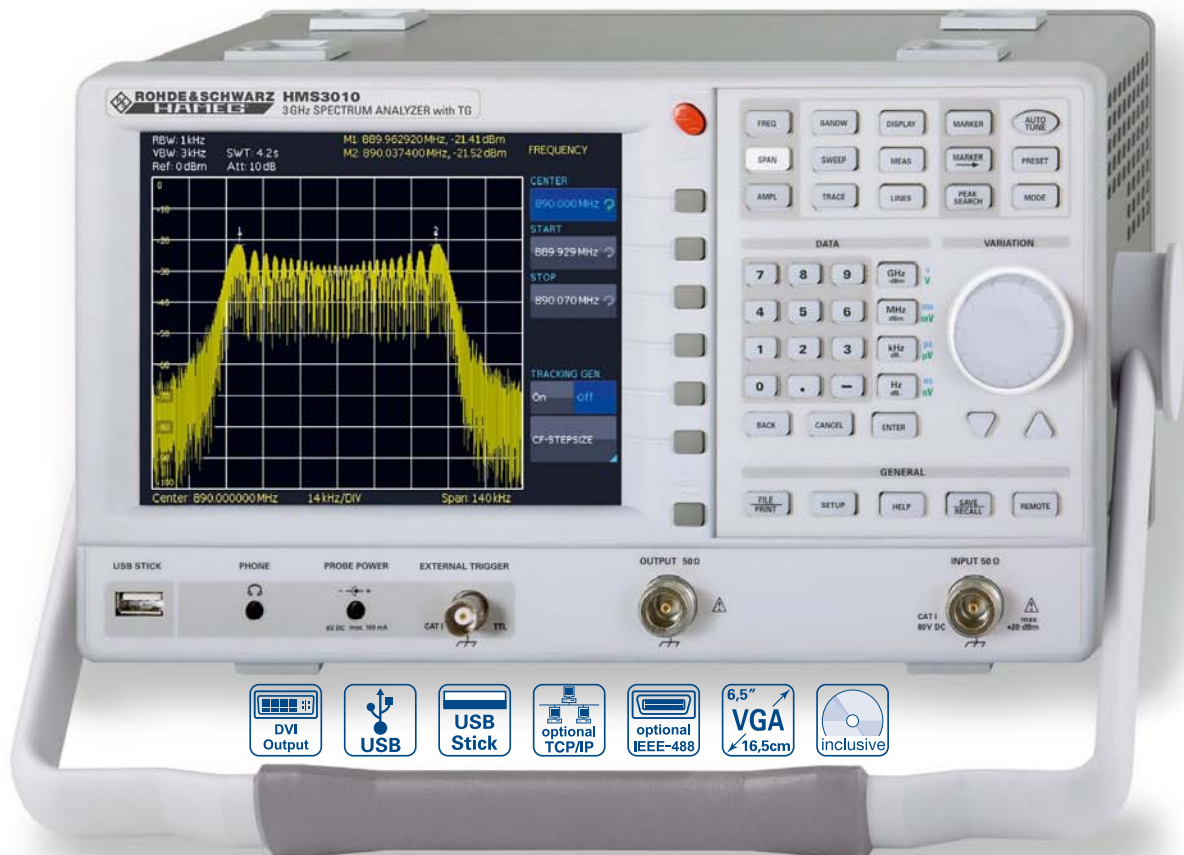


3GHz Spectrum Analyzer HMS3000/HMS3010



3GHz Spectrum Analyzer
HMS3000 without TG



3GHz EMI Near Field Probe
Set HZ550L



VSWR Test Unit HZ547



- Frequency Range 100kHz...3GHz
- Tracking Generator HMS3010 -20...0dBm
- Amplitude Measurement Range -114...+20dBm
DANL -135dBm with Preamp. Option H03011
- Sweep Time 20ms...1000s
- Resolution Bandwidth 100Hz...1MHz in 1-3 Steps,
200kHz (-3dB); additional 200Hz, 9kHz, 120kHz, 1MHz (-6dB)
- Spectral Purity <-100dBc/Hz (@100kHz)
- Video Bandwidth 10Hz...1MHz in 1-3 Steps
- Integrated AM and FM Demodulators (Phone and int. Speaker)
- Detectors: Auto-, Min-, Max-Peak, Sample, RMS, Quasi-Peak
- 8 Markers with Delta Marker, miscellaneous Peak Functions
- Crisp 16.5cm (6.5") TFT VGA Display, DVI Output
- 3 x USB for Mass-Storage, Printer and Remote Control,
optional IEEE-488 (GPIB) or Ethernet/USB Dual-Interface

**1.6 GHz Spectrum Analyzer HMS1000, HMS1010 (with TG)
[3 GHz Spectrum Analyzer HMS3000, HMS3010 (with TG)]**

Firmware: ≥ 2.022

All data valid at 23 °C after 30 minute warm-up.

Frequency

Frequency range:	
HMS1000, HMS1010	100 kHz...1.6 GHz
HMS3000, HMS3010	100 kHz...3 GHz
Temperature stability: ±2 ppm [0...30 °C]	
Aging: ±1 ppm/year	
Frequency counter:	
Resolution	1 Hz
Accuracy	±(Frequency x tolerance of reference)
Span setting range:	
HMS1000, HMS1010	0 Hz (zero span) and 100 Hz...1.6 GHz
HMS3000, HMS3010	0 Hz (zero span) and 100 Hz...3 GHz
Spectral purity, SSB phase noise:	
30 kHz from carrier (500 MHz, +20...30 °C) <-85 dBc/Hz	
100 kHz from carrier (500 MHz, +20...30 °C) <-100 dBc/Hz	
1 MHz from carrier (500 MHz, +20...30 °C) <-120 dBc/Hz	
Sweep time:	
Span = 0 Hz	2 ms...100 s
Span > 0 Hz	20 ms...1,000 s, min. 20 ms/600 MHz
Resolution bandwidths [-3 dB]:	
	100 Hz...1 MHz in 1-3 steps, 200 kHz
Tolerance	
≤300 kHz	±5% typ.
1 MHz	±10% typ.
Resolution bandwidths [-6 dB]:	
	200 Hz, 9 kHz, 120 kHz, 1 MHz
Video bandwidths: 10 Hz...1 MHz in 1-3 steps	

Amplitude

Display range: Average noise level displayed up to +20 dBm	
Amplitude measurement range: Typ. -114...+20 dBm	
Max. permissible DC at HF input: 80 V	
Max. power at HF input: 20 dBm, 30 dBm 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)
[at distance between signals ≤2 MHz]	60 dB typ. (+10 dBm TOI)
[at distance between signals >2 MHz]	66 dB typ. (typ. +13 dBm TOI)
DANL [Displayed average noise level]: (RBW 100 Hz, VBW 10 Hz, ref. level ≤-30 dBm 10 MHz...1.6 GHz resp. 3 GHz) -115 dBm, typ. -124 dBm With Preamp. -135 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) -70 dBc typ., [-55 dBc [2...3 GHz]]	
2nd harmonic receive frequency: (mixer level -40 dBm) -60 dBc typ.	
Level display:	
Reference level	-80...+20 dBm in 1 dB steps
Display range	100 dB, 50 dB, 20 dB, 10 dB, linear
Logarithmic display scaling	dBm, dBμV, dBmV
Linear display scaling	Percentage of reference level
Measured curves: 1 curve and 1 memory curve	
Trace mathematics: A-B (curve-stored curve), B-A	
Detectors: Auto-, Min-, Max-Peak, Sample, RMS, Average, Quasi-Peak	
Failure of level display: (ref. level -50 dBm, 20...30 °C)	

Marker/Deltamarker

Number of marker:	8
Marker functions:	Peak, next peak, minimum, center = marker, frequency, reference level = marker level, all marker on peak
Marker displays:	Normal (level, lin. & log.), delta marker, noise marker, (frequency) counter

Inputs/Outputs

HF Input:	N socket
Input Impedance	50 Ω
VSWR (10 MHz...1.6 GHz/3 GHz)	<1.5 typ.
Output tracking generator:	
(HMS1010/HMS3010)	N socket
Output Impedance	50 Ω
Frequency range	5 MHz...1.6 GHz [3 GHz]
Output level	-20...0 dBm, in 1 dB steps
Trigger input:	BNC female
Trigger voltage	TTL
Ext. reference input/output:	BNC females
Reference frequency	10 MHz
Essential level [50 Ω]	10 dBm
Supply output for field probes: 6 V _{dc} , max. 100 mA (2.5 mm DIN jack)	
Audio output (Phone):	3.5 mm DIN jack
Demodulation	AM and FM (internal speaker)

