Spectrum Analyzer R&S®HMS-X

Benutzerhandbuch
User Manual

ROHDE&SCHWARZ

CE
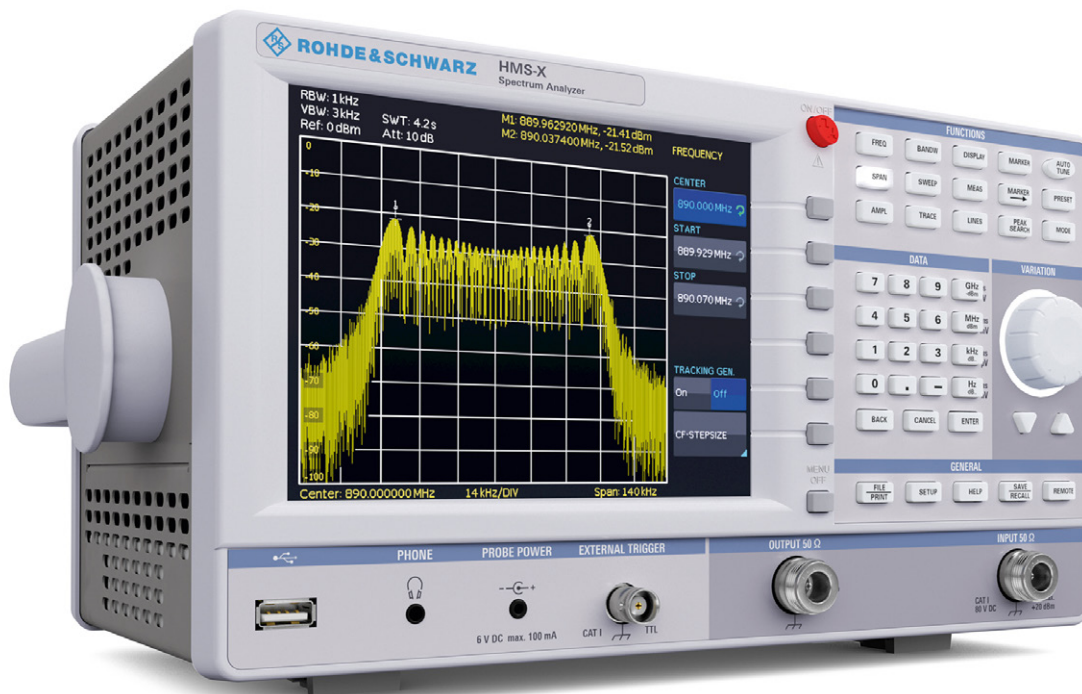
DECLARATION OF CONFORMITY

Manufacturer:
ROHDE & SCHWARZ GmbH & Co. KG · Mühldorfstr. 15 · D-81671 Munich

The ROHDE & SCHWARZ GmbH & Co. KG herewith declares conformity of the product:

Product name:	Spectrum Analyzer
Type:	R&S®HMS-X
with:	HO720
Options:	HO730, HO732, HO740

complies with the provisions of the Directive of the Council of the European Union on the approximation of the laws of the Member States

- relating to electrical equipment for use within defined voltage limits (2006/95/EC) [LVD]
- relating to electromagnetic compatibility (2004/108/EC) [EMCD]
- relating to restriction of the use of hazardous substances in electrical and electronic equipment (2011/65/EC) [RoHS].

Conformity with LVD and EMCD is proven by compliance with the following standards:

EN 61010-1:2011
EN 61326-1:2013
EN 61326-2-1:2013
EN 55011:2009 + A1:2010
EN 61000-3-2:2006 +A1:2009 + A2:2009
EN 61000-3-3:2008

For the assessment of electromagnetic compatibility, the limits of radio interference for Class A equipment as well as the immunity to interference for operation in industry have been used as a basis.

Date: 12.02.2015

Signature:

General Information Regarding the CE Marking

ROHDE & SCHWARZ measuring instruments comply with regulations of the EMC Directive. ROHDE & SCHWARZ is basing the conformity assessment on prevailing generic and product standards. In cases with potentially different thresholds, ROHDE & SCHWARZ instruments apply more rigorous test conditions. Thresholds for business and commercial sectors as well as small business are applicable for interference emission (class 1B). As to the interference immunity, the standard thresholds for the industrial sector apply. Measurement and data lines connected to the measuring instrument significantly affect compliance with specified thresholds. Depending on the respective application, utilized lines may differ. In regards to interference emission and immunity during measurements, it is critical that the following terms and conditions are observed:

1. Data Cables

It is imperative to only use properly shielded cables when connecting measuring instruments and interfaces to external devices (printers, computers, etc.). Unless the manual prescribes an even shorter maximum cable length, data cables (input/output, signal/control) may not exceed a length of 3m and may not be used outside of buildings. If the instrument interface includes multiple ports for interface cables, only one cable at a time may be connected. Generally, interconnections require double-shielded connecting cables. The double-shielded cable HZ72 (available at ROHDE & SCHWARZ) is well suitable as IEEE bus cable.

2. Signal Cables

In general, measuring cables for the transmission of signals between measuring point and measuring instrument should be kept as short as possible. Unless the manual prescribes an even shorter maximum cable length, signal cables (input/output, signal/control) may not exceed a length of 1m and may not be used outside of buil-dings. In general, all signal cables must be used as shielded conductors (coaxial cable- RG58/U). It is important to ensure proper ground connection. Signal generators require the use of double-shielded coaxial cables (RG223/U, RG214/U).

3. Impact on Instruments

If strong high-frequency electric and magnetic fields are present, it may occur despite diligent measurement setup that unwanted signal units are injected into the instrument via connected cables and lines. This does not result in destruction or shutdown of ROHDE & SCHWARZ instruments. In individual cases, external circumstances may cause minor variations in the display and measuring values beyond the selected specifications.

Content

1 Important Notes

1.1 Symbols

(1) (2) (3)

Symbol 1: Caution - Observe operating instructions
Symbol 2: Caution High Voltage
Symbol 3: Ground terminal

1.2 Unpacking

While unpacking, check the package contents for completeness (measuring instrument, power cable, product CD, possibly optional accessories). After unpacking, check the instrument for mechanical damage occurred during transport and for loose parts inside. In case of transport damage, please inform the supplier immediately. The instrument must not be operated in this case.

1.3 Setting up the instrument

As shown in the illustrations, the handle can be pivoted into different positions:
A and B = carrying
C = horizontal operating
D and E = operating at different angles
F = handle removal
G = operating using the feet's, batch use and for shipping in original packaging

> **Caution!**
>
> **To change the position of the handle, the instrument must be placed in a safe position so that it will not fall down (e.g. on a table). Then the handle knobs must be simultaneously pulled on both sides and pivoted in the direction of the desired position. If the handle knobs are not pulled out while pivoting them into the desired position, they may lock into the nearest locking position.**

The handle bar may be removed in position F by pulling it out further. To attach the handle bar, proceed in the reverse order.

1.4 Transport and Storage

Please keep the original packaging for possible shipping at a later point. Damage during transport due to inappropriate packaging is excluded from the warranty. The instrument must be stored in dry, closed indoor premises. If the instrument was transported under extreme temperatures, it is advisable to allow a minimum of two hours to reach the appropriate temperature before operating the instrument.

1.5 Safety

This instrument was built in compliance with VDE0411 part 1, safety regulations for electrical measuring instruments, control units and laboratory equipment. It has been tested and shipped from the plant in safe condition. It is in compliance with the regulations of the European standard

Griff entfernen (Pos. F)

Operating positions   Carrying positions   Stacking positions
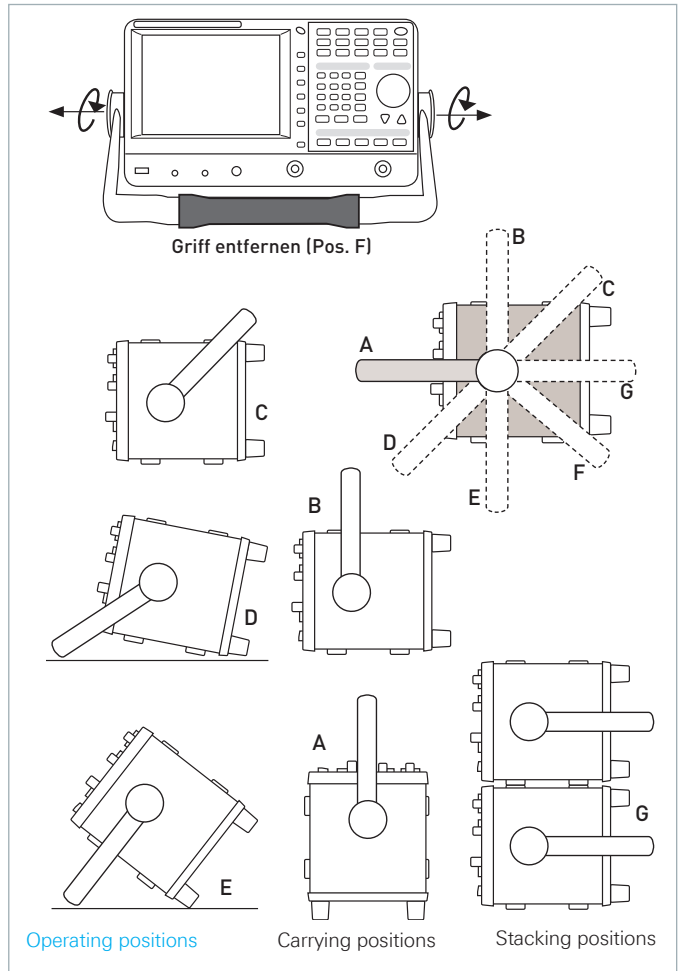
Fig. 1.1: Various positions for R&S®HMS-X

EN 61010-1 and the international standard IEC 61010-1. To maintain this condition and to ensure safe operation, the user must observe all instructions and warnings given in this operating manual. According to the regulations of protection class 1, all casing and chassis parts are connected to the protective earth conductor during operation.

> ⚠ **It is prohibited to disconnect the earthed protective connection inside or outside the instrument!**

If uncertainty exists about the function or safety of the power sockets, the outlets must be examined in accordance with DIN VDE 0100, part 610.
∎ The available mains voltage must correspond to the values specified on the instrument label.
∎ The instrument may only be opened by fully trained personnel.
∎ Prior to opening, the instrument must be turned off and isolated from all circuits.

In the following cases, remove the instrument from operation and secure it against unintentional operation:
∎ Visible damage to the instrument
∎ Cable damage
∎ Fuse holder damage
∎ Loose parts in the instrument

ɪ The instrument is no longer working
ɪ After an extended period of storage under unfavorable conditions (e.g. outdoors or in damp rooms)
ɪ Rough handling during shipment

Prior to switching on the product, it must be ensured that the nominal voltage setting on the product matches the nominal voltage of the AC supply network. If it is necessary to set a different voltage, the power fuse of the product may have to be changed accordingly.

1.6   Intended Operation

The measuring instrument is intended only for use by personnel familiar with the potential risks of measuring electrical quantities. For safety reasons, the measuring instrument may only be connected to properly installed safety socket outlets. Separating the grounds is prohibited. The power plug must be inserted before signal circuits may be connected.

Use the measuring instrument only with original ROHDE & SCHWARZ measuring equipment, measuring cables and power cord. Never use inadequately measured power cords. Before each measurement, measuring cables must be inspected for damage and replaced if necessary. Damaged or worn components can damage the instrument or cause injury.

The product may be operated only under the operating conditions and in the positions specified by the manufacturer, without the product's ventilation being obstructed. If the manufacturer's specifications are not observed, this can result in electric shock, fire and/or serious personal injury, and in some cases, death. Applicable local or national safety regulations and rules for the prevention of accidents must be observed in all work performed.

The measuring instrument is designed for use in the following sectors: Industry, residential, business and commercial areas and small businesses. The measuring instrument is designed for indoor use only. Before each measurement, you need to verify at a known source if the measuring instrument functions properly.

To disconnect from the mains, the low-heat device socket on the back panel has to be unplugged.

1.7   Ambient Conditions

Permissible operating temperatures during the operations range from +5°C to +40°C. During storage or transportation the temperature may be between –20°C and +70°C. In case of condensation during transportation or storage , the instrument will require approximately two hours to dry and reach the appropriate temperature. It can then be operated. The measuring instrument is designed for use in a clean and dry indoor environment. Do not operate with high dust and humidity levels, if danger of explosion exists or with aggressive chemical agents. Any operating position may be used; however adequate air circulation must be maintained. For continuous operation, a horizontal or inclined position (integrated stand) is preferable.

The maximum operating altitude for the instrument is 2000m. Nominal data with tolerance details apply once the ambient temperature of 23°C has been reached after about 30 minutes. Values without tolerance details are reference values of an average instrument.

⚠ **Do not obstruct the ventilation holes!**

1.8   Warranty and repair

ROHDE & SCHWARZ instruments are subject to strict quality controls. Prior to leaving the manufacturing site, each instrument undergoes a 10-hour burn-in test. Nearly every premature failure will be detected in intermittent operation. This is followed by extensive functional quality testing to examine all operating modes and to guarantee compliance with the specified technical data. The testing is performed with testing equipment that is calibrated to national standards. The statutory warranty provisions shall be governed by the laws of the country in which the ROHDE & SCHWARZ product was purchased. In case of any complaints, please contact your supplier.

Applicable only in EU countries:

If your instrument still requires repair work, customers within the EU can process repairs directly with HAMEG to accelerate the procedures. The HAMEG customer service (see RMA) is available for repair services even once the warranty period ends.

Return Material Authorization (RMA):

In any event, before returning an instrument, request a RMA number either via internet (http://www.hameg.com) or by fax. If you require technical support or suitable packaging (original box), please contact the HAMEG Service:

HAMEG Instruments GmbH
Service
Industriestr. 6
D-63533 Mainhausen
Phone: +49 (0) 6182 800 500
Fax: +49 (0) 6182 800 501
E-Mail: service@hameg.com

⚠ **The product may only be opened by authorized and qualified personnel. Prior to working on the product or before the product is opened, it must be disconnected from the AC supply network. Otherwise, personnel will be exposed to the risk of an electric shock.**

Any adjustments, replacements of parts, maintenance and repair may be carried out only by authorized ROHDE & SCHWARZ technical personnel. Only original parts may be used for replacing parts relevant to safety (e.g. power switches, power transformers, fuses). A safety test must always be performed after parts relevant to safety have been replaced (visual inspection, PE conductor test, insulation resistance measurement, leakage current measurement, functional test). This helps ensure the continued safety of the product.

1.9 Maintenance

Clean the outer case of the measuring instrument at regular intervals, using a soft, lint-free dust cloth.

The display may only be cleaned with water or an appropriate glass cleaner (not with alcohol or other cleaning agents). Follow this step by rubbing the display down with a dry, clean and lint-free cloth. Do not allow cleaning fluid to enter the instrument. The use of other cleaning agents may damage the labeling or plastic and lacquered surfaces.

Before cleaning the measuring instrument, please make sure that it has been switched off and disconnected from all power supplies (e.g. AC supply network or battery).

No parts of the instruments may be cleaned with chemical cleaning agents (such as alcohol, acetone or cellulose thinner)!

1.10 Measurement Categories

This instrument is designed for measurements on circuits that are only indirectly connected to the low voltage mains or not connected at all. The instrument is not intended for measurements within the measurement categories II, III or IV.

The measurement categories refer to transients that are superimposed on the mains voltage. Transients are short, very fast (steep) current and voltage variations which may occur periodically and non-periodically. The level of potential transients increases as the distance to the source of the low voltage installation decreases.

ı **Measurement CAT IV**: Measurements at the source of the low voltage installations (e.g. meters)
ı **Measurement CAT III**: Measurements in building installations (e.g. power distribution installations, power switches, firmly installed sockets, firmly installed engines etc.).
ı **Measurement CAT II**: Measurements on circuits electronically directly connected to the mains (e.g. household appliances, power tools, etc.)
ı **0** (instruments without measured measurement category): Other circuits that are not connected directly to the mains.

1.11 Mains voltage

The instrument has a wide range power supply from 105 to 253 V, 50 or 60 Hz ±10%. There is hence no line voltage selector. The line fuse is accessible on the rear panel and part of the line input connector. Prior to exchanging a fuse, the line cord must be pulled out. Exchange is only allowed if the fuse holder is undamaged. It can be taken out using a screwdriver put into the slot. The fuse can be pushed out of its holder and exchanged. The holder with the new fuse can then be pushed back in place against the spring. It is prohibited to "repair" blown fuses or to bridge the fuse. Any damages incurred by such measures will void the warranty.

Type of fuse:
Size 5 x 20 mm; 250V~, C; IEC 127, Bl. III;
DIN 41 662 (or DIN 41 571, Bl. 3).
Cut off: slow blow (T) 2A.

1.12 Batteries and Rechargeable Batteries/Cells

If the information regarding batteries and rechargeable batteries/cells is not observed either at all or to the extent necessary, product users may be exposed to the risk of explosions, fire and/or serious personal injury, and, in some cases, death. Batteries and rechargeable batteries with alkaline electrolytes (e.g. lithium cells) must be handled in accordance with the EN 62133 standard.

1. Cells must not be disassembled, opened or crushed.

2. Cells and batteries may not be exposed to heat or fire. Storage in direct sunlight must be avoided. Keep cells and batteries clean and dry. Clean soiled connectors using a dry, clean cloth.

3. Cells or batteries must not be short-circuited. Cells or batteries must not be stored in a box or in a drawer where they can short-circuit each other, or where they can be short-circuited by other conductive materials. Cells and batteries must not be removed from their original packaging until they are ready to be used.

4. Keep cells and batteries out of reach of children. Seek medical assistance immediately if a cell or battery was swallowed.

5. Cells and batteries must not be exposed to any mechanical shocks that are stronger than permitted.

6. If a cell develops a leak, the fluid must not be allowed to come into contact with the skin or eyes. If contact occurs, wash the affected area with plenty of water and seek medical assistance.

7. Improperly replacing or charging cells or batteries that contain alkaline electrolytes (e.g. lithium cells) can cause explosions. Replace cells or batteries only with the matching type in order to ensure the safety of the product.

8. Cells and batteries must be recycled and kept separate from residual waste. Cells and batteries must be recycled and kept separate from residual waste. Rechargeable batteries and normal batteries that contain lead, mercury or cadmium are hazardous waste. Observe the national regulations regarding waste disposal and recycling.

1.13 Product Disposal

Fig. 1.4: Product labeling in accordance with EN 50419

The Electrical and Electronic Equipment Act implements the following EG directives:

▪ 2002/96/EG (WEEE) for electrical and electronic equipment waste and
▪ 2002/95/EG to restrict the use of certain hazardous substances iin electronic equipment (RoHS directive).

Once its lifetime has ended, this product should be disposed of separately from your household waste. The disposal at municipal collection sites for electronic equipment is also not permitted. As mandated for all manufacturers by the Electrical and Electronic Equipment Act (ElektroG), ROHDE & SCHWARZ assumes full responsibility for the ecological disposal or the recycling at the end-of-life of their products.

Please contact your local service partner to dispose of the product.

2 R&S®HMS-X options

The basic unit R&S®HMS-X can be upgraded with different options. All options are combinable with each other. The following options (resp. voucher) are available in combination with the spectrum analyzer R&S®HMS-X:

Type	R&S®HMS-X Options[1]	Upgrade Voucher[2]
Unlock built-in Tracking Generator	R&S®HMS-TG	R&S®HV211
Bandwidth Upgrade to 3 GHz	R&S®HMS-3G	R&S®HV212
EMV Option incl. Preamplifier	R&S®HMS-EMC	R&S®HV213

Tab. 2.1: Overview R&S®HMS-X Options / Voucher

1) available only with purchase of HMS-X basic unit
2) activate R&S®HMS-X options at any time after purchase of HMS-X basic unit

The R&S®HMS-EMC option resp R&S®HV213 voucher is the most extensive option. With the R&S®HMS-EMC resp R&S®HV213 the EMC software, the preamplifier, diverse resolution bandwidths and an advanced amplitude measurement range are activated.

