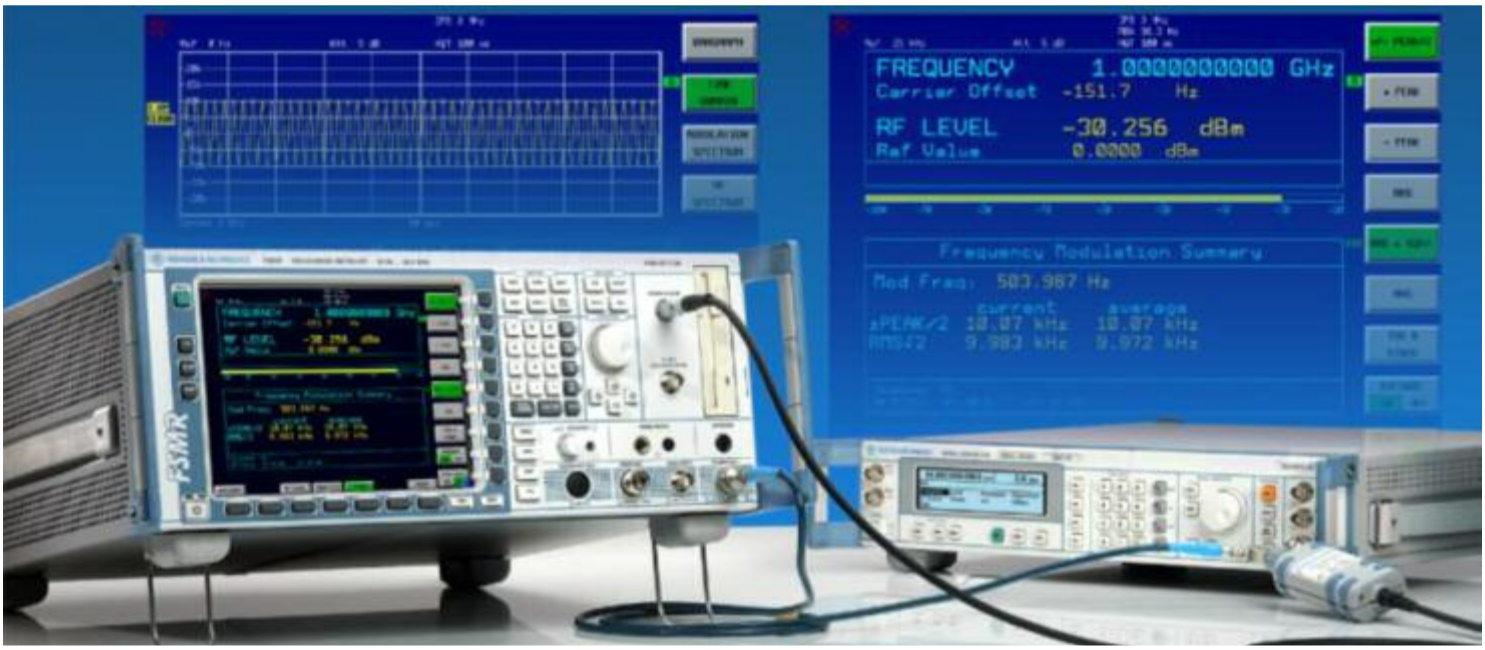


Product: Measuring Receiver FSMR

Measurement Examples with the Measuring Receiver R&S FSMR

Product Note

This product note provides information about the basic measurement setups. Measurement examples show the practical realisation of measurements like RF Power, Tuned RF Level and Demodulation. Some hints for low power measurement are given.

ROHDE&SCHWARZ

Contents - "Getting Started"

1 Getting Started

This chapter provides a fast introduction to operation by guiding the user step by step through measurement examples .

Before starting any measurement with the FSMR, please note the instructions given in chapter 1 of the users manual for putting the instrument into operation. In chapter 3 you will find detailed information on customizing the instrument and the display.

For a systematic explanation of all menus, functions and parameters and background information refer to the reference part in chapter 4.

