KWS | ELECTRONIC TEST
EQUIPMENT GMBH

VAROS 106

Combo measuring receiver
Manual

KWS | GERMAN
ENGINEERING

Contents

Chapter 1   Release notes

VERSION		NEW CONTENT (DESCRIPTION)
V5.0		Initial version
V5.1 **(Vxx.05b)**	DVB-T2	MER echo compensation
V5.2 **(Vxx.05c)**	WIFI-Interface	Hostnames of the device are shown (Figure 26-4)
V5.3 **(Vxx.05e)**	OTA-Update	OTA-update (update via WiFi)
V6.0 **(Vxx.06a)**	MIS, PLS (DVB-S2)	MIS (Multiple Input Stream) PLS (Physical Layer Scrambling)

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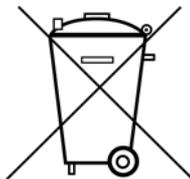
Passage from the battery regulations (BattV)
This device contains a battery which incorporates hazardous substances. It must not be disposed of I domestic waste. At the end of its working life it should be disposed of only through the ESC customer service department or at a designated collection point.

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		
SAT		910 – 2,150 MHz
	Resolution	1 MHz
		IF- / Transponder frequency input
TV		45 – 868 MHz
		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		45 – 868 (1,214) MHz
	Resolution	50 kHz
DAB		170 – 250 MHz
	Resolution	50 kHz
Wi-Fi™	802.11 b/g/n	2,412 - 2,472 MHz
	802.11 a	5,180 – 5,700 MHz

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 stereo-loudspeaker

RF INPUT	IEC socket / 75 Ohm (DIN 45 325)
Return loss	> 12 dB (5 – 1.214 MHz) all ranges except SAT
	> 10 dB (910 – 2.150 MHz) SAT
External voltage	max. 70 V_{eff} (DC – 50 Hz)
RF summation power	max. 500 mW (5 – 2.150 MHz)

INPUT ATTENUATOR	0 – 60 dB in 2 dB increments

LEVEL RANGE

Measuring Ranges	SAT	30 – 120 dBµV
	TV	20 – 120 dBµV
	FM	20 – 120 dBµV
	RC	25 – 120 dBµV
	DAB	20 – 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.
Measuring bandwidth	SAT DVB-S/S2	8 MHz, 4 MHz or 1 MHz depending on symbol rate
	TV analog	Video carrier 200 kHz Audio 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
	DAB	1 MHz
Acoustic level trend indicator		can be switched on/off

ANALYZER

Measuring bandwidth (RBW(-3dB))	SAT	8 MHz, 4 MHz, 1 MHz
	TV	4 MHz, 1 MHz, 200 kHz, 90 kHz
	FM	200 kHz, 90 kHz
	DAB	1 MHz, 200 kHz
	RC	200 kHz, 90 kHz
Span (frequency segment)	SAT	Total range, 600 MHz, 150 MHz, 75 MHz
	TV	Total range, 250 MHz, 100 MHz, 50 MHz, 25 MHz
	FM	Total range, 10 MHz
	DAB	Total range, 30 MHz
	RC	Total range, 20 MHz

MAX hold function
Switch directly between analyzer mode and receiver mode

DVB-S

QPSK demodulator		(per ETS 300421)
Symbol rates		2 – 45 MSym/s

Frequency offset (df)	Resolution	0.1 MHz
	Measuring accuracy	± 200kHz

Measuring parameters		
	CBER (before Viterbi)	$1.00 \cdot 10^{-8}$
	VBER (after Viterbi)	$1.00 \cdot 10^{-8}$
	MER	up to 20 dB
	Noise Margin, NM	up to 15 dB (depends on modulation)
	Resolution	0.1 dB
	Measuring accuracy	± 1.5 dB
	PE (Packet Errors)	up to $4 \cdot 10^{9}$
		counts packet errors since the start of measurement

Automatic detection	DVB-S/DVB-S2

Scan function

DVB-S2

QPSK / 8PSK demodulator		
16APSK, 32APSK		(per ETS 302307)
Symbol rates		2 – 45 MSym/s
		(for 32APSK up to 38 MSym/s)

Freqency offset (df)	Resolution	0.1 MHz
	Measuring accuracy	± 100 kHz

Measuring parameters		(per ETR 290)
	CBER (before LDPC)	$1.00 \cdot 10^{-8}$
	LBER (after LDPC)	$1.00 \cdot 10^{-8}$
	MER	up to 20 dB
	Noise Margin, NM	up to 19 dB (depends on modulation)
	Resolution	0.1 dB
	Measuring accuracy	± 1.5 dB
	PE (Packet Errors)	up to $4 \cdot 10^{9}$
		counts packet errors since the start of measurement

Automatic detection	DVB-S/DVB-S2

Scan function

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 $4 \cdot 10^{9}$
	counts packet errors since the start of measurement
Scan function	

J83B (US-DOCSIS)

QAM demodulator	(per ITU-T J.83B)
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)	$1.00 \cdot 10^{-6}$
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 $4 \cdot 10^9$
	counts packet errors since the start of measurement
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 $4 \cdot 10^9$
	counts packet errors from start of 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 $4 \cdot 10^{9}$
		Counts packet errors from start of 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)	up to $4 \cdot 10^{9}$
		Counts packet errors from start of 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, DVBS, DVBS2
3-dimensional display (Status frequency)		In color
Zoom function		In all 4 quadrants (except DTMB)
Stop function		Freezes the diagram

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

DAB/DAB+		
COFDM demodulator		(per ETSI EN 300401)
FFT		2k
Mode		1
Modulation scheme		DQPSK
Guard intervals		¼
Measuring parameters	CBER (before Viterbi)	$1.00 \cdot 10^{-6}$
	MER	up to 25 dB
	Resolution	0.1 dB
	Measuring accuracy	± 1.5 dB
DAB+ frame decoding		(per ETS TS 102563)
Scan function		
TII evaluation		

MPEG 2/4/H/AVS DECODER			Display of MPEG video parameters Video bit rate measurement in Mbit/s
Video decoding		MPEG-2 MP@HL	ISO/IEC 13818-2
		MPEG-4 AVC	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	ISO/IEC 13818-3
		MPEG-2 AAC	ISO/IEC 13818-7
		MPEG-4 AAC	ISO/IEC 14496-3
		Dolby Digital AC-3, Dolby Digital Plus	
DAB audio decoding		MPEG-1 Layer II	ISO/IEC 11172-3 and 13818-3
DAB+ audio decoding		HE-AACv2	ISO/IEC 14496-3

TRANSPORT STREAM EVALUATION		
		NIT evaluation
		Separate views for video, audio and data services
		Dynamic PMT
		LCD (Logical Channel Descriptor)
		LCN (Logical Channel Numbering)
		selected SI data
	Chinese character set	GB2312
	Cyrillic character set	

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	200
Memory protection function	

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/√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)

REMOTE SUPPLY Per RF input

Voltage		5 - 20 V in 1V steps
Power		up to 500 mA (short circuit-proof)
22kHz modulation	SAT only	0,8 V_{pp}
DiSEqC	SAT only	V1.0, V1.1, V1.2, V2.0, UNICABLE (EN 50494), JESS (EN 50607)
Current measuring	range	0 – 500 mA
	resolution	1 mA
	measuring accuracy	± 2% of final value
Short circuit message		Automatic switch-off

WI-FI™

Scan for access points in 2.4 and 5 GHz band with visualization of reception level

Listing of access points according to channels with reception level

Connection test with level measurement

POWER SUPPLY	
External 12V	11 – 15 V DC max. 3.0A or external primary power supply 12 V / 3 A (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
Operation time	approx. 3 hours (dependent upon the remote supply, keypad illumination and operating mode) automatic cutout as protection against exhaustive discharge
Charging time	approx. 4 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 / H / 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) Fiber cable SC/APC to FC/PC (option fiber) Power supply and external power cable USB stick Wi-Fi™ Antenna (Option Wi-Fi™) Manual

Chapter 4   Control and connection elements, pin configurations

4.1   Front panel

Figure 4-1 Front panel

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	LNB	-LNB/-remote feed
RECALL	-Recall from memory	HOME	-Start menue	AV-SET	-Audio (Volume)
					Video (Brightness)
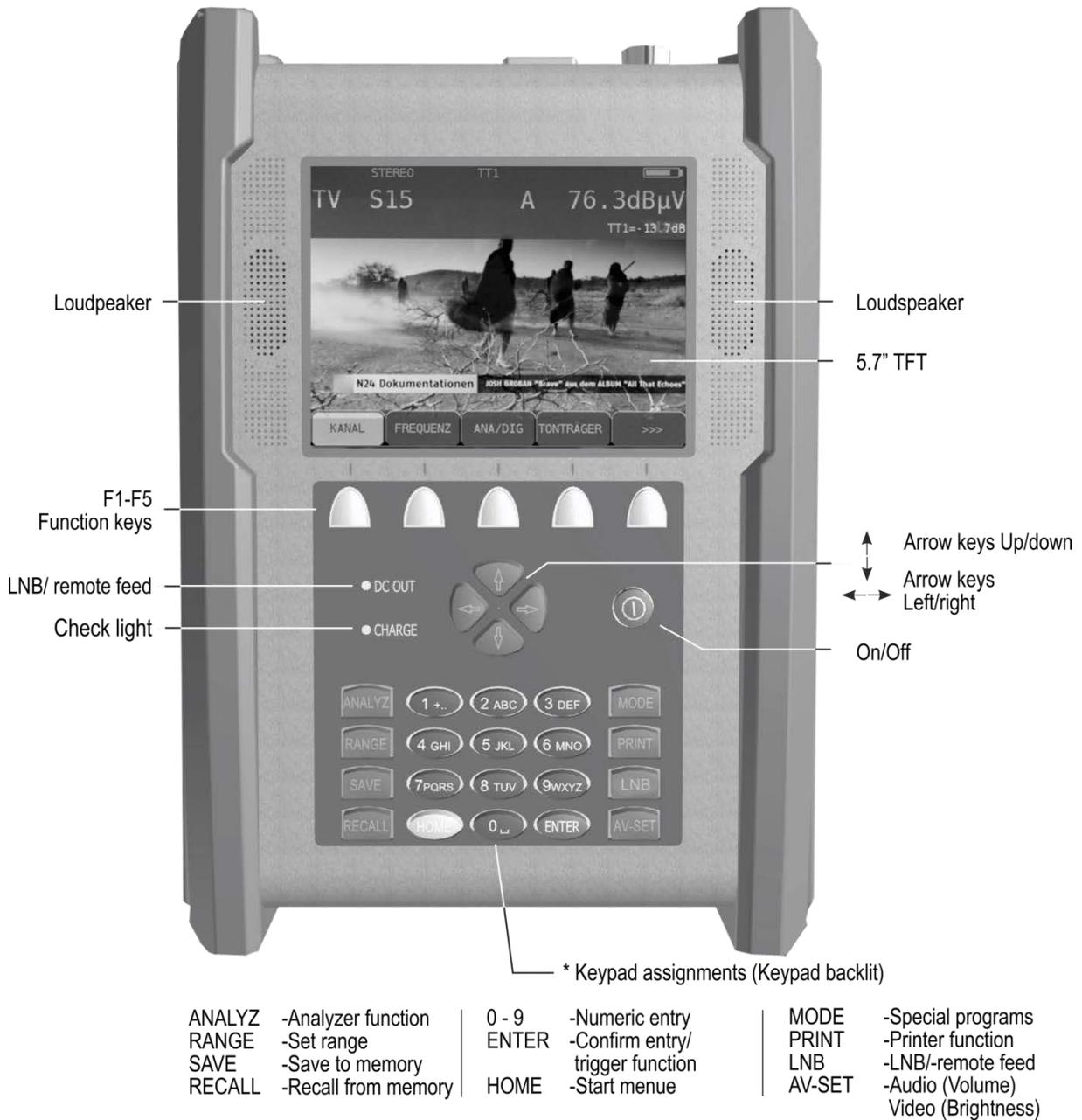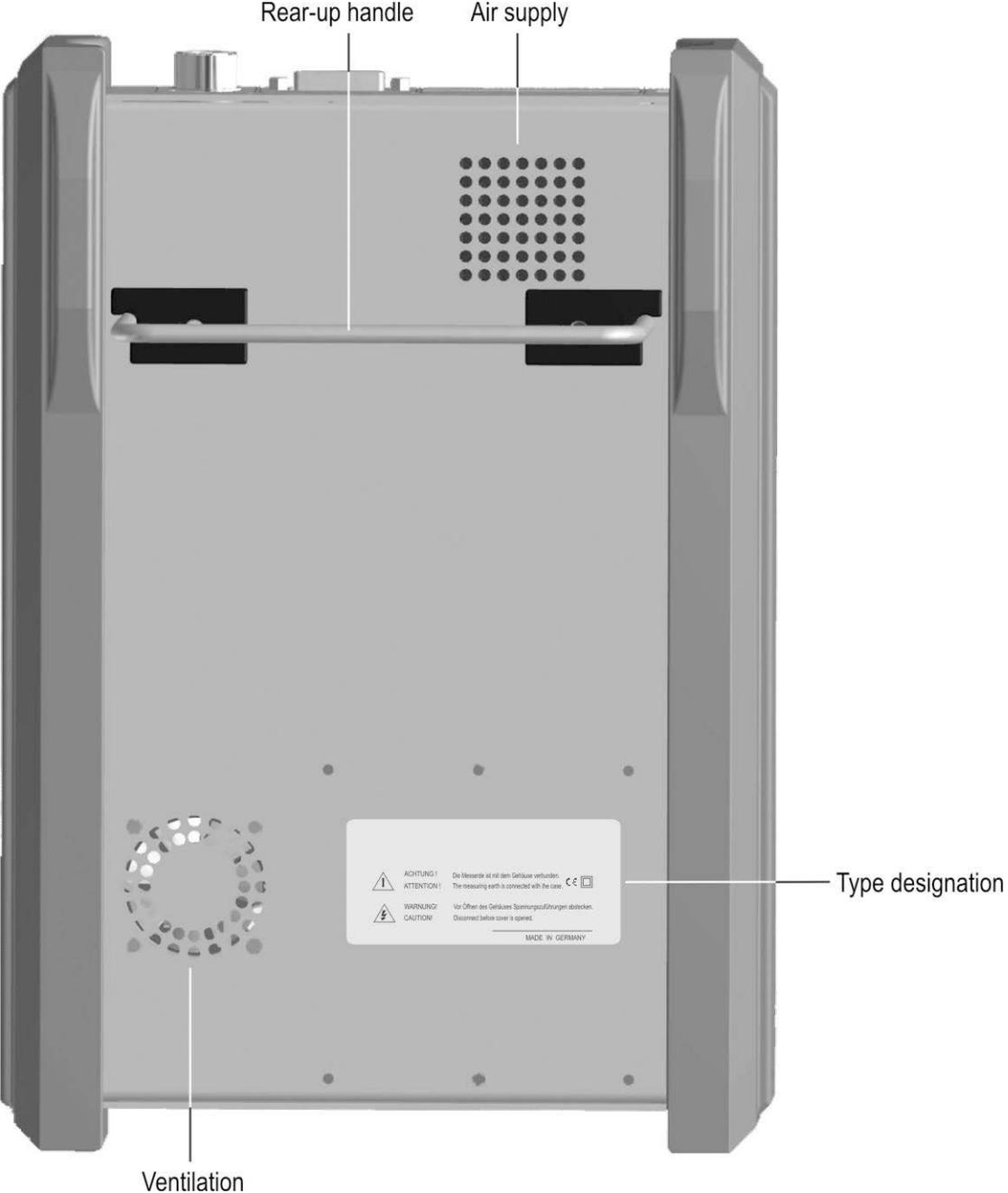
4.2   Rear panel

Figure 4-2 Rear panel

4.3   Top section of instrument

RF Input
75 Ohm

DVI-D
Digital Video
output

USB-A port

Wi-Fi™
Antenna connector

Optical input

CAM/PCMCIA (slot)
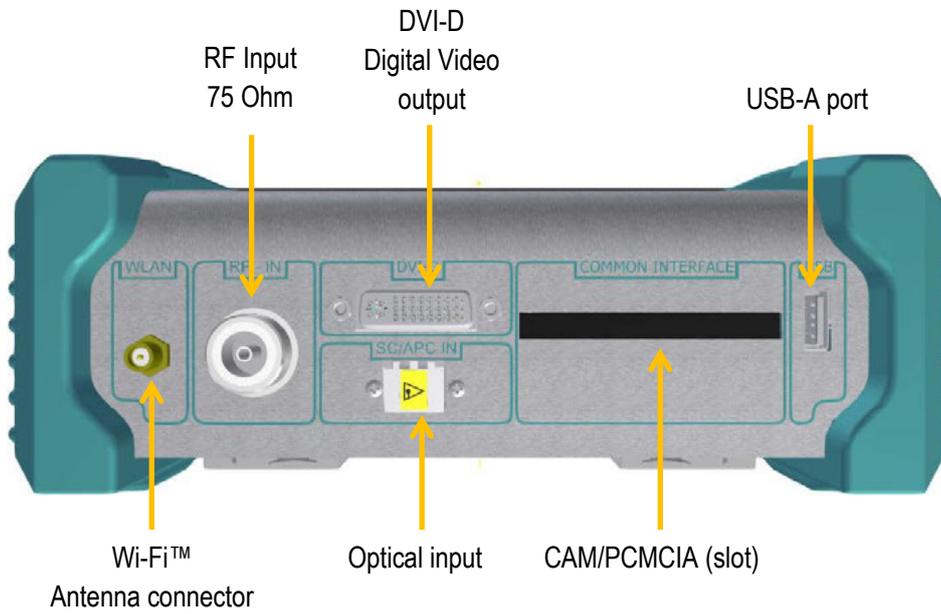
Figure 4-3 Top section of instrument

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
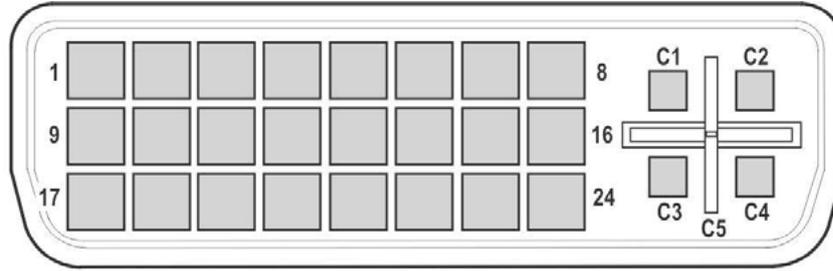
1 = T.M.D.S. Data 2-	11 = T.M.D.S. Data 1/3 Shield	21 = n.c.
2 = T.M.D.S. Data 2+	12 = n.c.	22 = T.M.D.S. Clock Shield
3 = T.M.D.S. Data 2/4 Shield	13 = n.c.	23 = T.M.D.S. Clock+
4 = n.c.	14 = +5V Power	24 = T.M.D.S. Clock-
5 = n.c.	15 = GND	
6 = DDC Clock	16 = Hot Plug Detect	C1 = n.c.
7 = DDC Data	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
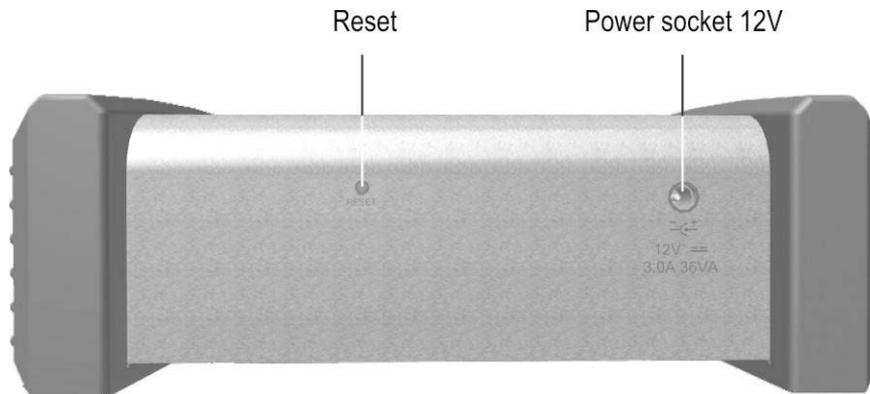
Figure 4-6 Bottom section of instrument

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

Chapter 7   SAT Measuring Range

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

Figure 7-1 SAT measuring range

7.1   Frequency input

Enter the value of the frequency in MHz or GHz (see below). Set the desired frequency using the number keys or arrow keys. The decimal unit can be changed from 0-9 by pressing arrow keys ↑/↓ when the cursor is on that unit. Use the ← and → keys to move the cursor left and right. Pressing a number key enters the corresponding value in the lowest decimal unit. All the positions above are set to zero. Every time an additional number is entered, the existing value shifts a position to the left and the latest entry is used for the lowest unit. Confirm by pressing **ENTER**. If the value entered is not within the valid range, it will be limited to the corresponding minimum or maximum value.
After that, the receiver is tuned and the actual measured values are displayed.

7.1.1   IF input

The figure above shows the default status for the entry of the SAT-IF frequency. The menu item RF is not activated. Here you can enter in the range 910 – 2,150 MHz.

7.1.2   RF input

The instrument offers the option of directly entering the transponder frequency in GHz.
For this, you must select the menu item RF, which is then displayed inverted.
The instrument calculates the SAT-IF frequency itself depending on the respective oscillator frequency in the LNB. For Ku-band LNBs, oscillators usually operate below the RF frequency. The following is applicable here:
IF = RF – LO.
The instrument calculates its tuning frequency from this relationship. C-band LNBs have oscillators that oscillate above the transponder frequency. The following is applicable here:
IF = LO – RF.
The measuring receiver has 3 preset oscillator frequencies available. These are for the Ku-low, Ku-high and C-band.

7.1.2.1   Input of the oscillator frequencies

With **MODE -> Settings-> LNB- Frequencies**, you can choose to enter three LO frequencies or to switch to the menu **LO-Allocation**. The local oscillator frequencies are available for Ku-Low, Ku-High and C-Band.

Figure 7-2 Input of oscillator frequency Ku-High-Band

This figure above shows the input window with the default setting for Ku-High-Band. The frequencies for the Ku-band can range between 9.000 und 11.000 GHz. For the C-band, the range is between 4.000 and 6.000 GHz. You can confirm and store the entries in the non-volatile memory by pressing **ENTER**.

7.1.2.2   LO assignment

Here you set which oscillator frequencies are considered during RF input.

With **MODE -> Settings-> LNB- Frequencies-> LO-Allocation**, a selection of Ku-Standard, Ku-LO-Low, Ku-LO-High and C-band appears.

The default setting is Ku-standard. During RF input, the instrument switches automatically between Ku-Low and Ku-High. The threshold for switching to the high band is 11.7 GHz. After entry of the transponder frequency, the instrument then issues the corresponding DiSEqC or 22 kHz switching commands.

With the setting Ku-LO-Low, the Ku-Low oscillator is taken into account independent of the SAT-IF layer that is set via the LNB supply. With Ku-LO-High, this is similarly applicable to the Ku-High oscillator frequency. If you choose the menu item C-band, the instrument uses the frequency of the C-band oscillator during RF input. After entry, the setting is stored in the non-volatile memory.

7.2   DVB-S/S2 operating mode

Here you can receive the digitally modulated signals in the DVB-S/S2 standard and measure their signal quality.

7.2.1   Selection of modulation

Under **MODULATION** -> **DVB-S** or **DVB-S2**, you can select the modulation type DVB-S/S2.
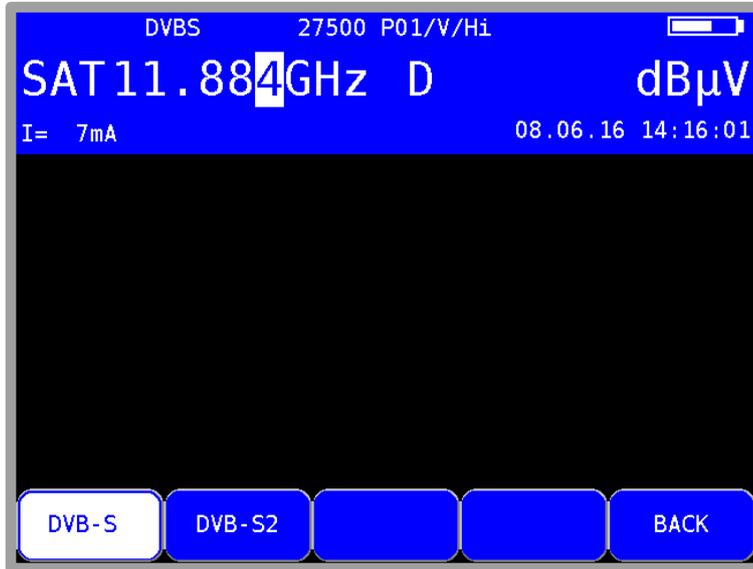
Figure 7-3 SAT modulation preset

Automatic standard detection:

The measuring receiver uses the set standard as the starting point for automatic standard detection. As soon as you enter a new frequency, the receiver attempts to demodulate the signal that is present. If it is not successful in the set standard, a different modulation type is automatically used. The standard of the signal received is shown on the display.

7.2.2   Symbol rate input

You must set the corresponding symbol rate before a DVB signal can be received.
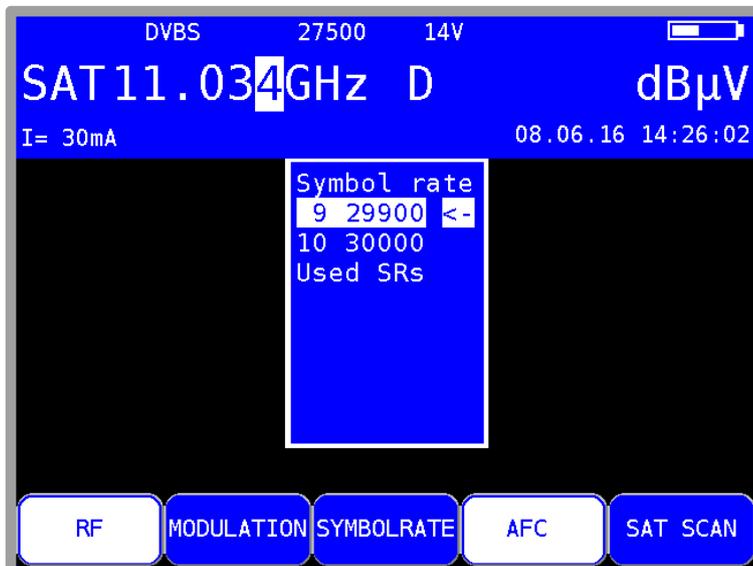
Figure 7-4 SAT symbol rate input

First select menu item **SYMBOLRATE**. Then you get a menu for 10 preset symbol rates. Select one of them and press **ENTER.** A short menu appears where you can choose **set** for apply the preset symbol rate or **edit** for changing it. Once the entries are confirmed by **ENTER** it is also stored in the non-volatile memory.
For reference: 27,500 kBd = 27,500 kSym/s = 27.5 MBd = 27.5 MSym/s

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 frequency, 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 of the list above for additional attempts. Just beginning with the 1st position up to 5th position as a standard but there is the possibility to extend this to the 10th position.

