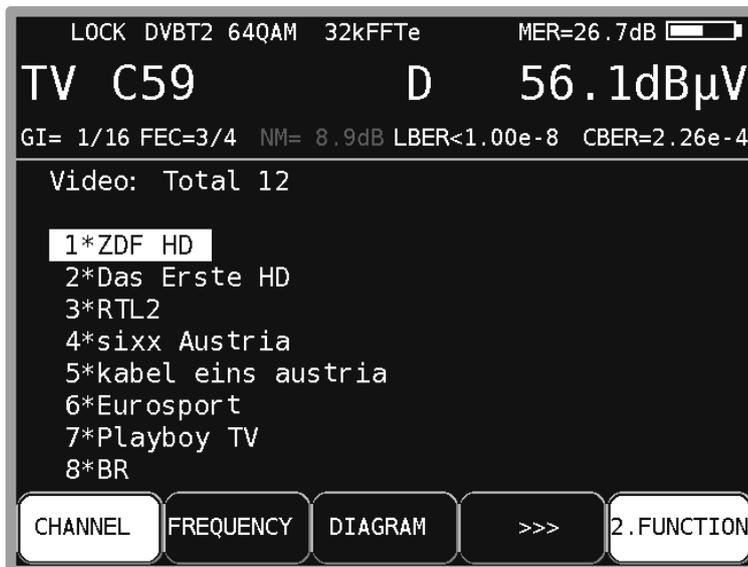
Figure 7-22 DVB-T2 parameters

Once the receiver is synchronized, additional parameters are shown on the display. The DVB-T2 receiver determines these automatically.

In Figure 7-22 DVB-T2 parameters the equipment receives a DVB-T2-signal with following parameters:

- 32kFFTe: 32k FFT, the e means "Extended Carrier Mode", i.e. bandwidth utilization is higher in this mode as additional OFDM single carriers are used.
- Modulation scheme: 64QAM
- Guard Interval (GI): 1/16
- FEC: 3/4

7.2.2.5.4 Further DVB-T2 parameters

The **PARAMETERS** menu item can be used to display a window in which additional DVB-T2 parameters are listed.

```
LOCK DVBT2 64QAM  32kFFTe  MPLP MER>35.0dB ▱
TV    300.00MHz D      55.0dBµV
GI= 1/16 FEC=2/3  NM>10.0dB LBER<1.00e-8  CBER=8.90e-4

  Video: Total 5
    ┌─────────────────────────────────┐
    │BW=8MHz  FEC=2/3  GI= 1/16        │
  1 S│PP4           PAPR=OFF           │
  2 S│FRAME=NORMAL  ROT=OFF            │
  3 S│Cell_ID=29185 Netw_ID=12402      │
  4*S│Sys_ID=7766   SISO               │
  5*S│PLPs=2(MULT)  PLP_ID(1)=0 V=1.3.1│
    │Post_Scrambeld=ON  Base_Lite=OFF │
    │Ok                               │
    └─────────────────────────────────┘

 ⟨ <<< ⟩ ⟨ PE-INFO ⟩⟨PARAMETERS⟩⟨BANDWIDTH⟩ ⟨ >>> ⟩
```
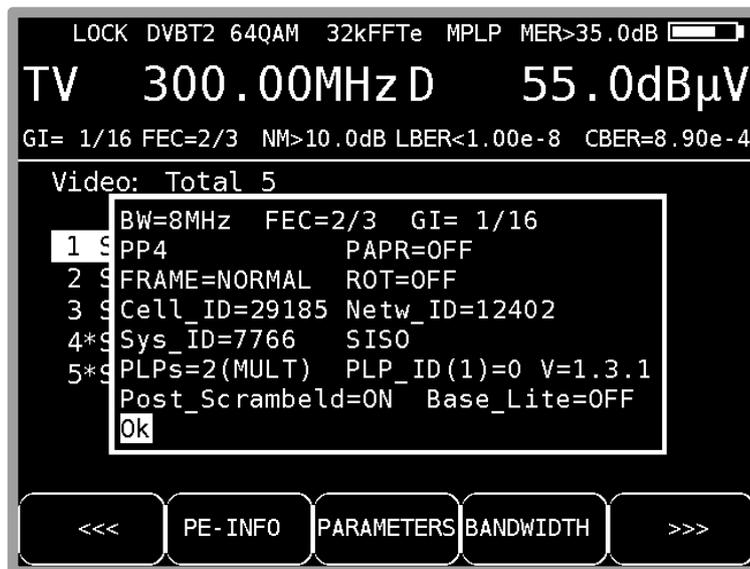
Figure 7-23 DVB-T2 parameters info

Explanations:

- Pilot Pattern = PP4
- PAPR = OFF ("Peak to Average Power Reduction = OFF") – Crest factor reduction off
- LDPC-Frame = Normal length
- ROT = OFF (Constellation rotation off)
- System = SISO (Single In Single Out) – A transmission antenna and a receiving antenna, as opposed to MISO which has two transmission antennas and a receiving antenna.
- PLPs: Physical Layer Pipes, more services in one channel maybe with different modulation.
- PLP_ID: Index of the chosen PLP
- V=1.3.1 active DVBT2-Version
- Post_Scrambeled: from Version 1.3.1 and higher additional coding.
- Base_Lite: additional PLP at lower code rate

7.2.2.5.5 Selection of PLPs (Physical Layer Pipes)

Are more services (PLPs) in a channel available, they can be selected by the menu SET PLP. Once a new PLP is selected, the corresponding lists are build and displayed.

7.2.2.5.6   BER measurement (Bit Error Rate)

The measurement of the bit error rate aids in the determination of the quality of a DVB-T2 signal.

To determine the bit error rate, the error correction mechanisms in the digital receiver are used. The data stream is compared before and after correction and the number of corrected bits is determined from that. This number is placed in a ration to the total throughput of bits and the BER is calculated based on that.

For DVB-T2, two independent error protection mechanisms work together. LDPC (Low Density Parity Check) is used for internal error protection, BCH (Bose Chaudhuri Hocquenghem) is used for external error protection.

The equipment measures the bit error rates before LDPC (CBER) and after LDPC (LBER).
Both values are shown on the display in exponential form.
The depth of measurement for the CBER is $1 \cdot 10^6$ bits, for the LBER it is $1 \cdot 10^8$ bits.

7.2.2.5.7   MER measurement (Modulation Error Rate)

In addition to measure the bit error rate, it is established practice with digital transmission to also measure MER. It is defined in ETR290. MER is calculated from the constellation points.
It is the counterpart to S/N measurement with analogue transmission methods. The measuring range goes up to 35 dB with a resolution of 0.1 dB.

If echoes occur during transmission the MER value is lowered. By using an echo-compensation this error is removed. By default this compensation is active and can be switched off in the settings. The constellation diagram is not affected so that echoes can be seen, even if echo-compensation is active.

7.2.2.5.8   Noise Margin (NM)

In case of white noise a limit value of MER for the minimum signal quality (QEF) can be determined dependent on the modulation type and the FEC.
The difference of MER to this limit value corresponds to the system reserve NM (noise margin). Just as MER it is displayed in dB with a resolution of 0.1 dB. For an easier assessment of the signal quality the NM is shown in the colors red for bad, yellow for limited and green for good signal quality. The limit values for the BER (>2e-4 for bad and <1e-6 for good) will also be included in this assessment.

Important!   The noise margin cannot be shown in DVB-T2 during active PE-measurement.

7.2.2.5.9 Impulse response

As with DVB-T, DVB-T2 is intended for operation in a single frequency network. This means several transmitters transmit on the same frequency.
The transmitters involved must operate synchronously on the same frequency.
The maximum transmitter distance depends on the Guard Interval used.
At the receiving location, the signals from individual transmitters superimpose on each other to form a sum signal.
The result can be constructive or destructive depending on the transit time difference and the received field strength. The impulse response graphically represents attenuation and transit time difference of the individual signals.
In order to calculate the channel impulse response, the DVB-T2 receiver requires information on the channel transmission function. The demodulator obtains this information by evaluating the pilot carrier in the OFDM signal.

The measuring receiver must receive a DVB-T2 signal in order to measure the impulse response. The instrument should be tuned to an appropriate channel to do this.
The instrument displays the impulse response on the screen when the $\boxed{\text{IMPULSERES}}$ menu item is selected. A menu for additional settings will appear at the same time.
You can "freeze" the picture using $\boxed{\text{FREEZE}}$. You can expand the impulse response in the horizontal direction using $\boxed{\text{ZOOM}}$. You can define the unit of the x-axis with $\boxed{\text{µs}}$ or $\boxed{\text{km}}$. Time and length are related via the speed of light, $c := 3 \cdot 10^8$m/s. You can end the display of the impulse response via the menu item $\boxed{\text{BACK}}$.
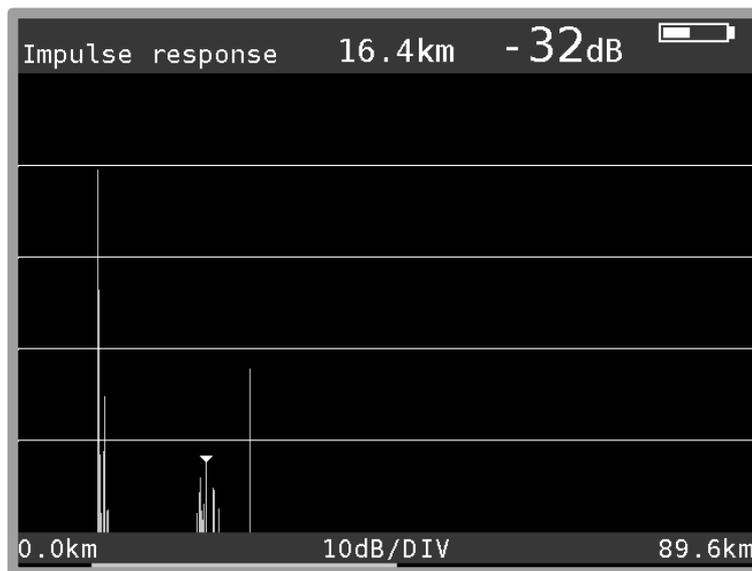
Figure 7-24 DVB-T2 Impulse response

The printed example shows an impulse response with a primary impulse (left picture edge) and several secondary impulses at a distance of approximately 16 km from the primary impulse.

You can move the cursor (small triangle) left and right using the ←/→keys. At the top right edge of the picture, the transit time difference and attenuation in relation to the primary impulse is displayed at the cursor position.

Peak-Search Function
While the impulse response is built up, the instrument determines the four highest secondary impulses apart from the main impulse. If there are echoes, the cursor moves to the highest secondary impulse after the second cycle. By pressing the keys ↑ and ↓ the cursor may be moved to further echoes cyclically one after the other. The distance and/or the delay as compared to the main impulse may be taking taken from the readings in the header of the diagram.

7.2.2.5.10 PE measurement (Packet Error)

Short interruptions in the DVB-T2 signal usually cannot be detected using MER and BER measurement. They can make entire packets in the transport stream unusable for the MPEG decoder, however. This can cause the picture to freeze temporarily or the sound to crackle.
The measuring receiver has a function with which corrupt transport stream packets are summed from the point in time of entry of a new channel. This function runs in the background constantly. An additional window can be shown on the display using the menu item PE-INFO . The number of packet errors (PE = Packet Error) and the amount of time that has passed since the last tuning process is displayed.

7.2.2.5.11 Picture and sound check

For digital television, picture and sound decoding take place in the MPEG decoder (see Chapter 13 MPEG decoder).

7.2.2.5.12 Remote supply

The measuring receiver can provide a remote power supply via the RF input socket for an active receiving antenna (see also chapter 10.9 Remote supply).

7.2.2.5.13 Constellation diagram

As soon as the measurement receiver is adjusted, the constellation diagram can be called up by choosing the menu item CONST . Further information can be found in Chapter 14 Constellation diagram.

7.2.2.6   DTMB

DTMB (Digital Terrestrial Multimedia Broadcasting) is a Chinese standard for digital TV and radio program transmission. DTMB was developed in 2007 out of the two drafts of DMB-T and ADTB-T. DMB-T, developed at the University of Beijing, is a multiple carrier standard similar to the European DVB-T/T2.

ADTB-T (single carrier) was derived from the American standard ATSC and was further developed at the University of Shanghai. Parts of the specification of DTMB, which supports a single and a multi-carrier mode, are written down in GB20600-2006. Like DVB-T2, DTMB uses for internal error correction the LDPC mechanism (Low Density Parity Check) and for external error correction the BCH mechanism (Bose Chaudhuri Hocguenghem). Thus the transmission standard is very robust, which makes it suitable for mobile TV reception. Additional DTMB can also be used in single frequency networks.

The DTMB receiver is activated via the menu items MODULATION -> DTMB.
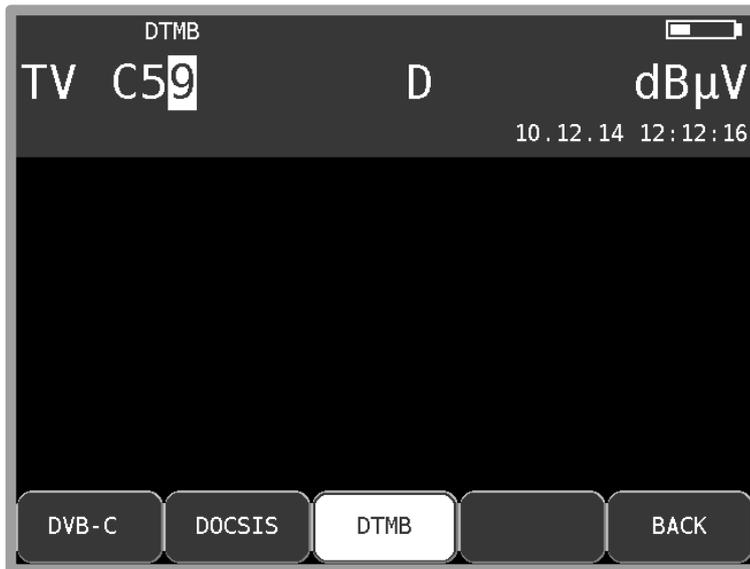
Figure 7-25 Modulation selection DTMB

After activating a new menu will appear where the DTMB mode can be adjusted.

Figure 7-26 DTMB selecting carrier mode

The single carrier mode (C1) is activated with SINGLECAR whereas the receiver is set to multi carrier mode (C3780) with MULTICAR.

7.2.2.6.1   Scan

You can use this function to scan the entire TV range for DTMB signals. To do this, you must switch the instrument to channel input mode.

In the digital operating mode, the arrow keys have a dual function. After entry of a new channel, the menu item 2.FUNCTION is inverted.

That means that the MPEG decoder can be operated with the arrow keys. To start the scan, first press the **F5** key in order to activate the first function of the arrow keys.

The scan is then started by first tuning the measuring receiver to a channel at which the scan should begin. Press the ↑ key to start the scan in the positive direction. Press the ↓ key to do the same in the negative direction. When the band limit is reached, the scan continues at the other end of the range. You can end the scan at any time by pressing ↑/↓ or **ENTER**. "SCAN" is shown on the display while the scan takes place.

7.2.2.6.2   DTMB parameters

As soon as the receiver has completed the synchronization process, several parameters are shown on the display. When LOCK appears, it means that the digital receiver is receiving a valid data stream.

In contrast, **UNLK** means that either the quality of the signal that is present is insufficient, or that the parameters of the receiver do not match, or that no DTMB signal can be received at this frequency.


```
LOCK DTMB  64QAM  MULTICR        MER>32.0dB ▭▭

TV C45            D      59.9dBµV

GI=420v  FEC=0.6  NM>10.0dB LBER<1.00e-8  CBER<1.00e-6

  Video:  Total 1

   ┌─────────┐    ┌──────────────────┐
   │ 1 Jump  │    │ 64QAM    MULTICR  │
   └─────────┘    │ CODE RATE=0.6     │
                  │ INTERLEAVER=720   │
                  │ GI=420v           │
                  │ Ok                │
                  └──────────────────┘



    <<<    PARAMETERS  ANA/DIG
```
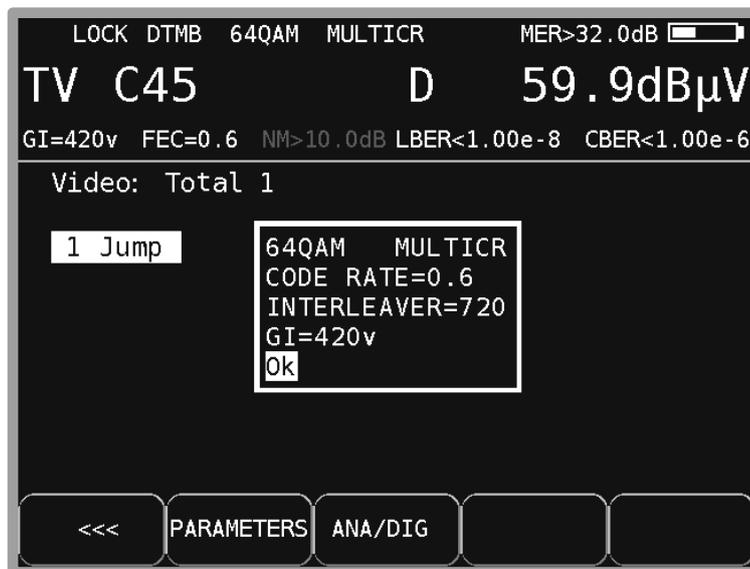
Figure 7-27 DTMB parameters

Once the receiver is synchronized, additional parameters are shown on the display. The DTMB receiver determines these automatically.

In the figure shown above, the instrument receives a DTMB-Signal with the following parameters:
Multi carrier modulation: MULTICAR (C3780)

Multi carrier modulation	(MULTICAR – C3780)
Modulation scheme	64QAM
Guard-Interval(GI)	PN420 variable (equivalent 125 µs)
FEC	0.6
Time interleaver	M_720

7.2.2.6.3   BER measurement (Bit Error Rate)

The measurement of the bit error rate aids in the determination of the quality of a DTMB signal.

To determine the bit error rate, the error correction mechanisms in the digital receiver are used. The data stream is compared before and after correction and the number of corrected bits is determined from that. This number is placed in a ration to the total throughput of bits and the BER is calculated based on that. With DTMB there are two independent error protections that work together.
The inner error protection comes from LDPC (Low Density Parity Check), the external error protection uses BCH (Bose Chaudhuri Hocguenghem).

The instrument measures the Bit Error Rate before LDPC (CBER) and after LDPC (LBER). Both results will be shown on the display in exponential form. The measurement depth is for CBER $1 \cdot 10^6$ Bits and for LBER $1 \cdot 10^8$ Bits.

7.2.2.6.4   MER measurement (Modulation Error Rate)

In addition to measurement of the bit error rate, it is established practice with digital transmission to also measure MER. It is defined in ETR290. MER is calculated from the constellation points. It is the counterpart to S/N measurement with analogue transmission methods. The measuring range goes up to 32 dB with a resolution of 0.1 dB.

7.2.2.6.5   Noise Margin (NM)

In case of white noise a limit value of MER for the minimum signal quality (QEF) can be determined dependent on the modulation type, the FEC and the other parameters.
The difference of MER to this limit value corresponds to the system reserve NM (noise margin). Just as MER it is displayed in dB with a resolution of 0.1 dB. For an easier assessment of the signal quality the NM is shown in the colors red for bad, yellow for limited and green for good signal quality. The limit values for the BER (>2e-4 for bad and <1e-6 for good) will also be included in this assessment. This assessment also considers the limit values of LBER (>1e-7 for bad).

Important!   The noise margin cannot be shown in DTMB during active PE-measurement.

7.2.2.6.6   Impulse response

For the measurement of the impulse response, the measuring instrument must receive a DTMB signal. For this, you must adjust the instrument to the appropriate channel.

By selecting the menu point IMPULSERES the instrument will show the impulse response on the display. Simultaneously you will see a further menu for adjustments.

With FREEZE you can "freeze" the picture. With ZOOM the impulse response can be spread horizontally. You can define the unit of x-axis with µs or km. Time and length values are related via the speed of light c:=$3 \cdot 10^8$ m/s. Via the menu point BACK you can end the display of the impulse response.
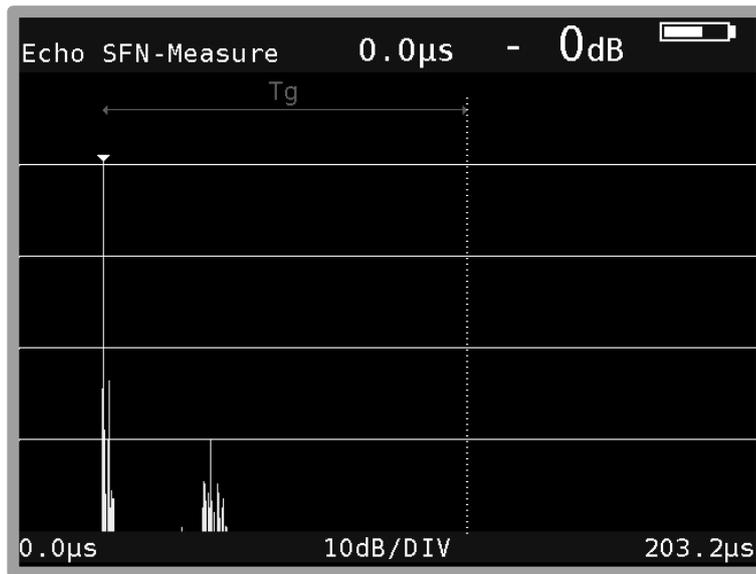
Figure 7-28 DTMB Impulse response

The example above shows an impulse response with a primary impulse (left picture edge) and several secondary impulses. The dotted line represents the guard interval. Echoes with high levels behind the guard interval cause loss of signal quality.

You can move the cursor (small triangle) left and right using the ←/→ keys. At the top of the picture is shown the transit time difference (or path difference respectively) and attenuation in relation to the primary impulse at the actual cursor position.

Peak-Search Function
While the impulse response is built up, the instrument determines the four highest secondary impulses apart from the main impulse. If there are echoes, the cursor moves to the highest secondary impulse after the second cycle. By pressing the keys ↑ and ↓ the cursor may be moved to further echoes cyclically one after the other. The distance and/or the delay as compared to the main impulse may be taking taken from the readings in the header of the diagram.

7.2.2.6.7   PE measurement (Packet Error)

Short interruptions in the DTMB signal usually cannot be detected using MER and BER measurement. They can make entire packets in the transport stream unusable for the MPEG decoder, however. This can cause the picture to freeze temporarily or the sound to crackle.
The measuring receiver has a function where corrupt transport stream packets are summed from the point in time of entry of a new channel. This function runs in the background continuously.
An additional window can be shown on the display using the menu item PE-INFO. The number of packet errors (PE = Packet Error) and the amount of time that has passed since the last tuning process is displayed. Press **ENTER** to close the window.

7.2.2.6.8   Picture and sound check

For digital television, picture and sound decoding take place in the MPEG decoder. See Chapter 13 MPEG decoder.

7.2.2.6.9   Constellation diagram

As soon as the measurement receiver is adjusted, the constellation diagram can be called up by choosing the menu item CONST. Further information can be taken from Chapter 14 Constellation diagram.

7.2.2.6.10 Remote supply

The measuring receiver can provide a remote power supply via the RF input socket for an active receiving antenna (see also chapter 10.9 - Remote supply).

7.3   Level measurement

After the measuring receiver is tuned, the automatic attenuation control and level measurement starts. The level measured is indicated on the right side of the display in dBµV with 0.1 dB resolution.
The measuring range spans from 20 to 120 dBµV. The measuring bandwidth is adjusted to the channel bandwidth of the signal measured. The measurement repetition rate is approx. 3 Hz.

7.3.1   Acoustic level trend

If when lining up an antenna, for example, no line of sight exists to the measuring instrument, you can switch on an acoustic level trend signal. A sound signal is emitted from the loudspeaker. Its frequency changes in proportion to the measured level. When the level increases, the frequency goes up and vice versa.

The sound signal can be switched on and off via the menu item ACOU. LEVEL .
When the sound signal is switched on, the menu item is displayed inverted.

7.3.2   Level measurement with DVB-C or DOCSIS

With DVB-C and DOCSIS, the spectra of the signals have characteristics similar to noise.
The signal energy is spread over the entire channel bandwidth. The measuring receiver uses its measuring bandwidth to measure the level in the channel center and extrapolates the channel bandwidth using the bandwidth formula.
The measuring bandwidth is adjusted to the current channel bandwidth.

7.3.3   Level measurement with analog TV (ATV)

With ATV, the peak value of the video carrier is measured. This coincides in time with the line sync pulse.
The level of the currently set sound carrier (see above) is measured and displayed relative to the video carrier level (e.g. –13.0 dB).

7.4   Diagrams

For a clearer presentation of the measured values, they may also be displayed as bar diagrams.

7.4.1   Operation

As soon as the instrument is adjusted, it is possible to change to the diagram display by selecting the menu item DIAGRAM . Thus the image display is stopped and the display of the program list is deleted. The diagram display is terminated by calling up DIAGRAM again or by terminating the measurement by selecting HOME .
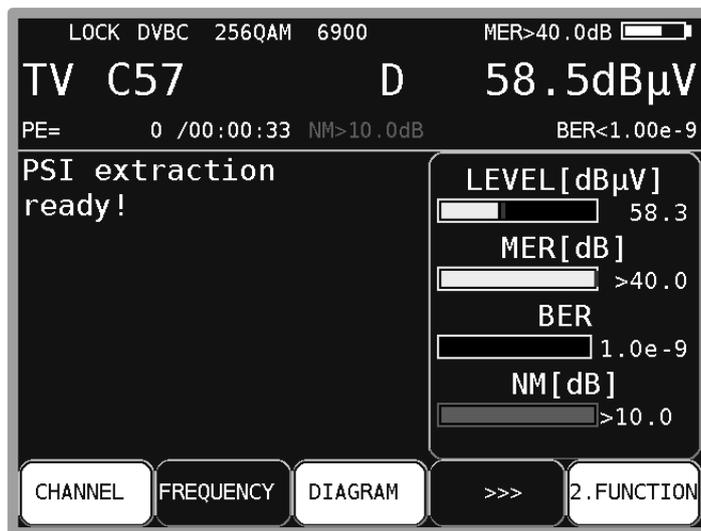
Figure 7-29 Diagram display

7.5   Blind Scan

This function can be used to determine the channel configuration in an unknown cable network. The measuring receiver scans the specified frequency range for ATV, DVB-C and DOCSIS signals. The instrument creates a channel list, which is displayed on the TFT during the scan. Once the function is complete, the list can be transferred in the tuning memory, saved as a XML file or exported as a CHA file. The latter file format can then be further edited in the PC software AMA Remote and imported into the instrument as a user-defined channel table.

7.5.1   Starting a new scan

Via **MODE -> BlindScan** you can access the following menu.

Figure 7-30 BlindScan start menu

Here you can set the parameters for the scan.

You can move the cursor to the individual entry fields using the ↑/↓ keys. You can specify the upper and lower limits for the scan entering the items **Starting at** and **Stopping at**. The entire TV range can be used.

Using the **F1-F4** soft keys, you can select which signals to include in the scan. To start the function, move the cursor to "START" and then press the **ENTER** key.

In the figure above, the instrument is set to perform a scan from 109 to 868 MHz. The minimum measurement increment is always 250 kHz. The measuring receiver will search for analog TV programs and for DVB-C channels.

For DVB-C, the common symbol rates of 6,875 kBd and 6,900 kBd are measured with the modulation schemes 64QAM and 256QAM. For DOCSIS, 64QAM and 256QAM are used. The symbol rate is permanently coupled to the modulation.

7.5.2   Aborting a scan manually

You can follow the progress as the instrument carries out the function.

```
    SCAN DVBC   64QAM  6875              ▭
 TV   358.00MHz              dBµV
                             26.09.17 12:03:29

           BlindScan-Channeltable
                  Items: 30
    25:TV  311.25MHz   ATV
    26:TV  319.25MHz   ATV
    27:TV  327.25MHz   ATV
    28:TV  335.25MHz   ATV
    29:TV  346.00MHz   DVBC 256QAM SR=6900
    30:TV  354.00MHz   DVBC  64QAM SR=6900



                                      ABORT
```
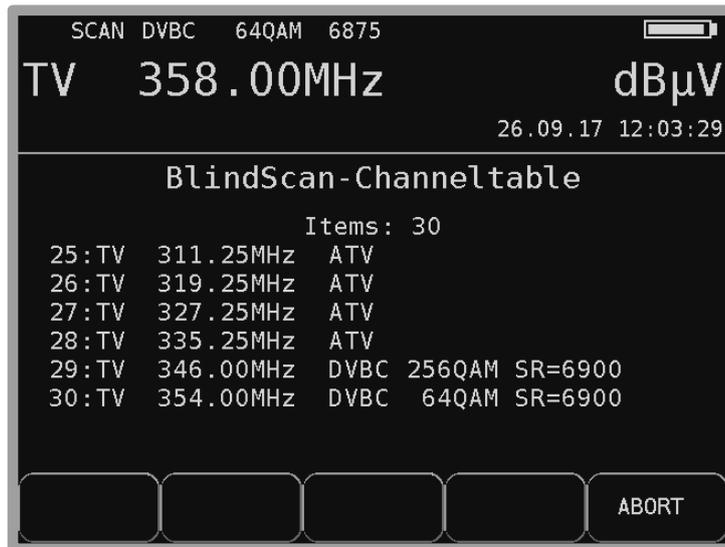
Figure 7-31 BlindScan Channeltable

The scan can be aborted at any time using the **F5** key. After a manual abort, the channel list determined up to that point remains available for further processing.
The following figure shows a list as it is displayed on the TFT of the instrument.

7.5.3 Exporting the channel list

Once the function is ended (either regularly or manually), the list determined by the instrument is available for further processing. Selecting the **EXPORT** menu item displays the following menu.

```
                                       ▭
 TV   588.00MHz              dBµV
                             22.09.17 12:18:39

           BlindScan-Channeltable
                  Items: 49
    33:TV  394 ┌─────────────────┐R=6900
    34:TV  402 │ Export to XML File│R=6900
    35:TV  410 │                  │R=6900
    36:TV  415 │ Name of File:    │
    37:TV  426 │ BlindScanName6   │R=6900
    38:TV  434.00MHz  DVBC 256QAM SR=6900
    39:TV  442.00MHz  DVBC 256QAM SR=6900
    40:TV  450.00MHz  DVBC 256QAM SR=6900
 ->CHA-FILE ->XML-FILE      ->MEMORY  BACK
```
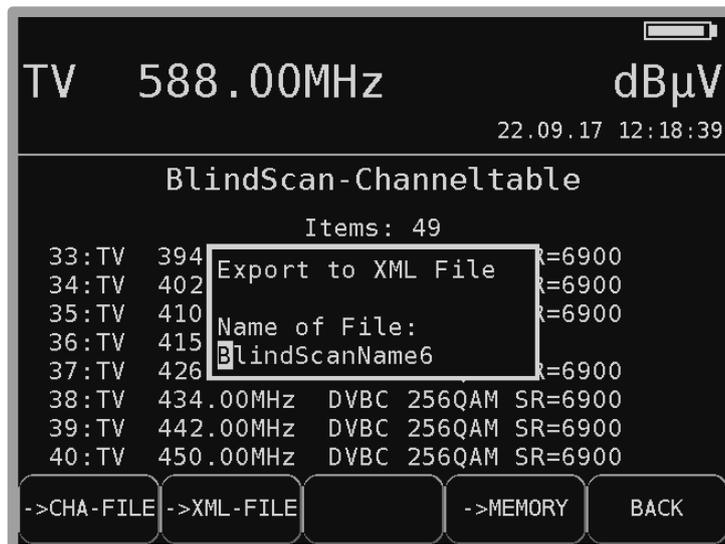
Figure 7-32 BlindScan export to XML file

The ->CHA-FILE menu item allows the list to be exported as a user-defined channel list (see chapter 18.8 - User-defined TV channel table). The instrument numbers the channels consecutively starting with C1. This can be easily adjusted using the "AMA Remote" PC software. This channel table can then be re-imported into the instrument.
This is particularly useful when a cable system has a frequency configuration that does not correspond to a standard channel table. This is necessary because special functions, such as the TILT measurement, require a suitable channel table.

The ->XML-FILE menu item allows the list to be saved in XML format. This is primarily used for documentation purposes.

Chapter 8   FM (VHF) Measuring Range

You activate the FM (VHF) range via **RANGE** -> FM .
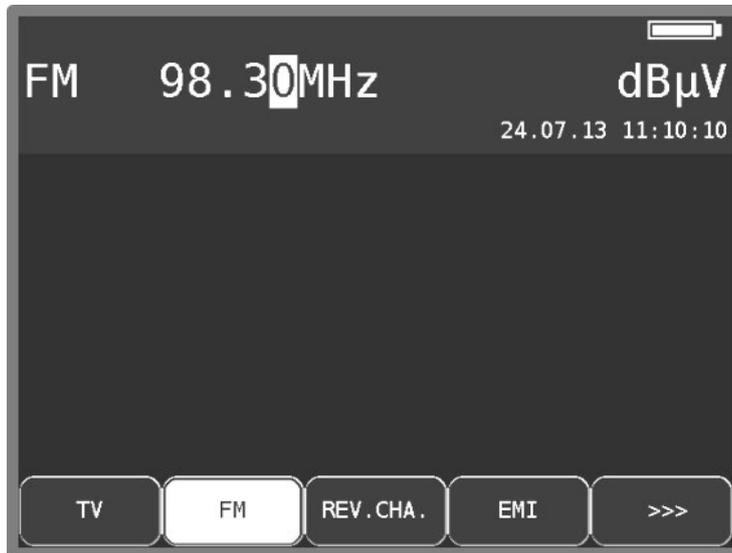
Figure 8-1 VHF measuring range

8.1   Frequency input

You can enter a frequency between 87.40 and 108.20 MHz using the numeric keypad or the arrow keys. Here the smallest frequency resolution is 0.01 MHz (10 kHz). You use the **ENTER** key to confirm the entry. After that, the receiver is tuned and the actual measured values are displayed. Invalid entries are limited to the corresponding minimum or maximum value.

8.2   Sound reproduction

The measuring instrument's VHF stereo receiver demodulates a received VHF signal and reproduces the audio signal using the built-in loudspeakers.