The options R&S®HMS-TG, R&S®HMS-3G and R&S®HMS-EMC can be purchased ex factory in combination with an

R&S®HMS-X basic unit. The upgrade voucher R&S®HV211, R&S®HV212 and R&S®HV213 allow an instrument upgrade at any later point in time via licence key. If an instrument option resp. upgrade voucher is activated, the R&S®HMS-X will show the activated options with a green hook on the starting display. The inactive options are marked with a red X. Additionally the activated options can be verified in the SETUP-Menü with the softkey DEVICE INFO.

Please find the most important differences at the following table 2.1. For each instrument find the complete technical data at ROHDE & SCHWARZ homepage.
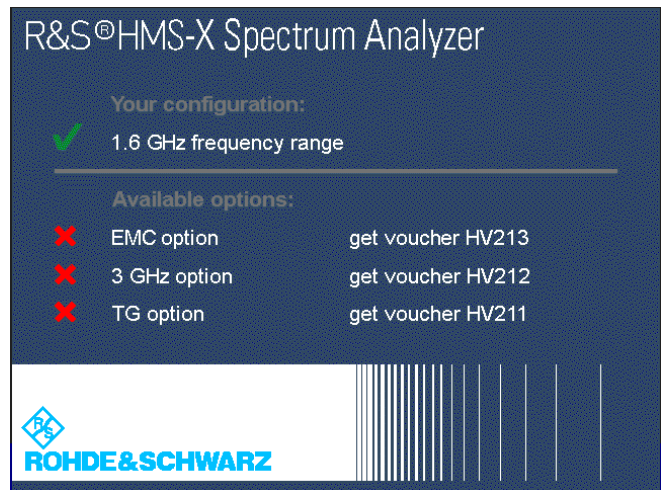

Fig. 2.1: Starting display R&S®HMS-X with activated TG

Type	R&S®HMS-X basic unit	R&S®HMS-X basic unit + R&S®HMS-TG / R&S®HV211 (Unlock TG)	R&S®HMS-X basic unit + R&S®HMS-3G / R&S®HV212 (Upgrade 3GHz)	R&S®HMS-X basic unit + R&S®HMS-EMC / R&S®HV213 (EMV)
Span setting range:	0 Hz (Zero Span) and 1 MHz to 1,6 GHz	0 Hz (Zero Span) and 1 MHz to 1,6 GHz	0 Hz (Zero Span) and 1 MHz to 3 GHz	0 Hz (Zero Span) and 100 Hz to 1,6 GHz
Resolution bandwidths (-3 dB):	10 kHz to 1 MHz in 1–3 steps, 200 kHz			100 Hz to 1 MHz in 1–3 steps, 200 kHz
Resolution bandwidths (-6 dB):	–			200 Hz, 9 kHz, 120 kHz, 1 MHz
Video bandwidth:	1 kHz to 1 MHz in 1-3 steps			10 Hz to 1 MHz in 1-3 steps
Amplitude measurement range:	typ. -104 dBm to +20 dBm			typ. -114 dBm to +20 dBm
DANL (Displayed average noise level):	typ. -104 dBm			typ. -135 dBm
Detektors:	Auto-, Min-, Max-Peak, Sample, RMS, Average			Auto-, Min-, Max-Peak, Sample, RMS, Average, Quasi-Peak
Linear display scaling (level):	–			Percentage of reference level
Marker displays:	Normal (level & log.), delta marker, noise marker			Normal (level & log.), delta marker, noise marker, frequency counter
Trigger:	Free run, Single Trigger, ext. Trigger			Free run, Single Trigger, ext.Trigger, Video Trigger
Tracking-Generator	–	yes	–	–
Bandwidth 3GHz	–	–	yes	–
Preamplifier	–	–	–	yes
EMV-Software	–	–	–	yes

Tab. 2.2: Specifications overview R&S®HMS-X with available options

3 Description of the Operating Elements

Front panel of R&S®HMS-X

1. Display - 6,5" VGA TFT Display
2. Interaktive Softkeys - Direct access of all relevant functions
3. POWER - Power switch turns the instrument on/off

Area A :

4. AMPL - Setting of amplitude parameters
5. SPAN - Setting of the Span
6. FREQ - Setting of the frequency
7. TRACE - Trace configuration
8. SWEEP - Setting of the sweep time and trigger source
9. BANDW - Setting of the resolution (RBW) and video bandwidth (VBW)
10. LINES - Configuration of limit lines
11. MEAS - Implementation of extended measurements
12. DISPLAY - Setting of the display
13. PEAK SEARCH - Measuring value peak display
14. MARKER → - Next marker selection by activating more than 1 marker

15. MARKER - Selection and arrangement of the absolute and relative marker
16. MODE - Switching between SWEEP- and RECEIVER-Mode
17. PRESET - Factory reset
18. AUTO TUNE - Automatically setting of instrument settings

Area B (Data):

19. Numeric keypad - Setting of operating parameters
20. BACK - Set back inputs
21. CANCEL - Terminate the editing mode
22. ENTER - Confirm the values via keypad

Area C (Variation):

23. Rotary knob - Setting and confirming parameters
24. Arrow buttons ▼▲ - Zoom-In / Zoom-Out functionality

Area D (General):

25. FILE/PRINT - Selection of automatical storage of instrument settings, curves and screenshots
26. SETUP - General instrument settings
27. HELP - Instrument help function
28. SAVE/RECALL - Store and restore of instrument settings, curves and screenshots
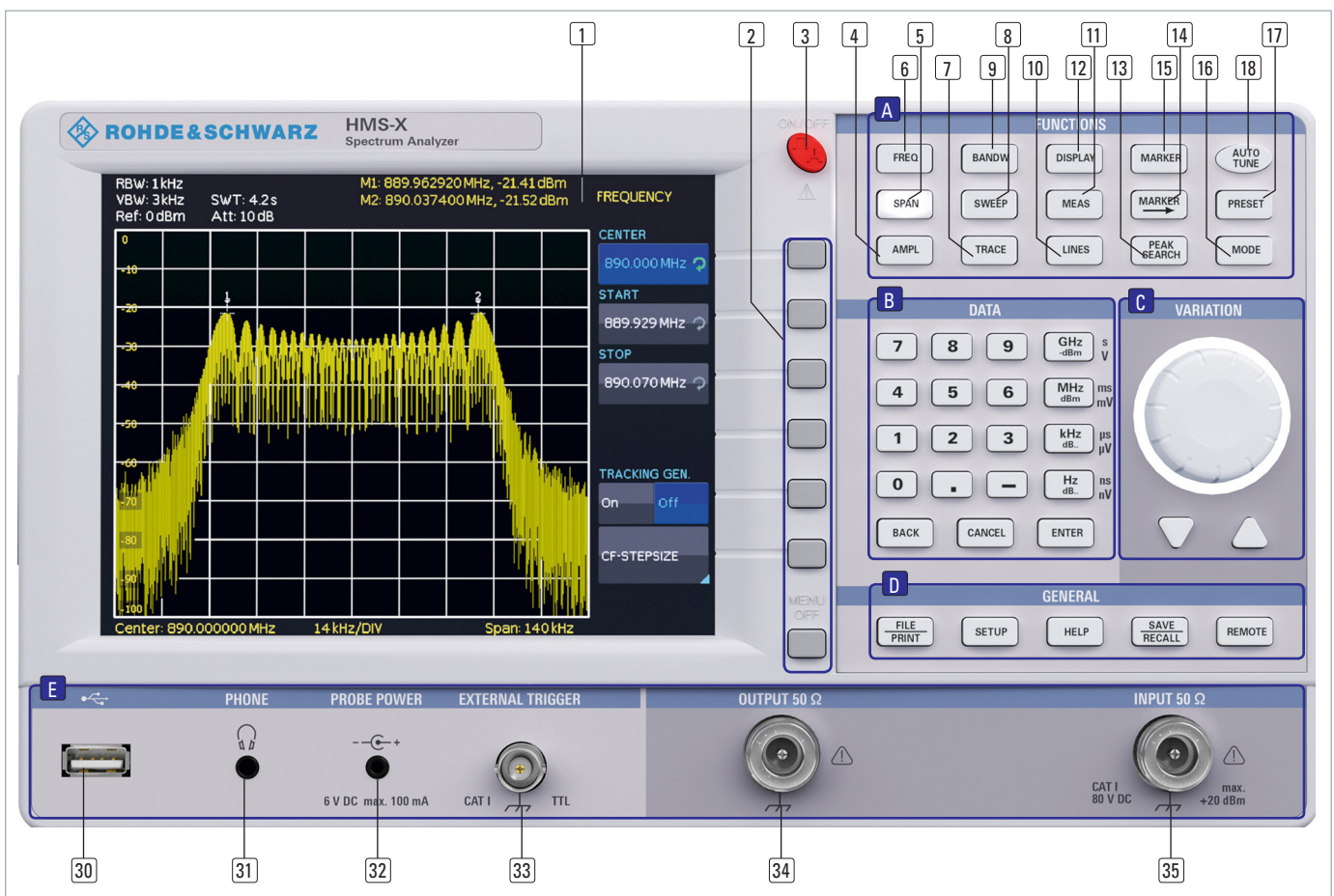29. REMOTE - Toggling between front panel and external operation

Fig. 3.1: Front panel of the HMS-X

Area E:

30 USB stick port - Front USB port for storing parameters
31 PHONE Ω (connector) - Headphone connector 3,5 mm
    jack; impedance > 8 Ω
32 PROBE POWER (connector) - Power supply (6 VDC) for
    probes (2,5 mm jack)
33 External TRIGGER (BNC socket) - BNC input for exter-
    nal trigger signal
34 OUTPUT 50 Ω - Tracking Generator (N connector)
29 INPUT 50 Ω - Input N connector

Rear panel of R&S®HMS-X

36 Mains input connector with fuse
37 Interface - HO720 Dual-Interface (USB/RS-232) is provi-
    ded as standard
38 DVI-D (connector) - Display of instrument screen 1:1 on
    external DVI monitor or projector with DVI-D connector
39 USB stick port - Additional USB stick port
40 REF IN (BNC socket) - Reference input
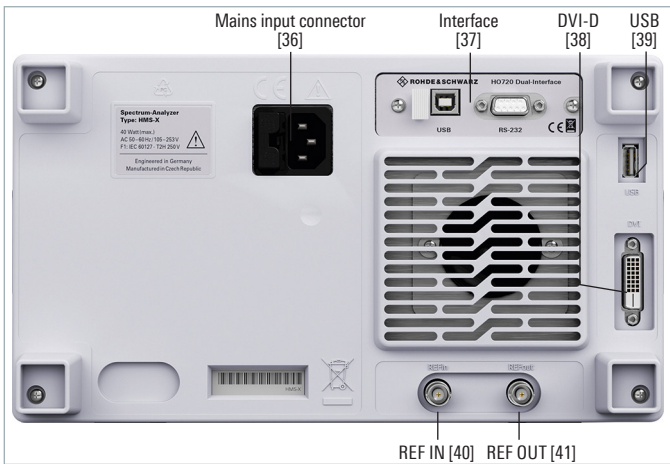41 REF OUT (BNC socket) - Reference output

Fig. 3.2: Rear panel of the R&S®HMS-X

4 Brief Description

The following chapters are intended to introduce you to the most important functions and settings of your new R&S®HMS-X spectrum analyzer (in this example R&S®HMS-X with all available options) in order to enable you to immediately use it. You find more detailed explanations in the chapters following these ones.

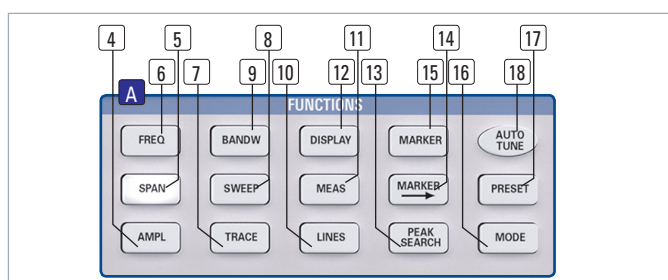## 4.1 How to measure a sine wave signal

Fig. 4.1: Area A of the control panel

The fundamental measurement with a spectrum analyzer is the measurement of the level and the associated frequency of a sine wave signal. The following measurement example demonstrates the steps to be taken for the settings which allow to effectively perform this measurement with the R&S®HMS-X. The signal source is a HF synthesizer, e.g. the Hameg HM8135. Connect the HF output of the synthesizer to the HF input of the spectrum analyzer.

Settings on the synthesizer:
I Frequency 100 MHz
I Level –10 dBm

Press the AUTO TUNE key ⟨18⟩ in order to cause the instrument to scan the whole measuring range in order to find the highest signal peak and to display it at the screen center together with the proper RBW and span settings. This procedure may take several seconds.
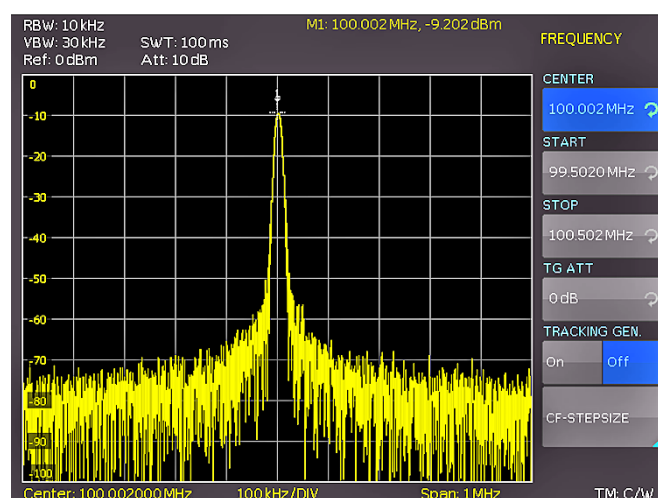

Fig. 4.2: Display with the AUTO TUNE function

4.2 Level measurement

In order to now perform the previouly automatically taken steps manually, press the key PRESET ⟨17⟩ which resets the instrument to its initial settings. The analyzer displays the frequency spectrum of its full frequency range from 100 kHz to 1.6 GHz resp. 3 GHz. At 100 MHz the generator signal will be discernible as a line. Harmonics of the oscillator are also displayed at multiples of 100 MHz (not visible here). In order to analyze the generator signal further, use the frequency settings menu (key FREQ ⟨6⟩) to set the start frequency to 50 MHz and the stop frequency to 250 MHz. The spectrum analyzer now displays the signal with a higher resolution. In order to determine the level of the signal, the R&S®HMS-X offers up to 8 markers. The marker is always attached to the measuring curve. The instrument indicates the level and the frequency at the relevant position on the screen.

Press the key MARKER ⟨15⟩ to enter the marker settings menu. Marker [1] will be activated by the soft key DISPLAY, it will be automatically positioned to the center frequency of the actual curve. The marker frequency is indicated by a cross resp. arrow symbol (next to the activated marker). The spectrum analyzer displays the level and the frequency of the marker position numerically at the top of the screen. Now move the marker [1] to the displayed level at 100 MHz by pressing the soft key Position and, after selecting the marker (the marker indication will turn to orange), use the knob to move it to the left; you may also enter the desired frequency of 100 MHz directly via the keyboard.
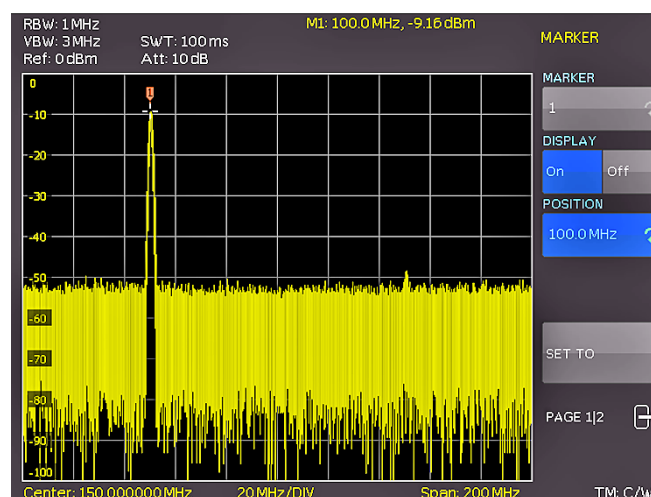

Fig. 4.3: Level measurement with marker

4.3 Measurement of the harmonics of a sine wave signal

Due to the property of a spectrum analyzer to resolve different signals in the frequency range, it is well suited to measure harmonics or the distance between harmonics and the fundamental. The R&S®HMS-X offers extended marker functions which allow to arrive at a result after just a few key pressures. Due to the previous settings in chapter 4.2, the first marker is already located on the fundamental which should stand clearly out of the noise floor in the left-hand screen area. The marker should also display the selec-

ted level of –10 dBm in the upper screen area. The first harmonic of the sine wave should now appear at 200 MHz. Depending on the purity of the signal this harmonic may be well or hardly visible with the presently active settings.

In order to measure the distance of the first harmonic to the fundamental proceed as follows:
Press the soft key MARKER and move the knob by one detent position to the right in order to select a second marker (M2). Activate the marker by pressing the soft key DISPLAY. The second marker will now appear in the center of the display. Select the marker by pressing the soft key DISPLAY (the marker indication will turn to orange) and move it with the knob (to the right) or via the keyboard by directly entering the value 200 MHz.
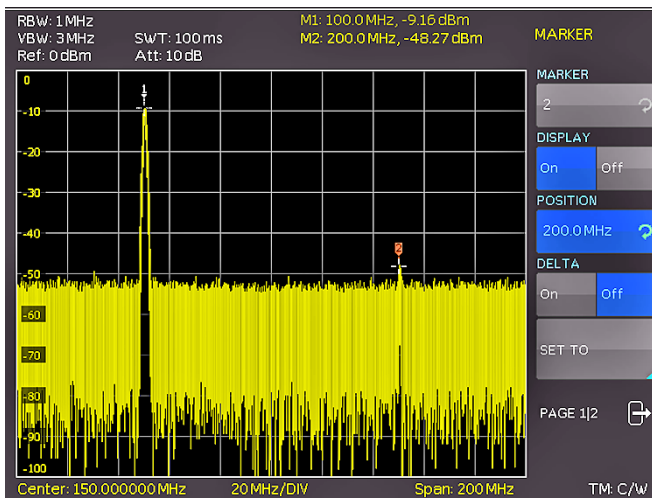

Fig. 4.4: Measurement of the harmonic of a sine wave signal

4.3.1 Selection of the proper filter settings

In order to better resolve the harmonic from the noise, the RBW and the VBW filters should be adapted to the measurement task by using the bandwidth menu (key BANDW 9). The R&S®HMS-X standard procedure is to automatically set the RBW and VBW filters such that a first approximation of a measurement of the input signal will be possible. Manual selection of the filters will be always superior to an automatic presetting. Activate the key BANDW 9 to enter the filter menu of the spectrum analyzer. Due to the presettings, the RBW and the VBW will be set to Auto. Activate manual setting by pressing the top soft key, then use the knob to select the 100 kHz filter from the list in the menu which will appear. The noise band displayed formerly should now be markedly reduced such that the first harmonic will be better visible. A further reduction of the RBW would display the harmonic still better at the expense of a massively extended sweep time. Here, a compromise must be found between display quality and measurement time, optimum for the actual measurement task.