Set number of used symbol rates:

For automatic detection of the symbol rates you can extend the used symbolrates from 5 to 10. With **SYMBOLRATE** -> **Used SRs** you get a menu (see Figure 7-4 SAT symbol rate input) where you can set this.

7.2.3   PLS (DVB-S2)

PLS is short for „Physical Layer Scrambling". The transport-stream is interleaved according to a specific pattern, which increases protection against errors. For demodulation, the associated key must be known to the receiver. There are two types of keys: Root-key and Gold-key. These can be set up by pressing the softkey **MODULATION** then softkey **PLS SETUP** on the second page and a menu appears as shown below (depends on hardware; DVB-S2 must be active).
In initial state the parameters are shown on the upper area of the display, when PLS is activated. In Figure 7-5 the settings are: PLS, Root-key with a value (key-value) of 8.

Figure 7-5 PLS settings

7.2.4   MIS (DVB-S2)

MIS is short for „Multiple Input Stream". When MIS is used, more than one data stream can be put on a transponder. Every stream gets its unique ID: ISI – Input Stream ID. The stream is then selected by its ID. This ID can be configured by pressing the softkey **MODULATION** then

MIS ID on the second page and a menu appears as shown below (depends on hardware; DVB-S2 must be active).

In initial state the ISI (Input Stream ID) is shown on the upper area of the display, when MIS is activated. In Figure 7-6 the stream with ID 1 is selected. If the input stream ID is changed while the measurement receiver is tuned, the transport stream is re-scanned.
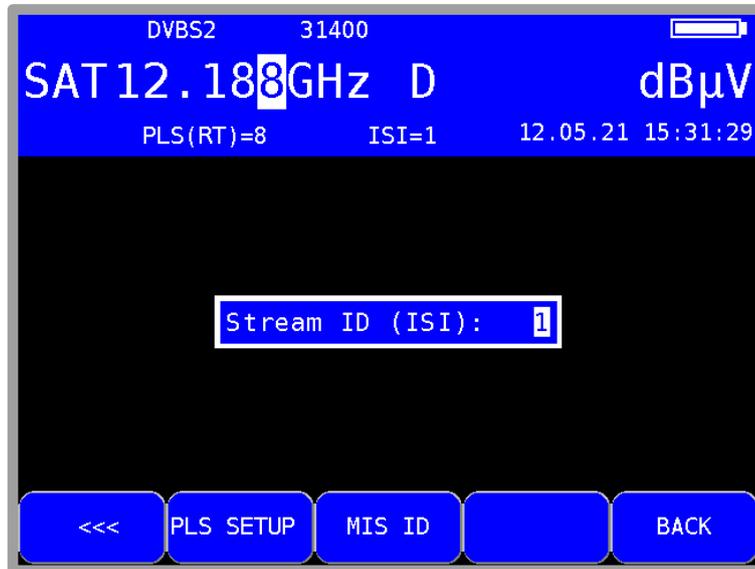
Figure 7-6 MIS - Input Stream ID

7.2.5   Scan

You can use this function to scan the entire SAT frequency range (910 - 2,150 MHz) for DVB-S/S2 signals. Within the scan, the DVB-S/S2 parameters or the set symbol rate plus the two first of the list above are used.

In the digital operating mode, the arrow keys have a dual function. After entry of a new frequency, the menu item **2.FUNCTION** appears in inverse. 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 started by first tuning the measuring receiver to a frequency (see chapter 7.1 - Frequency input) 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.

Note!   **In the UNICABLE operating mode, the scan function is deactivated.**
If RF input mode is active and the LO assignment is set to „Ku-Standard", the instrument switches automatically between the low and high bands during scanning. The switching threshold is 11.7 GHz (see chapter 7.1.2.2 - LO assignment).

7.2.6   DVB-S/S2 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 the parameters of the receiver do not agree, or no DVB-S/S2 signal can be received at this frequency.

If the receiver has synchronized, the set standard (DVB-S/S2) and the current FEC (Forward Error Correction) are displayed.

For DVB-S2, the modulation scheme (here 8PSK) and the presence of pilots are also displayed.

Figure 7-7 SAT DVB-S/S2 parameters

7.2.6.1   Parameters in the MPEG area

After the program search has been successfully completed (see Chapter 13 MPEG Decoder) the provider and the satellite position is shown in the upper right corner. This information is extracted from the NIT.

7.2.7   Special receiver settings

The device allows specific parameters in the DVB-S/S2 receiver to be changed.

If the measuring instrument is working with modified receiver settings, an inverted "**!**" symbol appears on the display.

These settings are volatile. This means that after the device has been switched off and on or the range has been changed, the measuring receiver switches back to the standard settings.

7.2.7.1 AFC (Automatic Frequency Control)

The device operates with the AFC switched on in the standard settings. This means that if the DVB-S/S2 receiver detects a frequency offset between the transmitter and the receiver, the tuner on the receiver is adjusted accordingly so that the frequency offset disappears.

However, if, for example, the frequency drift of an LNB is to be observed, it is useful to switch off the AFC. In this case, the device shows the frequency offset in the display (df = …).

The resolution is 0.1 MHz. The sign in front of the value is determined by the following relationship:

$f_{LNB} = f_{instrument} + \Delta f$

with f_{LNB} = LNB frequency, $f_{instrument}$ = adjusted frequency in the intrument, Δf = frequency drift
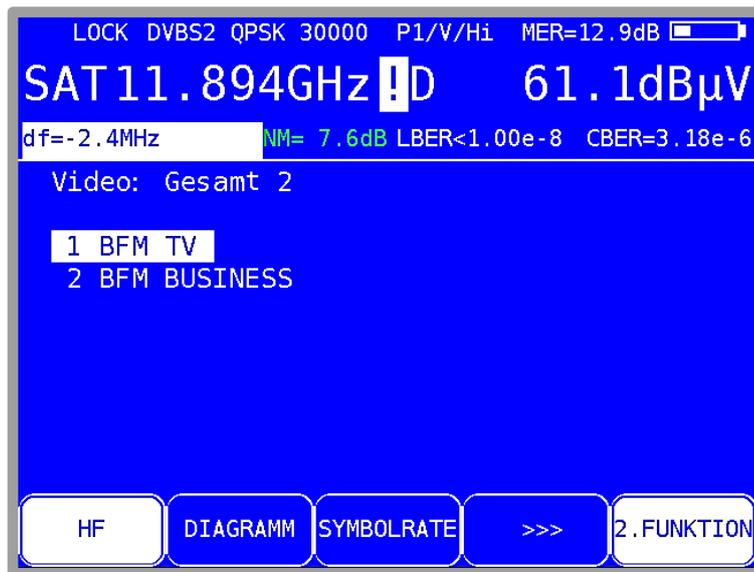
Figure 7-8 SAT frequency offset

Note!   **The measured values from the measuring receiver are calibrated with AFC switched on. Therefore, the AFC should only be switched off in order to check for a frequency offset.**

The AFC of the receiver can be switched on and off using the AFC menu item and it always activated after stopping the measurement using **HOME**. This behavior can be changed at **MODE -> Settings -> SAT AFC Mode**. (Factory setting: Auto-Mode)

7.2.8 BER measurement (Bit Error Rate)

The measurement of the bit error rate aids in the qualitative assessment 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-S/S2, two independent error protection mechanisms work together. So-called internal error protection (after the demodulator) is called Viterbi with DVB-S and LDPC (Low Density Parity Check) with DVB-S2. The external error protection is carried out after that. It is called Reed-Solomon with DVB-S and BCH (Bose Chaudhuri Hocquenghem) with DVB-S2.

For DVB-S, 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 is $1 \cdot 10^8$ bits for high symbol rates (>10,000 kBd) und $1 \cdot 10^7$ bits for low symbol rates.

For DVB-S2, the bit error rates are measured before LDPC (CBER) and after LDPC (LBER). Both values are displayed in exponential form. The depth of measurement is generally $1 \cdot 10^8$ bits.

7.2.9 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 analog transmission methods. The measuring range goes up to 20 dB with a resolution of 0.1 dB.

7.2.10 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. For DVB-S the limit values for the VBER (>2e-4 for bad and <1e-6 for good) and for DVB-S2 the limit values for the LBER(>2e-4 for bad) will also be included in this assessment

7.2.11 Constellation diagram

If the measuring receiver is tuned, you can access the constellation diagram via the menu item CONST . Additional information can be found in chapter Chapter 14 - Constellation diagram.

7.2.12 PE measurement (Packet Error)

Short interruptions in the DVB-S/S2 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 frequency.
This function runs in the background continuously. To active the display of packet errors you can press the function key 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.

7.2.13 Picture and sound check

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

7.3 Level measurement

As soon as the measuring receiver is tuned, the automatic attenuation control and level measurement starts.
The level measured is indicated on the right side of the LCD in dBμV with 0.1 dB resolution.
The measuring range spans from 30 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

When no line of sight to the measuring instrument exists while lining up a parabolic antenna, an acoustic level trend signal can be switched on. A sound signal is emitted from the loudspeaker. It's frequency changes in proportion to the measured level. When the level increases, the frequency goes up and vice versa.
This function 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.

7.4   LNB supply

The measuring receiver controls a connected LNB or multi-switch with the conventional 14/18 V – 22 kHz control (max. 4 SAT-IF layers) or with DiSEqC control.

The supply is short-circuit proof and provides a maximum current of 500 mA. The instrument automatically switches off the LNB supply if there is a short-circuit or if the current is too high.

The LED "DC OUT" at the keypad of the instrument lights in red as soon as the LNB supply is active.

7.4.1   14/18 V – 22 kHz control

You activate the 14/18 V – 22 kHz control (if DiSEqC is off) with **LNB -> SAT-IF-Laye**r **-> 14V**, **18V**, **14V/22kHz**, **18V/22kHz**.Thereby the desired SAT-IF layer is set.

If DiSEqC is active press the **LNB** key, the **LNB** menu is displayed. You must first switch off the DiSEqC or UNICABLE control with **DiSEqC** -> **OFF**. Then you can select one of the 4 SAT-IF layers via menu item **SAT-IF-Layer**. The layer name is in brackets.

The current selection is then shown on the top line of the display.
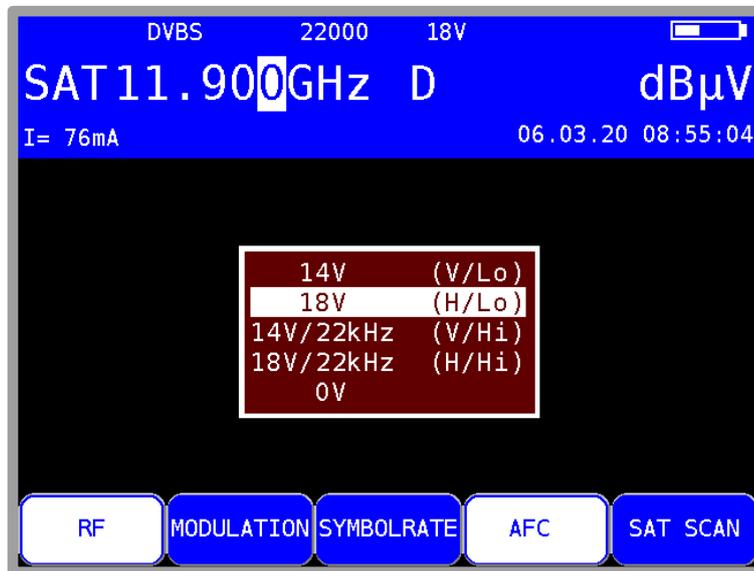
Figure 7-9 SAT-IF-Layer

7.4.2   Changing the fixed voltages

Two fixed voltages (14 V and 18 V) are set ex-works for the LNB supply.

In some cases, it can be useful to change the voltages (for example, to define the horizontal or vertical switching threshold of an LNB or multi-switch).

If the **SAT-IF-Layer** menu is opened as shown in Figure 7-9 SAT-IF-Layer, you can access the input menu by pressing the → arrow key. Now you can enter the new LNB voltage using the numeric keypad or with the arrow keys from 5 V to 20 V in 1 V increments. Press ENTER to store this setting. The setting is non-volatile.
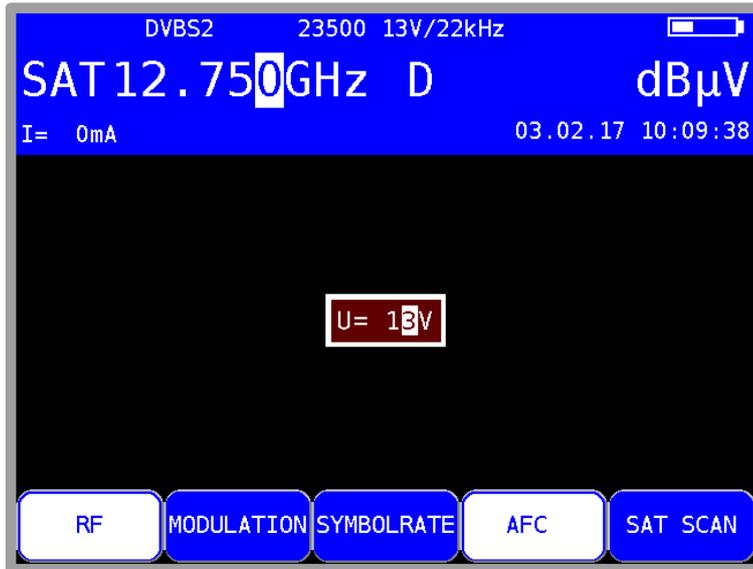
Figure 7-10 Change LNB-voltage

When a voltage is changed an exclamation mark is shown. This indicates the layer in brackets might not be correct in respect to the current setting of the voltage. The exclamation mark will disappear when the voltage is reset to default value. For default values see Figure 7-9.
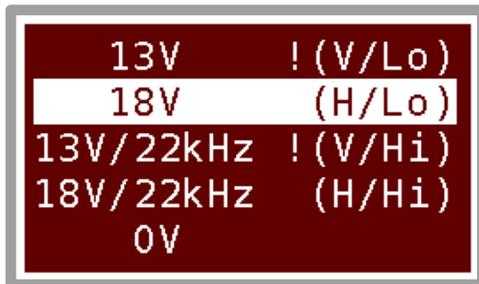
Figure 7-11 Value of LNB-voltage changed

7.4.3   DiSEqC

DiSEqC (Digital Satellite Equipment Control) defines a standard which transfers the control commands from the master (e.g. receiver) to the slave (e.g. multi-switch, positioner) via FSK (frequency shift keying of 22 kHz) on the RF cable. DiSEqC is backwards compatible to the 14V/18V/22 kHz control.

The following diagram shows the chronological sequence of a DiSEqC1.0 sequence:
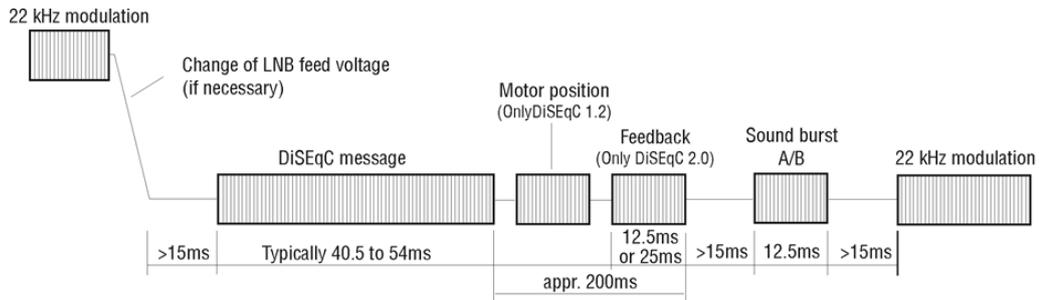
Figure 7-12 DiSEqC 1.0 Sequence

The 14V/18V/22kHz control follows immediately after a DiSEqC sequence. This allows non-DiSEqC compatible components to be run when DiSEqC control is active.
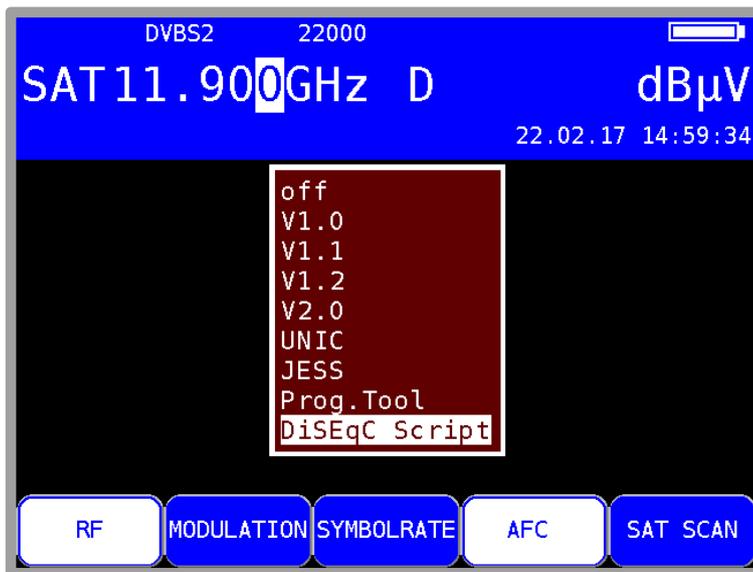
Figure 7-13 DiSEqC menu

7.4.3.1   DiSEqC V1.0 control

LNB -> **DiSEqC** -> **V1.0** activates DiSEqC standard V1.0.
This allows up to 4 satellite positions with up to 4 SAT-IF layers each to be controlled. You set a SAT-IF layer using **LNB ->IF-Layer -> V/Lo**, **H/Lo**, **V/Hi** or **H/Hi**.

You can set a satellite position using **LNB** -> **Satellite** -> **P1 – P4**. P1 can then be used for ASTRA and P2 for EUTELSAT, for example.

7.4.3.2   DiSEqC V1.1 control

LNB -> **DiSEqC** -> **V1.1** switches the instrument to DiSEqC V1.1 control. V1.1 allows a total of up to 256 SAT-IF layers to be controlled. V1.1 also incorporates DiSEqC component cascading. That means that corresponding multi-switches or switching relays can be connected in series. This

requires multiple repetitions of the DiSEqC command. See the example that follows for further information.

The settings for the SAT-IF layer and the satellite position are identical to those for V1.0. Added to this is the control of 'Uncommitted switches', which is operated under **LNB** -> **Uncommitted Switch**. "Uncommitted switches" allow the 16 SAT-IF layers possible with V1.0 to be split into another 16 branches using 4 additional switches (uncommitted switches), thanks to the cascading option. This allows a total of up to 256 SAT-IF layers to be controlled.
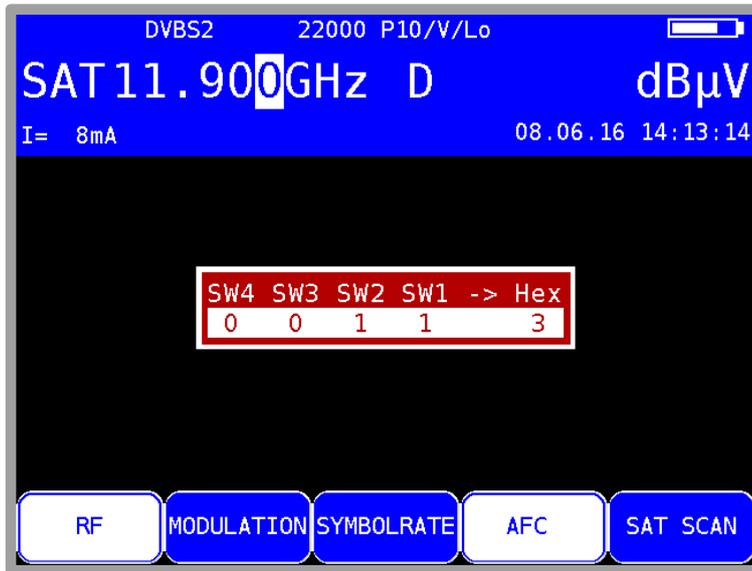
Figure 7-14 DiSEqC 1.1 Uncommitted switches

V1.1 incorporates DiSEqC component cascading. Therefore, the commands must be repeated. The number of repetitions selected should be as low as possible, as otherwise unnecessary DiSEqC commands are sent, slowing the control. **LNB** -> **Repeats** allows you to select between 0, 1 (default), 2 and 3 repetitions. If you press **ENTER** the setting is accepted.
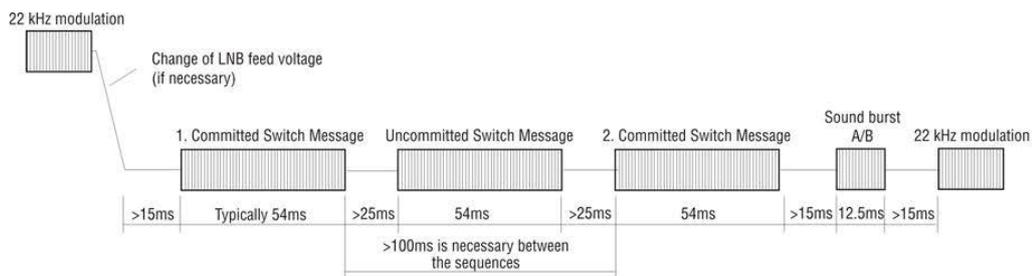
Figure 7-15 DiSEqC 1.1 control sequence with 1 repetition

As already mentioned above, DiSEqC V1.1 is capable of cascading. For this, the control sequences must be repeated. DiSEqC components further back in the chain cannot receive the commands intended for them until the earlier components in the chain have processed their commands.

Therefore, DiSEqC1.0 (committed switches) and DiSEqC1.1 (uncommitted switches) commands are repeated. The next figure shows a possible setup in which 64 SAT-IF layers are controlled.
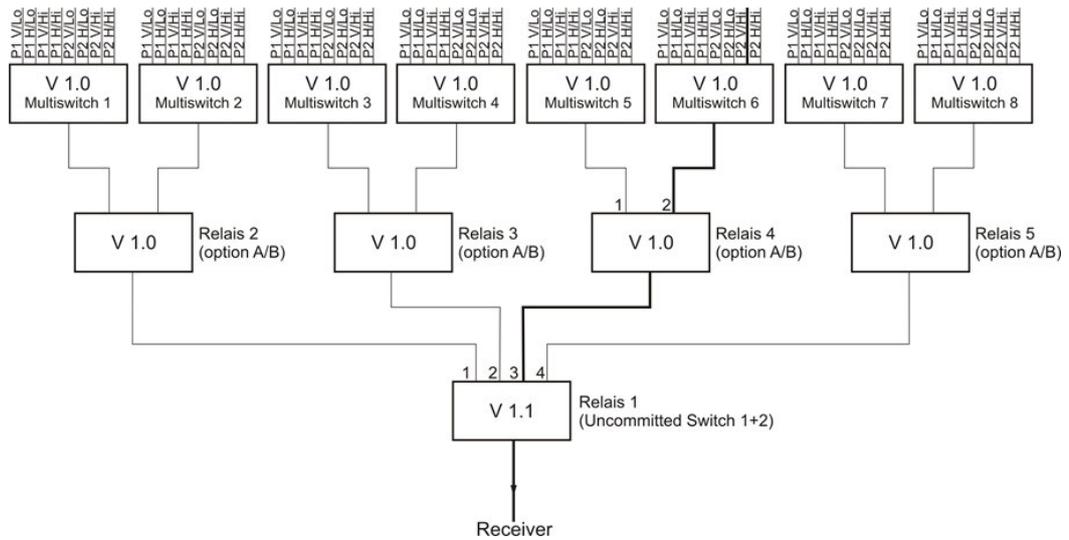
Figure 7-16 24 DiSEqC 1.1 setup with 64 SAT-IF layers

The structure includes 3 hierarchy levels. Consequently, 2 repetitions must be set. The following settings must be made to connect the SAT-IF route marked in bold type:

Relay 1 works with 'uncommitted switches' and reacts to switches 1 and 2. The binary combination "10" is required to connect the route to output 3. That means that SW1 must be set to 0 and SW2 must be set to 1. SW3 and SW4 are not relevant here and can be left on 0.

Relay 4 works with 'committed switches' and reacts to the option bit. The option bit must be set to connect the route to output 2. This corresponds to DiSEqC1.0 positions P3 or P4.

Multi-switch 6 switches 8 SAT-IF layers. The selected path can be reached with P2 V/Hi. However, as relay 4 requires the option bit to be set, the "committed switches" setting must be P4 V/Hi.

Therefore, you must make settings in all 4 DiSEqC1.1 submenus for the marked SAT-IF route:
*   Set SAT-IF layer to V/Hi
*   Set satellite position to P4
*   Set 'uncommitted switches' to SW1:=OFF und SW2:=ON
*   Set repetitions to 2

Afterwards, the display should show "P42/V/Hi". This setting connects the SAT-IF route marked in bold type in the example. All settings are incorporated in the tuning memory and can easily be recalled later.

7.4.3.3   DiSEqC V1.2 control

LNB -> **DiSEqC** -> **V1.2** activates the DiSEqC V1.2 control. V1.2 can be used to control rotating systems with DiSEqC rotors. As with DiSEqC1.0, up to 4 SAT-IF layers can be operated.

The display of the position after 'P' in the top line of the display refers to the most recent position number called from the position memory of the DiSEqC rotating motor. If you switch to DiSEqC1.2, the rotation motor will drive to position number 1 at first.

You can open the menu for rotation motor control via **LNB** -> **Positioner**. Here you can carry out the following functions:

Drive:

This allows the motor to be turned to the east and west.

Figure 7-17 DiSEqC 1.2, menu drive

After the menu is opened, the menu item STOP (motor is stopped) is activated. While you press the left arrow key, the rotor moves in the easterly direction and stops immediately after releasing the key. The same does the right arrow key in the westerly direction.

East limit:

This enables an eastern limit to be set for the rotating system that it cannot pass. To do so, proceed as follows: First use the DRIVE function to move the motor to the position to be set as the eastern limit. If you select the menu item **Limit East**, the eastern limit will be stored in the rotating system.

West limit:

This enables a western limit to be set for the rotating system that it cannot pass. To do so, proceed as follows: First use the DRIVE function to move the motor to the position to be set as the western limit. If you select the menu item **Limit West**, the western limit will be stored in the rotating system.

Limits off:

This function allows you to override the eastern and western limits of the rotating system. The motor can then travel to its mechanical limits again. If you select the menu item **Limits off**, the limits in the rotating system will be deleted.

Save:

This function allows you to save in one of the 100 position memory locations a position to which you have previously moved. The numbering of the memory locations goes from 0-99.
Position 0 is reserved for reference position 0 degrees. If you select the menu item
Save, the following entry field is displayed:
You can use the numeric keypad to enter a memory location between 0 and 99. If you press the **ENTER** key, the current rotor position is stored in the pertinent memory location of the rotating system electronics.

Recall:

With the menu item **Go to**, you can recall a previously stored rotor position. The motor then turns to the saved position. Position 0 corresponds to the reference position 0 degrees. The most recently recalled motor position is shown on the display.

This position is incorporated in the tuning memory of the measuring instrument. It allows various orbital positions to be recalled from the tuning memory. There is then no need to open this indirectly via the **LNB** -> **Positioner** -> **Go to** menu.

7.4.3.4   DiSEqC V2.0 control

LNB -> **DiSEqC** -> **V2.0** activates the DiSEqC V2.0 control. The difference to V1.0 is the additional feedback query of a controlled DiSEqC component.