8.3 Stereo indicator

The stereo decoder of the VHF receiver evaluates the 19 kHz pilot signal. If a pilot is present, **STEREO** appears in the top line; **MONO** is otherwise displayed.
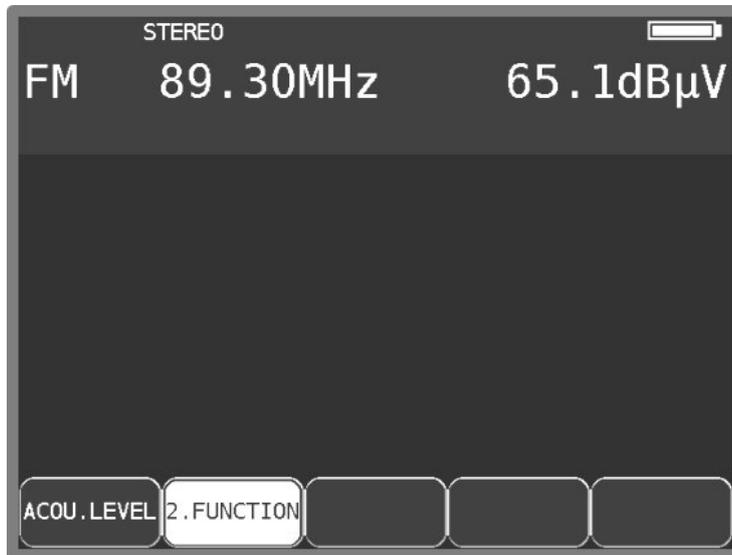
Figure 8-2 VHF stereo indicator display

8.4 RDS (Radio Data System)

RDS is the counterpart to videotext for TV. Additional to audio, digital data are transmitted. These are modulated up to a 57 kHz subcarrier in PSK (Phase Shift Keying). The RDS specification comes from the standard EN50067.

These data are sent in what are referred to as groups. Every group transmits different information. The repetition rate of every group also differs.

The measuring receiver evaluates only the groups of type 0A, 0B, 2A and 2B. Groups 0A or 0B make up approx. 40% of the total data. The proportion with groups 2A and 2B is only 15%. Among other data, the program name is transmitted with a maximum of 8 characters in groups 0A and 0B.

The program name (e.g. "Bayern 3") is shown in the top line of the display. In addition to the program name, the PI (Program Identification) code is shown in the top line of the display. The PI code is used as unique identification of the radio programs.

8.5 Scan

You can use this function to scan the entire range (87.40...108.20 MHz) for VHF broadcast signals. You start the scan by first tuning the measuring receiver to a frequency at which the scan should begin. After entry of a new channel, the menu item 2.FUNCTION is inverted. The arrow key can be used to set the frequency or interrupt a measurement that is currently running. To start the scan, first press the **F2** key in order to activate the first function of the arrow keys. Press the ↑ key to start the scan in the positive direction. Press the ↓ key to do the same in the negative direction. When the band limit is reached, the scan continues at the other end of the range. You can end the scan at any time by pressing **ENTER**. "SCAN" is shown on the display while the scan takes place.

8.6 Level measurement

As soon as the instrument is tuned to a frequency, it begins to measure the level and displays the measured value in dBμV. The measuring range is from 25 to 110 dBμV with a resolution of 0.1 dB. The measuring rate for the numerical level value is approx. 3 Hz.

8.6.1 Acoustic level trend

When no line of sight to the measuring instrument exists while lining up an antenna, an acoustic level trend signal can be switched on. A sound signal is emitted from the loudspeaker. Its frequency changes in proportion to the measured level. When the level increases, the frequency goes up and vice versa. The sound signal can be switched on and off via the menu item ACOU. LEVEL.
When the sound signal is switched on, the menu item is displayed inverted.

Chapter 9   RC (Return Channel) Measuring Range

You access the RC range via **RANGE** -> RC.

Figure 9-1 RC measuring range

9.1   Frequency input

You can enter a frequency between 5.0 MHz and 65.0 MHz using the numeric keypad or the arrow keys.
Here the smallest frequency resolution is 0.05 MHz (50 kHz). You use the **ENTER** key to confirm the entry. Invalid entries are limited to the corresponding minimum or maximum value.

9.2   Level measurement

As soon as the instrument is tuned to a frequency, it begins to measure the level and displays the measured value in dBµV. The measuring range is from 25 to 110 dBµV with a resolution of 0.1 dB. The measuring rate for the numerical level value is approx. 3 Hz.

9.2.1   Max hold function

The usable signal on the return path of a cable system is generated by the active (online) cable modem. According to the cluster size of a network, the cable modem can transmit more or fewer frequencies. The registered cable modem may only transmit in certain short time slots. Therefore, the maximum level for a frequency may only be present for a short amount of time.

For this reason, a max hold function can be switched on in the measuring instrument. Here the maximum level is saved, starting from the point in time of activation. This indicator only changes when an even higher level exists temporarily. This function can be switched on and off via the menu item **MAX HOLD**. If the max hold function is active, the menu item **MAX HOLD** is inverted.

Figure 9-2 RC Max Hold function

9.2.2 Setting the channel bandwidth

Cable modems transmit in bursts with the modulation types QPSK or QAM. Because every active cable modem is assigned to only certain time slots, it can only transmit briefly. This means that a short burst is generated in QPSK or QAM. In order to precisely measure the level in the return path, the measuring instrument must know the channel bandwidth of the return path signal. In the DOCSIS standard, bandwidths are set to 200 kHz, 400 kHz, 800 kHz, 1.6 MHz, 3.2 MHz and 6.4 MHz. They correspond to the symbol rates used: 160 kBd, 320 kBd, 640 kBd, 1,280 kBd, 2,560 kBd and 5,120 kBd. This setting can be carried out via the menu item **BANDWIDTH**.

If one of the bandwidths is activated, the instrument adjusts its measuring bandwidth to the channel bandwidth automatically. It also carries out a level correction in relation to the set channel bandwidth.

Figure 9-3 RC Setting channel bandwidth

Using the menu item **BANDWIDTH** -> **OFF**, you can switch off adjustment to the channel bandwidth. Now the instrument measures with a measuring bandwidth of 1 MHz.
This setting should be implemented if a comb generator (sinusoidal signal) or a noise generator is used as the signal source. This is also the instrument's default setting. The channel bandwidth setting is stored in non-volatile memory. This position is also incorporated in the tuning memory.

9.2.3 Acoustic level trend

When no line of sight to the measuring instrument exists during line-up, an acoustic level trend signal can be switched on. A sound signal is emitted from the loudspeaker. Its frequency changes in proportion to the measured level. When the level increases, the frequency goes up and vice versa. The measurement repetition rate is approx. 10 Hz.
The sound signal can be switched on and off via the menu item **ACOU. LEVEL**.
When the sound signal is switched on, the menu item is displayed inverted.

Chapter 10 Electromagnetic Interference Measurement

The German regulation on the protection of public telecommunication networks and transmission and receiving radio plants that are operated in the defined frequency ranges for security purposes (SchuTSEV) ["Verordnung zum Schutz von oeffentlichen Telekommunikationsnetzen und Sende- und Emfpangsfunkanlagen, die in definierten Frequenzbereichen zu Sicherheitszwecken betrieben werden"] has been in effect since May 2009. This regulation controls, for example, the switching off of analog TV content in the special channels S2 to S5 for the protection of aircraft radio frequencies (108 - 137 MHz). In addition, the regulation sets high requirements on the cable networks regarding their maximum, permitted transmitted interference field strengths.

The principle of the procedure implemented in this measuring instrument for measuring electromagnetic interference is implemented by many major cable network operators and is fully compatible with their measuring procedures.

Basic information on measuring radiation and on the required measuring equipment can be found in application note "AN002 – Electro Magnetic Interference Measurement (EMI)". This document is available from the webpage www.kws-electronic.de in the support section: "SUPPORT" – "Application notes".

10.1   Calling-Up

Call measuring of electromagnetic interference (EMI) under **RANGE** -> **EMI**.

Figure 10-1 Electromagnetic interference measurement main screen

10.2   Frequency input

You can enter a frequency between 45.00 MHz and 868.00 MHz using the numeric keypad or the arrow keys. Increments are made in steps of 50 kHz. Use the **ENTER** key to confirm the entry. It is important to make sure that identification frequency generator and measuring receiver are tuned to the same frequency.

10.3   Antenna selection

The field strength that is displayed is acquired by measuring the antenna voltage and converting it, taking into consideration the physical properties of the antenna used. The antenna being used can be set under ANTENNA . Types EMI 240 and EMI 241 are currently supported.

A pre-amplifier is already integrated in the EMI 241 antenna. For the EMI 240/Y antenna, note, that the correct measuring results will be obtained only in connection with the EMI 240/V pre-amplifier.

10.3.1   User-defined EMI antenna

In addition a user-defined antenna may also be defined. Enter the name and correction factor for the EMI antenna using the menu item EMIANT .

Use the ↑/↓arrow keys to choose between name and factor or select the →arrow key to access the respective editing menu. Press **ENTER** to complete the entry.
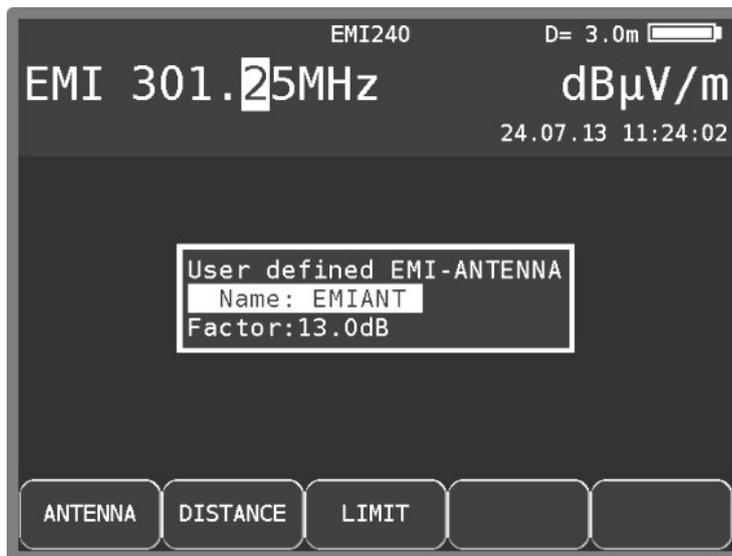
Figure 10-2 EMI user-defined antenna

The edited name of the user-defined antenna is also applied for the corresponding menu item in the ANTENNA menu. The correction factor that is entered governs the conversion of the level measured by the receiver (in dBµV) to the displayed field strength (in dBµV/m). The following relationship applies: E[dBµV/m] = L[dBµV/m] + Factor[dB].

10.4   Entering the distance

The limits for observing the EMI are based on the norm-distance of 3m to the outer wall of the building. As it is not always possible to take a measurement from 3m away, the interference field strength at a greater distance can be measured and converted to the reference spacing of 3m based on the current spacing to the building. The measuring instrument requires the distance to be entered for the conversion.

The measured distance can be entered under DISTANCE . This can be determined easily with the help of the additionally available DLE 70 laser distance measuring device, which can be mounted to the EMI 240/Y antenna.

10.5   Entering the limit

There are official regulations for observing the interference radiation of cable systems. They set limits for the emission field strength at a distance of 3 m. The maximum field strength can be entered into the instrument. The instrument uses it for certain warnings when the limit has been exceeded. The maximum field strength in dBµV/m can be entered with the LIMIT button.

10.6   Analysis of identifier

The electromagnetic interference measurement is based on using the KFG 242 frequency identification generator. This generator is used as a defined source of interference in a cable system and should be integrated into the head end.

The signal of the interference transmitter is modulated with an identifier for the unique assignment of the interference emission. This can be programmed in the frequency identification generator as text with up to 13 characters.

The measuring instrument demodulates the identifier and shows it in the top row on the display. To demonstrate that the identifier is being received continuously, the instrument clears the text and shows it again.

10.7   Measuring the interference field strength

Figure 10-3 EMI measure field strength

When tuned to a frequency, the instrument measures the antenna voltage of the receiving antenna and converts it into the equivalent field strength. The absolute field strength is displayed in dBµV/m in a larger font. The measuring range is from 3 – 103 dBµV/m (EMI 241) or 5 – 105 dBµV/m (EMI 240) with a resolution of 0,1 dBµV/m.

At the same time, the instrument calculates, in connection with the current spacing, reference field strength at a distance of 3 m to the building and displays it in a smaller font in the row above the menu bar. If the reference field strength exceeds the set limit, a warning message will appear on the display. A warning signal sounds at the same time over the loudspeaker.

10.8   Setting the identifier

The measuring instrument has a help setting for setting the identifier of the frequency identification generator. Application note "AN002 – Measuring electromagnetic interference" contains information on how to set and change the identifier for KFG 242.

If a character received from the identifier is marked showing that this character is one that can be changed with two buttons on KFG 242, this character will be displayed inverted on the display. If no character is displayed inverted (normal mode), it means that there is no character that is currently selected for modification.

10.9   Remote supply

The measuring receiver can provide a remote power supply for active receiving antennas via the RF input.

Antennas EMI 240 (with the EMI 240/V pre-amplifier) and EMI 241 require a supply of 5 V.

The supply is short circuit-proof and provides a maximum current of 100 mA. A red LED in the keypad area at the device (DC OUT) indicates that the supply is on.
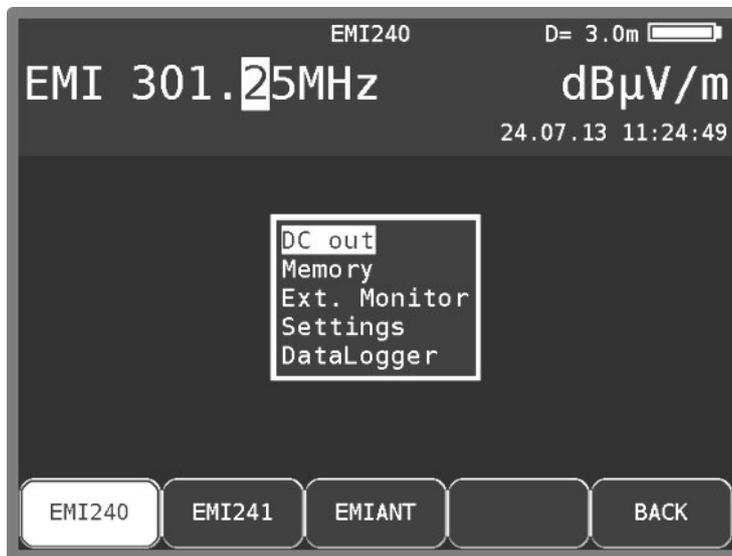
Figure 10-4 EMI Remote supply

Important!   Before switching on a remote supply, always check the compatibility of the system connected to the remote supply that is selected. Otherwise, terminating resistors may be overloaded or active components may be destroyed.

10.9.1   Setting the remote supply voltage

Press the **MODE** key to open the drop-down menu. Use the **DC out** menu item to access a selection menu where you can choose between 0 V and 5 V.

Chapter 11 Upstream Generator

The Upstream Generator can be used during analysis of the return channel range (5 MHz to 65 MHz). One or four carriers can be transmitted in that range. The Upstream Generator usually acts as modem, the transmitted signals could be analyzed by the head end equipment (e.g. CMTS). From DOCSIS-3.1-Analyzer it is possible to send up to 8 single carrier (CW, QAM-modulated) or one OFDM modulated carrier. The frequency range can be choosen between 5 to 85 MHz and 5 to 204 MHz, depending on the diplexer setup (18.14 - DOCSIS3.1 Setup the maximum Upstreamfrequency).

The carrier(s) is/are transmitted unmodulated as a pure sinusoidal signal, or modulated as a PRBS signal (pseudorandom binary sequence). A sinusoidal signal can be used to gain information about the incoming level strength, whereas a modulated signal can also be used to determine error rates, i.e. MER and BER.

An adapted AMA310 / UPM 3500 / WA 71 type measuring receiver at the headend can therefore be used to tune to a carrier in the return channel measuring range. Levels can be measured, MER and BER can also be measured for modulated signals, the constellation diagram can be checked, monitoring can be started or the DataGrabber can be used. If the measuring instrument in the head end supports SNMP and it is connected with the network via LAN, the measurement results can be analyzed directly at the Upstream Generator using a network-connected laptop running AMA.remote software.

11.1   Upstream-Generator Version DOCSIS3.0

11.1.1   Starting and Profile Support

The Upstream generator is called up via **RANGE** -> Upstr. Gen..
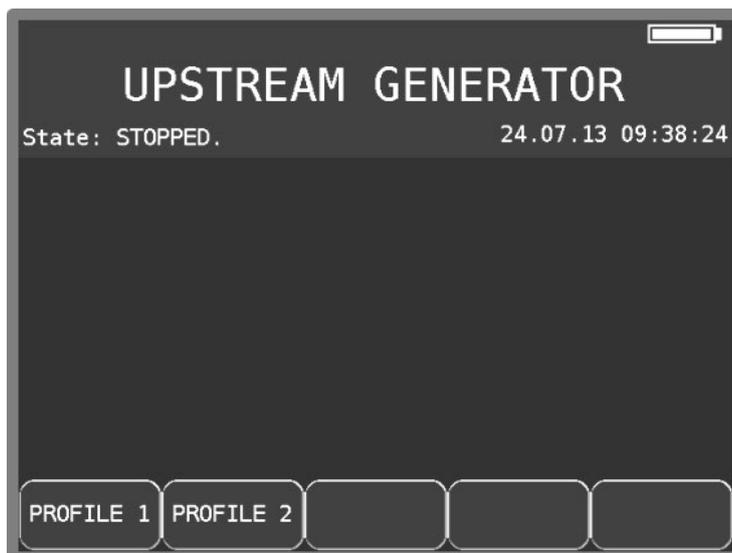
Figure 11-1 Upstream Generator Measuring Range

Two configurable profiles are available for presetting of the transmit carrier(s). You can access the configuration and transmission screen by selecting one of the profiles.

11.1.2   Configuration

Use the CONFIG. menu item to access the setting options.
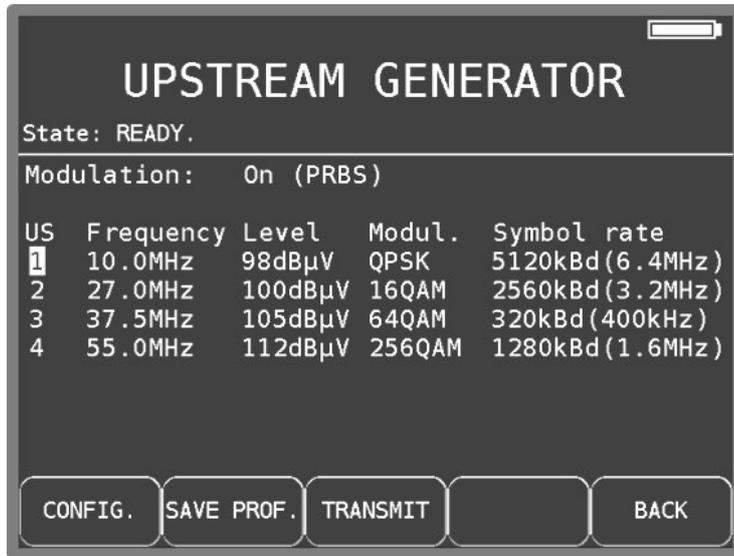
Figure 11-2 Upstream Generator overview

11.1.2.1   Setting the modulation

Modulation is activated or deactivated by opening the SINUS/QAM menu item. "On (PRBS)" or "Off (Sinus)" is displayed on the screen under Modulation accordingly.
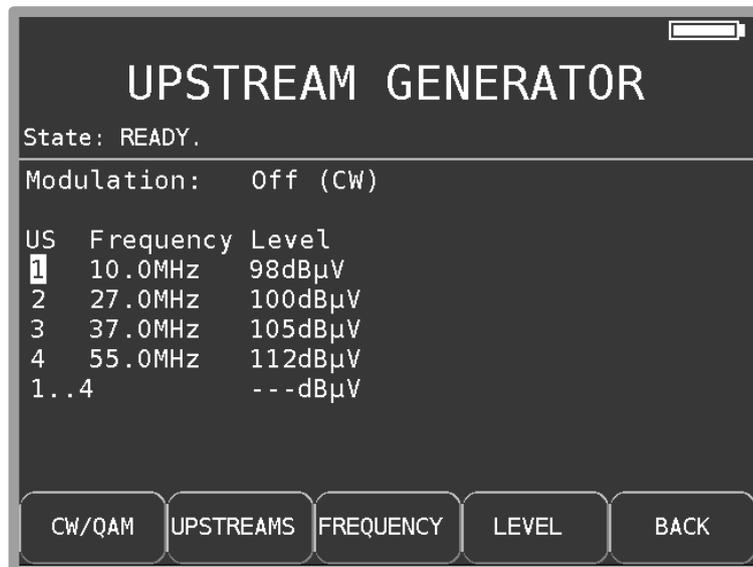
Figure 11-3 Upstream Generator configuration selection

The menu item CW/QAM is displayed inverted if modulation is activated. The item "1-4" is only at configuration secetion available .

11.1.2.2   Setting the number of upstream carriers

Specify the number of carriers under the UPSTREAMS menu item. You can select between one and four carriers.

```
                                         ▭
       UPSTREAM GENERATOR
State: READY.
Modulation:   On (PRBS)

US: Frequency Level   Modul.   Symbol rate
    10.0MHz   98dBμV  QPSK     5120kBd(6.4MHz)




 1 CARRIER  4 CARRIER                     BACK
```
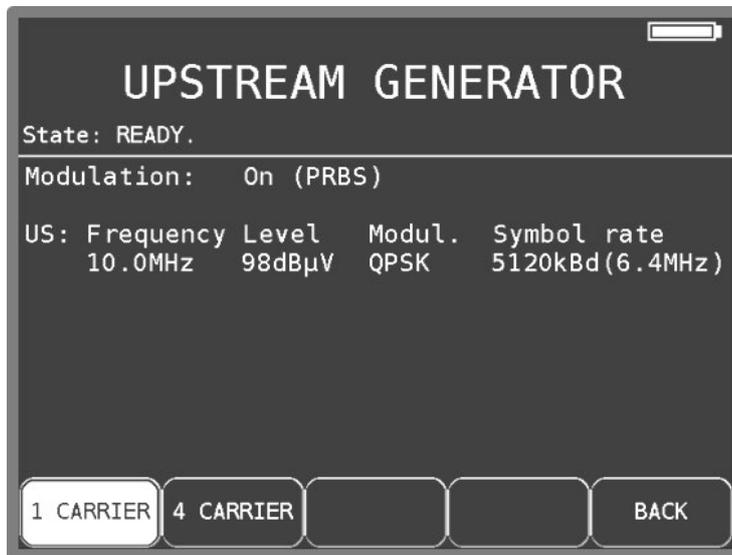
Figure 11-4 Upstream Generator carrier selection

11.1.2.3   Entering the frequency

After selecting the FREQUENCY menu item, use the numeric keypad or the arrow keys to set a frequency between 5 MHz and 65 MHz. The smallest frequency resolution is 0.1 MHz (100 kHz).
The decimal place of the current cursor position can be changed from 0-9 by pressing the arrow key ↑/↓. The cursor can be moved to the left and right using the ←/→keys. Use the **ENTER** key to confirm the entry. If the value entered is beyond the valid range it is limited to the corresponding minimum and/or maximum value.

11.1.2.4   Entering the transmission level

After selecting the LEVEL menu item, use the numeric keypad or the arrow keys to set a level between 70 and 112 dBμV. The lowest level resolution is 1dB.
The decimal place of the current cursor position can be changed from 0-9 by pressing the arrow key ↑/↓. The cursor can be moved to the left and right using the ←/→ keys. Use the **ENTER** key to confirm the entry. If the value entered is beyond the valid range it is limited to the corresponding minimum and/or maximum value.

11.1.2.5 Common transmission level

The level difference between two carriers is limited to 16dB. So to change the transmission level of 4 carriers in one step there is the item "**1-4**". As soon as this item is active all levels show the same value. Now the common level for the 4 carriers can be changed in the same way as shown in chapter 11.1.2.4 above.
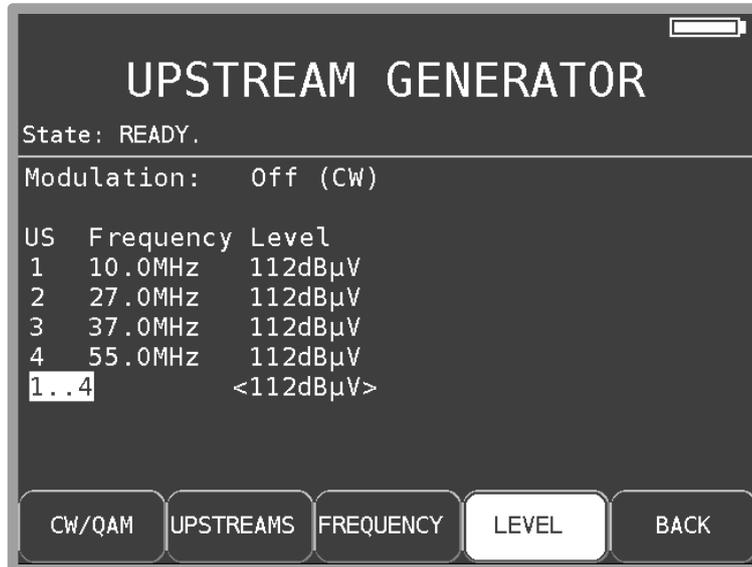
Figure 11-5 Upstream Generator change common transmission level

11.1.2.6 Entering the modulation mode

If modulation is activated, i.e. when a PRBS signal is to be sent, you can select the modulation mode via the MODULATION menu item. The selections QPSK, 16QAM, 64QAM, and 256QAM are available.
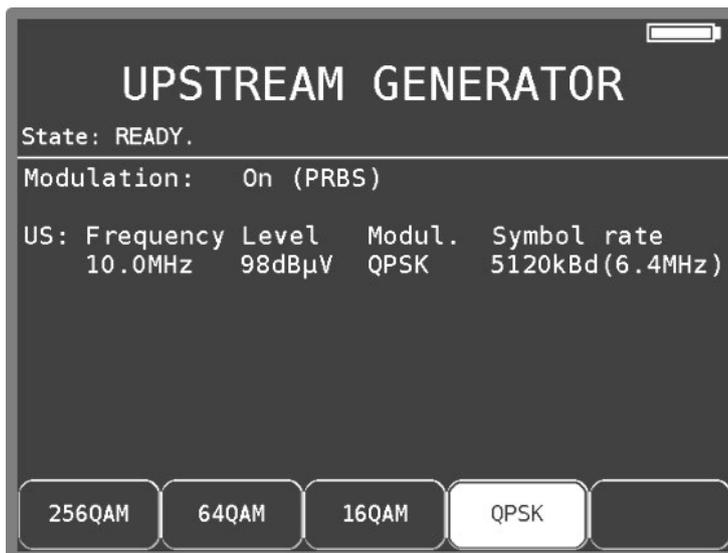
Figure 11-6 Upstream Generator selection modulation

11.1.2.7   Setting the symbol rate

The bandwidths 400 kHz, 800 kHz, 1.6 MHz, 3.2 MHz and 6.4 MHz are defined in DOCSIS Standard. These correspond to the symbol rates 320 kBd, 640 kBd, 1,280 kBd, 2,560 kBd and 5,120 kBd. This setting can be carried out via the SYMBOLRATE menu item if modulation is activated.
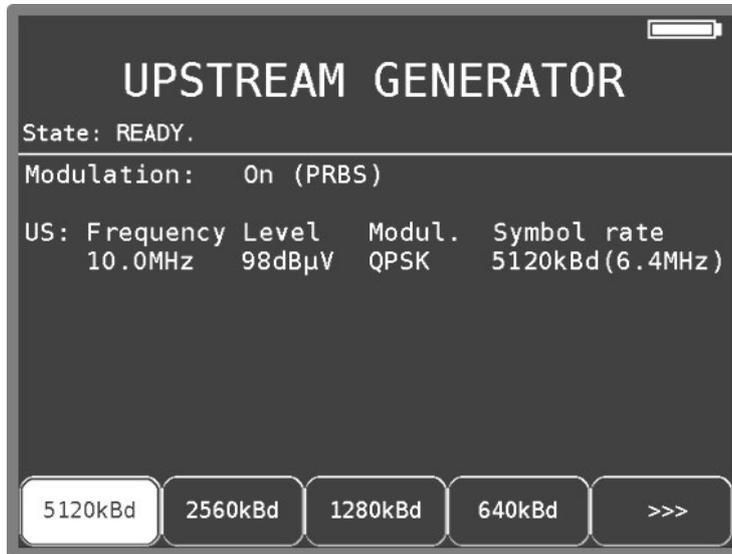
Figure 11-7 Upstream Generator selection symbol rate

11.1.3   Saving Profile settings

The settings made are saved in the current used profile using the SAVE menu item.

11.1.4   Transmitting

The message "Booting..." appears on the screen while the corresponding module is booting. When this process is completed, "Ready" appears on the screen and the carrier(s) can be activated via the TRANSMIT. menu item. The status then changes to "Transmitting..."

Important!   **Before transmitting in the return range, ensure that if a DOCSIS system is active (like modems) avoid using frequencies which are occupied by the DOCSIS systems. Otherwise those devices can be disturbed by the Upstream Generator. Also observe the used bandwidths.**

The menu item is displayed inverted during transmission. Select the TRANSMIT. menu item again to stop transmission.

11.2   Upstream-Generator Version DOCSIS3.1

11.2.1   Starting and Profile Support

Like in DOCSIS Version 3.0 the Upstream-Generator can be started with **RANGE -> UPSTR.GEN.
-> Profile 1/2** (see Chapter 11.1.1 - Starting and Profile Support). Two different Profiles are
supported.

11.2.2   Configuration

With the F-Key **CONFIG.** the settings can be entered.
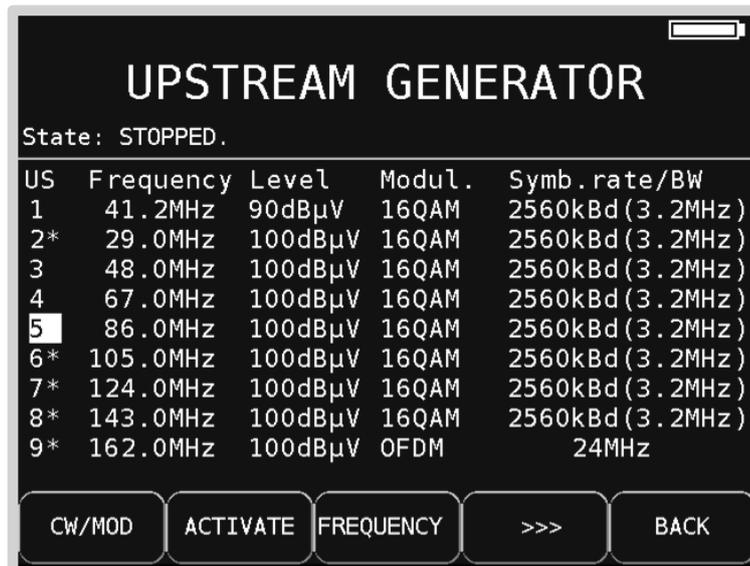
Figure 11-8 Upstream-Generator 3.1 overview

11.2.2.1   Setting the modulation

Modulation is activated or deactivated by opening the **SINUS/QAM** menu item. "On (PRBS)" or "Off
(Sinus)" is displayed on the screen under Modulation accordingly.
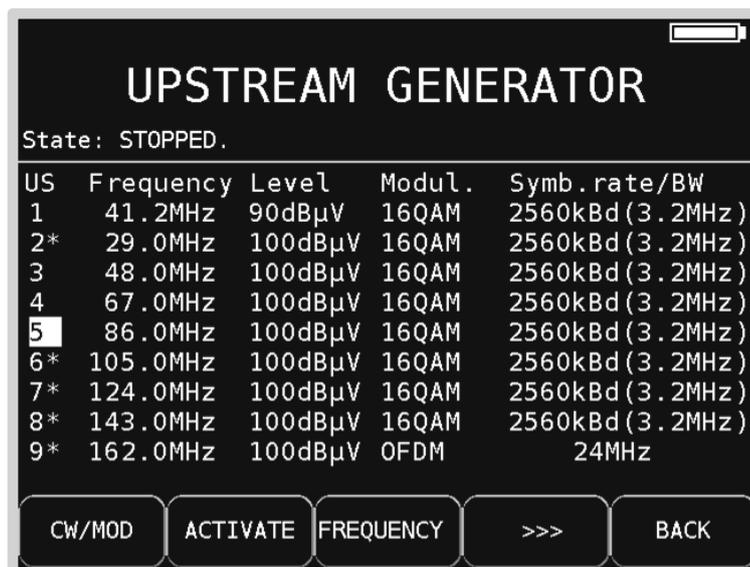
Figure 11-9 Upstream Generator configuration selection

11.2.2.2   Setting the number of upstreams

The amount of carrier can vary between one to eight. All not with an * marked carriers are active and can be transmitted. With the F-Key ACTIVATE can the selected upstream activated or disabled (with * marked) for the transmission.

11.2.2.3   Entering the frequency

After selecting the FREQUENCY menu item, use the numeric keypad or the arrow keys to set a frequency between 5 MHz and 85 MHz or 204 MHz. The smallest frequency resolution is 0.1 MHz (100 kHz).
The decimal place of the current cursor position can be changed from 0-9 by pressing the arrow key ↑/↓. The cursor can be moved to the left and right using the ←/→keys. Use the ENTER key to confirm the entry. If the value entered is beyond the valid range it is limited to the corresponding minimum and/or maximum value.

11.2.2.4   Entering the transmission level

After selecting the LEVEL menu item, use the numeric keypad or the arrow keys to set a level between 70 and 112 dBµV. The lowest level resolution is 1dB.
The decimal place of the current cursor position can be changed from 0-9 by pressing the arrow key ↑/↓. The cursor can be moved to the left and right using the ←/→ keys. Use the ENTER key to confirm the entry. If the value entered is beyond the valid range it is limited to the corresponding minimum and/or maximum value.