Instrument overview

The R&S FSMR is a very versatile instrument that combines many measurement capabilities required for calibration, troubleshoot and development into a single box instrument. The following functions are included:

- **RF Power Meter**, for highest accuracy RF power measurement.
- **RF Level Meter**, for measurements of low level signals.
- **Modulation Analyzer**, for AM/FM and φM modulated signals.
- **Audio Analyzer**, for Audio Signal level and distortion, using the Audio input.
- **Frequency Counter**, fastest frequency measurements with „mHz“-resolution.
- **Spectrum Analyzer**, for high performance spectral analysis capabilities.

The R&S FSMR still offers an easy-to-use operation which does not require expert knowledge to perform the basic measurements.

This product note is designed to explain the functions and operation of the Measuring Receiver R&S FSMR. In the following descriptions, each step is explained in detail so that the instrument can be immediately used without the need for learning all of the available functions.

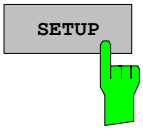
Setup the instruments

Most of the following examples use the same test setup. To perform the measurements, in addition to the Measuring Receiver R&S FSMR a signal generator and a power sensor is required. The examples in this paper will require a single, stable RF test signal at lower RF frequencies (for example 100 MHz). The generator shall offer analog modulation capabilities (at least AM modulation) at a variable modulation rate from 1 kHz to 3 kHz and 30 % modulation depth.
For the audio measurement examples a LF generator is required. Most of the R&S signal generators are equipped with a modulation generator which is sufficient for these measurements (for example R&S SML, R&S SMIQ).
The power sensor used in the examples shall be one of the sensors from the R&S NRP series. There are many different sensors available, a terminating average power sensor will best fit to the requirements (for example R&S NRP-Z21)

Select the Preset state

All of the following examples assume the standard settings for the measuring receiver. These are set with the *PRESET* key. The *PRESET* must be set to Factory default values and measuring Receiver Mode.

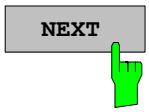
Check the *PRESET* setting with the following steps:



1. *Define Preset instrument mode*

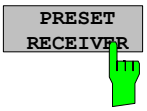
➢ *Press the SETUP key.*

The setup menu is opened.



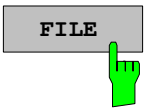
➢ Press the menu change key *NEXT*.

The submenu is opened.



➢ *Press the PRESET RECEIVER softkey.*

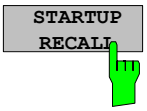
The following presets will force the instrument into the Measuring Receiver mode.



2. *Define the Startup Recall*

➢ *Press the FILE key.*

The file menu is displayed.



➢ *In the FILE menu press the STARTUP RECALL softkey.*

A table with available instrument recall states is displayed.

➢ *In the STARTUP table, highlight the entry named "FACTORY" and enable it with the Enter key as STARTUP RECALL.*

3. *Reset the instrument.*

➢ *Press the PRESET key.*

The main receiver menu is opened.The receiver mode is set.

Fig.1-1 Display after selecting the default setup in receiver mode

The main default parameters are listed in the following table:

Table 1-1 Default parameters after preset in measuring recveiver mode

Parameter	Parameter Name	Value
Receiver frequency	Frequency	100 MHz
Reference Level	Ref Level	Manual -20 dBm
RF attenuation	RF ATT	Auto
Preamplifier	Preamp	Off
Demodulation	Demod	FM
Detector	Det.	+/- peak/2
Measurement time	Meas Time	100 ms
Trigger	Trigger	Free run

Measurement Examples

All of the following examples assume the standard settings for the measuring receiver. These are set with the *PRESET* key
The described measurement applications are:

- Measurement of the RF power of a signal using the Power Meter mode.
- Measurement of low level signals using the Tuned RF Level mode.
- Measurement of AM modulated signals and modulation distortion with the Modulation Analyzer mode.
- Measurement of audio signals with the Audio Analyzer mode.