If the instrument controls a multi-switch with DiSEqC V2.0, the multi-switch sends an answer back to the instrument. The instrument evaluates this feedback and reports "Reply OK" if successful, in case of an error "incorrectly received". If the reply was received correctly but the message is not the expected code for "Replay ok" (0xE4), there is a report in a blue window: "DiSEqC Reply = 0x.." with the corresponding HEX-Code.

7.4.4   UNICABLE (EN 50494)

UNICABLE (satellite signal distribution over a single coaxial cable distribution network) is a variant of the DiSEqC control and corresponds to the EN 50494 standard. With this system, the desired transponder is converted to a fixed frequency (center frequency of the userband (UB) slot or band pass) in the UNICABLE unit (LNB or multi-switch). The information, regarding which transponders should be converted on which UB slot, is transmitted to the UNICABLE unit via a special DiSEqC command. The standard supports up to 8 UB slots. This allows up to 8 receivers to be operated on 1 cable.

The UNICABLE message contains the following information:

- SCR address (SCR = satellite channel router)
- Polarization (horizontal and vertical)
- Low or high band
- Tuning transponder frequency

With UNICABLE systems, the signal-generating receiver generates a high DC level as it transmits, which is added to the UNICABLE message (special DiSEqC command).

After transmitting the UNICABLE message, the receiver returns to an idle state in which a low DC level is generated. The receiver must return to a low DC level so that the system is available for other receivers. The measuring receiver uses 14 V for the low DC level and 18 V for the high DC level.

The following control routine is used in this instrument:
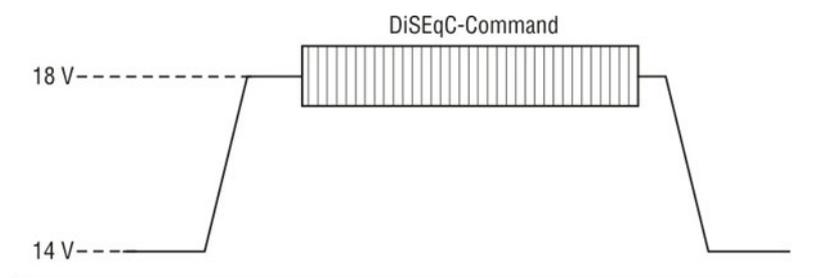
Figure 7-18 UNICABLE command

7.4.4.1   Activation and configuration

By pressing **LNB** -> **DiSEqC** -> **UNIC** the UNICABLE control is activated.

A menu is then displayed which can be used to edit the relationship between the satellite channel router (SCR) address and the center frequency of the user band (UB) band pass slot that the measuring receiver is to use: **SCR-ADR**. These parameters can be obtained from the data sheet of the UNICABLE unit being used. There are 8 banks of which each has 8 slots to store SCR addresses. (Bank1 has 4 slots)

UB slots always start with 1, SCR addresses start from 0. Therefore SCR address 0 corresponds to UB slot 1.

The name of the bank can also be edited. The user-defined name for the bank appears in the menu for selecting the bank.
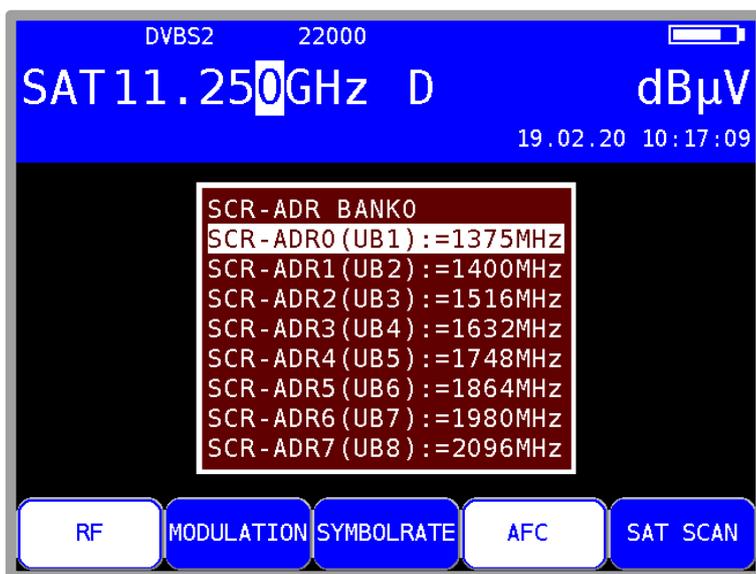
Figure 7-19 UNICABLE SCR-ADR activate menu

Change the settings of a UB slot: **LNB -> DiSEqC -> UNIC -> SCR-ADR.**

Select one of the UBs and press **ENTER** and the measuring receiver now operates with UNICABLE control.

To change the settings displayed, proceed as follows:

Use the Up and Down keys to select the required SCR address. Then press the $\rightarrow$ key to access the following menu.
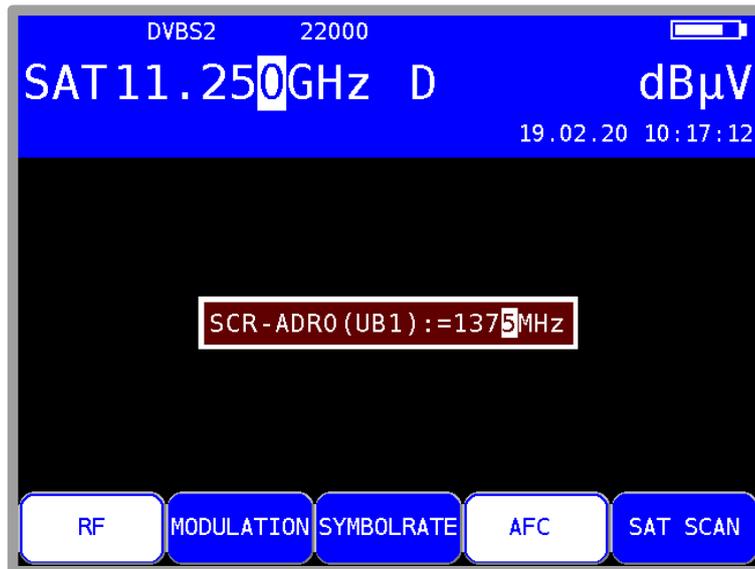
Figure 7-20 UNICABLE SCR-ADR edit center frequency

Here you can set the UB center frequency that corresponds to the selected SCR address. This is the frequency that a connected receiver needs to tune to. Use the ← and → keys, or the numeric keypad to set the UB center frequencies within the range from 950 MHz to 2150 MHz. Enter 0 MHz to mark the SCR address as unused ("----MHz").

Press **ENTER** to save the entry; the menu with the SCR address list reappears. Press **ENTER** again to complete configuration of the UNICABLE control in the measuring receiver.
All entries are stored in non-volatile memory; the instrument will operate using these settings when it is next switched on.

Alternatively, the slot frequencies can be read automatically from a connected CSS (Channel Stacking Switch), which is a multi-switch with UNICABLE output capability (see chapter 7.4.4.3 - Reading UB slot frequencies from CSS).

Entering a name for the bank: LNB -> DiSEqC -> UNIC -> Select Bank

You can select one bank in the SCR-ADR Bank selection menu. After pressing **ENTER** a new menu will appear. Select **Edit name** to assign a specific name of the bank. For example, you could enter the name of the manufacturer of the UNICABLE components. Using the ← or → arrow keys for moving the cursor to the desired position in the label. With the numeric keypad, you can enter or edit a name up to 20 digits in length. Pressing the ENTER key closes the input menu is and stores the name in non-volatile memory.

Entering of a startup time for the bank: LNB -> DiSEqC -> UNIC -> Select Bank

You can enter a time in ms, which a connected multiswitch needs until it is ready after power up to process DiSEqC commands. The default setup is 700ms. That time must be increased, if a UNICABLE device does not respond after recalling from the tuning memory.
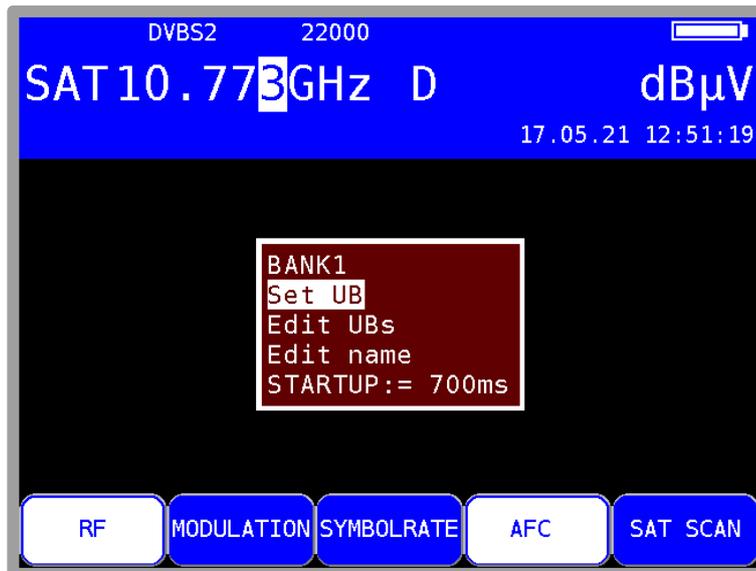
Figure 7-21 Entering a startup time for Unicable devices

SCR-ADR bank:

The market offers UNICABLE units for 4 and 8 receivers per cable. These units generally operate with different UB center frequencies. To simplify the procedure for the user, the instrument offers a feature that enables switching between 8 SCR address banks. That means that the instrument has 8 banks of SCR addresses for UNICABLE units that operate with up to 8 receivers. The UB center frequencies can be changed within the 8 banks as described above. The active selected bank is non-volatile. That means that the next time the device is switched on, it will operate again with these SCR-ADR <-> UB center frequency relationships. In addition, the bank setting is stored in the tuning memory. This makes it possible for you to combine memory locations with Bank0 to Bank7 as desired. You can switch between the banks using **LNB** -> **Select Bank** -> **BANK0** up to **BANK7**. The menu item names "BANK0" to "BANK7" are used in place of the user-defined bank designations.

Wideband RF mode: (only accessible if a UB slot is selected)

Some UNICABLE units (LNB) operate only on a single oscillator frequency. This means that the low band and the high band are combined into a one band. This special mode can be set in the measuring instrument via **LNB** -> **MODE** -> **Wideband RF**. The UNICABLE control is switched back into standard mode with 2 oscillator frequencies via **LNB** -> **MODE** -> **Standard RF**. This is also the instrument's default setting. This setting is non-volatile; the measuring receiver will work in this mode when UNICABLE control is next accessed. This setting is also stored in the tuning memory.

LO-Frequency (applies to Wideband RF mode only):

As already mentioned, some LNBs with UNICABLE support operate only on a single oscillator frequency. This frequency must be set in the instrument before it can be used to control these units. You can choose between oscillator frequencies 10.000 GHz, 10.200 GHz, 10.400 GHz, 13.250 GHz and 13.450 GHz via **LNB** -> LO-Frequency. The setting is also non-volatile. This setting is also additionally stored in the tuning memory. The default setting is 10.200 GHz.

7.4.4.2   Operation

The UNICABLE control can be used to convert up to eight SAT IF levels in up to eight UB slots. These are further divided into two satellite positions, each with four SAT IF levels or two SAT IF levels in wideband mode. Each connected receiver (max. 8) operates using a dedicated UB slot. This is defined via the SCR address.

These UNICABLE control parameters are set via **LNB** -> **SAT-IF-Layer** and **LNB -> Satellite**

The measuring receiver is tuned as described in chapter 7.1 - Frequency input.

The difference when using the UNICABLE control is that the desired transponder frequency is converted to the center frequency of a UB slot in the UNICABLE unit.

This means that the measuring receiver must send the transponder frequency to the UNICABLE unit as a UNICABLE command and then tune itself to the correct UB slot center frequency.

Whenever there is a new tuning process, the entire UNICABLE control command is sent to the UNICABLE unit. Since UNICABLE enables up to eight receivers to be connected to a single cable, collisions may occur between the connected receivers during control. If this situation arises when using the measuring receiver, send the control command again by pressing **HOME** and **ENTER** in sequence.

The following figure shows the instrument in UNICABLE mode with the LNB menu open.
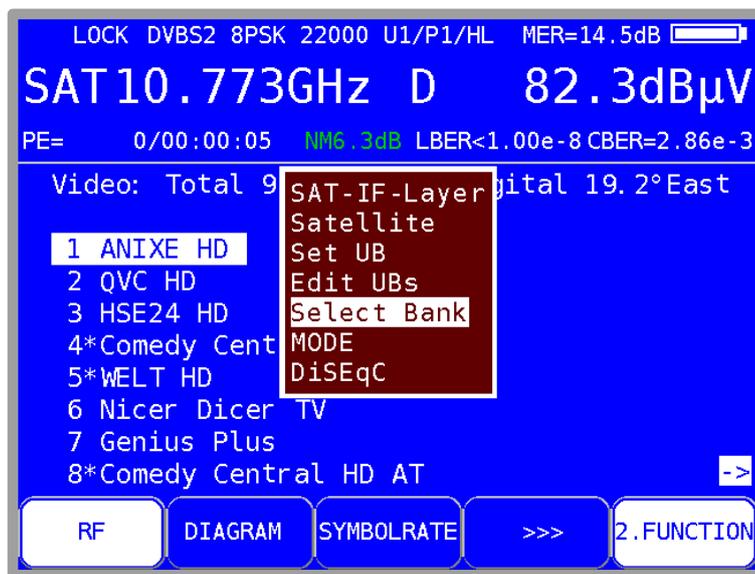
Figure 7-22 UNICABLE LNB menu

Wideband RF mode:

As described above, these UNICABLE units operate with a single oscillator frequency and the low and high bands combined on one band. This reduces the number of SAT IF levels to 2 (vertical and horizontal). If the instrument is in this mode, vertical (V) or horizontal (H) polarisation can be set via **LNB** -> **SAT-IF-Layer**. This also switches the measuring receiver to RF frequency input mode. A transponder frequency of between 10.700 GHz and 12.750 GHz can be entered.

Note: **In the UNICABLE and JESS operating mode the scan function is deactivated.**

7.4.4.3   Reading UB slot frequencies from CSS

This functionality is only available when the instrument is not tuned (default status).

As an alternative to manually entering the UB slot frequencies, the instrument can automatically read the parameters of a connected UNICABLE multi-switch (CSS: Channel Stacking Switch). The instrument uses the procedure as described in EN 50494. While UNICABLE control is active, open the LNB menu using the **LNB -> Scan SCR ADR**.

Press **ENTER** the scan starts and took about 10s. Then the determined UBs are shown along with their center frequencies.

After successful scan select one of the 8 items "Transfer UBs to BANKx" for saving the displayed frequencies in the non-volatile memory of the bank selected and overwrites the existing frequencies.

7.4.4.4 Programming antenna wall outlets

For single-cable systems, there is a possibility that participants sharing a cable will cause each other interference by using the same UB slots. To prevent this, programmable antenna wall outlets are available which accept only UNICABLE or JESS commands for the programmed UB slots (e.g., the SSD6 series of wall outlets from Axing or the JAP series from Jultec, etc.).

First, the device has to be in initial state (running measurements stop by pressing HOME).

Selecting **LNB** -> **DiSEqC**->**Prog. Tool**. opens a "Configurator" which can be used to analyze and program an antenna wall outlet connected to the measuring instrument. The figure below shows the measuring instrument in the antenna wall outlet configuration mode. There are up to 32 user band (UB) bandpass slots that can be programmed.
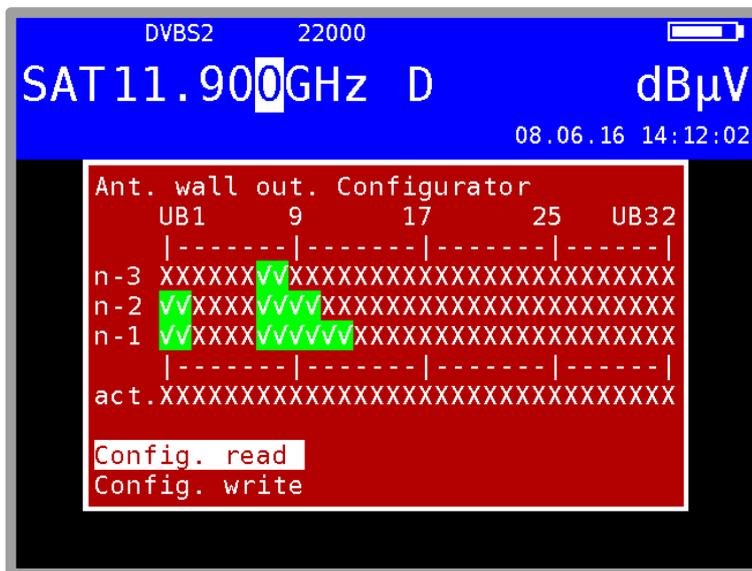
Figure 7-23 Antanna wall outlet configurator

Note: **With UNICABLE EN 50494 only the first 8 UB slots are addressable (see also chapter 7.4.5 - JESS (EN 50607)).**

An X represents a locked UB bandpass slot and a green check mark indicates an unlocked UB slot. The current configuration is displayed in the "act." line. This configuration can be determined by selecting **Config. read** or edited by selecting **Config. write**. The "n-1" line displays the last successfully programmed configuration, "n-2" displays the configuration previous to this, etc.

To change the current configuration, proceed as follows:

Select the "Config. write" menu using the up and down keys. Then press the → key to access the following menu (see Figure 7-24 Edit antenna wall outlet configuration).

The desired configuration can be set using the ↑/↓ keys as well as the ← and → keys. Pressing **ENTER** programs this configuration and returns you to the original menu.

If the programming was successful, this configuration is shown in the lines "n-1" and "act.", the previous contents of line "n-1" is now in line "n-2", etc. If the programming was not successful, the message "DiSEqC answer incorrect" appears briefly and the lines n-1 to n-3 remain unchanged (the configuration is transmitted using DiSEqC commands).
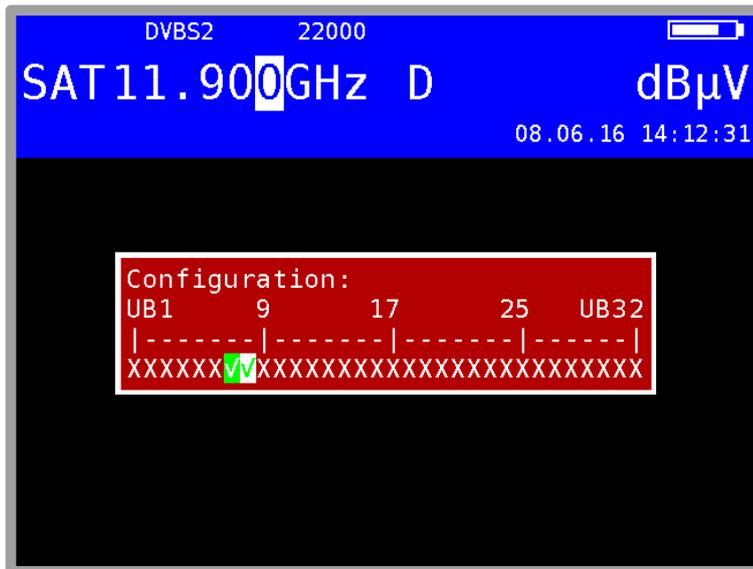
Figure 7-24 Edit antenna wall outlet configuration

7.4.5   JESS (EN 50607)

JESS (Jultec Enhanced Stacking System) is an expansion on the EN 50494 standard (UNICABLE). The following additions to UNICABLE have been incorporated:

- Up to 32 UB slots are supported (8 with UNICABLE).
- Up to 8 satellite positions can be controlled (2 with UNICABLE).
- The frequency of the JESS converter can be set in 1 MHz increments (in 4 MHz increments with UNICABLE).

7.4.5.1   Activation and configuration

JESS control is activated by selecting **LNB** -> **DiSEqC** -> **JESS**.
A menu is then displayed in which you can use **Set UB** to select the user band (UB) bandpass slot that the measuring receiver is to use. There are up to 32 UB slots in one Bank. By pressing **ENTER** the selected user band is being activated. **Edit UBs** is used to change the corresponding center frequencies of the user bands.
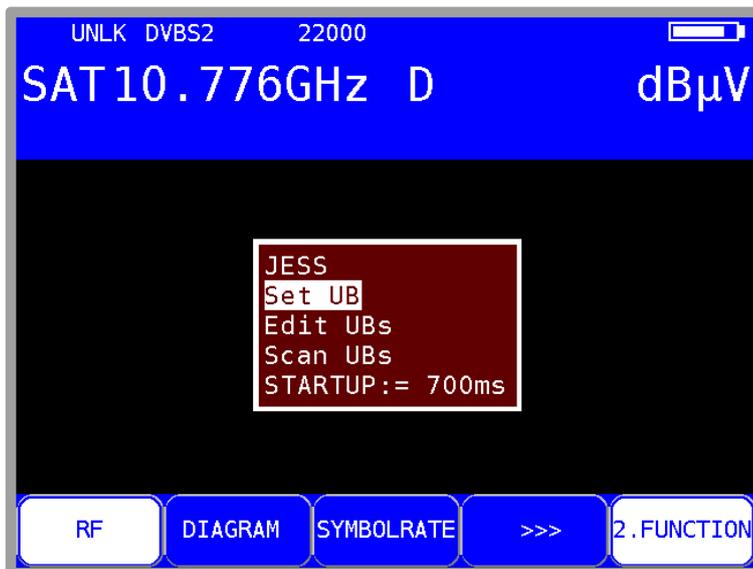
Figure 7-25 Jess UB selection

Entering of the User Band center frequency

Select the item **Edit UBs** in the menu above to open a submenu where you can set the UB center frequency that corresponds to the selected SCR address. This is the frequency that a connected receiver needs to tune to. Use the ↑/↓ keys, the ← and → keys, or the numeric keypad to set the UB center frequencies within the range from 950 MHz to 2.150 MHz.

Press **ENTER** to save the entry. The menu with the SCR address list will reappear.

All entries are stored in non-volatile memory. The instrument will operate using these settings when it is next switched on.

These parameters can be obtained from the data sheet of the JESS unit being used or, more simply, read directly from the JESS unit using a DiSEqC command (chapter 7.4.4.3 - Reading UB slot frequencies from CSS).

Entering a startup time for the user band

The time that a connected multiswitch needs to power up after applying LNB supply, you can enter in ms. The default setup is 700ms. That time must be increased, if a UNICABLE device does not respond after recalling from the tuning memory. See Figure 7-21 Entering a startup time for Unicable devices.

7.4.5.2   Operation

The JESS control can be used to convert 32 SAT-IF layers in a maximum of 32 UB slots. These are further divided into 8 satellite positions with 4 SAT-IF layers each. Each connected receiver (maximum of 32) operates using a dedicated UB slot. This is defined via the UB number.

These JESS control parameters are set via **LNB -> SAT-IF-Layer**, **LNB -> Satellite** and **LNB -> Set UB**.

The measuring receiver is tuned as described in the chapter 7.1 - Frequency input.

The difference when using the JESS control is that the desired transponder frequency is converted to the center frequency of a UB slot in the converter unit.

That means that the measuring receiver must send the transponder frequency to the converter unit as a JESS command and then tune itself to the correct UB slot center frequency.

Whenever there is a new tuning process, the entire JESS control command is sent to the CSS (Channel Stacking Switch) again. Because JESS enables the use of up to 32 receivers connected to one cable, clashes may occur between the connected receivers during control. If this situation arises when using the measuring receiver, send the control command again by pressing the **HOME** and **ENTER** key combination.

Note!   **In the JESS operating mode, the scan function is deactivated. In general, JESS components are backwards compatible and can also understand conventional EN50494 commands. If the expanded features of JESS are not required, UNICABLE control can also be used.**

7.4.5.3   Reading UB slot frequencies from CCS

In contrast to UNICABLE, where the UB configuration is indirectly determined using a scan function, JESS allows the number and center frequencies of the available UB slots to be read out from the CSS unit using DiSEqC commands. This makes the process significantly faster.

With JESS control active, select **LNB -> Scan UBs** and press **ENTER.** Available UB slots on the connected converter are determined, and they are displayed along with their center frequencies.
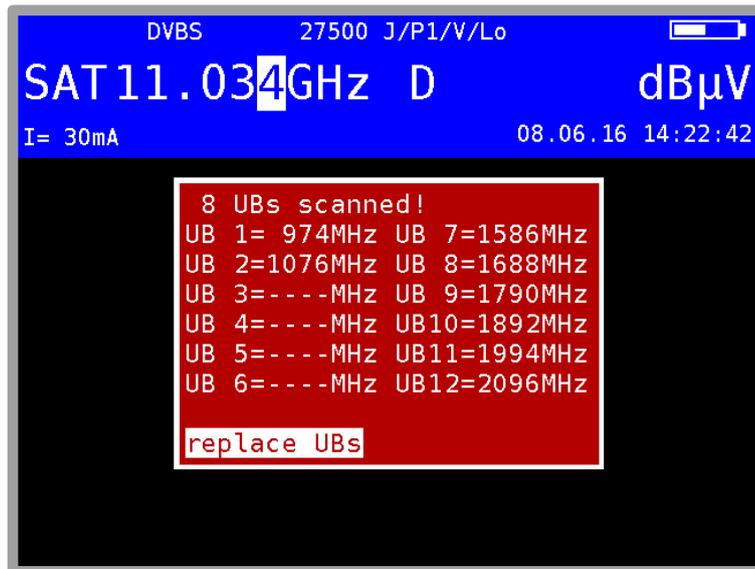
Figure 7-26 JESS: Reading UB slots frequencies from CSS

In the example above, 8 UBs are determined, the UBs 3 to 6 are blocked by a programmable wall outlet. The UB slots marked with "----" have no function. Press **ENTER** at **replace UBs** to store the frequencies to the UBs in the non volatile memory of the instrument.

7.4.5.4   Programming antenna wall outlet

See chapter 7.4.4.4 - Programming antenna wall outlets.