11.2.2.5   Common transmission level

The level difference between two carriers is limited to 16dB. To avoid to change each carrier individual you can use the F-Key ALL LEVELS to manipulate all carriers at once. As soon as that Key is active, you can enter a new value and after pressing ENTER the value will be used for all carriers.

```
                                            ▭

      UPSTREAM GENERATOR

State: STOPPED.

US  Frequency Level   Modul.   Symb.rate/BW
1    41.2MHz  90dBµV   16QAM    2560kBd(3.2MHz)
2*   29.0MHz  100dBµV  16QAM    2560kBd(3.2MHz)
3    48.0MHz  100dBµV  16QAM    2560kBd(3.2MHz)
4    67.0MHz  100dBµV  16QAM    2560kBd(3.2MHz)
5    86.0MHz  100dBµV  16QAM    2560kBd(3.2MHz)
6*  105.0MHz  100dBµV  16QAM    2560kBd(3.2MHz)
7*  124.0MHz  100dBµV  16QAM    2560kBd(3.2MHz)
8*  143.0MHz  100dBµV  16QAM    2560kBd(3.2MHz)
9   162.0MHz  100dBµV  OFDM        24MHz
1..9*          <101dBµV>
  1 LEVEL   ALL LEVELS                    BACK
```

Figure 11-10 Upstream Generator change common transmission level

11.2.2.6   QAM-modulation order

At activated modulation (non CW mode) a PRBS sequence will be transmitted. You have the option to change the order of the QAM modulation with the F-Key MODULATION. This is only for the first eight carriers possible, the last one (number 9) is an OFDM carrier. You can choose between QPSK, 16QAM, 64QAM and 256QAM.

11.2.2.7   Setting the symbol rate

For DOCSIS single QAM carriers following bandwidths are defined: 400 kHz, 800 kHz, 1.6 MHz, 3.2 MHz and 6.4 MHz. These correspond to the symbol rates 320 kBd, 640 kBd, 1,280 kBd, 2,560 kBd and 5,120 kBd. This setting can be carried out via the $\boxed{\text{SYMBOLRATE}}$ menu item if modulation is activated.

11.2.2.8   Setting the OFDM upstream bandwidth

If an OFDM carrier as transmit channel selected, then instead of $\boxed{\text{SYMBOLRATE}}$ the $\boxed{\text{BANDWIDTH}}$ button is available. You can enter a bandwidth between 6 and 96 MHz.

11.2.3   Saving Profile settings

The settings made are saved in the current used profile using the $\boxed{\text{SAVE}}$ menu item.

11.2.4   Transmitting with Upstream-Generator Version 3.1

After the bootprocess is finished, the F-Key buttons $\boxed{\text{TRANSMIT}}$ and $\boxed{\text{OFDM TRANS}}$ are available. With $\boxed{\text{TRANSMIT}}$ all activated single QAM carrier will be transmitted (CW or modulated). With $\boxed{\text{OFDM TRANS}}$ the OFDM channel will be transmitted. In the Status line the state will changed to "TRANSMITTING…". Before the transmission starts, a crosscheck of the plausability of all carrier settings will be performed. If the check fails, e.g. a parameter is out of its valid range, the transmission will be canceld and an error messages tells you where the problem is. The settings must be fixed before a transmission can be started.
It is not possible to send QAM and OFDM modulated carriers at the same time.

Attention:	**Before you initiate a transmission in the upstream frequency range, you have to check if no active DOCSIS system can be interrupted. Select only frequency ranges which are not used from an acitve DOCSIS system. Be carefully in adjusting the bandwidth to avoid any interruptions between modems and CMTS.**

During transmitting carriers the F-Key button is shown inverted. A further pressing of that button stops the transmission.

11.3   Telemetry channel

This video image can be transmitted using a previously saved analog or digital TV channel. If, for example, the interface of a measuring instrument that evaluates signals transmitted by the upstream generator is set to the telemetry channel using a video encoder, changed settings for the generator can be checked at another location.

11.3.1   Saving the telemetry channel

A transmitter must be tuned in the TV range (analog or DVB-C).
Using the **MODE** button, you can access the **Save as telemetry channel** menu item.

As in the **Saving** section, pressing **ENTER** will open a menu that displays the currently stored telemetry channel (see chapter 15.1 - Saving). Press **ENTER** to save it.

As with all tuning memory locations, you must confirm the overwriting process again. Only one telemetry channel can be stored at a time, so no memory number is displayed.
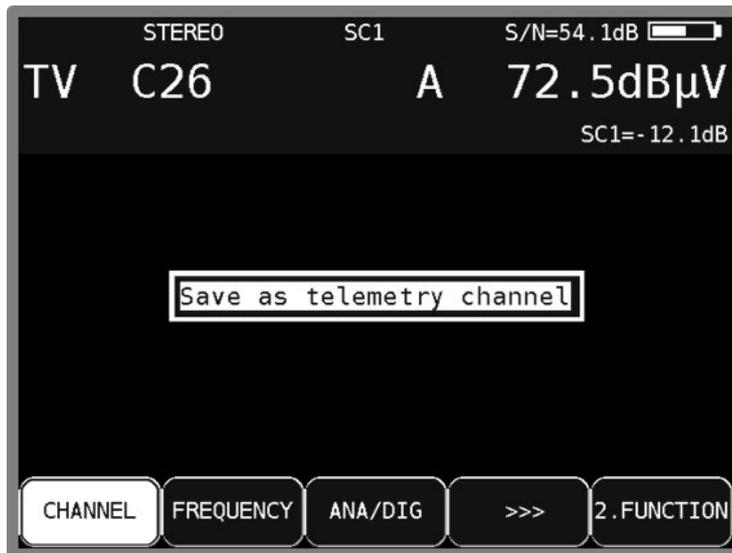
Figure 11-11 Telemetry channel saving

11.3.2   Accessing the telemetry channel

First, the device must be active in upstream generator mode, i.e. already booted up. The **OSD/VID** button opens the stored telemetry channel and the video display is shown as a superimposed image in addition to the interface of the upstream generator. You can use the OSD menu item to switch between the superimposed video display and the basic video display. The **OSD/VID** button will take you back to the initial state of the upstream generator interface.
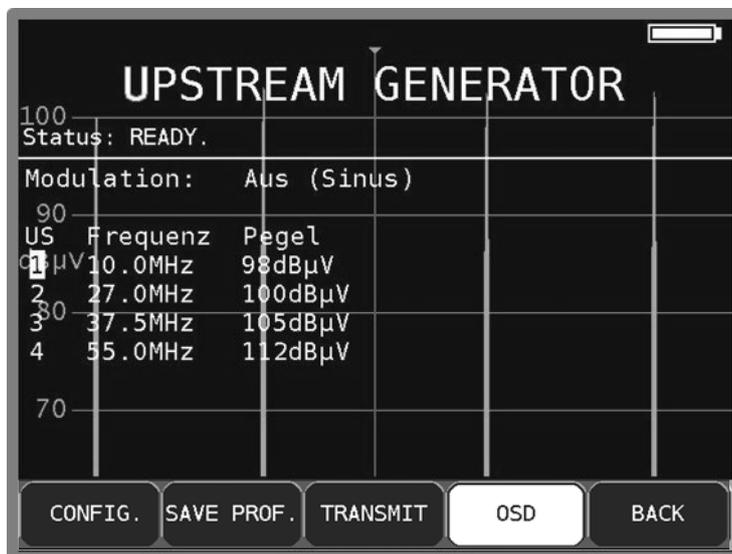
Figure 11-12 Upstream Generator with overlayed telemetry video stream

Chapter 12 **DOCSIS Analyzer**

12.1   Introduction

The analyzer of the measuring receiver operates in accordance with specification DOCSIS 3.0 or DOCSIS 3.1. DOCSIS stands for "Data-Over-Cable Service Interface Specification". The standard sets the rules for fast, bi directional communication and IP data exchange between the headend and the user either via a pure coaxial network or an HFC network (Hybrid Fiber/Coaxial). The counterpart station for the cable modem (CM) on the user side is the CMTS (Cable Modem Termination System) in the headend.
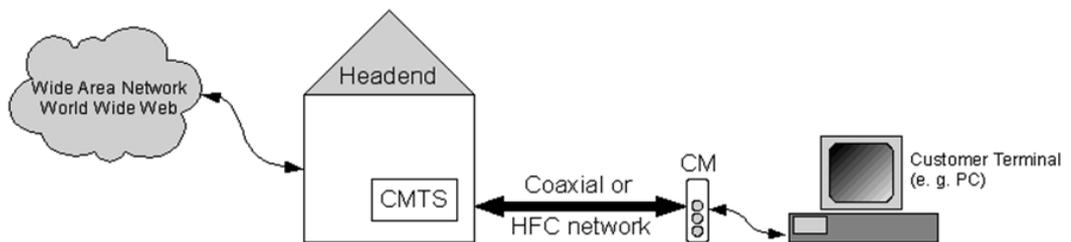

Figure 12-1 Communication network

The data from the head end to the customer is transmitted in the so-called downstream (DS); information returning from the customer is transmitted in the upstream (US). The US and DS are transmitted in the same cable but in different frequency ranges.
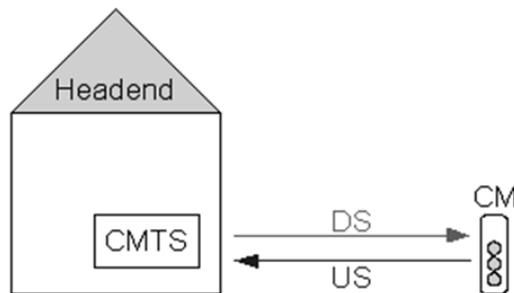
Figure 12-2 Head-end - Modem

With DOCSIS, there are two different specifications: Euro-DOCSIS and US-DOCSIS. You can measure both standards with the measuring instrument. The differences are in the DS error protection and the DS channel bandwidths and in the channel spacing and DS and US frequency range (see chapter 7.2.2 - DIGITAL (DVB-C, DOCSIS) operating mode). The content of the messages that are exchanged between the head end and the user is identical in both specifications.

The main extension in DOCSIS3.1 is the additional OFDM-Standard for transmission. The fundamentals of that are also known from the DVB-T/T2 standard. The maximum downstream bandwidth is increased up to 192MHz and therefore much bigger than in EU/US-Docsis. Also the frequency range is increased, so the maximum possible datarate for transmissions are much higher than in DOCSIS3.0. Further details you can read in the Application Note Docsis-3.1.

12.2   Connection of the measuring receiver to the multimedia socket

For measurement with the DOCSIS analyzer, you must connect the instrument via an F-plug to IEC-plug adapter with the F-connection of a multimedia socket on which a DOCSIS signal is present.

12.3   Measurement of the DOCSIS downstream

For downstream, the same measurement parameters can be recorded as for a DVB-C signal (MER, BER, constellation diagram, packet error measurement, level measurement; see chapter 7.2.2 - DIGITAL (DVB-C, DOCSIS) operating mode). You can also assess the downstream via the spectrum analyzer (see also Chapter 16 - Spectrum analyzer)

12.4   DOCSIS analysis and measurement of the DOCSIS upstream

To obtain information about the upstream, the measuring instrument must first be receiving a valid downstream channel.
The DOCSIS analyzer receives information about the upstream and the communication with the CMTS.
You activate the downstream receiver of the measuring instrument via the menu item MODULATION -> DOCSIS in the TV measuring range (see also chapter 7.2.2 - ScQAM-DOCSIS (downstream)).
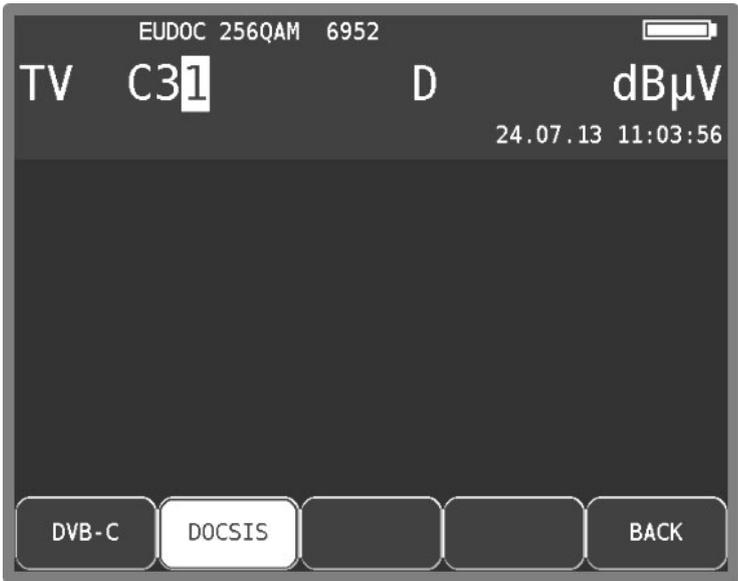

Figure 12-3 DOCSIS measuring range

You select the modulation scheme for the DOCSIS variant in another menu.
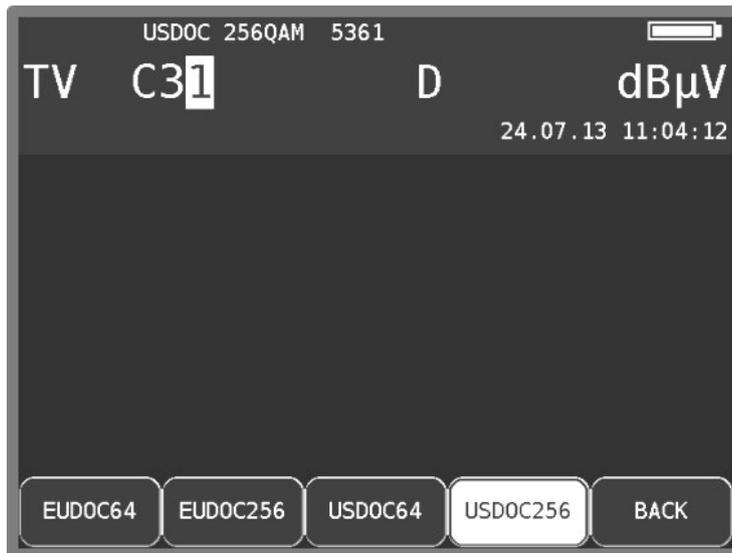
Figure 12-4 DOCSIS selection of modulation scheme

The associated symbol rate is automatically set.

Automatic scan of the DOCSIS variant:

If you enter a new channel, the receiver attempts to synchronize with the current settings (DOCSIS variants, modulation schemes). If this is not successful, the instrument alternatively uses the other settings EUDOC64, EUDOC256, USDOC64 or USDOC256 to receive the signal that is present.

The graphic display begins to show a summary relating to the DOCSIS analysis.

In addition to the direct channel entry of a known DOCSIS DS channel, it is also possible to carry out an automatic scan of the entire TV frequency band (see also chapter 7.2.2.1.2 - Scan).

12.4.1   DOCSIS DS parameters

As soon as the receiver has completed the DS synchronization process, several parameters are shown in the measured value display. When LOCK appears, it means that the digital receiver is receiving a valid data stream. In contrast, UNLK means that either the quality of the signal that is present is insufficient, or that the parameters of the receiver do not agree, or that no DOCSIS signal can be received at this frequency.

Once the receiver synchronized the DOCSIS analyzer queries whether valid DOCSIS packets are being received. Is this the case, the indicator on the graphic display under the "Downstream" item changes from "Scan running..." to "Valid".

12.4.2   DOCSIS US parameters

After a valid DS is detected, the analyzer automatically extracts the upstream parameters from the downstream information. The most important are shown on the graphical display.

Communication with the CMTS is now established. During this, the transmitting power and other important parameters for problem-free communication between the cable modem and head end are set iteratively. This process is called "ranging." The current transmitting power is shown on the graphical display. After the first successful ranging, the screen on the graphical display under the "Ranging" item switches from "running..." to "finished".

After the cable modem and the CMTS have been synchronized, the analyzer switches to a mode for continuous ranging, which means that communication with the CMTS is maintained and the transmitting power on the graphical display is updated after every data exchange.

12.4.3   Downstream and upstream analysis using DOCSIS-3.0 analyzer

The DOCSIS 3.0 analyzer can be used to draw a conclusion about whether the communication between a modem and the CMTS at the site of the measurement works in principle. Furthermore, the analyzer can be used as an instrument for levelling return path amplifiers.

The boot time of the DOCSIS analyzer is around 18 seconds. When the DOCSIS analyzer is activated, a home screen initially appears in the graphic display on which the boot progress is displayed in percent. The actual graphics interface of the analyzer is then displayed.

The instrument uses the DOCSIS 3.0 analyzer to provide a graphical overview of all bundled downstream and upstream channels with their level ratios and channel bandwidths.
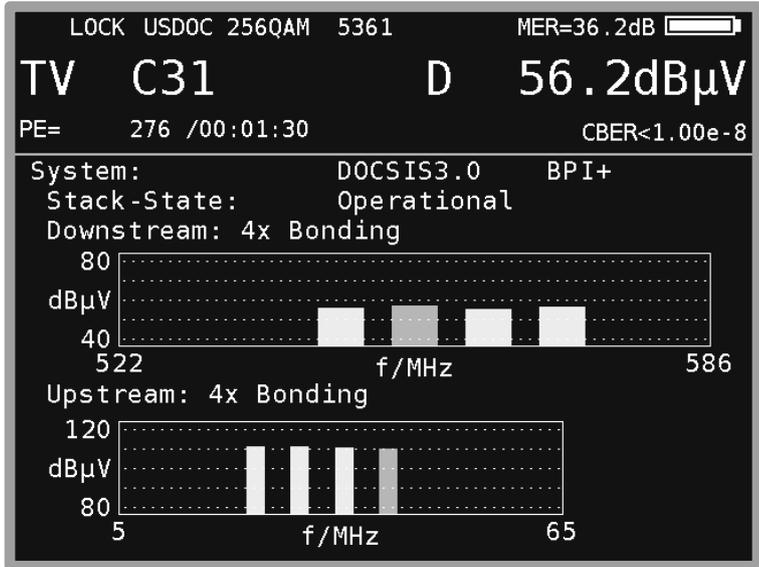

Figure 12-5 DOCSIS typical measurement display

The following measurement parameters are available on the graphic display when there is a functioning DOCSIS connection:

- DOCSIS standard (e.g..: DOCSIS1.1, DOCSIS2.0)
- Display of the encryption system used (e.g. BPI+)
- Stack State of synchronization to CMTS
- Number of bundled DS channels
- Number of bundled US channels

The uppermost line provides information about the DOCSIS system currently being measured. Here you can see if the system is a pure 1.1, 2.0 or 3.0 system, or if mixed-mode using different systems has been activated to enable modems to communicate with the head end according to different specifications.

The "Stack-Status" parameter provides information about how far the analyzer can synchronize or logon to the CMTS. At the beginning of a measurement, the modem searches for information about how it should transmit data upstream. If this data is found, the stack-status changes to "UsParameters Acquired". Once ranging has been completed successfully, the status changes to "Ranging Complete". The status is "DHCP Complete" if the modem is able to obtain an IP address from the DHCP. The status changes to "Operational" if it has been possible to completely log on to the head end.

The graphical overview provides an overview of all existing downstream and upstream ratios. For the downstream, a distinction is made between primary and secondary channels.

The primary channels in the downstream contain SYNC and UCD messages; the secondary channels do not. Primary channels can be used to create a connection between a modem and CMTS; secondary channels are used only for data rate multiplication. The primary downstream channel is shown in green in the graphic. The channels bundled with the primary channel appear in yellow. In some systems, all bundled downstream channels are primary channels. Other systems contain only one primary downstream. In the latter case, the download data rate is higher because the sync and UCD messages are sent on one channel only, which avoids the associated overhead.

For the upstream channels, there is no distinction between primary and secondary channels. In the diagram, the upstream through which the modem was able to successfully establish a connection with the CMTS is shown in green. The upstream channels bonded to this during subsequent registration are shown in yellow in the diagram.

The DOCSIS 3.0 analyzer supports the bundling of up to 8 downstream channels, although these must be within 64 MHz. Up to 4 bundled upstream channels are supported.

The top figure shows the graphic screen of the DOCSIS 3.0 analyzer following successful ranging in a DOCSIS 3.0 system.
Depending on the cable network operator, the US or DS frequency could automatically change during measurement. This is because in systems with several upstream and downstream frequencies, CMTS can force the modem onto other frequencies in order to balance the load across all channels. In the measurement parameter range, you can always read the frequency or channel on which the modem is currently using to receive data. The same applies to the DOCSIS analyzer display. The frequency on which the modem is currently using to transmit is always marked on the upstream display. In theory it is also possible for further US parameters to change during measurement.

12.4.3.1   Downstream analysis

You can open the menu by pressing the **MODE** key. You can navigate around the menu using the arrow keys and the **ENTER** key. The figure below shows the graphic that appears after choosing the DOWNSTREAM menu item.
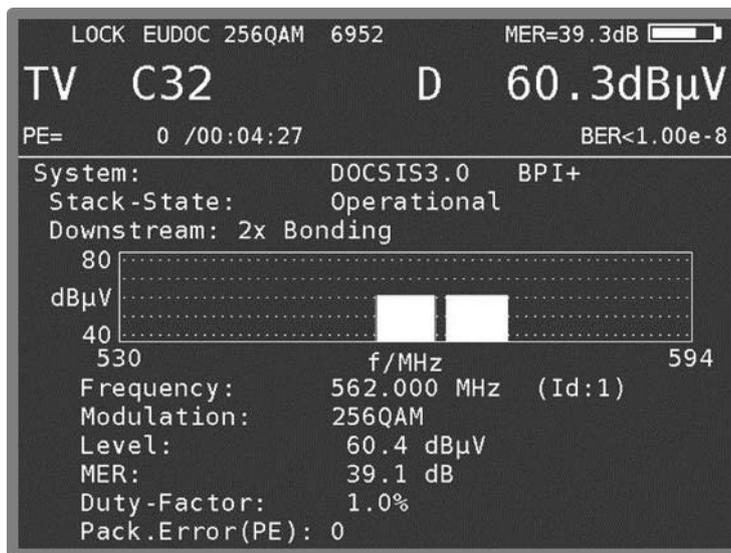
Figure 12-6 DOCSIS downstream analysis

Each bar represents a DS channel. You can use the ←/→ keys to select the relevant channel in the graphic. The currently selected channel is highlighted in red. The information shown below applies to the selected channel.

Each DS channel in the system has a unique identification (ID) that is displayed after the corresponding frequency.

The DS duty factor provides information on how many MPEG packets of the DS data stream, the DOCSIS PID (pack identification) 0x1FFE carries in relation to all the incoming packets. The load is shown only for the primary channel marked in green.

12.4.3.2   Upstream analysis

Select the UPSTREAM menu item from the main menu to view additional information about the US channels.
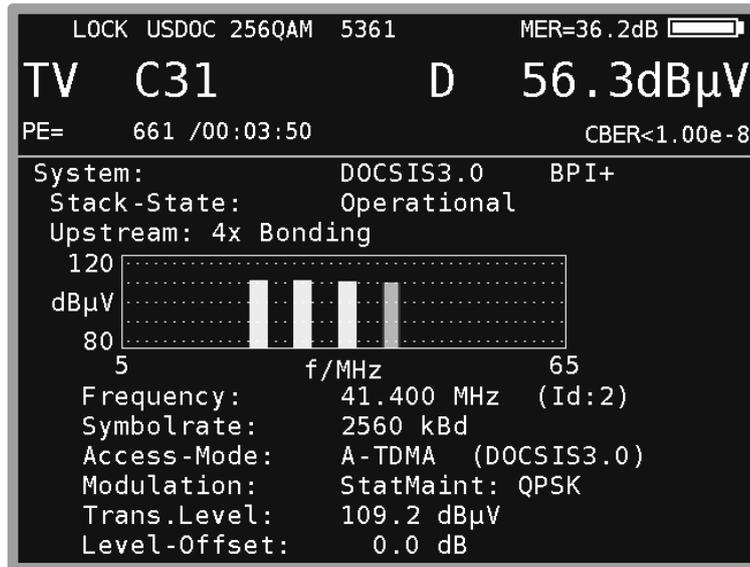

Figure 12-7 DOCSIS upstream analysis

Each bar represents a US channel. You can use the ←/→ keys to select the relevant channel in the graphic. The currently selected channel is highlighted in red. The information shown below applies to the selected channel.
Each US channel in the system has a unique identification (ID) that is displayed after the corresponding frequency.
Select the ADVANCED and FRQRESP menu items to view additional US information. This information is described in more detail in the following sections.

As many DOCSIS modems communicate with the CMTS on the same upstream frequency the modems must therefore share an upstream channel. The access method to achieve this can be read on screen. For DOCSIS1.1 only TDMA (time division multiple access) is offered as an access method. The modems share the upstream bandwidth such that each modem only transmits in specially reserved time slots. A-TDMA (advanced TDMA) or S-CDMA (synchronous code division multiple access) are also optionally used for DOCSIS2.0 and 3.0. For A-TDMA, as opposed to DOCSIS1.1, it is also possible to transmit upstream with 64QAM at a symbol rate of 5120kSymb/s. For S-CDMA, several modems can transmit simultaneously on one frequency. The CMTS assigns messages to the individual modems according to special codes and the mathematical formula of correlation. The CMTS specifies the access method which is binding for all connected modems.

During ranging, the CMTS sends correction values regarding the transmission power to the modem. You can view the correction values under "Level offset" on the graphic display. The modem continuously adjusts its transmission power so that the level offset is zero. That means that messages that are sent by the modem arrive at the CMTS at the required level.

The offset is note qual to zero, if, for instance, you set a return channel amplifier and adjust the amplification during measurement. The modem adjusts its transmission power so that the offset is equal to zero again the next time ranging messages are exchanged.

If the level offset is constantly not equal to zero then there is an error in the return channel path (example: the modem is already transmitting at 114 dBµV and the level offset is +9 dB. The modem would therefore have to transmit at 123 dBµV so that the head end can identify the transmission power as being correct, but the modem cannot achieve this transmission power. A possible cause of this error is an incorrectly set or faulty return amplifier).

12.4.3.3   Advanced upstream time slice analysis

As soon as ranging has started, you can select the **ADVANCED** menu item by pressing **MODE** and **ENTER**.

The following figure shows the DOCSIS 3.0 analyzer.

```
LOCK USDOC 256QAM  5361          MER=36.2dB ▭
TV  C31            D   56.3dBµV
PE=    661 /00:03:50              CBER<1.00e-8
System:            DOCSIS3.0   BPI+
 Stack-State:      Operational
Upstream: 4x Bonding
 120
dBµV
  80
   5            f/MHz          65
   Frequency:      41.400 MHz  (Id:2)
   Symbolrate:     2560 kBd
   Access-Mode:    A-TDMA  (DOCSIS3.0)
   Modulation:     StatMaint: QPSK
   Trans.Level:    109.2 dBµV
   Level-Offset:     0.0 dB
```
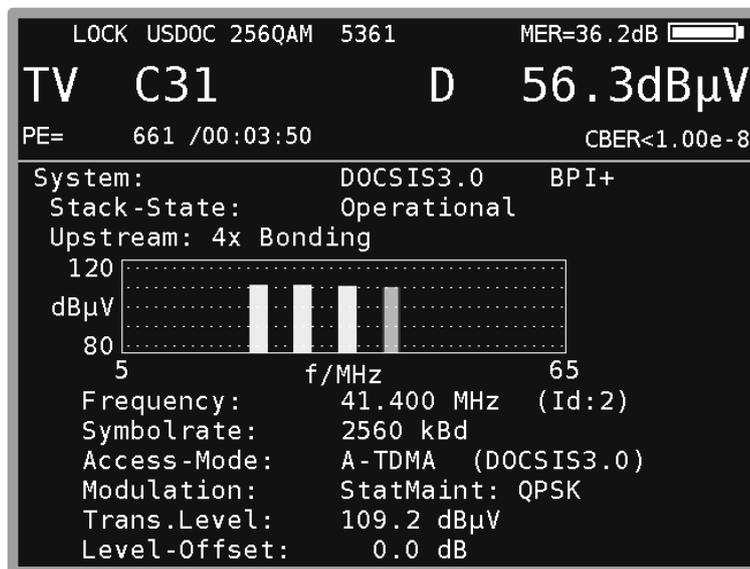
Figure 12-8 DOCSIS upstream details

Use the ←/→ keys to select the relevant upstream channel in the graphic.
Press **MODE** and **ENTER** to leave the **ADVANCED** menu.

12.4.3.4   QAM Upstream frequency response

As soon as ranging is complete, you can select the **FRQRESP** menu item by pressing **MODE** and **ENTER**.

The various DOCSIS specifications provide an equalizer for the upstream sender of the modem. This equalizer filter can be configured with the filter parameters that the CMTS sends to each modem individually.

The purpose of this filter is to equalize the frequency response between the modem and head end that arises through the upstream transmission link between the modem and head end (for example, through micro-reflections where the cable is damaged). This means that equalizer parameters can be used to find which frequency response is prevalent within the transmission bandwidth of the modem (e.g. 3.2 MHz at a symbol rate of 2,560 kSymb/s). This frequency response can be determined in the **FRQRESP** submenu. If the submenu cannot be entered, the head end is not sending any equalizer data to the connected modems (this feature is optional in the DOCSIS specifications).

The following figure shows the DOCSIS-3.0 analyzer.
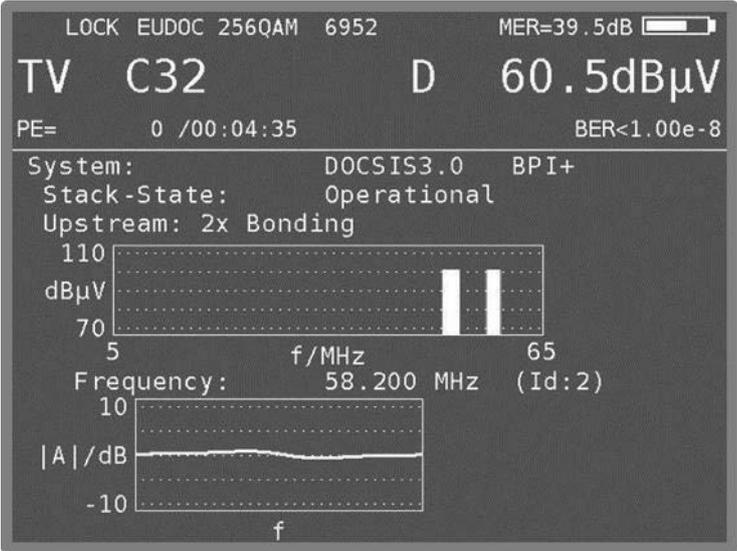
Figure 12-9 DOCSIS QAM upstream frequency response

You can use the ←/→ keys to select the relevant upstream channel in the graphic.
The frequency response is always shown for the upstream channel marked in red.

Press **MODE** and **ENTER** to leave the FRQRESP menu.

12.4.4   Speed test

The speed test (data throughput test) is a test function to determine the data rate that can be actually achieved both in the uplink and the downlink. You can combine it with the PING test and the downstream duty factor to get a very detailed clue of the HFC network's performance.

The data throughput test is based on FTP (file transfer protocol). For an uplink test, data is loaded onto a FTP server connected to the head end. For a downlink test, a file with a known file path and size is downloaded from this server. The time required for uploading or downloading is measured. In combination with the known file sizes, this time is used to determine the achieved data rate.

For detailed information on the speed test, please refer to application note "AN004 – DOCSIS 3.0 Analyzer". You can find this at www.kws-electronic.de, in the support section ("SUPPORT" –> "Application Notes").

In order for the speed test to be performed, registration between the DOCSIS modem and the head end must be fully completed, meaning that the measuring instrument must have the "Operational" stack status. You cannot open the submenus for performing a speed test before this point. Select **MODE** to open a selection menu that, among others, contains both options for the speed test Speed Test Downlink and Speed Test Uplink.
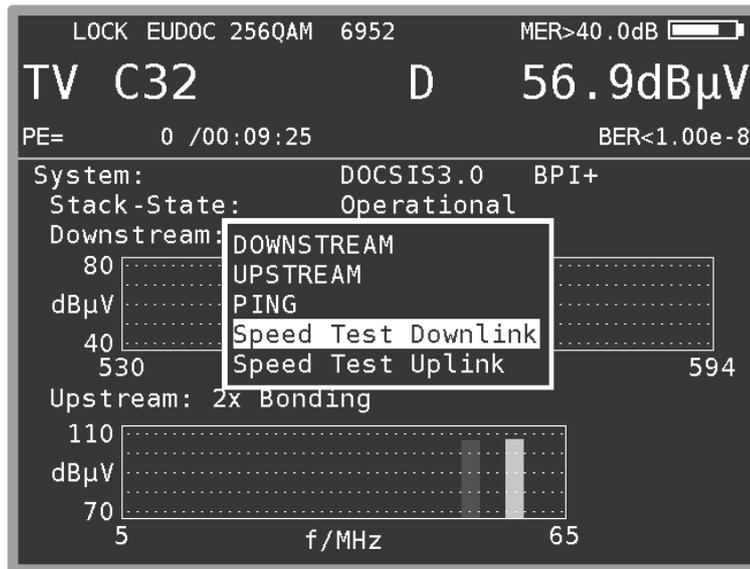
Figure 12-10 DOCSIS selection menu

Several parameters in the measuring instrument are necessary for performing the speed test. These are:

- IP address of the FTP server
- username and password of the FTP server
- name and size of the download file (only for downlink tests)
- size of the upload file (only for uplink tests)

You can enter this data using Instrument Management (see chapter 18.13 - Configuration of speed test in the DOCSIS analyzer). The measuring receiver offers four profiles which allow you to store the data for multiple HFC clusters or head ends.

If the submenu is activated for one direction of the throughput test, the corresponding test will start as soon as possible. During this process, the top line of the display will indicate the current status of the test. The status will go through the phases "started", "initialized", "running..." and "finished". If the test cannot be completed properly, the status will be "aborted".

Under this status bar, the measuring instrument will show the parameters set in Instrument Management for the current test. If the speed test was completed successfully, the bottom line of the display will show the data rate achieved as the measurement result. The following image shows the conditions for a successfully performed downlink speed test.
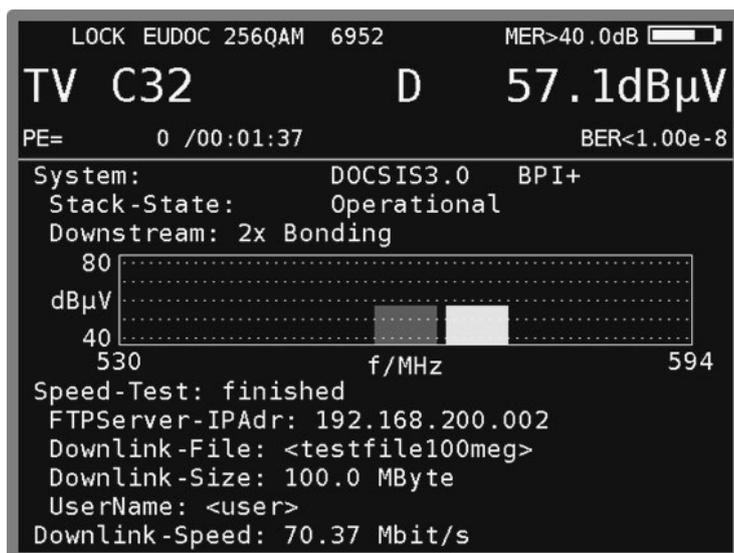
Figure 12-11 DOCSIS speed test results

For uplink tests, the display is the same except of minor difference that the line for the file name remains empty because random data is sent from the measuring receiver to the FTP server in this case. After the end of the test, the measuring receiver deletes the data from the server.