Miscellaneous

Display:	16.5 cm [6.5"] TFT Color VGA Display
Save/Recall memory	10 complete device settings
Trigger	Free run, Video Trigger, Single Trigger, external Trigger
Interfaces:	Dual-Interface USB/RS-232 (HO720), USB-Stick (frontside), USB-Printer (rear side), DVI-D for ext. monitor
Power supply:	105...253 V, 50...60 Hz, CAT II
Power consumption:	Max. 40 W at 230 V, 50 Hz
Protection class:	Safety class I [EN61010-1]
Operating temperature:	+5...+40 °C
Storage temperature:	-20...+70 °C
Rel. humidity:	5...80 % (non condensing)
Dimensions (W x H x D):	285 x 175 x 220 mm
Weight:	3.6 kg

Accessories supplied: Line cord, Operating manual, HZ21 Adapter plug, N-plug to BNC socket (2x HMS1010/3010), CD, Software

Recommended accessories:

HO730	Dual-Interface Ethernet/USB
HO740	Interface IEEE-488 (GPIB), galvanically isolated
HO3011	Preamplifier -135 dBm DANL (100 Hz RBW)
HZ13	Interface cable (USB) 1.8 m
HZ14	Interface cable (serial) 1:1
HZ20	Adapter, BNC to 4 mm banana
HZ33	Test cable 50 Ω, BNC/BNC, 0.5 m
HZ34	Test cable 50 Ω, BNC/BNC, 1.0 m
HZ46	4RU 19" Rackmount Kit
HZ72	GPIB-Cable 2m
HZ99	Carrying Case for protection and transport
HZ520	Plug-in Antenna with BNC connection
HZ525	50 Ω-Termination, N plug
HZ530	Near-Field Probe Set 1 GHz for EMI diagnostics
HZ540/550	Near-Field Probe Set 3 GHz for EMI diagnostics
HZ540L/550L	Near-Field Probe Set 3 GHz for EMI diagnostics
HZ547	3 GHz VSWR Bridge for HMS1010, HMS3010
HZ560	Transient limiter
HZ575	75/50 Ω Converter
HZ030	Active probe 1 GHz [0.9 pF, 1 MΩ, including many accessories]

3 Controls and display

Front panel

(HMS1010 differs in frequency range;
HMS3000 / HMS1000 / HMS1000E without Tracking Generator)

- 1 **Display** (TFT)
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:**
This area includes the parameter settings.
- 4 **AMPL** (illuminated button)
Setting of amplitude parameters
 - 5 **SPAN** (illuminated button)
Setting of the Span
 - 6 **FREQ** (illuminated button)
Setting of the frequency
 - 7 **TRACE** (illuminated button)
Configuration of data acquisition and analysis
 - 8 **SWEEP** (illuminated button)
Setting of the sweep time and the trigger source
 - 9 **BANDW** (illuminated button)
Setting of the resolution and video bandwidth
 - 10 **LINES** (illuminated button)
Configuration of displayed and limit lines
 - 11 **MEAS** (illuminated button)
Implementation of extended measurements
 - 12 **DISPLAY** (illuminated button)
Setting of the display
 - 13 **PEAK SEARCH** (illuminated button)
Measuring value peak display
 - 14 **MARKER →** (illuminated button)
Search function of marker
 - 15 **MARKER** (illuminated button)
Selection and arrangement of the absolute and relative marker
 - 16 **MODE** (illuminated button)
Switching between SWEEP- and RECEIVER-Mode
 - 17 **PRESET**
Factory reset
 - 18 **AUTO TUNE**
Automatically setting of instrument settings

Area B (Data):

This area includes the possibility of setting parameters via numerical keyboard and unit keys.



- 19 **Numerical keyboard** (buttons)
Set of all operating parameters
- 20 **BACK**
Set back of inputs
- 21 **CANCEL**
Terminate the editing mode
- 22 **ENTER**
Confirm the values via keyboard

Area C (Variation):

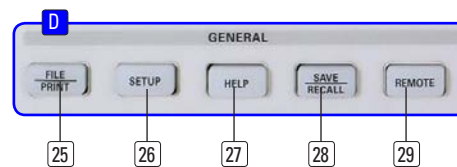
This area includes the settings via rotary knob and arrow buttons



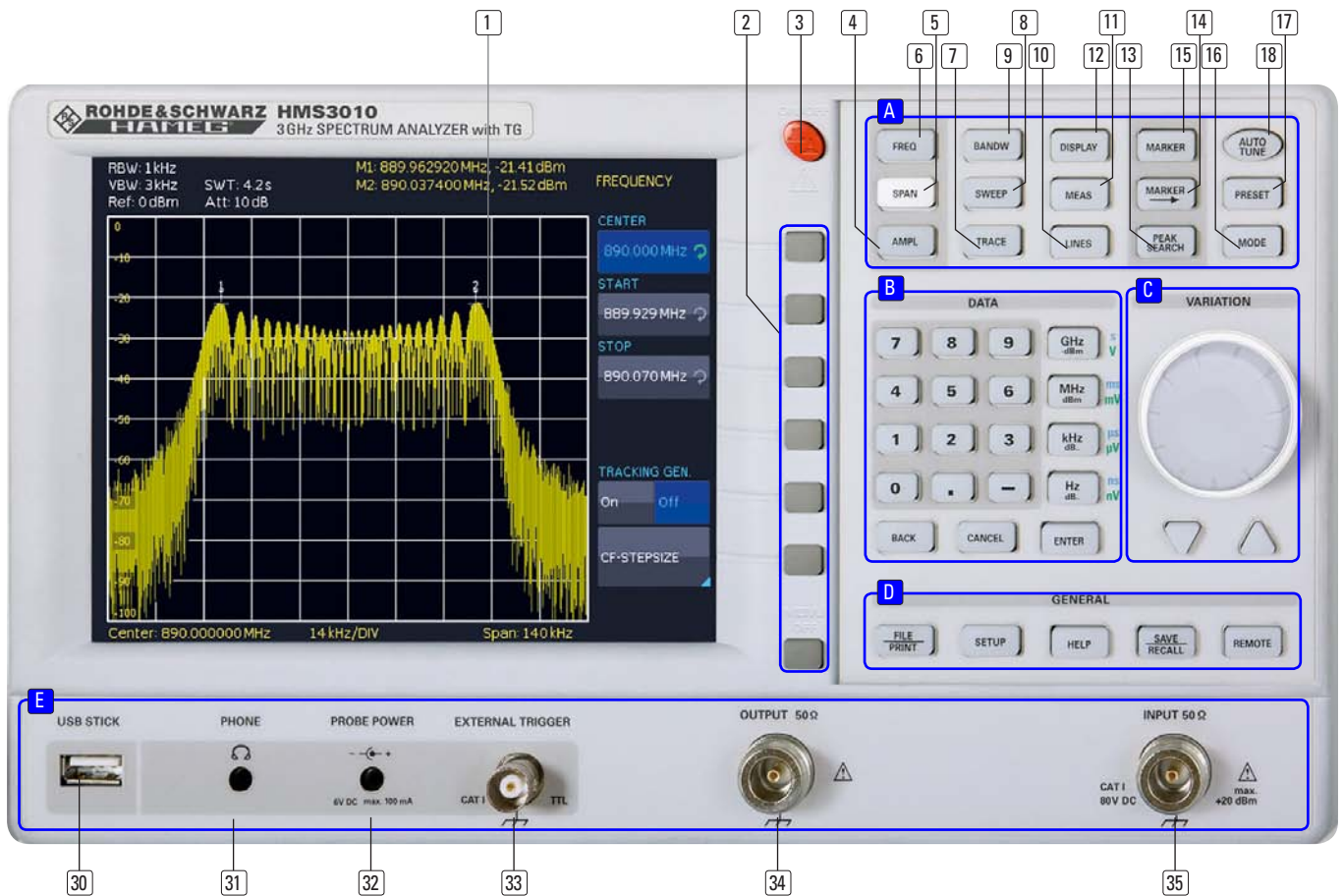
- 23 **Rotary knob**
Knob to adjust and activate the values or menu items by pushing
- 24 **Arrow buttons ▲ ▼** (buttons)
Zoom-In / Zoom-Out functionality

Area D (General):

This area includes the general instrument settings



- 25 **FILE/PRINT**
The key FILE/PRINT on the front panel allows you to store instrument settings, curves, screenshots or printing.
- 26 **SETUP** (illuminated button)
Display of general instrument settings
- 27 **HELP**
Including display help
- 28 **SAVE/RECALL** (illuminated button)
Store and restore of instrument settings, curves and screenshots



29 REMOTE
 Toggling between front panel and external operation

Area E:
 This area includes a series of connectors.