Another means of spectrum analysis is the socalled video bandwidth (VBW). This is nothing else but a low pass filter which filters high frequency components from the signal. Using this filter can also cause a massive increase of the sweep time, and again a sound compromise has to be

found between display quality and measurement time. Activate the manual VBW selection by pressing the associated soft key and use the knob to select a 10 kHz filter from the list in the menu which will appear. Both levels (fundamental and harmonic) should now be well visible on the R&S®HMS display.
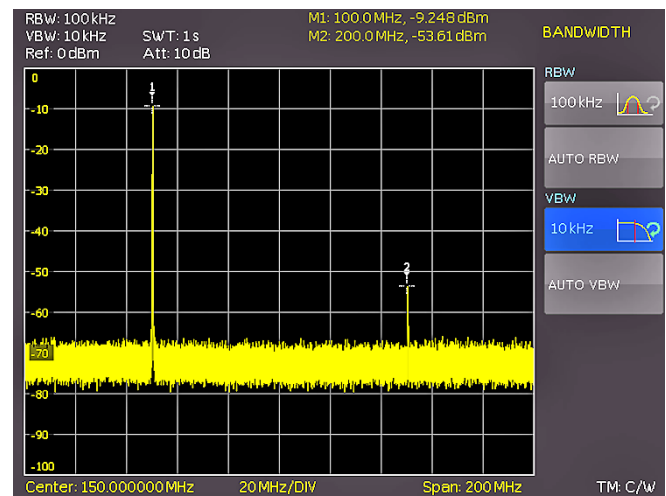

Fig. 4.5: Selection of the proper filter settings

4.3.2 How to measure the harmonic

In chapter 4.3.1 already two markers were positioned on the fundamental and the harmonic, the second one on the harmonic. Open the marker menu by pressing the key MARKER 15. The marker [2] is still selected (shown as an entry on the top soft key) Change the active marker [2] from an "absolute" marker to a "relative" delta marker by pressing the soft key DELTA. The marker display will change from an absolute frequency and level display to a relative frequency and level display; the values shown refer always to the main marker (marker [1]).
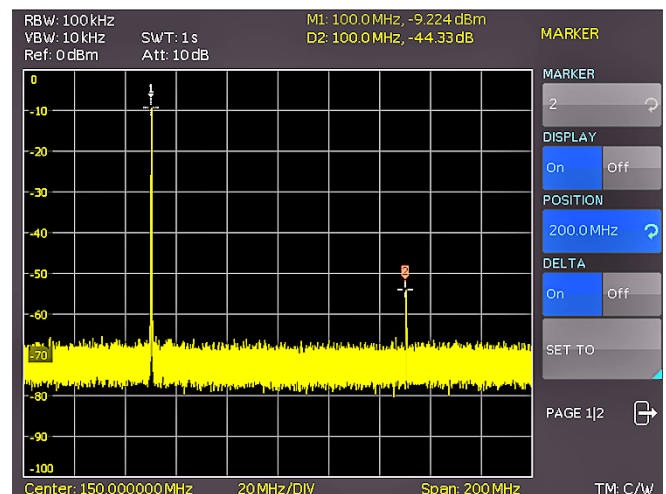

Fig. 4.6: Measuremen of the harmonic using the delta marker

4.3.3 Extended marker functions (PEAK SEARCH)

Press the key PEAK SEARCH in order to reach the extended marker functions. Select the marker to be used with the key (MARKER > 14). In the top screen area (where the level and frequency values of the markers can be read) the lettering of the marker selected will be shown pronounced
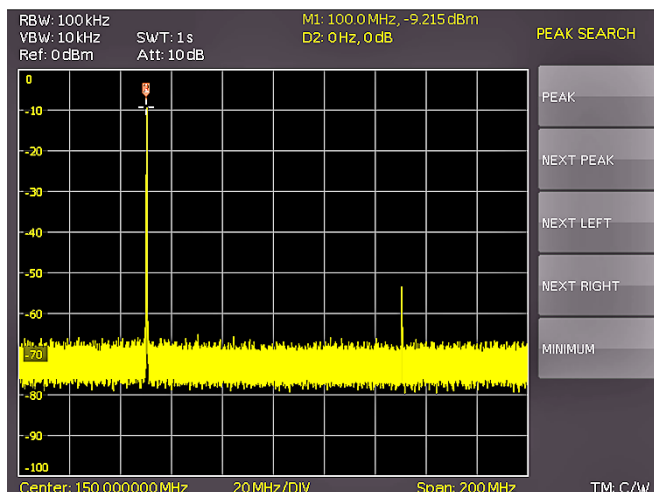
Fig. 4.7: PEAK SEARCH function

bright. Select the marker [2] and press the soft menu key PEAK. The second marker should now jump to the same spot where marker [1] already resides (that is the position of the fundamental), because the level of this is the highest. The values displayed for (Delta-) frequency and level should be "0". Press the soft menu key NEXT PEAK in order to cause the active marker to position again on the first harmonic. The values displayed for (Delta-) frequency and level should be identical to the original ones.
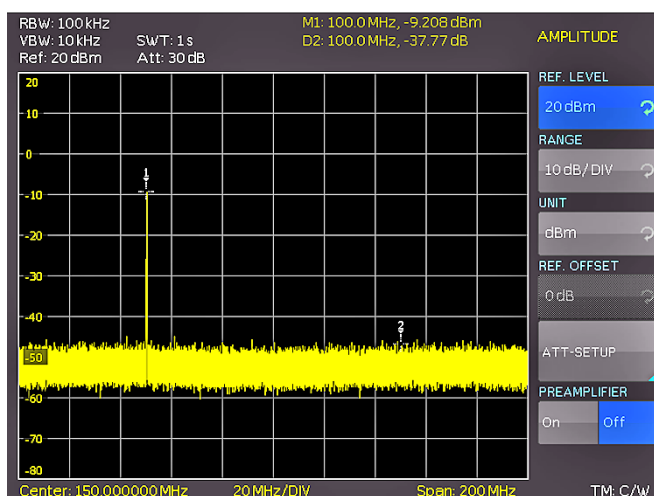
4.4 Setting of the reference level

Fig. 4.8: Setting of the reference level

The reference level in spectrum analyzers is always the level of the top graticule line. In order to realize the maximum dynamic range in spectrum measurement, the level display range of the spectrum analyzer should be fully used. This means that the highest level in the actual spectrum should be as close to the top graticule line (= reference level) as possible. The maximum value of the level display (Y axis) of the measurement display is determined by the reference level. However, take care that the top graticule line is not exceeded as this would cause overdrive of the spectrum analyzer input stage. In order to prevent overdriving the input, the input attenuators of the spectrum analyzer are independently selectable and linked to the reference level. If the reference level in the amplitude

selection menu (key AMPL [4]) is increased by 20dB (0 to 20dBm), the input attenuator will be automatically switched to 30dBm.This will cause the first harmonic of the signal (marker 2) to disappear in the noise floor.

4.5 Operation in the receiver mode

For the measurement of levels of a signal frequency the R&S®HMS-X offers the receiver mode. The spectrum analyzer operates like a receiver which is tuned to a frequency and measures the level. The menu of the measurement functions will open by pressing the key MEAS [11], If the soft key CF→RX is activated, the R&S®HMS will switch to the receiver mode and measures the level of the center frequency set. The most important settings of the measurement parameters are directly accessible in the main menu of the receiver mode and can be activated by pressing the appropriate keys. In the receiver mode the same bandwidths are available as in the analyzer mode. Additionally, the bandwidths 200 Hz, 120 kHz, and 1 MHz (−6 dB) for emi measurements according to CISPR are provided (only available in combination with R&S®HMS-EMC resp. R&S®HV213). These can be chosen by pressing the key BANDW and using the knob.
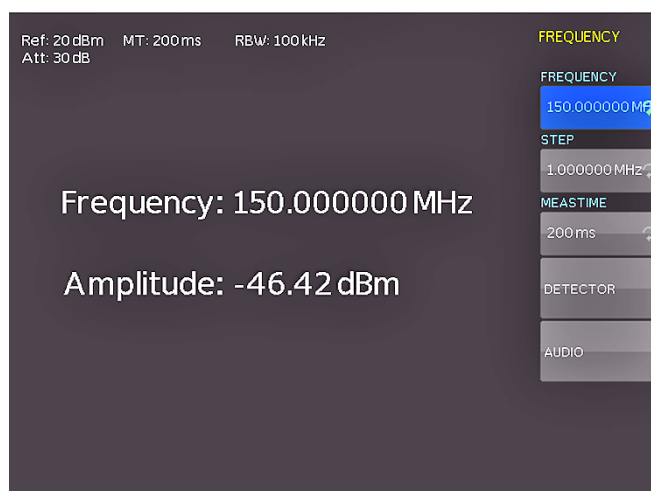

Fig. 4.9: Receiver mode with a center frequency set

The R&S®HMS-X receiver mode offers peak, average, RMS and quasi-peak detectors. The detector is selected in the main menu of the receiver mode with the soft key DETECTOR.

> The quasi-peak detector is only available in combination with R&S®HMS-EMC option resp. R&S®HV213 voucher.

The measuring time is the time during which the spectrum analyzer collects measurement results and combines them for a result, depending on the detector selected. With the knob the measuring time may be varied, or it can be entered directly via the keyboard.

> If the quasi-peak detector is selected, the measuring time should be >100 ms in order to measure varying or pulsed signals correctly.

5 Setting of Parameters

5.1 Display segmentation in sweep mode

Three methods of setting signal parameters are offered: numeric keypad, knob and the arrow buttons. Please use the soft menu keys for selecting the respective menu item.
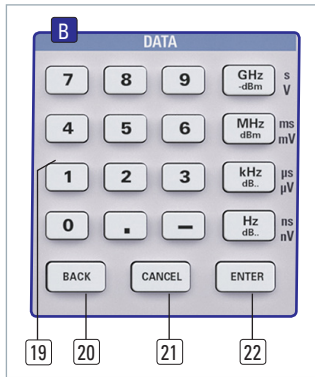
5.2 Numeric keypad

Fig. 5.2: Section B with numeric keypad, unit and command keys

The simplest method of entering parameters quickly and exactly is the entry via the numerical keyboard with the number keys (0...9), the decimal point key (.) and the minus key (-). When entering parameters via the keyboard the value will be accepted upon pushing the respective unit key GHz (-dBm), MHz (dBm), kHz (dB..) or Hz (dB..). The keys have multiple assignments. Prior to pushing any key an entry may be deleted by pushing the key BACK. During the operations the window will remain open. The CANCEL key will terminate the entry of parameters and close the window. In text mode characters can be confirmed with the ENTER key.

5.3 Rotary knob

It is possible to only use the knob for all settings. Values can also be entered with the rotary knob. The entry is changed in steps and the spectrum analyzer immediately sets the appropriate entry parameter. Turning the knob CW will increase the value, turning it CCW will decrease it. Such parameters can be modified only by using the knob (for example display settings).
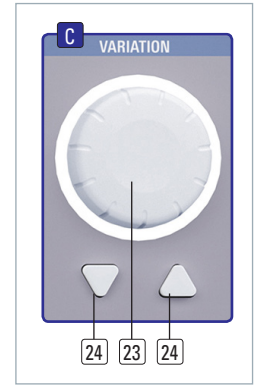
5.4 Arrow buttons

The arrow buttons allow the Zoom-In resp. Zoom-Out functionality. The ▲ button will double the span, the ▼ button will halve the span.

5.5 Interactive softkeys

The grey soft menu keys at the righthand side of the screen are used for the menu field displayed. Use the knob or the numeric keypad for setting the parameter selected. If a menu field was selected via the soft menu keys, this item will be marked in blue, it is now activated for entering a parameter. If an instrument function should not be available due to a specific setting, the associated soft menu key will be deactivated, the lettering will be shown in gray.

5.6 How to enter numerical values

▮ Use the gray soft menu keys for the selection of a menu item.
▮ Enter the value of the parameter using the numerical keyboard or modify it with the knob.
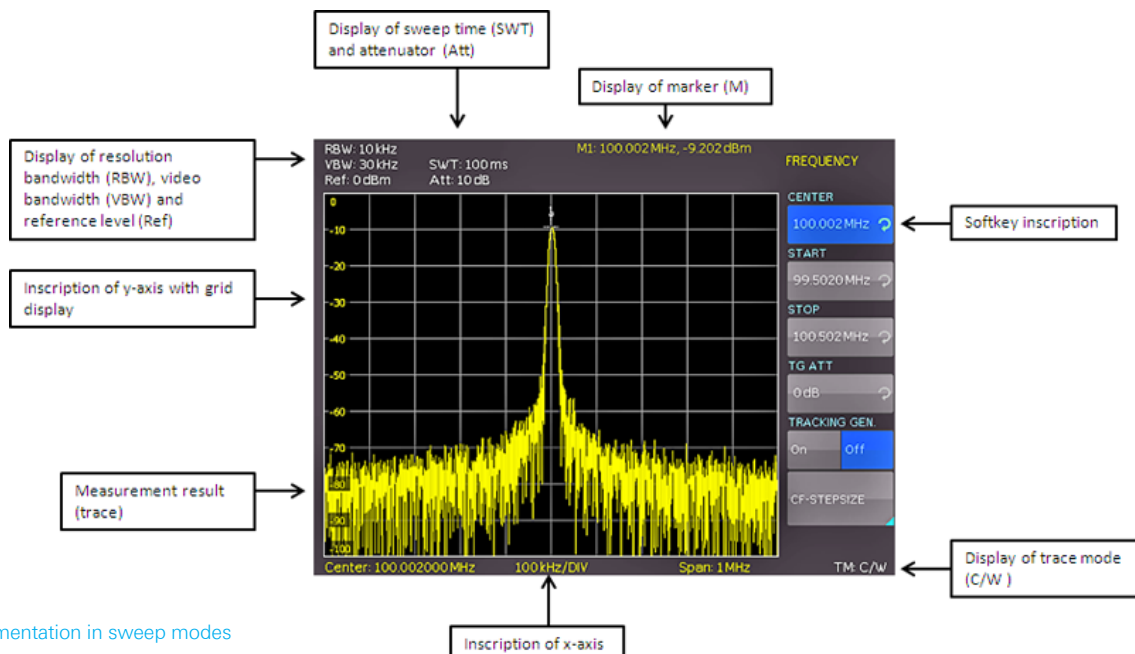▮ After a keyboard entry push the respective unit key.

Fig. 5.3: Rotary knob with arrow buttons

Fig. 5.1:
Display segmentation in sweep modes

6 Instrument Functions

6.1 Setting of the frequency (FREQ)

Pushing the FREQ key will call the menu for setting the frequency. The setting is performed as described in chapt. 5.

Spectrum display needs to be parameterised before measurement is started. The two most important parameters are start and stop frequency of the sweep. The frequency can be specified in terms of the center frequency (center freqency = frequency at the center of the frequency axis in the measurement diagram) or the start and stop frequency for a particular span. The start frequency sets the frequency at the left border of the trace, the stop frequency sets the highest frequency at the right hand border. In some applications it is easier to modify the center frequency. In this case start and stop frequencies are automatically adapted. It is best to enter the center frequency when a signal is to be measured at a known frequency. When you are investigating signals, e.g. harmonics, that are within a particular frequency range, the best option is entering a start and stop frequency to define the span.

The step size of the center frequency can be modified with CF-STEPSIZE. By pushing this soft menu key the settings menu will open.

ı **0.1 x SPAN** (Basic setting): The step size is always 1/10 of the currently selected span (= 1 vertical division).
ı **0.5 x SPAN**: The step size is always 1/2 of the currently selected span (= 5 vertical divisions).
ı **SET TO CENTER**: The step size of the frequency is equal to the present center frequency. This mode is especially useful for the measurement of harmonics because each step will move the center frequency to the next harmonic.
ı **MANUAL**: Any step size is available. This allows the easy measurement of spectra with regular frequency steps.

6.2 Aktivating / parameterizing the built-in tracking generator (TG) *)

„Tracking" of a tracking generator means the generator fundamental frequency is in the center of the analyzer passband at every instant of time. The tracking generator sweeps the entire available frequency range depending on the current measurement frequency of the spectrum analyzer. The tracking generator allows the user to perform frequency measurements for filters, amplifiers or mixers, for instance. With this system, it is also possible to measure reflection coefficients or return loss and consequently also investigate voltage standing wave ratios (VSWR). The output signal of the tracking generator is transmitted at the component to be examined, and the output voltage is applied to the spectrum analyzer input. The output of the tracking generator is nominal 0 dBm. It can be reduced via an adjustable TG attenuator (TG Att) in 1 dB steps up to

–20 dBm (tracking generator attenuation). The tracking generator generates an output signal on the same frequency which is currently received by the analyzer.

It is recommended to deactivate the tracking generator, whenever it is not required for the measurement. With activated tracking generator, the instrument is not able to compensate all imperfections anymore. This will be indicated with a red „TG on" message on the bottom right of the display, as well as a UNCAL message at the top of the display. The UNCAL message disappears, once the trace mathematics (please refer to chapter 6.7.1) of the R&S®HMS-X is used to compensate the effects described above.

6.2.1 Performing measurements with the TG *)

One of the most common application for TG measurements is the spectral investigation of hardware components. For this purpose, the DUT (device-under-test) is looped into the signal path between TG output and receiver input. In order to compensate any influences caused by cables, adaptors etc. used at the application, these will be directly connected to the spectrum analyzer without the DUT in the loop. The resulting trace shows the interference of the cables, connectors, etc. and needs to be stored in the trace memory of the spectrum analyzer. Afterwards the trace mathematics (TRACE - MEM) shall be activated. Due to the mathematical compensation of all interferences, necessarily a straight line is displayed and the UNCAL message is removed. After connection of the DUT into the signal path, the frequency response of the DUT is shown at the display, based on the selected frequency range.

The UNCAL message disappears by using the trace math.

The signal output of the tracking generator does not show a "true" sine wave signal. The output signal of the TG is generally not sinusoidal in even spectrum analyzers from other manufacturers. A generator which can generate a uniform sinusoidal signal from 5 MHz to 1.6 GHz/3 GHz, is not absolutely necessary to provide the desired function. The shape of the signal output is frequency dependend. A sinusoidal signal curve is not required for the "interpretation" at the R&S®HMS-X input. Through the reduction of the TG output signal to the input and the use of R&S®HMS-X (view in relation) narrow-band filter, neither the shape nor the signal harmonics of the signal are evaluated. The correct function of the TG by using the R&S®HMS-X is ensured at any time. Since the existing tracking generator has to display frequencies in a very broad context, it is usually that the tracking generator can not display low frequency signals (frequency range 5 MHz to 1.6 GHz resp. 3 GHz).

Further information about the TG in combination with the trace math you can find in chapter 6.7.2.

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*) only available in combination with R&S®HMS-TG resp. R&S®HV211

6.3 Frequency range displayed (SPAN)

The span is the frequency range centered on the center frequency which a spectrum analyzer displays on the screen. In principal there are two methods to define the displayed frequency range: defining start and stop frequency or center frequency and span. The frequency range called span is the range on both sides of the center frequency which a spectrum analyzer displays on its screen. The span to be selected depends on the signal to be analyzed, in general, it should be at least twice as wide as the bandwidth of the signal. With the span the bandwidth of the signal to be analyzed is set. Mathematically the span is the difference between stop and start frequency. In simple terms, the span is the magnitude of the spectral range and the center frequency defines the position in the spectrum.
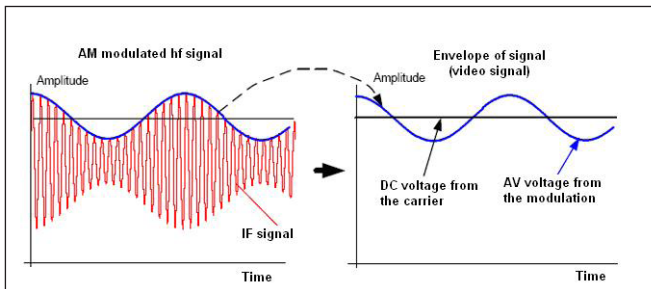

Fig. 6.1: Hf signal modulated by a sine wave signal and the resultant video signal vs. time

The R&S®HMS-X resp. the R&S®HMS-X incl. options offers the following frequency ranges (spans):

R&S®HMS-X (basic unit)   **1 MHz to 1.6 GHz**
R&S®HMS-X +
R&S®HMS-3G / R&S®HV212   **1 MHz to 3 GHz**

In zero span mode (0 Hz - Zero) the spectrum analyzer acts similar to a receiver tuned to the center frequency. In this case the trace display does not represent a spectrum, but the amplitude over time. In other words the spectrum analyzer acts like a selective oscilloscope. For example the zero span mode can be used to determine the maximum of fluctuating signals at a specific frequency more detailed or to represent parts of an amplitude modulation. Use the softkey FULL to select the full span from 1MHz (100Hz) to 1.6GHz resp. 3GHz. The softkey LAST will restore the last span setting. The setting is performed as described in chapt. 5.