If the respective status permits, you can exit the submenu again via **MODE** -> **BACK**. The message "Test running!" is briefly displayed if this is currently not possible. For downlink tests, you can also use this button to cancel the test before it is finished. It is not possible to cancel uplink tests before they are finished. The reason is that the data that was already transferred to a server is not deleted after a cancellation. If you were to keep performing and cancelling the tests, the amount of unusable data on the server would continue to grow and take up storage space. As a result, you should always wait until the end of the speed test in the uplink direction.

After the speed test is completed (or cancelled), the DOCSIS analyzer returns to the continuous update of all upstream and downstream measurement parameters.

12.4.5   PING test

The PING test is a diagnostic tool that is well-known from the PC world. It can be used to assess the quality of an IP connection. In this test, certain IP packets are sent to a host, and the host must respond to them (insofar as it supports the protocol). The quantity of responses received to the PING packets that are sent and how long this time delay is (round trip delay) are used to provide qualitative information.

A PING test is triggered with the selection of the "PING" submenu in the DOCSIS analyzer. Since an IP connection is required for a PING test, the user cannot access the submenu until the stack status is "DHCP Complete" or "Operational." The PING test is configured (number and time interval of the PING packets to be sent) in instrument management (See chapter 18.11 - Configuration of PING test in the DOCSIS analyzer).

As with the above submenus, the DS data and the most important US parameters appear in the upper portion of the graphical display. The top row of the PING menu shows in the status of the test ("initialized", "running..." or "finished").

Below this row, the assigned device and gateway IP-address from the DHCP server are displayed.

If the ping status switches to "finished", the results are summarized below in statistical form (packets sent; packets received; packets lost, calculated from packets sent and received; and the minimum, maximum and average time to receive a response from the individual PINGs). Since many PINGs can be sent (at most 100 packets) a detailed listing for each individual PING would not be helpful here.

During the PING test, detailed progress information appears in the line after "Ping statistics".
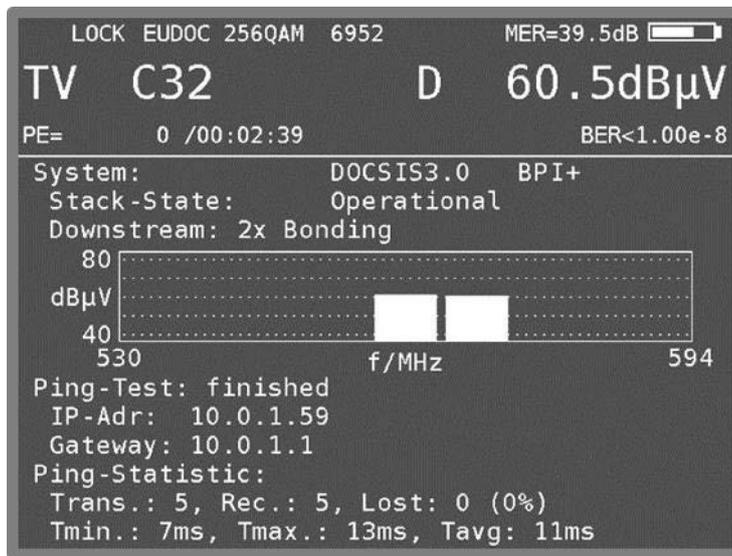

Figure 12-12 DOCSIS ping test statistics

Press **MODE** and **ENTER** to exit the PING test. This not possible until the test has completely finished and the statistical evaluation has been displayed.

12.5   DOCSIS3.1-Analyzer

Starting from DOCSIS3.1-standard additional to the single QAM carrier modulations an OFDM modulation is introduced. That modulation is also known from DVB-T/T2. In downstream frequency range the bandwidth of one OFDM-channel is up to 192MHz wide. In the upstream frequency range up to 96MHz. The OFDM technic allows a much more robust and efficient usage of the limited channel bandwidths.

For DOCSIS 3.1 the measurement receiver can work in two different frequency ranges:
5 - 85 MHz for upstream, 111 - 1218 MHz for downstream
5 - 204 MHz for upstream, 258 - 1218 MHz for downstream
Therefore the device includes a switchable diplexer filter. Also refer to chapter 17.14 DOCSIS3.1 Setup the maximum Upstream frequency.

The switchable diplexer can also be set in the main menu under **US 5..85** or **US 5..204**. The factory setting is **US 5..85**.

```
        DOC31  OFDM                        ▭
TV   246.00MHz D                    dBµV
  Center or PLC-Freq.            01.07.19 14:11:15




      <<<      +US     US 5..85  US 5..204
```
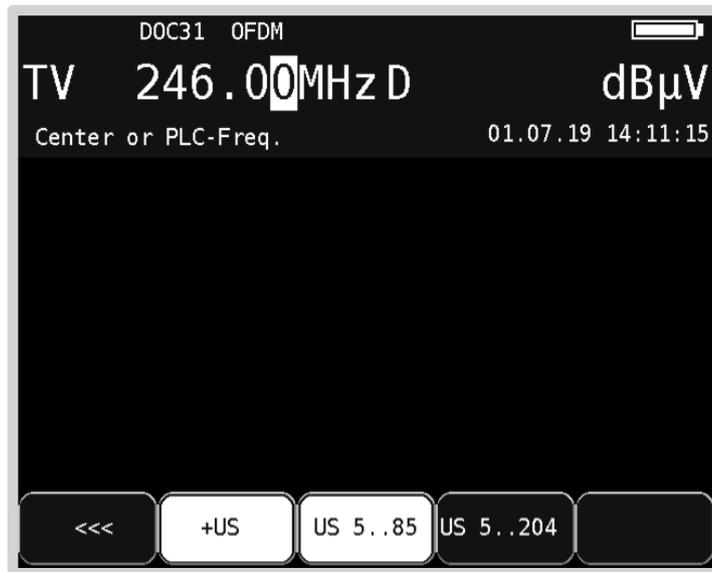
Figure 12-13 DOCSIS diplexer setup

Definitions:
The QAM modulation used in DOCSIS3.0 is also referred here as ScQAM (Single Carrier QAM). ScQAM is a single-carrier modulation, while OFDM is a multi-carrier modulation scheme.
PLC: Physical-Link-Channel, a special range inside an OFDM channel, which transmits all data used for demodulation. The PLC uses a robust and low modulation scheme (16QAM).

For DOCSIS3.1 a different hardware is used and the operation is changed accordingly. Contrary to the DOCSIS 3.0 version described above, all functions are called up here via the F-keys F1 - F5 and not via the MODE key.

12.5.1   Tuning to an OFDM-downstream

The menu item **MODULATION** -> **DOCSIS** in the TV measuring activates the downstream receiver of the measuring device.
In another menu, the modulation scheme and the DOCSIS variant are selected. Here, in addition to the ScQAM modulated EURO- and US-DOCSIS variants, the menu item **OFDM** is also available. If OFDM is selected, then the center frequency or the PLC frequency of an OFDM downstream must be entered. The device then searches for an OFDM downstream. As soon as it can be locked onto an OFDM-channel, the frequency display changes to the center frequency and the determined bandwidth and the FFT order of the OFDM-channel are displayed.

Another possibility to activate OFDM is the usage of the so called D-channel (user defined, see Chapter 18.8.1 - D-Channels). In a D-channel the bandwidth indicates a ScQAM (6 or 8MHz) or an OFDM (24..192MHz) channel. For automatic detection of the standard, EU- or US-DOCSIS must be predefined, otherwise the receiver operates always in OFDM mode.

Figure 12-14 DOCSIS activate OFDM standard

With **ENTER** the boot- and lock-process can be started. The progress of the boot-process (ca. 30 seconds) is shown in a graphic with the percentage value. Depending of the modulation standard, signal level, signal quality (MER) and the lock-status are also shown. If the boot-process is finished, the main screen of the DOCSIS-3.1-Analyzer is shown, with two diagrams for Up- and Downstream. OFDM Information can only be evaluated after a complete boot process and a first lock to the OFDM channel. That Information can be shown in submenu DOWNSTREAM.

12.5.2   Down- and Upstream analysis with DOCSIS-3.1-Analyzer

With the DOCSIS-3.1-Analyzer you can make a statement, if a communication between modem and CMTS can be principally established. Furthermore the Analyzer is an instrument for leveling back channel amplifiers.

After a successful lock to a CMTS, the DOCSIS-3.1-Analyzer offers a graphical overview of all bonded Down- and Upstream channels with level information and channel bandwidths. The ranging process only works in the main screen, in the submenus only the evaluated data is visible.
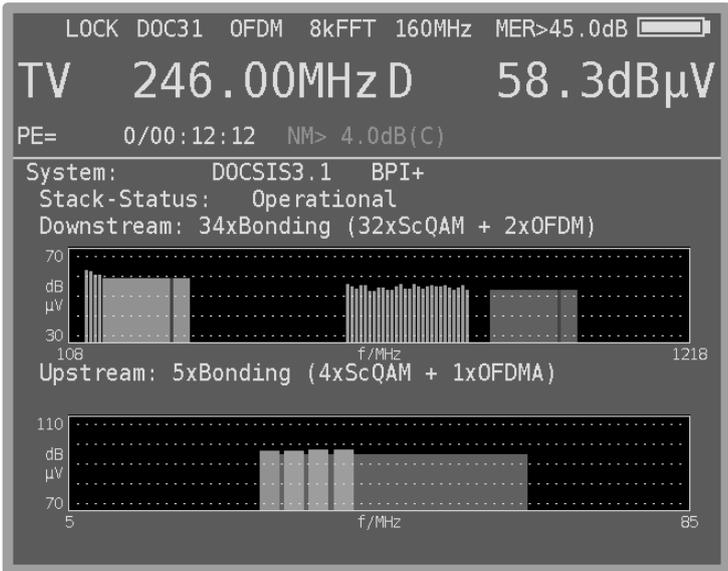
Figure 12-15 DOCSIS-3.1-Analyzer main screen

Following measurement variables are available after successful connection with CMTS:

- DOCSIS-standard (DOCSIS 3.0 or DOCSIS 3.1)
- display of the used security system (e.g. BPI+)
- amount of bonded downstream channels
- amount of bonded upstream channels
- Primary downstream on which the log-in process was started
- Level (at OFDM the Level of the PLC measured with 6MHz bandwidth)
- MER
- Packet Errors
- Center frequency or channel
- NM (Noise Margin) (at OFDM, the highest modulation profile is considered here)

The System line shows the actual used DOCSIS System (3.0 or 3.1). The line with "Stack-Status" shows the actual ranging status of the modem.

The graphical overview offers a system overview about the up- and downstream setups. In Downstream section shows the actual tuning channel in green (ScQAM) or cyan (OFDM), other channels are shown in yellow (ScQAM) or cyan (OFDM).

12.5.3   DOCSIS 3.1 downstream analysis

The Downstream-Analyze window will be called with the function key DOWNSTREAM.
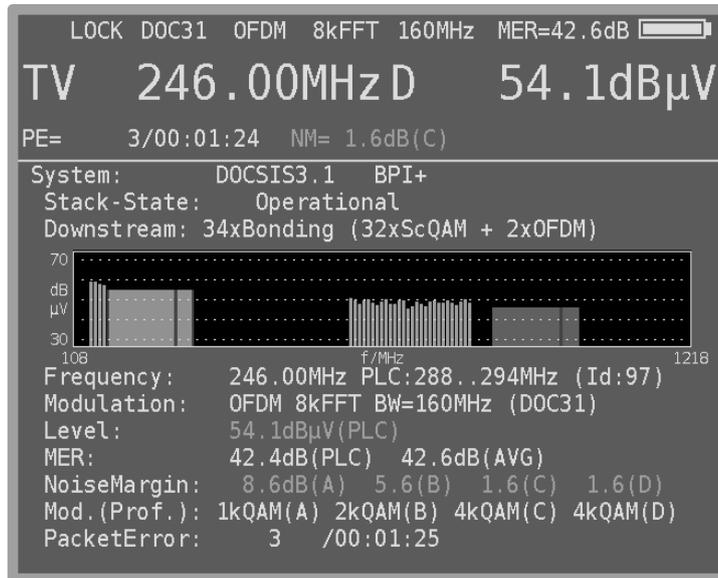
Figure 12-16 Downstream Analyze Windows with OFDM info

Each bar indicates one downstream channel. With the arrow keys ←/→ you can choose the desired channel. The actual selected channel is marked in red. In the function key menus are more detailed downstream analyzer functions available, depending on the modulation scheme (ScQAM or OFDM).
Each downstream channel has its own identification number (Id), which is shown behind the specific frequency (middle frequency). In Figure 12-16 is an example of an OFDM downstream channel.

- Center frequency and PLC frequency
  (The PLC Physical-Link-Channel is a 6MHz wide area within the OFDM channel that transmits information to the demodulator).
- Together with the modulation type OFDM, the FFT order (4k or 8k) and the channel bandwidth in MHz are displayed.
- The level corresponds to the level of the PLC in relation to a measuring bandwidth of 6MHz.
- The MER of the signal is given once as an average over the bandwidth (AVG) and for the PLC.
- Noise Margin (NM) in dB with respect to the different profile (A..D) modulations
- Package Errors: Amount of not correctable packets inside the data stream

Parameters of a ScQAM carrier are the same as used in DOCSIS-3.0-Analyzer (refer Chapter 12.4.3.1 - Downstream analysis). The downstream channel load works only at the ScQAM carrier, which is used for tuning.

12.5.3.1   PLC parameter

With the menu item PLC PARAM you can show an information list of the selected OFDM downstream carrier. The list has more subpages, which can be switched with the F-keys <<< and >>>.
The section OCD (OFDM-Channel Descriptor) contains all information about demodulation for the receiver side. The further sections contain the DPD (Downstream-Profile-Descriptor) information. The measurement receiver only shows the first four profiles.
With the F-key BACK you can leave the list.

```
 LOCK DOC31  OFDM  8kFFT  160MHz  MER=42.6dB ▭
TV   246.00MHz D     54.0dBµV
PE=    28/00:06:07   NM= 1.6dB(C)
 (1/4)          PLC Parameter
 ------------------
 OCD:              OK
 FFT Length:       8k
 Cyclic Prefix:    2.5000µs
 Roll Off:         1.2500µs
 ChaBw:            160.00MHz (6320 Subcar)
 CentreLocation:   246.00MHz (4096 Subcar)
 PLCLocation:      291.00MHz (5888 Subcar)
 DS Chan.Id:       97
 Interleaver Depth:16
 Cont. Pilots:     48
 Excl. Bands:      0..935 - 7256..8191
```
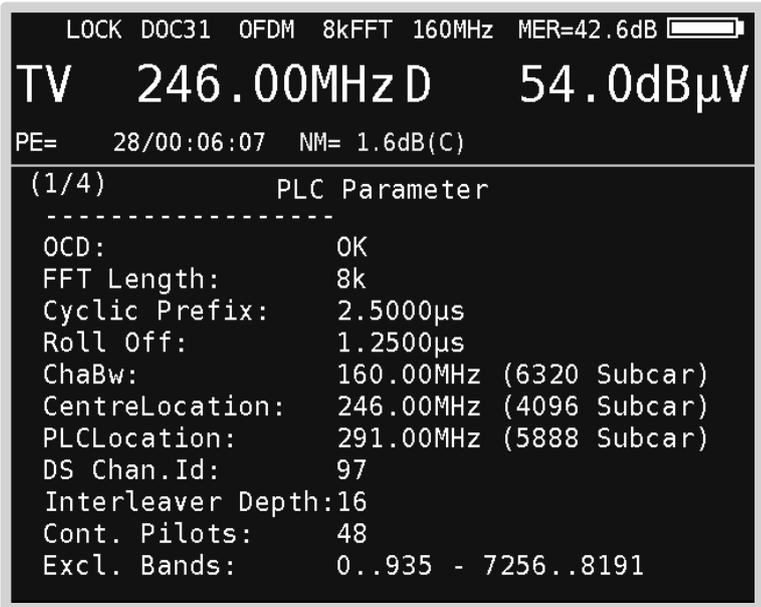
Figure 12-17 List of PLC parameters

12.5.3.2   OFDM level diagram – Level(f)

With the level diagram function you can show the level trend inside the selected OFDM channel. That diagram can be reached with the F-Key **LEV(f)**.
Herein, the up to 192MHz wide OFDM channel is divided into 6MHz sections and the level of these sections is plotted against the frequency (center frequency of the sections).
The area of the PLC is marked red in this illustration.

```
 LOCK DOC31  OFDM  8kFFT  160MHz  MER=42.5dB ▭
TV   246.00MHz D     54.0dBµV
PE=    65/00:12:46   NM= 1.5dB(C)
System:       DOCSIS3.1   BPI+
 Stack-State:     Operational
 LEVEL(f): BW=6MHz            TILT= 4.0dB
                      53.5
     70
  dBµV
     30
      147          f/MHz          345
 Cursor-Frq.:  249.00MHz  (Id:97)
 Modulation:   OFDM 8kFFT BW=160MHz (DOC31)
 Level:        54.0dBµV(PLC)
 MER:          42.4dB(PLC)  42.5dB(AVG)
 NoiseMargin:   8.5dB(A)  5.5(B)  1.5(C)  1.5(D)
 Mod.(Prof.): 1kQAM(A) 2kQAM(B) 4kQAM(C) 4kQAM(D)
 PacketError:   65   /00:12:46
```

Figure 12-18 OFDM level diagram

The cursor can be moved with the ← / → keys and the corresponding level is displayed above the diagram. In addition, the device measures the maximum level difference within the 6MHz sections and displays the value after TILT. This gives a statement about the ripple or the level skew within the OFDM channel. With the menu item **BACK** the diagram is left.

12.5.3.3 OFDM MER diagram – MER(f)

With the MER diagram function you can show the MER trend inside the selected OFDM channel. That diagram can be reached with the F-Key MER(f) .
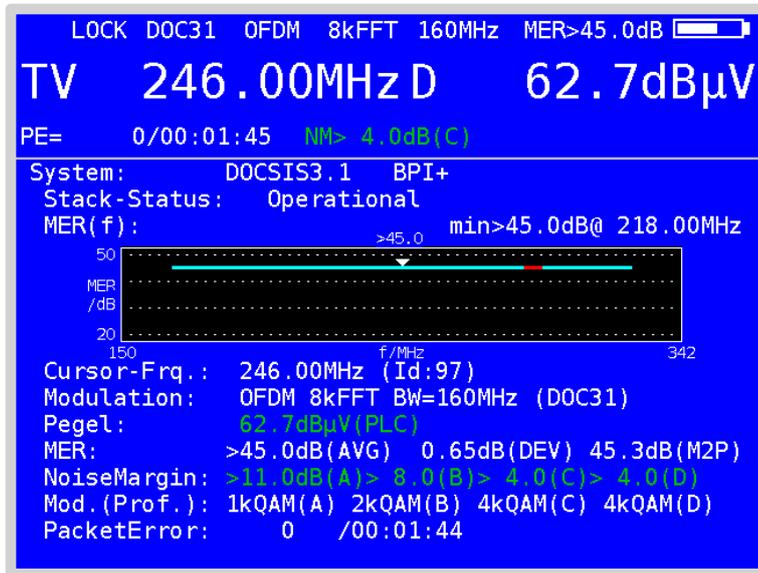

Figure 12-19 OFDM MER diagram

The MER value associated with each cursor position is displayed above the graph and the corresponding frequency below. The section of the PLC is marked red. The cursor can be moved with the ← / → keys.

At the same time, the device measures the minimum MER within the OFDM channel and displays the value along with the associated frequency. The standard deviation "DEV" and the best MER value of the worst 2% of the subcarriers is shown in the line starting with MER.

With the menu item MINHOLD the MER min-hold function can be activated and deactivated. If the function is active, the minimum MER is saved. Thus, it is possible to detect drops (due to, for example, LTE interference) of the MER (f) over time.

With the menu item BACK the diagram is left.

12.5.4   OFDM Upstream analysis

If the menu item UPSTREAM is selected from the main menu, further information on the US channels is displayed.
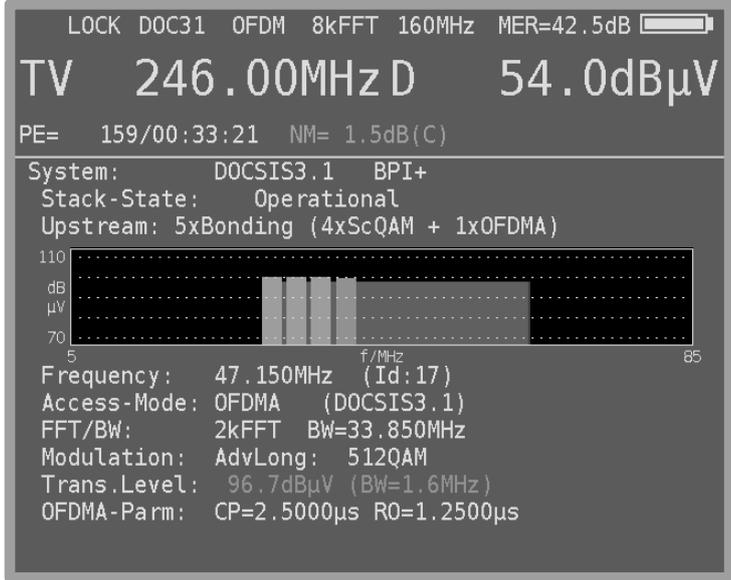

Figure 12-20 DOCSIS 3.1 Upstream analysis

One bar each represents a US channel. Use the ← / → keys to select the desired channel in the graph. The currently selected channel is highlighted in red. The following information applies to the selected channel. Depending on the modulation type, OFDM or single carrier QAM, different submenus are available.

Each US in the system has a unique identifier (Id), which is displayed after the corresponding center frequency. As shown above, the OFDM carrier may overlay other QAM carriers, since they are not active at the same time (time slot method). The access method here is according to OFDMA.

The current transmitter level of the modem is displayed.

The upstream level showed at an OFDMA channel does not correspond to the complete channel power but belongs to the average level of a 1.6MHz width section. At single carrier QAM upstreams the transmission level is measured over the complete channel bandwidth.

As the above figure shows, OFDMA upstreams display additional parameters such as FFT order, bandwidth, cyclic prefix (CP) and roll-off (RO).

The modulation schemes (QAM order) of the different upstream data packets can be displayed via the ADVANCED menu. In general, the highest modulation order is used in the "AdvLong" packets.

12.5.4.1   OFDM Upstream frequency response

The OFDM upstream receiver of the CMTS determines the channel frequency response within the occupied OFDM bandwidth on the basis of the pilots of the OFDM transmission signal. This information is used to set the pre-equalizer in the OFDM transmitter of the cable modem. Based on the pre-equalizer data, the meter can calculate the channel frequency response from the subscriber line to the CMTS.

Via the menu item FRQRESP the upstream frequency response can be displayed. The meter measures the frequency response and displays the maximum deviation behind TILT. Thus, a statement about the maximum ripple or skew in this area of the transmission line can be made.
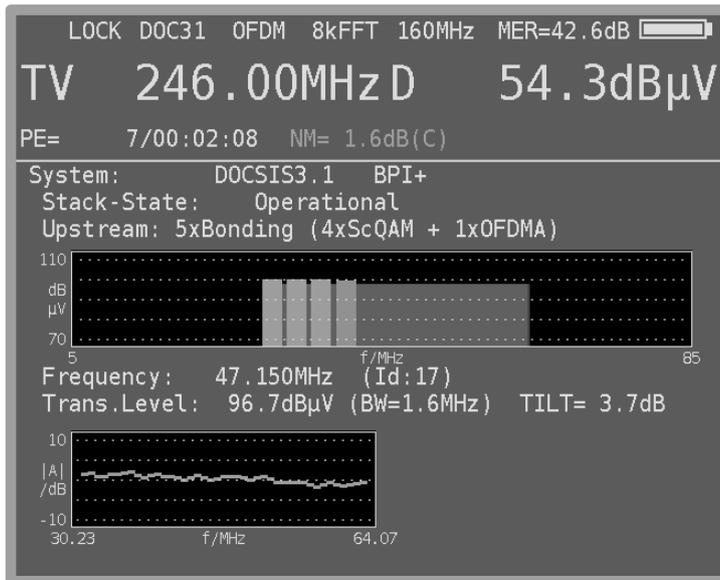
Figure 12-21 OFDM upstream frequency response

With the menu item **BACK** the diagram is left.

12.5.5   Downstream-Upstream-List

If the DOCSIS modem is in the "Operational" state and all measured values for the bonded downstream and upstream channels are available, a corresponding list can be displayed in the device as an alternative to the graphical representation of the bonding configuration.
To do this, select **DS-US-LIST** from the main menu. The list comprises several pages, which can be turned over with the arrow keys ← / →.
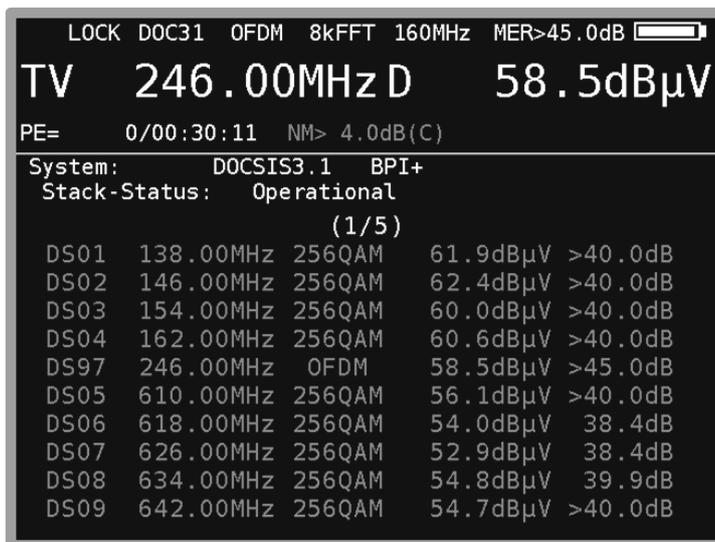
Figure 12-22 Downstream bonding list

In addition, a color rating is made in the list. A downstream line will appear green if the noise margin (NM) is more than 3dB. If it is between 0 and 3dB the line is yellow, if it is negative, red accordingly.
An upstream line is displayed in green if the transmitting level is in the range 85.0 to 105.0 dBµV, otherwise the line will appear yellow.

```
LOCK DOC31  OFDM  8kFFT  160MHz  MER>45.0dB ▭
TV   246.00MHz D      58.5dBµV
PE=      0/00:29:52   NM> 4.0dB(C)
System:       DOCSIS3.1   BPI+
 Stack-Status:  Operational
                  (5/5)
 US01 30.800MHz  QAM    92.9dBµV
 US02 34.000MHz  QAM    93.0dBµV
 US03 37.200MHz  QAM    93.2dBµV
 US04 40.400MHz  QAM    93.2dBµV
 US17 47.150MHz  OFDMA  92.9dBµV
```
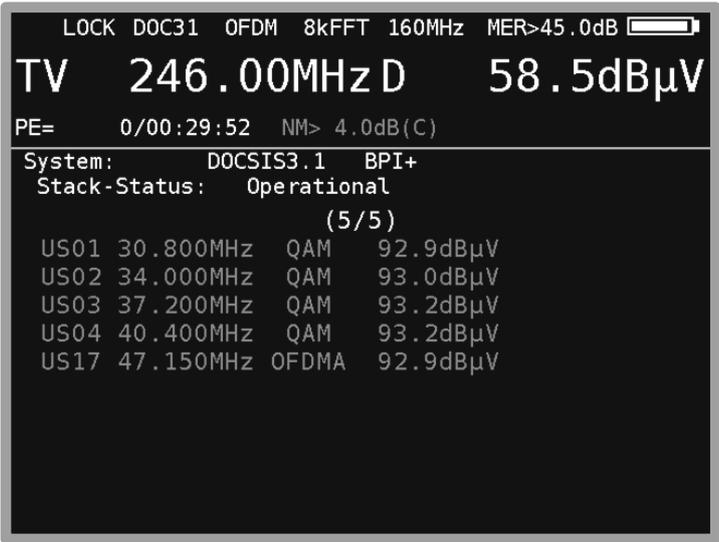
Figure 12-23 Upstream bonding list

With the menu item BACK the diagram is left.

12.5.6   DOCSIS-Protocol

With this function, a protocol can be generated in the form of an XML file on the USB stick. In this case, all bonded downstream and upstream channels with their parameters and measured values are stored in the form of a table. This file can later be used with a spreadsheet program, e.g. MS Excel read and processed.

CUSTOMER_NAME.XML					done at: 01.07.19 13:49		
System: DOCSIS3.1					34xDS-Bonding (32xScQAM 2xOFDM)		
Downstream ID	Frequency/MHz	Mode	Modulation	Bandwidth/MHz	RxLevel/dBµV	MER/dB	NM/dB
1	138,00	ScQAM	256QAM	8	57,9	>40,0	>11,0
2	146,00	ScQAM	256QAM	8	58,4	>40,0	>11,0
3	154,00	ScQAM	256QAM	8	57,0	>40,0	>11,0
4	162,00	ScQAM	256QAM	8	56,6	>40,0	>11,0
97	246,00	OFDM	4kQAM(C)	160	54,0	42,5	1,5
5	610,00	ScQAM	256QAM	8	50,1	35,8	6,8
6	618,00	ScQAM	256QAM	8	49,0	33,5	4,5
7	626,00	ScQAM	256QAM	8	46,9	32,4	3,4
8	634,00	ScQAM	256QAM	8	48,8	33,5	4,5
9	642,00	ScQAM	256QAM	8	49,7	34,6	5,6
10	650,00	ScQAM	256QAM	8	47,6	32,4	3,4
11	658,00	ScQAM	256QAM	8	46,5	31,3	2,3
12	666,00	ScQAM	256QAM	8	48,4	33,5	4,5
13	674,00	ScQAM	256QAM	8	49,3	33,5	4,5
14	682,00	ScQAM	256QAM	8	47,2	31,3	2,3
15	690,00	ScQAM	256QAM	8	47,1	31,3	2,3
16	698,00	ScQAM	256QAM	8	49,1	33,5	4,5
17	706,00	ScQAM	256QAM	8	48,0	33,5	4,5
18	714,00	ScQAM	256QAM	8	45,0	30,2	1,2
19	722,00	ScQAM	256QAM	8	46,0	30,2	1,2
20	730,00	ScQAM	256QAM	8	48,0	32,4	3,4
21	738,00	ScQAM	256QAM	8	47,0	31,3	2,3
22	746,00	ScQAM	256QAM	8	46,0	30,2	1,2
23	754,00	ScQAM	256QAM	8	48,0	32,4	3,4
24	762,00	ScQAM	256QAM	8	48,9	33,5	4,5
25	770,00	ScQAM	256QAM	8	47,8	31,3	2,3
26	778,00	ScQAM	256QAM	8	47,8	31,3	2,3
27	786,00	ScQAM	256QAM	8	48,7	33,5	4,5
28	794,00	ScQAM	256QAM	8	47,6	31,3	2,3
29	802,00	ScQAM	256QAM	8	46,5	31,3	2,3
30	810,00	ScQAM	256QAM	8	48,5	29,1	0,1
31	818,00	ScQAM	256QAM	8	49,5	26,0	-3,0
32	826,00	ScQAM	256QAM	8	46,6	31,3	2,3
98	946,00	OFDM	2kQAM(D)	160	45,5	30,4	-6,6
					5xUS-Bonding (4xScQAM 1xOFDMA)		
Upstream ID	Frequency/MHz	Mode	Modulation	Bandwidth/MHz	TxLevel/dBµV		
1	30,80	ScQAM	64QAM	3,20	99,1		
2	34,00	ScQAM	64QAM	3,20	99,0		
3	37,20	ScQAM	64QAM	3,20	99,2		
4	40,40	ScQAM	64QAM	3,20	98,7		
17	47,15	OFDMA	512QAM	33,85	96,7		

Figure 12-24 DOCSIS protocol

In the main menu, first select the menu item PROTOCOL . A window appears in which a file name must be entered via the keyboard. After pressing the ENTER key, the device generates the XML-file. The following figure shows an example of a protocol opened via MS Excel.

12.6   Sequence of a measurement

After the measuring receiver is connected to a multimedia socket (or another point at which the DOCSIS connection can be tested, for example, a return channel amplifier), the measuring receiver should be tuned either by entering the channel of a known DOCSIS DS channel directly or by scanning for a valid DS channel. A summary of the US measuring parameters starts in the graphical display. The DS can be assessed qualitatively in the measured value display.

Since, in practice, a measured value update comes once every 5 to 20 seconds during continuous ranging, the instrument-internal beeper signals when the measured values were updated and the CMTS sent positive feedback ("Ranging complete") on the last data exchange. This makes the work easier, such as, when adjusting the return channel amplifiers. If the beeper is activated, the user knows that a correct value for the required US transmitting power is present.

If a cable network operator offers several US and DS channels, ranging may not function on the selected DS. In this case, scanning should take place after the next DOCSIS downstream, or, if known, a new DS frequency should be entered directly.

As was described above, the DOCSIS 3.0 analyzer can be used to perform further tests, in addition to pure US and DS level tests, after successful ranging.

12.7   Ingress measurement

An important measuring parameter with return channel capable systems is ingress (interference level through external stray pick-up in the coaxial cable).

The measuring receiver can assess ingress with the aid of the spectrum analyzer (see also chapter 16.13 - Ingress measurement in the return path and Chapter 9 - RC (Return Channel) Measuring Range)).

12.8   Notes regarding compatibility

Basically, up to DOCSIS 3.0 the different DOCSIS standards (1.0, 1.1, 2.0 and 3.0) are downward compatible with one another. This means that the DOCSIS analyzer generally operates with any head end.
However, if a cable network operator has issued only DOCSIS 2.0 modems to its customers, for example, and no longer has any 1.1 modems in circulation, it can switch off mixed mode and change over to pure DOCSIS 2.0 or DOCSIS 3.0 operation. Beginning from DOCSIS 3.1, only a downward compatibility down to DOCSIS 3.0 is possible, older standards are not supported.
Additionally, there are some network operators that identify a modem using the MAC address and assign it to a customer during the very first ranging. It can therefore happen that measurement is only possible once the measuring receiver's MAC address has been configured in the head end. The MAC address can be read out (see also chapter 18.6-MAC address).

However, the above aspects are dependent on the operator.