- 30 USB 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 field probes
 (2,5 mm jack)
- 33 External TRIGGER** (BNC socket)
 BNC input for external trigger signal
- 34 OUTPUT 50 Ω**
 Tracking Generator (N connector)
 (HMS3000, HMS1000/1000E haven't got this connector)
- 29 INPUT 50 Ω**
 Input N connector

Rear panel

- 36 Mains input connector with fuse**
- 37 Interface**
 H0720 Dual-Interface (USB/RS-232) is provided as standard

38 DVI (connector)
 Display of the instrument display 1:1 on an external DVI monitor or projector with DVI-D connector

- 39 USB port**
 Additional USB port
- 40 REF IN** (BNC socket)
 Reference input
- 41 REF OUT** (BNC socket)
 Reference output



4 Quick introduction

The following chapters are intended to introduce you to the most important functions and settings of your new HAMEG HMS spectrum analyzer (here: HMS3010) in order to enable you to immediately use it. You find more detailed explanations in the chapters following these ones.

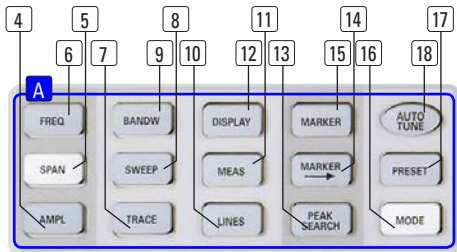


Fig. 4.1: Area A of the control panel

4.1 How to measure a sine wave signal

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 HMS series. The signal source is a HF synthesizer, e.g. the HM8135. Connect the HF output of the synthesizer to the HF input of the spectrum analyzer.

Settings on the synthesizer:

- Frequency 100 MHz
- 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.

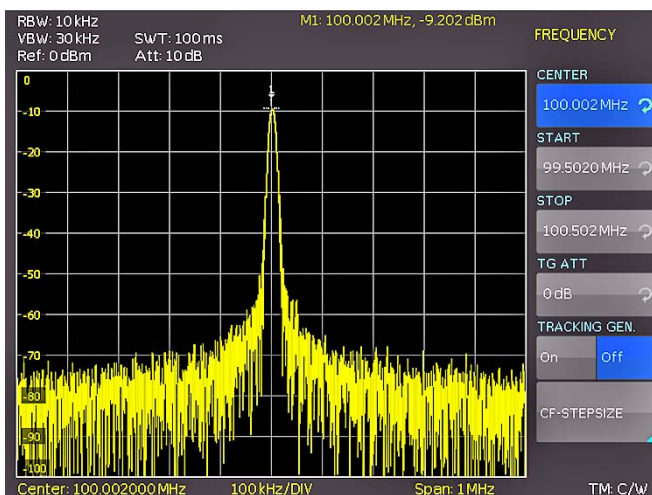


Fig. 4.2: Display with the AUTO TUNE function

4.2 Level measurement

In order to now perform the previously 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 HMS series 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.

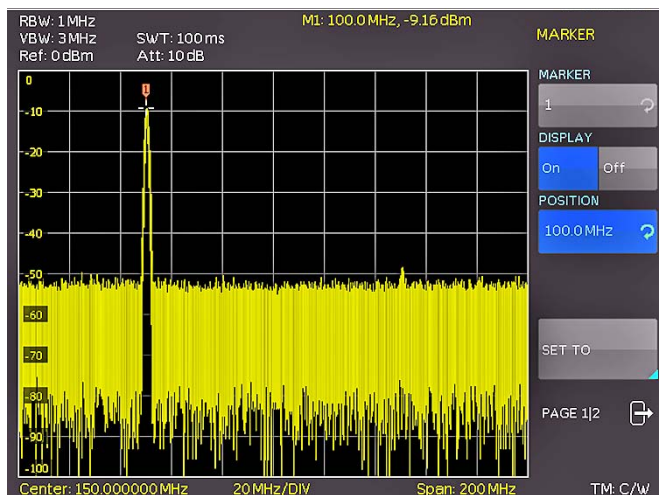


Fig. 4.3: Level measurement with marker

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 HMS 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 lefthand screen area. The marker should also display the selected 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 POSITION (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.

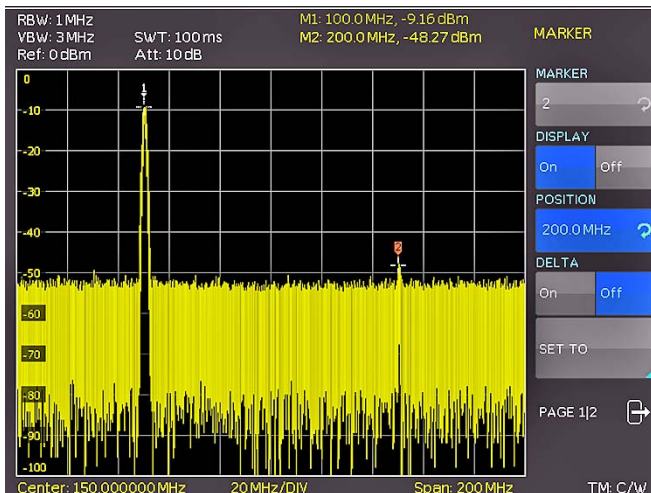


Fig. 4.4: Measurement of the harmonic of a sine wave signal

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 HMS series 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.

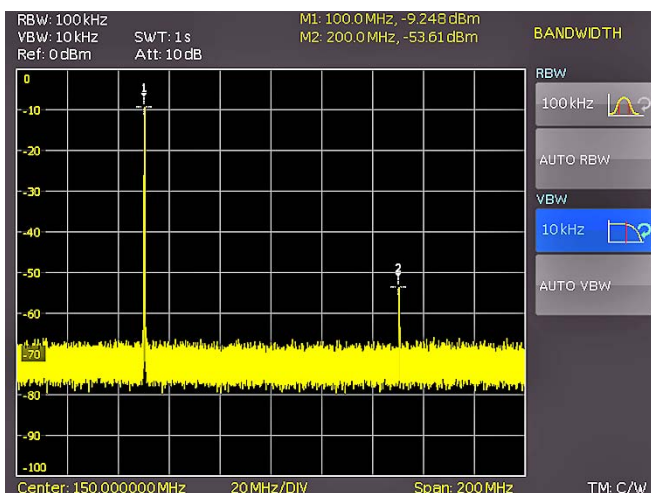


Fig. 4.5: Selection of the proper filter settings

Another means of spectrum analysis is the so-called 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 HMS display.

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]).

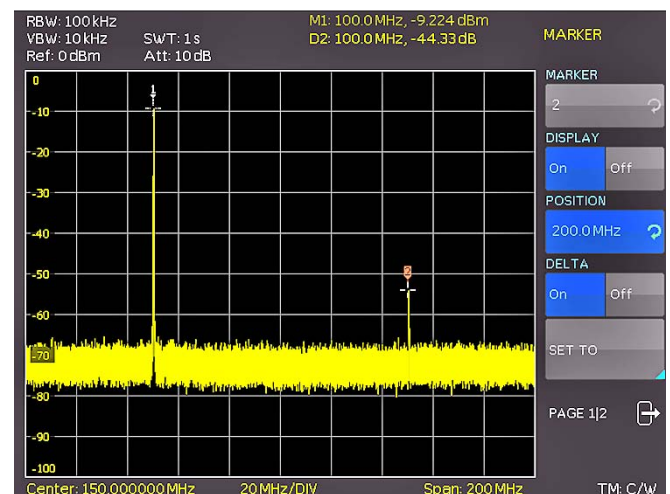


Fig. 4.6: Measurement of the harmonic using the delta marker

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 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.