6.4 Setting of the amplitude parameters (AMPL)

The key AMPL is used for all settings of the displayed amplitude. The reference level (soft menu item REF. LEVEL) is identical to the top graticule line of the display. The setting is performed as described in chapter 5. The reference level represents the amplitude level which is displayed at the upper trace screen. The RF attenuation setting at the input of the spectrum analyzer is directly coupled to the reference level. Lowering the reference level increases the sensitivity. Normally the reference level

is chosen to display the whole dynamic range on screen. If the input signals are strong, a high reference level must be set to prevent the analyzer signal path from being over-driven and to keep the signal display within the display range. When displaying the spectrum of a composite signal, the reference level should be at least high enough to ensure that all the signals are within the measurement diagram.

> **The receiver input will be overloaded by a disadjusted reference level.**

The RF attenuation setting at the input of the spectrum analyzer is directly coupled to the reference level. If the reference level is high, RF attenuation is switched on in steps according to the table 6.1, so that the input mixer always remains in the linear range.

The default unit (UNIT) of the reference level is dBm. Alternatively, the unit dBµV or the linear unit V and W can be selected using the knob. The scaling of the linear units V and W is set dynamically. Unit selection is of most relevance to the marker level display as the marker level is displayed in the unit of the reference level.

> **If the linear unit V or W is selected, the reference level is adjusted automatically. The linear scaling is only available in combination with R&S®HMS-EMC resp. R&S®HV213.**

The measurement range (RANGE) determines the resolution along the level axis in the measurement diagram. The basic scaling is in dB. The standard scaling is 10dB/DIV. The spectrum analyzer also provides the level ranges 5dB/DIV, 2dB/DIV and 1dB/DIV which enhance resolution along the level axis. A higher resolution does not increase the accuracy, it only improves the readability. An appropriate combination of reference level and vertical scale can be used to get a more detailed display of the trace. If the Unit is set to dBm or dBµV, the scaling of the reference level can be set to LIN% (linear percentage display). This means that a logarithmic unit is represented as a percentage value of the reference level. This mode is useful if you want to display, for example, a carrier being amplitude modulated in the time domain (Span = 0 Hz).

The RF attenuation setting at the input of the R&S®HMS-X is directly coupled to the reference level. The attenuation setup menu is used to influence the thresholds used for automatic attenuator selection when the reference level is adjusted. The instrument offers two different modes of coupling which are selected via the softkey ATT-SETUP:
- **LOW NOISE:** When adjusting reference level switching thresholds for attenuator and gain are optimised to get the best signal/noise ratio.
- **LOW DISTORTION:** When adjusting reference level switching thresholds for attenuator and gain are optimised for lowest possible distortion.

If the spectrum analyzer contains the R&S®HMS-EMC option resp. R&S®HV213 voucher incl. preamplifier the soft-

key PREAMPLIFIER activate or deactivate the preamplifier. The preamplifier increases the signal/noise ratio by 10 dB.

6.4.1 Reference Offset

The reference offset function is only selectable if the trace math is activated (TRACE). If the trace math is activated the reference offset function is not grayed out anymore.

The reference offset is used to vertically shift the trace if trace math is switched on. The reference offset adds a selectable value to the reference level. This is useful when prior to the RF input, an attenuator or an amplifier is used. The spectrum analyzer automatically takes the loss or gain into account when the level is displayed and no manual calculations are necessary. A loss introduced at the RF input must be entered as a positive number and a gain as a negative number. The value input of the reference offset (REF. OFFSET) is always given in dB, even if the reference level is set to a different unit.

6.5 Setting of the bandwidth (BANDW)

Spectrum analyzers resolve the spectral content of a signal and display a frequency spectrum. The quality of the resolution is determined by the resolution bandwidth (RBW). Additionally, the spectrum analyzer offers a selectable video bandwidth. The instrument will automatically (or, if desired, manually) choose a slower sweep time if the span was set too wide for the selected RBW (provided that the user did not set the span to manual).

If a wide span was set manually or the sweep time was too high, the amplitudes will be displayed with incorrect level; in such cases a red UNCAL message will warn. The span must then be reduced until the UNCAL message disappears.

The video bandwidth (VBW) affects that the video voltage is smoothed by video filtering to, say, reduce noise on the trace. It is determined by the bandwidth of the low pass filter inserted between the video signal and the display. In contrast to the resolution bandwidth the video bandwidth has no influence on the resolution properties of the spec-trum analyzer. By pushing the BANDW key the setting menu of the bandwidths will open. Both the resolution bandwidth (RBW) and the video bandwidth (VBW) may

RBW	VBW
100 Hz *)	10 Hz *)
300 Hz *)	30 Hz *)
1 kHz *)	100 Hz *)
3 kHz *)	300 Hz *)
10 kHz	1 kHz
30 kHz	3 kHz
100 kHz	10 kHz
200 kHz	30 kHz
300 kHz	100 kHz
1 MHz	200 kHz
	300 kHz
	1 MHz

Table 6.2: Available RBW and VBW settings

*) only available in combination with R&S®HMS-EMC resp. R&S®HV213

be set within the specified limits. The table 6.2 shows the step sizes which are available: Additionally automatic selection for both bandwidths (AUTO RBW/AUTO VBW) may be chosen with the respective softkey. The knob is used for the setting of the parameters.
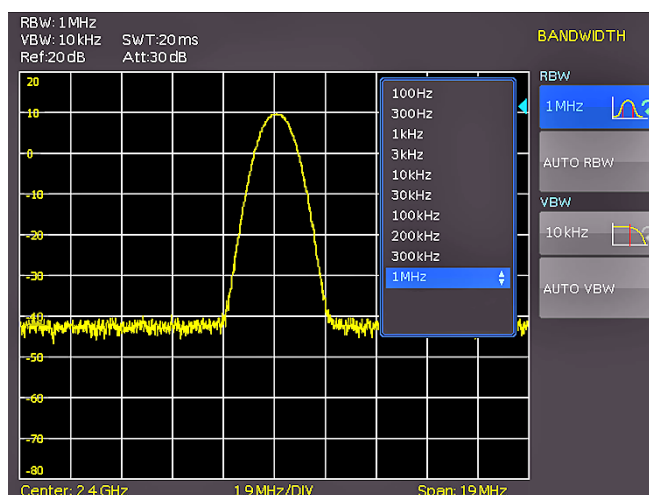

Fig. 6.2: The selections offered in the RBW menu

6.6 Setting of the SWEEP

With a frequency spectrum of f > 0 Hz the sweep time is the time the spectrum analyzer requires for sweeping the selected frequency range to measure the spectrum. Cer-

Reference Level	Preamplifier OFF		Preamplifier ON		
	ATT-Setup Low Noise	ATT-Setup Low Distortion	ATT-Setup Low Noise	ATT-Setup Low Distortion	Preamplifier
20 dBm	30 dB	30 dB	30 dB	30 dB	OFF
15 dBm	30 dB	30 dB	30 dB	30 dB	OFF
10 dBm	20 dB	30 dB	20 dB	30 dB	OFF
5 dBm	20 dB	30 dB	20 dB	30 dB	OFF
0 dBm	10 dB	20 dB	10 dB	20 dB	OFF
–5 dBm	10 dB	20 dB	10 dB	20 dB	OFF
–10 dBm	0 dB	10 dB	0 dB	10 dB	OFF
–15 dBm	0 dB	10 dB	10 dB	10 dB	ON
–20 dBm	0 dB	0 dB	10 dB	10 dB	ON
≤ –25 dBm	0 dB	0 dB	0 dB	0 dB	ON

Table 6.1: Relation between reference level and automatic setting of RF attenuation

tain limits have to be observed (e.g. the resolution band-width set) in order to obtain a correct display. Pushing the key SWEEP will open the selection menu. The sweep time can be varied within the specified limits. The setting of the parameters is performed as described in chapter 5. In or-der to assist the user when setting the sweep time, an au-tomatic selection of the sweep time with respect to the RBW and the span settings may be chosen with the soft-key Auto. The automatic mode will always set the sweep time to the shortest possible value consistent with the cor-rect display of the spectrum content.

The R&S®HMS-X spectrum analyzer will sweep the selec-ted frequency range continuously (softkey CONTINUOUS), i.e., after a sweep was completed, a new one will be star-ted and the display refreshed. If continuous sweeping is not desired (e.g., if a single event shall be recorded upon a trigger), there is also the possibility of selecting SINGLE sweep. If single sweep is selected, the spectrum analy-zer will sweep the frequency range once or it displays the video signal vs. time if the span is set to zero. The instru-ment will only repeat the measurement after the softkey Single was pushed again. Additionally the soft menu TRIG-GER offers diverse trigger functions in order to react to events.

6.6.1 Source

The video trigger can be only activated in zero span (span = 0 Hz).

With the softkey SOURCE an internal / external trigger source or the video trigger (VIDEO) can be selected. If the internal source is selected (int.), the spectrum analyzer is in the continuous sweep mode, i.e. when one sweep of the span has been completed, the sweep is automatically repeated from the start of the span. If the external source is selected (ext), the sweep is started by an external trigger signal. The video trigger (VIDEO) allows to trigger on a de-fined signal level. A sweep starts when the video voltage exceeds a settable value. When a frequency spectrum is being displayed (for example span 100 kHz), there is no gu-arantee that a signal to generate a video voltage is pre-
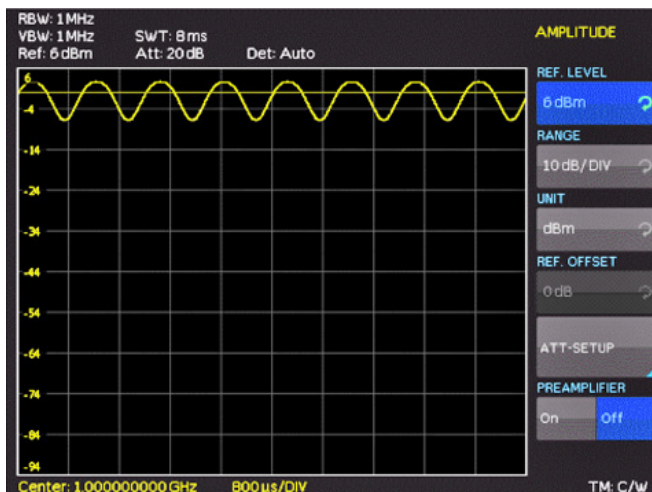

Fig. 6.4: Signal with AM modulation 50% in zero span with logarithmic scaling

sent at the start frequency. Under these circumstances the spectrum analyzer would never perform a sweep. With a span setting of 0 Hz (zero span) the spectrum analyzer chan-ges the display from spectrum versus time to discrete vol-tage versus time. The X-axis of the measurement diagram represents the time axis, starting with time 0s and ends with the selected sweep time. The minimum sweep time in zero span mode is 2 ms, the maximum is 1000 s.
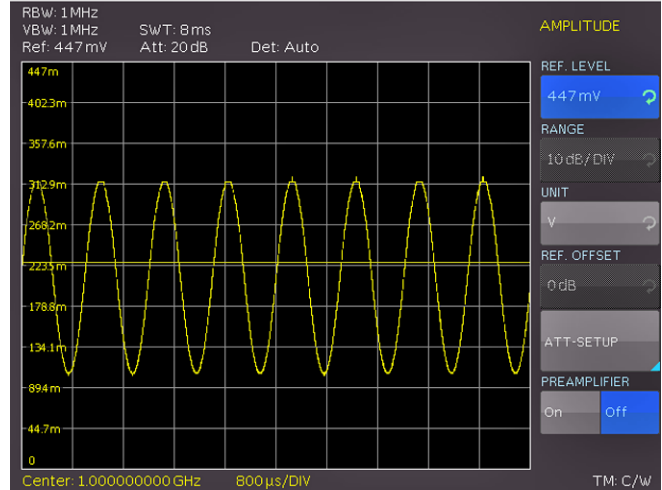

Fig. 6.3: Signal with AM modulation 50% in zero span with linear scaling

This so-called edge trigger works reliably up to a delta of at least 3 dB between the selected level (trigger line) and the maximum applied signal amplitude. The level of the vi-deo trigger (y-axis) can be set with the softkey LEVEL.

6.6.2 Slope
With the softkey SLOPE the sweep will be started by a positive or negative edge of an external trigger signal. The external trigger signal is applied via the BNC connector EXTERNAL TRIGGER (TTL logic levels).

The sweep can only be started by an external trigger signal. A trigger delay can be not defined.

6.7 Trace settings (TRACE)
The trace menu can be opened by pressing the TRACE key. The R&S®HMS-X can simultaneously display up to 3 waveforms on the screen. The trace mode of trace 2 and 3 is fixed and can not be changed by the user:
ı **Trace 1** = normal Sweep (yellow / free configurable)
ı **Trace 2** = Max hold trace (purple)
ı **Trace 3** = Min hold trace (green)

Trace 2 and 3 are each based on the freely configurable trace 1. Trace 2 and 3 can only be turned on (ON) or off (OFF). If all traces are enabled, it is possible to analyze the signal „progression" by the resulting min-max graph (ple-ase refer to figure 6.5).

There are several modes of curve display (TRACE MODE):
ı **CLEAR / WRITE** (default setting): clears the old trace during a new sweep

ı **MAX HOLD**: the trace indicates the maximum value that has been measured up to that point in time. Intermittent signals in the spectrum or the maximum of fluctuating signals are easy to find with Max Hold.

ı **MIN HOLD**: the trace indicates the minimum value that has been measured up to that point in time. With Min Hold, sine signals within the noise can be highlighted or intermittent signals suppressed.

ı **AVERAGE**: the R&S®HMS-X takes the level average over consecutive traces. In the default setting, averaging is on a pixel-by-pixel basis, sliding over the previous traces. The average mode makes it easy to display sine signals in the vicinity of noise.

ı **HOLD**: freezes the presently displayed trace. The measurement is aborted. This allows subsequent evaluation of spectra with the aid of the marker.

The selected trace mode function will be displayed at the bottom right on the display (for example C/W for Clear/Write).
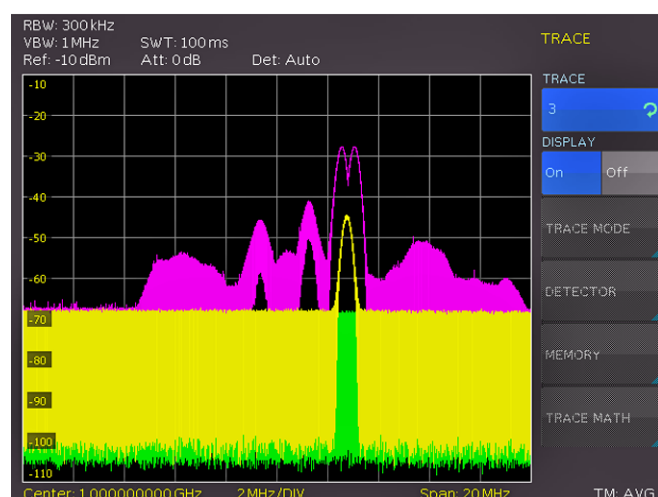

Fig. 6.5: Simultaneous display of 3 traces

6.7.1 Detector

A detector converts the video signal of a spectrum analyzer before it will be displayed. It functions pixel-by-pixel, determining how the value of a pixel will be measured. The R&S®HMS-X always measures the whole spectrum. The trace only has 500 pixels in the x direction for displaying results. If a large span is selected, all the spectrum information must somehow be represented using only 500 points. Each pixel represents a frequency range equal to span/500. For example, if the span is 3 GHz: 3 GHz/500 = 6 MHz. With a span of 3 GHz the minimum space between two pixels is 6MHz.

The smaller the span, the smaller the space between two pixels.

Pushing the softkey DETECTOR will open the detector settings menu. Following detector types are available:

ı **AUTO PEAK:** displays the maximum and minimum level at each pixel for the frequency range represented by that pixel, no signals will be lost. If the signal level fluctuates (noise), the width of the trace will indicate the width of the signal fluctuations (default setting).

ı **SAMPLE:** Only displays an arbitrary point within a display pixel. The sample detector should always be used for measurements with span = 0 Hz, as this is the only way of correctly representing the timing of the video signal. The sample detector can also be used to measure noise power as noise usually has a uniform spectrum with a normal amplitude distribution. If the sample detector is used for signal spectrum measurements with a span that is greater than (resolution bandwidth x 501), signals may be lost.

ı **MAX PEAK:** In contrast to the auto peak detector this detector only finds the maximum value within the frequency range associated with one trace pixel. Its use is recommended for measurements on pulse-like signals or FM signals.

ı **MIN PEAK:** yields the minimum value of the spectrum within a pixel of the trace. Sine signals are displayed with correct level, but noise-like signals are suppressed. The Min Peak detector can be used to highlight sine signals in the noise spectrum.

6.7.2 Trace Speicher (Memory)

With the softkey TRACE → MEMORY in the submenu MEMORY a trace can be transferred into the background curve memory. By pushing the softkey SHOW MEMORY the stored trace will be displayed and can be compared with the presently displayed curve. The stored curve will always be shown in white and thus can be easily differentiated from the presently displayed curve. In order to let the stored curve disappear, push the SHOW MEMORY softkey again.
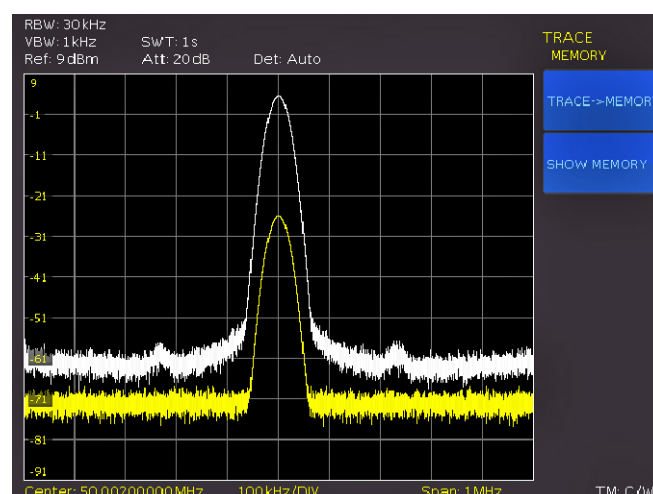

Fig. 6.6: Display of a measured and a stored reference curve

6.7.3 Trace mathematics

The spectrum analyzer can subtract a stored trace from an active trace and display the difference. If a trace is stored under TRACE→ MEMORY the difference between the stored an the active trace will be displayed by pushing the softkey TRACE MATH. In order to let the stored curve disappear push the key TRACE MATH and select OFF.

The trace math function can not be used in HOLD mode.

Pushing the softkey TRACE MATH will open the menu of the trace mathematics. After saving a trace in memory (via the softkey TRACE → MEMORY) the difference between the stored trace and the actual trace can be displayed using the TRACE - MEM button. If there a trace is stored the difference between the stored an the active trace will be displayed by pushing the softkey MEM-TRACE. With the softkey OFF the stored trace can be faded out. The trace in the trace memory will be stored as bitmap file. The R&S®HMS-X will not adapt the stored curve if the reference level or the displayed frequency range are changed.