Example 1: RF Power Measurements with a Power Sensor

Measurement

The FSMR includes a power meter functionality. Measurements of RF Power will be performed in the power meter mode with highest accuracy. The FSMR will automatically handle all required correction factors and compensate the measurements. The FSMR does support the following Rohde&Schwarz power sensors:

- R&S NRP-Z11 10 MHz to 8 GHz / 200 pW to 200 mW
- R&S NRP-Z21 10 MHz to 18 GHz / 200 pW to 200 mW
- R&S NRP-Z51 DC to 18 GHz / 1 uW to 100 mW
- R&S NRP-Z55 DC to 40 GHz / 1 uW to 100 mW

Main Receiver Functions

The power meter functions are available in the Measuring Receiver *POWER METER*-mode. All required settings and evaluations can be reached from the POWER METER main menu.

Measurement Setup

Fig.1-2 RF Power measurement setup

The following settings are used on the generator:

1. *PRESET* the generator.
2. Set RF Frequency to 1 GHz.
3. Set the output level to 0 dBm.

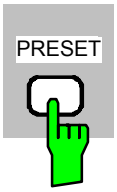
Measurement Sequence – RF Power Measurements

Connect the Power sensor with the Signal Generator output and with the Measuring Receiver power sensor connector on the front panel.

The following steps are performed:

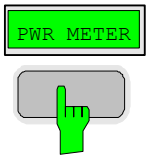
1. Zero the power sensor.
2. Connect the power sensor to the DUT.
3. Set the RF frequency.
4. Measure the RF Power

1. Zero the Power Sensor



- ***Reset the instrument.***
- *Press the PRESET key.*

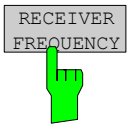
The main receiver menu is opened. The receiver mode is set.



Switching to Power Meter Mode

- *Press the PWR METER hotkey.*

The power meter menu is displayed.

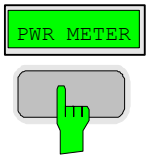


Set the measuring frequency

- Press the *FREQ* key on the front panel.

  The measuring receiver frequency menu is displayed.
- In the frequency menu press the *RECEIVER FREQUENCY* softkey.

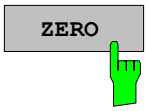
  The frequency entry is displayed. Enter the measuring frequency with the number keys and the appropiate unit key. The frequency will be used by the instrument to calculate the calibration factors for the power sensor head.
- In the RECEIVER FREQUENCY entry window key in "*1000 MHZ*".



Zero the power sensor

- Press the *PWR METER* hotkey.

  The power meter menu is displayed.



- In the POWER METER menu press the *ZERO* softkey.

- In the message box, confirm CONTINUE and press ENTER.

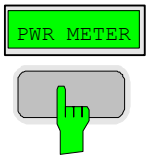
  The zeroing of the sensor will be performed.

After the zeroing is completed, a message will appear on the screen.

Fig.1-3 RF power measurement after Zeroing

2. Measure the RF power in Watt

Connect the power sensor to the signal generator RF output



Linear display – Change the Unit to Watt

- Press the *PWR METER* hotkey.

  The POWER METER menu is displayed.

- In the POWER METER menu press the *DISPLAY LOG / LIN* softkey.

  The RF power unit is changed from dB to Watt.

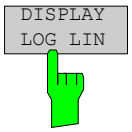


Fig.1-4 RF power measurement in UNIT Watt

Example 2: Low RF Level Measurements with Tuned RF Level Mode

Measurement

The main functionality of a measuring receiver is the RF level measurement. Measurements of low power RF signals will be performed in the Tuned RF Level mode with highest accuracy. The FSMR will automatically handle all required settings.

Main Receiver Functions

The measurement of RF levels over a wide input level range is performed in three different level ranges. To reach the highest possible accuracy, a calibration is performed with a power sensor. The FSMR does offer fully automated calibration procedures in the Tuned RF Level mode. The following example will guide through the calibration steps. All functions for Tuned RF level measurements can be reached from the RF LEVEL main menu.