7.4.5.5   Show Continuous Wave (CW) tones

To get a general survey of the available UBs and the frequency-response curve, a CW tone at all available UBs is started and can displayed by the analyzer.
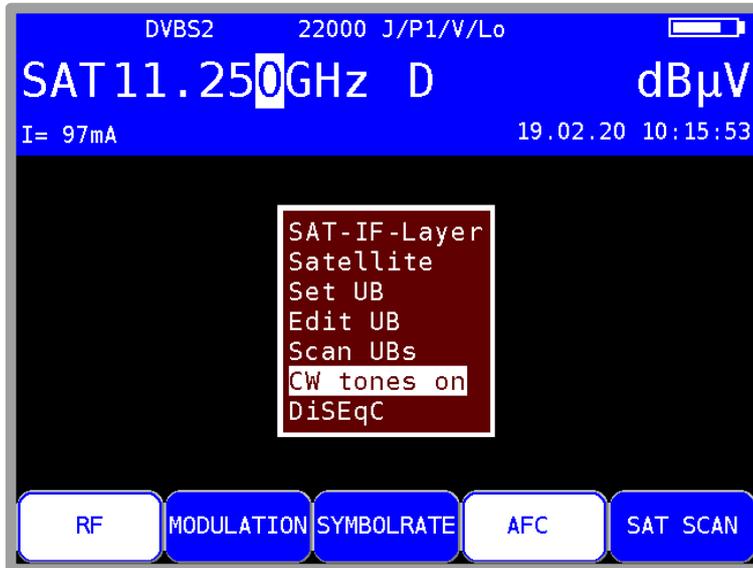
Figure 7-27 LNB menu JESS

First, the JESS-Mode must be activated. Selecting **LNB -> CW tones on**, a CW tone at all available UBs is started and the device gets in the analyzer mode.
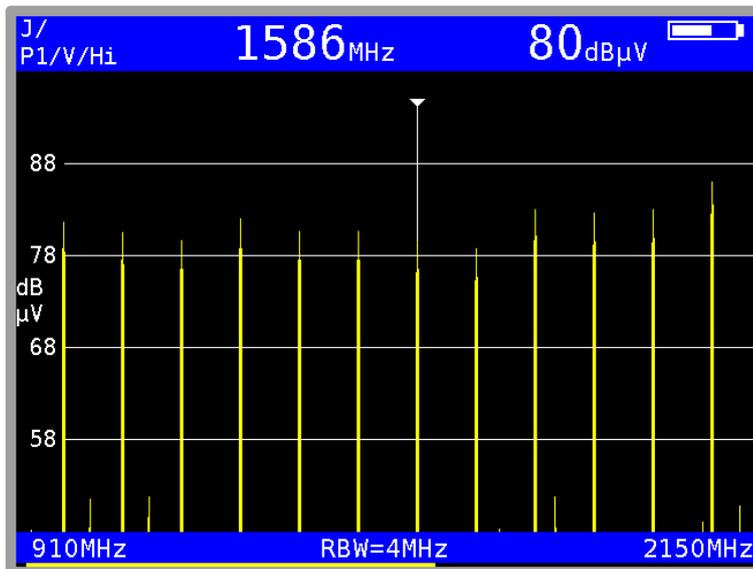
Figure 7-28 LNB Continuous Wave tones

Note!   **This feature is only available for devices according the EN50607. Using this, other receivers on the same cable are impeded, so it's only for service purpose.**

7.4.6   LNB current measurement

For this, you must bring the measuring instrument into the default status of the SAT measuring range. You can do this by pressing the **HOME** key. If an LNB supply is activated, the measuring receiver measures the amount of DC current flow at the RF input socket (e.g. to supply an LNB) and displays the current in mA on the left edge of the OSD. The measuring range spans from 0 - 500 mA with a resolution of 1 mA.

In Figure 7-27 LNB menu JESS a current of 8 mA is measured.

If the measuring receiver is tuned, the current indicator disappears from the display.

7.4.7   DiSEqC Script

Newer multiswitches for single-cable systems are programmable by DiSEqC-signals (like JULTEC a2CSS series). Usually manufacturers provide special program adaptors and PC-software tools. But this programming is also possible by this measuring receiver with the DiSEqC-Script function. A set of DiSEqC commands according EN 50494/50607 can be easily edited in a common texteditor end saved with the ending .dsq. You can get appropriate files from the manufacturer (e.g. JULTEC). These files must be stored on an USB-stick which can be connected to the measuring receiver. The script function sends the set of DiSEqC commands line by line over the RF-connector to the DiSEqC-Unit.
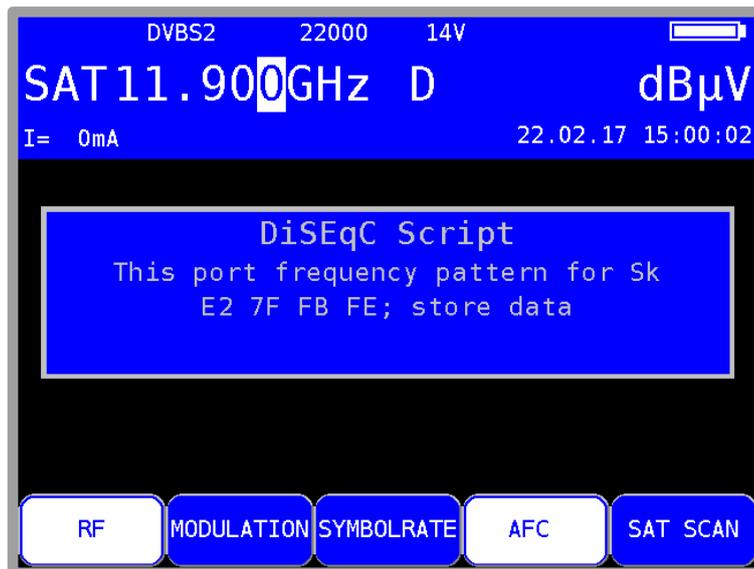
Figure 7-29 DiSEqC Script

7.4.7.1   Do the DiSEqC Script

First, the device has to be in initial state (stop running measurements by pressing **HOME**).

Plug in the USB-stick, which containing the script-files, into the receiver and connect it to the DiSEqC-Uint via RF-Connector. Selecting **LNB -> DiSEqC Script,** choose one of the ".dsq-files" shown in the directory and pressing **ENTER** to start the function. A window shows the first comment of the script file and the currently processed line. In the last line of the window a possible DiSEqC-response is shown.

7.4.7.2   Script structure

Sample of a DiSEqC-Script:

WideBand mode UAS 474 2 x 950..3000 MHz
E2 7F FB 40 00 00 03 52 00 00 03 52; LOF 9,75 GHz, IF 950..3000 MHz
E2 7F FB FE; store data
// comment

First line: Comment, which is shown during the whole processing.
Further lines: DiSEqC-commands composed of hexadecimal figures and a blank between each 2 bytes. A command have to start in the first column of a line and is terminated by a semicolon. The rest of the line is treated as a comment.
A double backslash // marks a comment.
An exception is the „18V" codeword, which must be written in an own line. Thereby the LNB-voltage is set to 18V to be confort for an UNICABLE standard transmission. Otherwise the LNB-Voltage is set to 14V

Chapter 8   TV Measuring Range

You access the TV range via **RANGE** -> TV .
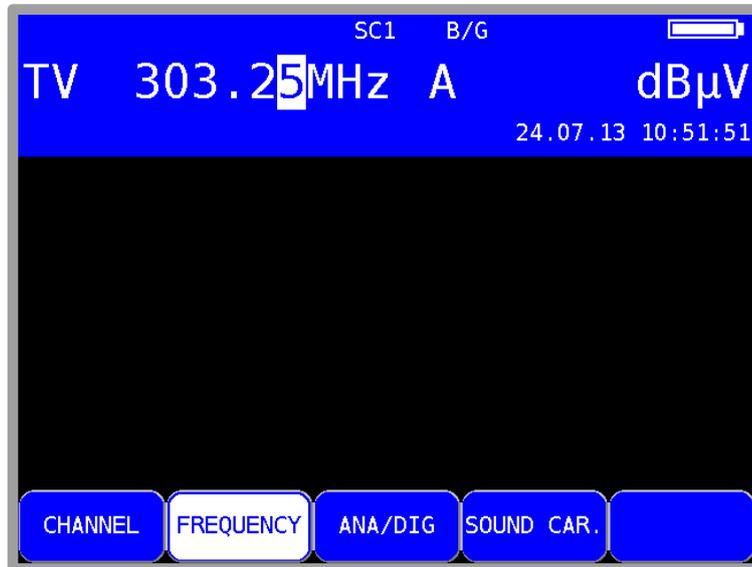
Figure 8-1 TV measuring range

8.1   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.

8.1.1   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 (B/G, 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 ignored and the last valid channel number is shown again.

8.1.2   Frequency input

You can enter the frequency within a range of 4MHz and 868.00 MHz (1214 MHz optional) 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.

8.2   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.

8.2.1   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.

8.2.1.1   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.

8.2.1.2   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 8-2 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.

8.2.1.3   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 not inverted. That means the first function of the arrow keys is active

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**.

To use the second function of the arrow keys, first press the **F5** key and then the item 2.FUNCTION gets inverted. Now the measurement parameter area can be hidden or shown using the arrow keys.

8.2.1.4   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 are interrupted by using **PRINT** ore **SAVE.** To restart reproduction use **ENTER**.

8.2.1.5   S/N measurement
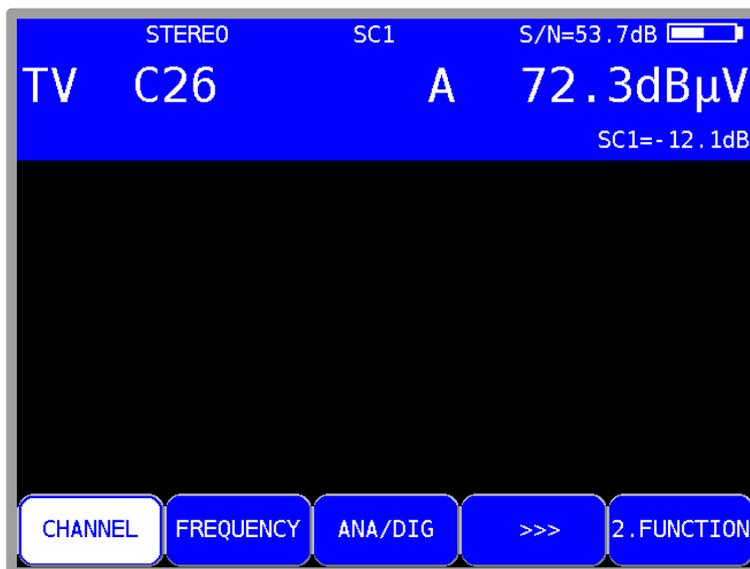
Figure 8-3 S/N measurement display

The S/N (Signal/Noise) measurement (see Figure 8-3) 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.

8.2.1.6 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 EN 500083-7 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.

8.2.2 DIGITAL (DVB-C, DOCSIS-Downstream, DVB-T/T2) operating mode

Here you can receive the digitally modulated DVB-C/-T/-T2 or DOCSIS signals and measure their signal quality.

8.2.2.1 DVB-C

The DVB-C receiver of the measuring instrument is activated via the menu item MODULATION -> DVB-C.
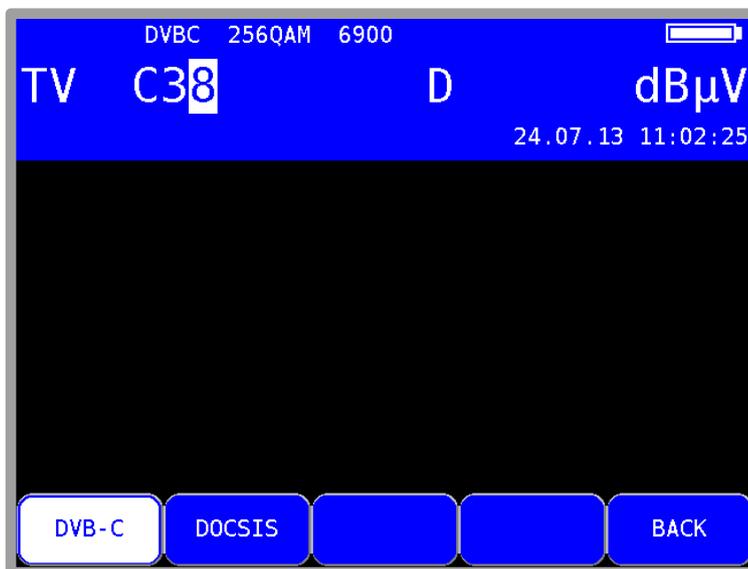
Figure 8-4 DVB-C mode

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.

8.2.2.1.1 Symbol rate input

You must set the corresponding symbol rate before a DVB-C (QAM) signal can be received.
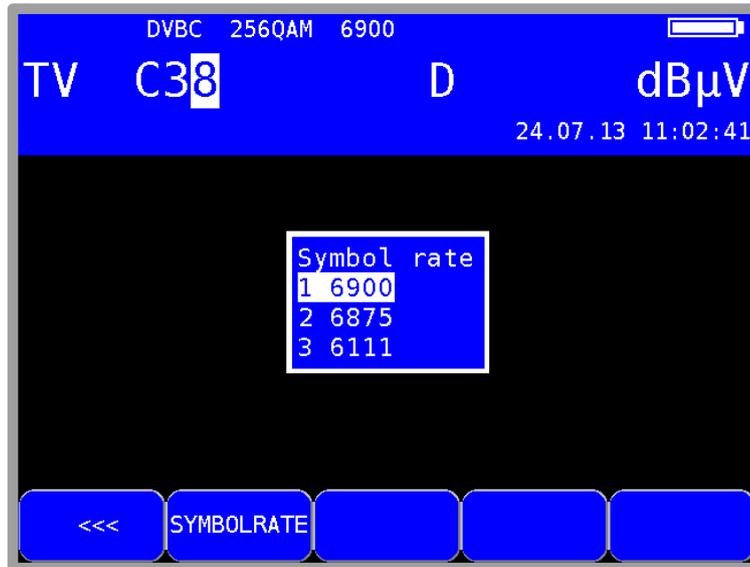
Figure 8-5 Symbol rate setting

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 1000 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.

8.2.2.1.2 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.

```
    LOCK DVBC  256QAM  6900          MER>40.0dB ▭
   TV   S 3            D   59.8dBµV
   PE=      0 /00:00:06              BER<1.00e-8
   Video: Total 3

    1 ZDF HD
    2 zdf_neo HD
    3 zdf.kultur HD




    CHANNEL  FREQUENCY  ANA/DIG    >>>     2.FUNCTION
```
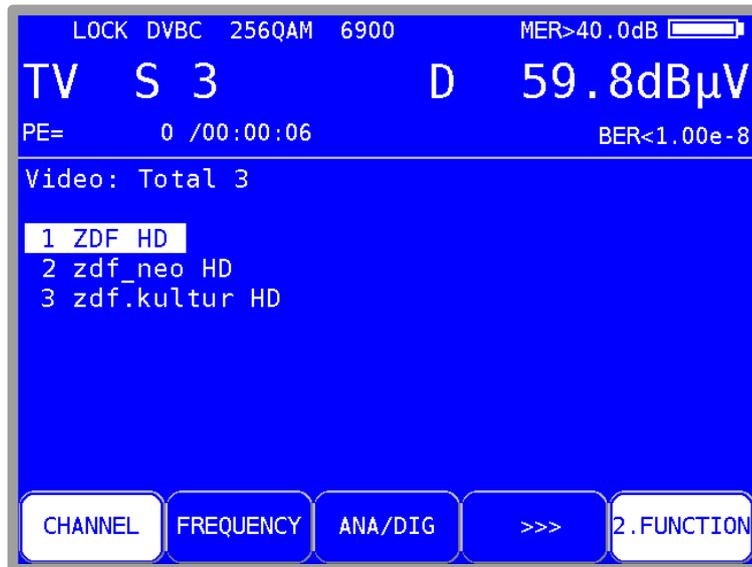
Figure 8-6 DVB-C select service

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.

8.2.2.1.3   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.

8.2.2.1.4   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.

8.2.2.1.5   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.

8.2.2.1.6   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.

8.2.2.1.7   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.

8.2.2.1.8   Picture and sound check

For digital television, picture and sound decoding take place in the MPEG decoder. (See **Fehler! Verweisquelle konnte nicht gefunden werden.**)

8.2.2.1.9   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 14 Chapter 14 Constellation diagram.

8.2.2.2   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).

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

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.
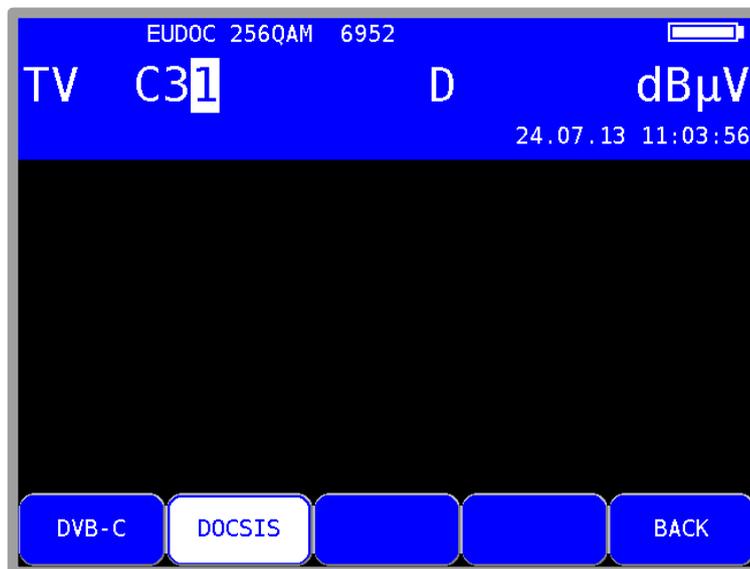
Figure 8-7 DOCSIS mode

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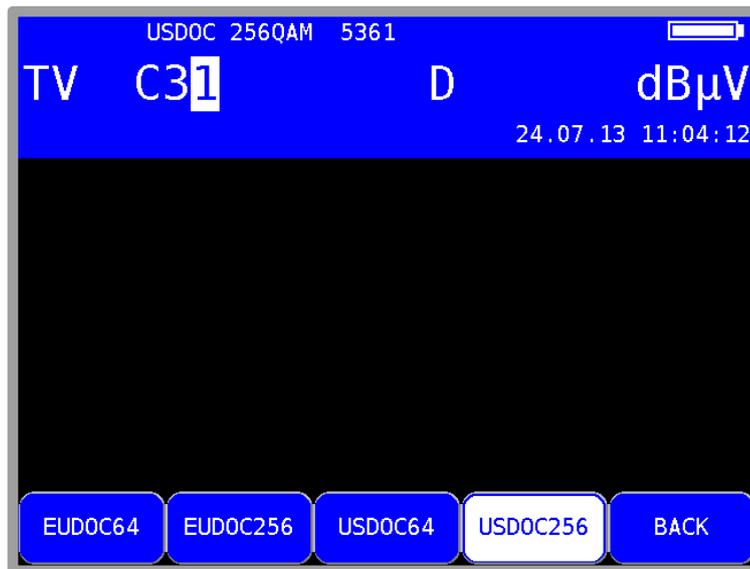
Figure 8-8 DOCSIS modulation type

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.

8.2.2.2.1 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).

8.2.2.2.2   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 scan is 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.
In this mode the item 2.FUNCTION is not inverted after the entry of a new channel. That means that the scan can be operated with the arrow keys. To first press the F5 key in order to activate the first function of the arrow keys is not necessary.

8.2.2.2.3   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 displayed in exponential form. For US-DOCSIS the measuring depth is $1 \cdot 10^8$ bits.

8.2.2.2.4   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.

8.2.2.2.5   Noise Margin (NM)

The measurement is identical to that of DVB-C (chapter 8.2.2.1.6 - Noise Margin (NM)).

8.2.2.2.6   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.

8.2.2.2.7   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.

8.2.2.3   DVB-T

The DVB-T receiver of the measuring instrument is activated via the menu item $\boxed{\text{MODULATION}}$ -> $\boxed{\text{DVB-T}}$.
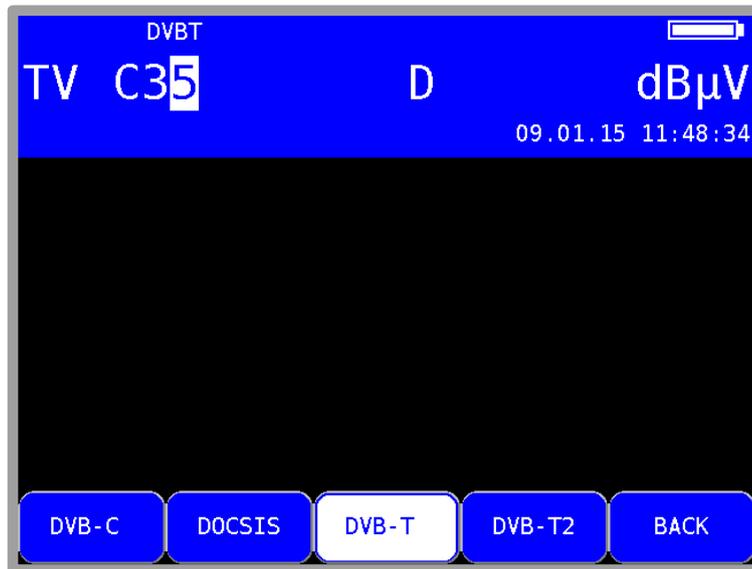
Figure 8-9 DVB-T modulation

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.

8.2.2.3.1   Selection of the COFDM bandwidth (channel bandwidth)

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

Figure 8-10 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.

8.2.2.3.2   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.

8.2.2.3.3   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.
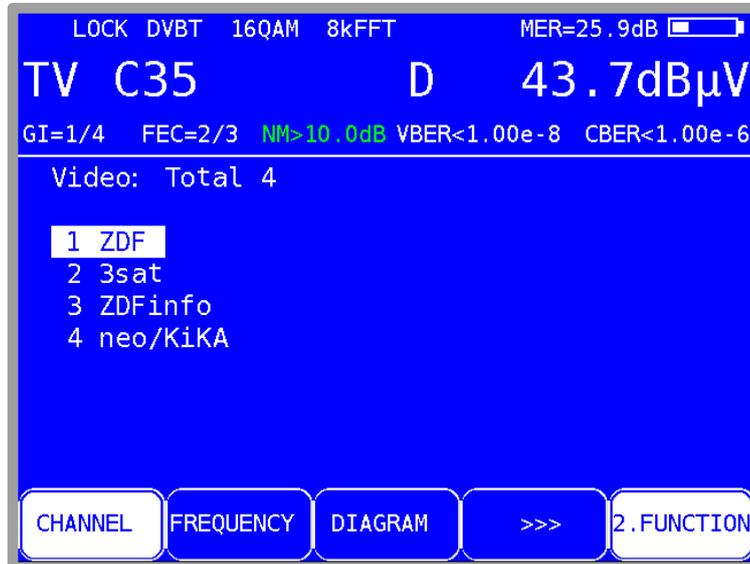
Figure 8-11 DVB-T parameters

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 8-11 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.

8.2.2.3.4   Further DVB-T parameters

The menu item **PARAMETERS** opens a sub menu with further DVB-T parameters.

```
 LOCK DVBT  16QAM  8kFFT        MER=26.9dB ▭
TV C35           D    46.2dBµV
GI=1/4   FEC=2/3  NM>10.0dB VBER<1.00e-8  CBER<1.00e-6

  Video: Total 4

  1 ZDF
  2 3sat BW=8MHz        16QAM
  3 ZDFi GI=1/4         FEC=2/3
  4 neo/ 8kFFT          Cell_ID=00513
       Ok



   <<<    PARAMETERS ANA/DIG   Const
```
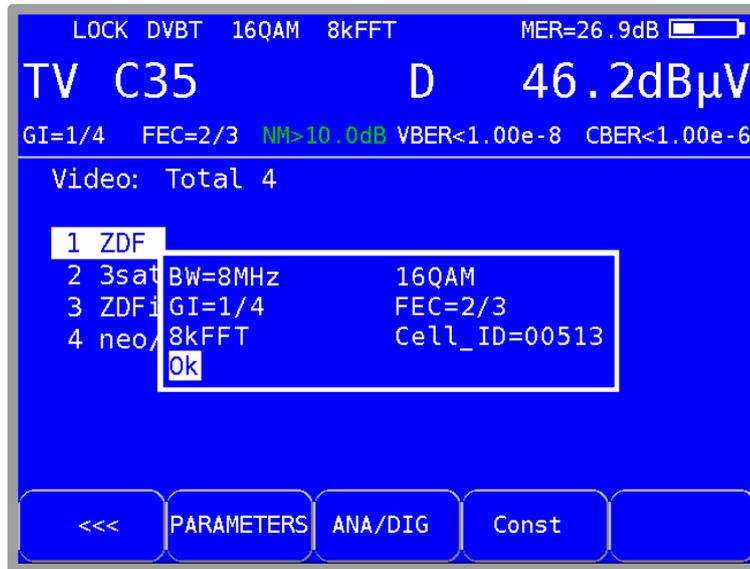
Figure 8-12 DVB-T parameter information

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

8.2.2.3.5   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.

8.2.2.3.6   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.

8.2.2.3.7   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.

8.2.2.3.8   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 $\boxed{\text{IMPULSERES}}$. A menu for additional settings will then appear.
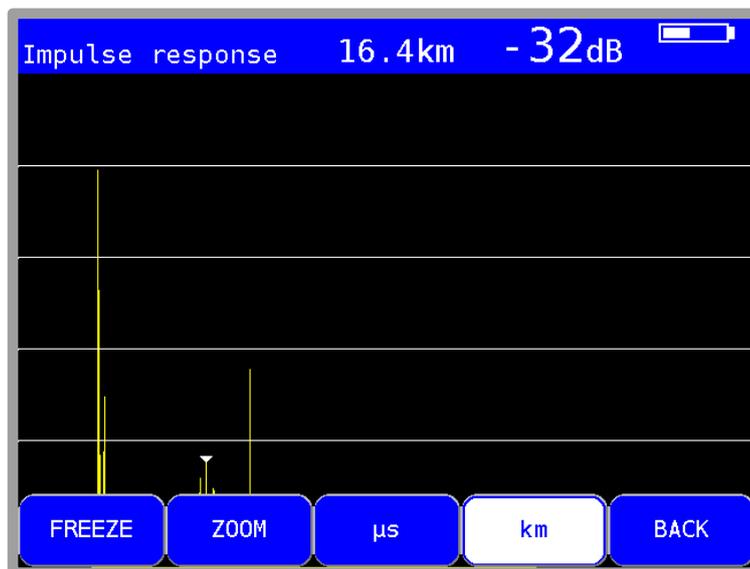
Figure 8-13 DVB-T Impulse response menu options

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 then see more details near the primary impulse. You can define the unit of the x-axis with $\boxed{\mu s}$ or $\boxed{km}$. 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 $\boxed{\text{BACK}}$.
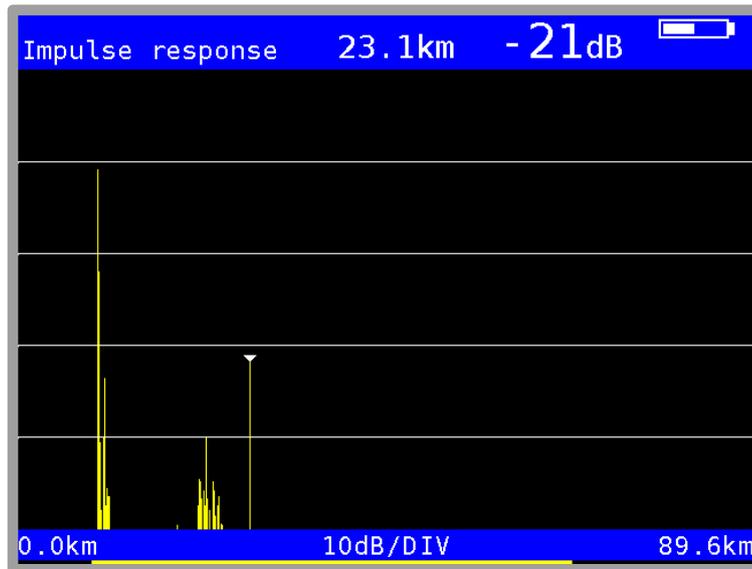
Figure 8-14 DVB-T Impulse response

Figure 8-14 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.