6.7.4 Trace math functionality example with TG

Using the tracking generator (only available with R&S®HMS-TG option resp. R&S®HV211 voucher) a spectral analysis of hardware components should be done. For this purpose, the DUT is looped into the signal path between TG output and receiver input. Creating this loop requires one or more RF cables.

The trace mathematics of the R&S®HMS-X spectrum analyzer allows you to compensate the characteristics of the RF cable(s) used. This is done by subtracting a stored trace from an active trace and display the difference. To measure the characteristics of the RF cable and to compensate the connector the tracking generator output will be connected to the input of the spectrum analyzer. Now, the tracking generator function in the FREQ menu will be activated. After activating the tracking generator (softkey TRACKING GEN.) the red UNCAL message will appear. This message indicates that the measurement with the tracking generator is unaligned. The spectrum analyzer shows the following trace:

Fig. 6.7: Tracking generator measurement unaligned

Fig. 6.7 shows the transmission characteristics of the cable and the connector. This curve will be stored with the softkey TRACE → MEMORY in the Memory menu (TRACE button). The stored memory curve will be displayed by pushing the SHOW MEMORY softkey. The spectrum analyzer shows the following trace:
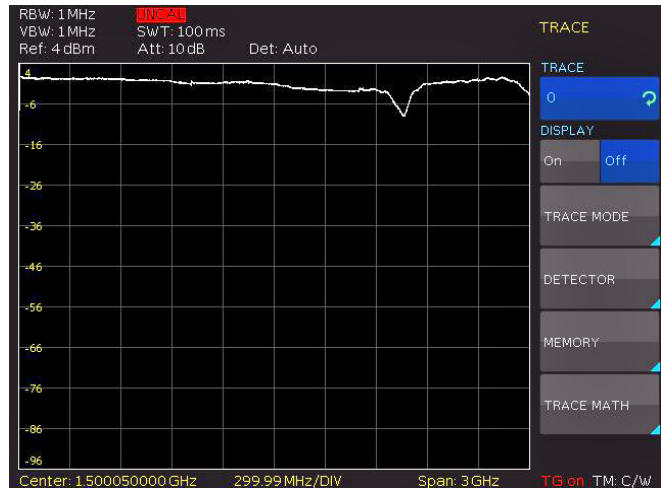

Fig. 6.8: Display of the stored trace (Show Memory)

The following result will be displayed if you activate the trace mathematics (TRACE MATH softkey) and choose the softkey TRACE - MEM:
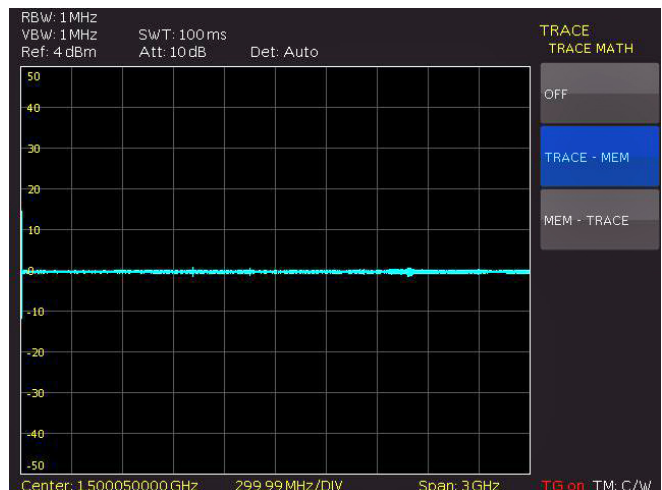

Fig. 6.9: Aktivation of the trace math

By calculating the difference between the recorded and the stored curve, there is a differential curve of approximately zero, because the two curves are nearly identical (except the noise). The characteristics of the RF cable are now compensated which will make UNCAL message disappear.

Now that we have compensated the characteristics of the RF cable we can make a little change in the measurement setup by loosening the RF cable. By doing this we simulate an antenna transmission which will result in the following image:
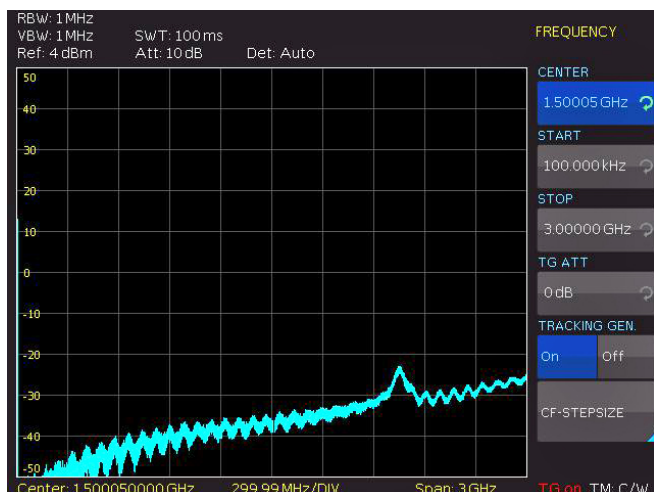
Fig. 6.10: Loosening of the RF cable

As expected, less power will be transmitted from the tracking generator to the input of the spectrum analyzer. The delta to the previous zero line will be displayed. Removing the connection at this point will create a delta so big that the curve is outside of the display area (please refer to figure 6.11):

Fig. 6.11: Loosening of the RF cable completely

In this case, using the reference offset function in the AMPL menu the zero point can be moved and you get the following image:

Fig. 6.12: Trace shifting with reference offset

Fig. 6.12 just only shows the noise at the input. But you can see that the properties of the connection cable, which had previously been connected, will be included.

6.8 The use of markers

The R&S®HMS-X offers several markers and delta markers for the evaluation of curves. The markers are always tied to the curve and indicate the frequency and the level at that. The frequency position of the marker is marked by an arrow icon. The nurmerical values of the frequency and the level are shown as a "M" at the top of the screen. The unit of the level is the same as the unit selected for the reference level.

The knob allows to choose up to 8 different markers via the MARKER menu. The individual markers can be switched on and off with the softkey Display. The softkey Position is used to set the frequency position of the marker along the trace. The marker will be calculated from the display values (pixel).
For example, if marker 1 is activated, a frequency counter function can be enabled for this marker by pushing the the softkey Counter. The corresponding frequency value of the marker is now shown at the top of the display marked with an „F".
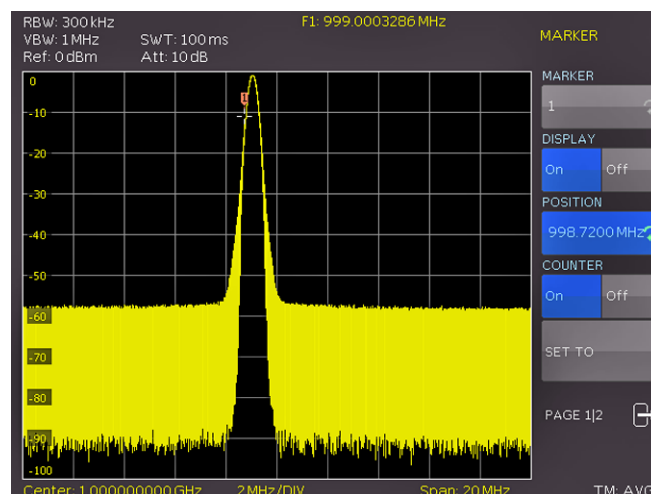

Fig. 6.13: Frequency counter

The values for the frequency marker will be calculated by hardware (TCXO). When frequency measurements are being made, the R&S®HMS-X briefly stops the sweep at the marker position and measures the frequency using the frequency counter (resolution 1 Hz). The frequency counter only gives completely accurate readings for sine signals that are at least 20 dB above the noise floor. If the signal noise ratio is less, noise affects the results.

If two different markers are activated (for example Marker1 and Marker2), you can calculate the delta between the two markers with the softkey DELTA. The delta marker level is always relative to the level of the main marker (Marker1). The delta marker unit is always dB. If a marker is set to delta mode it is marked by a "D" in the read out to distinguish it from a standard marker designated by a leading "M".

The submenu SET TO offers addition marker functions. Marker to center (MKR TO CENT) allows to set the activated marker to the center frequency. In contrast to marker to center allows center to marker (CENT TO MKR) to set the center frequency to an activated marker. A noise marker displays the noise at the marker position. The REF TO MKR softkey allows to set the reference level to the value of the current marker. This makes it easy to optimize the R&S®HMS-X level display range if the levels being investigated are low. The Noise function is used to calculate the noise power density at the marker position.The spectrum analyzer calculates the noise power density in dBm/Hz from the trace pixel values, the selected resolution bandwidth and the detector. Noise power density can provide useful information when measurements are made on noise or digitally modulated signals. Valid results are only obtained, if the spectrum in the vicinity of the marker has a flat frequency response. The function gives incorrect results if measurements are made on discrete signals. Noise marker mode is designated by a leading "N" in the marker readout. The noise marker can be switched on/off by pressing the softkey. The softkey ALL OFF can be used to turn off all previous activated markers simultaneously.

6.9 Peak-Search
The PEAK SEARCH key activates a menu which is used to detect peaks in the trace and assign markers to them:
ı **PEAK**: this function places the marker or the delta marker on the highest peak of the trace. The function acts on the active marker which is activated in the marker menu.
ı **NEXT PEAK**: this function places the marker or the delta marker relative to their current positions on the next lower peak of the trace. The function acts on the active marker which is activated in the marker menu.
ı **NEXT LEFT**: this function places the marker or the delta marker relative to their current positions on the next left peak of the trace. The function acts on the active marker which is activated in the marker menu.
ı **NEXT RIGHT**: this function places the marker or the delta marker relative to their current positions on the next right peak of the trace. The function acts on the active marker which is activated in the marker menu before.
ı **MINIMUM**: this function places the marker or the delta marker on the lowest value of the trace. The function acts on the active marker which is activated in the marker menu.
ı **ALL TO PEAK**: This function will set all markers to the highest peak. From this point a new arrangement can be realized easily.

6.10 Limit Lines
Limit lines are used to set limits for level characteristics versus time or versus frequency on the display. They must not be exceeded. For instance, the upper limits of permissible spurious or harmonics of a DUT are marked by limit lines. In the R&S®HMS-X the upper and lower limit value can be preset by way of limit lines. Pushing the key LINES will open the setting menu to set limit lines. The softkey UPPER LIMIT activates / deactivates the upper limit line

which is displayed as a red line. After activating the softkey UPPER POS the amplitude value for the upper limit line can be set via the knob. The softkey LOWER LIMIT activates / deactivates the lower limit line which is displayed as a red line. After activating the softkey LOWER POS the amplitude value for the lower limit line can be set via the knob.

> **Staged limit lines are not possible with the R&S®HMS-X directly. In this case the EMC software resp. the EMC option (R&S®HMS-EMC / R&S®HV213) is needed to create limit lines as CSV file.**

Additionally, the softkey BEEP activates an acoustic signal which warns as soon as the trace leaves the amplitude range defined by the upper and lower limit line. The softkey MESSAGE activates a message in the upper left corner of the trace display which shows if the whole trace is inside (pass/green) or outside (fail/red) the amplitude range defined by the upper and lower limit line.

6.11 Measure Menu
The key MEAS opens the measure menu with different options. The softkey CF➔RX opens the receiver mode tuned to the actual center frequency. The softkey M1➔RX opens the receiver mode tuned to the actual frequency of marker M1. The softkey REFLECTION CAL starts the calibration wizard of the reflection measurement. To use the wizard the HAMEG VSWR bridge HZ547 can be used. The VSWR bridge HZ547 allows the measurement of the voltage standing wave ratio (VSWR) and the reflection coefficient of 50 Ω devices. The frequency range of the HZ547 is 100 kHz to 3 GHz.
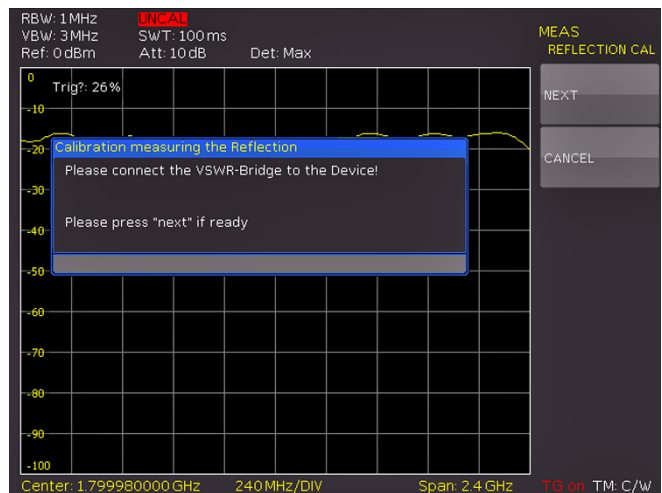

Fig. 6.14: Calibration menu of the VSWR wizard

The R&S®HMS-X with activated TG option (R&S®HMS-TG / R&S®HV211) guides the user through all steps of the reflection measurement sequentially. Concerning the reflection measurement you have to connect the VSWR measuring bridge to the spectrum analyzer. The tracking generator (TG) will be switched on automatically, if you don't have activated it already.

> **The wizard for the reflection measurement is only available with the TG option R&S®HMS-TG resp. R&S®HV211 voucher.**

The signal source (tracking generator / OUTPUT) needs to be connected to the IN connector of the VSWR bridge.

The OUT terminal of the bridge needs to be connected to the input (INPUT) of the spectrum analyzer. At first, you have to let the DUT terminal open which equals total mismatch. Afterwards, a short calibration measurement will perform. A review of these two signals with the trace math will illustrate that both measurements are phase shifted by 180°. The white waveform describes the open calibration measurement, the yellow waveform describes the short calibration measurement. Based on the trace math (TRACE - MEM) a total compensation of the measurement deviation is archieved and the deviation of the device under test to a zero measurement will be shown.

> Before starting the wizard you have to select a trace detector. The selected detector will be used during the measurement automatically.

The measured reflected energy by the spectrum analyzer which will now indicate the algebraic difference between both measurements in dB which is the desired return loss. Once the return loss has been determined use the table on the VSWR measuring bridge to read the Reflection Coefficient and the VSWR. More detailed information about the VSWR measuring bridge HZ547 you can find in the appropriate manual which can be downloaded from our homepage www.hameg.com.

6.12 Auto Tune
By pushing the AUTO TUNE key the instrument performs a scan at full span, locate the maximum peak value and center it in combination with applicable RBW and span settings on the display. This is a comfort function to assist the user. The closer the signal level is located to the general noise floor, the harder the peak is detectable for the AUTO TUNE algorithm. Therefore, it is possible that the settings must be slightly adjusted by the user. This process can hold up few seconds.

6.13 Receiver-Mode
By pushing the MODE key a setting menu will be opened which allows to switch between sweep mode (analyzer mode) and receiver mode. The spectrum analyzer acts like a receiver which measures the level at a preselected frequency. The most important parameters such as e.g. frequency, amplitude, resolution bandwidth may be set using the appropriate keys and can be vary via knob or numerical keyboard. In the receiver mode the same bandwidths are available as in the spectrum analyzer mode. Additionally, the bandwidths 200 Hz, 9 kHz, 120 kHz and 1 MHz are available with avtivated EMC option R&S®HMS-EMC resp. R&S®HV213 for EMI emission measurements according to CISPR. Following detectors are available in the receiver mode and can be set with the softkey menu DETECTOR:

ɪ **PEAK**: displays the highest level during the set measurement time.
ɪ **AVG**: displays the linear average of the measurement signal within the selected measurement time.
ɪ **QPEAK**: evaluates the measurement signal according to the evaluation curves defined in the CISPR standard (only available with R&S®HMS-EMC resp. R&S®HV213).
ɪ **RMS**: takes the RMS value of the measurement signal during the set measurement time.

The measurement time is the amount of time during which the spectrum analyzer collects measured values and compiles them into a display result for the selected detector. With the soft menu AUDIO the R&S®HMS-X offers an AM and a FM demodulator allowing listening to modulated signals. The demodulated signal can be listened with a headphone and an intern speaker. The headphone is connected to the headphone connector ③① (3.5 mm female connector). If the headphone is activated, the intern speaker will be deactivated. The respective softkey allows to switch the demodulator on or off and to set the volume (0% to 100%).

> If an AM or FM demodulation is activated, the device demodulates the signal and can not perform a level measurement simultaneously. The unit shows n/a dBm on the display.
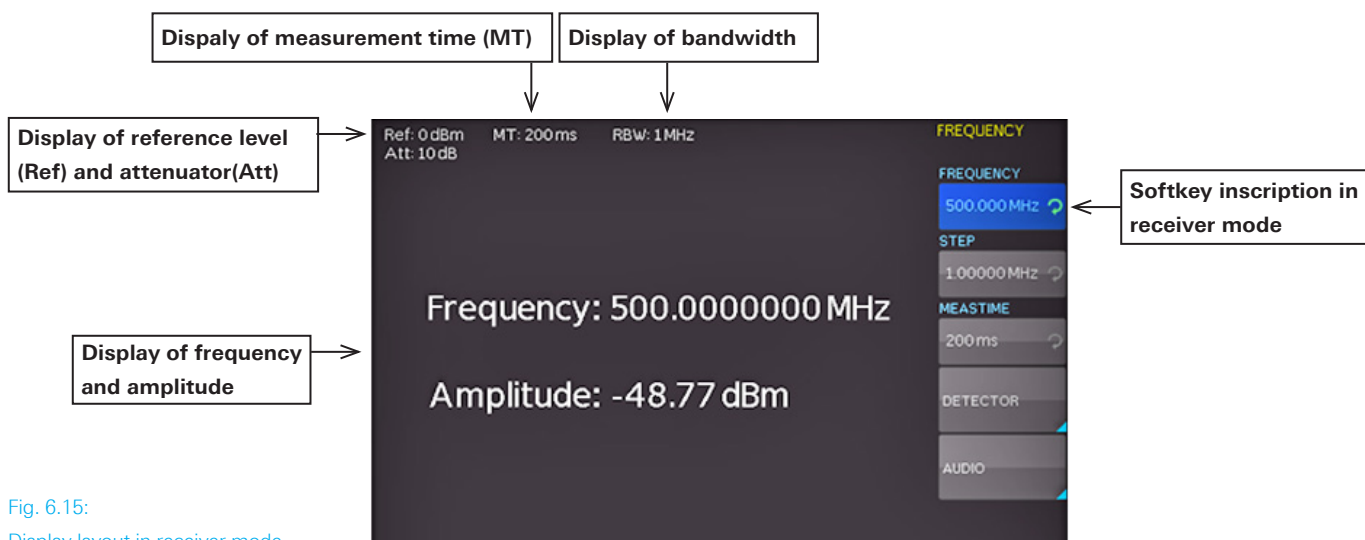

Dispaly of measurement time (MT)
Display of bandwidth
Display of reference level (Ref) and attenuator(Att)
Softkey inscription in receiver mode
Display of frequency and amplitude

Ref: 0 dBm MT: 200 ms RBW: 1 MHz
Att: 10 dB

FREQUENCY
FREQUENCY
500.000 MHz
STEP
1.00000 MHz
MEASTIME
200 ms
DETECTOR
AUDIO

Frequency: 500.0000000 MHz

Amplitude: -48.77 dBm

Fig. 6.15:
Display layout in receiver mode

7 Storing/Recalling of Settings

Push the key SAVE/RECALL for opening the main menu for storage and load functions. The spectrum analyzer can store different kinds of data:

⏽ Device settings
⏽ Traces
⏽ Screenshots

Traces and screenshots can only be stored on USB sticks. Device settings can be stored either on a USB stick or in the instrument's non-volatile memories.

The USB stick should be FAT/FAT32 formatted (4GB max.). It should be avoided to store a large number of files on the USB stick.