Measurement Setup

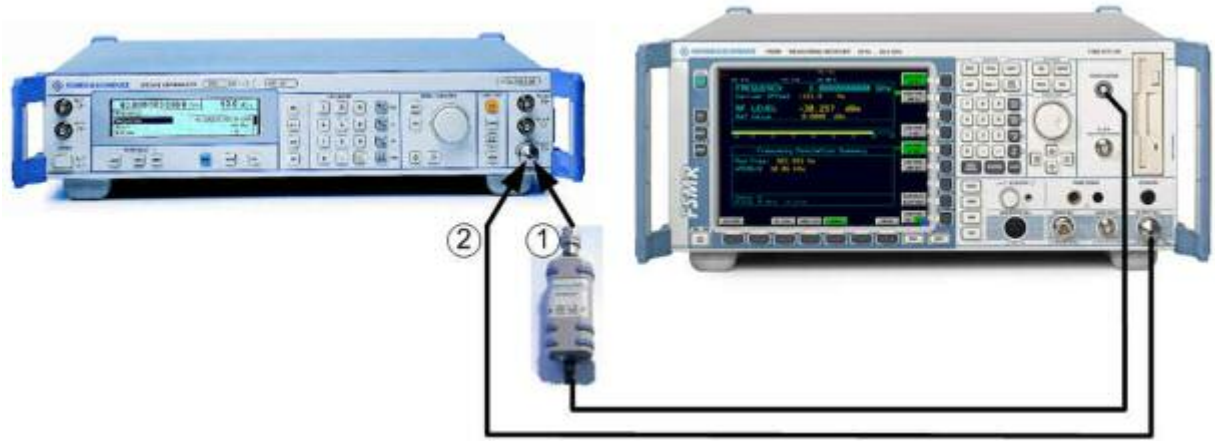


Fig.1-5 Tuned RF Level measurement setup

The following settings are used on the generator:

1. *PRESET* the generator.
2. Set RF Frequency to 300 MHz.
3. Set the output level to 0 dBm.

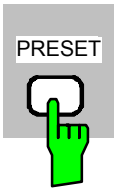
Measurement Sequence – Tuned RF Level Measurements

Connect the Power sensor with the Signal Generator output and with the Measuring Receiver power sensor connector on the front panel.

The following steps are performed:

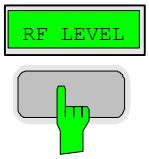
1. Calibrate the FSMR with the power meter.
2. Change the output level and perform further Range calibrations.
3. Average the results for enhanced stability.
4. Measure an unstable source (unstable frequency)

1. Calibrate the setup- absolute power calibration



- ***Reset the instrument.***
- *Press the PRESET key.*

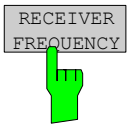
The main receiver menu is opened. The receiver mode is set.



Switching to Tuned RF Level Mode

- *Press the RF LEVEL hotkey.*

The Tuned RF level menu is displayed.



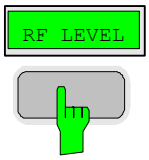
Set the measuring frequency

- Press the *FREQ* key on the front panel.

  The measuring receiver frequency menu is displayed.
- In the frequency menu press the *RECEIVER FREQUENCY* softkey.

  The frequency entry is displayed. Enter the measuring frequency with the number keys and the appropiate unit key.
- In the RECEIVER FREQUENCY entry window key in "*300 MHZ*".

Connect the power sensor to the signal generator RF output



Calibrate the Tuned RF Level – Absolute Power calibration

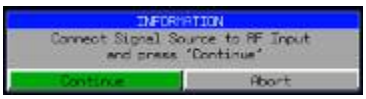
- Press the *RF LEVEL* hotkey.

  The RF LEVEL menu is displayed.
- In the RF LEVEL menu press the *CAL ABS POWER* softkey.