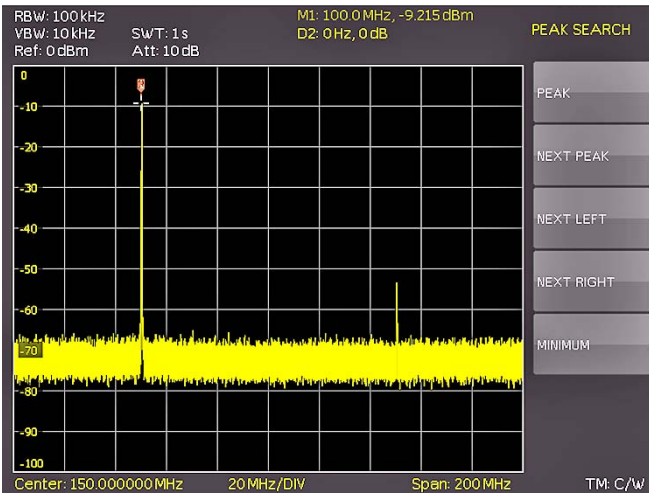


Fig. 4.7: PEAK SEARCH function

4.4 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 20 dB (0 to 20 dBm), the input attenuator will be automatically switched to 30 dB. This will cause the first harmonic of the signal (marker 2) to disappear in the noise floor.

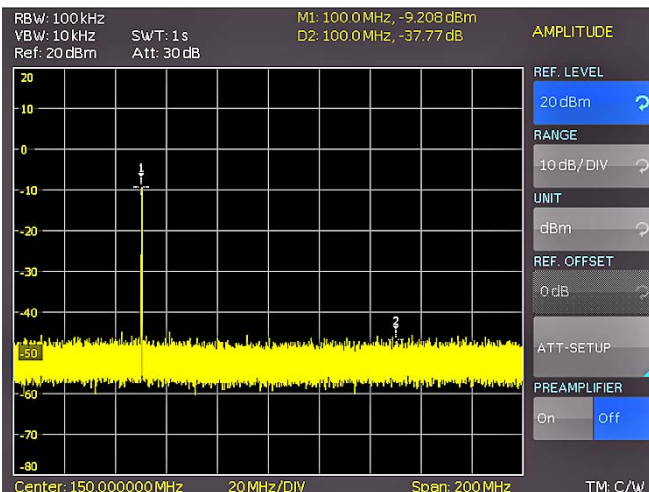


Fig. 4.8: Setting of the reference level

4.5 Operation in the receiver mode

For the measurement of levels of a signal frequency the HMS series 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 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.

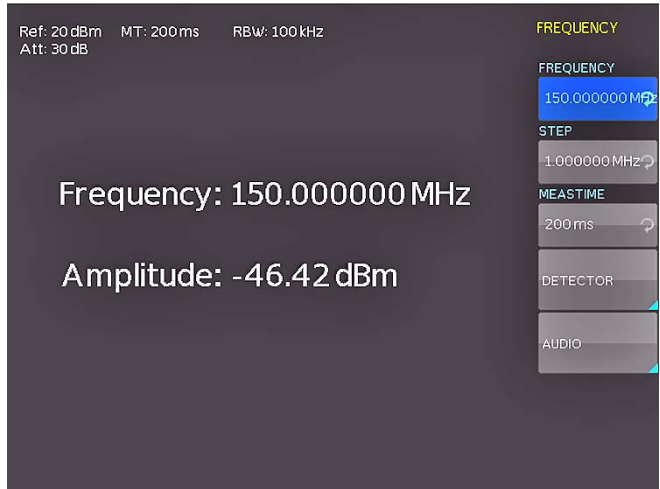


Fig. 4.9: Receiver mode with a center frequency set

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 (not available for HMS1000E). These can be chosen by pressing the key BANDW and using the knob.

The HMS series 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 not available for the HMS1000E.

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:

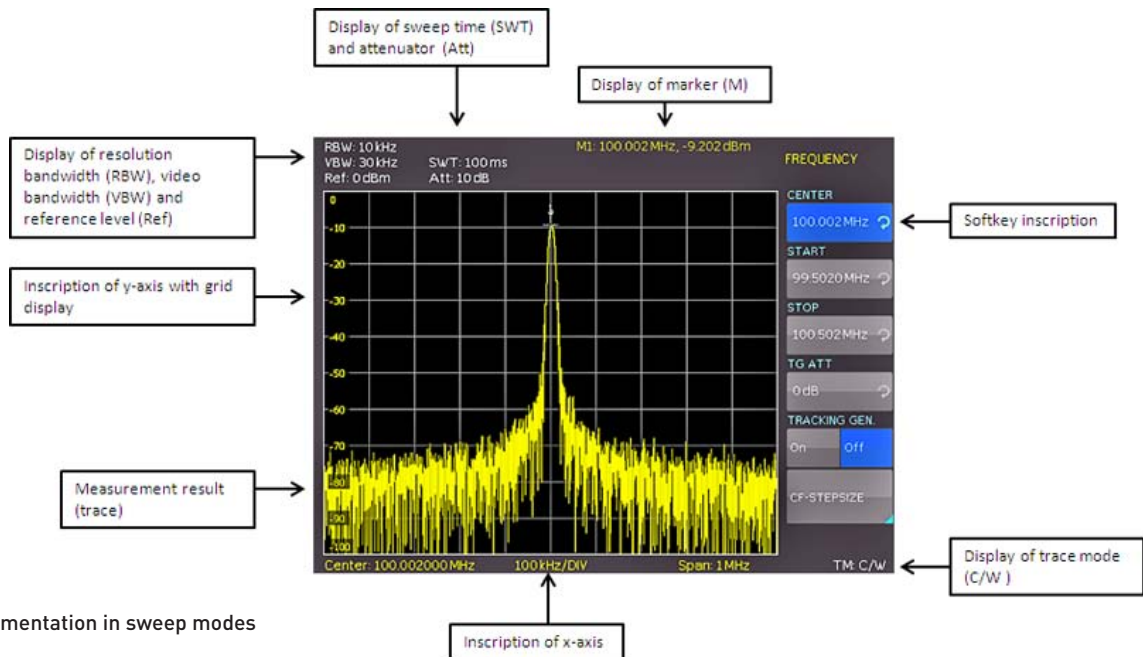


Fig. 5.1:
Display segmentation in sweep modes

- numerical keyboard
- knob
- arrow buttons

Please use the soft menu keys for selecting the respective menu item.

5.2 Numerical keyboard

The simplest method of entering parameters quickly and exactly is the entry via the numerical keyboard. 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..]. Prior to pushing any such key an entry may be deleted by pushing the key BACK. During these operations the window will remain open. The CANCEL key will terminate the entry of parameters and close the window.



Fig. 5.2:
Section B with numerical keyboard, unit and command keys

5.3 Knob

It is possible to only use the knob for all settings. 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 numerical keyboard 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 grey.

5.6 How to enter numerical values

- Use the grey 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.

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 chapter 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 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 via the CENTER key. In this case start and stop frequencies are automatically adapted. The step size of the center frequency can be modified with CF-STEPSIZE. By pushing this soft menu key the settings menu will open.

- **0.1 x SPAN (Basic setting):** The step size is always 1/10 of the currently selected span (= 1 vertical division).
- **0.5 x SPAN:** The step size is always 1/2 of the currently selected span (= 5 vertical divisions).
- **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.
- **MANUAL:** Any step size is available. This allows the easy measurement of spectra with regular frequency steps.

6.2 Aktivating/parameterizing the built in TG


The output of the tracking generators is nominal 0 dBm. It can be reduced via an adjustable TG attenuator 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 strongly 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 any more. 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 [Chapter 6.7.1] of the HMS is used to compensate the effects described above.

Performing measurements with the tracking generator

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 of the HMS1010/3010 shows no “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 dependent. For the “interpretation” at the input of the HMS does not require a sinusoidal signal curve.

Through the reduction of the TG output signal to the input and the use of HMS (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 HMS is ensured at any time.

Since the existing tracking generator have to display frequencies in a very broad context, it is customary that the tracking generator can not display low frequency signals (frequency range 5 MHz to 1.6 GHz resp. 3 GHz).

6.3 Frequency range displayed (SPAN)

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.

The HMS series offers the following frequency ranges (Spans):

HMS1000E	1 MHz bis 1.6 GHz
HMS1000/1010	1 kHz bis 1.6 GHz
HMS3000/3010	100 Hz bis 3 GHz

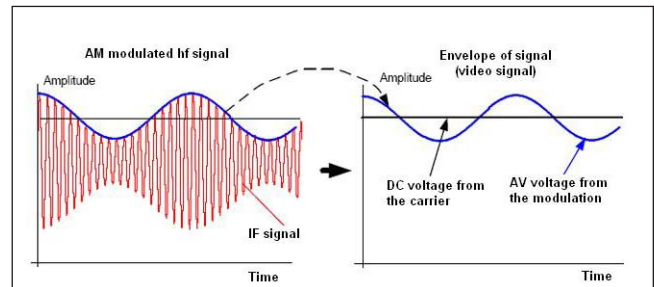


Fig. 6.1: Hf signal modulated by a sine wave signal and the resultant video signal vs. time

In zero span mode 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 behaves like a selective oscilloscope. In order to select the full (maximum) frequency range of 100 kHz to 1.6 GHz resp. 100 Hz to 3 GHz by pushing once, the soft menu item FULL is provided. The soft menu key LAST will restore the former setting (the last span setting). The setting is performed as described in chapter 4.