12.9   Further information

Further information for measuring using the DOCSIS 2.0/3.0 analyzer can be found in application note "AN004 – DOCSIS 3.0 analyzer". This is available from the homepage www.kws-electronic.de in the support section ("SUPPORT" – "Application Notes").
For DOCSIS 3.1 topics you can refer the Application Note "DOCSIS 3.1 Analyzer".

Chapter 13   **MPEG decoder**

The instrument is equipped as standard with a MPEG2/4 decoder. This forms the back-end of a DVB receiver. It analyses the Program Service Information (PSI) and decodes the digital audio and video data.

13.1   Program Service Information (PSI)

For digital television (DVB), data is transmitted as sequential data bytes in a transport stream (TS). As a rule the transport stream contains several video and audio programs, but also data streams and additional information on programs, which are transmitted in time multiplex. Special tables, which can be transmitted in the transport stream, provide information about the programs being broadcast or about data services. The receiver must first analyses the PSI tables in order to provide the user with an overview in the form of program lists. This process can last a few seconds (depending on the number of programs) and can be viewed in the MPEG area of the display.

Figure 13-1 DVB-C PSI information

In this operating mode, the central area of the screen is used as the MPEG area. The display shows a running new program search in a DVB-C channel.

A program list is displayed in this screen area when the program search has been successfully completed. The inverted display of the 2.FUNCTION menu item in the menu bar indicates that the program list can be navigated around using the arrow keys.

13.2   Network-Information-Table (NIT)

The NIT (Network Information Table) is a special table containing information about other transponders/channels within the network (e.g. satellite, cable, DVB-T network). Information from the NIT can be used for navigation purposes (program search).

The measuring receiver must first receive a digital channel. NIT search is started by pressing **MODE** -> **NIT**. If a NIT is found, the decoder displays the NIT entries in a list.

```
  LOCK DVBC  256QAM  6900          MER>40.0dB ▭

TV   S29            D    57.0dBµV
PE=       0 /00:00:25                 BER<1.00e-8

NIT consists of 46 items
Name: KWS
Network_ID: 1
41*730.000MHz 6900 256QAM
42 738.000MHz 6900 256QAM
43 746.000MHz 6900 256QAM
44 826.000MHz 6900  64QAM
45 850.000MHz 6900 256QAM
46 858.000MHz 6900 128QAM


 CHANNEL  FREQUENCY  ANA/DIG    >>>   2.FUNCTION
```
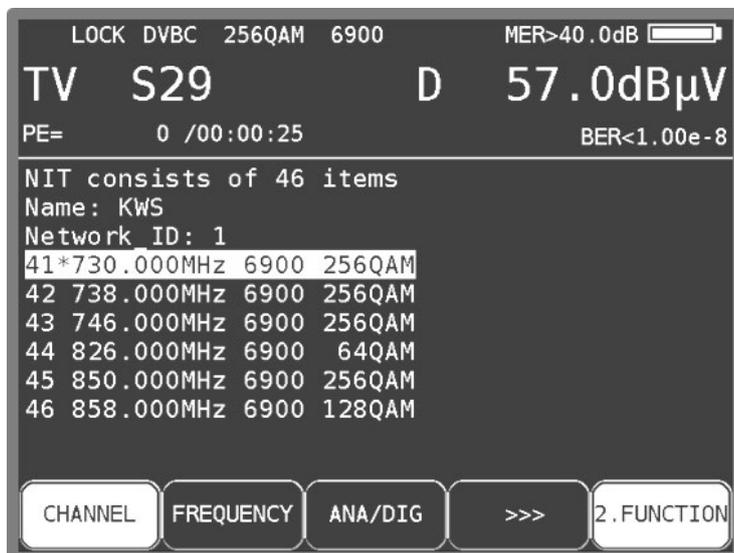
Figure 13-2 DVB-C NIT table

The channel or transponder to which the receiver is currently tuned is marked with* in the NIT. You can now select a different entry using the ↑/↓key. By pressing the ENTER key you get a menu displaying more details about the chosen channel including the Transport-Stream-ID, the Original-Network-ID and the NIT-Version.

```
  LOCK DVBT  16QAM  8kFFT          MER=25.8dB ▭

TV C35             D    45.3dBµV
GI=1/4   FEC=2/3   NM>10.0dB VBER<1.00e-8  CBER<1.00e-6

Name: ZDF
Network_ID:12290 Version:7
 1*586.000MHz 8kFFT 16QAM
   BW: 8 MHz    FFT: 8 k
   COFDM 16 QAM
   Hierarchy: none
   FEC:  2/3
   Guard_Intervall: 1/4
   TS_ID: 514 = 202h
   OrgNetw_ID:8468=2114h


 CHANNEL  FREQUENCY  DIAGRAM    >>>   2.FUNCTION
```
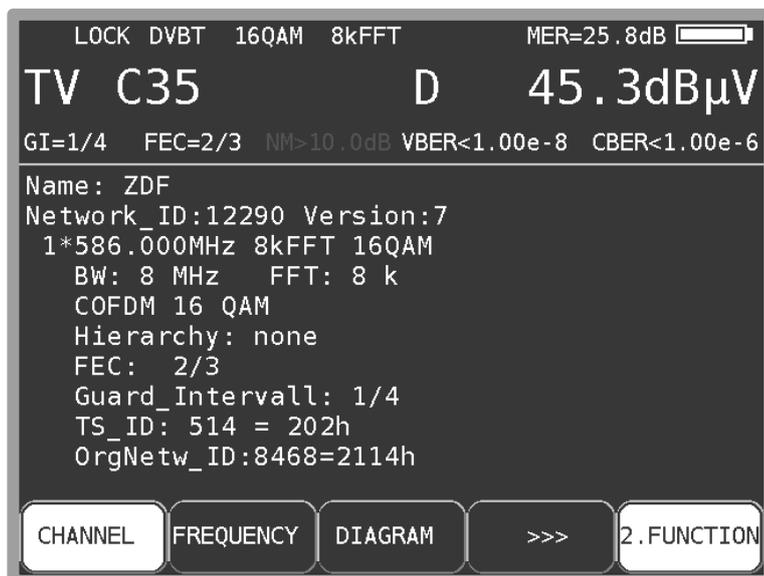
Figure 13-3 NIT Details at DVB_T Channel

The receiver can be tuned to the new transponder or channel by pressing the **ENTER** key. The instrument retrieves the information from the previously selected NIT entry.

You can populate the tuning memory directly from the NIT list. Do this by selecting the corresponding entry from the NIT. Then, as described in the chapter 15.1 - Saving, you can select a memory location and save the NIT entry. Press **SAVE** enter the SAVE menu.

If the NIT includes more than 8 entries, you can use the ←/→ keys to scroll between the individual pages in the list.

13.3   Logical Channel Numbering (LCN-List)

For a suitable receiver, the order of the stations can be controlled using the logical channel descriptor (LCD) which is transmitted within the NIT. This means that the network operator can determine which program receives which memory location number in the receiver. This can be useful in places such as hotels or hospitals in order to ensure that the memory locations are identical for all receivers.

To evaluate the LCN, the device has to be locked on a digital service. By selecting MODE->LCN, the evaluation of LCN starts. If no NIT was evaluated before it starts with evaluation of the NIT first and then shows the sorted LCN-List.
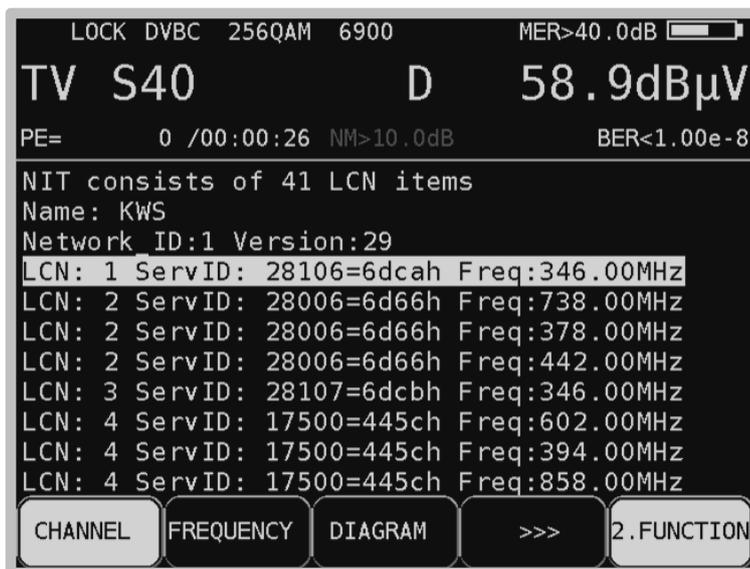
Figure 13-4 LCN-LIST

Per page 8 entries are displayed. Use the ← and → keys to scroll through the entries. An entry consists of the LCN, service ID and transponder frequency.

An " * " after the LCN indicates that the current transport stream originates from this transponder/channel. You can move the yellow bars up and down with the ↑ and ↓ keys

13.4   Picture and sound check

As described in chapter 13.1Program Service Information (PSI), several video and audio programs are transmitted in the same multiplex (TS). As soon as the MPEG decoder identifies a TS, it analyses the PSI data and then generates the program lists. This process can be observed in the MPEG area. The program list is displayed in this screen area once the decoder has finished generating program lists. The illustration below shows a video program list.
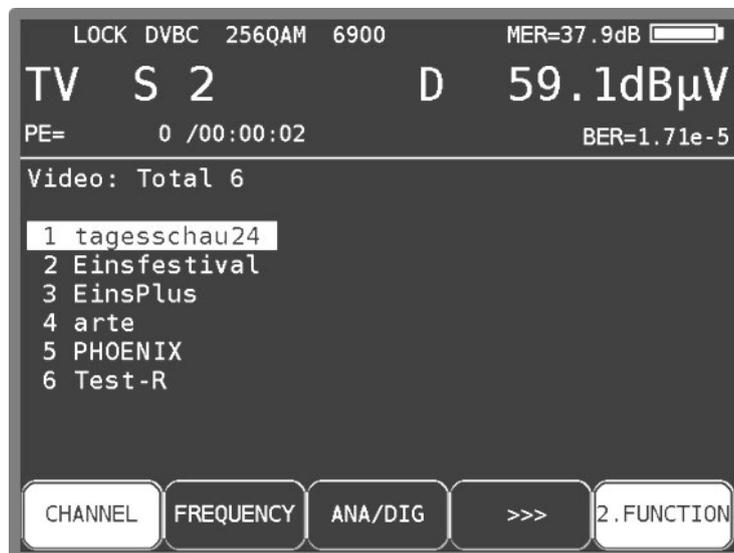
Figure 13-5 DVB-C video program list

A list of video programs always appears first. The audio program list is displayed by pressing **MODE** -> **AUDIO List** and data channels can be shown with **MODE** -> **DATA List**.

Press **MODE** -> **VIDEO List** list to return to the previous menu. All programs marked with * are encrypted.

You can move the cursor within the program list to the required program by using the ↑/↓ arrow keys. You can use the ←/→ keys to scroll between the pages of the program list.
Press the **ENTER** or **OSD-VID** key to see further detailed information about this program. This information includes the program name, provider, Service-ID, Transport-Stream-ID, Original-Network-ID and the PIDs (packet identifiers) for the elementary text streams involved.

Many programs are broadcast with multiple audio streams, e.g. several languages. The desired audio channel can be selected in the program details menu.

Start the program by pressing **ENTER** or **OSD-VID** again. The video program is now being shown on the screen. The measurement parameters are still displayed in a translucent manner in the upper area of the screen. The sound from the loudspeaker can be monitored at the same time. The measurement parameter area can be displayed or hidden any time using the ↑/↓ arrow keys.

NOTE: **With digital transmission, it is not possible to draw conclusions about reception quality based on the quality of the picture and the sound. Picture and sound quality are always perfect up to a certain transmission quality. Below this point reproduction is no longer possible. It is only in a small transitional area where the picture exhibits characteristic blocking (brick wall effect) and the sound often stops. The broadcast quality can only be determined based on the measurements (BER, MER).**

Press **ENTER** or **OSD-VID** to show the previous program list again where you can select another program. Press **HOME** to stop the measurement and immediately reset values back to the default status of the respective measuring range.

13.5   Display of MPEG video parameters

As soon as a live picture can be seen, the MPEG decoder displays the following parameters in a window at the bottom right of the screen.

Profile and level: e.g. MP @ ML
Chroma format: e.g. 4:2:0
Video resolution: e.g. 720*576
LetterBoxFormat: 4:3 or 16:9

The parameter window can be displayed or hidden at any time using the ←/→ keys.

13.6   Video bit rate measurement

The MPEG decoder measures the current bit rate of the video stream being broadcast while a live picture is shown. It is shown in the unit [Mbit/s] in the window described in the above section. The measuring time is 1 second.

13.7   Dynamic program switching

Some program providers split their broadcast into regional content at specific times. This means that, for example, 4 programs may appear in the MPEG program list, which has the same content at certain times and different content at other times. The program map table (PMT) in the data stream therefore changes over time. In this way, the station can prompt the receiver to use different packet identities (PIDs).

In the standard setting, the MPEG decoder of the instrument uses the PMT that was sent at the time of the last program search. With other words a static PMT.

The dynamic PMT update function can be activated using **MODE** -> **Settings** -> **Dyn. program switching**. If you start the program now, the decoder continually searches for a new PMT version. If the instrument detects a change in the PMT, the current program is stopped, the message "Dynam. program switching" appears and then the program is restarted with the updated PIDs. This setting remains active until it is deactivated in the menu above, or until the next restart.

Chapter 14   Constellation diagram

14.1   Introduction

The constellation diagram is a graphic representation of the signal states of a digitally modulated signal in a two-dimensional coordinate system. The individual signal states can be viewed as position vectors with the components I (Inphase - horizontal axis) and Q (Quadrature - vertical axis). However, in the diagram only the tips of the vectors are displayed. Within the two-dimensional field, there are different numbers of decision fields (e.g. 64 with QAM64) depending on the modulation method. A fixed bit combination is assigned to these decisions fields.

Under ideal conditions all signal states concentrate in the center of the decision fields. However, a real signal is subjected to various disturbances. If these disturbances are viewed as vectors, superimposed on the ideal signal states, the tips of the sum vectors result in an image of the deviation from the ideal state. The worse the signal quality, the larger is the distribution in the two-dimensional state space. The form of the constellation diagram makes it possible to draw conclusions as to the type of signal disturbance, as will be explained later by means of examples.

The middle between two ideal states is called the decision limit (shown in the diagram by horizontal and vertical lines). If the signal is disturbed so vehemently that some signal states exceed the decision limit, bit errors will result. This means: the better all signal states concentrate around the ideal states (the smaller the signal clouds are), the better the signal.

Approximately 15,000 symbols are gathered and displayed in color on the TFT depending on a frequency analysis. The color graduation gives information on the frequency distribution of the signal states. Here the graduation is in blue, green, yellow and red with increasing frequency. In this way the constellation diagram also gives a three-dimensional impression.

14.2   Operation

As has already been mentioned, the constellation diagram can be displayed with all digital standards (DVB-C, DVB-T, DVB-T2, DTMB and DOCSIS). The measuring receiver first has to be tuned in a digital range. Subsequently the constellation diagram can be activated by selecting the menu item CONST. At the same time a sub-menu is opened which makes it possible to call up further functions.
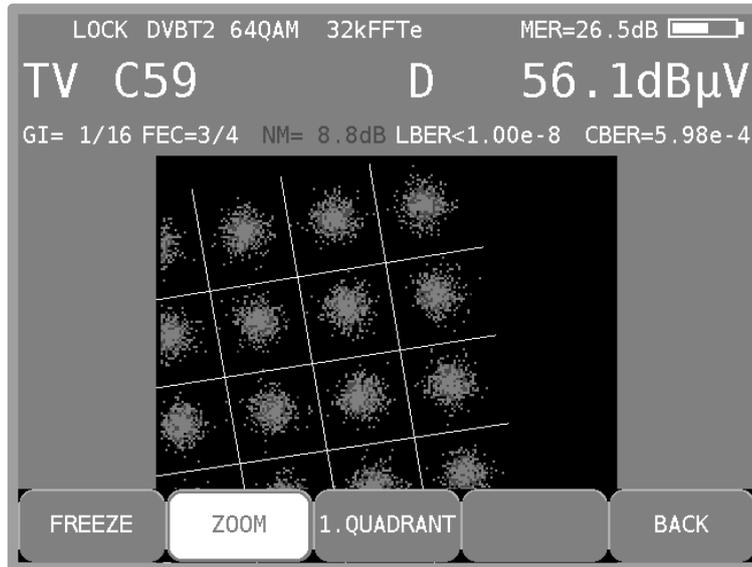
Figure 14-1 Constellation diagram DVB-T2 zoom

By selecting the menu item FREEZE the diagram can be frozen. By selecting ZOOM another menu appears in which each individual quadrant of the constellation diagram can be enlarged to the full screen size. The screen layout in the ZOOM mode is a bit slower than in the full screen mode due to the serial reading of the I/Q data. Thus, in case of DTMB there is no ZOOM mode available.

14.3   Examples

The figures below show images of constellation diagrams. In addition possible errors and their causes will be addressed.
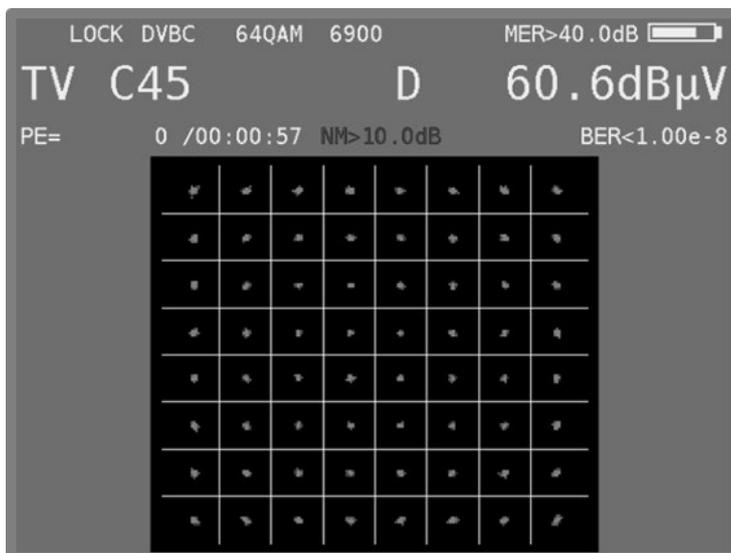
Figure 14-2 Ideal constellation diagram
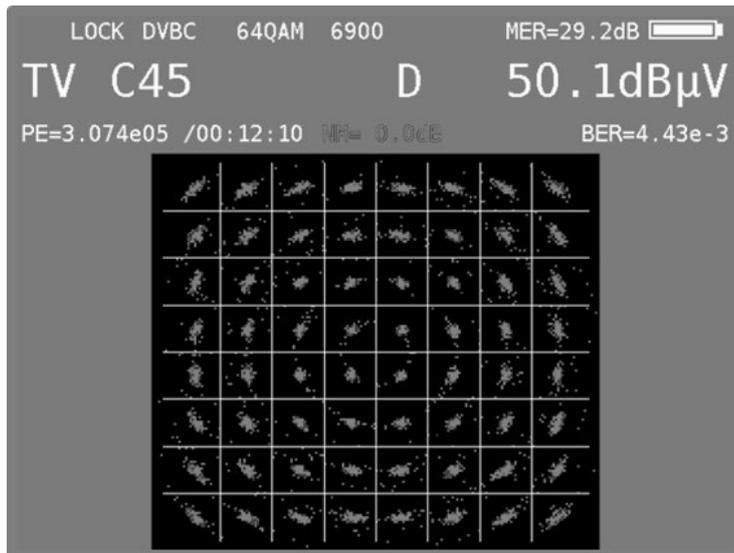
Figure 14-3 Constellation diagram with phase jitter

Error phase jitter: The carrier is subjected to a low-frequency frequency modulation.
Cause: Defect or not correctly adjusted QAM modulator.
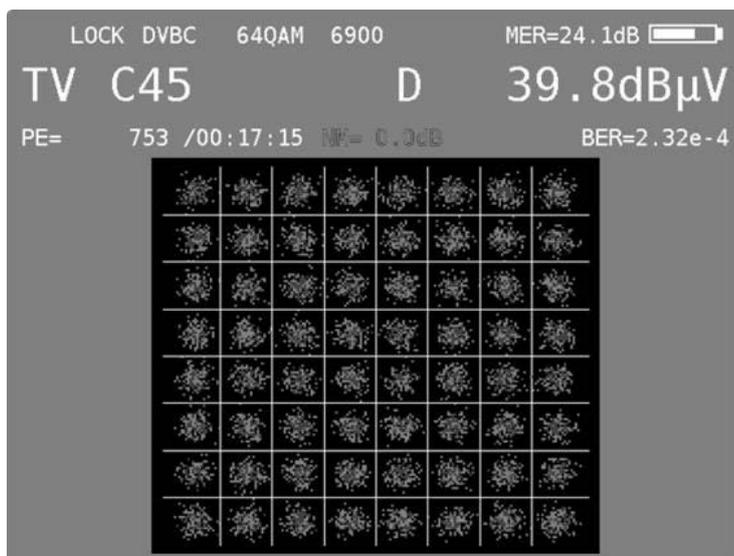
Figure 14-4 Constellation diagram with noisy signal

Error: noisy signal
Cause: bad C/N -> the level is possibly too low.
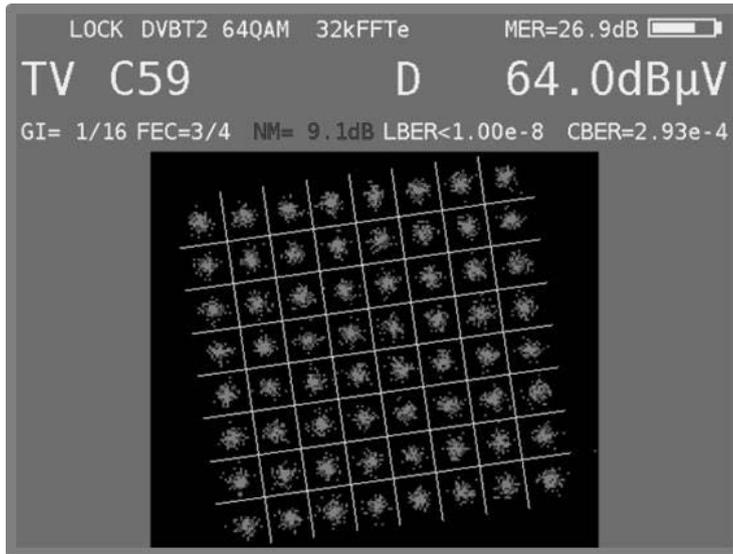
Figure 14-5 Real constellation diagram DVB-T2
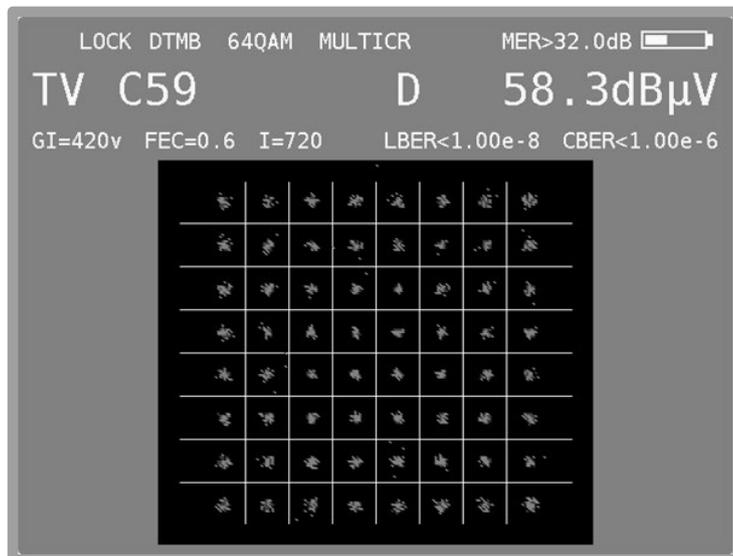
Figure 14-6 DTMB constellation diagram

Chapter 15 **Memory management**

The instrument has a tuning memory with 199 program locations. The memory preview allows the user to gain an overview of the tuning memory without having to access all memory locations or having to make corresponding notes when saving. The memory preview is activated when saving and accessing program locations and with some memory functions. The ↑/↓ key and the ←/→ keys can be used in increments of ten to scroll through the tuning memory.
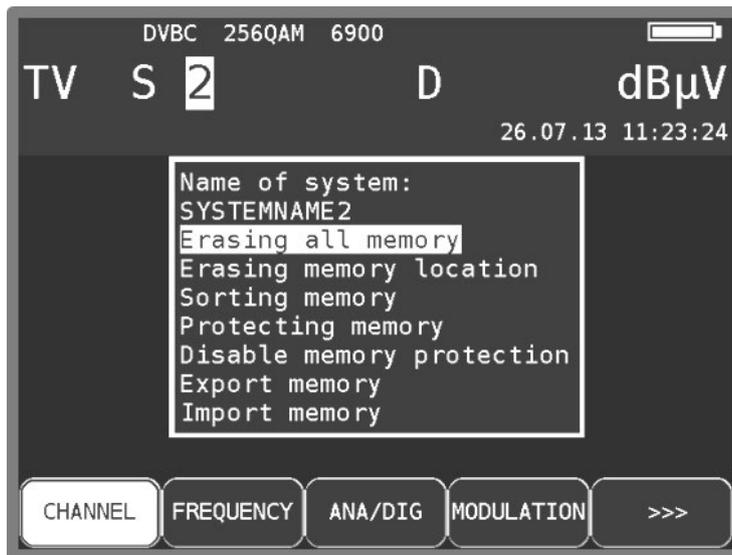
Figure 15-1 Memory management

15.1   Saving

The receiver must first be tuned. You can access the "SAVE" menu using **SAVE**. The instrument searches the tuning memory for the first free location and suggests the user use this memory location number for saving. Any other memory location between 0-199 can, naturally, be selected using the keypad. The content of the memory location is displayed after each the memory number. Press **SAVE** or **ENTER** to save. The instrument issues a warning if the desired memory location is already occupied. If you want to overwrite the memory location, press **ENTER** or **SAVE** again.

15.2   Recalling

Press **RECALL** to open the "RECALL" menu. The instrument will suggest memory location 1 when the menu is opened for the first time after switching the instrument on. The memory location is increased by 1 each time after opening the memory. This means the instrument will suggest memory location 2 next time. Any other memory location can, naturally, be selected using the keypad or the ↑/↓ keys (one memory location) – ←/→ keys (ten memory locations). Press the **RECALL** or **ENTER** keys again to open the memory. The measuring receiver then accepts the settings from the memory. If the memory location is empty, the old settings remain unchanged.

15.3   Memory functions

The memory functions can only be controlled when the measuring receiver has not been tuned.

15.3.1   Erasing all memory

Press **MODE** -> **Memory** -> **Erasing all memory** to delete the entire tuning memory. A warning is issued beforehand. Press **ENTER** again to confirm that the instrument is to erase its tuning memory. This may take a few seconds. The instrument will issue a message indicating that the process is complete.

15.3.2   Erasing a memory location

You can erase a consecutive group or a single memory location within the tuning memory using this function. You can access this function by pressing **MODE** -> **Memory** -> **Erasing memory location**. You will initially be asked which location should be erased first. Confirm with **ENTER**; you will then be asked which location should be erased last. If the first and last memory locations are identical, only one memory location will be erased. Here, the instrument will also issue a warning. Press **ENTER** to acknowledge the warning and continue. The instrument will then issue a message indicating that the process is complete.

15.3.3   Sorting memory

You can use this function to scan the entire tuning memory according to different criteria.

According to A/D mode:
The memory is sorted according to analogue and digital memory locations.
This can be accessed via **MODE** > **Memory** > **Sorting memory** > **according A/D-mode**.

According to frequency:
The memory is sorted here according to ascending frequency.
You can access this function by pressing **MODE** -> **Memory** -> **Sorting memory** -> **according frequency**.

According by range:
Here the memory is sorted according to TV (beginning), FM, RC and EMI range.
You can access this function by pressing **MODE** -> **Memory** -> **Sort memory** -> **according range**.

It may take a few seconds to sort the memory. The instrument is blocked for this time and will issue a message indicating that the process is complete.

15.3.4   Memory protection

This function can be used to apply memory protection to the entire tuning memory, subgroups or individual memory locations. This prevents the user from accidentally overwriting a memory location.
This function can be accessed via **MODE** -> **Memory** -> **Protecting memory**. As in the chapter 15.3.2 - Erasing a memory location, the instrument will ask for the first and last memory location to which memory protection is to be applied. Press **ENTER** to confirm. The instrument will then issue a corresponding message. The next section explains how to disable memory protection.
Memory protection is enabled for memory locations marked with '*'.

15.3.5   Cancelling memory protection

This function is used to disable an existing memory protection.
This function can be accessed via **MODE** -> **Memory** -> **Disable memory protection**. This is done in the same way as memory protection is activated. The instrument then responds with a corresponding message.

15.3.6   Exporting the memory

With this function, the entire tuning memory can be copied as a "MEM" format file on a USB data carrier.
This function can be accessed via **MODE** -> **Memory** -> **Export memory**.

The instrument suggests a file name, which, for example, represents a system (measuring location). It can be set alphanumerically using the arrow keys or the number keys and the ←/→ keys.
Press **ENTER** to complete entry.
The name entered is identical to the MEM file name. If a file with the same name already exists, you will receive a warning. A different name can be entered by pressing **HOME**, or by pressing **ENTER** to overwrite the existing file. The next section explains how to import the tuning memory.

15.3.7   Importing the memory

This function can be used to import a tuning memory saved on a USB data carrier in MEM file format into the instrument.
This function can be accessed via **MODE** -> **Memory** -> **Import memory**. All saved MEM files are then displayed for selection. Use the ↑/↓ arrow keys to move the cursor to the desired file. Press the **ENTER** key to overwrite the instrument's tuning memory with the data from the MEM file. The name of the selected MEM file is saved in the instrument as a system name and is displayed in the header of the memory menu.
This name is offered as a file name during the next measurement. The name can also be changed here.
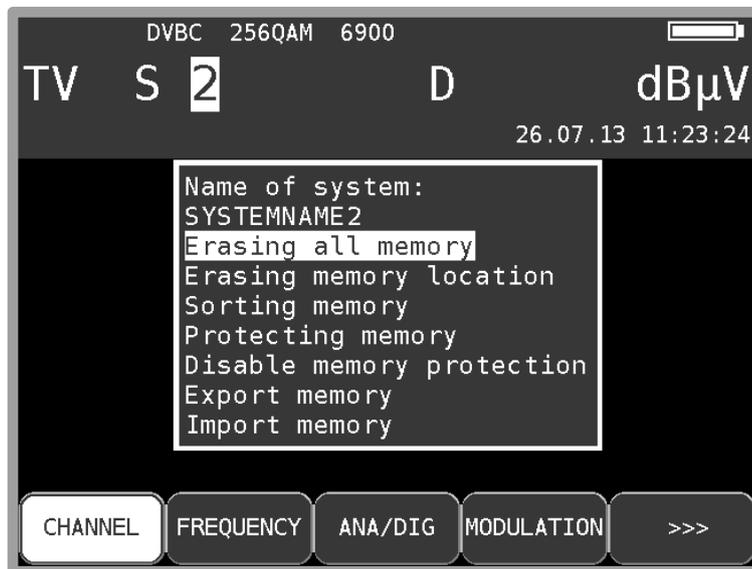
Figure 15-2 Memory management menu options

Chapter 16 **Spectrum analyzer**

You can access the spectrum analyzer in the TV, FM und RC ranges.
An example of a broadband cable spectrum is shown below.
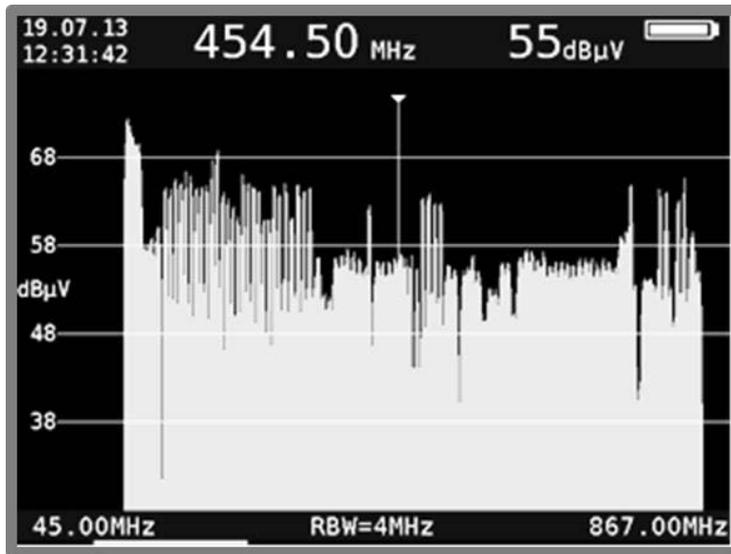
Figure 16-1 Spectrum analyzer

The level-axis has a step width of 10 dB/div. The maximum dynamic range is 40 dB. The blue region at the bottom of the screen contents the center frequency (CF), the resolution band width (RBW) and the frequency segment (span), or in full span mode the start- and stop-frequency. The blue region at the top of the screen contents date and time, the frequency and level of the actual cursor position and the remaining battery capacity. Pressing one of the five function Keys (**F1…F5**) shows the menu item bar for some seconds.

16.1   Accessing the analyzer

Press the **ANALYZ** key in the currently active measuring range (TV, FM, ...) to access the analyzer. The status of the measuring receiver is now important. If the receiver is not tuned to a channel (e.g. previously pressing **HOME**), the analyzer "sweeps" over the entire measuring range FULLSPAN. But if the instrument is in the tuned mode (measuring mode), the analyzer displays the spectrum segment in the range of the measuring frequency.