The calibration of the receiver will be performed. A message box with instructions about the setup appears. The first step is a power measurement with the power sensor connected to the source.

- In the message box, confirm CONTINUE and press ENTER.

  In the next step of the calibration the receiver is connected to the source.



- ***Connect FSMR RF input to the signal generator RF output***
- In the next message box, confirm CONTINUE and press ENTER.

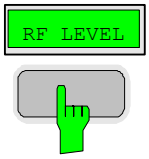
The FSMR is now calibrated in one RF level range (the upper level range does handle RF levels from -10 dBm to +30 dBm). Measurements in this level range can now performed with full accuracy.

Fig.1-6 Tuned RF Level measurement after calibration

2. *Range to range calibration- relative calibration*

Change the signal generator output level

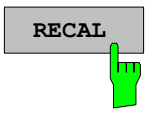
- The following settings are used on the generator:
  Change the signal generator RF Level in 1 dB steps down. Observe the FSMR screen for the yellow RECAL message to appear (at levels about -10 dBm). This is the point where the automated Range-to-Range calibration can be performed.



The FSMR is now ready for a RF level range change. The calibration of the level difference due to the range change will be performed.

- Press the *RF LEVEL* hotkey.

  The RF LEVEL menu is displayed.



- In the RF LEVEL menu press the *RECAL* softkey.

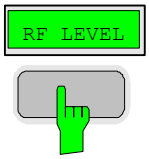
  The RECAL procedure is performed. Do not change any signal generator settings at this time.

A message box appears. The instrument will perform a measurement in the calibrated range, then change the RF settings (RF attenuator, IF gain) and then measure again. After the recalibration measurements with high accuracy are available in the RF level range 2 (covers levels from -10 dBm to -50 dBm).

Change the signal generator output level further down

➢ The following settings are used on the generator:

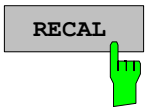
Change the signal generator RF Level in 10 dB steps down. Observe the FSMR screen for the yellow RECAL message to re-appear again (at levels about -50 dBm).



As soon as the RECAL flag appears, the FSMR is ready for a next RF level range change. The calibration of the level difference due to the range change will be performed.

➢ Press the RF LEVEL hotkey.

The RF LEVEL menu is displayed.



➢ In the RF LEVEL menu press the RECAL softkey.

The RECAL procedure is performed.

A message box appears. The instrument will perform a measurement in the calibrated range, then change the RF settings (RF attenuator, IF gain) and then measure again. After the recalibration measurements with high accuracy are available in the RF level range 3 (covers levels from -50 dBm to noise level).

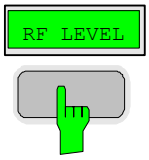
The FSMR is now calibrated in all RF level ranges (for RF levels from -140 dBm to +30 dBm). Measurements in all level ranges can now be performed with full accuracy. No further calibration is required, the Autorange function will automatically adapt the level setting of the FSMR to the input signal.

Fig.1-7 Tuned RF Level measurement at low levels

3. Average the results for enhanced stability

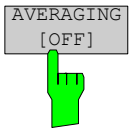
Change the signal generator output level further down

➢ The following settings are used on the generator:
Change the signal generator RF Level to -110 dBm).



The FSMR is now performing a calibrated measurement at – 110 dBm. The reading will be flickering due to a low signal to noise ratio. For a more stable reading, the FSMR does offer several functions.

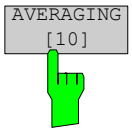
The stability of a low level measurement is mainly depending on the measurement time. A longer acquisition of the signal does allow for a more accurate measurement. The averaging of several single acquisitions will lead to an effective longer measurement time.



➢ Press the RF LEVEL hotkey.

The RF LEVEL menu is displayed.

➢ In the RF LEVEL menu press the AVERAGE softkey.



The AVERAGE will be switched on. The number off measurements can be entered in the AVERAGING COUNT box which appears on top of the screen. The default value is set to 10 Averages.

The instrument will now perform an averaged measurement. The average function is a floating average over the number of measurements chosen with the Average Count entry (default value: 10).