6.4 Setting of the amplitude parameters (AMPL)

The key AMPL is used for all settings of the amplitude displayed. 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.

	Preamplifier OFF		Preamplifier ON		
Reference Level	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

The reference level represents the amplitude level which is displayed at the upper trace screen boundary. The actual setting is shown in the third line left in the readout. Adjusting the reference level automatically switches attenuator, gain and the optional preamplifier. Lowering the reference level increases sensitivity. Normally the reference level is chosen to display the whole dynamic range on screen. For strong input signals the reference level must be set high in order to prevent overdriving of the signal amplifier chain and in order to keep the signal within the visible display window. For spectra with many signals, the reference level should be so high that all signals remain within the display area.



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

Directly coupled to the reference level is the setting of the RF input attenuation on the spectrum analyzer. If the reference level is too high, the spectrum analyzer switches the RF attenuation automatically according to table 6.1, so the input mixer can operate in the linear range at any time.

The basic unit (UNIT) of the reference level is dBm. Alternatively, the unit dB μ V or (from firmware version 2.000) the linear unit V and W can be selected by pushing the softmenu key and using the knob. The scaling of the linear units V and W is set dynamically.



If the linear unit V or W is selected, the reference level is adjusted automatically.

The range [RANGE] defines the resolution of the amplitude axis of the display. The basic scaling is in dB. The standard scaling is 10 dB/DIV. In order to obtain a higher visual resolution, the spectrum analyzer also offers the scalings 5 dB/DIV, 2 dB/DIV, and 1 dB/DIV. 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 dB μ V, 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 set reference level. This representation is useful if, for example, in the time domain (span = 0 Hz) a modulation of an AM-modulated carrier needs to be displayed.

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 input of the reference offset is always given in dB, even if the reference level is set to a different unit.

The setting of the reference level will also directly affect the amount of RF attenuation at the input of the spectrum analyzer. 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 unit contains the option „Preamplifier“ this soft key is used to activate or deactivate the preamplifier (not available for HMS1000E). The preamplifier increases the signal/noise ratio by 10 dB (refer to chapter 13.1 for activate the optional preamplifier).

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. Additionally, the spectrum analyzers offer 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 RBW (resolution bandwidth) selected (provided the user did not set the span to manual operation).

The video bandwidth affects the smoothing (reduction of noise) of the displayed curve. 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 spectrum analyzer.

RBW	VBW
100 Hz *	10 Hz *
200 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
1MHz	200 kHz
	300 kHz
	1 MHz

Table 6.2: Available RBW and VBW settings
*) for the HMS1000E not available

 If the span was set manually too wide or the sweep time to 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.

By pushing the key BANDW you will enter the menu for setting the bandwidths. Both the resolution bandwidth (RBW) and the video bandwidth (VBW) may 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 soft menu key. The knob is used for the setting of the parameters.

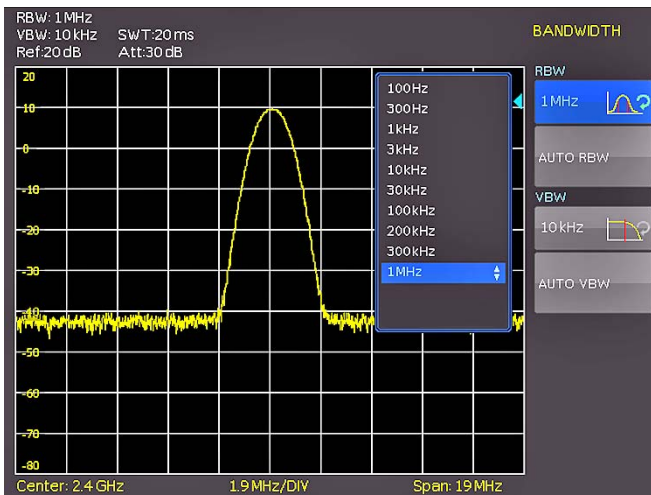


Fig. 6.2: The selections offered in the RBW menu

6.6 Setting of the SWEEP


At 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. Certain limits have to be observed (e.g. the resolution bandwidth set) in order to obtain a correct display. Pushing the key SWEEP will call 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 order to assist the user when setting the sweep time, an automatic selection of the sweep time with respect to the

RBW and the span settings may be chosen with the soft menu key AUTO. The automatic mode will always set the sweep time to the shortest possible value consistent with the correct display of the spectrum content.

The HMS series will sweep the selected frequency range continuously, i.e., after a sweep was completed, a new one will be started 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 analyzer will sweep the frequency range once or it displays the video signal vs. time if the span is set to zero. The instrument will only repeat the measurement after the soft key SINGLE was pushed again. Additionally the soft menu TRIGGER offers diverse trigger functions in order to react to events.

6.6.1 SOURCE

With the submenu SOURCE an internal/ external trigger source or the video trigger can be selected.

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

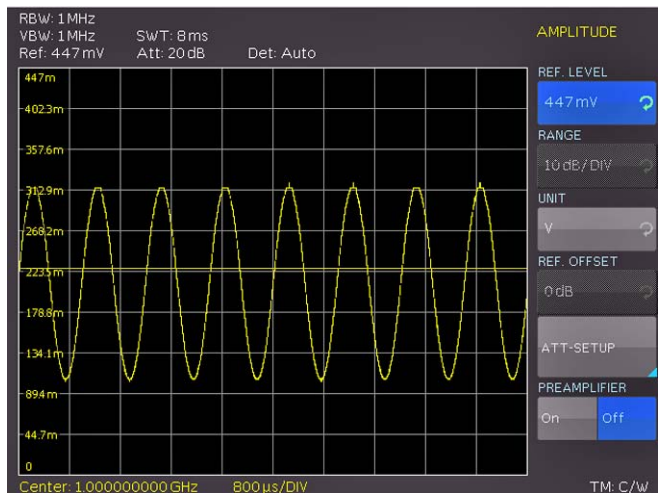


Fig. 6.3: Signal with AM modulation 50% in zero span with linear scaling

With a span setting of 0 Hz (zero span) the spectrum analyzer changes the display from spectrum versus time to discrete voltage versus time. The X-axis of the measurement diagram represents the time axis, starting with time 0s and ends with

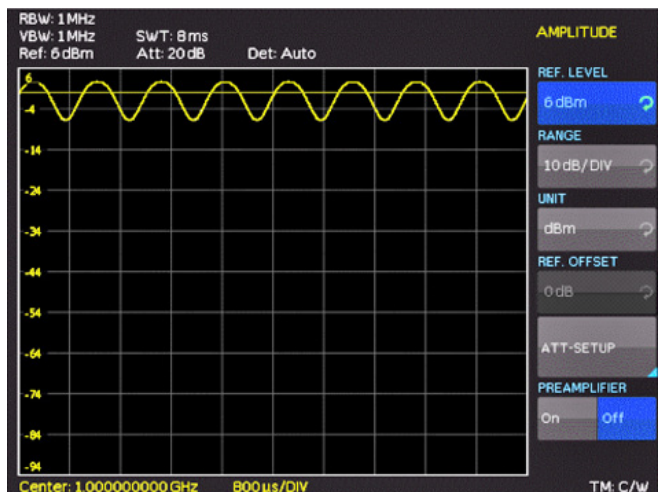


Fig. 6.4: Signal with AM modulation 50% in zero span with logarithmic scaling

6.7.2 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. Pushing the soft menu key DETECTOR will call the settings menu for the selection of various types of detectors.

- **AUTO PEAK:** The spectrum analyzer will display the maximum and minimum value of each pixel from the frequency range represented by that pixel, no signal will be lost; if the signal level fluctuates (noise), the width of the curve will indicate the width of the signal fluctuations (Basic setting).
- **SAMPLE:** Only displays an arbitrary point within a display pixel. The sample detector should be always used at span = 0 Hz, because this is the only method for a correct display of the video signal vs. time. Can be used for the measurement of noise power. For spans wider than than the resolution bandwidth x 501, signals may be lost.
- **MAX PEAK:** In contrast to the auto peak detector this detector will deliver only the maximum value of the spectrum within a pixel of the curve (e.g. the measurement of pulsed signals or frequency modulated signals).
- **MIN PEAK:** Delivers the minimum of a spectrum within a pixel of the curve. Sine wave signals will be displayed with their correct levels while noise-like signals will be suppressed (e.g. for filtering sine wave signals from noise).