16.2   Frequency segment (SPAN)

In all measuring ranges, you can change the frequency segment displayed.
You can do this via the menu items **SPAN** -> **FULLSPAN** , **FULL EXT** or **xxMHz** , or the **Up/Down** keys.
In the **FULLSPAN** mode, the frequency segment spans the entire measuring range. At TV-Range **FULLSPAN** spans the frequencies up to 867MHz and depending of options there is a **FULL EXT** mode which comprises the entire frequencies up to 1.2GHz.
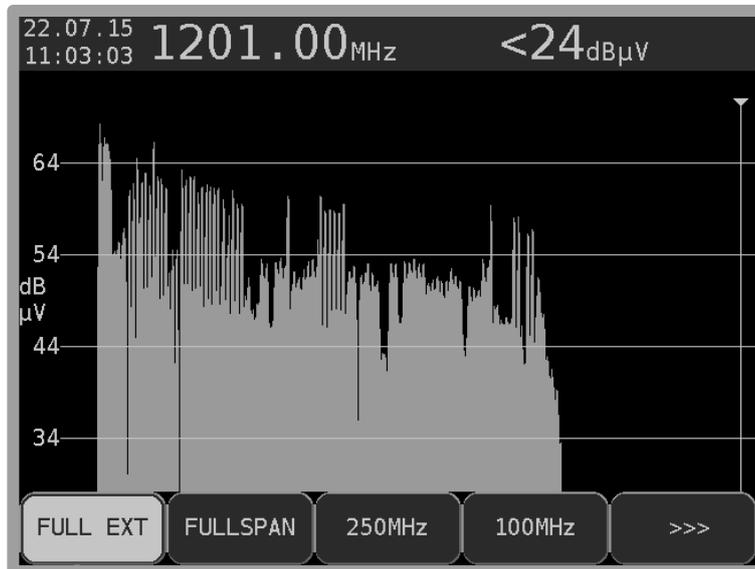
Figure 16-2 Spectrum analyzer selection of bandwidth

16.3   Measuring bandwidth (RBW)

The measuring instrument makes several measuring bandwidths available. These are coupled with the SPAN setting. The current setting is shown in the analyzer image.

16.4   Cursor

Der The cursor appears on the screen as a vertical white line with a tip. You can move the cursor within the frequency segment with the ←/→ keys. The current cursor frequency is shown in the upper center of the screen.

TV range in the channel input mode:

Here you can move the cursor in the channel grid. The measuring receiver also detects whether the channels are analogue or digital. With analogue channels, the cursor jumps to the video carrier frequency; with digital channels, the cursor expands to a window that corresponds to the channel bandwidth. The channel bandwidth is assigned based on the channel table.

16.5   Input of the center frequency

You can enter and activate a new center frequency at any time using the numeric keypad and by pressing **ENTER**. The cursor is then moved to the new position or, if the distance to the cut-off frequencies permits, the frequency segment is shifted such that the cursor is in the center.

TV range in the channel input mode:

Using the menu item CHANNEL , you can switch between the input of C channels and S channels. Now you can type in a channel number using the numeric keypad. After you confirm with the **ENTER** key, the measuring instrument displays the spectrum around the set channel. Invalid entries are ignored.

16.6   Switching between frequency and channel mode

You can only do this in the TV range. You can switch between modes via the menu items CHANNEL and FREQUENCY .

16.7   Level display

During each search, the level of the cursor frequency is measured and displayed in the upper right edge of the screen in dBμV. Level measurement in analyzer mode is comparable to a pure spectrum analyzer.
The power within the measuring bandwidth (RBW) is measured and converted into level in dBμV.

On the other hand, the level measurement in measuring receiver mode always measures the power (level) in the channel.

TV range in the channel input mode:

The measuring instrument differentiates here automatically between analog and digital channels. With analog channels, the level is based on the peak value of the video carrier. With digital channels, the total power within the channel bandwidth is measured. It is not important here which SPAN is set.

16.8   Progress bar

A yellow bar on the lower edge of the screen grows from left to right during each new search by the analyzer. This allows you to follow the position of the "sweep".

16.9   Level diagram in the broadband cable range

Assuming the measuring receiver is operating in the TV range, the mode is set to channel input and the frequency segment is FULLSPAN respectively FULL EXT, the instrument provides a very useful feature.

As you can see in Figure 16-3, the diagram shows the relationship of the levels in a broadband cable system independent of the modulation (ATV or DVB-C) of the individual channels.
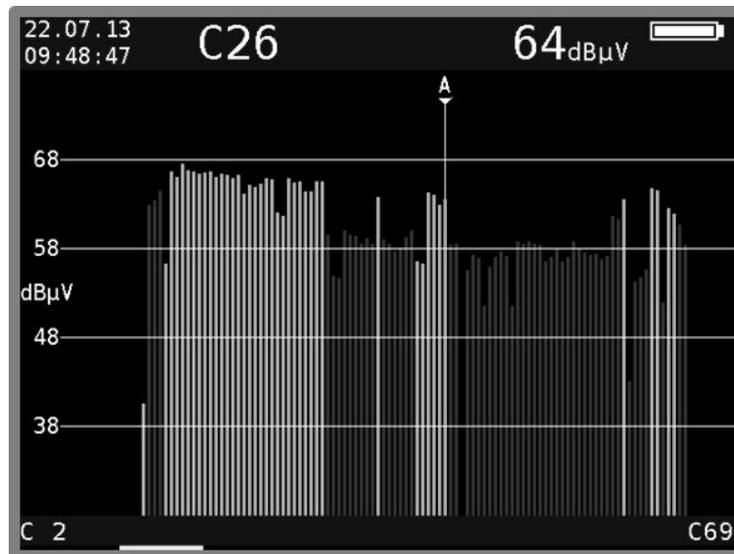
Figure 16-3 Level diagram

During the process, the instrument measures the levels of every individual channel and displays them in the diagram as a green or red bar.

The green bars are analog and the red bars are digital channels. The cursor is marked with an "A" or "D".

In this diagram, tilted levels or abnormal drops in levels can be immediately detected with digital channels.

16.10   TILT measurement in the TV range

This function is activated via the TILT menu item. You can end the tilt measurement by selecting the BACK menu item.

This mode is an expansion on the level diagram in the TV range with the following additions:

You can select as many individual channels from the full channel table as you wish to include in the tilt measurement. The fewer "active" channels, the higher is the repetition rate of the diagram. The specific combination of channels can be saved in a profile. The measuring instrument can manage two independent profile settings per FULLSPAN and per FULL EXT mode.

A second cursor appears for the tilt measurement. This can be moved with the ↑/↓ keys. The first cursor is moved with the ←/→keys.

If the channels upon which the two cursors are located are occupied, the device draws a reference line between the peaks of the level lines. To facilitate a tilt analysis in a system with both analog and digital channels, an "offset" line corresponding to the level reduction is added to the peaks of the level lines for digital channels.

If the difference in level between an analog and a digital channel corresponds to the specified level reduction, the level lines are displayed with the same height in the diagram.

The instrument also determines the modulation for digital channels, and the "offset" line is displayed in a different color according to the modulation.

This allows you to quickly identify which DVB-C channels have 256 QAM and which have 64 QAM, for example.
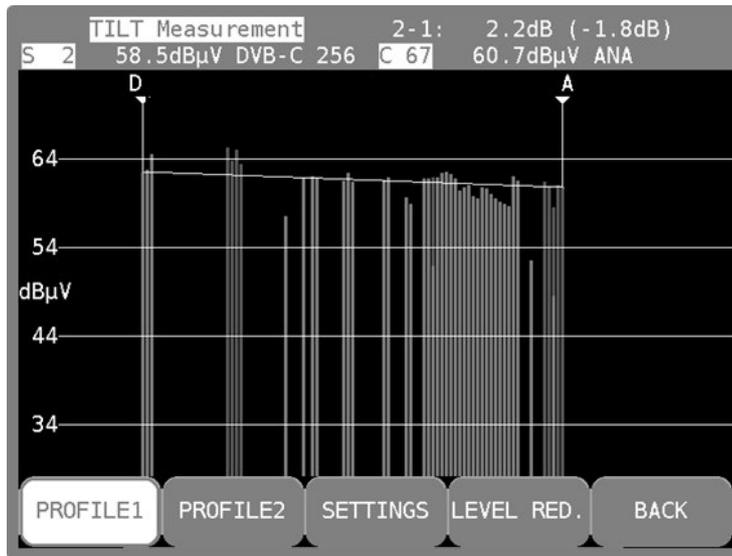
Figure 16-4 TILT measurement

For every cursor position, the upper blue display area shows the channel, the level measured during the last search, the channel type (analog/digital) and, for digital channels, the modulation. The values assigned to the cursor are displayed to the left or right in the 2nd line according to the cursor position.

The level differential between the two cursor positions is also displayed in the 1st line to the right "2-1" stands for the difference between the right (2nd) and left (1st) cursor.

No level reduction is taken into account in the level displays. This means that these are the absolute levels. The level differential which appears in the brackets does, however, include the level reduction. This means that these displays can be used to set the reference line between the cursors exactly horizontal.

16.10.1   Digital level reduction

Using the menu item LEVEL RED ., the level reduction for digital channels can be set depending on the modulation scheme.
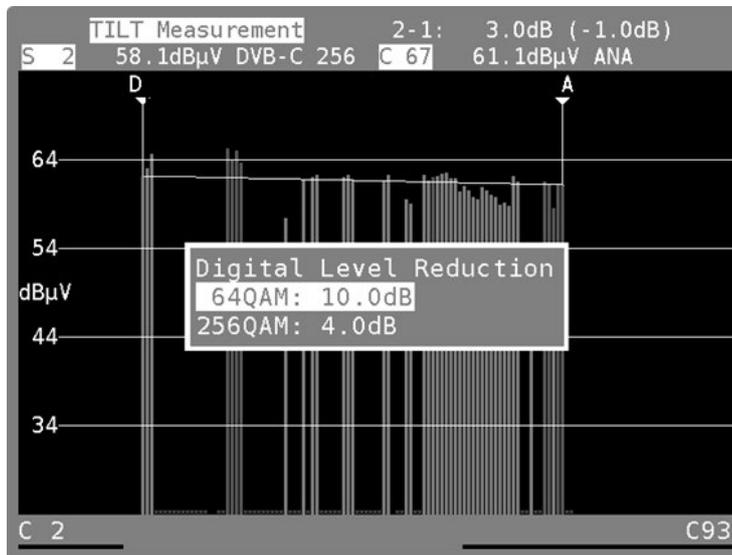
Figure 16-5 TILT measurement - digital level reduction

You can use the ↑/↓ keys to select the desired entry field and open the input mask by pressing **ENTER**. You can now change the value using the numeric keypad or the arrow keys. Confirm every entry using the **ENTER** key. The cursor then jumps to the next field and the value entered is permanently saved.

Exit this menu by selecting **HOME**.

16.10.2   Selecting a profile

The measuring instrument can manage two different profiles per FULLSPAN and FULL EXT mode for the tilt measurement. The profiles save the channels which are to be used for the measurement. The profiles can be selected using the menu items PROFILE1 and PROFILE2. Thereby the profiles correspond to the active span, so the PROFILE1 of the FULLSPAN mode contains different data as the PROFILE1 of FULL EXT mode.

16.10.3   Creating or changing a profile

The currently active profile can be adjusted using the menu item SETTINGS. After the menu item was selected, the diagram is frozen and the 2nd cursor appears.
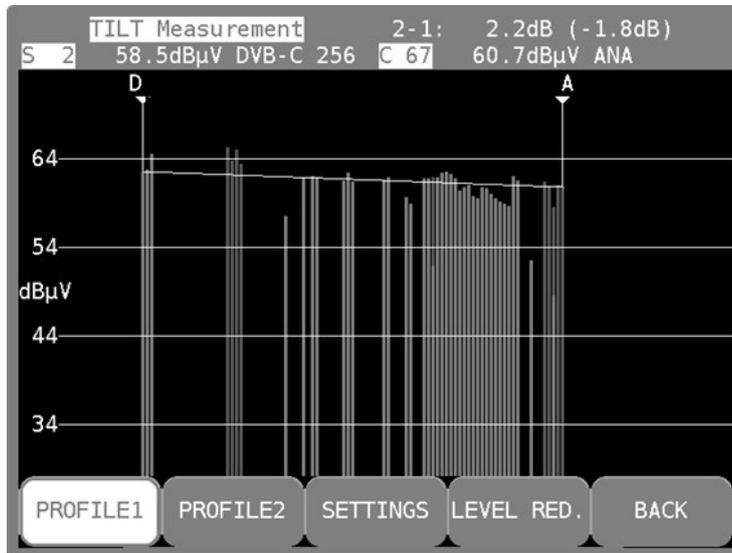
Figure 16-6 TILT measurement - Selecting a profile

You can use the ←/→ keys to move the cursor within the diagram. The current position is shown on the LCD.

Activate/deactivate individual channels

The channel on which the cursor is located can either be included in the measurement or skipped using the menu item ACT./DEACT. If a channel is excluded from the measurement, a small, light-blue X appears in the diagram instead of the level line. When you activate a channel, the small, light blue X will disappear and the corresponding level line will only be updated when the analyzer is next run.

Activate all channels

The menu item ACT. ALL includes all channels in the measurement. All light-blue Xs in the diagram disappear. However the level lines won´t be shown before the next analyzer run has been updated..

Deactivate all channels

The menu item DEACT. ALL excludes all channels from the measurement, including the two on which the cursors are located.

Save profile

The menu item SAVE PROF. stores the channel profile. This confirms the adjustment of the profile and the diagram resumes updating with the modified settings.

Do not save profile

The menu item BACK discards all changes and the measurement resumes with the old settings.

16.10.4   Application

There are two basic applications.

„Line up" a system:

A profile is created with the channels that are occupied in the system. Move the 1st cursor onto the lowermost channel and the 2nd cursor onto the uppermost channel. First set the lowermost channel to the desired absolute level. You then have two options.

No predistortion:

Set the level of the uppermost channel so that the reference line between the two cursors is horizontal or raise the level display.

With predistortion:

Set the level of the uppermost channel appropriately higher.
The channels in between can then be "lined up" using the reference line.

Checking the tilt of the system:

A profile is created with the channels which are to be analyzed in the test. This may be fewer than the number which are occupied in the system. Including fewer channels increases the repetition rate.
Move the two cursors to the uppermost and the lowermost channels. Then check the level lines of the channels in between using the reference line.

16.11   Switching to measuring receiver mode

In most modes you can switch directly from the analyzer to measuring receiver mode while in all measuring ranges. The instrument uses the current cursor frequency to tune the measuring receiver. In the ranges FM and RK direct switching is only possible in the lower spans, not FULLSPAN. At TV is possible in channel mode only, but in every span. Press **ENTER** to trigger the process.
As already mentioned in the "Chapter 15.4 - Cursor", in range TV the instrument can distinguish between analog and digital channels based on the spectrum. This feature is used when switching into the measuring receiver mode. When the instrument detects an ATV channel, the corresponding measuring receiver mode is activated.
If it is a digital channel, the instrument switches to the last digital mode that was active (DVB-C, DVB-T or DOCSIS).

16.12   Max-Hold-Function

This function can be switched on and off via the menu item ⬚MAX HOLD⬚. The menu item is then displayed inverted. The spectrum is only updated when the level increases. Since with an active return path, the spectrum changes depending on the activity of the connected cable modem a reasonable representation of the spectrum is only possible with this function.
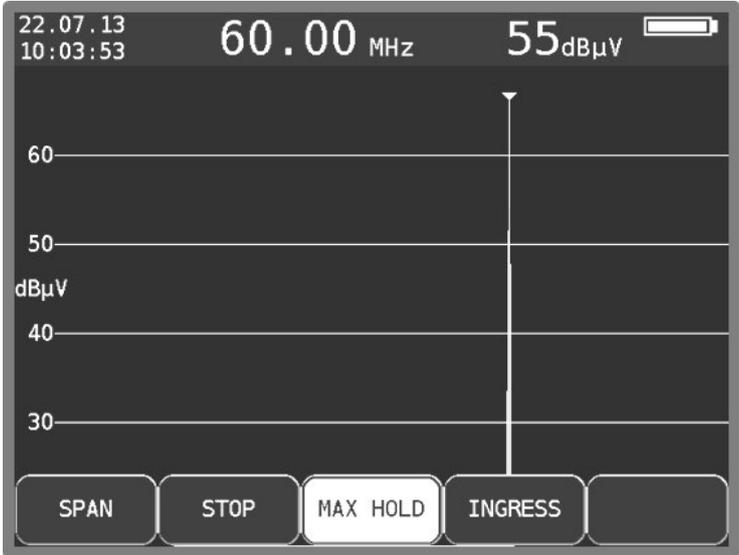
Figure 16-7 Spectrum analyzer - Max Hold function

This function can also be called upon in different analyzer ranges.

16.13   Ingress measurement in the return path

This function is activated via the menu item INGRESS. Ingress refers to all interference spectra those mix with the signal in the return path. Those can be strong short wave stations, CB radio, baby monitors or interference emissions from electrical machines. Badly shielded return path components and incorrectly mounted plug connections can also increase the ingress. Ingress reduces the signal-to-noise ratio of return path signals and can therefore lead to errors in transmission.

The consequence is that the required data rates in interactive cable networks can no longer be maintained. It is therefore crucial to keep ingress as low as possible.

To support ingress measurement, the instrument provides a special function.
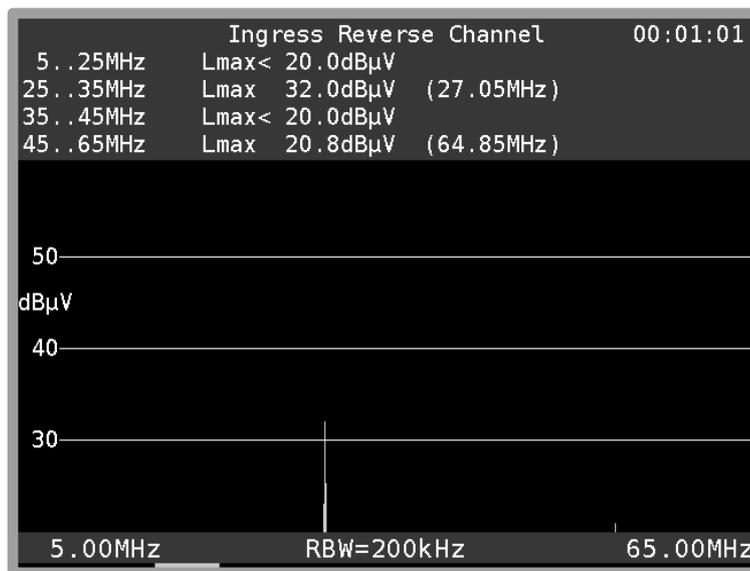
Figure 16-8 Spectrum analyzer - Ingress measurement

The frequency range from 5 to 65 MHz is divided into 4 ranges. Within these ranges, the maximum level and the frequency with which this level occurred is continuously measured and shown on the display. The instrument also shows the elapsed time since the start of the ingress measurement. The spectrum in Figure 16-8 shows a strong interference at 27 MHz (CB radio). You can end the ingress measurement by selecting the menu item BACK. The ingress measurement makes use of the max hold function.

Chapter 17   **Optical Receiver**

17.1   Introduction

RF signals are increasingly being transmitted via fiber optic cables. Optical transmission in broadband networks is gaining importance. While optical transmission in most existing networks still occurs exclusively at network level 2, the trend is moving towards fiber optic distribution up to the subscriber terminals.

Optical fibers:

The optical fiber is the medium through which the light signal is transmitted. There are 2 different fiber types. With multi-mode fibers, the light can move through the optical fibers on multiple "path's" (modes). This result in modal dispersion (distortion), which limits the bandwidth and the transmission distance. With single-mode fibers, on the other hand, the light can only move through the fibers on a single path, preventing modal dispersion and resulting in higher bandwidths. At the moment, almost all fibers used are single-mode.
They have a core diameter of 9 μm and a sheath diameter of 125 μm. A single-mode optical fiber has an attenuation of approx. 0.3 dB/km.

Optical plug connection:

There are two different kinds of fiber optic plug connection. The first one has a straight polish. This version, called PC (physical contact), has a somewhat worse return loss. Connectors with APC (angled physical contact) have an interface with an angle of 8°. PC connectors have blue markings, whereas APC connections have green ones.
Fiber optic plug connections are available in various forms such as FC (threaded connection), SC (plug connection), and E2000 and LC (both with snap/plug connection).
An SC/APC plug connection is built into the measuring instrument.

The measuring instrument is equipped with an optical receiver that converts the light signal back into an RF signal. After the optical receiver, the RF signal behaves as if it had been supplied via the coax input of the measuring receiver. This means that all the measurements available through the RF input can also be taken via the optical input. There is one restriction: For DOCSIS, only the downstream can be measured because the device does not have an optical transmitter for the upstream.

The optical receiver itself is not wavelength-selective. In some systems, light with different wavelengths is transmitted in the same optical fiber. This is known as wavelength division multiplex (WDM). In this type of system, the wavelengths must be separated again before the optical receiver because otherwise the signals from two wavelengths would be mixed in the optical receiver, leading to interference. A patch cable with an integrated wavelength filter should be used for this type of application. But generally, only one wavelength is used, making this unnecessary. In most cases, wavelengths of 1,310 nm, 1,490 nm and 1,550 nm are used.

Optical input power

The measuring instrument does not have an integrated adjustable optical attenuator element.
As a result, the measuring instrument's optical receiver can be operated with up to 8 dBm of continuous power.

However, the optimal range for the receiver is from -7 dBm to +3 dBm. At lower power levels, the reception quality is reduced because of the receiver noise.
At higher input power levels, the intermodulation products have a negative effect on the performance. In this case, optical attenuation elements should be used.

Example: Measurements must be taken on an optical transmitter with an output power of 8 dBm. The optical power can be measured directly. However, an attenuation element of 5 to 10 dB should be connected between the transmitter and the receiver to determine the signal quality.

17.2   Activating the optical input

You can activate the instruments optical input using **RANGE** -> FIBRE-IN .

Figure 17-1 Optical input

If the instrument's optical input is activated, "FIB XXXXnm" will appear in the display. XXXXnm stands for the wavelength set, e.g. 1,310 nm. Now you can set a specific measuring range, e.g. TV. The spectrum analyzer also uses the signal from the optical receiver.

17.3   Setting the wavelength

As previously stated, the integrated optical receiver is not wavelength-selective. However, you must set the wavelength used because it is required for measurement of the optical power and the optical modulation index (OMI). The responsivity of the integrated photodiode depends on the wavelength.
Using **MODE** -> **Settings** -> **Right** -> **LAMBDA** (second page) you can set the wavelength to 1,310 nm, 1,490 nm or 1,550 nm. The **wavelength LAMBDA** menu is located on the 2nd page of the settings menu. With the ←/→ arrow keys, you can switch between the pages of a menu.

17.4   Measuring the optical power

```
            MONO            SC1           S/N=46.8dB ▭
TV  C23                    A  FIB 1310nm        2.0dBm
                              OMI= 4.8%        81.6dBµV
                                           SC1=-12.7dB




   CHANNEL   FREQUENCY   ANA/DIG      >>>     2.FUNCTION
```
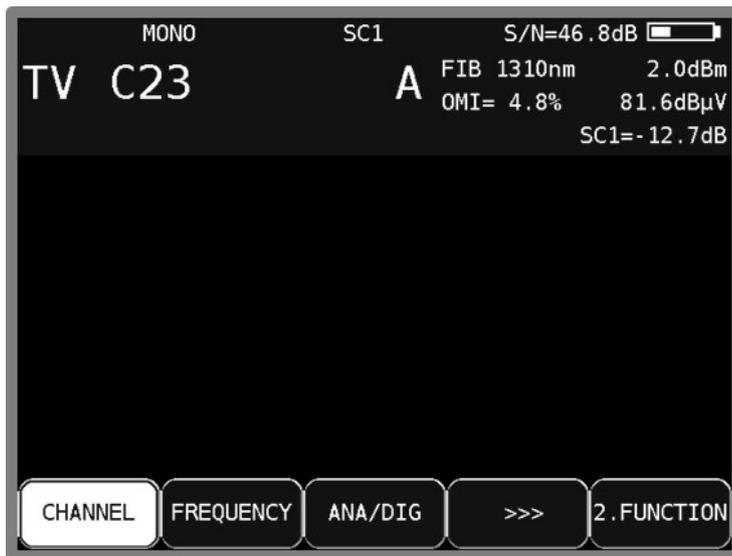
Figure 17-2 Optical power measurement

Optical transmission involves modulation of the intensity of the light power.
The measuring instrument measures the average optical power in dBm. This power is also measured when the light is supplied from an unmodulated laser source. In this case, the instrument can be used as a purely optical power measuring instrument.

Start the measurement by entering the frequency/channel and pressing **ENTER** to confirm.

17.5   Measuring the optical modulation index (OMI)

Der The optical modulation index (OMI) is comparable with the modulation index for an amplitude modulation. The amplitude (intensity) of a carrier – here, the light – is modulated. The greater the difference between the maximum intensity and the minimum intensity is, the greater the OMI and the RF voltage (level) are after the optical receiver. There are now two options for specifying the OMI. One option is selectively measuring the OMI for a specific. This measurement only takes the RF power within the channel bandwidth into account. The total OMI measurement or OMI sum takes the entire RF power after the optical receiver into account. For this purpose, the instrument measures the average RF power after the optical receiver in the range from 5 to 2,150 MHz. Signals outside of this frequency range are included in the OMI sum in attenuated form.
In professional optical transmitters, the total OMI is adjusted to a fixed average value using an AGC. This means that it is independent of the frequency plan of the RF signal supplied. However, channel OMI can change based on the frequency plan (configuration with ATV, FM, DOCSIS and DTV channels). The attainable signal-to-noise ratio depends on the channel OMI. For ATV signals, a value of around 4% is ideal. Generally, the OMI sum ranges from 16 to 20%.

The measuring receiver can measure both the channel OMI and the OMI sum. After the receiver is tuned, the instrument displays the channel OMI (see above). The OMI sum is displayed in analyzer mode in the FULLSPAN setting. The OMI is specified in %.
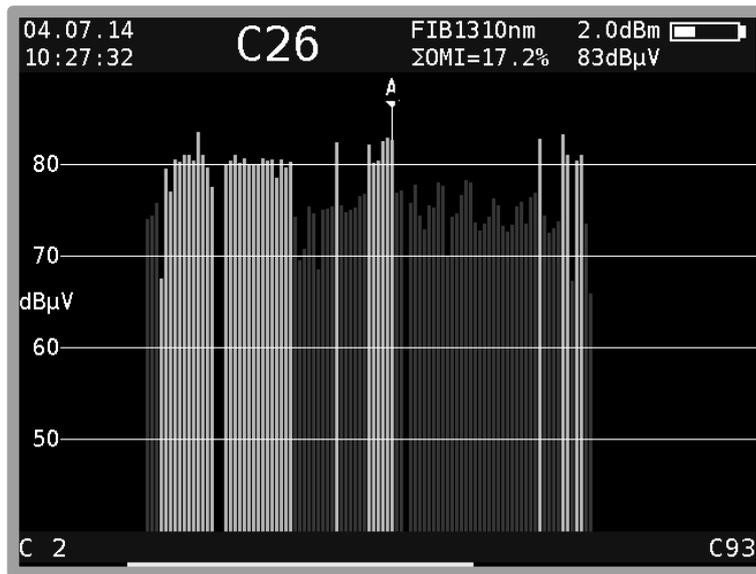
Figure 17-3 Spectrum analyzer in optical mode

Note!   **The level specified after the OMI value corresponds to the internal RF level after the optical/electrical converter. This information is only relative. This specification is primarily used to determine the relationships between the levels of the individual channels.**

A brief overview of the relationships between optical power, RF level and OMI is provided below:

- If the optical power is increased by 1 dB for optical transmission, the RF voltage increases by 2 dB after the optical receiver, while the optical modulation index (OMI) remains unchanged. The RF voltage is proportional to the square of the optical power.
- If the optical modulation index is doubled (e.g. increased from 2% to 4%) with the same optical power, the RF voltage after the optical receiver increases by 6dB. This means that the OMI and RF voltage are linearly proportional to one another.

17.6   Cleaning the fiber optic plug connection

The weak point of every optical transmission system lies in the splice and plug connections. For plug connections, it is important to ensure that the contact surfaces are very clean. But the ferrules of a fiber optic connection must also remain free of dust so that no contamination reaches the connectors' interfaces when they are plugged in. Industry-standard cleaning sets are available for this purpose. Immediately after cleaning the plugs and connections, you should put dust covers on them unless you are going to use them again right away.

The measuring receiver's fiber optic connection is equipped with a hinged lid that seals the connection as soon as the plug is removed. However, you must still ensure that the area around the lid remains free of contamination.

17.7   USB Microscope

A USB microscope can be connected to the device for plug connector inspection. The device supports DI-1000 type USB microscopes from Lightel Technologies.

Contamination in optical plug connections can impair the signal quality. Typical types of contamination include dust particles, hand lotion, skin and alcohol residues.
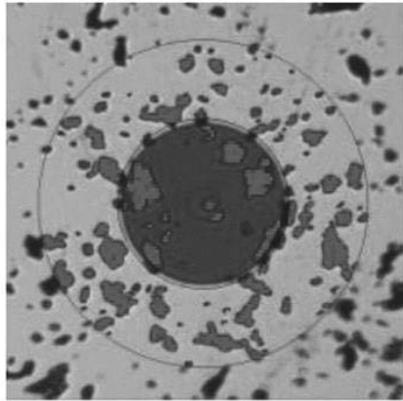
Dust Particles
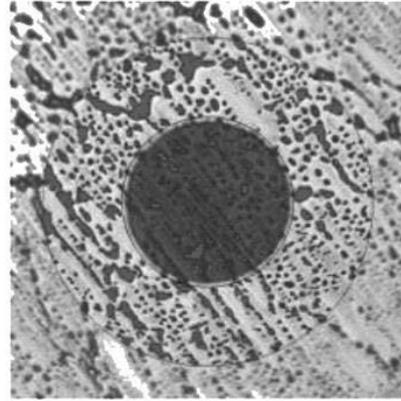
Hand Lotion
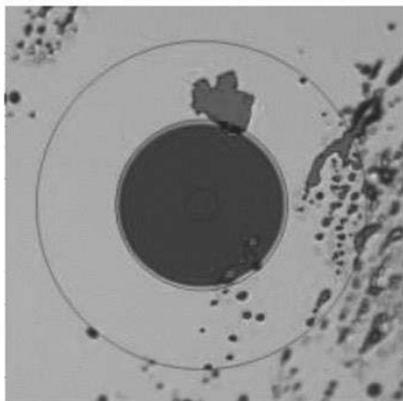
Skin Oil and Dead Skin Flakes
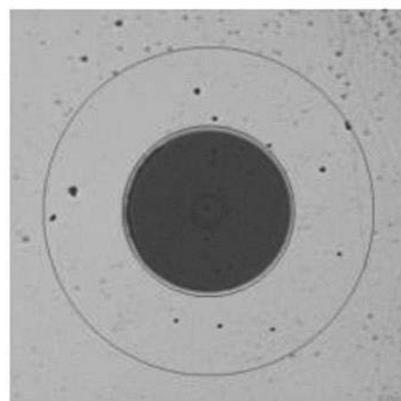
Alcohol Residue

Figure 17-4 typical contamination on the optical fibers

Contamination on the optical fibers can cause the following problems:

- the signal path can be disrupted in the core region
- good physical contact can be prevented in the plug connector
- cause scratches and associated damage

The following figure shows a typical example of a poor physical contact in a plug connector. Here, a dust particle prevents the two optical fibers from creating a flush contact with one another.
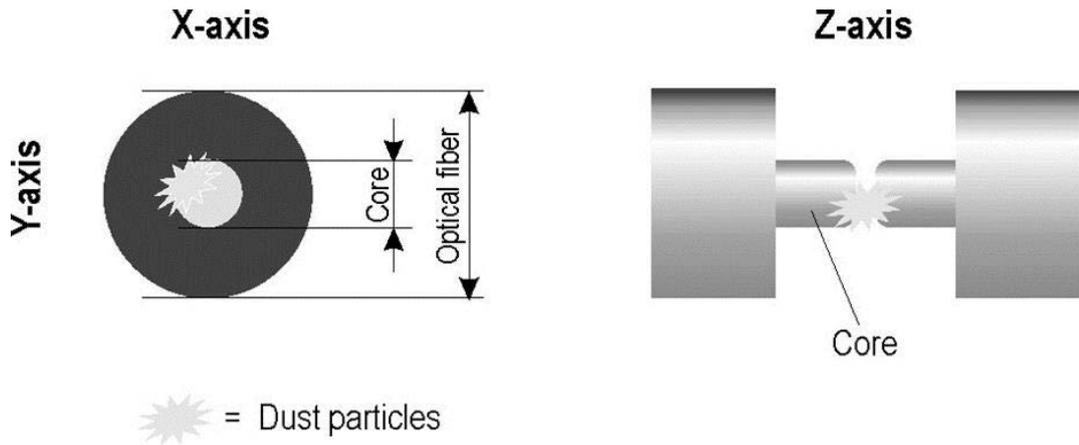
Figure 17-5 Poor physical contact because of dust particles

The microscope image in the measuring receiver shows a large magnification of the optical fiber (Figure 17-6). That figure is taken with Lightel DI-1000 USB microscope with an optical magnification of 200. The core of the optical fiber is visible in the center.
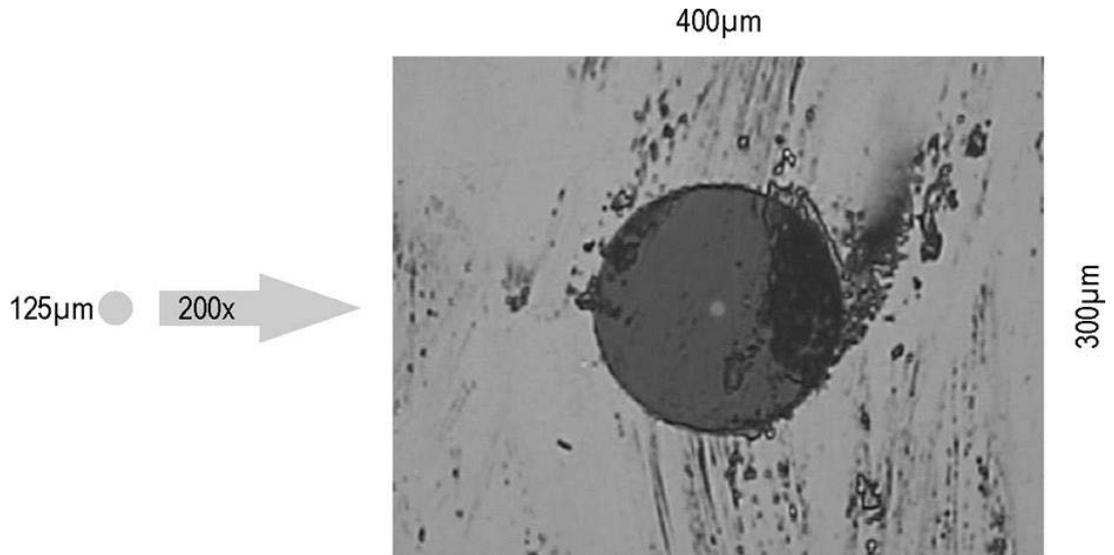
Figure 17-6 Microscope zooming

Typical requirements for single-mode fibers:

Zone name (diameter)	Scratches	Damage
A: Core (0-9 µm, 0-25 µm)	Non permitted	Non permitted
B: Cladding (25-120 µm)	No limits	all < 2 µm 5 in 2 – 5 µm range None > 5 µm
C: Adhesive (120-130 µm)	No limits	No limits
D: Contact (>130 µm)	No limits	No limits

The shows the schematic structure of a typical single-mode fiber with a 9µm core.
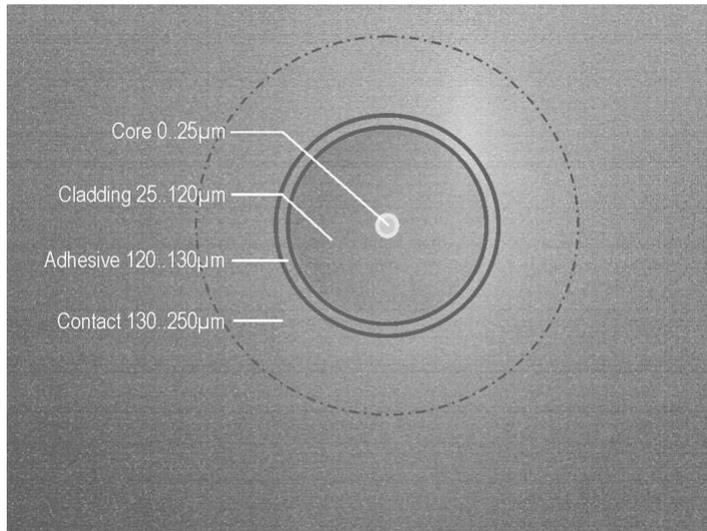
Figure 17-7 Schematic structure of a typical single-mode fiber

17.7.1   Operation

The microscope range is called up by pressing the **RANGE** -> **Microscope** key. The following image settings can be made with the F buttons:

Brightness	BRIGHT +	BRIGHT -
Contrast	CONTRAST +	CONTRAST -
Saturation	SATURAT +	SATURAT -
Sharpness	SHARP +	SHARP -
Gamma	GAMMA +5	GAMMA -5
White Balance	WHITE+100	WHITE-100
Gain	GAIN +	GAIN -

The microscope's default settings can be loaded by pressing the DEFAULT button located near the F buttons. As the manufacturer's settings are not always ideal, you can permanently save the currently set values in the measuring instrument by selecting the **SAVE** button. You can load these values again any time by selecting the **RECALL** button.