8.2.2.3.9 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.

```
 LOCK DVBT  16QAM  8kFFT          MER=30.4dB ▭
TV C35            D      52.2dBµV
PE=      0 /00:05:15      VBER<1.00e-8  CBER=1.91e-6
 Video: Total 4

 1 ZDF
 2 3sat
 3 ZDFinfo
 4 neo/KiKA



    <<<    MODULATION IMPULSERES  PE-INFO    >>>
```
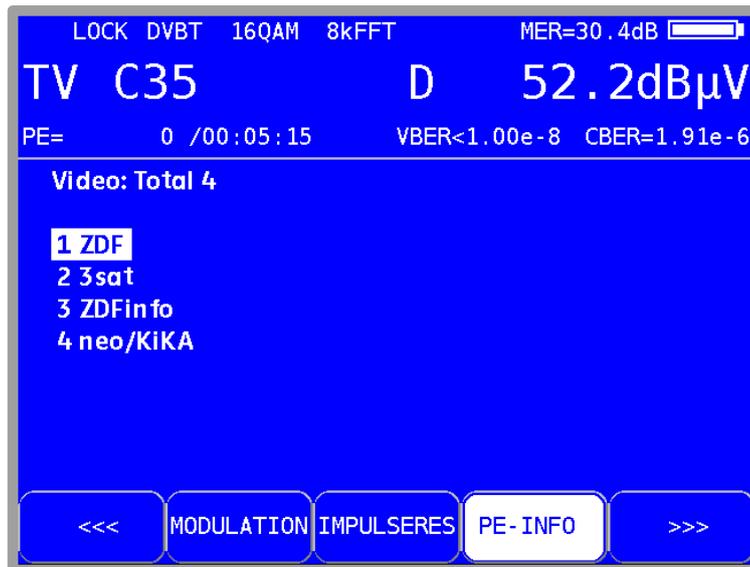
Figure 8-15 DVB-T packet error

8.2.2.3.10 Picture and sound check

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

8.2.2.3.11 Remote supply

The measuring receiver can provide a remote power supply via the RF input socket for an active receiving antenna (see also chapter 12.9 - Remote supply).

8.2.2.3.12 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 taken from Chapter 14 - Constellation diagram.

8.2.2.4 DVB-T2

The DVB-T2 receiver of the measuring instrument is activated via the menu item MODULATION -> DVB-T2 .
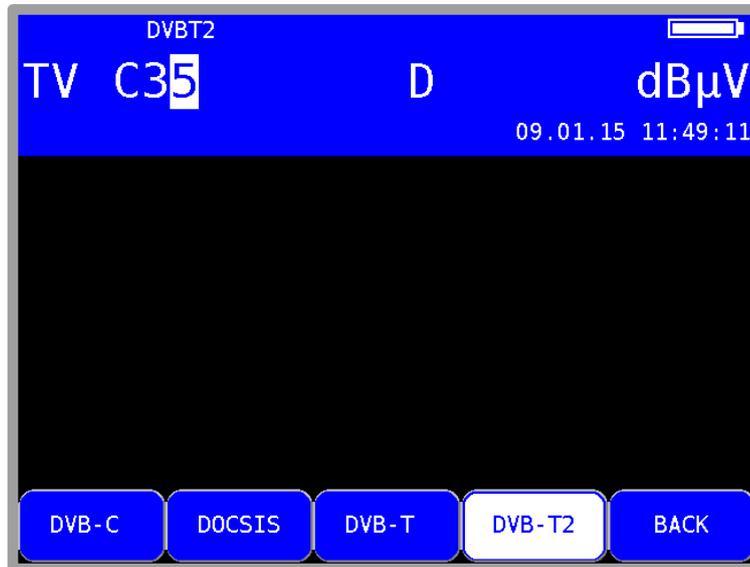
Figure 8-16 Modulation mode DVB-T2

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.

8.2.2.4.1 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.

8.2.2.4.2 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.

8.2.2.4.3   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 8-17 DVB-T2 parameters

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

In Figure 8-17, 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

8.2.2.4.4   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   >>>
```
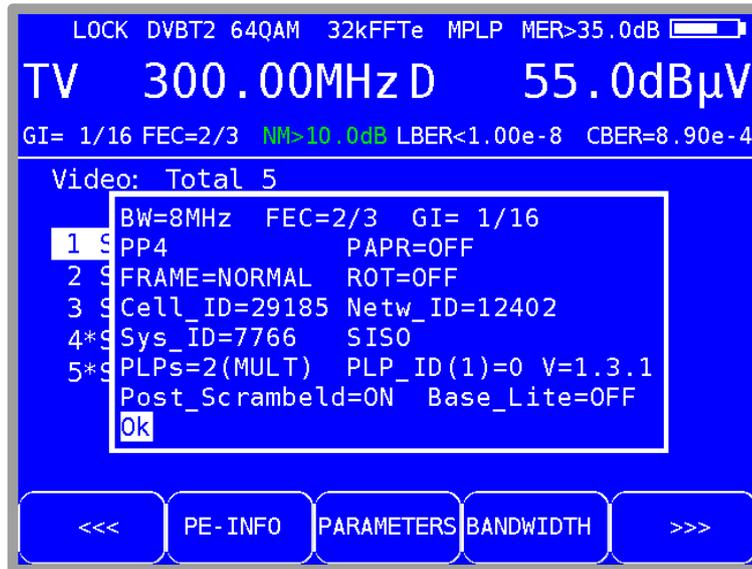
Figure 8-18 DVB-T2 parameters info

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)
- Cell_ID = cell of the transmitter
- System = SISO (Single In Single Out) – One transmission antenna and one 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 DVB-T2-Version
- Post_Scrambeled: from Version 1.3.1 and higher additional coding.
- Base_Lite: additional PLP at lower code rate

8.2.2.4.5   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.

8.2.2.4.6   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.

8.2.2.4.7   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.

8.2.2.4.8   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.

8.2.2.4.9   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, $c := 3 \cdot 10^8 \text{m/s}$. You can end the display of the impulse response via the menu item $\boxed{\text{BACK}}$.
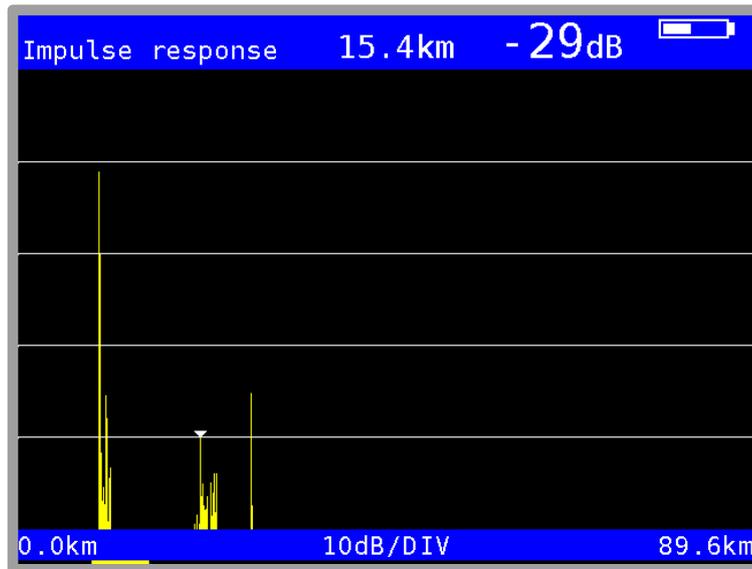
Figure 8-19 DVB-T2 Impulse response

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.

8.2.2.4.10 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.

8.2.2.4.11 Picture and sound check

For digital television, picture and sound decoding take place in the MPEG decoder (see Chapter 13 - MPEG Decoder**Fehler! Verweisquelle konnte nicht gefunden werden.**).

8.2.2.4.12 Remote supply

The measuring receiver can provide a remote power supply via the RF input socket for an active receiving antenna (see also chapter 12.9 - Remote supply).

8.2.2.4.13 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 taken from Chapter 14 - Constellation diagram.

8.2.2.5   DTMB (Option)

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**.
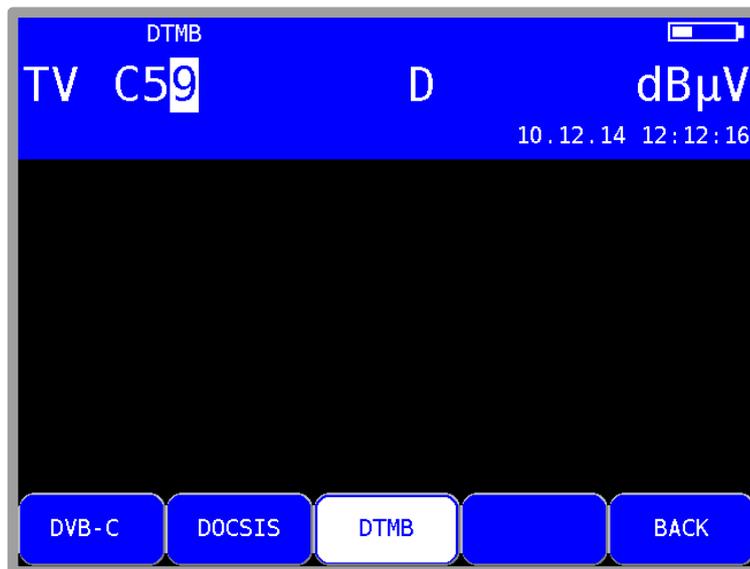
Figure 8-20 Modulation selection DTMB

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

Figure 8-21 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.

8.2.2.5.1   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.

8.2.2.5.2   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 │ │        │ │        │
    └──────┘ └───────────┘ └─────────┘ └────────┘ └────────┘
```
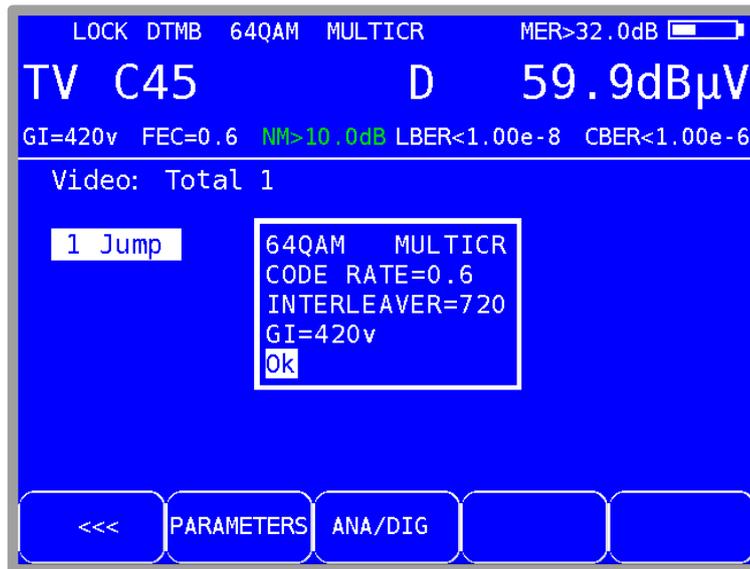
Figure 8-22 DTMB parameters

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

8.2.2.5.3 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.

8.2.2.5.4 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.

8.2.2.5.5 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 value of LBER (>1e-7 for bad).

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

8.2.2.5.6 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.
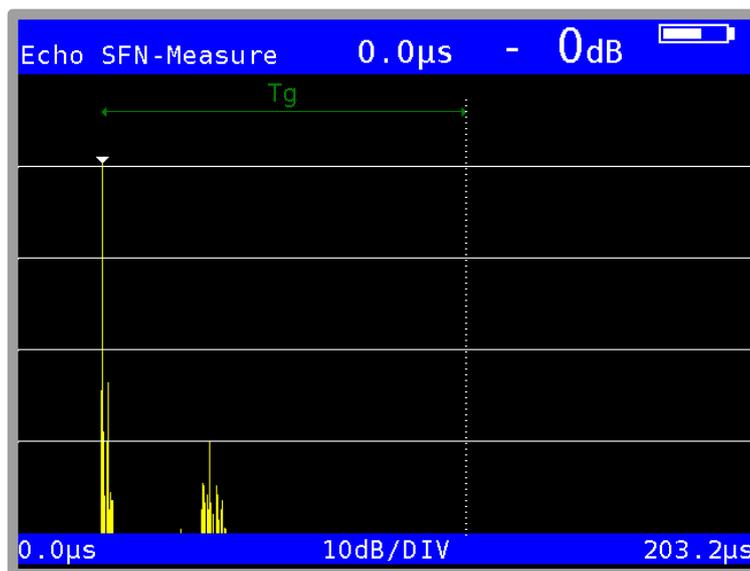
Figure 8-23 DTMB Impulse response

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.

8.2.2.5.7 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.

8.2.2.5.8 Picture and sound check

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

8.2.2.5.9 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.

8.2.2.5.10 Remote supply

The measuring receiver can provide a remote power supply via the RF input socket for an active receiving antenna (see also chapter 12.9 - Remote supply).

8.3 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.

8.3.1 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.

8.3.2 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.

8.3.3 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).

8.4 Diagrams

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

8.4.1 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 .
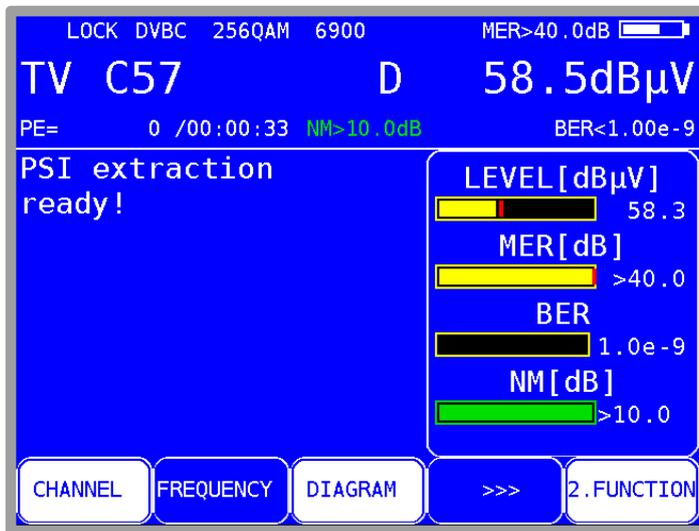
Figure 8-24 Diagram display

8.5   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.

8.5.1   Starting a new scan

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

Figure 8-25 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.

8.5.2   Aborting a scan manually

You can follow the progress as the instrument carries out the function.
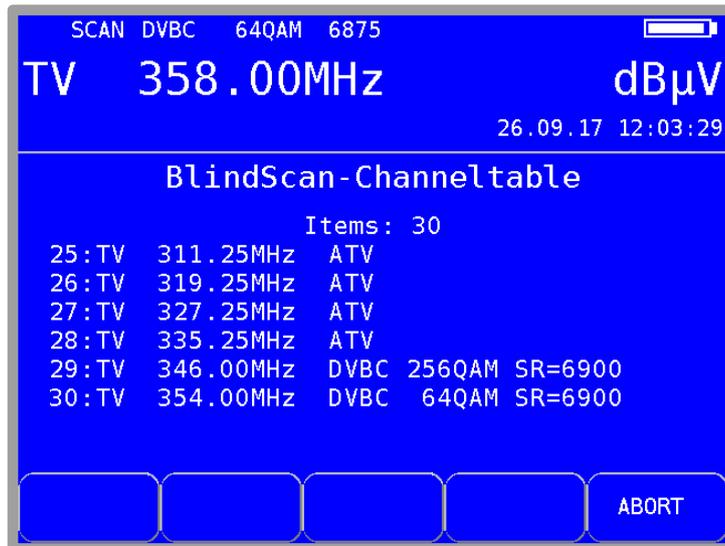
Figure 8-26 BlindScan Channeltable

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.

8.5.3 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.
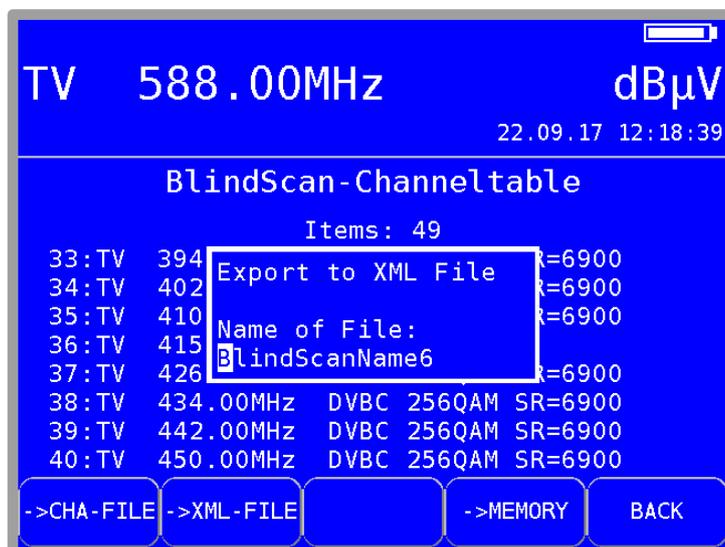
Figure 8-27 BlindScan export to XML file

The **->CHA-FILE** menu item allows the list to be exported as a user-defined channel list (see "19.7 - 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 9   FM (VHF) Measuring Range

You activate the FM (VHF) range via **RANGE** -> FM .
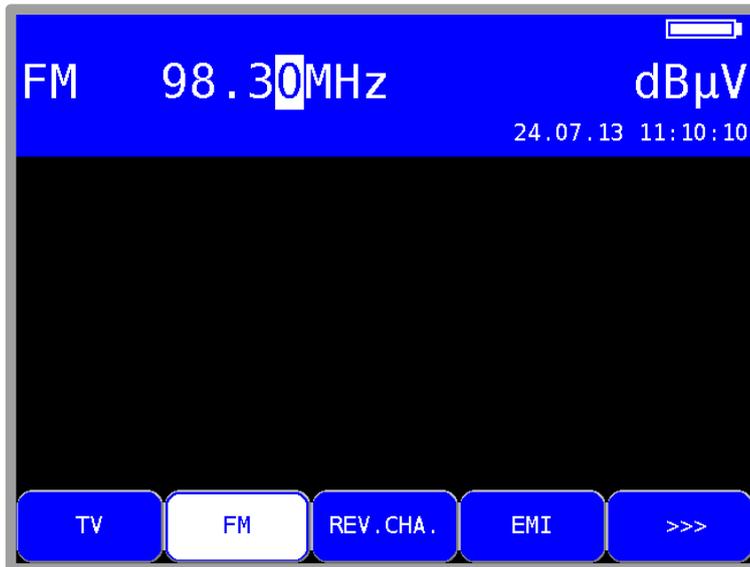
Figure 9-1 VHF measuring range

9.1   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.

9.2   Sound reproduction

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

9.3   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 9-2 VHF stereo indicator display

9.4   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.

9.5   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. 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.

9.6   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.

9.6.1 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 10 RC (Return Channel) Measuring Range

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

Figure 10-1 RC measuring range

10.1   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.

10.2   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.

10.2.1   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 10-2 RC Max Hold function

10.2.2   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.
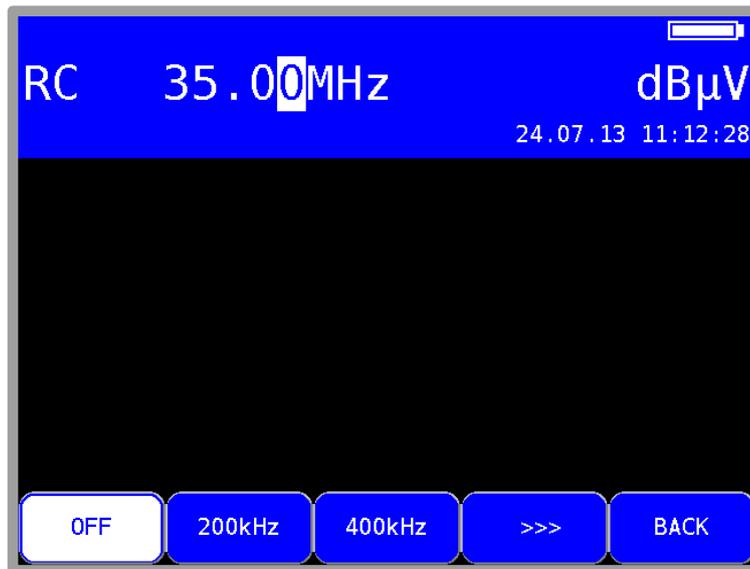
Figure 10-3 RC Setting channel bandwidth

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.

10.2.3   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 11 DAB Measuring Range

DAB stands for "Digital Audio Broadcasting". The measuring receiver can demodulate both DAB and DAB+ modulated signals and decode the FIC (Fast Information Channel) and MSC (Main Service Channel) information contained within.
You access the DAB range via **RANGE** -> **DAB** .
This range spans the frequency range from 170.00 to 250.00 MHz.
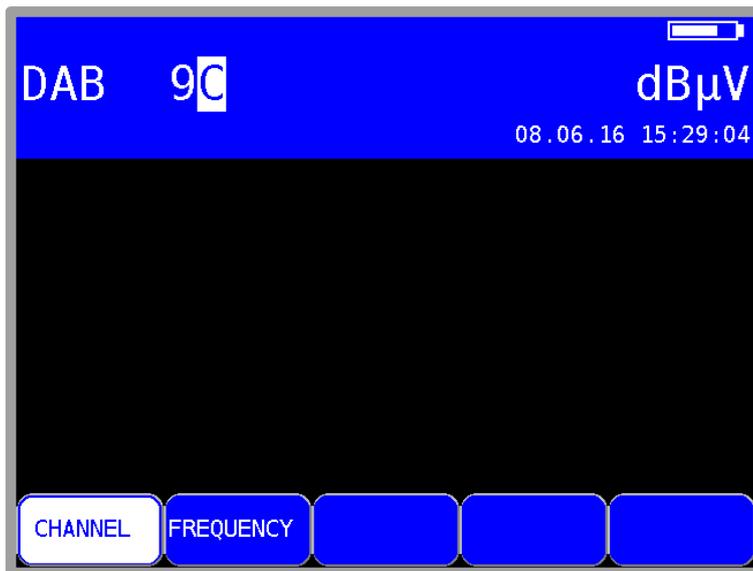
Figure 11-1 DAB mode

11.1   Switching between frequency and channel input

The instrument can be tuned by entering the channel center frequency or by entering the channel. You can switch between modes using the menu items **CHANNEL** or **FREQUENCY**. After selection, the corresponding menu item is displayed inverted.

11.1.1   Frequency input

Using the numeric keypad, you can enter a frequency between 170.00 and 250.00 MHz. The smallest frequency resolution is 0.05 MHz (50 kHz). 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   Channel input

A channel table stored in the instrument serves as the basis for channel input. The table contains a center frequency for each channel.
The DAB channel grid is derived from the original TV channel grid in the VHF range.
A DAB channel has a bandwidth of 1.75 MHz. A maximum of 4 DAB channels can therefore share an original 7 MHz channel. This fact must be taken into account in the numbering of DAB channels in the VHF range (mode I). The channel with the lowest frequency receives a channel number with the index "A", and the next 3 channels receive the indices "B", "C" and "D". Channel 13 is a special case, where the DAB channels are defined as 13E and 13F. The complete channel table is provided in the appendix of these instructions.

You can enter the desired channel number using the numeric keypad. The channel index ("A"-"F") can be entered using keys 1 (for "A") to 6 (for "F"). Use the **ENTER** key to confirm the entry. Invalid entries are ignored.

If the measuring receiver is tuned and the menu item 2.FUNCTION is not inverted, you can set the previous or next channel using the ← and → keys. In this way, you can key in the channels one by one.

11.2   Scan

You can use this function to scan the entire range for DAB/DAB+ signals. For this, you must switch the instrument to channel input mode.
In the DAB 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

11.3   Level measurement

After the measuring receiver is tuned, the automatic attenuation control and level measurement starts.
The spectra of the signals for DAB 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 level measured is indicated on the right side of the display in dBµV with 0.1 dB resolution.
The measuring range extends 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.

11.3.1   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. In this case, an acoustic signal is emitted from the speaker. Its frequency changes in proportion to the measured level. When the level increases, the frequency goes up and vice versa.
The acoustic signal can be switched on and off via the menu item ACOU.LEVEL.
When the acoustic signal is switched on, the menu item is displayed inverted.

11.4   DAB 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 no DAB signal is received at this frequency.

Figure 11-2 DAB tuned with FIC-list

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

4 different modes are defined for DAB. Mode I is intended for transmission in the VHF range. The other 3 modes are reserved for transmission in the L band.

Station ID: A station ID is also transmitted in DAB. This
TII (Transmitter Identification Information) is transmitted in the first DAB symbol (zero symbol).
Each DAB station transmits its own unique Main ID and Sub ID. These numbers allow a station to be uniquely identified in a single-frequency network. This is unlike in DVB-T, where each station in a cluster transmits the same station ID.

11.5   BER measurement (Bit Error Rate)

The measurement of the bit error rate aids in the determination of the quality of a DAB 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 this. This number is placed in a ratio to the total throughput of bits, and the BER is calculated based on this.

In DAB, the FEC (Forward Error Correction) consists of convolutional coding. In the DAB receiver, the decoding is performed by a Viterbi decoder. In DAB, the various symbols in the DAB frame can be protected against errors in different ways. In this way, information components can be transmitted more or less robustly.

To determine the bit error rate, the measuring receiver evaluates the corrected bits in the MSC (Main Service Channel).
Once the receiver has locked in on a DAB signal, the BER is shown on the display in exponential form. The displayed CBER is the BER before Viterbi of the MSC. This is the channel bit error rate. The depth of measurement is $1 \cdot 10^6$ bits.

11.6   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, e.g. for DVB-T, and can be applied to DAB in a similar manner. MER is calculated from the DQPSK constellation points.
It is the counterpart to S/N measurement with analog transmission methods. The measuring range extends up to 25 dB with a resolution of 0.1 dB.

11.7   FIC decoding

Once the measuring receiver has locked in on a DAB signal, the DAB frame is analyzed. The data of the FIC (Fast Information Channel) are then analyzed. This contains information on the composition of the ensemble. For DVB, this corresponds to evaluation of PAT, PMT and SDT. The instrument then creates a program list and displays this on the TFT. This is performed in a similar manner as for DVB (see chapter 13.1 - Program Service Information (PSI)).

The decoder lists the names of all audio programs contained in the ensemble.
Pure data streams are not included. DAB+ programs receive an additional label. If the list comprises multiple pages, you can switch between pages of the program list using the ← and → keys.

11.8   MSC decoding and audio playback

You can play a program from the list by moving the cursor onto the desired program name using the ↑ and ↓ keys.

When **ENTER** is pressed once, the decoder lists the corresponding program details Extracted from the main service channel (MSC).