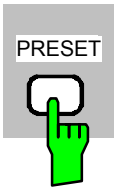
Fig.1-8 Tuned RF Level measurement with Averaging

4. Measure an unstable source (unstable in frequency)

The simulation of unstable sources requires a signal which is unstable in the frequency domain. This signal can be simulated with active frequency modulation on the signal generator.

➢ The following settings are used on the generator:

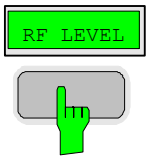
1. *PRESET* the generator.
2. Set RF Frequency to 100 MHz.
3. Set the output level to 0 dBm.
4. Select FM Modulation, 3 kHz deviation.
5. Set the Modulation frequency to 1 kHz.



➢ Reset the instrument.

➢ Press the PRESET key.

The main receiver menu is opened. The receiver mode is set.

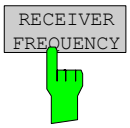


Switching to Tuned RF Level Mode

➢ Press the RF LEVEL hotkey.

The Tuned RF level menu is displayed.

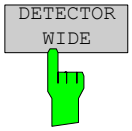
Set the measuring frequency



➢ In the RF LEVEL menu press the RECEIVER FREQUENCY softkey.

The frequency entry is displayed. Enter the measuring frequency with the number keys and the appropriate unit key.

➢ In the RECEIVER FREQUENCY entry window key in “100 MHZ”.



The measurement of an unstable signal requires the measuring receiver to use a wide bandwidth. The FSMR offers a wideband detector mode to acquire wideband signals with high accuracy

➢ In the RF LEVEL menu press the DETECTOR WIDE softkey.

The wideband detector mode acquire signals with the full acquisition bandwidth. The acquisition bandwidth (DEMOD BW) of the FSMR can be set in the BW menu, the preset value is 12.5 kHz. The bandwidth must be set wide enough to capture the maximum frequency deviation of the input signal. In this example, the frequency deviation is set to 3 kHz and the default bandwidth is 12.5 kHz.

Note: The wideband detection is not only suitable for unstable signals, it can also be used to accurately measure modulated signals

Next steps:

The following steps will be performed as described in the previous example (Tuned RF Level).

Example 3: AM Modulation and Modulation Distortion Measurements

Measurement

The FSMR includes a modulation analyzer. Measurements like AM, FM or PM modulation will be performed in the modulation analyzer mode. The instrument offers standard measurements like modulation depth, deviation and modulation frequency, but also more sophisticated function like modulation distortion or audio frequency response are available.

Main Receiver Functions

The modulation analyzer functions are available in the Measuring Receiver *DEMOD*-mode. All required settings and evaluations can be reached from the DEMOD main menu.

Measurement Setup

Fig.1-9 AM modulation measurement setup

The following settings are used on the generator:

1. *PRESET* the generator.
2. Set RF Frequency to 100 MHz.
3. Set the output level to - 30 dBm.
4. Select the AM Modulation, 30% modulation depth.
5. Set the Modulation frequency to 1 kHz.

Measurement Sequence – AM Modulation Measurements

Connect the Signal Generator output with the Measuring Receiver RF Input.

The following measurement steps are performed:

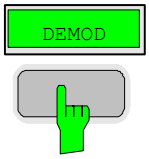
1. Measure the AM modulation depht.
2. Relative Audio measurements
3. Measure the Total harmonic distortion in %.

1. Measure the AM modulation depth

➢ ***Reset the instrument.***

➢ *Press the PRESET key.*

The main receiver menu is opened. The receiver mode is set.

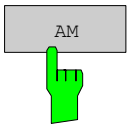


Switching to AM demodulation

➢ *Press the DEMOD hotkey.*

The analog demodulation menu is displayed.

➢ *In the DEMOD menu press the AM softkey.*



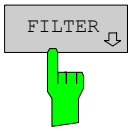
The modulation frequency and the AM modulation depth with peak detection measurement results are displayed in the lower window of the screen. The upper window shows the RF Frequency and the RF input level.