The USB microscope info field can be displayed/hidden at the top of the screen by selecting the **OSD-VID** button.

You can directly return to the TV range by pressing the **HOME** button; you can also switch to a different range by selecting **RANGE** and leave the USB microscope range.

17.7.2   Logging

For documentation purposes, it is possible to make a screenshot of the current microscope image. As the measuring instrument is only equipped with a single USB interface, 4 images can be saved in the internal buffer of the measuring instrument.

Once all 4 storage locations are occupied, you will have to save these images on a USB stick to free up these locations up again.

Saving an image as a screenshot in the cache:
- Press **PRINT**. The image will be saved if space is free in the buffer. This can take several seconds; a corresponding message will appear on the screen "**Screenshot saving…**".
- The screen message changes to "**Screenshot saved**" as soon as the image is saved.
- The message "**No buffer free**" appears if no more space is free in the buffer. All storage locations must first be saved to a USB stick. See the following point.

Saving buffer images to a USB stick:
- Switch to the TV range by pressing the **HOME** or **RANGE** button.
- Unplug the USB microscope and connect a USB memory stick
- Press **MODE**
- Select **Export Screenshots** -> **USB**
- Depending on the number of occupied storage locations, corresponding files are generated with the file name MICROSCOPE_xx.BMP, (xx represents a consecutive number). Files already saved on the USB memory stick are not overwritten.

The message "**Screenshots transferred, memory locations cleared**" appears on the screen once the data has been successfully transferred to the USB memory stick.

Chapter 18 **Management of the instrument**

These functions can only be accessed when the instrument is not tuned.

18.1   Keypad

The key tone and the key illumination can be switched on and off via the **MODE** -> **Settings** -> **Keypad** menu.

18.2   Language of the user guidance

The user guidance (menu interface) can be displayed in German or English. Use **MODE** -> **Settings** -> **Language** -> **German**, **English** to select the desired language.

18.3   Software

You can query the software version, or load new firmware on to the instrument by selecting **MODE** -> **Settings** -> **Software**.

18.3.1   Info

The user can query the software version (firmware) by pressing **MODE** -> **Settings** -> **Software** -> **Info**.

18.3.2   Update

You can upload a new firmware release onto the device at any time.
The software is provided as a ".bin" file. Request this file from the manufacturer and copy it from a computer onto the included USB stick.

Important: **It is highly recommended to plug the instrument to mains before updating the firmware. Do not switch off the instrument while update is in progress.**

Next insert the USB stick into the instrument and select **MODE** -> **Settings** -> **Software** -> **Update**. A selection appears containing all saved ".bin" files. Select the desired file using the arrow keys (**Up/Down**) and press **ENTER** to start the software update. The instrument deletes the old version from the memory before writing the new software to the internal flash drive. Previously settings will not be overwritten (e.g. Profiles, language …)
This takes approximately 1 minute.

Note: **You can find the latest information about software on our homepage.**

18.3.3   OTA-Update (over the air update)

Over the air updates are updates by WiFi. The measurement receiver will connect to a server and download the update files from it. This requires appropriate hardware to be built in, an activation in the software and an established connection to an access-point which is connected to the internet. The connection can be established as described in chapter 25.2.1

Note: This function is supported as of ESP V1.4

By pressing **MODE** -> **Settings** -> **Software** -> **Check for updates** the measurement receiver connects to a server and looks for updated firmware. If updates are found a menu appears as shown below.
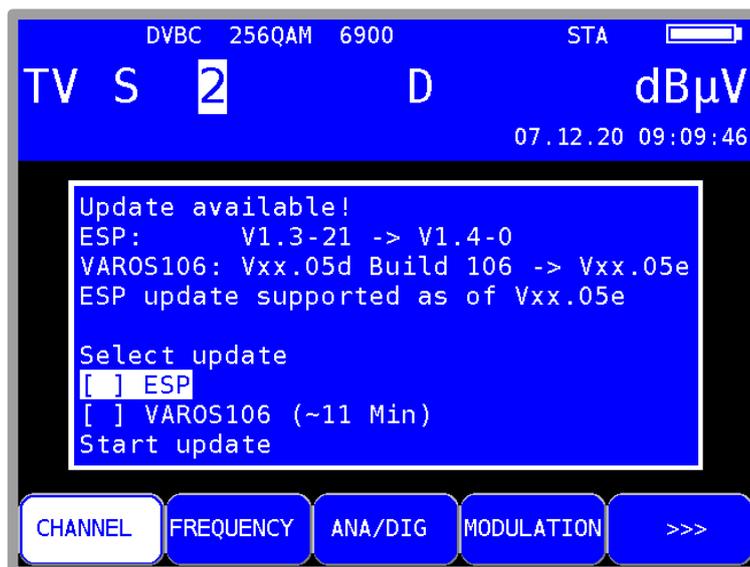
Figure 18-1 OTA menu with available updates

Here, you select the components whose software you want to update. By selecting **Start update** the updating process is started.

18.4   Clock

The instrument has a real time clock that is powered by the internal battery.
Set the date and time using the **Clock** menu. To do this, select the corresponding menu item and open it with **ENTER**. You can now set the time and date. Press **ENTER** to accept the value and return to the previous menu.

Figure 18-2 Clock adjustment

Another way to set the clock is to use the DVB time. The measuring receiver must first receive a digital channel. Press **MODE** and if there were time information received, the item **Setup clock to DVB time** is available. Select this item and use **ENTER** to set the clock.

18.5   Serial number

The serial number can be found on the name plate on the back of the instrument. It can also be requested on the device using **MODE** -> **Settings** -> **Serial number**.

18.6   MAC address

A MAC address (Media Access Control Address) is the physical address that each individual network adapter has for unique identification of the device in a computer network. Every instrument is given a MAC address that is unique worldwide. This can be viewed using **MODE** -> **Settings** -> **MACADR**.

18.7   Factory settings

Use the "PRESET" function **MODE** -> **Settings** -> **Factory settings** to reset all instrument settings to the factory default settings. The content of the tuning memory is not included; PRESET does not make any changes to it.

Figure 18-3 Factory settings

18.8   User-defined TV channel table

In addition to the preset channel tables that the instrument uses in combination with the used TV-standard, a user-defined channel table can be loaded onto the instrument. Users can use the AMA.remote PC software to create their own tables and export them as files.
The channel table currently used in the instrument can be exported so as not to have to create a channel table from scratch.
To do this, use the menu items **MODE** -> **Settings** -> **User Channellist** -> **Export activ Channellist**. The instrument creates a ".CHA" file with a file name that is derived from the name of the currently active channel table, for example "STANDARD_BG.CHA". This file can be used as a template in AMA.remote PC software.
If you wish to import a channel table using a ".CHA" file, the following steps are necessary.
Select **MODE** -> **Settings** -> **User Channellist** -> **Import User Channellist** to see a selection of ".CHA" files saved on the USB stick. Use the cursor to select the desired file and confirm by pressing the **ENTER** key. The measuring receiver loads the channel table from the file into a non-volatile memory. If the file is corrupt, the process is cancelled and a corresponding message will be displayed.

Press **MODE** -> **Settings** -> **User Channel list** -> **User Channellist Info**, and the instrument will display the file from which the most recently loaded channel table originates.

The loaded channel table is switched on/off by pressing **MODE** -> **Settings** -> **User Channellist** -> **activate**. This option is not available if a channel table has not been loaded.
If the user-defined table is enabled, the suffix (USER) is shown below in the menu bar in the menu item $\boxed{\text{CHANNEL}}$. The table is now used for all functions based on a channel table. This setting is non-volatile. This means that the loaded table is used even after the instrument is switched on/off. Furthermore, the channel table is taken into account in the tuning memory. Entries from the standard and the user-defined channel table can be saved.

Caution!   At Changes in the User Channellist, eventually you must adjust corresponding entries in the tuning memory.

This function is disabled in default setting and the instrument uses the fixed pre-defined TV standard.
AMA.remote PC software can be downloaded from the www.kws-electronic.de homepage, finding in section "PRODUCTS" – "AMA.remote" as well as a user manual.

18.8.1   D-Channels

Beside the S- and C-Channels the user-defined channel table can also provide a special numbering, consisting of the character "D" and the frequency in MHz (e.g. D114 instead of S2; D650 instead of C43 etc.). Because of omitting analog TV Channels in some cable systems a new frequency grid and a new standard to name the channels is used. The D-Channels could be part of a user-defined channel table and can be used in the same way as others.

18.9   Dynamic program switching

See chapter 13.7 - Dynamic program switching.

18.10   Hardcopy

For documentation purposes, the screen contents can be saved on a USB stick or on one of two internal memory locations. Videos and drop-down menus for settings, etc. cannot be copied. By selecting **PRINT**, you can access a menu where you can choose between "**Screenshot** -> **USB**", "**Screenshot** -> „int. Memory Location" and "**USB Directory**". Any existing files with the "BMP" file extension can be deleted in the "**USB Directory**" menu. In the **Screenshot** -> **USB**" menu, you can enter a name for the new file and create it with **ENTER**. Additionally an area with the filename, the time and date of creation are copied to the screenshot.
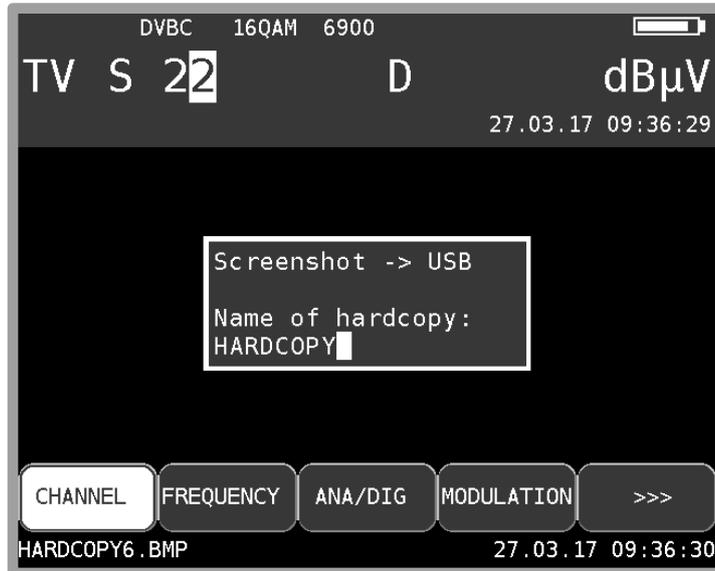
Figure 18-4 Hardcopy

Saving buffer images to a USB stick:

- Switch to the TV range by pressing the **HOME** or **RANGE** button.
- Connect the USB memory stick
- Press **MODE**
- Select **Export Screenshots** -> **USB**
- Depending on the number of occupied storage locations, corresponding files are generated with the file name MICROSCOPE_xx.BMP (for microscope images) or HARDCOPY_xx.BMP (for all other screen copies), (xx represents a consecutive number). Files already saved on the USB memory stick are not overwritten.
- The message "Screenshots transferred, memory locations cleared" appears on the screen once the data has been successfully transferred to the USB memory stick.

View screenshots from USB stick:

- Only screenshots made by the measuring receiver itself excluding the microscope images can be shown.
- Bring device to default status by pressing **HOME**.
- Connect the USB memory stick
- Press **MODE**
- Select "**View Screenshots <- USB**"
- All files ending with ".BMP" are shown.
- Select one and the image is shown filling the whole display.
- Press any button to go back normal view.

18.11   Configuration of PING test in the DOCSIS analyzer

You can configure a Ping test by selecting **MODE** -> **Settings** -> **DOCSIS analyzer** -> **Ping Test**. 64 byte long PING packets are sent as standard during the test. The number of packets to be sent and the time interval between two PINGS can be configured in this submenu.

You can set the number of packets to be sent by selecting **MODE** -> **Settings** -> **DOCSIS analyzer** -> **Ping Test** -> **Packets**. The number of packets is set after opening the submenu. You can use the numerical keypad to change this number. The permissible value range is 5 to 100 packets. If a value below 5 or above 100 is entered, the display will switch to the last correctly entered value. After entering a valid value and pressing **ENTER** twice, the setting is applied for all future PING tests until a new value is entered. The entry is non-volatile and is saved even when the instrument is switched off.

Select **MODE** -> **Settings** -> **DOCSIS analyzer** -> **Ping Test** -> **Interval** to set the interval between two PINGs. You can choose between 0.5, 1, 2 and 5 seconds. Exit the submenu by pressing **ENTER**. The entry is non-volatile and is saved even when the instrument is switched off.

18.12   Deactivating the DOCSIS analyzer

The DOCSIS analyzer can be deactivated manually. This can be useful in many cases.

If no return-path-capable components are integrated in a system, but the DOCSIS downstream channel is still to be measured, this will prevent the measuring instrument on the upstream from trying to send. As this occurs in such a case with a high transmitting power, the downstream measurements can be interrupted in some circumstances.
With automatic measurements (DataLogger), the upstream transmitting power is also taken into consideration with the active DOCSIS analyzer. However, to do this, the ranging process must be completed. This usually takes a few seconds. If only the downstream parameters are to be recorded with DOCSIS, it is better to deactivate the DOCSIS analyzer.

MODE -> **Settings** -> **DOCSIS analyzer** -> **Upstream** can be used to activate and deactivate the DOCSIS analyzer. The menu item for the currently active setting (on or off) is displayed in an inverted manner.
This setting is non-volatile. It is also incorporated in the tuning memory. For this reason, memory locations can be created with an active or inactive DOCSIS analyzer. Memory entries, for which the DOCSIS analyzer is active are marked with **+US**.
In the default setting, the DOCSIS analyzer is active.

18.13   Configuration of speed test in the DOCSIS analyzer

The speed test (data throughput measurement) works in uplink and downlink directions. The test is based on transmission of data from or to an FTP server that is connected to the head end. Several parameters must be stored in the measuring instrument for this test.

You can use **MODE** -> **Settings** -> **DOCSIS Analyzer** -> **Speed Test** to configure the test.
This section offers four profiles which also allow you to store the data for multiple HFC clusters or head ends.
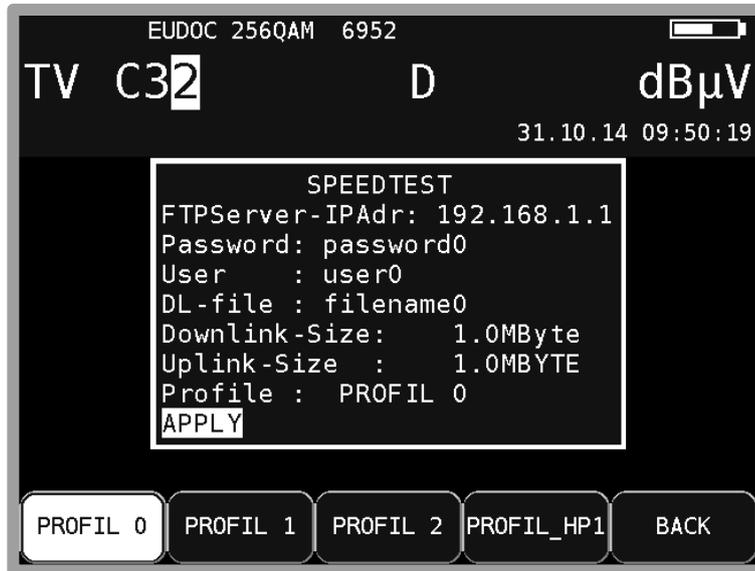
Figure 18-5 DOCSIS speed test settings

You can use keys **F1** to **F4** to select a profile. You can edit the selected profile using the steps described below. At the same time, the parameters of the most recently selected profile are automatically selected for future speed tests of the DOCSIS analyzer.

You can use the ↑/↓keys to select the desired profile entry field and open the input mask to change individual parameters by pressing **ENTER**. You can use the measuring instrument's numerical keypad to enter not only numbers, but also letters and special characters. The individual keys include both their numerical value, and a label of the letters they can be used to enter. By pressing a key multiple times, you can switch between the individual letters, uppercase and lowercase, and the numerical value. You can enter a space with the **0** key, and the **1** key can be used for various special characters.

Enter the IP address in the usual format: the username and password of the FTP server and the name (and path, where applicable) of the download file and the profile name are alphanumeric character strings.
16 characters are available for the password, 18 for the username and 30 for the file name or file path. The value range for the downlink file size is 0.1 to 2,048 MByte. The uplink file size is 0.1 to 500 MByte. Even though, for example, a profile is only configured for a downstream test, a valid figure must be entered for the upstream file size. When you are done entering a value, use the **ENTER** key to skip straight to the next value. The parameters are only saved when you select **APPLY**, you then exit the menu. Using the **APPLY** key, you can permanently store all the parameters in the measuring instrument's memory. The name entered for the profile – which can be no more than 10 characters long – is displayed above the corresponding F key after you reopen the speed test configurator.

18.14   DOCSIS3.1 Setup the maximum Upstreamfrequency

The measurement receiver can use two different frequency ranges for DOCSIS3.1 mode. The first one is 5 to 85 MHz for upstream and 111 to 1218 MHz for downstream. The seconde one is 5 to 204 MHz for upstream and 258 to 1218 MHz for downstream. That is solved by an adjustable filter (diplexer). That diplexer is used for the upstream generator as well as for the DOCSIS-3.1-Analyzer.

To adjust that filter, goto **MODE -> Settings -> DOCSIS analyzer -> max upstream frequency** and select the desired maximum upstream frequency of 85 MHz or 204 MHz. The current used frequency is shown inverted.

18.15   DOCSIS3.1 Readout Modemsettings

The measurement receiver has a integrated DOCSIS-3.1 modem with it's own firmware. For future usage it could be possible to read out different informations. With **MODE -> Settings -> DOCSIS analyzer -> read modem infos** you can call the info screen. It needs some time (45 seconds) until all information are available. With **ENTER** or **HOME** you can leave that menu.
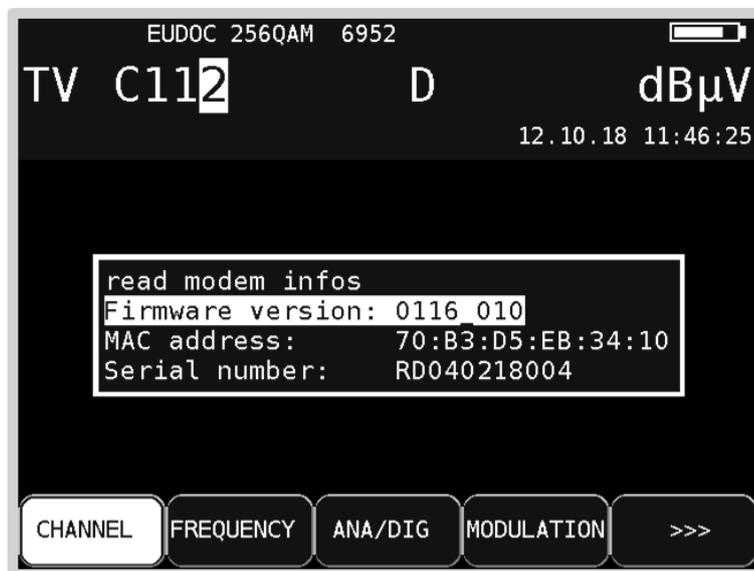
Figure 18-6 DOCSIS3.1 Modeminformations

18.16   DOCSIS Analyzer power-off timer

A DOCSIS-Analyzer is integrated into the measurement device. It is used when measuring DOCSIS-channels (upstream enabled), using Upstream Generator and Upstream Monitoring System UMS. To prevent the Analyzer to boot up every time it is needed, auto-switching off can be delayed. By selecting **MODE** -> **Settings** -> **DOCSIS Analyzer** -> **Power-saving options** you can open a menu where the delay can be configured. See table below:

0	Analyzer off immediately
1…59	Analyzer off after 1…59 minutes not being used
60	Analyzer always on

Whenever the setting is changed, it takes effect on the analyzer immediately. If the power-off timer is running the time is reset. Factory preset is 1 minute.

18.17   Unlock software options

Software options can be unlocked by entering an 8-digit key code. You can request the individual key code for each option from the manufacturer. **MODE** -> **Settings** -> **SoftwareKeys** appears a submenu, which the options available currently (e.g.: UMS).

To unlock this option, confirm the menu item with **ENTER**. An entry field for the 8-digit key code is then displayed.
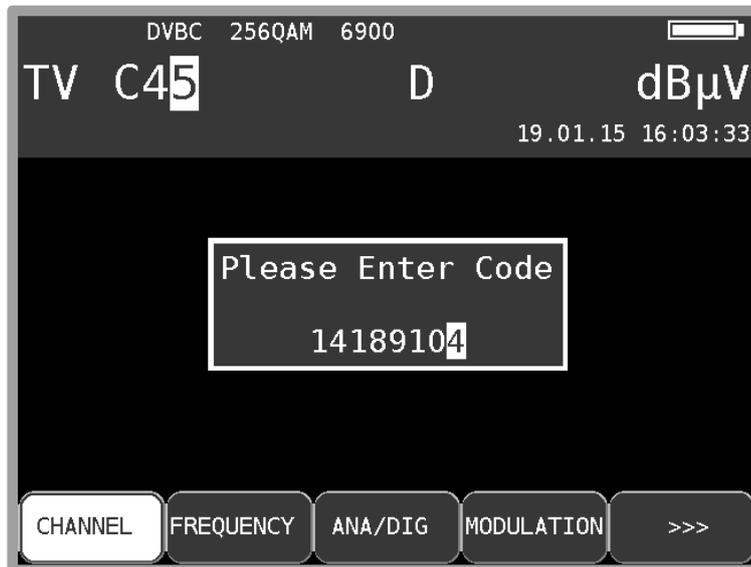
Figure 18-7 Activating software options

If the code is entered correctly, the following message appears: **Option activated!**
Now the corresponding option is enabled for use.

18.18   DVB-T2 echo compensation

Here the echo compensation can be switched on or off. For more information see chapter 7.2.2.5.7 (MER measurement DVB-T2).

18.19   Control of the WIFI interface

The measurement device has an integrated WIFI interface, which can be reached via http-REST. It has the possibility to establish a connection to an already running network (Station-Mode) or to open a WIFI-Access-Point (Access-Point-Mode), where further WIFI-capable client devices (Laptop, Tablet, Smartphone) can connect to. After the successful establishment of a connection between the measurement device and the client device, it is possible to work with specified measurement sequences and other functions. A more detailed specification and the functionality of the interface are given in a separate document.
The handling of the new functionality of the integrated WIFI interface are described in Chapter 25 more in detail.

Chapter 19   Measurement Data Memory (DataLogger)

The instrument is equipped with a measurement data memory (DataLogger). This allows you to save measured values automatically on a USB stick as an XML file. The data can then be read and processed using a spreadsheet program such as MSExcel™ or OpenOfficeCalc.

19.1   Automatically storage of series of measurements

You can open the "DataLogger" menu item via **MODE** -> **DataLogger**. The menu appears with the selection "New Measurement" or "Directory". Measurements can be added by selecting the menu item "New Measurement". You are then prompted to enter a name for the system (measuring location). This can then be set alphanumerically by using the arrow keys or the number keys. Press **ENTER** to complete entry. The entered name is identical to the file name of the XML file, which contains the measured values at the end. If a file with the same name already exists, you will receive a warning. A different name can be entered by pressing **HOME**, or by pressing **ENTER** to overwrite the existing file. After this, enter the individual measurement parameters. The instrument now refers to the tuning memory, whereby only the first and last memory locations must be entered for the measurements. Any blank storage positions are skipped. After this, the instrument automatically accesses the tuning memory locations individually and saves the measured values in the XML file mentioned above. The measurement's progress can be tracked following the corresponding message in the frequency window.

If the signal does not lock due to poor signal quality or an incorrect parameter, and if, as a result, not all measured values can be recorded, "Signal unlocked" appears. The measurements can be continued by pressing **ENTER** and can be interrupted by pressing **HOME**. At the end of the set of measurements, a status message is displayed in a window. This message shows how many of the measurements were successful. If all of the measurements were successful then the window is blue; otherwise it is red. The display is shown until it is confirmed by pressing **ENTER**.
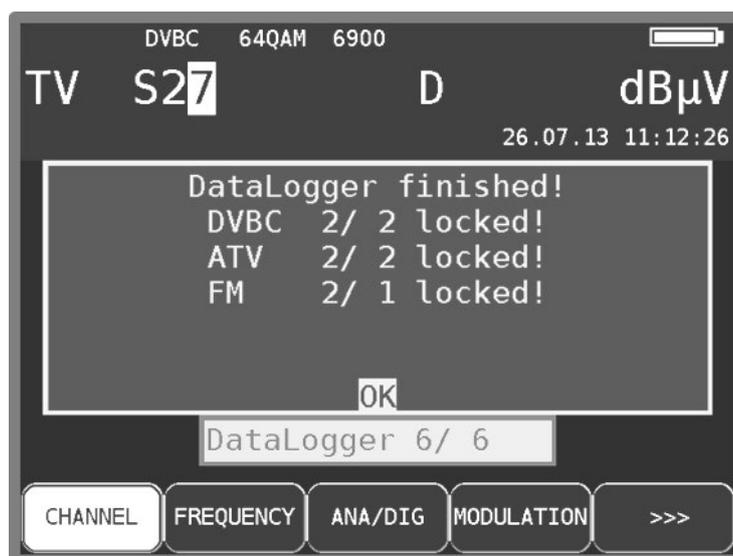
Figure 19-1 DataLogger finished screen

19.2   Transferring and evaluating a series of measurements on the PC

To evaluate, document or process the measurements, the data must first be transferred to a PC or laptop using a USB stick. As already mentioned, the measurement data saved in an XML file on the USB stick, which can be readed and processed using MSExcel™ or OpenOfficeCalc. Right-click the desired file, then select "**Open with**" -> **MSExcel** or **OpenOfficeCalc**.

Important!   Transfer only possible with MSExcel-version 2002 and upwards.

The illustration below shows a set of measurements in MSExcel™:

	A	B	C	D	E	F	G	H	I	J	K	L	M
1		Bereich	Kanal	Frequenz/MHz	Uout	Modus	Modulation	Symbolrate	Pegel/dBµV	TT1/dB	TT2/dB	MER/dB	CBER
2	1	FM		107,60					59,8				
3	2	TV	S02	113,00		DVB-C	QAM256	6900	56,9			39,2	1,80E-8
4	3	TV	S03	121,00		DVB-C	QAM256	6900	57,5			>40,0	<1,00E-8
5	4	TV	S04	130,00		DVB-C	QAM256	6900	58,8			>40,0	<1,00E-8
6	5	TV	S06	140,25		ATV			61,9	-13,7	-20,4		
7	6	TV	S10	168,25		ATV			62,7	-12,6	-19,9		
8	7	TV	C05	175,25		ATV			62,2	-11,7	-18,9		
9	8	TV	C12	224,25		ATV			59,9	-13,4	-20,7		
10	9	TV	S11	231,25		ATV			59,0	-11,0	-18,3		
11	10	TV	S22	314,00		DVB-C	QAM 64	6900	56,2				
12	11	TV	S23	319,25		ATV			62,2	-13,6	-20,7		
13	12	TV	S25	335,25		ATV			61,3	-12,8	-20,0		
14	13	TV	S26	346,00		DVB-C	QAM256	6900	55,4			>40,0	<1,00E-8
15	14	TV	S26	346,00		DVB-C	QAM256	6900	55,3			>40,0	<1,00E-8
16	15	TV	S27	354,00		DVB-C	QAM 64	6900	50,2			37,1	<1,00E-8
17													

Figure 19-2 Evaluating DataLogger results in Excel

19.3   Deleting a series of measurements from the instrument

If a USB stick has been inserted into the instrument, choose **MODE** -> **DataLogger** -> **Directory to access** a list of files already saved on the stick. The free memory capacity of the USB stick can also be read in percent. For example the file shown above needs 18 kByte on the USB stick. With a capacity of 512 MByte, approx. 29,000 of these series of measurements can be saved.
A file can be deleted by moving the cursor with the ↑/↓ arrow keys onto the file you wish to delete and selecting **ENTER**. The instrument first issues a warning message. This allows series of measurements that are no longer needed to be removed, which gives a clearer overview for later evaluations.

Chapter 20 **Measurement Data Recording (DataGrabber)**

The DataGrabber allows the measuring receiver to record measurement data over a specified period of time and display the results graphically. The shortest period of time that you can enter is one minute. The longest period is 23 hours and 59 minutes.

The memory depth is 500. This means that 500 values are recorded in equivalent time periods for each measurement parameter. The time interval between two samples thus depends on the recording period that has been specified. In each case the worst value of a sample period will be recorded, this is especially important for long-term recordings.

The table below provides an overview of the recording options that are available. This applies to a fully equipped instrument.

Range	Operating mode	Recorded parameters
TV		
	ATV	Level, S/N (option S/N only)
	DVB-C	Level, MER, BER, PE (Packet Errors)
	EUDOCSIS	Level, MER, BER, PE (Packet Errors) DF (Duty-Factor, Downstream capacity utilization)
	USDOCSIS	Level, MER, VBER, PE (Packet Errors) DF (Duty-Factor, Downstream capacity utilization)
	DVB-T	Level, MER, CBER, PE (Packet Errors)
	DVB-T2	Level, MER, CBER, PE (Packet Errors)
	DTMB	Level, MER, CBER, PE (Packet Errors)
FM		Level
RC		Level

If the optical input is activated, the optical power trend is recorded instead of the level.

Note on recording the duty factor:

Before recording starts, the menu item DUTYFACTOR can be used to select recording with or without duty factor. If this item is active, the diagram with the bit error rate is omitted.

For all measurement parameters apart from packet error (PE), the value saved is the one that is active during recording at the time of sampling.

The situation is slightly different when packet errors are captured. During normal measuring operations, packet errors are continuously added up (accumulated). When the DataGrabber function is used, packet error counter changes from one sampling time point to the next are recorded. This makes it possible to subsequently determine how many packet errors occurred and at what times. The absolute number of packet errors is shown in the upper display area while the measurement data is recorded and is incorporated in the graphics screen once the measurements are finished.

Note!   **Packet errors can also occur when the measuring receiver's automatic attenuation control changes the input attenuation. In order to achieve optimal performance at all times, attenuation control must also operate during measurement data recording. Packet errors that occurred due to a change in the input attenuation are displayed in magenta by the measuring receiver while "normal" errors are shown in yellow.**

If no measured values are available for particular measurement parameters at the time of sampling, a vertical red bar appears in the respective diagram.

This can happen if the receiver goes to "unlocked", for example. If the status of the receiver subsequently changes back to "locked", the measurement parameters are recorded again and the packet error counter is set to zero. However, this does not affect the previously recorded packet errors in the diagram. They remain unchanged.

20.1   Starting the recording

The measuring instrument must be in the tuned mode (measuring mode) when the DataGrabber function is started.

The following submenu opens when the DATAGRABB. menu item is called up:
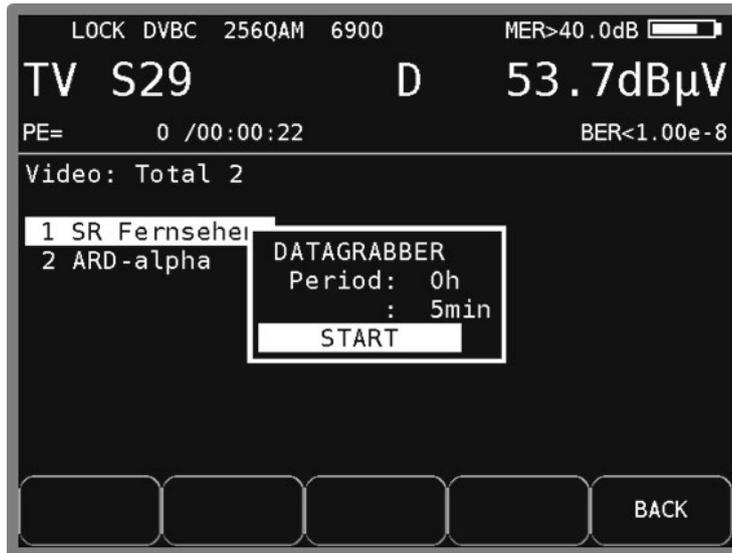
Figure 20-1 DataGrabber configuration of measurement time

This is where you specify the recording time period.