6.8 The use of markers

The HMS series 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 numerical 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. The individual markers can be switched on and off with the respective soft menu key. The soft menu key POSITION is used to set the frequency position of the marker along the trace. If marker 1 is activated, a frequency counter function can be enabled for this marker by pushing the the soft menu key „COUNTER“. The corresponding frequency value of the marker is now shown at the top of the display marked with an „F“.

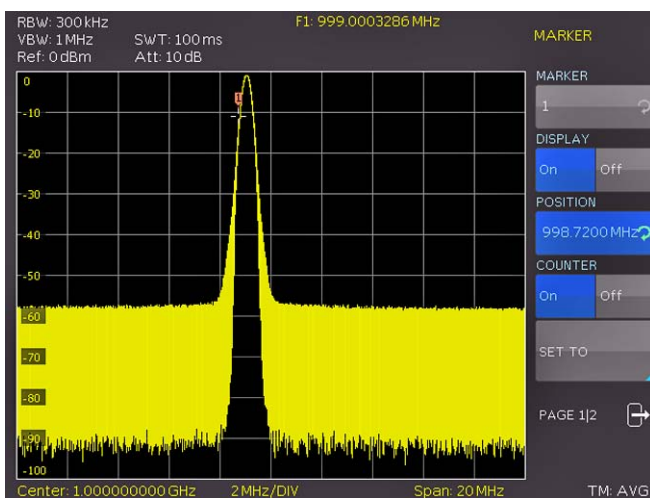


Fig. 6.7: Frequency counter

The delta marker level is always relative to the level of the main marker (Marker 1), the unit of level 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".

This button activates a submenu in which the active marker can be set to the center frequency or the center frequency can be set to the frequency of the active marker. 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 button allows to set the reference level to the value of the current marker.

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. However, valid results are obtained only 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. Please note that the unit for the level measurement switches from dBm to dBm/Hz. The noise marker can switch on/off with a push on the softkey. The submenu All Marker Off can be used to turn off all previous activated markers simultaneously. In addition it's possible to switch off all markers by pushing the softmenu button ALL OFF.

6.9 Peak-Search

The so called Peak-Search key will show the user the display of the next maximum value. The button PEAK SEARCH activates a menu which is used to detect peaks in the trace and assign markers to them:

- **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 before.
- **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 before.
- **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 before.
- **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.
- **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 before.
- **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 HMS series, the upper and lower limit value can be preset by way of limit lines.


Pushing the button LINES will call 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 POSITION 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 POSITION the amplitude value for the lower limit line can be set via the knob.

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 button MEAS opens the measure menu with different options. The softkey CF \Rightarrow RX opens the receiver mode tuned to the actual center frequency. The softkey M1 \Rightarrow RX opens the receiver mode tuned to the actual frequency of marker 1.


The softkey button REFLECTION CAL starts the calibration wizard of the reflection measurement.

 **The reflection measurement menu is only available with HMS1010 and HMS3010.**

To use the wizard, the HAMEG VSWR bridge HZ547 is recommended. 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 is 100 kHz to 3 GHz.

The HMS1010 resp. the HMS3010 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 ge-

nerator (TG) will be switched on automatically, if you don't have activated it already.

 **Before starting the wizard, the user is able to select a trace detector. The selected detector will be used during the measurement.**

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 achieved and the deviation of the device under test to a ZERO measurement will be shown now.

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

The AUTO TUNE button forces the HMS to perform a scan at full span, locate the maximum peak value and center it in combination with applicable RBW and span settings on the display.

The AUTO TUNE function is a comfort function to aid 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

6.13.1 Display layout in receiver mode

By pushing the MODE key the selection menu will be called which allows to switch between sweep mode (analyzer mode) and receiver mode. The spectrum analyzer acts as 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.

6.13.2 Operation in the Receiver-Mode

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 for emi emission measurements according to CISPR (not available for HMS1000E).

Following detectors are available in the receiver mode and can be set with the softkey menu DETECTOR:

- **PEAK:** the peak detector displays the highest level during the set measurement time.

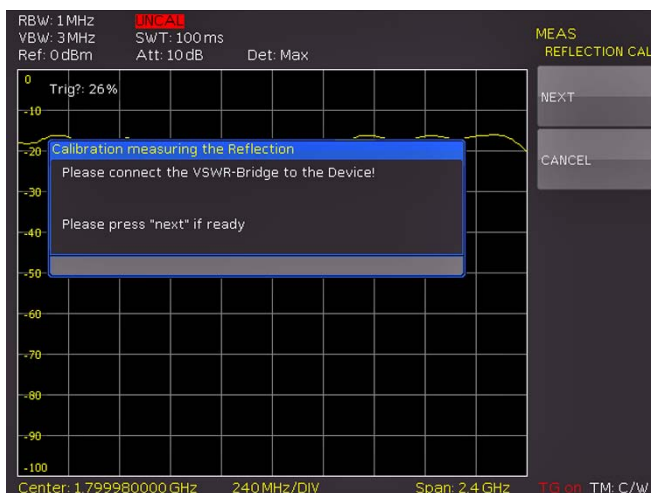



Fig. 6.8: Calibration menu of the VSWR wizard

- **AVG:** the Average detector displays the linear average of the measurement signal within the selected measurement time.
- **QPEAK:** the quasi-peak detector evaluates the measurement signal according to the evaluation curves defined in the CISPR standard (not available for HMS1000E).
- **RMS:** the RMS detector takes the rms value of the measurement signal during the set measurement time.

The key **FREQ** and the softkey **DETECTOR** selects the detector (Peak, RMS, Average and Quasi-Peak). The measurement time is the time during which the spectrum analyzer collects measurements and combines them according to the detector selected for a display.

With the soft menu item **AUDIO** the HMS series offers an AM and a FM demodulator allowing listening to modulated signals. The demodulated signal may be listened to with a headphone and an intern speaker. The headphone is connected to the headphone connector (3.5 mm female connector). If the headphone is activated, the intern speaker will be deactivated. The respective soft menu keys allow to switch the demodulator on or off and to set the volume.

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

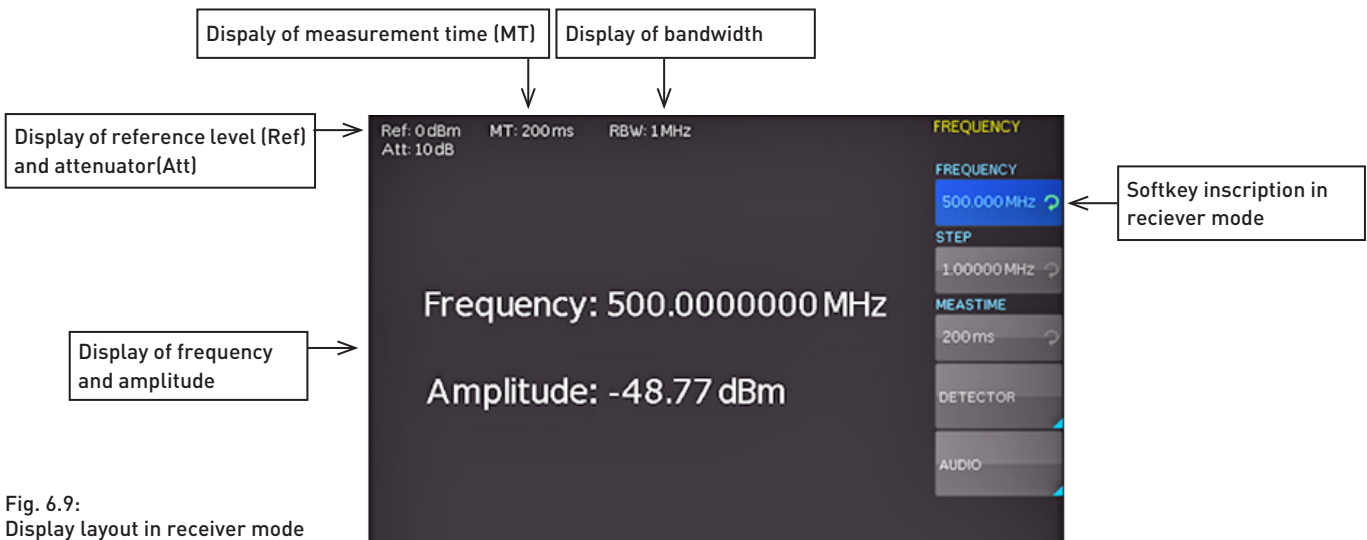


Fig. 6.9: Display layout in receiver mode

7 Store and recall instrument settings

Your spectrum analyzer can store three different kinds of data:

- Instrument settings
- Waveforms
- Screen displays

Waveforms and screen displays can only be stored on USB sticks. Instrument settings can be stored either on a USB stick or in the instrument's non-volatile memories.