Limiting the bandwidth - Audio Filters

➢ Press the *DEMOD* hotkey.

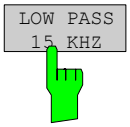
The analog demodulation menu is displayed.

➢ In the DEMOD menu press the *FILTER* softkey.



The audio filter menu is displayed. To suppress unwanted broadband noise or harmonics of the demodulated signal, the bandwidth of the measurement can be limited with highpass and lowpass filters.

➢ In the FILTER menu press the *LOW PASS 15 KHZ* softkey.



The following screen is displayed:

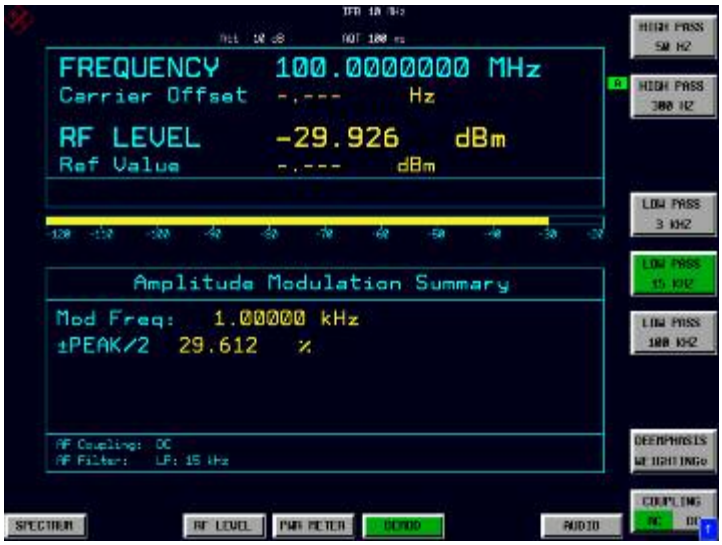
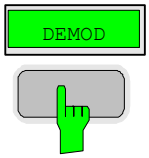


Fig.1-10 AM Modulation measurement in the *DEMOD* mode

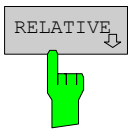
➢ ***In the FILTER menu press the LOW PASS 15 KHZ softkey again to switch the filter off.***



2. Relative Audio measurements – audio frequency response

➢ Press the *DEMOD* hotkey.

The analog demodulation menu is displayed.



➢ In the DEMOD menu press the *RELATIVE* softkey.

The RELATIVE menu is displayed.In the relative menu, only the detectors which have been switched on in the DETECTOR menu are available for relative measurements.

➢ In the RELATIVE menu press the *RELATIVE DB %* softkey.

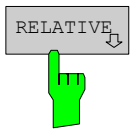
The actual measurement value of the detector will be saved as a reference value and the result display will change to a relative reading (indicated with Δ 0.00 %).

Change the modulation frequency to 50 kHz

➢ The following settings are used on the generator:

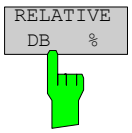
1. Select the AM Modulation, 50 kHz modulation frequency.

Relative display – Change the Unit to dB



➢ Press the *DEMOD* hotkey.

The analog demodulation menu is displayed.



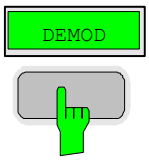
➢ In the DEMOD menu press the *RELATIVE* softkey.

The RELATIVE menu is displayed.

➢ In the RELATIVE menu press the *+- PEAK/2* softkey.

The actual result display will change from a relative reading indicated in % to a dB reading.

Fig.1-11 Relative measurement in the demod mode

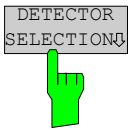


3. *Measure the harmonic distortion - Choosing the detector*

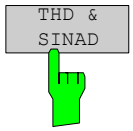
➢ Press the *DEMOD* hotkey.

➢ In the DEMOD menu press the *DETECTOR SELECTION* softkey.