Fig. 7.1: Basic menu for instrument settings

7.1 Instrument settings
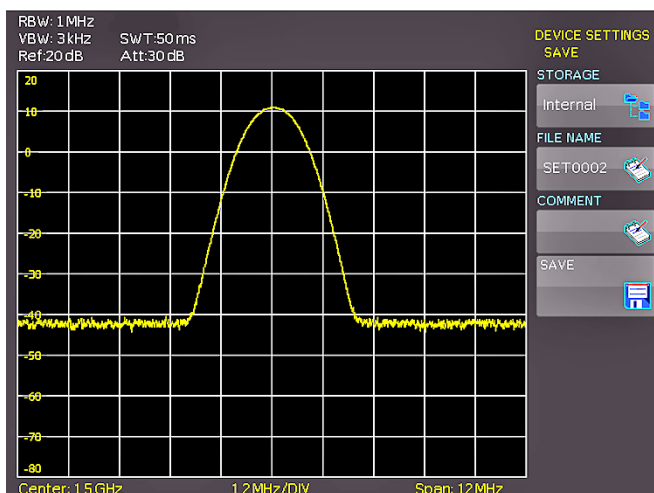
Fig. 7.2: Saving instrument settings

The soft menu DEVICE SETTINGS allows you to save current instrument settings or load saved settings resp. to export/ import instrument settings. Additionally, the softkey

DEFAULT SETT. will reset the instrument to the factory settings. Press the softkey SAVE to open the storage menu. You can use the softkey STORAGE to select a possible location (internal memory or front/rear USB stick connection) where you would like to save the instrument settings. Pressing this key opens the file manager. The File Name can be changed or adjusted to the corresponding setting (SET is the default label). You can use the softkey COMMENT to enter a comment which will be displayed in the file manager footer once a file has been selected. The softkey SAVE will store the settings.
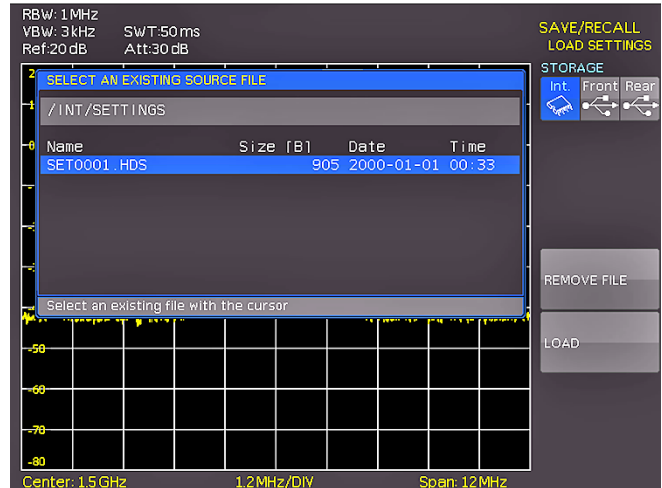

Fig. 7.3: Loading instrument settings

To load stored instrument files press the softkey LOAD to open the soft menu. Once the storage location and the respective settings file has been selected, you can load the file by pressing the softkey LOAD. To remove files select the respective settings file and remove it by pressing the softkey REMOVE FILE. If an USB stick is connected and the storage location Front is selected, you can also change or delete directories.

The soft menu IMPORT/EXPORT allows you to copy a file from an internal memory to an external storage medium (USB stick) or vice versa. Source and Destination must be selected for copying. By pushing the softkey IMPORT/ EXPORT the selected settings file will be copied as
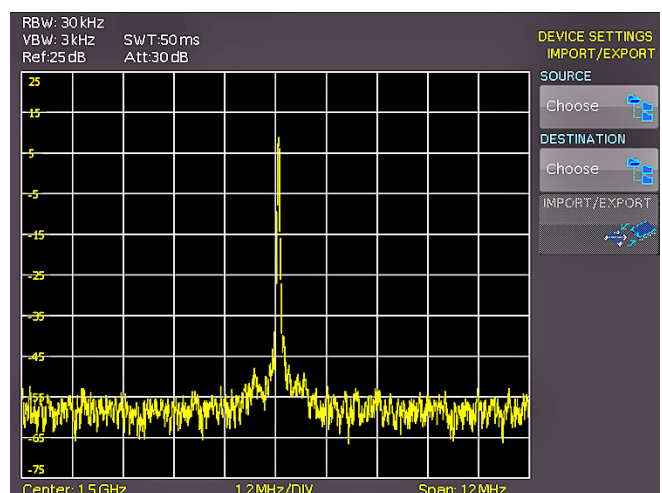

Fig. 7.4: IMPORT / EXPORT menu for instrument settings

previously chosen. It is possible to copy from the internal memory to the external memory and also between two USB sticks (front/rear).

Device settings from a previous firmware version can not be loaded with a new firmware version.
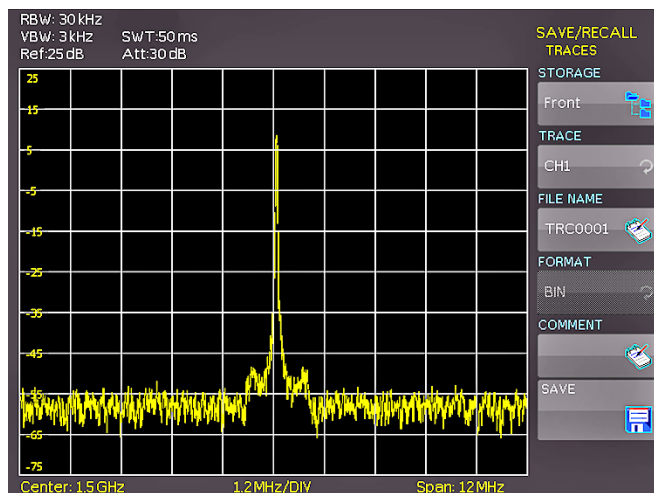
7.2 Traces

Fig. 7.5: Menu to save a waveform

The waveform data can be stored only on external USB sticks, not internally. Following formats to save the trace data are possible:

ı CSV (Comma Separated Values)
In CSV files, curve data is stored in table format. Each table row is separated by a comma.

Example for CSV file
[Hz],Trace1[dBm]
9.253540000E+08,-1.00890E+02
9.253540000E+08,-7.39215E+01
9.253560000E+08,-1.05031E+02
9.253560000E+08,-7.21179E+01
9.253580000E+08,-9.49329E+01
9.253580000E+08,-7.41840E+01
9.253600000E+08,-8.93787E+01
9.253600000E+08,-7.76752E+01

ı TXT
TXT files are ASCII files that only contain amplitude values (no time values). Amplitude values are separated by a comma. The value pairs are listed as single values without identification.

Example for TXT file:
-1.07915E+02,-7.80322E+01,-1.05590E+02,-7.59998E+01,-9.59735E+01,-7.28748E+01,-1.04189E+02,-7.37231E+01

The soft menu STORAGE allows you to use the USB connection on the front or rear side of the instrument as storage location. Selecting the respective storage location is possible when a USB stick has been recognized. If a USB stick is connected, you can also change, create or delete

directories. Press ACCEPT DIR. to confirm the target directory and you will automatically return to the trace main menu. The softkey FILE NAME opens the menu for the name entry, where you can use the universal knob to enter a name and confirm your entry by pressing ACCEPT (TRC is the default name). The trace main menu will display automatically. You can use the softkey COMMENT to enter a comment which will be displayed in the file manager footer once a file has been selected. Pushing the softkey SAVE will store the trace according to the selected settings.

7.3 Screenshots

The most important format to store information for documentation purposes is the screenshot. A screenshot is an image file which shows the current screen content at the time that storage takes place.
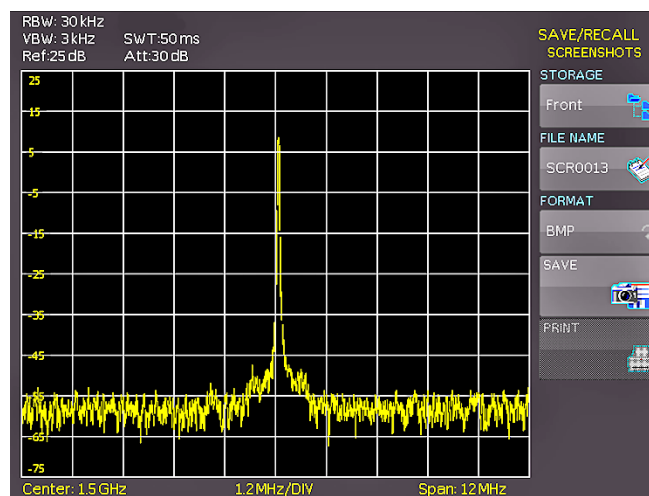

Fig. 7.6: Menu for screenshots

The softkey STORAGE allows you to use the USB connection on the front or back of the instrument as storage location. Selecting the respective storage location is possible when a USB stick has been recognized. If a USB stick is connected, you can also change, create or delete directories. Press ACCEPT to confirm the target directory and you will automatically return to the screenshot main menu.

The soft menu key FILE NAME opens the menu for the name entry where you can use the knob to enter a name and confirm your entry by pressing ACCEPT (SCR is the default name). The screenshot main menu will display automatically. The file format of a graphics file determines the color depth and the type of compression. The quality of the various formats is identical for the spectrum analyzer graphics. You can choose from the following file formats in the soft menu FORMAT:

ı BMP = Windows Bitmap Format
ı GIF = Graphics Interchange Format
ı PNG = Portable Network Graphic

Press the softkey COLOR MODE to to choose from Grayscale, Color or Inverted with the knob. If Grayscale is selected, the colors are converted to gray scales when the

data is stored, if Color is selected, the data is stored as it displays in the screen, and if Inverted is activated, data will be stored in color with a white background. If you press the key SAVE, the current screen will be saved immediately to the selected storage location with the selected name and format.

If a printer is detected the soft menu key Print is no longer grayed out. Pushing this softkey will open a sub-menu where you can select the paper format and the color mode. The paper formats A4, A5, B5, B6, and Executive are possible. The menu item Color Mode allows the selection of the modes Grayscale, Color or Inverted. The Grayscale mode converts a color display to a grayscale display which can be printed on a Black-and-White printer. The Color Mode will print the display in color as it is shown on the screen (black background). In the Inverted Mode the color display will be printed in color with a white background on a color printer in order to save toner and ink. With the softkey MENU OFF you can jump back to the last menu.

7.3.1 Printer
The soft menu key PRINT allows you to print a screenshot immediately to a connected printer. PCL-5, PCL-XL (= PCL-6) and Postscript settings are supported as „printer language" (PCL-3 is not supported). If a printer is detected, the soft menu key PRINT will no longer be grayed out.

Fig. 7.7: Supported printer example

The supported printer will be displayed in the soft menu DEVICE INFOS. The message „This printer is supported" does not guaranteed the the connected printer will be supported. This message only means that the USB printer connection was successful and the important printer properties are available.(e.g. printer language PCL or PCL-XL). Connected PLC printers send an identification string to the instrument. This identification string should be for all printers the same (standard), but there are many printers on the market, which have another identification string. In this case, the instrument is not able to detect the printer because the instrument does not have a Windows system internally to handle the identification string deviation.

If a printer connection is not possible, you have the possibillity to use the HMExplorer software with the screenshot software module. The free software HMScreenshot (software module of the HMExplorer software) enables the transfer of screenshots in bitmap, GIF or PNG format from the spectrum analyzer via interface to a connected PC where the screenshots may then be saved or printed. For additional information on the software, refer to the HMExplorer software help.
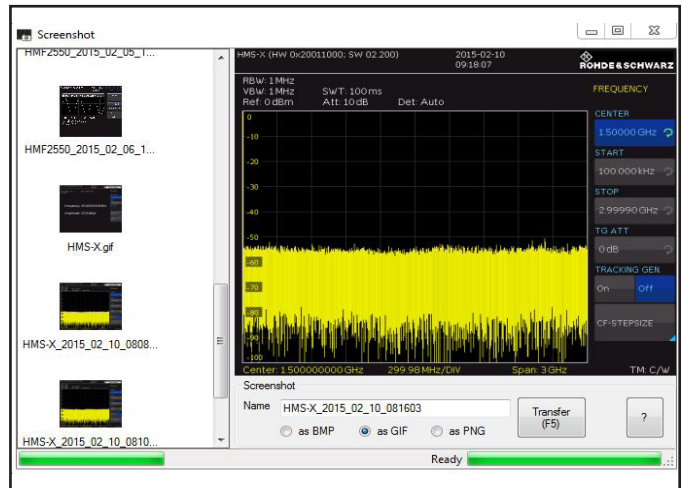

Fig. 7.8: Screenshot-module

7.3.1 Screenshot example
In order to store data you have to define the kind of data and the destination. First attach a USB stick (refer to 10.1 USB connector) to the front panel connector. Press SAVE/RECALL in order to call the respective menu.
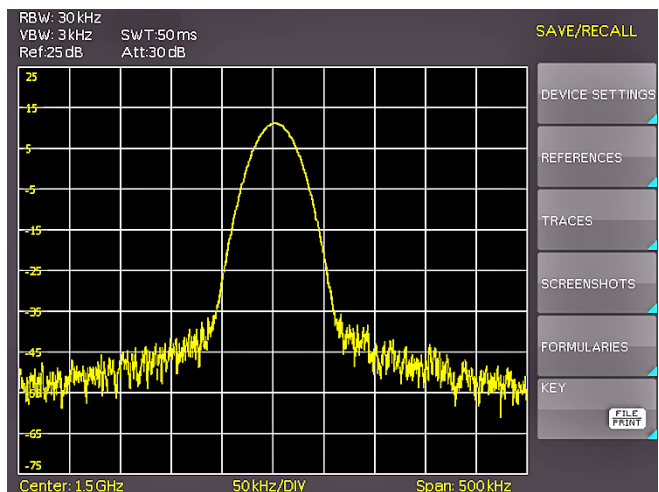

Fig. 7.9: Save/Load menu

Select the kind of data by pressing the respective softkey (in this example the softkey SCREENSHOT) in order to access the settings menu.
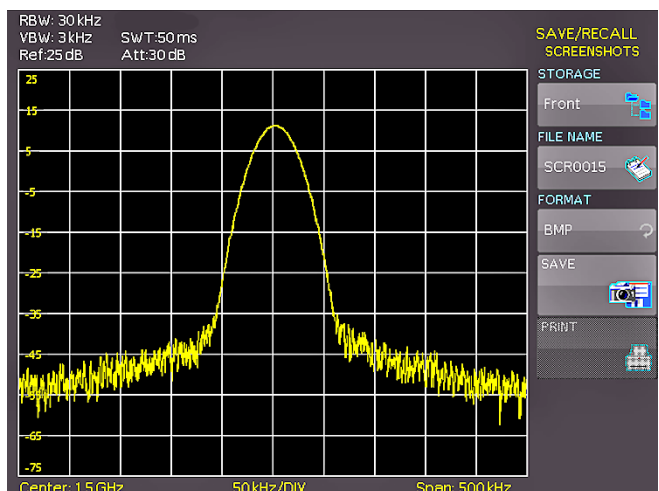

Fig. 7.10: Menu with the settings for screenshots

Please verify that the USB connector into which you plugged the USB stick (front or rear) is written in the top softmenu. You can change the destination by opening the respective menu if you press the softkey STORAGE. You can save a screenshot if you press the softkey SAVE using the predefined name written in the menu below File Name. You may name the destination memory with up to 7 characters; in order to do this select the menu File Name and define the name by using the knob. After pressing the softkey ACCEPT the instrument has stored the name and return to the settings menu. Now you can store the actual screen display by pressing the SAVE softkey.

Alternatively, you can select the menu FILE/PRINT. In the following menu press the softkey Screenshot: this will assign the function screenshot to the key FILE/PRINT with the settings chosen. This enables you to store a screenshot file on your USB stick by just pressing FILE/PRINT at any time and in any menu.
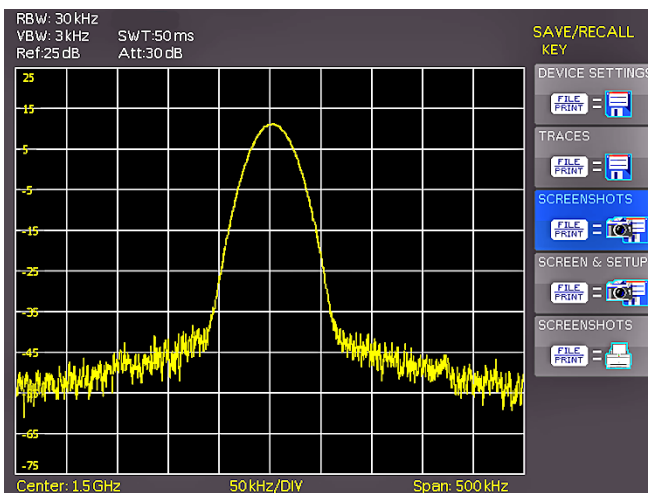
Fig. 7.11: Settings of the button FILE/PRINT

8 Advanced Functions

8.1 Using the help function

The integrated help function can be activated by pressing the key HELP. A window will open. The text of the window box is dynamically updated depending on the key (including softkey's) you are pushing. Additionally, the appropriate SCPI interface command is displayed. If you don't need the help function anymore, you can switch off the help window by pushing the HELP key.
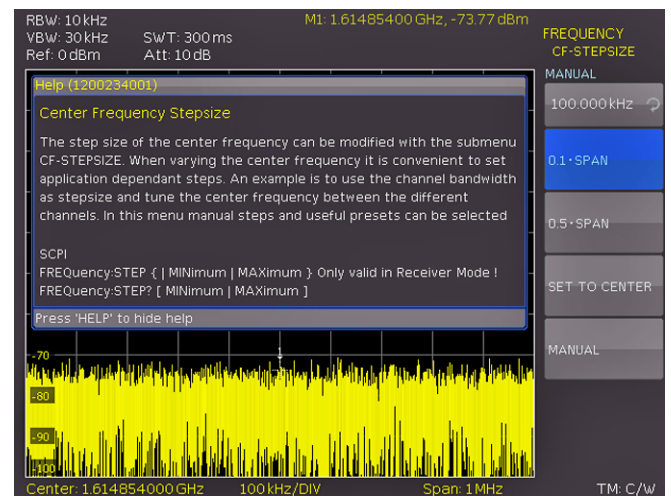

Fig. 8.1: Internal help function

8.2 Display settings

By pushing the key DISPLAY the display settings menu will be opened. Following display settings are available:
- **TRACE:** Adjustment of the trace intensity (0%...100%) of the displayed spectrum.
- **BACKLIGHT:** Adjustment of the backlight intensity (10%...100%).
- **GRID:** Adjustment of the raster intensity (0%...100%). The soft menu item GRID SETUP allows to select a cross, raster lines or no raster with the respective soft menu
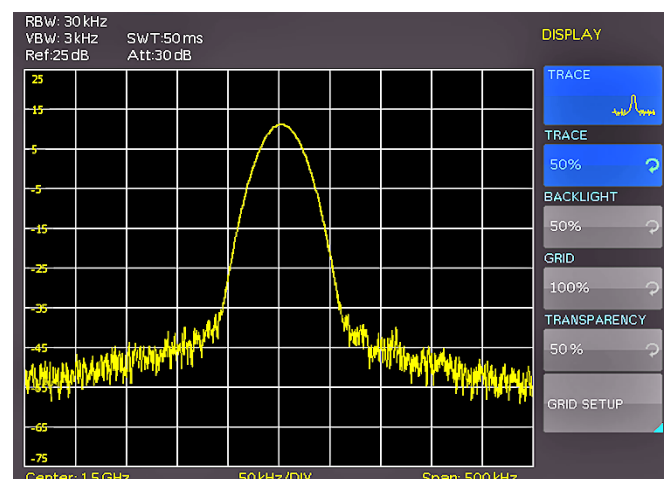

Fig. 8.2: Display settings menu

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keys. Also the raster designations (SCALE) can be switched on or off. The soft menu key LED BRIGHTNESS changes the LED intensity from dark to light, this is effective for all backlighted keys and all other display LED's on the front panel.