You can use the **Up**/**Down** keys to select the desired entry field and open the input mask by pressing **ENTER**. You can set the recording period to a value between 00h 01min and 23h 59min by using the numeric keypad or the arrow keys. This means that recording can take place over a whole day. The factory setting is 01h 00min. Once you have finished entering the hours and/or minutes by pressing **ENTER**, the cursor moves to the next field. When you select the **START** field and press the **ENTER** key, the measuring instrument begins recording the measurement data. The instrument first captures the active measured values and uses these to calculate the scaling for the individual diagrams. Individual diagrams then appear on the graphics screen for each measurement parameter. Data is now continuously added to these diagrams. Here is an example of what the LCD might display while the DataGrabber is running.
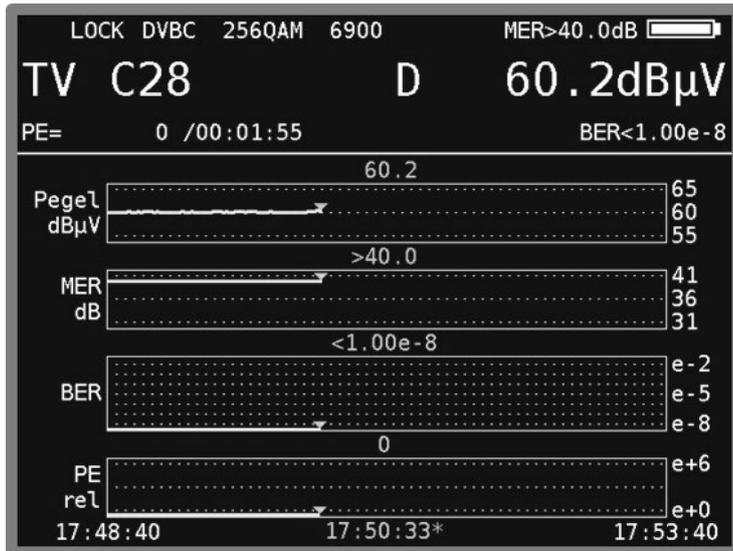
Figure 20-2 DataGrabber recording

The absolute number of packet errors is also displayed in this operating mode.

You can use the ABORT menu item to stop the recording before the specified time period has elapsed. This only stops the recording. Data that was recorded up until this point remains saved on the graphics screen.

If the instrument reaches the end of the recording process normally, i.e., without being interrupted, a beep sounds and the screen like in the next message.
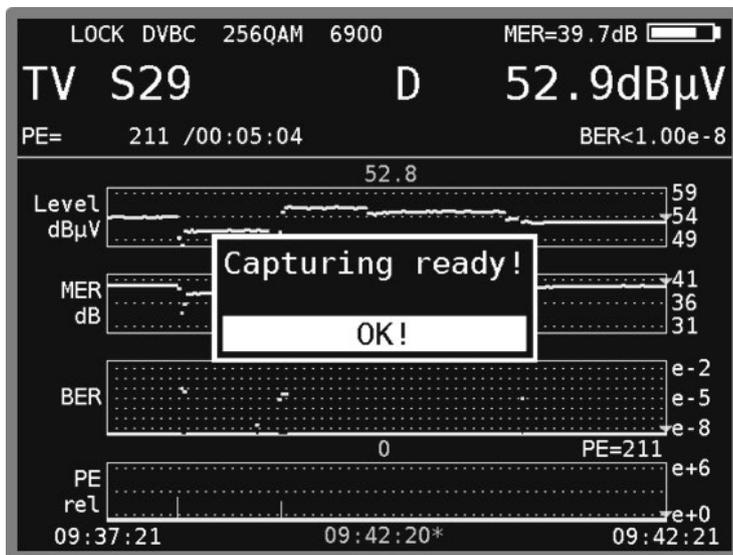
Figure 20-3 Datagrabber recording finished

The RESTART menu item allows you to initiate a new recording process using the same settings.

20.2   Evaluating of the recording

Once the DataGrabber has finished (automatically or stopped manually), you can use the cursor function to determine the time at which a possible error occurred in the system. To do this, you use the ←/→ keys to move the cursor (represented by a triangle) to the required position.
The next figure shows sample measurement data that was recorded for a DVB-C channel.
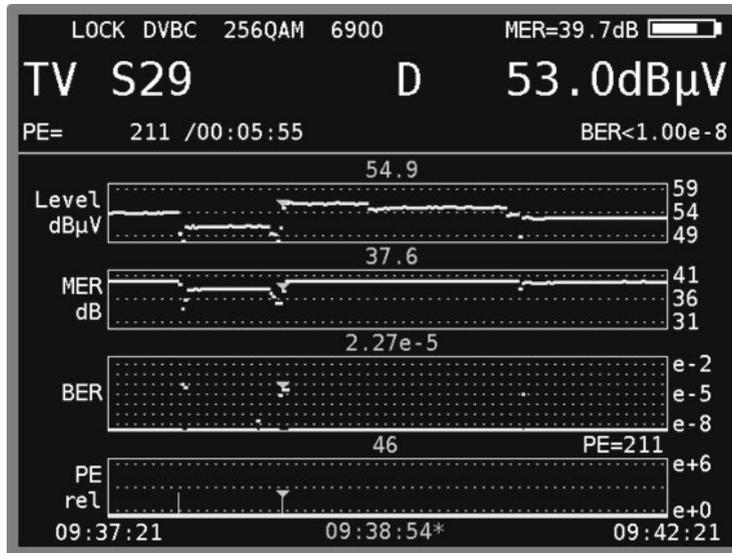
Figure 20-4 DataGrabber recording packed errors

The level, MER, BER and packet errors (relative) are recorded for the DVB-C mode.
The start time and time at which recording ended (normally) appear in the lower left and lower right of the display respectively. The cursor time is marked with a '*'. The measured value at the cursor position is displayed above each diagram. In the above example, 46 packet errors occurred at 09:38:54. PE=211 means that an absolute number of 211 packet errors occurred in the period from 09:37:21 to 09:42:21.

20.3   Documenting a recording

The graphics screen can be saved as a bitmap file for documentation purposes. Refer to chapter 18.10 – Hardcopy for further information.

Chapter 21 **Upstream monitoring system UMS**

21.1   Introduction

The Upstream Monitoring System (UMS) is a measuring system consisting of a device in the headend and one or several handheld devices (also called field devices). The UMS permits to measure the return path in a DOCSIS network. Two different devices are supported as headend:

• The first is the **UMS** for the AMA310 Headend UMS device which permits the following measurements: wobbling (frequency response measurement), TILT measurement (tilted position measurement), BER measurement, MER measurement, constellation diagram, real-time spectrum. The measurements can be performed with the DOCSIS modems in operation.
• The second is the **X16** for the Kronback X16/KWS device which supports the measurements wobbling, TILT and real-time spectrum, also when the DOCSIS modems are in operation.

The data transmission from the headend to the handheld devices is done via transport stream and DVB-C modulation. If the headend disposes of a transport stream multiplexer, the UMS data stream may be added to an existing DVB-C-channel.

Further information may be taken from the Application Note "AN006 - Upstream-Monitoring-System UMS" on www.kws-electronic.de under "SUPPORT" -> "Application Notes".

21.2   Unlock of the software option

If the handheld has been retrofitted with the software option UMS and has not yet been unlocked in the factory, the device can be unlocked with the 8-digit code provided as an option.
First change to the TV range: **RANGE** -> **TV**
Then open the item SoftwareKeys in the mode menu: **MODE** -> **Settings** -> **SoftwareKeys**.
Select the UMS option (Upstream Monitoring System) and enter the 8-digit code. After successful activation a note in green "Option activated!" confirms the activation. Now the Upstream Monitoring Systems are available as new range **RC-MEASSYS** . See also chapter 17.14 - Activating software options.

21.3   Settings on the field device

Before using it with the headend, the DVB-C channel used for data transmission and the relevant service ID of the data channel have to be set in the field device: The UMS mode is selected via **RANGE** -> **RC-MEASSYS** -> **UMS** / **X16**. Now the settings can be made via the mode menu.

21.3.1   DVB-C channel

This presetting can be made directly as channel frequency or also as channel number.
MODE -> **Channel frequency**: change to the relevant position with the ←/→ keys and the ↑/↓ keys or enter the desired figure directly. Confirm it by pressing **ENTER.**

Alternatively: **MODE** -> Channel number : change to the relevant position with the arrow keys ←/→ and ↑/↓ or enter the desired channel number directly. The channel type can be chosen between C and S with the arrow keys ↑/↓. Confirm by pressing **ENTER.**
The mode menu can be left by pressing the **MODE** key again.

Note: **The settings will only be used after UMS is called up again.**

21.3.2   Service ID

This presetting is the service ID, also called program number, of the DVB-C program in which the data will be sent from the headend to the field devices. The measuring instrument scans the DVB-C channel set for this number. It can also be called up in the mode menu via **MODE** -> Service ID .

Note: **The settings will only be used after UMS is called up again.**

21.4   Measurement options

The following sections give just a rough description of the operation and the call-up of measurement options of the two Upstream Measurement Systems UMS and X16 . Depending on the measurement system not all measurement options are available. The exact description of the individual measurement ranges can be taken from the Application-Note "AN006 - Upstream-Monitoring-System UMS" on www.kws-electronic.de under "SUPPORT" -> "Application Notes".

21.4.1   Real-time spectrum

Selection with the function key SPECTRUM . Now the real-time spectrum of the cluster received is shown on the headend over the total return channel range. The spectrum measurement can be left again with the function key BACK   (if the function keys are not shown, any function key can be pressed). If supported by the headend, also a Max-Hold mode can be activated via the function keys in the spectrum view.
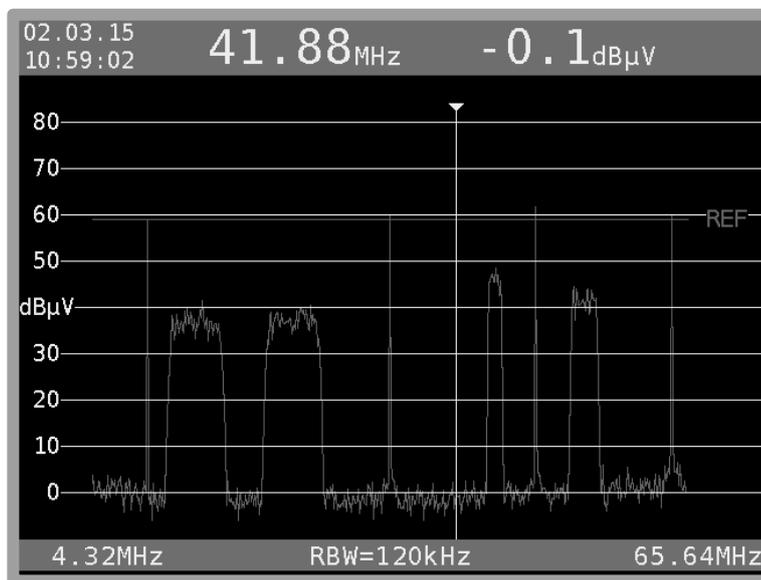
Figure 21-1 UMS real-time spectrum

21.4.2   Wobbling (Frequency Response Measurement)

This measurement determines the frequency response in the return channel range. The handheld transmits a constant level over the total frequency range, the frequency response received at the headend is shown in graphic form in the display.

Selection with the function key WOBBEL of the UMS main menu. The wobbling measurement can be left again by pressing the function key BACK (if the function keys are not shown, press any key).
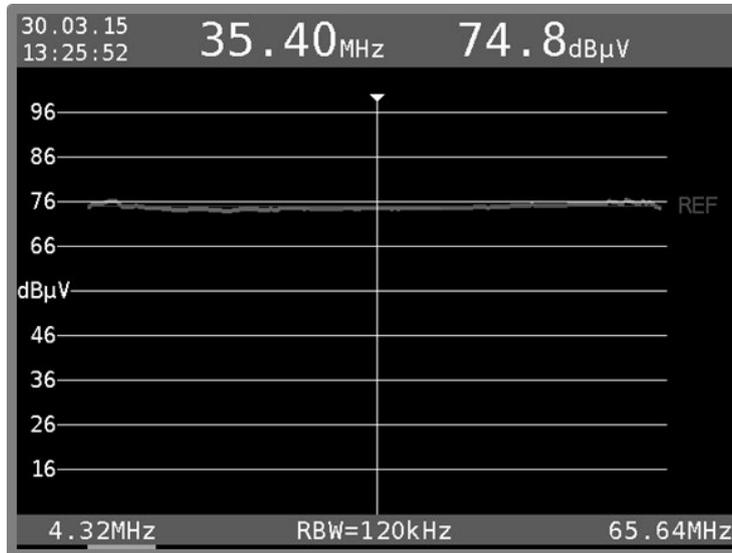
Figure 21-2 UMS frequency response measurement

21.4.3   MER/BER measurements, constellation diagram

These measurements permit a qualitative assessment of the channel quality. The measuring instrument sends a PRBS modulated signal in a predefined (by the headend) frequency range which will be measured in the headend as to Modulation Error Rate (MER) and Bit Error Rate (BER). The measurement results will be shown in real time on the display.

Selection with the function key MER/BER from the UMS main menu. The MER/BER measurement can be left again by pressing the function key BACK. You can choose between four measurements (in set frequency ranges) which are marked as MEASURE1, MEASURE2, MEASURE3 and MEASURE4 .This corresponds to the stored measurement parameters in the headend. Ongoing measurements can be stopped again by the function key BACK. If a measurement is active, the constellation diagram obtained can also be shown by pressing the function key CONST. This diagram can be closed again by pressing the function key CONST again.

21.4.4   TILT measurement / Line-up

The TILT measurement serves for an easy line-up of amplifiers (in the line as well as house installation amplifiers). Selection by the function key LINE-UP of the UMS main menu. The TILT measurement can be left again by pressing the function key BACK .

Depending on the measurement location the TILT measurement can be done at the OUTLET an at the house-amplifier HOUSE or at the Line-amplifier LINE . More details are given in the Application-Note "AN006 - Upstream-Monitoring-System UMS".

Appropriate measurement parameters such as the maximum transmission level of the modem or an amplifier testpoint attenuation can be made via **MODE** -> **desired transmit level outlet, MODE -> desired transmit level line**, as well as **MODE** -> **Amplifier Testpoint Attenuation**. The mode menu can be left again by pressing the key **MODE** again.

21.4.5   Waterfall chart of the real-time spectrum

Selection with the function key WATERFALL. Then the real-time spectrum of the received cluster at the headend will be shown over the overall return channel range as waterfall diagram. This chart can be left again by pressing the function key BACK (if the function keys are not shown, press any function key).
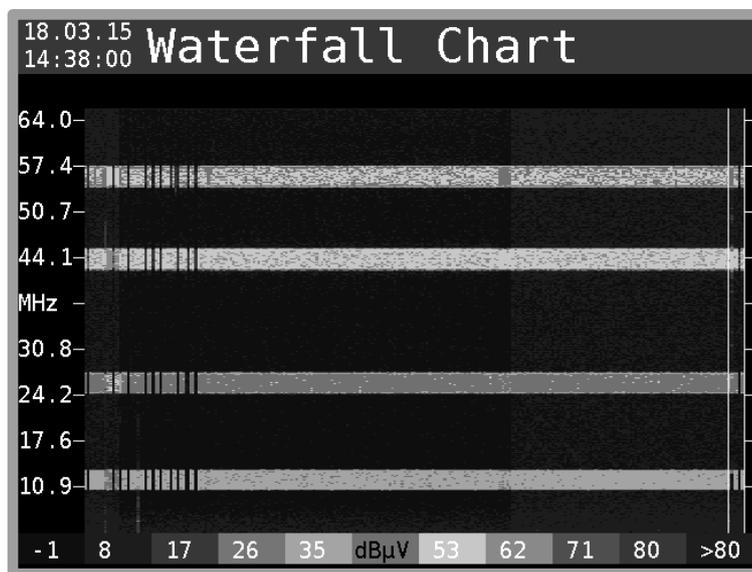
Figure 21-3 UMS waterfall chart

The frequency axis is shown in Y-direction, the temporal course in X-direction. Every vertical line represents a complete snapshot of the real-time spectrum, measured by the headend. The height of the individual levels in the spectrum is coded by colors in this chart, i.e. the lower the level, the more bluish is it shown in this diagram and the higher this level, the more reddish is the relevant color. In the lower area of the display the color coding is shown for better orientation.

21.4.6   Report

This measurement mode permits an automated sequence of several measurements and their results are stored on a USB stick in an XML file. The scope of the measurements depends on the headend used. Details can be taken from the Application-Note "AN006 - Upstream-Monitoring-System UMS" on www.kws-electronic.de under "SUPPORT" -> "Application Notes"

Selection by the function key REPORT. This measurement presupposes a plugged-in USB stick on the field device. After a successful detection of a suitable storage medium the file name for the new report is requested. The file name can be set at will by means of the number keys and the ←/→ arrow keys.

The data name is adopted by pressing **ENTER** and the measurement starts. If the file name already exists, a warning is given in which the overwriting can be confirmed (with **ENTER)** or you can return again to the file name input by pressing the **HOME** key. Subsequently the measurements are carried out automatically in sequence. During the overall measuring procedure, the function key REPORT is shown inversely. After finishing the reporting process, a message "Report successfully finished" appears and the function key REPORT is shown in a non-inverted form again.

21.4.7   Display headend settings

Many measurement settings and parameters are predefined by the headend and cannot be changed in the field device. This should make the operation easier and prevent unintended disturbances of the modem operation. These settings and some information as to the headend can be shown on the measuring instrument.

Selection by the function key TS-INFO of the UMS main menu. By pressing the function key BACK it is possible to return to the main menu. By pressing the function keys >>> and <<< it is possible to scroll to the right and left, thus showing various settings. Details as to the settings to be displayed can be taken from the Application-Note "AN006 - Upstream-Monitoring-System UMS" on www.kws-electronic.de under "SUPPORT" -> "Application Notes"

21.4.8   Quick Check

This measuring mode gives a quick overview of the return channel quality. This mode is only supported by headends with MER/BER measuring functionality.
Selection with the function key QUICKCHECK of the UMS main menu. All four MER/BER measuring channels will be transmitted in sequential order and the measuring results obtained will be shown on the display. The determination of all measurement results may take some time. The measuring procedure can be stopped at any time by pressing the function key BACK.

21.4.9   Headend: Lock handheld device

Active measurements such as wobbling, MER/BER and TILT must only be performed by one field device at a time to prevent possible reciprocal influences. This is ensured by a log-in and log-out mechanism of the field devices in the headend. As soon as one field device is logged in, active measurements of other field devices are not possible during this time. If a field device has not logged out independently (e.g. battery is empty) and no timeout has been effected in the headend, this can be done by every field device by the mode UNLOCK HH (if this is admitted in the head device).
This can be initiated in the UMS main menu with the function key UNLOCK HH . In the main menu the headend status changes from "LOCKED (xxxxx)" to UNLOCKED if the log-out has been successful. Now active measurements (and/or log-in procedures) of field devices are possible again. This function should be used carefully. In case of doubt contact the relevant service technician/colleague who is just logged in.

Chapter 22   **DVI Output**

The measuring instrument is equipped with a DVI/HDMI interface for connecting a Full HD TV set. This allows you to check the functionality of the DVD/HDMI interface on an external LCD screen, for example. The DVI interface is on the top of the instrument.

The instrument cannot output a video signal to the DVI output and to the internal instrument display at the same time. Do not tune the instrument to a station if you wish access the monitor function. This function can be accessed via **MODE** -> **Ext. Monitor**.

When you call up the **DVI out**, **LCD off** menu item, the screen of the instrument darkens and the video signals are only output through the DVI output. For this reason you should connect the instrument to a suitable display device via the DVI output before the instrument is switched over. When the instrument is switched off and restarted, the picture is shown again on the internal display.
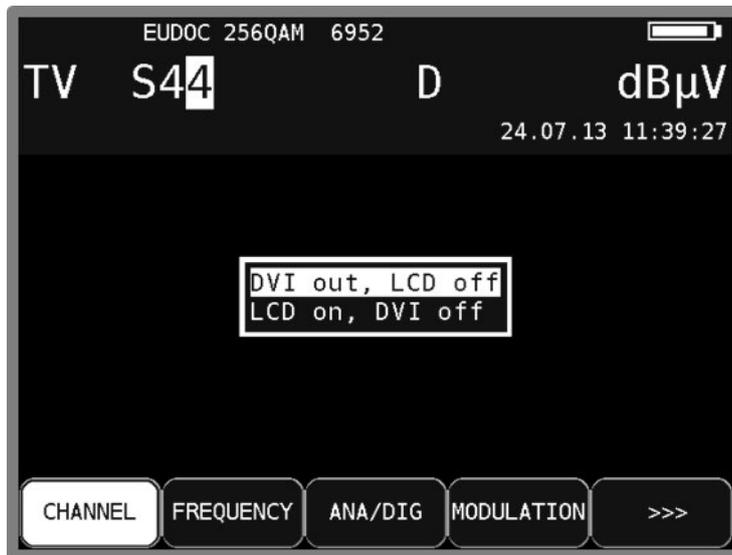
Figure 22-1 DVI output, selection menu

DVI stands for "Digital Visual Interface" (HDMI means "High-Definition Multimedia Interface"). Physically, the interface is designed as a DVI-I socket. However, the protocol is HDMI-compliant. This means that both video and audio data are transmitted. The measuring instrument can be connected to the HDMI input of a TV set using a DVI/HDMI adapter. However, the measuring receiver does not support HDCP (High-bandwidth Digital Content Protection). HDCP prevents digital and audio material from being tapped within the HDMI connection. HDCP is required by the playback program. If an HDTV program requires HDCP, the measuring instrument cannot transmit the data via the DVI/HDMI interface. The connected TV set remains blank in this case.

Important!   **- The device's screen is dimmed when the DVI output is active.**
- The screen resolution is fixed at 1920x1080i.

Adjusting the picture of HEVC and AVS+ programs to the display of the instrument is done by downscaling first. For the output via DVI/HDMI upscaling is done to the default resolution 1920x1080i again. This results in loss of picture quality in the output signal. While running HEVC and AVS+ programs the DVI/HDMI output can be directly fed by the decoder with full resolution in the formats 1280x720p50Hz, 1920x1080p50Hz, 3840x2160p25Hz and 3840x2160p30Hz via **MODE-> Video output DVI <> internal**.
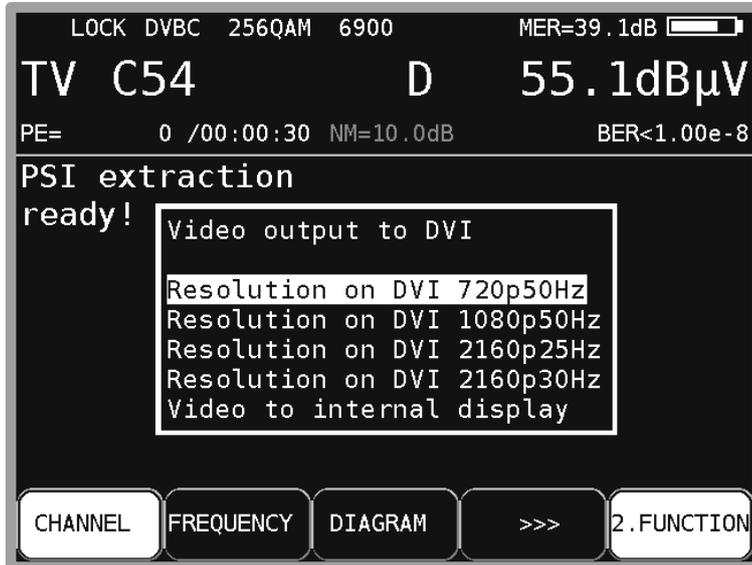
Figure 22-2 Video resolution at HDTV via DVI menu

In this case the live picture on the internal display has to be stopped. There is an according note on the OSD about the video output to DVI.
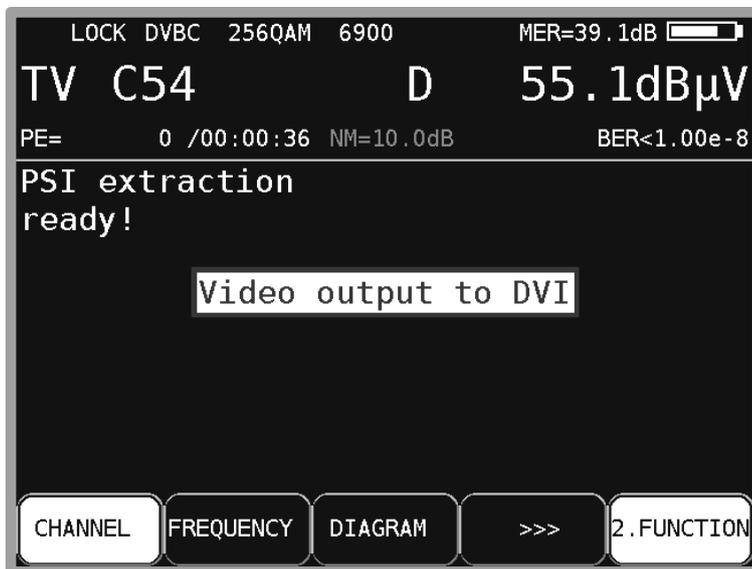
Figure 22-3 Note during HDTV via DVI

Via **MODE -> Video output DVI <> internal -> Video to internal display** the picture is shown on the internal display again. This way it is possible to run a UHD monitor in full resolution with the measurement receiver.

Chapter 23   **USB-A Interface**

The measurement receiver has a USB-A interface. The corresponding port is at the top section of instrument (see chapter 4.3 - Top section of instrument). The interface is compatible with USB 2.0 specification in high speed mode. The measuring instrument only supports the MASS STORAGE DEVICE class (USB stick) and some USB-Microscopes.

The measuring receiver software can read files from, and write files to, a USB stick using the FAT32 file system. A USB stick is used to carry out firmware updates or to record measurement data (DataLogger).

We recommend using the original USB stick from the instrument manufacturer. The USB stick is included in delivery.

Chapter 24 **Common Interface**

The instrument is equipped with a CI interface. This consists of a PCMCIA slot (see chapter 4.3 - Top section of instrument). The PCMCIA slot is compatible with all common conditional access modules (CAM). This means that all DVB channels can be decoded with an appropriate CA module and activated smartcard. Data streams are exclusively decoded in the inserted CAM, not in the MPEG decoder itself.

24.1   Inserting a CA module

The instrument must be switched off when a CA module is inserted. Insert the module into the port at the top section of the instrument. When inserting the module, ensure that the polarity is correct and that the barcode is pointing **to the rear**. Do not force the module into the slot if there is significant resistance.

Figure 24-1 Inserting a CA module

24.2   Operation

The inserted module is initialized when the instrument is cold-started. Use the Common Interface menu to query the inserted CA module. Enter **MODE** -> **Common Interface** to access the menu. The CA module name is shown as a menu title.

Use the first menu item ("CA-SystemIDs") to query CA systems supported by the module. The next section explains the second menu item ("Card Menu"). To check the picture and sound quality of encoded channels, proceed as described in chapter 13.4 Picture and sound check.

24.3   Card menu

This option allows you to access the module-specific menu. Various details and services can be called up for each module. For example, smartcard information, software version, software update, PIN code entry for youth protection, and so on. The menu is laid out just like the other menus on the instrument. The text and menu items come from the CAM itself, however. The language is also defined by the module. The picture below shows the card menu of an AlphaCrypt CAM.

Figure 24-2 Card menu

Chapter 25   WIFI Interface

25.1   Introduction

The measurement device has an integrated WiFi-interface, which allows a communication with other devices. It is possible with the measurement device to sign on a network (Station-Mode) or to establish an Access-Point (accesspoint-mode), where other WiFi-capable devices (Laptop, Tablet, Smartphone, etc.) can sign in. To establish a connection between the mobile device and the measurement device in Station-Mode, both devices must be registered in the same network. In accesspoint-mode the mobile device must be logged in at the access-point offered by the measurement device. After a successfully established connection, specified measure sequences and further functionality can be executed by the mobile device. The devices communicate via REST over HTTP-protocol.

The first application which integrates the interface of the measurement device to a documentation and planning tool was implemented in collaboration with the company AND Solution and their identically named software solution. The client, in this case the AND WebAccess, can establish a connection with the measurement device using its hostname/IP-address. The client can request for device data, like serial number and software revisions, and can also start a measurement of a channel table on a specific measuring point which was picked beforehand. The measurement is proceeded automatically, and the measured data will be transferred to the AND WebAccess. Furthermore you can store the values on the Server for documentation.

A more detailed specification of the functionality of the interface can be found in the separate document „KWS - REST-Interface Specification ". More details for the integration into an environment with an HTTP-REST interface, using the example of the AND WebAccess, can be found in Application Note „AN008 – WIFI Interface Integration ".

25.2   Configuration of the WIFI interface

The menu item for configuration and control of the interface can be reached via **MODE -> Settings -> WiFi settings**. There, a submenu will appear, which depends on the current mode (Station-Mode or Accesspoint-mode) of the interface.

In both modes there is a menu item called **WiFi on/off**. Here you can activate / deactivate the WiFi-Module. More items are only shown if WiFi is activated. To change the setting, select the entry using the arrow keys and confirm the selection with ENTER. In the menu shown afterwards select the setting you want and confirm it by pressing ENTER. The current setting is shown with a white background color. (preset: WiFi on)

Once WiFi is active another menu item called **Select mode** is shown in both modes (optional). This item shows the current mode the interface is working and provides the possibility to change the mode. When you select the submenu item by pressing ENTER, the selection for both modes appears. The item with inverted text (white background color) is the currently running mode. To change the mode navigate to the wanted mode with the arrow keys and press ENTER.
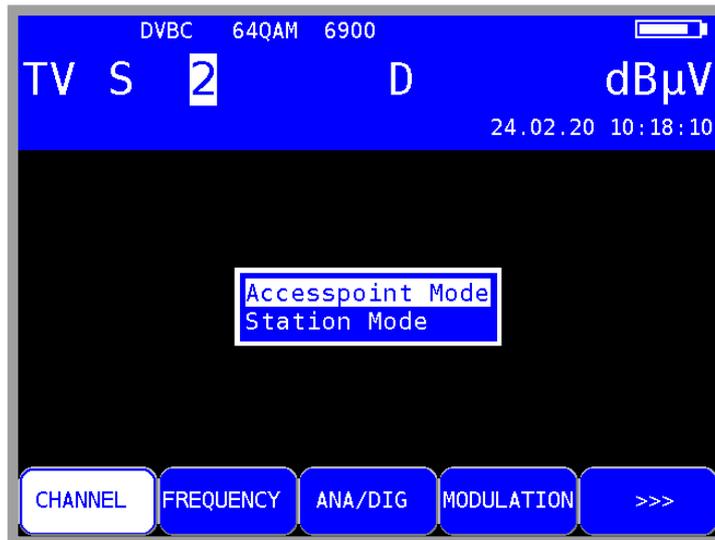
Figure 25-1 WIFI Mode Select, currently in accesspoint-mode

25.2.1   Station-Mode

The submenu in Station-Mode contains **Select mode**, **SSIDs available** and **Net connected**.

The item **SSIDs available** will show up to 16 surrounding networks after proceeding a net-scan, sorted by transmitting power (highest first). If there are more than 16 networks available, lower transmitting-power networks are not shown. SSIDs where no valid password is known are prepended with the asterisk character.

Figure 25-2 available networks in surrounding area after net-scan

To establish a connection to a listed network, it is necessary to navigate to the wanted network with the arrow keys and confirm the selection by pressing ENTER. If the selected network is already known, the password is automatically read from the memory and an attempt to connect to the network is started. If the selected network is not known yet another window will appear after pressing ENTER on the selected network, where you can enter a password. The password can be typed in via the alphanumerical keyboard and is confirmed with ENTER. After that an attempt to connect to the network is done. If the connection is established successfully, the password is stored in the memory for future use. A message will be shown and left to the battery charge symbol the abbreviation "STA" (station) will appear. This indicates the measurement receiver is in station mode and connected to an accesspoint.

Figure 25-3 Password input for selected WIFI Access Point

In the submenu called **Net connected** the data of the currently connected network is shown. The submenu is called by pressing ENTER. There, the current SSID of the connected network, the current IP-address and the two hostnames of the measurement device will appear. This info is needed if you want to communicate with the measurement device. Depending on the operating-system you are using the device is addressable by one or both hostnames shown.
Attention! To address the device by hostnames mDNS must be supported by your operating system.

Figure 25-4 Information of the connected network

25.2.2   Access-Point-Mode

If the interface is running in access-point mode, the submenu contains **Select mode**, **Info Accesspoint** and **Preset Accesspoint**.

Info Accesspoint will show the parameters of the currently set up access-point. The current SSID is shown, which defaults of the device type and the serial number separated by a dash. Furthermore, there also is shown the IP-address of the access-point, which is necessary for establishing a communication between the measurement device and the mobile device. By default, the IP-address is set to 192.0.0.1. The last shown parameter contains the current password of the access-point, which is by default the serial number twice in a row.

As an example, the default configuration of an access-point with a VAROS107 with the serial number 12345 is shown here. The following parameters would be the result for the SSID, IP address and password:

SSID: VAROS107-12345
IPAdr: 192.0.0.1
Password: 1234512345
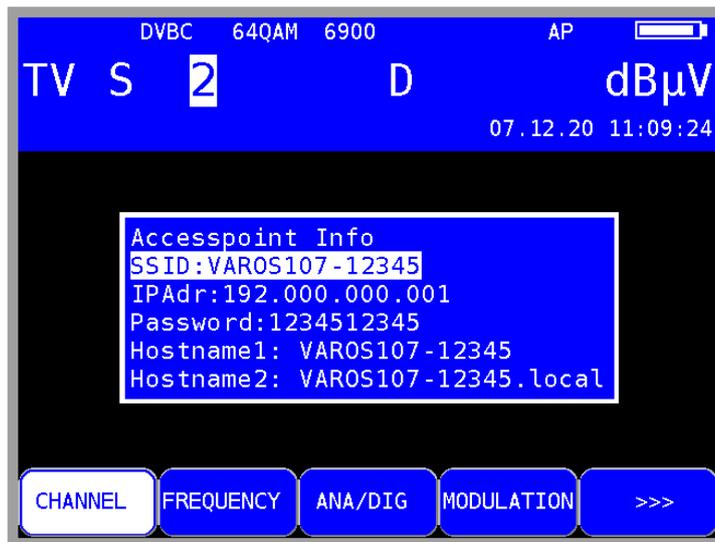
Figure 25-5 Default access-point information

The item **Preset Accesspoint** resets the configuration of the access-point back to the default values (see above). The command is executed when the menu item is selected with the arrow keys and confirmed with ENTER.

Chapter 26 **Figure index**