7.1 Instrument settings

Push the key SAVE/RECALL for calling the main menu for storage and load functions. First a listing is shown of the kinds of data which can be stored and loaded. By pushing the key next to the top menu item DEVICE SETTINGS this menu will open.

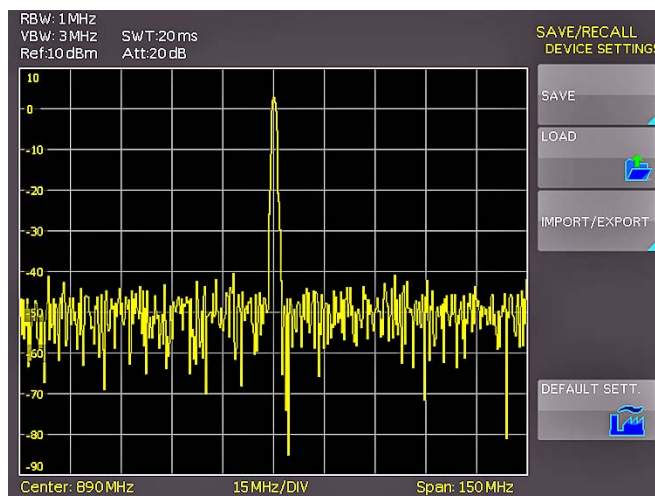


Fig. 7.1: Basic menu for instrument settings

In this menu, by pushing the respective key, it is possible to call the menu for storing, the data manager for loading, and the menu for exporting and importing instrument settings. Additionally, the menu item DEFAULT SETT. will reset the instrument to the factory settings. The storing menu is opened by pushing the SAVE key.

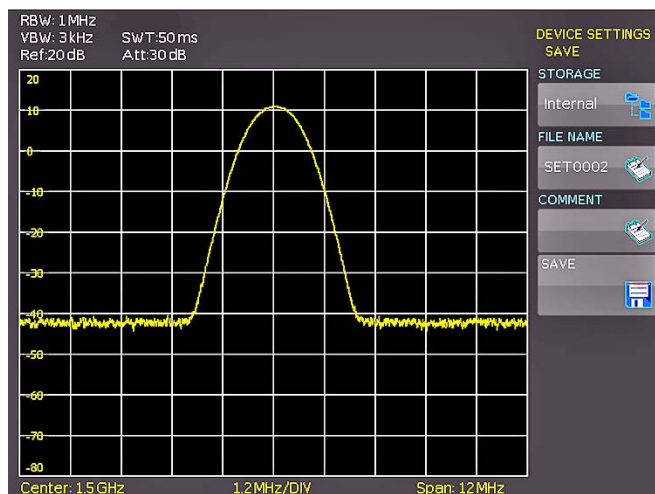


Fig. 7.2: Saving instrument settings

Here the storage location (internal memory, front panel USB, rear panel USB) is selected, also a name and a commentary can be added; these will be stored by pushing the soft menu

key next to SAVE. In order to recall stored instrument settings, call the main instrument settings menu and select LOAD by pushing the respective soft menu key. The data manager will open, use the menu keys and the universal knob for navigating.

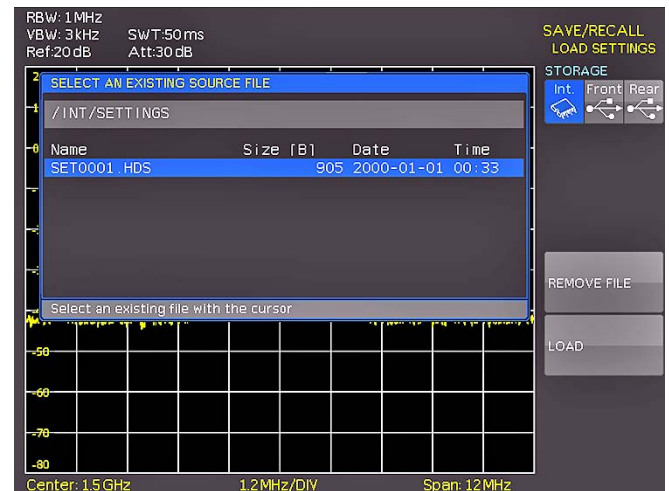


Fig. 7.3: Loading instrument settings

Here the location is selected from which the settings data are to be loaded. After the selection in the data manager, load the settings by pushing the soft menu key LOAD. The data manager also allows you to erase individual settings in the internal memory. If a USB stick is plugged in and has been selected as the location, it is also possible to change or erase directories. In order to export or import instrument settings, a USB stick must be plugged in, otherwise this menu can not be accessed. Provided this is fulfilled, pushing the key next to IMPORT/EXPORT will open a menu allowing to copy instrument settings between the internal memory and a USB stick.

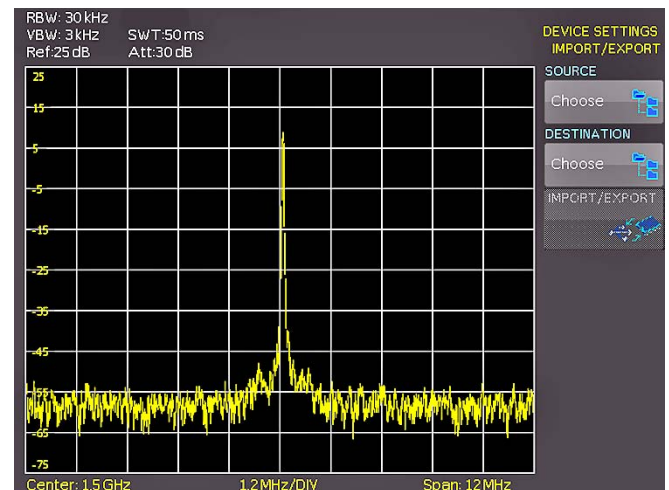


Fig. 7.4: IMPORT / EXPORT menu for instrument settings

The source is selected by pushing the respective key (e.g. INTERNAL), the selection will be indicated by its blue background. Then the destination is selected (e.g. FRONT). By pushing the key next to IMPORT/EXPORT, the selected settings data will be copied as previously chosen (in this example from the internal memory to a USB stick). It is possible to copy from the internal memory to the external memory and also between two USB sticks.

7.2 Waveforms

In addition to references, the waveform data can be stored only on external USB sticks, not internally.

- **HAMEG Binary format:**
A binary data set may contain bytes of any length. The curves will be stored without any time information.
- **CSV (Comma Separated Values):**
CSV data sets store the curves in tables, the lines are separated by commas.
- **TXT data sets** store the trace data in a comma separated list. These data sets differ from CSV files, due to the absence of tabstops and carriage returns.

In order to store waveforms, push the key SAVE/RECALL and select in the main menu the item TRACES by pushing the respective softmenu key.

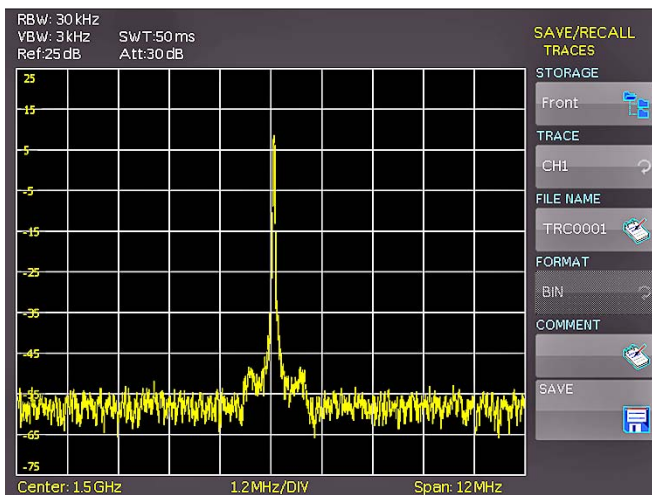


Fig. 7.5: Menu to save a waveform

In this menu which will open, the top item allows the selection of the front or rear panel USB port. This choice is only possible if the instrument recognized a USB stick at the designated port. If a stick is present and the port selection done by pushing the respective soft key, the first time this happens, the data manager will appear with the associated menu. Here, a listing of destinations can be selected or generated. Confirm the selection of the destination listing by pushing OK, this will recall the menu for storing curves. Pushing the soft key next to the second menu item (TRACE) will activate this function as indicated by the blue background.