ı **TRANSPARENCY:** Adjustment of the transparency (0%...100%) of the raster inscriptions.

If a soft menu item is activated, its background will be blue highlighted. The setting of the value parameter is performed with the knob. If a submenu is selected you can jump back to the last menu by pushing the DISPLAY key.

8.3 Selection of the standard instrument settings (PRESET)

By pushing the key PRESET the spectrum analyzer will resume its preset standard settings. This allows to generate a new configuration, starting from defined parameters, no parameter from a former setting will be active anymore.

8.4 EMC Precompliance measurement

To perform EMC measurements, a free of charge software is necessary. The software can be downloaded from www.hameg.com. For further information to the HAMEG EMC software please refer to the software manual.

An EMC software is only available in combination with the option **R&S®HMS-EMC resp. R&S®HV213 voucher.**
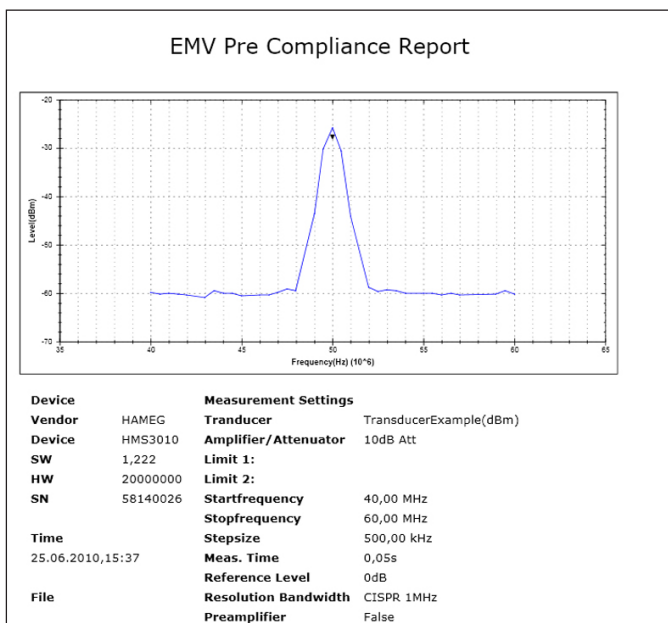

Fig. 8.3: EMC report

During EMC measurement the REMOTE key lights up and the front panel controls of the spectrum analyzer are locked. To unlock the front panel controls use the softkey **UNLOCK KEYS** .

9 General Instrument Settings

Basic settings like language of the user interface and miscellaneous settings can be set using the menu MISC. Pushing the softkey MENU OFF you can jump back to the last menu.

9.1 Language settings
The R&S®HMS-X provides four different languages for the menu and help text:
ı **German**
ı **English**
ı **French**
ı **Spanish**

By pushing the soft menu key LANGUAGE you can select the language. The selected language is active if the menu item text is blue highlighted. Pushing the softkey MENU OFF you can jump back to the last menu.

9.2 Basic settings
9.2.1 Date & Time
Pushing the softkey Date & Time will open the time and date settings menu. These settings will be used for adding a time and date stamp on print-outs and stored files. The user can modify the time and date with the knob. The respective soft menu item is active if it its menu text is blue highlighted. The time and date settings will be accepted by pushing Save. Pushing the softkey MENU OFF you can jump back to the last menu.

9.2.2 Sound
The HMS-X offers the possibility to sound a warning which can be switched on or off using the submenu which opens after pressing the softkey Sound. The control resp. warning tone will be active if the respective menu text is blue highlighted. Pushing the softkey MENU OFF you can jump back to the last menu.

9.2.3 Device Name
In this menu item you can set a name for the HMS-X. By pressing the softkey a key panel will show. You can choose the character via the knob. The character will confirm with the enter button. Pushing the softkey MENU OFF you can jump back to the last menu.

9.2.4 Device Infos
Choosing this soft menu item will call instrument information such as serial number, software version etc. Pushing the softkey MENU OFF you can jump back to the last menu.
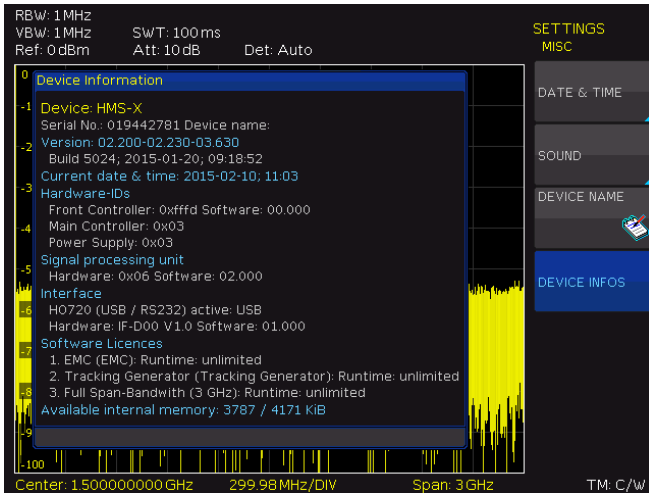
Fig. 9.1: Instrument Informations

9.3 Interface settings

This menu item is used for the settings of the diverse interfaces:

▪ Dual Interface HO720 USB/RS-232 (baud rate, number of stop bits, parity, handshake on/off)
▪ LAN Interface HO730/HO732 (IP address, sub net mask etc., see the manual of the HO730/HO732) and
▪ the IEEE-488 GPIB interface HO740 (GPIB-address)

The desired interface can be selected with the respective soft menu key. Use the soft menu item PARAMETER to set the necessary interface parameters. More information about the selected interface you can find in chapter 12 or in the appropriate interface manuals. Pushing the softkey MENU OFF you can jump back to the last menu.

9.4 Printer settings

The R&S®HMS-X supports printing of the screen contents on a connected printer (USB printers with postscript). The menu item Print contains settings for PCL or PCLX printers. If a printer is detected the soft menu key PRINT is no longer grayed out. Pushing this softkey will open a submenu where you can select the paper format and the colour mode. The paper formats A4, A5, B5, B6, and Executive are possible. The menu item Color Mode allows the selection of the modes Grayscale, Color or Inverted. The grayscale mode converts a color display to a grayscale display which can be printed on a Black-and-White printer. The Color Mode will print the display in color as it is shown on the screen (black background). In the Inverted Mode the color display will be printed in color with a white background on a color printer in order to save toner and ink.

9.5 Reference frequency

This submenu is used to switch between the internal (TCXO) and external reference source. The softkey INTERNAL switches to the built in TCXO. The softkey EXTERNAL is used to select a 10 MHz reference source which will be input via Ref In BNC connector on the backside of the instrument.

9.6 Update (Firmware / Help)

Attention!
At the time of the update the unit will not respond on any inputs and the display will be resettet. Does not switch off the unit during the update process. A interruption of power supply can destroy the unit!

If a new firmware version of the R&S®HMS-X is available you can download the actual firmware from the ROHDE & SCHWARZ homepage. The firmware is packed into a ZIP data packet. After downloading the ZIP data unpack it into the basic directory of a FAT or FAT32 formated USB stick (.hfu file). Afterwards insert the stick into the USB port on the HMF front panel and push the key SETUP. After selecting the menu item UPDATE a window will open which displays the actual firmware version indicating the version number, the date and build information
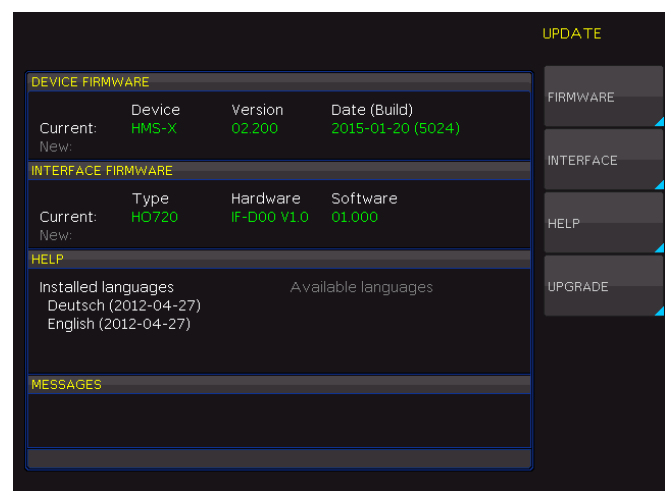

Fig. 9.2: Updating menu

Pressing the softkey to update the instrument firmware will result in a search for the corresponding file on the USB stick. The information for the new firmware to be installed will then be displayed on the stick below the row labeled NEW:. The version number will be displayed in red in case the existing firmware on the instrument is identical to the latest version; otherwise the version number will be shown in green. Only if this is the case, press the soft menu EXECUTE to start the update.
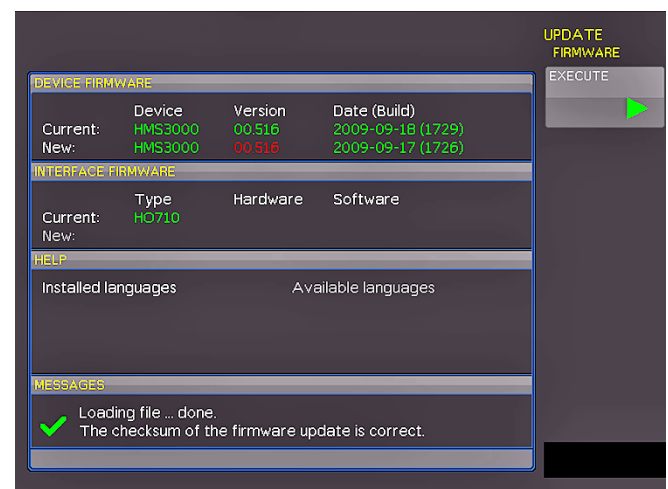

Fig. 9.3: Info display of help update

Choose the HELP menu item in the Update menu if you intend to update the help or add a new language for help. With the softkey EXIT you can close the update menu.

9.7   Upgrade of software options (voucher)

The R&S®HMS-X can be upgraded with options (voucher) which will become accessible after inputting a licence key. The following vouchers are available for the R&S®HMS-X:
ı **R&S®HV211**: Unlock built-in tracking generators (TG)
ı **R&S®HV212**: Bandwidth upgrade to 3 GHz
ı **R&S®HV213**: EMC option incl. preamplifier

After purchasing the voucher the licence key can be generated via http://voucher.hameg.com. This file is an ASCII file and can be opened with an editor, then the true key can be read. There are two methods for employing the key to use the desired option: the automatic or the manual input. The fastest and simplest method is the automatic input: first store the file on an USB stick, then conect the stick with the front panel USB port and press the key SETUP. The SETUP menu will open. Select page 2|2 and the softkey Upgrade to open the upgrade menu.
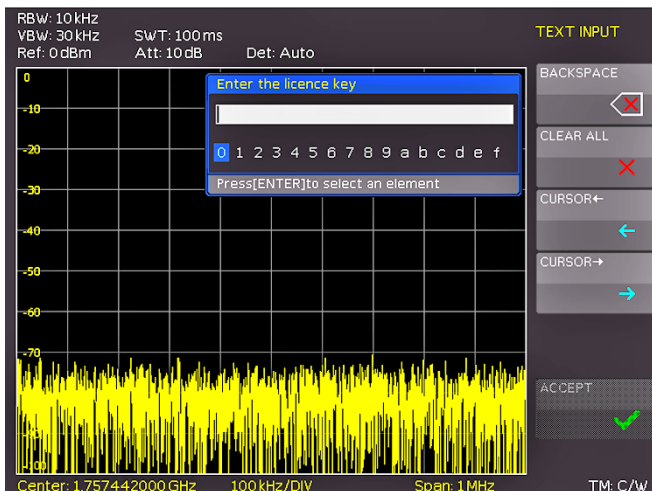

Fig. 9.4: Manual licence key input

The softkey READ LICENCE FILE opens the data manager. Use the knob to select the correct file and press the softkey LOAD. This will load the licence key; the option will be ready to use immediately after a restart of the instrument.

Alternatively, you can use the manual input of the licence key. Select the menu UPGRADE and press the softkey MANUAL KEY INPUT. Use the knob and the ENTER-key to input the licence key. After input of the complete key please press the softkey ACCEPT in order to input the key into the system. The option will be activated after a restart of the instrument.
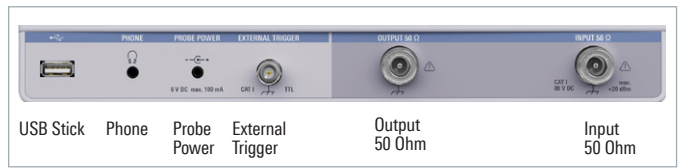
10 Front Panel Connections

Fig. 10.1: Front panel connections

10.1 USB stick connector

Using the USB connector on the front or the rear side a software update of the R&S®HMS-X firmware can be performed or screenshots can be strored. Please use only FAT or FAT32 formatted mass memory (chapter 9.6). Additional information about the firmware update or the storage of data you can find in chapter 7 and 9.

10.2 PHONE connector

The signal available at this connector comes from an AM detector and it helps to identify the sources of interference e.g. when making precompliance measurements. If an headphone is connected to the analyzer input, selecting Center and using the knob the analyzer can be tuned to a transmitter (Receiver mode chapter 6.13). The demodulation has to activated. Please note that this operational mode may be subject to national restrictions. A 3.5 mm jack is provided for headphones. The internal impedance of the connector is approx. 10 E.

10.3 PROBE POWER

This connector can be used as a supply (6 V_{DC}) e.g. for HAMEG probes HZ540 or HZ550. The inner contact is +6 V, the outer contact is connected to the instrument housing and thus with the measurement inputs' ground potential and also protective earth (PE).

10.4 EXTERNAL TRIGGER

The external trigger input connector is used for the control of measurements by an external signal. The external trigger signal is applied via the BNC connector EXTERNAL TRIGGER. The trigger threshold is similar to TTL signals. More information about the external trigger signal you can find in chapter 6.

The sweep will be started via the external trigger signal. A trigger delay can not be defined.

10.5 OUTPUT 50 Ω (Tracking Generator)

The tracking generator output has to be connected to the measuring object with a N connector cable. The tracking generator function is only available in combination with R&S®HMS-TG option resp. R&S®HV211 voucher. A test signal with a spectrum from 5 MHz to 1.6 GHz resp. 3 GHz is available.

⚠ **Caution!**
The output is AC-coupled and a voltage that does not exceed the voltage stated on the R&S®HMS-X housing can be fed into the output; if this voltage is exceeded, the output may be destroyed.

10.6 INPUT 50Ω

Connect the RF input via a cable with an N connector to the DUT. Make sure that it is not overloaded. The maximum permissible continuous power with an attenuation of 10 dB to 50 dB at the RF input is +20 dBm (100 mW). Without attenuation (Att 0 dB) $80\,V_{DC}$ must not be exceeded. The outer contact is connected to the instrument chassis and thus to safety ground (PE). The maximum input levels resp. voltages must not be exceeded. Danger of destruction!

⚠ **Caution!**
The RF input is AC-coupled. The DC input voltage must never exceed the value specified on the housing; otherwise the input may be destroyed.

11 Rear Panel Connections
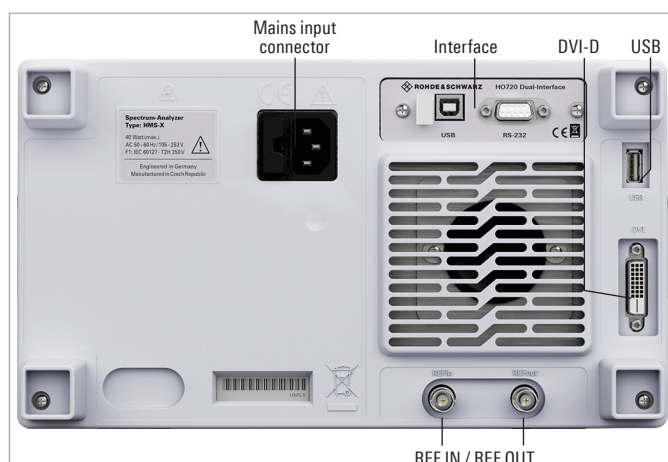
Fig. 11.1: Rear panel connections

11.1 USB stick connector

The USB connector on the rear panel can be used to connect a printer (see chapter 9.4).

11.2 DVI-D connector

The rear panel of the spectrum analyzer includes a standard DVI-D connector to connect external monitors and projectors. The DVI-D connector can only send digital signals. This means it is impossible to connect monitors or beamers via their analog inputs. The R&S®HMS-X yields a DVI signal with VGA resolution (640 x 480). This design enables connectivity with all standard TFT monitors. Modern flat screens extrapolate the signal, allowing users to see a full screen. Beamers can also be connected to the R&S®HMS-X. Ideal beamers in this case are those designed to be connected to computers/ notebooks as these are also able to process a 640x480 pixel resolution.

DVI-VGA adapters as well as DVI-composite adapters are not supported. You might encounter difficulties when connecting the R&S®HMS-X to an HDTV set through an HDMI adapter, as most HDTV sets expect an HDMI signal of 720p and higher.

11.3 REF IN / REF OUT

In order to further increase the frequency stability, the internal oscillator may be replaced by an external oscillator which can be connected to the REF IN/ REF OUT BNC connectors on the rear panel. The external 10MHz reference frequency signal must comply with the specifications given with respect to frequency accuracy and amplitude. The switching between internal and external reference frequency can be effected via the SETUP key and the softkey REF. FREQ.

12 Remote Control

By default, the R&S®HMS-X includes a HO720 USB/RS-232 interface. You can find the drivers for this interface on the product CD enclosed with the instrument or on the ROHDE & SCHWARZ Homepage.

To achieve external control, the R&S®HMS-X uses the scripting language SCPI (= Standard Commands for Programmable Instruments). The provided USB/RS232 dual interface (optional Ethernet/USB or IEEE-488 GPIB) enables you to control the ROHDE & SCHWARZ instrument externally via remote connection (remote control). As a result, you can access nearly all functions that are available during the manual operating mode via front panel. To download a PDF document with a detailed list of supported SCPI commands, please visit the ROHDE & SCHWARZ homepage.

> To enable communication, the selected interface and the respective settings in the measuring instrument must be identical to the selections for the PC.

12.1 RS-232

The RS-232 interface is built with a 9-pin D-SUB connector. This bidirectional interface allows the transfer of setup parameters, data and screenshots from an external device (e.g. PC) to the power supply or vice versa. It is possible to establish a direct connection from the PC (serial port) to the interface via 9-pin shielded cable (1:1 wired). The maximum length must not exceed 3 m. The pin assignment for the RS-232 interface (9-pin D-SUB connector) please refer to fig. 6.1.
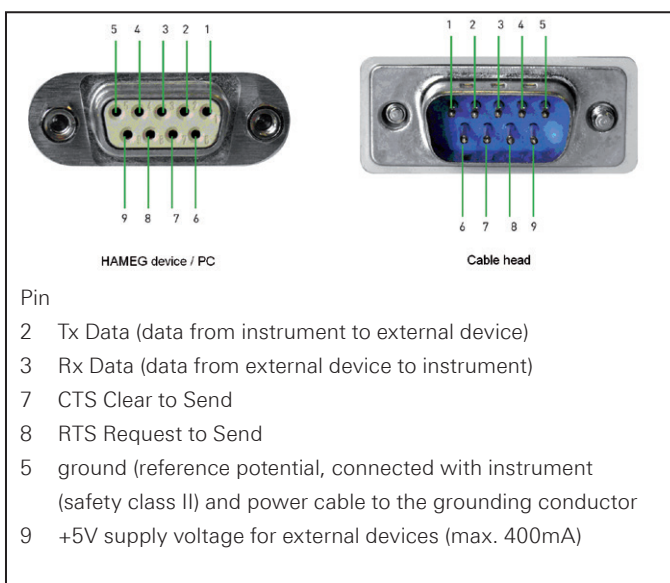

Pin
2   Tx Data (data from instrument to external device)
3   Rx Data (data from external device to instrument)
7   CTS Clear to Send
8   RTS Request to Send
5   ground (reference potential, connected with instrument (safety class II) and power cable to the grounding conductor
9   +5V supply voltage for external devices (max. 400mA)

Fig. 12.1: Pin assignment of the RS-232 interface

The maximum voltage variation at the Tx, Rx, RTS and CTS connections is ±12 Volt. The RS-232 standard parameters:
ı **8-N-1** (8 data bits, no parity bit, 1 stop bit)
ı RTS/CTS hardware protocol: none.