LOCK	MODE I	MER>25.0dB

```
DAB10D                      51.5dBµV
TII: MainId=01 SubId=01           CBER<1.00e-6

  Programmme properties

  Name:  KULTRADIO
  Prov:  Bayern
  ServiceID: 1013h 4115d
  Type:  DAB+
  Data rate:  72kBit/s

  Start program

CHANNEL  FREQUENCY  ACOU.LEVEL  >>>  2.FUNCTION
```
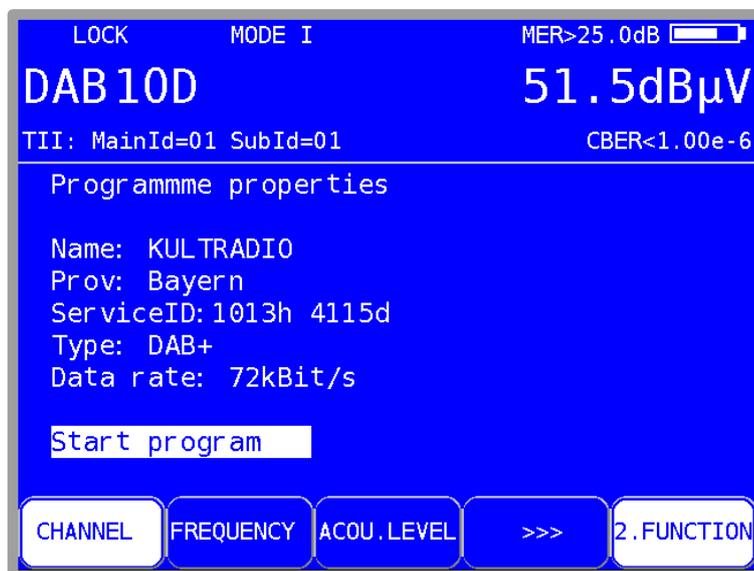
Figure 11-3 DAB program details

This includes the program name, program provider, service ID, DAB type and the audio data rate of the particular program. The example above is for a DAB+ program with 72 kbit/s.

Pressing **ENTER** again starts audio playback and the sound can be monitored using the internal speakers or the headphone jack. Pressing again stops playback of the current program, and the program list again appears on the screen.

11.9   Remote supply

The measuring receiver can provide a remote power supply via the RF input; for example, this may provide power for an active receiving antenna. You may choose between 5 V, 14V, 18 V and no remote supply.

The supply is short circuit-proof and provides a maximum current of 500 mA. The instrument automatically switches off the remote supply if there is a short circuit or if the current is too high. The red LED on the RF input lights up as soon as the remote supply is active.

Important!   Always check that the connected system is compatible with the selected remote supply before switching on the remote supply. Otherwise, terminating resistors may be overloaded or active components may be destroyed.

11.9.1   Setting the remote supply

Press **LNB** to open the selection menu. You may select from the available voltages (0V, 5V, 14V and 18V) using the arrow keys and activate the supply by pressing **ENTER**.

11.9.2   Measuring the remote supply current

For this, you must the measuring instrument into the default status in the DAB range. You can do this by pressing the **HOME** key. If remote supply is activated, the measuring receiver measures the amount of DC current flowing from the RF input socket (e.g. to supply an active antenna) and displays the amperage in mA on the left edge of the display. The measuring range extends from 0 -500 mA with a resolution of 1 mA.

Chapter 12 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".

12.1   Calling-Up

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

Figure 12-1 Electromagnetic interference measurement main screen

12.2   Frequency input

You can enter a frequency between 45.00 MHz and 868.00 MHz (or 1214.00 MHz if the device is equipped with the corresponding hardware option) 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.

12.3   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.

12.3.1   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.
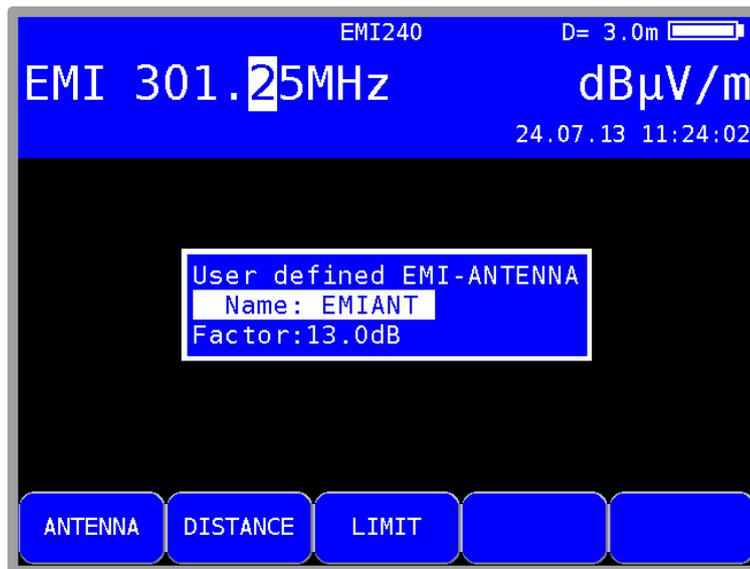
Figure 12-2 EMI user-defined antenna

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].

12.4   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.

12.5   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.

12.6   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.

12.7   Measuring the interference field strength

Figure 12-3 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.

12.8   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.

12.9 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 500 mA. A red LED in the keypad area at the device (DC OUT) indicates that the supply is on.

```
     W  TE T 1234 EMI240      5V     D= 3.0m ▭▮
 EMI 301.25MHz      31.6dBµV/m
 Limit exceeded!              E(3.0m)= 31.6dBµV/m



                    18V
                    14V
                     5V
                     0V



 ANTENNA   DISTANCE   LIMIT
```
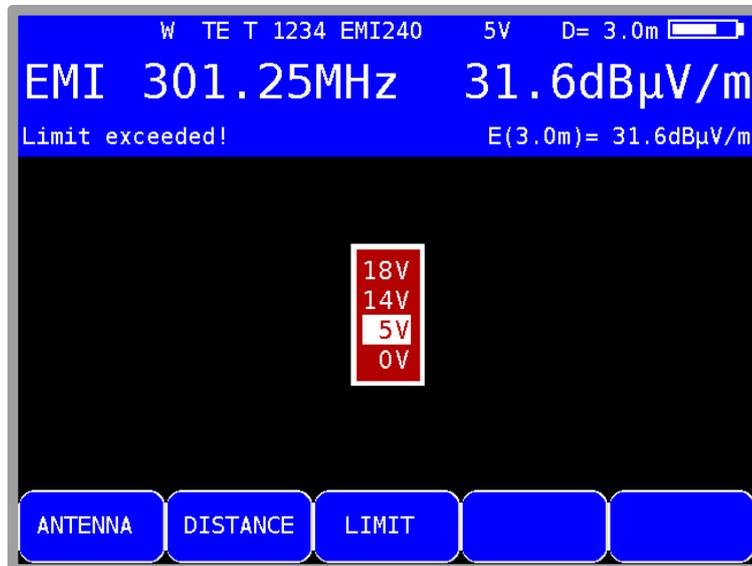
Figure 12-4 EMI Remote supply

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.**

12.9.1 Setting the remote supply voltage

Press the **LNB** key to open a selection menu where you can choose between 0 V, 5 V, 14V and 18V (default setting). By using **ENTER** the voltage will be activated.

12.9.2 Changing the fixed remote supply voltages

Three fixed voltages (5, 14 and 18 V) are set ex-works for the remote supply.

In order to adjust the voltage according to the requirements of the active components that are supplied, each of the three voltages can be changed independently of one another from 5 V to 20 V. For this, select one of the three voltages and access the input menu by pressing the → arrow key. Now you can enter the new remote voltage using the numeric keypad or with the arrow keys in 1 V increments. Press **ENTER** to store this setting. The setting is non-volatile.

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.

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.
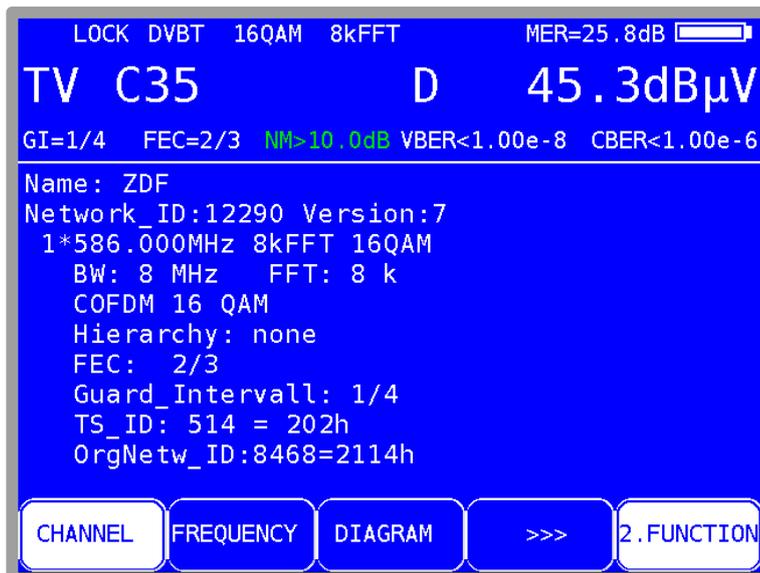
Figure 13-3 NIT Details at DVB_T Channel

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.

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

TV S40              D      58.9dBµV

PE=       0 /00:00:26 NM>10.0dB            BER<1.00e-8

NIT consists of 41 LCN items
Name: KWS
Network_ID:1 Version:29
LCN: 1 ServID: 28106=6dcah Freq:346.00MHz
LCN: 2 ServID: 28006=6d66h Freq:738.00MHz
LCN: 2 ServID: 28006=6d66h Freq:378.00MHz
LCN: 2 ServID: 28006=6d66h Freq:442.00MHz
LCN: 3 ServID: 28107=6dcbh Freq:346.00MHz
LCN: 4 ServID: 17500=445ch Freq:602.00MHz
LCN: 4 ServID: 17500=445ch Freq:394.00MHz
LCN: 4 ServID: 17500=445ch Freq:858.00MHz
 CHANNEL   FREQUENCY   DIAGRAM    >>>    2.FUNCTION
```

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 ↓ key.

13.4   Picture and sound check

As described in the chapter 13.1 - Program 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.
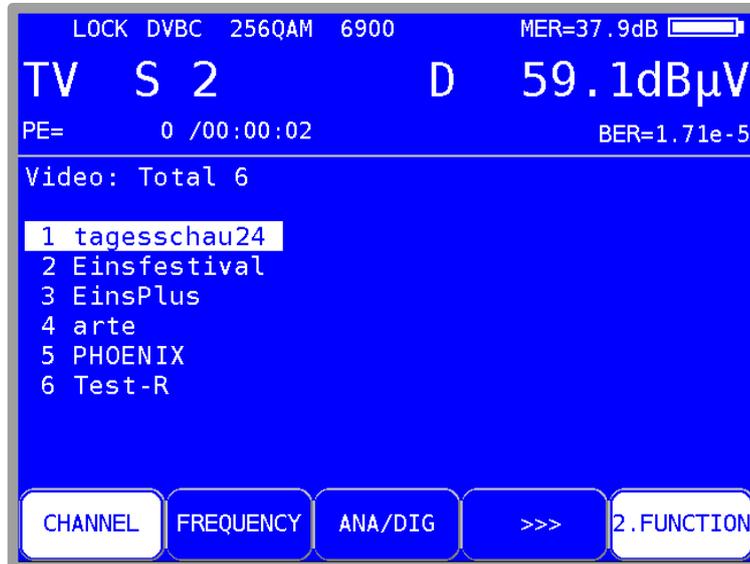
Figure 13-5 DVB-C video program list

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** 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** 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** 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.
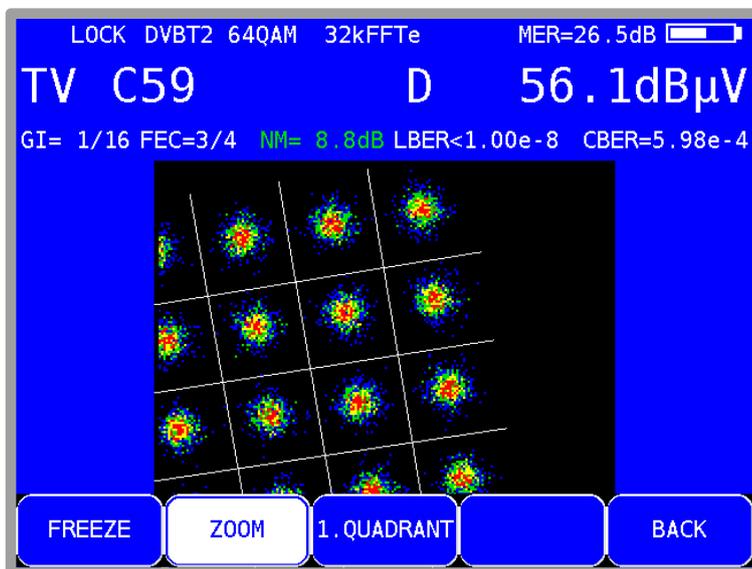
Figure 14-1 Constellation diagram DVB-T2 zoom

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 size of the constellation diagram display area. 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.
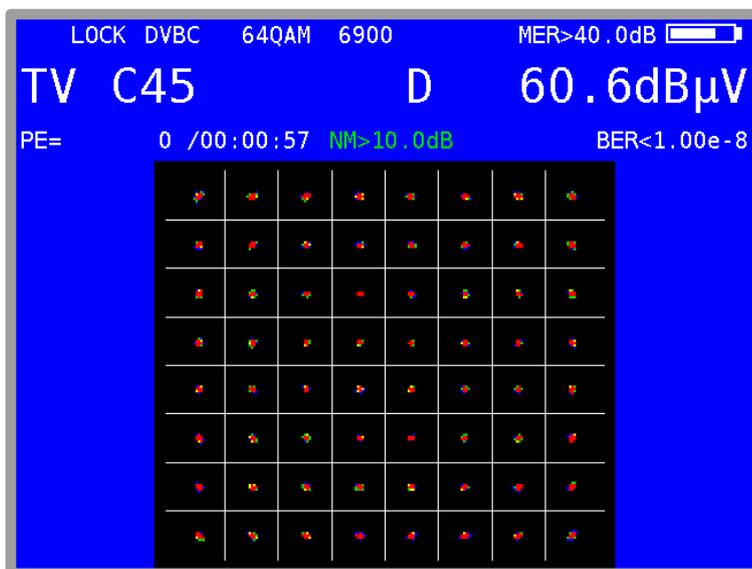
Figure 14-2 Ideal constellation diagram
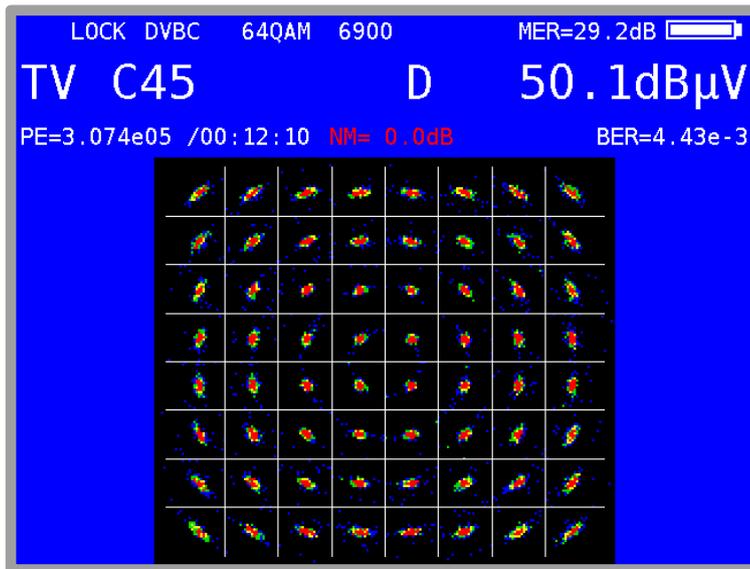
Figure 14-3 Constellation diagram with phase jitter

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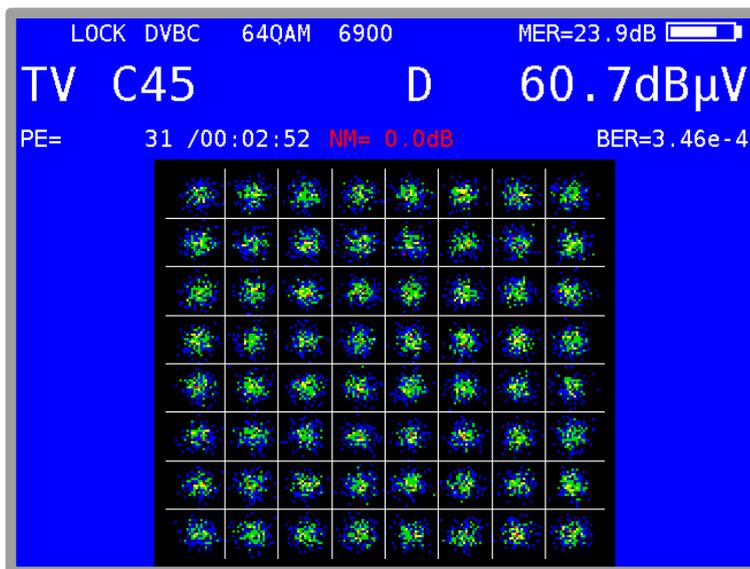
Figure 14-4 Constellation diagram with noisy signal

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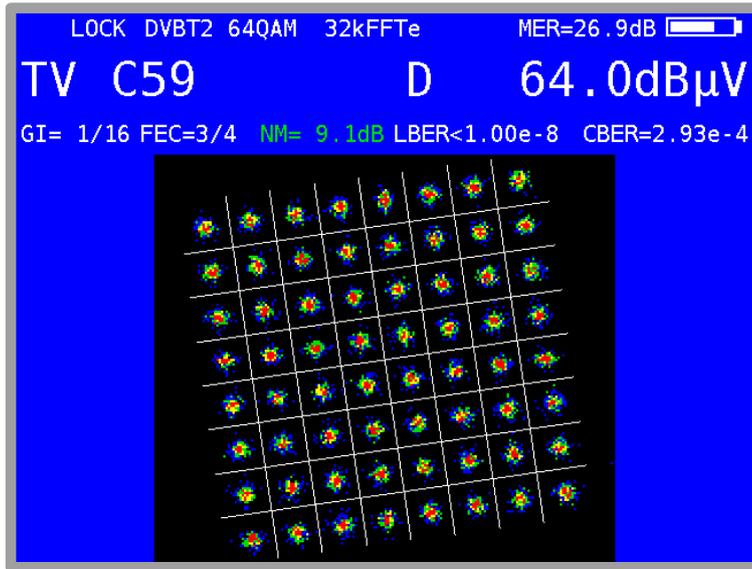
Figure 14-5 Real constellation diagram DVB-T2
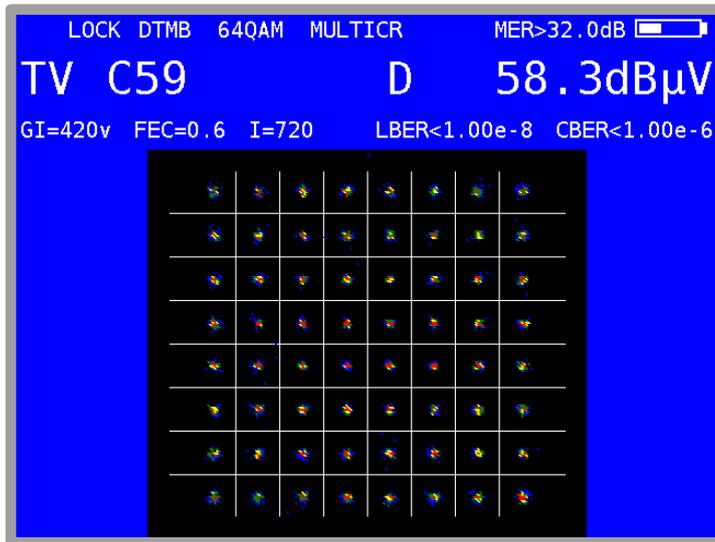
Figure 14-6 DTMB constellation diagram

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.
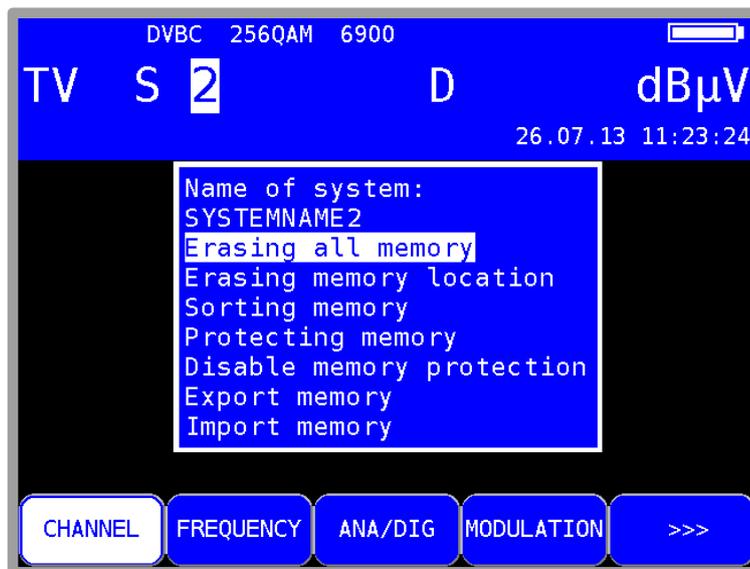
Figure 15-1 Memory management

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 SAT, TV, FM, RC and DAB ranges.
An example of a broadband cable spectrum is shown below.
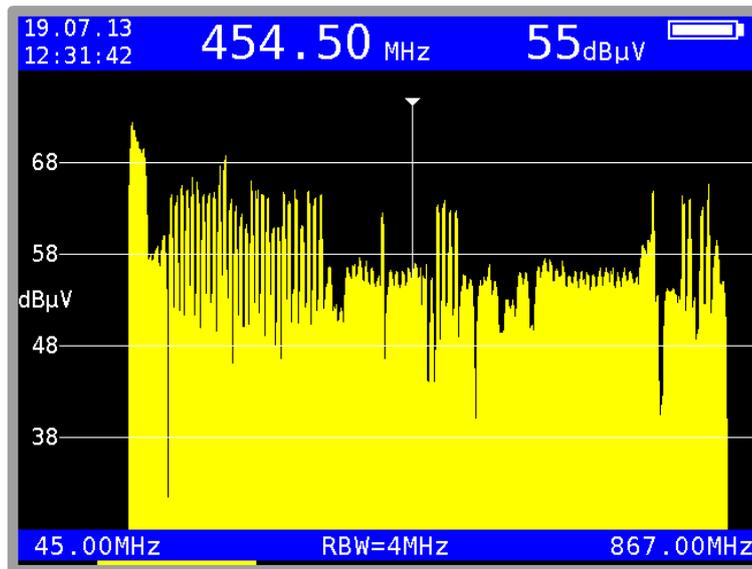
Figure 16-1 Spectrum analyzer

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.
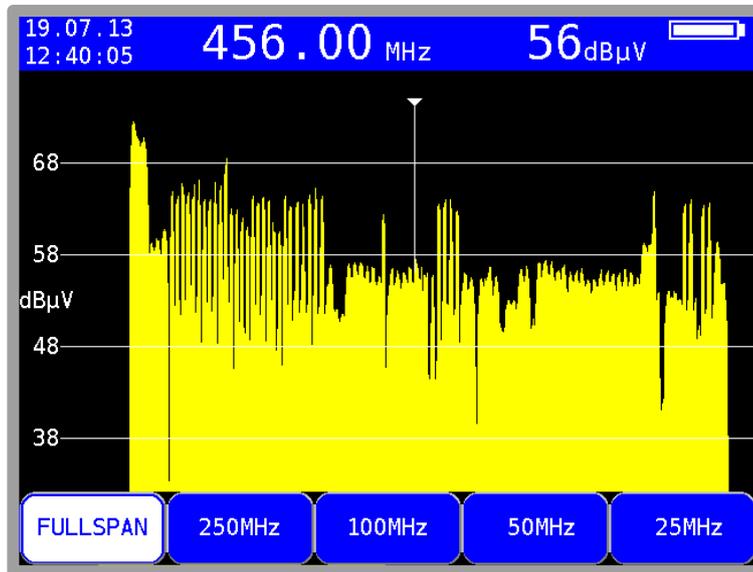
Figure 16-2 Spectrum analyzer selection of bandwidth