Pushing the menu key next to FILE NAME will open the menu for entering names: in order to do this first push the CURSOR/SELECT key, then use this menu and the universal knob to enter the desired name which will be stored by pushing ACCEPT. This will recall again the menu for storing waveforms. Now push the soft key FORMAT, this will open a window for selecting the format. The selection is performed again with the universal knob. Additionally, a commentary can be stored along with a curve. This is done by pushing the menu key next to COMMENTARY, this will open a window for the entry. After entering the commentary and storing it by pushing ACCEPT, again the menu for storing curves will appear. After completion of all these entries, pushing the menu key next to STORE will store the curve according to the selected settings.

7.3 Screenshots

The most important method of storing for documentation purposes is the screen photo. At least one USB stick must be connected, only then will any settings regarding the destination and the format be possible. Push the keys SAVE/RECALL and SCREENSHOTS for opening the appropriate menu.

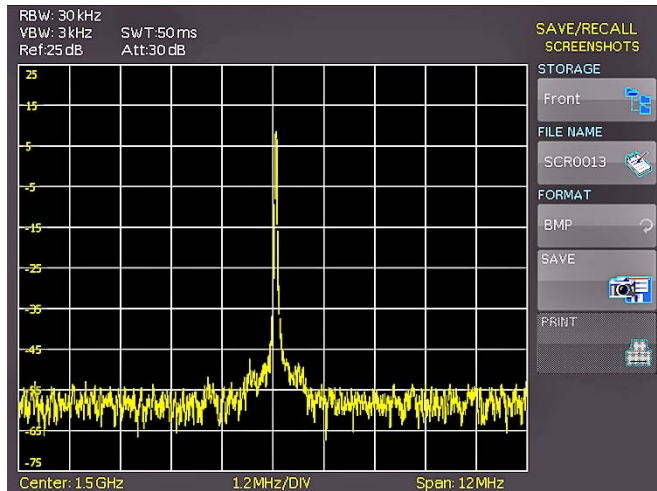


Fig. 7.6: Menu for screenshots

Also in this menu the destination (according to the USB sticks connected) can be selected with the top menu key. When this is done the first time, the data manager will appear in order to either select or generate a destination listing. After the entry of this information, the SCREENSHOTS storing menu will reappear. The second menu item FILE NAME allows you to enter a name with the respective name entry menu which will open automatically upon selecting this menu item. If FORMAT is selected with the respective menu key, these formats will be offered and can be selected with the universal knob: BMP = Windows Bitmap (uncompressed format) and GIF. Pushing the key next to SAVE will store the actual screen display along with the name and format at the destination selected.

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.

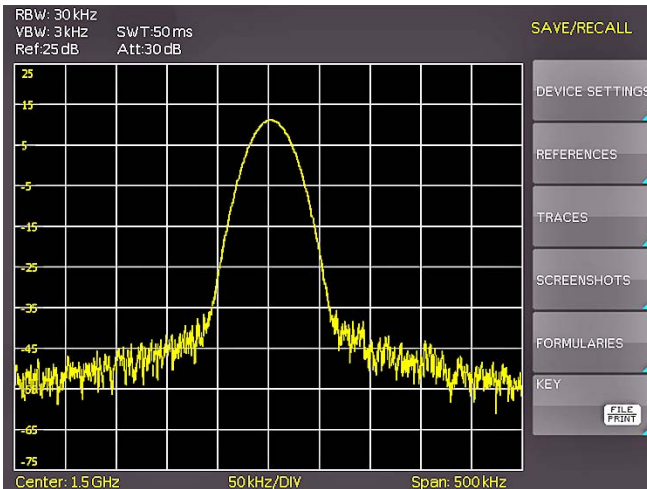


Fig. 7.7: Save/Load menu

Select the kind of data by pressing the respective soft key (in this example SCREENSHOTS) in order to access the settings menu.

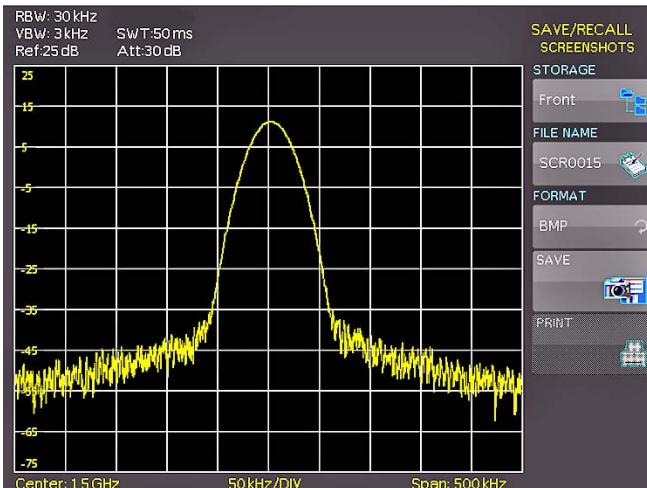


Fig. 7.8: Menu with the settings for screenshots

Please verify that the USB connector into which you plugged the USB stick (front or rear) is written in the top softmenu (you can

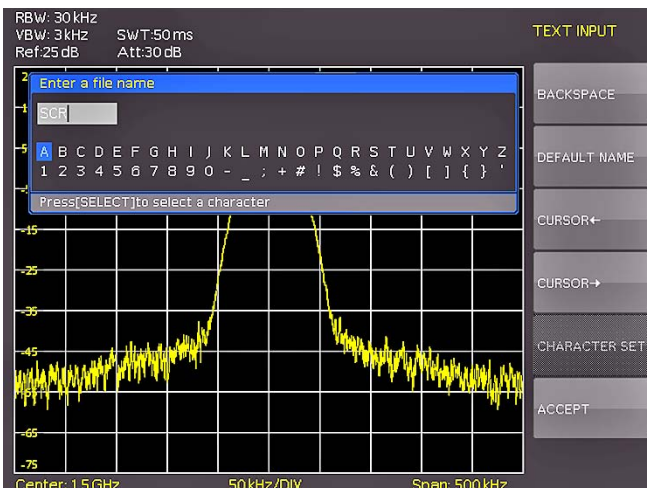


Fig. 7.9: Defining file names

change the destination by opening the respective menu if you press the softkey next to STORAGE). You can now save a Screenshot if you press the softkey next to 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 item FILE NAME and define the name by using the knob and the CURSOR SELECT key (in this example PRINT).

After the softkey next to ACCEPT was pressed the oscilloscope will have stored the name and return to the settings menu. Here you can now store the actual screen display by pressing the SAVE softkey. Alternatively, you can return to a lower menu level (by pressing the lowest Menu OFF key) and select the menu item key FILE/PRINT. In the following menu press the soft menu key next to SCREENSHOTS: this will assign the function screenshot to the key FILE/PRINT with the settings chosen. This enables you to store a bitmap file on your USB stick by just pressing FILE/PRINT at any time and in any menu.

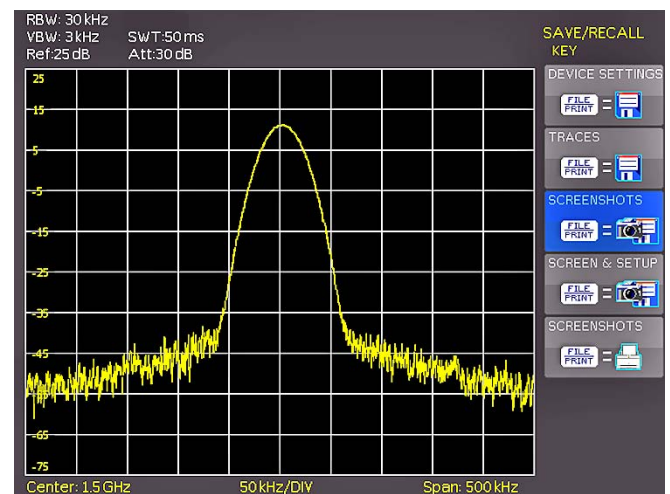


Fig. 7.10: Settings of the button FILE/PRINT