In order to set these parameter at the instrument, please press the SETUP key and choose the menu item INTER-FACE. Make sure that the RS-232 interface is chosen. The softmenu PARAMETER opens a menu where you can set all parameters for the RS-232 communication.

12.2 USB

> The currently available USB driver have been fully tested and released for Windows XP™, VISTA™, Windows 7™ and Windows 8™ (32 + 64 Bit).

The USB interface must be selected in the menu of the spectrum analyzer and requires no further action. The actual USB driver can be downloaded from the ROHDE & SCHWARZ homepage for free. If a connection between PC and the instrument has been established and no R&S®HMP USB driver is installed, the operating system answers with "Found New Hardware". Only in this case the USB driver must be installed. Further information about the USB driver installation you can find in the HO720/HO730/HO732 installation guide internal of the driver file.

> The following requirement for USB driver installation are necessary:
> 1 R&S®HMS-X with an activated USB interface.
> 2 A PC with operating system Windows XP, VISTA, Windows 7 or Windows 8 (32 or 64Bit).
> 3 Administrator rights are necessary for the installation of the driver. If an error message regarding spelling errors appears, the rights to install the driver are not given. In this case, please contact your IT department to obtain the necessary rights.

In addition, you may use the free software HMExplorer. This Windows application offers the R&S®HMS-X a terminal, a screenshot and an EMC function.

12.3 Ethernet (Option HO730/HO732)

For the direct connection with a host (PC) or indirect connection over a SWITCH, a doubly protected network cable (e.g. CAT.5, CAT.5e, CAT.5+, CAT.6 or CAT.7) is required, equipped with an Ethernet plug type the RJ-45 at each end. Either an uncrossed or a crossed network cable (cross over cable) can be used.

12.3.1 IP networks (IP – Internet protocol)

In order that two or several network elements (e.g. measuring instruments, host/PC's, …) can communicate over a network with one another, some fundamental connections have to be considered, so that data communication is error free and unimpaired.

For each element in a network an IP address has to be assigned, so that they can exchange data among themselves. IP addresses are represented (with the IP version 4) as four decimal numbers separated by points (e.g. 192.168.15.1). Each decimal number is represented by a binary number of 8 bits. IP addresses are divided into public and private address ranges. Public IP addresses will be

able to route by the Internet and an Internet service Provider (ISP) can to be made available. Public IP addresses can be reached directly over the Internet to directly exchange internet data. Private IP addresses are not routed by the Internet and are reserved for private networks. Network elements with private IP addresses cannot be reached directly over the Internet so no data can be directly exchanged over the Internet. To allow network elements with a private IP address to exchange data over the Internet, they require a router for IP address conversion (English NAT; Network address translation), before connection to the Internet. The attached elements can then data exchange over this router, which possesses a private IP address (LAN IP address) and also a public IP address (WAN IP address), via the Internet.

If network elements exchange data only over a local network (without connection with the Internet), appropriate use private IP addresses. Select in addition e.g. a private IP address for the instrument and a private IP address for the host (PC), with which you would like to control the instrument. If you might connect your private network with the Internet later via a router, the private IP addresses used in your local network can be maintained. Since within each IP address range the first IP address is used as network IP address and the last IP address is used as Broadcast IP address, in each case two IP addresses have to be taken off from the "number of possible host addresses" (see table 1: Private IP address ranges). Apart from the organization of IP addresses into public and private address ranges, IP addresses are also divided into classes (Class: A, B, C, D, E). Within the classes A, B, and C are also include the private IP of address ranges described before. The categorisation from IP addresses is for the assignment of public IP address ranges of importance and essentially depends on the size of a local network (maximum number of hosts in the network), which is to be connected with the Internet (see table 2: Classes of IP addresses). IP addresses can fix (statically) or variable (dynamically) to be assigned. If IP addresses in a network are assigned fix, an IP address must be preset manually with each network element. If IP addresses in a network are assigned to the attached network elements automatically (dynamically), a DHCP ser-

ver (English DHCP becomes; Dynamic Host Configuration Protocol) is required for the dispatching of IP addresses. With a DHCP server an IP address range for the automatic dispatching of IP addresses can be preset. A DHCP server is usually already integrated in a router (DSL router, ISDN router, Modem router, WLAN router, …) integrated. If a network element (e.g. an instrument) is connected by a network cable directly with a host (PC), the IP addresses cannot be assigned to the instrument and the host (PC) automatically, since no network with DHCP server is present here. They have to be preset therefore at the instrument and at the host (PC) manually.

IP addresses are divided by using subnet mask into a network quota and into a host quota, so similarly e.g. a telephone number is divided in pre selection (land and local area network number) and call number (user number). Subnet mask have the same form as IP addresses. They are represented with four decimal numbers separated by points (e.g. 255.255.255.0). As is the case for the IP addresses here each decimal number represents a binary number of 8 bits. The separation between network quota and host quota is determined by the subnet mask within an IP address (e.g. the IP address 192.168.10.10 by the subnet mask 255.255.255.0 is divided into a network quota 192.168.10.0 and a host quota of 0.0.0.10). The allocation takes place via the transformation of the IP address and the subnet mask in binary form and afterwards a bit by bit one logical AND operation between IP address and subnet mask. The result is the network quota of the IP address. The host quota of the IP address takes place via the bit by bit logical NAND operation between IP address and subnet mask. By the variable allocation of IP addresses in network quota and host quota via subnet masks, one can specify IP address ranges individually for large and small networks. Thus one can operate large and small IP networks and connect if necessary to the Internet via a router. In smaller local networks the subnet mask 255.255.255.0 is mostly used. Network quota (the first 3 numbers) and host quota (the last number) are simple here without much mathematical expenditure to determine and it can with these subnet mask up to 254 network elements (e.g. measuring instruments, hosts/PC's…) in a network be operated at the

adress range	subnetz mask	CIDR way of writing	number of possible host adresses
10.0.0.0 –10.255.255.255	255.0.0.0	10.0.0.0/8	$2^{24} - 2 = 16.777.214$
172.16.0.0 –172.31.255.255	255.240.0.0	172.16.0.0/12	$2^{20} - 2 = 1.048.574$
192.168.0.0 –192.168.255.255	255.255.0.0 255.255.255.0	192.168.0.0/16 192.168.0.0/24	$2^{16} - 2 = 65.534$ $2^{8} - 2 = 254$

Table 10.1: Private IP adress ranges

class	adress range	net quota	host quota	max. number of networks	max. number of hosts
A	0.0.0.1 - 127.255.255.255	8 Bit	24 Bit	126	16.777.214
B	128.0.0.1 - 191.255.255.255	16 Bit	16 Bit	16.384	65.534
C	192.0.0.1 - 223.255.255.255	24 Bit	8 Bit	2.097.151	254
D	224.0.0.1 - 239.255.255.255			Reserved for multicast applications	
E	240.0.0.1 - 255.255.255.255			Reserved for special applications	

Table 10.2: Classes of IP adresses

same time. Often also a standard gateway is present in a network. In most local networks is this gateway with the router to the Internet (DSL router, ISDN router etc.) is identical. Using this (gateway -) router a connection can be manufactured with another network. Thus also network elements, which are not in the same (local) network, can be reached and/or network elements from the local network are able to exchange data with network elements from other networks. For a network-spreading data exchange the IP address of the standard gateway must also be preset. In local networks, mostly the first IP address within a network for this (gateway -) router is used. Mostly routers in a local network to be used as gateway have an IP address with a „1" in the last place of the IP address (e.g. 192.168.10.1).

12.3 Ethernet settings

PC and instrument have to be connected to the same network. Otherwise a remote connection is not possible.

In addition to the USB interface, the optional interface card HO730 resp. HO732 includes an Ethernet interface. The required parameters are selected in the spectrum analyzer once ETHERNET has been selected as interface. You can specify all parameters and assign a fixed IP address. You can also assign a dynamic IP address with the activated DHCP function. Please contact your IT management to configure the settings properly.

If DHCP is used and the system cannot assign an IP address to the R&S®HMS-X (for instance, if no Ethernet cable is connected or the network does not support DHCP), it may take up to three minutes until a timeout allows the interface to be configured again.

If the device has an IP address, it can be accessed via web browser at this IP since the HO730 resp. HO732 includes an integrated web server. Enter the IP address in the location bar on your browser (http//xxx.xxx.xxx.xx). This opens a window that includes the instrument name and type, serial number and interfaces with technical information and configured parameters. For further information, please refer to the HO730 resp. HO732 manual on the ROHDE & SCHWARZ homepgage.

In general, the HO730 works with a RAW-Socket communication to control the instrument and to retrieve the measuring values. Therefore, a TMC protocol or a similar protocol will not be used.

12.4 IEEE 488.2 / GPIB (Option HO740)

The optional interface card HO740 includes a IEEE488.2 interface. Configure the settings of the HMS-X for all necessary parameters after you select IEEE488 as interface and press the softkey Parameter. For further information, please refer to the HO740 manual.

13 Optional HAMEG accessories

13.1 19'' Rack mount kit 4HE HZ46

For the application in rack systems we provides a kit for the R&S®HMS-X Technical details and a description about the mounting you can find in the HZ46 manual on www. hameg.com.

13.2 Carrying case HZ99

Fig. 13.1: Carrying case HZ99

The carrying case HZ99 is used to transport your spectrum analyzer.

13.3 VSWR bridge HZ547 (usable with option R&S®HMS-TG resp R&S®HV211 voucher)
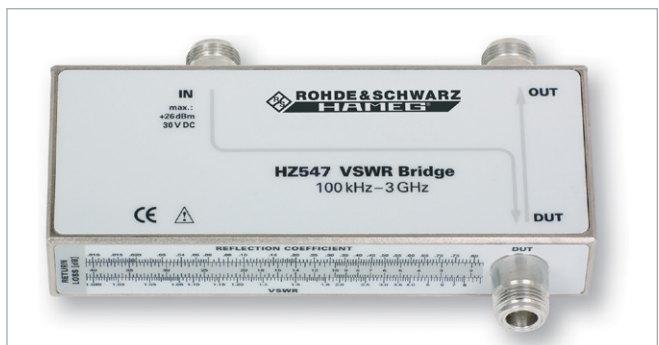

Fig. 13.2: VSWR bridge HZ547

The VSWR bridge HZ57 allows the measurement of the voltage standing wave ratio (VSWR) and the reflection co-efficient of 50Ω devices. Typical objects are e.g. 50Ω attenuators, load resistors, amplifiers, cables, mixers, frequency selective devices. The frequency range is 100kHz to 3GHz. The technical specifications and the measurement set-up are decribed in the HZ547 manual on www. hameg.com.

13.4 Near field probe sets HZ530/HZ540/HZ550

The set includes 3 hand-held probes with a built-in pre-amplifier covering the frequency range from 100kHz to 1GHz resp. 1MHz to 3GHz. When used in conjuction with

a spectrum analyzer or a measuring receiver, the probes can be used to locate and qualify EMI sources, as well as evaluate EMC problems at the breadboard and proto-type level. The power can be supplied either from batteries (HZ530) or through a power cord directly connected to an spectrum analyzer (HZ540). Signal feed is via a BNC-cable or SMA/N-cable. They enable the user to evaluate radia-ted fi elds and perform shield effectiveness comparisons. The HZ530 or HZ540 probes – one magnetic field probe, one electric field probe and one high impedance probe – are all matched to the 50 Ω inputs of spectrum analyzers. The technical specifications are described in the HZ530/HZ540 manual on our homepage http://www.hameg.com/downloads.

> **HAMEG probes are only used for so-called relative measure-ments. Neither the frequency response nor a correction factor or something similar is required for the measurement**

13.5 Transient Limiter HZ560

Fig. 13.3: Transient Limiter HZ560

The transient limiter HZ560 protects the input circuit of spectrum analyzers and measurement receivers, in par-ticular in combination with the use of a Line Impedance Stabilization Network (i.e. HAMEG LISN HM6050-2). The technical specifications are decribed in the HZ560 manual on www.hameg.com.

13.6 75/50-Ω-Converter HZ575

Fig. 13.4: 75/50-Ω-Converter HZ575

The converter HZ575 has a 75 Ω AC coupled input and a 50Ω DC coupled output. Using HZ575, spectrum analyzers with 50Ω input can be used for measurement in 75Ω en-vironment. HZ575 can be used reversed too. A 50Ω signal applied at the 50Ω "output" is present at the 75Ω BNC "in-put" socket with an impedance of 75Ω. The technical spe-cifications are decribed in the HZ575 manual on www.ha-meg.com.

14 Technical Data

Frequency	
Frequency range	
basic unit	100 kHz to 1,6 GHz
with HMS-3G (HV212) option	100 kHz to 3 GHz
Temperature stability	±2 x 10^{-6} (0°C to +30°C)
Aging (per year)	±1 x 10^{-6}
Frequency counter (with HMS-EMC, HV213 option)	
Resolution	1 Hz
Accuracy	±(frequency x tolerance of reference)
Span range	
basic unit	0 Hz (Zero Span), 1 MHz to 1.6 GHz
with HMS-EMC (HV213) option	0 Hz (Zero Span), 100 Hz to 1.6 GHz
with HMS-3G (HV212) option	0 Hz (Zero Span), 1 MHz to 3 GHz
with HMS-3G (HV212) and HMS-EMC (HV213) option	0 Hz (Zero Span), 100 Hz to 3 GHz
Spectral purity, SSB phase noise	
30 kHz from carrier (500 MHz, +20°C to +30°C) with HMS-EMC (HV212) option	<-85 dBc/Hz
100 kHz from carrier (500 MHz, +20°C to +30°C)	<-100 dBc/Hz
1 MHz from carrier (500 MHz, +20°C to +30°C)	<-120 dBc/Hz
Sweep time	
f_{span} = 0 Hz (zero span)	2 ms to 100 s
f_{span} > 0 Hz	20 ms to 1000 s, min. 20 ms per 600 MHz
Resolution bandwidths (-3 dB)	
basic unit	10 kHz to 1 MHz (in 1 to 3 steps), 200 kHz
with HMS-EMC (HV213) option	100 Hz to 1 MHz (in 1 to 3 steps), 200 kHz
Tolerance	
f ≤ 300 kHz	±5% typ.
f > 1 MHz	±10% typ.
Resolution bandwidths (-6 dB)	
with HMS-EMC (HV213) option	CISPR: 200 Hz, 9 kHz, 120 kHz, 1 MHz
Video bandwidths	
basic unit	1 kHz to 1 MHz (in 1 to 3 steps)
with HMS-EMC (HV213) option	10 Hz to 1 MHz (in 1 to 3 steps)
Amplitude	
Display range	Average noise level displayed up to +20 dBm
Amplitude measurement range	
basic unit	-104 dBm to +20 dBm (typ.)
with HMS-EMC (HV213) option	-114 dBm to +20 dBm (typ.)
Max. voltage at HF input	80 V$_{DC}$
Max. power at HF input	20 dBm (permanently), 30 dBm (temporarily for max. 3 min)

Intermodulation-free range	
TOI products, 2 x -20 dBm (-10 dBm ref. level)	66 dB (typ.) (typ. +13 dBm third-order-intercept)
signal distance ≤2 MHz	60 dB (typ., +10 dBm TOI)
signal distance >2 MHz	66 dB (typ., +13 dBm TOI)
DANL (displayed average noise level) (ref. level ≤-30 dBm, frequency range 10 MHz to 3 GHz)	
10 kHz (RBW), 1 kHz (VBW)	-95 dBm (typ. -104 dBm)
100 Hz (RBW), 10 Hz (VBW) with HMS-EMC (HV213) option	-115 dBm (typ. -135 dBm)
Preamplifier with HMS-EMC (HV213) option	-124 dBm (typ.)
Inherent spurious	
ref.-level ≤-20 dBm, f >30 MHz, RBW ≤100 kHz	<-80 dBm
Input related spurious (mixer level ≤-40 dBm)	
Carrier offset: 1 MHz to 1.6 GHz	-70 dBc (typ.)
1.6 GHz to 3 GHz with HMS-3G (HV212) option	-55 dBc (typ.)
2nd harmonic receive frequency	
Mixer level: -40 dBm	-60 dBc (typ.)
Level display	
Reference level	-80 dBm to +20 dBm (in 1 dB steps)
Display range	
basic unit	100 dB, 50 dB, 20 dB, 10 dB
with HMS-EMC (HV213) option	linear
level display error (ref. level -50 dBm, 20°C to 30°C)	<1.5 dB (typ. 0.5 dB)
Display scaling	
logarithmical	dBm, dBµV, dBmV
linear, with HMS-EMC (HV213) option	percentaged from reference level
Measured curves	1 curve and 1 memory curve
Trace mathematics	A-B (curve-stored curve), B-A
Detectors	
basic unit	auto-, min/max. peak, sample, RMS, average
with HMS-EMC (HV213) option	same as basic unit, quasi-peak in addition

Marker and delta marker	
Number of markers	8
Marker functions	peak, next peak, minimum, center to marker, frequency, reference level to marker level, all marker on peak
Marker display	
basic unit	normal (level, logarithmic), delta marker, noise marker, normal (linear)
mit HMS-EMC (HV213) option	(frequency) counter[2])

Connectors	
HF Input	
Connector	N socket
Input impedance	50 Ω
VSWR (10 MHz to 3 GHz)	<1.5 (typ.)
Tracking generator output	
Connector	N socket
Output impedance	50 Ω

Frequency range	
basic unit	5 MHz to 1.6 GHz
with HMS-3G (HV212) option	5 MHz to 3 GHz
Output level	-20 dBm to 0 dBm (in 1 dB steps)
Trigger input	
Connector	BNC socket
Trigger voltage	TTL
Trigger types	
basic unit	free run, single trigger, external trigger
with HMS-EMC (HV213) option	same as basic unit, video trigger in addition
External reference input / output	
Connectors	BNC socket
Reference frequency	10 MHz
min. level (50 Ω)	10 dBm
Interfaces	
for mass storage	2x USB-host (type A), FAT16/32
for remote control	HO720 dual interface: RS-232 / USB-device (type B)
Optional interfaces	HO730 dual interface: Ethernet (RJ45) / USB-device (type B) HO740 interface: IEEE-488 (GPIB)
Video output	DVI-D (480p, 60Hz), HDMI compliant
Save and recall	on internal file system (up to 10 device settings) or external USB memory (max. 4 GB)
Additional connectors	
Supply output for field probes	$6 V_{DC}$, max. 100 mA (2.5 mm DIN jack)
Audio output	3.5 mm DIN jack
Demodulation	AM and FM (via internal speaker)
General Characteristics	
Display	
screen size / type	16.5 cm (6,5") VGA color TFT
resolution	640 x 480
backlight	LED
Power supply	
AC supply	105 V to 253 V, 50 Hz to 60 Hz, CAT II
power consumption	40 W (typ.)
Safety	safety class I (EN61010-1)
Temperature	
operating temperature range	+5 °C to +40 °C
storage temperature range	-20 °C to +70 °C
Rel. humidity	5% to 80% (without condensation)
Mechanical data	
dimensions (W x H x D)	285 x 175 x 220 mm
weight	3.6 kg
All specifications at 23°C after 30 minutes warm-up	

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