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.
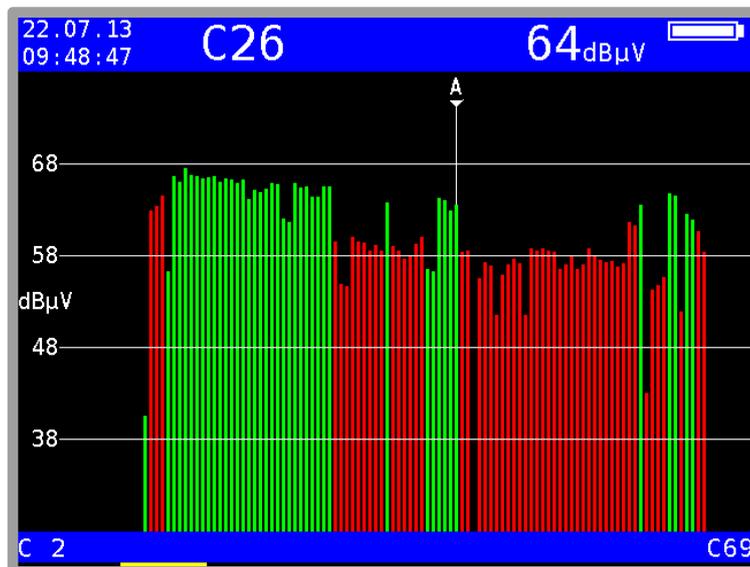
Figure 16-3 Level diagram

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 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.
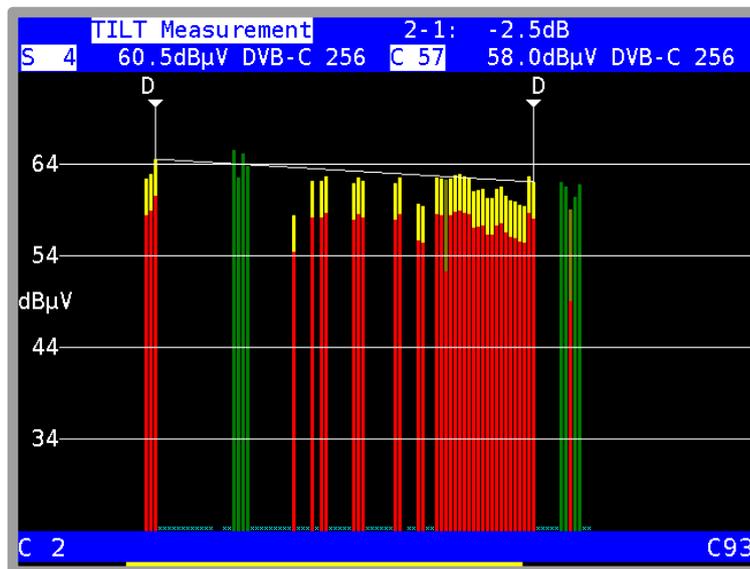
Figure 16-4 TILT measurement

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.

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

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.
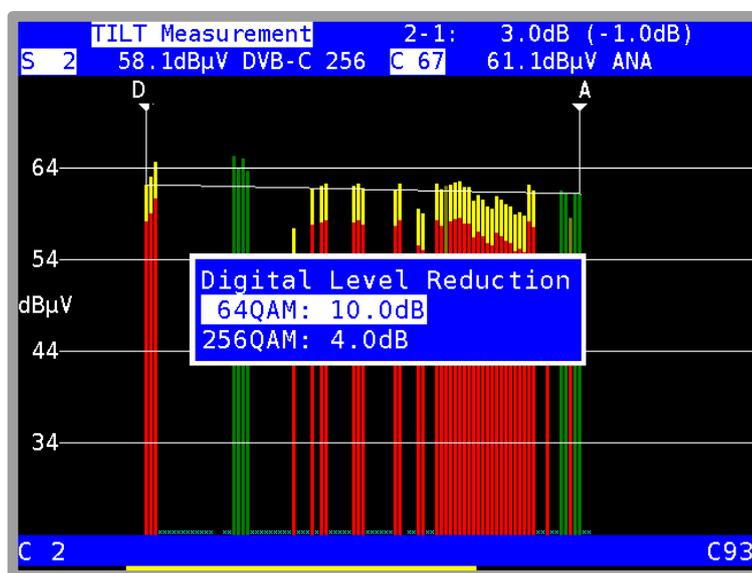
Figure 16-5 TILT measurement - digital level reduction

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.
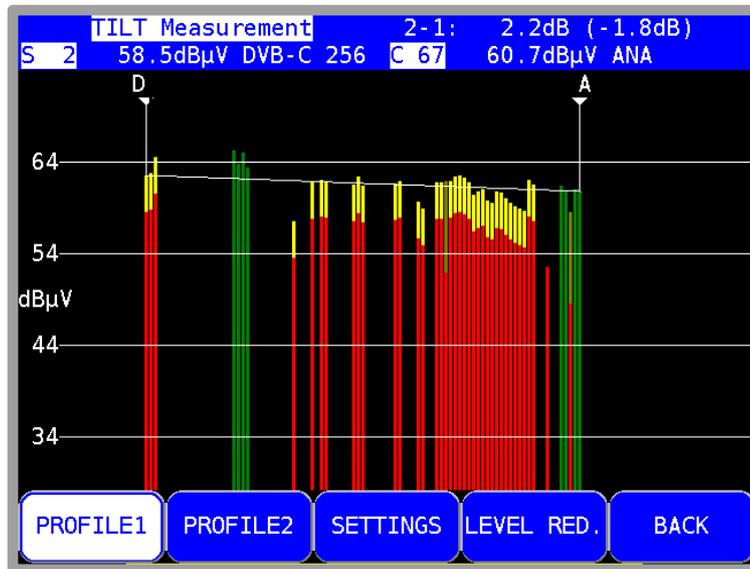
Figure 16-6 TILT measurement - Selecting a profile

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.

16.11.1   SAT range

When the UNICABLE control is active, the frequency display always refers to the spectrum that was converted by the UNICABLE unit.
Additional functions: With **MODE** you get a menu to select between "SAT SCAN"(Chapter 17.1) and "TRANSPONDER SCAN". By pressing **ENTER** they can be started. For explanation please look at next chapter.

16.11.1.1   Transponder SCAN

Depending on the respective SPAN, the following additional functions are executed when the SCAN button is pressed.
At FULLSPAN: Starting from the current cursor position, the next maximum is searched and the centre frequency of this transponder is determined. The analyzer then switches to SPAN1(600MHz) with the frequency it has determined as the cursor position.
At every lower span than FULLSPAN the centre frequency of the next transponder is searched and tuned to. In addition to the five or ten preset symbol rates, the entire range of the symbol rates is searched from 2 to 45 MSym/s.

16.11.2   TV range in the channel input mode

As already mentioned in the "Chapter 16.4 - Cursor", 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.
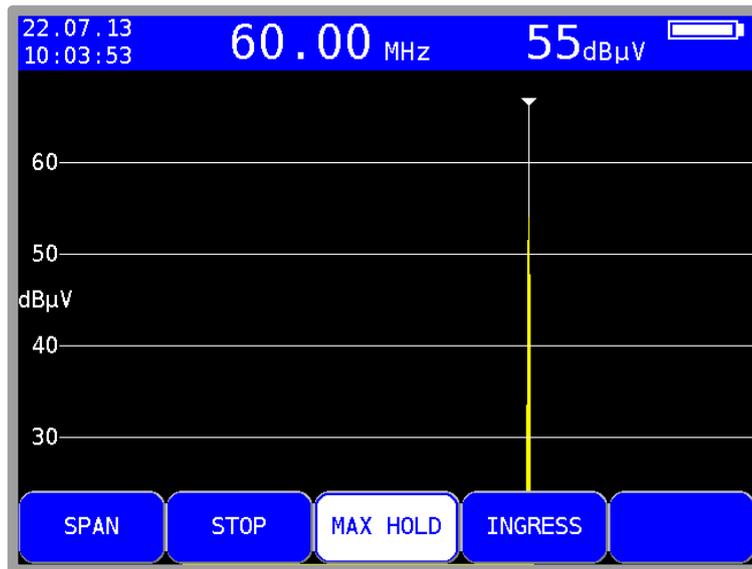
Figure 16-7 Spectrum analyzer - Max Hold function

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.
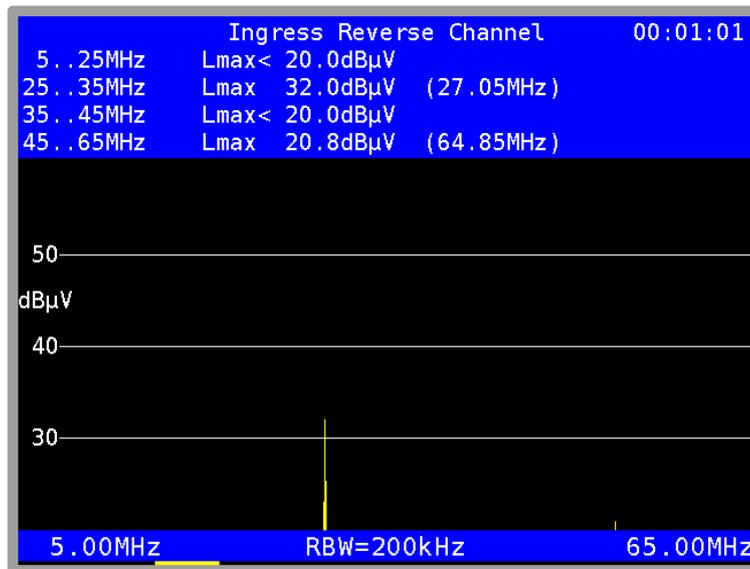
Figure 16-8 Spectrum analyzer - Ingress measurement

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   SCAN Support for Finding Satellites

Several functions are gathered together in the SCAN-function which makes looking and identifying a satellite position easier. First of all the device should be in range SAT and in default state. Using **MODE** -> **Satlist** to open the selection menu where you can choose the following functions:

- SAT SCAN
- SAT List
- Import Satlist
- Erase favourites

The function **SAT SCAN** can also be started using the soft key F5 SAT SCAN. If the analyzer function is active you can get a submenu by pressing **MODE**. Here you can select the function **SAT-SCAN** or **TRANSPONDER SCAN**.
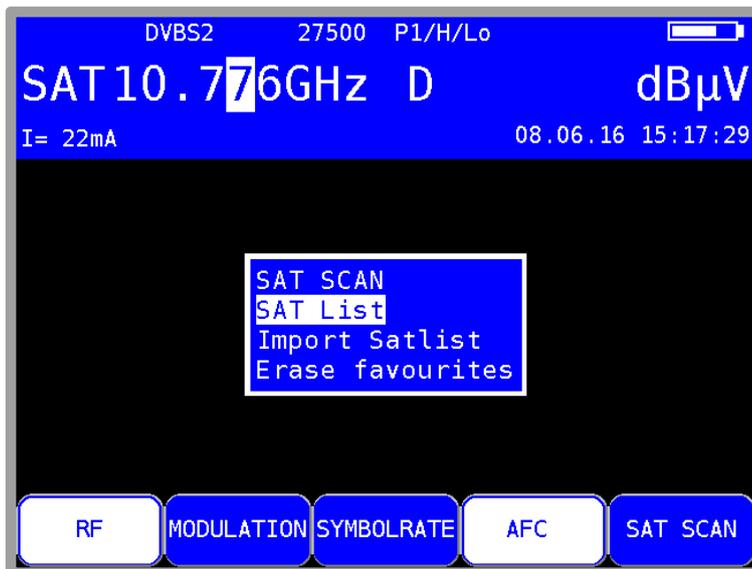
Figure 17-1 SAT SCAN menu

17.1   SAT SCAN

This function can be chosen from the displayed menu described above or immediately using the soft key F5 SAT SCAN. A search cycle starts in a range from east to west where the most important satellites are tuned to its transponders. A separate window opens and show the actual searching status. If the satellite system can be clearly identified, the it's position and the satellite name will be shown. The search cycle can be leave with BACK or **HOME**, switched to analyzer mode with **ANALYZ** or changing into regular measurement mode with **ENTER**.

Note: **By starting the function SAT SCAN also a voltage over the RF input is supplied. Always check that the connected system is compatible with 14V and 18V. Otherwise there could be some damage.**
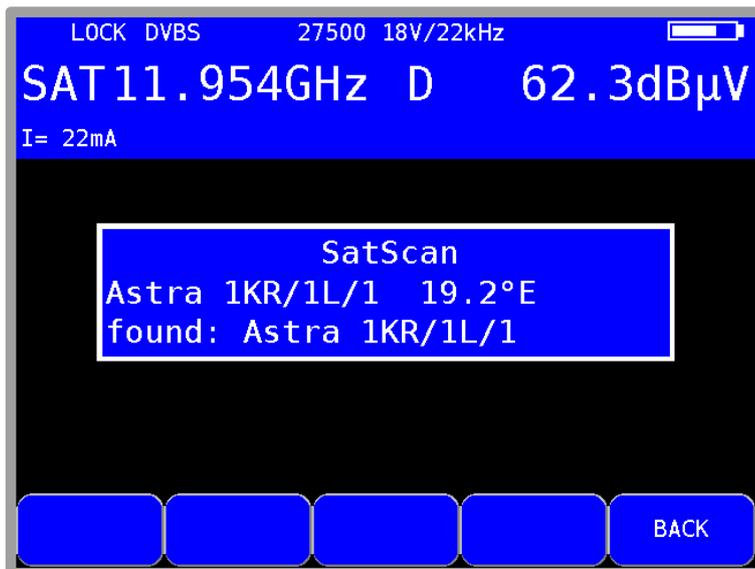
Figure 17-2 SAT SCAN satellite found

The scan parameter (satellite, transponder frequency etc.) are a fixated component of the satellite list. Therefore the SAT list should be kept up-to-date. (View chapter 17.5 - Importing a SAT list).

Note: **If Quattro LNBs are used, the various SAT identifications are not sent on all levels. The LNB should be connected to the connectors for the horizontal high or vertical low levels since only these levels are searched. The relevant data can be found in the document which accompanies the SAT list.**

17.2   SAT list

Open the SAT list by pressing **MODE -> Satlist -> SAT List** if device is in default state. Use the ← and → keys to browse through the list pages. Individual satellites can be selected using the ↑ and ↓ keys. Pressing the **ENTER** button displays the transponder list for the selected satellite.
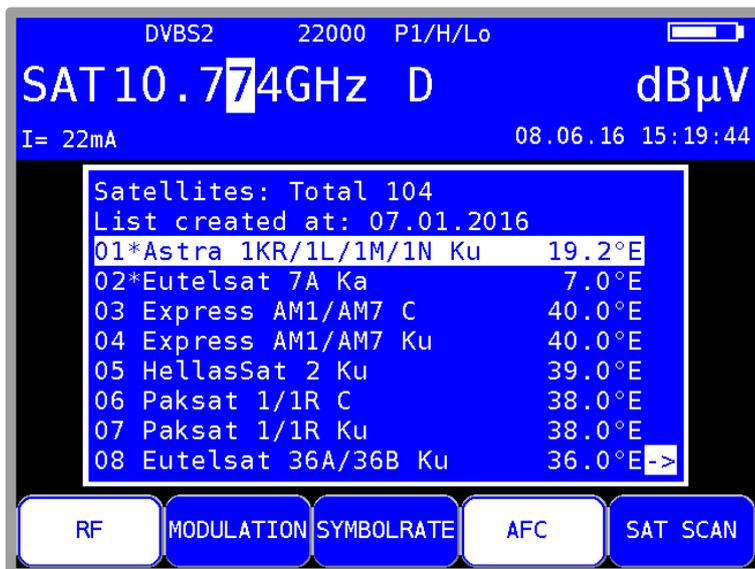
Figure 17-3 SAT list

The SAT list is provided by the instrument manufacturer and updated on a regular basis. Check whether the list being used is up-to-date (use the date code in the second line of the list for this). For updating the list refer chapter 17.5 -Importing a SAT list.

17.3   Transponder list

In addition to reception parameters such as frequency and modulation, the transponder list includes transponder numbers and names if they are known. A transponder can be selected with the ↑ and ↓ key, followed by **ENTER** to tune. Press **HOME** for returning to the previous list.
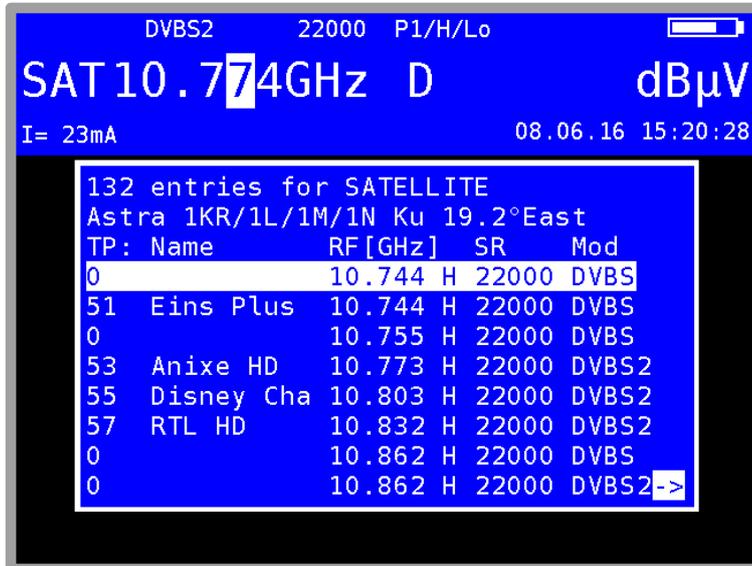
Figure 17-4 Transponder list

17.4   Favorites list

You can save frequently required satellites in a favorites list so that they can be found more quickly. To do so, select the corresponding satellite from the SAT list and press **SAVE**. The following menu appears:
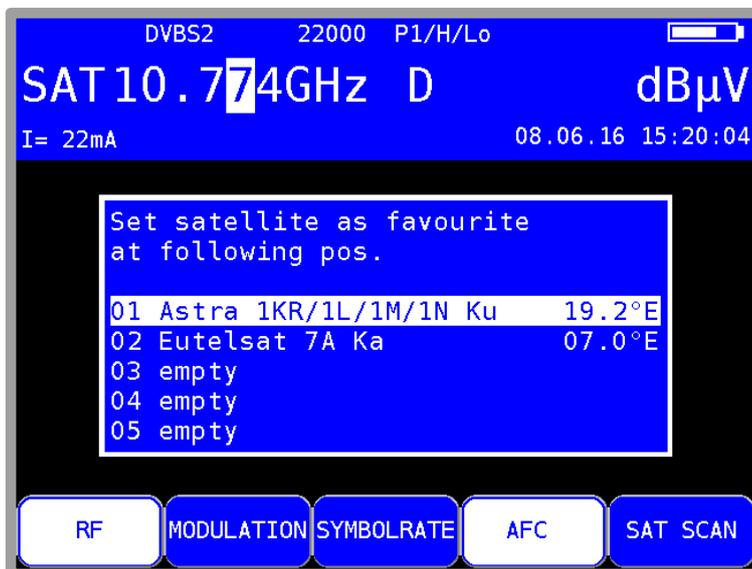
Figure 17-5 Favorites list

You can now select the position in the favorites list. Pressing SAVE again saves the item as a favorite and the SAT list is displayed again. The favorites now appear at the top of the SAT list and are marked with (*). You can replace one favorite with another at any time. With **MODE** -> **Satlist** -> **Erase favorites** list to erase all favorites.

17.5   Importing a SAT list

The current SAT-list can be found at www.kws-electronic.de. To import a SAT list, you first need to connect a USB memory device with the downloaded corresponding file.

First of all the device should be in range SAT and in default state. Using **MODE** -> **Satlist** to open the selection where you can choose **Import Satlist**. Press **ENTER** to call up all of the ".sat" files stored on the memory device. Select and import the desired list by pressing **ENTER**. This action overwrites the existing list on the instrument.

Chapter 18 Optical Receiver

18.1   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.

Even in the field of SAT-IF distribution, solutions are already available for optical transmission.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.**

18.2   Activating the optical input

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

Figure 18-1 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. SAT or TV. The spectrum analyzer also uses the signal from the optical receiver.

18.3   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** -> **LAMBDA** you can set the wavelength to 1,310 nm, 1,490 nm or 1,550 nm. The **wavelength LAMBDA** menu itself is a soft key menu.

18.4   Measuring the optical power

```
        MONO           TT1        S/N=47.5dB ▭
TV  C23              A  FIB 1310nm      2.0dBm
                       OMI= 4.8%      81.7dBµV
                                   TT1=-12.8dB




   ┌────────┐┌────────┐┌────────┐┌────────┐┌──────────┐
   │ KANAL  ││FREQUENZ││ANA/DIG ││  >>>   ││2.FUNKTION│
   └────────┘└────────┘└────────┘└────────┘└──────────┘
```

Figure 18-2 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.

18.5   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 e. g. in the broadband cable field, 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 %.
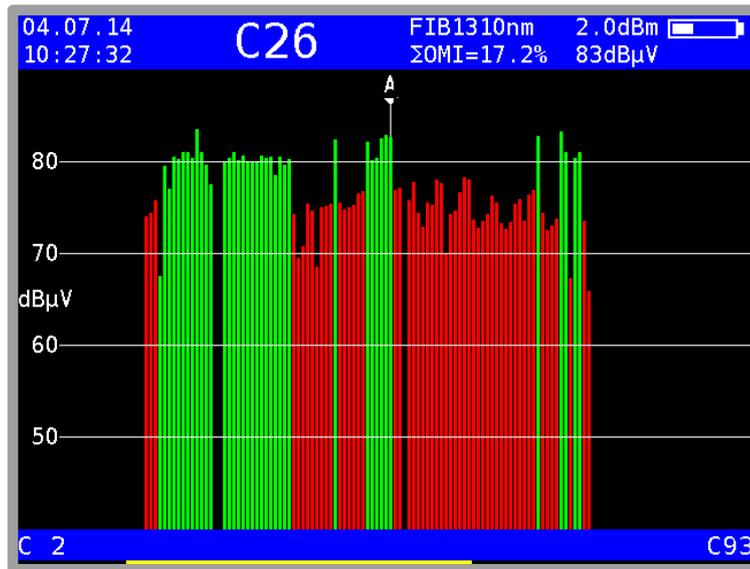
Figure 18-3 Spectrum analyzer in optical mode

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.

18.6   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.

18.7   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.
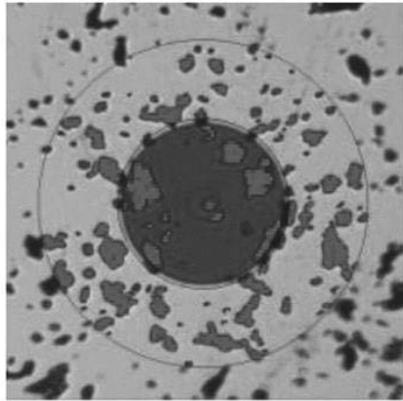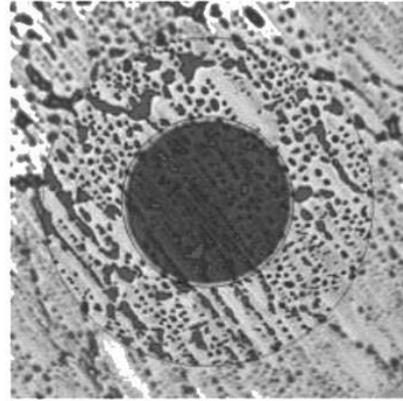
Dust Particles   Hand Lotion
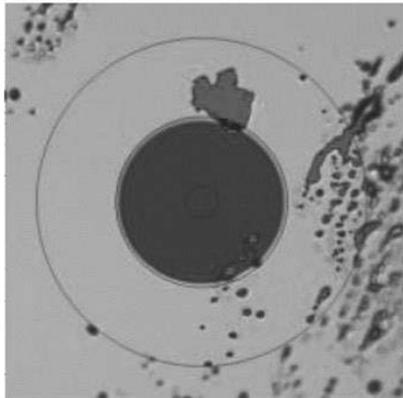
Skin Oil and Dead Skin Flakes   Alcohol Residue
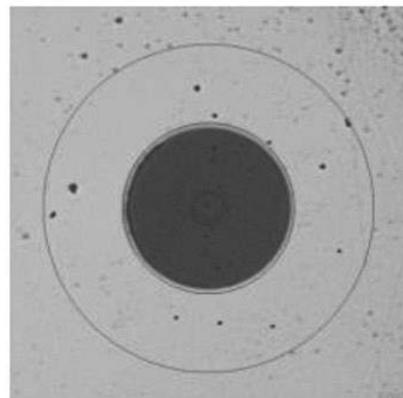
Figure 18-4 typical contamination on the optical fibers

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.

X-axis

Z-axis
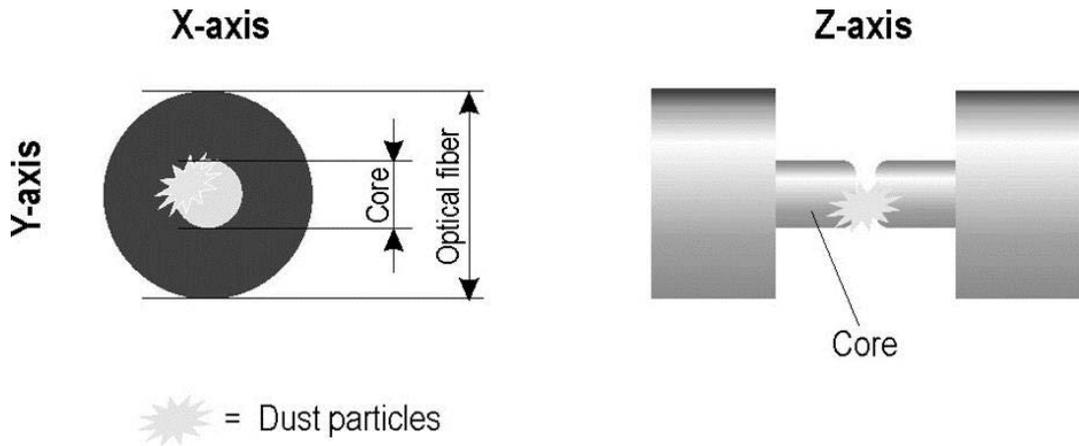
= Dust particles

Figure 18-5 Poor physical contact because of dust particles

The microscope image in the measuring receiver shows a large magnification of the optical fiber (Figure 18-6). 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.
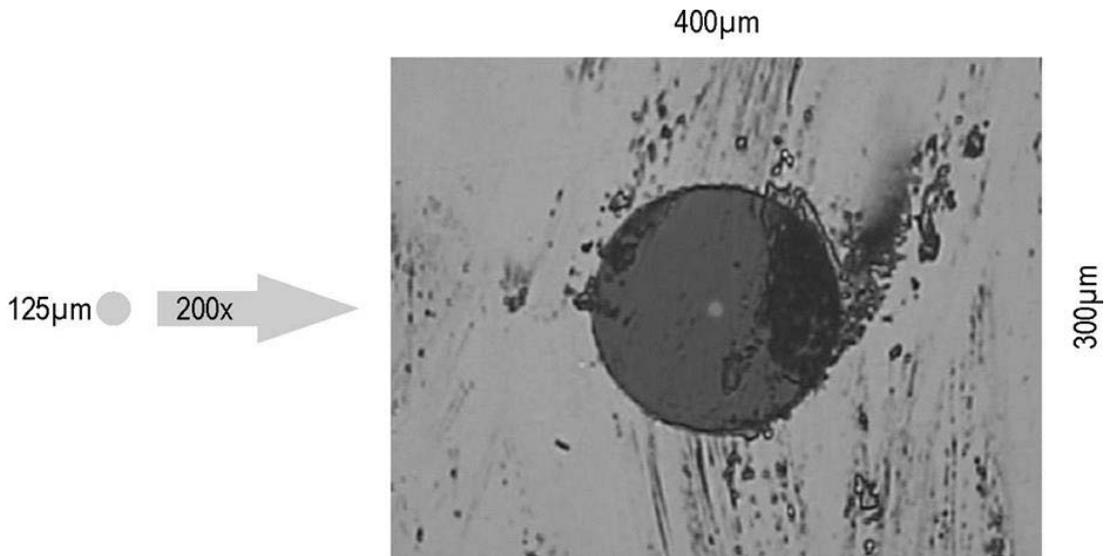
Figure 18-6 Microscope zooming

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 figure shows the schematic structure of a typical single-mode fiber with a 9µm core.
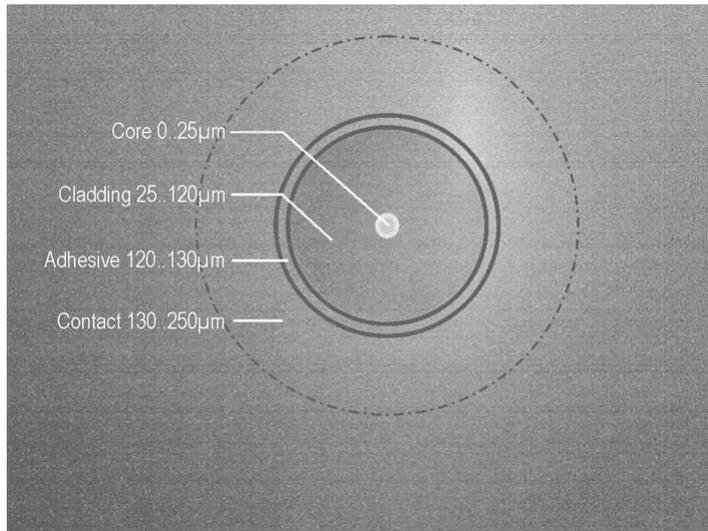
Figure 18-7 Schematic structure of a typical single-mode fiber

18.7.1   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 **ENTER** 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.

18.7.2   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 19 Management of the instrument

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

19.1   Keypad

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

19.2   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.

19.3   Software

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

19.3.1   Info

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

19.3.2   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.**

19.3.3   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 26.2.1

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.
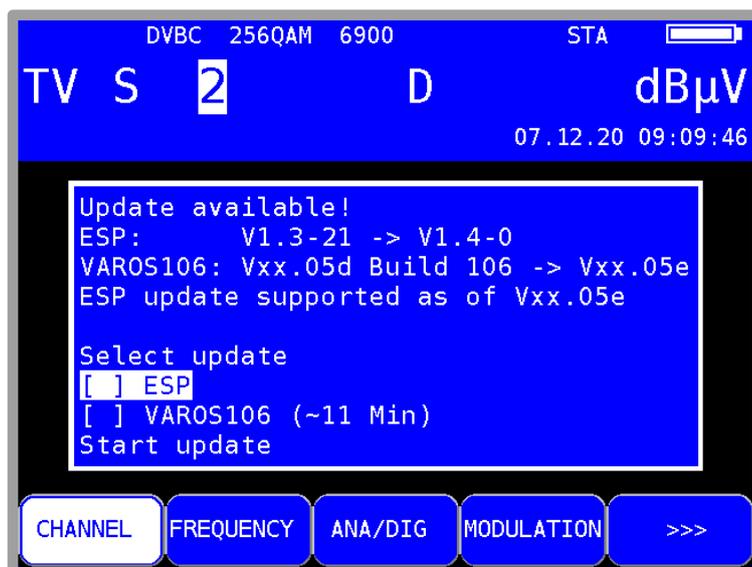
Figure 19-1 OTA menu with available updates

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

19.4   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 **MODE** -> **Settings** ->**CLOCK** 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 19-2 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.

19.5   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**.

19.6   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.
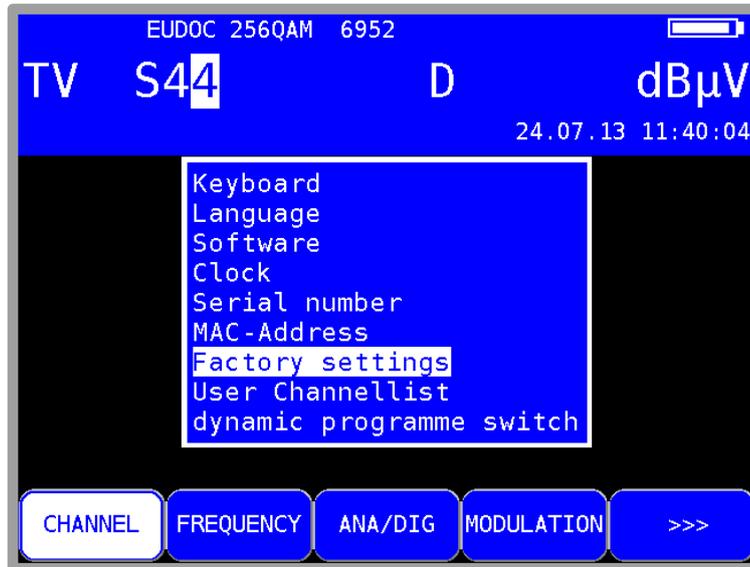
Figure 19-3 Factory settings

19.7   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 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, you must possibly 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.

19.7.1   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.

19.8   Dynamic program switching

See chapter **Fehler! Verweisquelle konnte nicht gefunden werden.**13.7 - Dynamic program switching.

19.9   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**.

Figure 19-4 Hardcopy

Saving buffer images to a USB stick:

- Bring device to default status by pressing **HOME**.
- 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.

19.10   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 contains the options available currently (e.g.: DVB-T / DVB-T2, UMS).

To unlock an option, confirm the menu item with **ENTER**. An entry field for the 8-digit key code is then displayed.
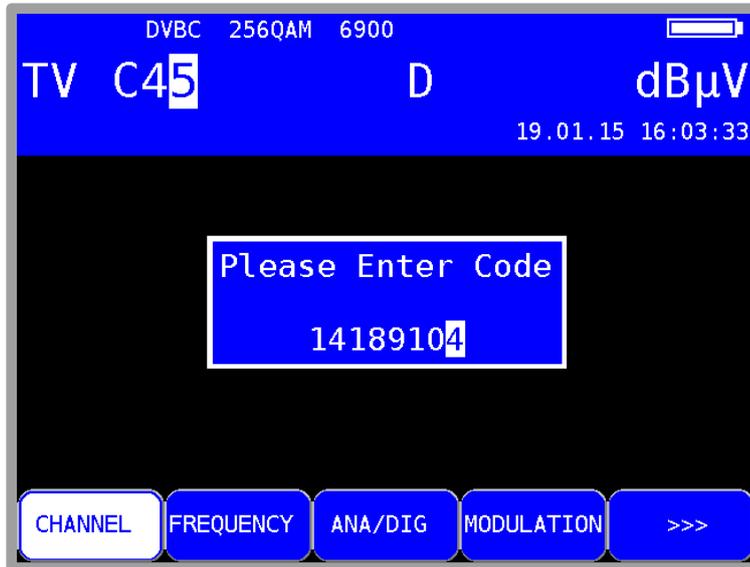
Figure 19-5 Activating software options

If the code is entered correctly, the following message appears: **Option activated!**

19.11   DVB-T2 echo compensation

Here the echo compensation can be switched on or off. For more information see chapter 8.2.2.4.7 (MER measurement DVB-T2).

19.12   Now the corresponding option is enabled for use.Control of the WI-FI™ 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 (Accesspoint-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 **Fehler! Verweisquelle konnte nicht gefunden werden.**more in detail.

Chapter 20 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.

20.1   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**.
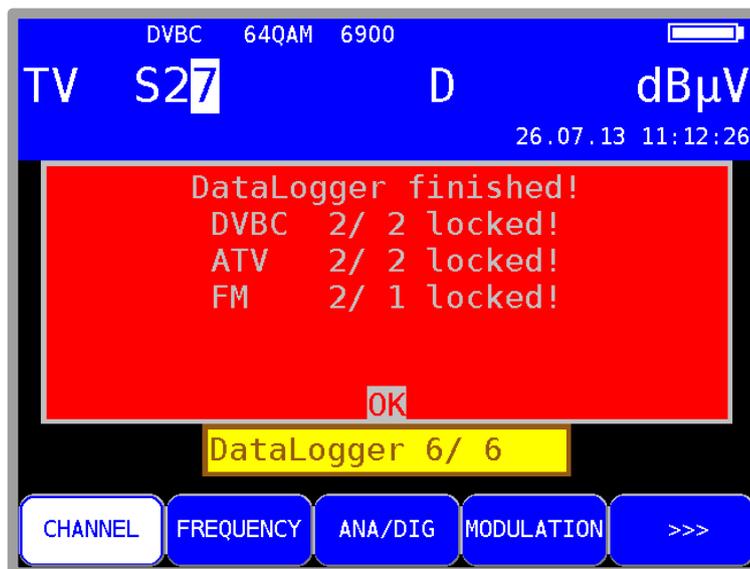
Figure 20-1 DataLogger finished screen

20.2   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 read 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™:

Figure 20-2 Evaluating DataLogger results in Excel

20.3   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 21 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
SAT		
	DVB-S	Level, MER, CBER, PE (Packet Errors)
	DVB-S2	Level, MER, CBER, PE (Packet Errors)
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
DAB		Pegel, MER, CBER

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.

21.1   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:
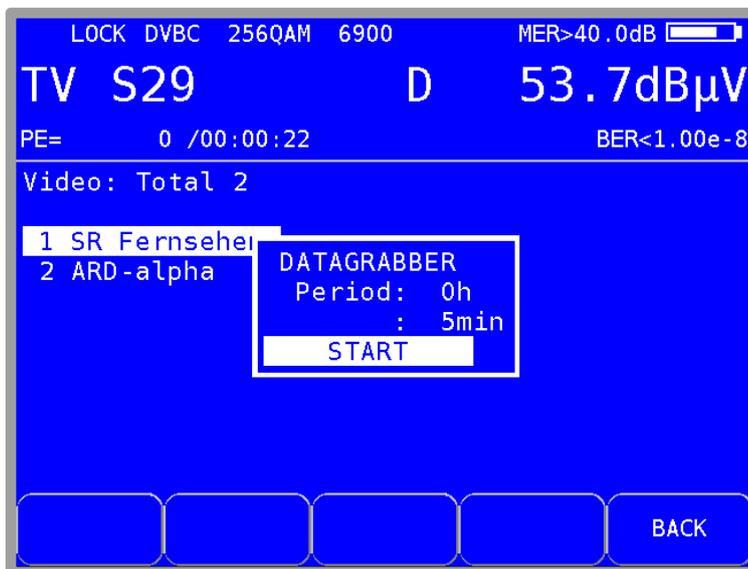
Figure 21-1 DataGrabber configuration of measurement time

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.
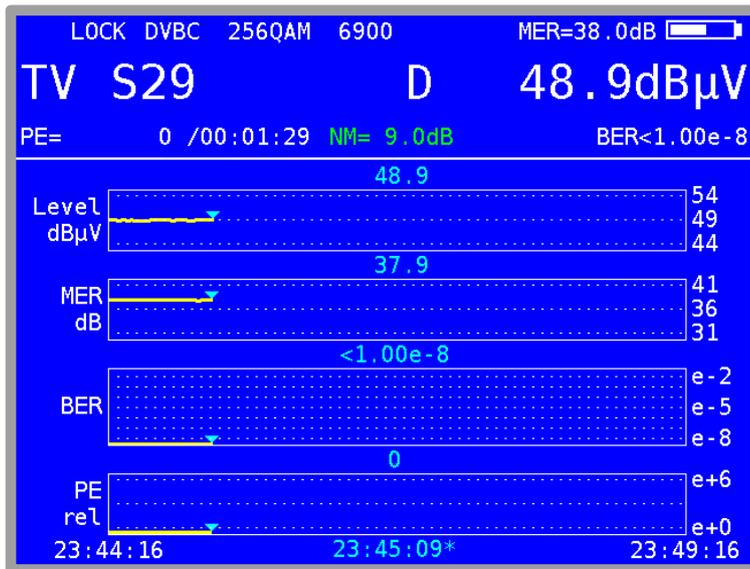
Figure 21-2 DataGrabber recording

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.
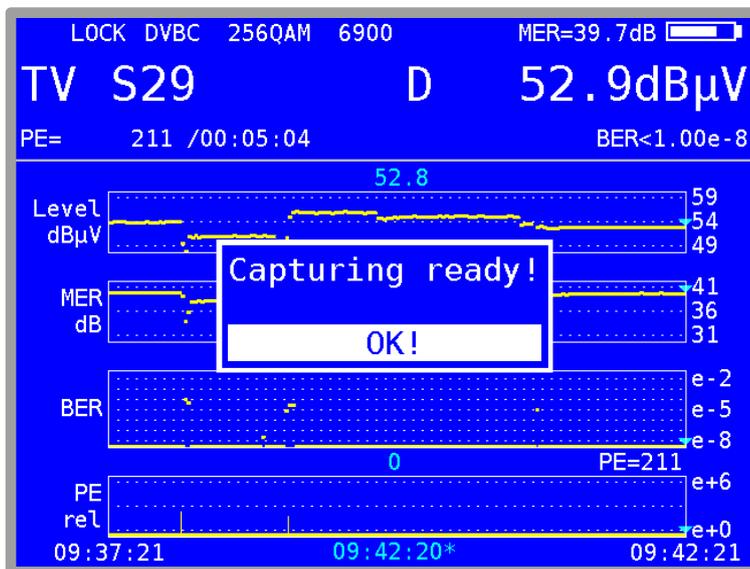
Figure 21-3 Datagrabber recording finished

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

21.2   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.
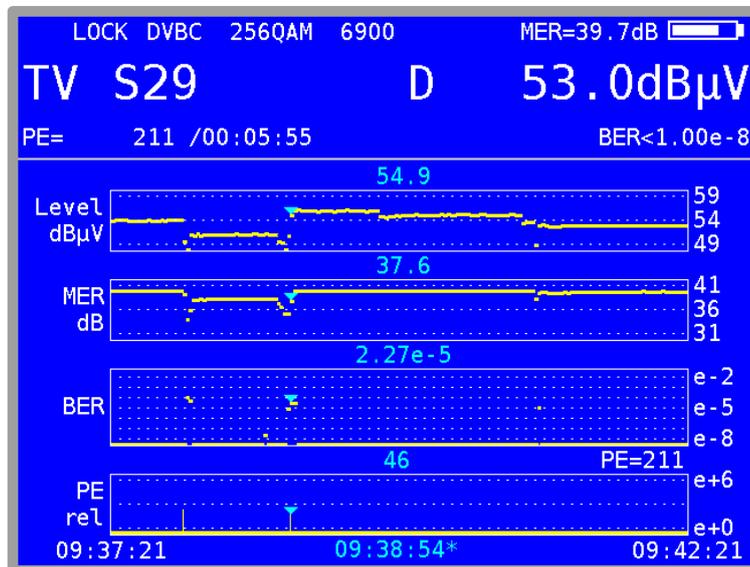
Figure 21-4 DataGrabber recording packed errors

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.

21.3   Documenting a recording

The graphics screen can be saved as a bitmap file for documentation purposes. Refer to chapter 19.9 – Hardcopy for further information.

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**.
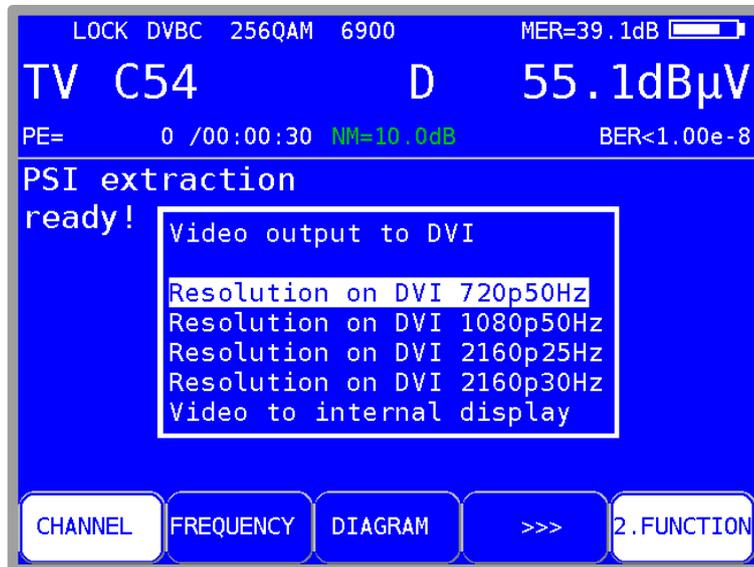
Figure 22-2 Video resolution at HDTV via DVI menu

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, Screenshots, …).

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 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 Wi-Fi™ measurements

25.1 Introduction

Wireless range supports field technicians when setting a wireless router at the customer side. Decisive for a good wireless reception throughout the home is the site and possibly the orientation of the antennas at the access point. With the measuring receiver receiving conditions can be compared at different locations within the household in the wireless mode. This does not correspond to highly accurate level measurement, but should only be an aid in site selection for wireless router.

25.2 Connecting antenna

To perform wireless measurements supplied Wi-Fi™ antenna must be connected to the meter. For this, screw the antenna on the WLAN designated SMA jack at the top of the device.

25.3 Entering the WLAN Measurement Mode

The function key **RANGE** invokes the range change menu, the respective areas are listed above the function keys **F1** to **F5**.
With **RANGE -> WiFi** can be changed in the wireless measurement mode. The wireless module in the instrument needs a little moment until it is ready for operation. Likewise, when you exit the Wi-Fi™ measurement mode and change to another range.

25.4 MAC address of the wireless module

The MAC address of the built-in wireless module can be displayed with the function key **MODE -> MAC-address**. This menu is available only in the started Wi-Fi™ measurement range.

25.5   Measurement Capabilities

25.5.1   Channel allocation

The cannel assignment of all access points found in the area are plotted on a graph (Figure 25-1 Wi-Fi™ channel diagram). The function keys **2.4 GHz** or **5 GHz** you can call the diagram for the 2.4 GHz band (802.11 b/g/n) or 5 GHz band (802.11a).

Depending of the band (2.4 GHz or 5 GHz) varies the number of possible channels. Each access point is transmitting on a particular channel. The bar height corresponds to the reception level in dBm (from -40 dBm to -96 dBm).

When multiple access points sending on the same channel, only the beam of the best received access point will be shown. Below the chart will display up to four access points (which are best received) transmitting on the channel. Use the cursor keys to switch between the individual channels.

With the function key **START SCAN** a renewed single scan started for new access points.
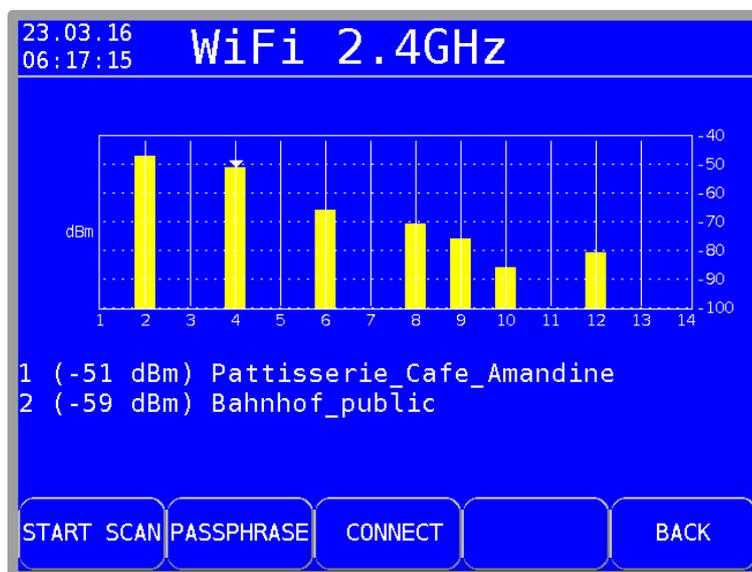
Figure 25-1 Wi-Fi™ channel diagram

25.5.2   Overview of all access points in the area

In the main menu, all access points found are displayed with their respective level, channel and encryption. The order is sorted by the reception level strength. With the channel number on which the access point sends can the frequency band detected: Channels y 15 are in the 2.4 GHz band, channels > 35 are in the 5 GHz band. From this view, a level measurement can be started. Using the cursor keys ↑ and ↓ to select the corresponding access point.

Continuous scan mode:

With the function key **START SCAN** a continuous scan can be activated. To stop the continuous scan operation press the same function key (**STOP SCAN**). Stopping the scan may take a few seconds until the last scan is completely finished.
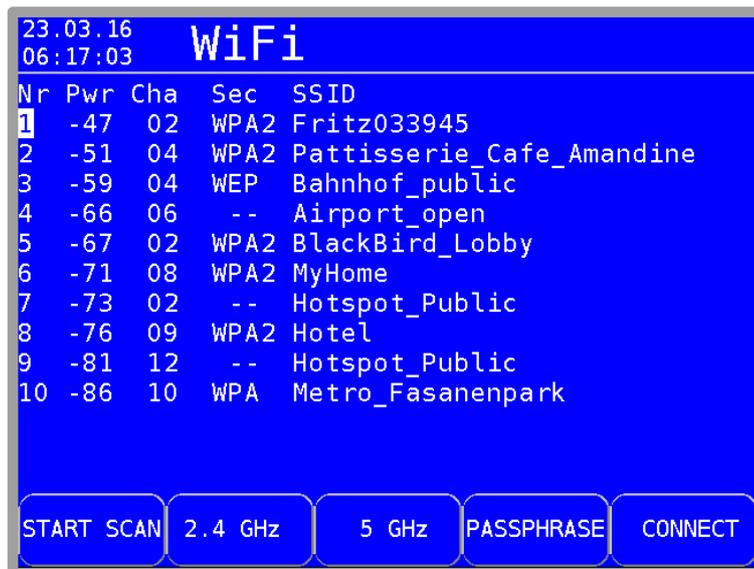
Figure 25-2 Wi-Fi™ accesspoint list

25.5.3   Level measurement of a single access point

In the level measurement, the measuring device has to connect with the access point before. For this purpose, depending on the encryption of the connection, a password is required. The entry of the password is performed with the function key PASSPHRASE: here can be selected between 4 memory locations for storing. The stored passwords are retained even after switching of the device. Which password is active, shows the inverse representation of the respective space. If an accesspoint using no secured connections, then it is not necessary to select a specific password / memory location.

After selecting the appropriate password / space a connection to the access point can be started.

For this use the cursor keys ↑ and ↓ to select the appropriate access point and then press the function key CONNECT. Upon successful connection, the picture changes into a histogram graph (Figure 25-3 Wi-Fi™ level histogram graph). A red cursor indicates the currently measured level, this value can also be read at the top of the display as a numerical value. Below the chart, the MAC address of the access point, the BSSID and the assigned IP address are displayed.
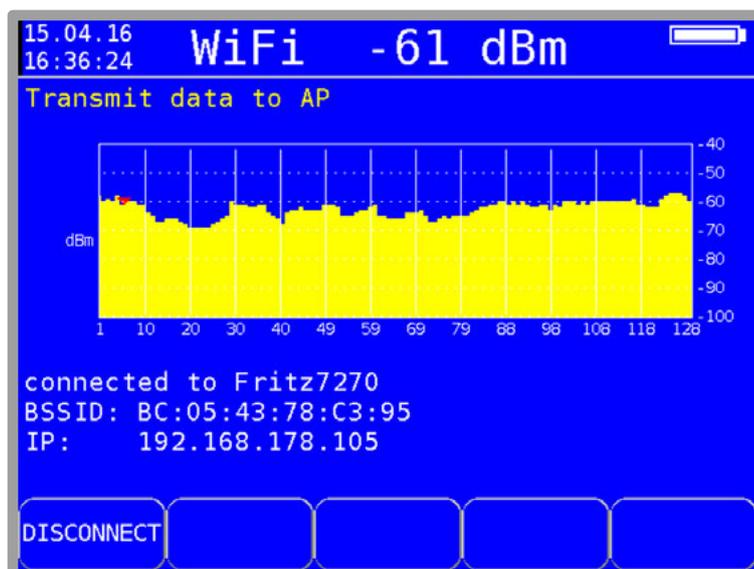
Figure 25-3 Wi-Fi™ level histogram graph

25.6   Tips for WiFi™ receive

Common questions about the installation of an WiFi™ router in a flat/house often can not be simple answered. If the radius of the to covered area small, then mostly the router can be placed anywere, and the antenna orientation is also second-rate. But if the limits will be used, a few centimeter or a few degree of the antenna evelation leads to the deciding improvement.

- If possible, place minimum one antenna in 90° angle to the farest WiFi™ device, because with this the highest radiation is given
- If you need a long vertical range, e.g. more floors, it could be helpful to orientate the antenna horizontal
- Very bad is a flat angle through ferroconcrete, e.g. the router placed in the first floor lefthand side, an the receive device placed in the upper floor right hand side
- Glass has a high attenuation factor to the signal
- Rig walls also have a high attenuation factor, that is important to consider, if you plan to place the router in the attic.
- Make attention to hidden barriers: metal cupboards, wall shutters, metal shelves in the neighboring room, steel-roolcontainers under the desk: all these objects creates a signal shadow wich can lead to larger WiFi™ holes.
- Older cordless phones and older DECT models can massively disturb the WiFi™: In case of doubt, only a test is helpful: pull the mains plug from the base stations and remove the batteries from the handsets
- USB 3.0 devices can cause massive interference in the WiFi™. Directly connected USB 3.0 devices to the router, or also in the immediate vicinity of the router, should be temporarily disconnected an make a re-test
- Look for reflections. Mettalic objects directly next to WiFi™ devices can reflect the radiation and impair the reception quality in the worst case due to interference. Check for a clean nearby environment

Play with the alignment of the antennas (if possible). Move the antennas in 5° increments and check the signal strength

Chapter 26 WI-FI™ interface for automated measurements

26.1   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 ".

26.2   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.
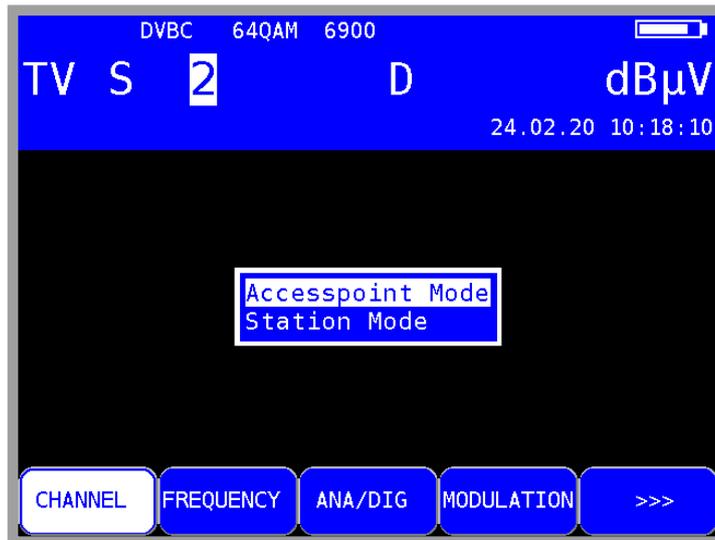
Figure 26-1 WIFI Mode Select, currently in accesspoint-mode

26.2.1   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.
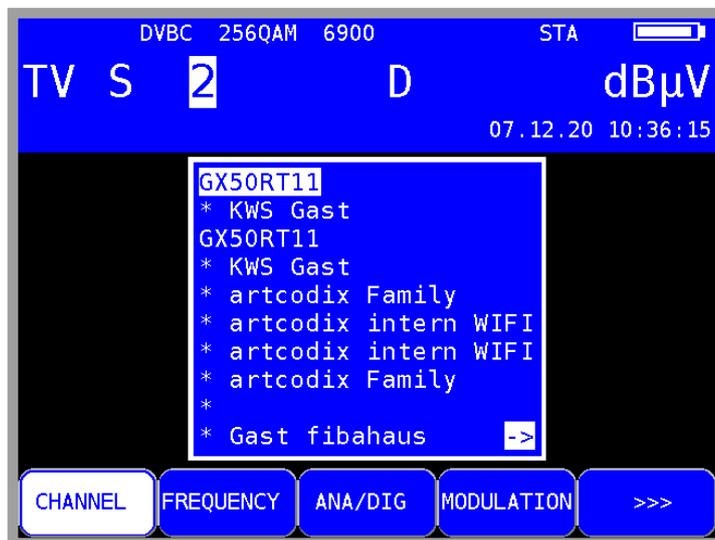
Figure 26-2 available networks in surrounding area after net scan

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 26-3 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 26-4 Information of the connected network

26.2.2   Accesspoint 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
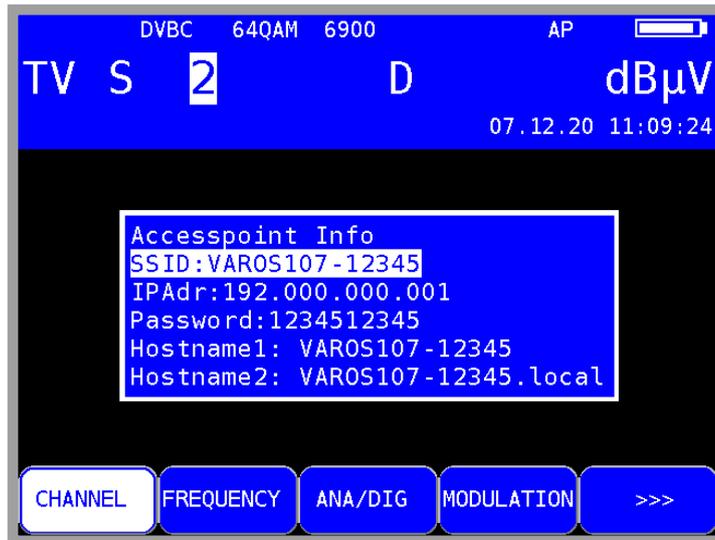
Figure 26-5 Default access-point information

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.

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