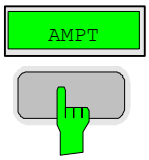
The DETECTOR SELECTION menu is displayed



The instrument is equipped with a wide range of detectors for measuring modulation signals. The peak detectors are a good choice for capturing the highest positive or negative peak within the measurement time, while the RMS and Average detectors are the best choice for measuring noise and residual modulation. The THD & SINAD detector measure the distortion of the demodulated audio signal. All detectors can be used in parallel.



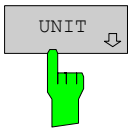
➢ In the DETECTOR SELECTION menu press the *THD & SINAD* softkey.



Total Harmonic Distortion – Change the Unit to %

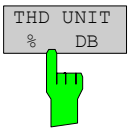
➢ Press the *AMPLITUDE* hardkey on the frontpanel.

The amplitude settings menu is displayed.



➢ In the AMPLITUDE menu press the *UNIT* softkey.

The measuring receiver UNIT menu is displayed.



➢ In the UNIT menu press the *THD UNIT % / DB* softkey.

The actual result display for the THD measurement will change from a “DB” reading to a “%” reading.

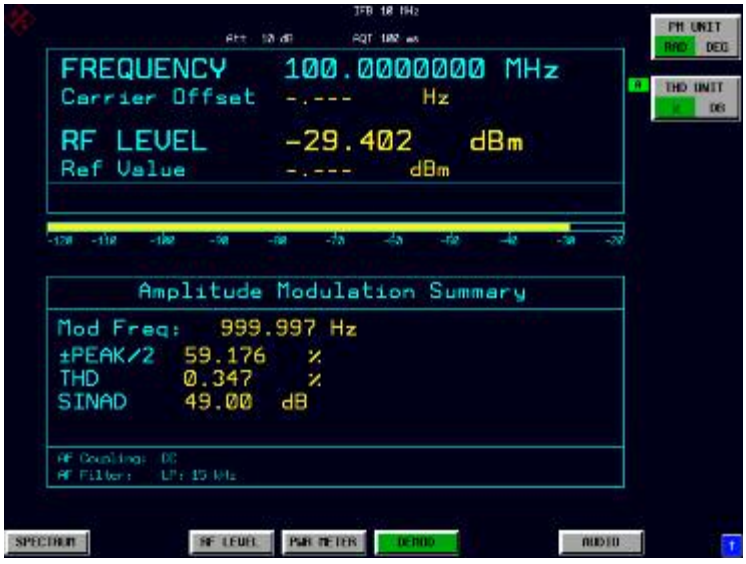


Fig.1-12 THD measurement in UNIT %

Example 4: Audio Measurements with the Audio Analyzer mode

Measurement

The FSMR includes an audio analyzer functionality. Measurements of audio signals will be performed in the audio analyzer mode with highest accuracy. The FSMR will automatically handle all required settings.

Main Receiver Functions

The audio analyzer functions are available in the Measuring Receiver *AUDIO*-mode. All required settings and evaluations can be reached from the AUDIO main menu.

Measurement Setup

Fig.1-13 Audio measurement setup

➢ ***Connect the signal generator LF (low frequency) output with the FSMR Audio input.***

The following settings are used on the generator:

1. *PRESET* the generator.
2. Set LF output to ON .
3. Set the LF output level to 1 volt.
4. Set the LF output frequency to 1 kHz.

Measurement Sequence – Audio Measurements

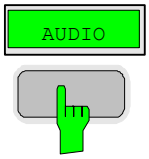
The following steps are performed:

1. Measure the audio level and frequency.
2. Measure the frequency response of the audio filters.
3. Measure the influence of the input impedance.

➢ ***Reset the instrument.***

➢ *Press the PRESET key.*

The main receiver menu is opened. The receiver mode is set.



Switching to Audio Mode

➢ *Press the AUDIO hotkey.*

The audio menu is displayed. The audio measurement results are displayed in parallel, no further settings like frequency is required.

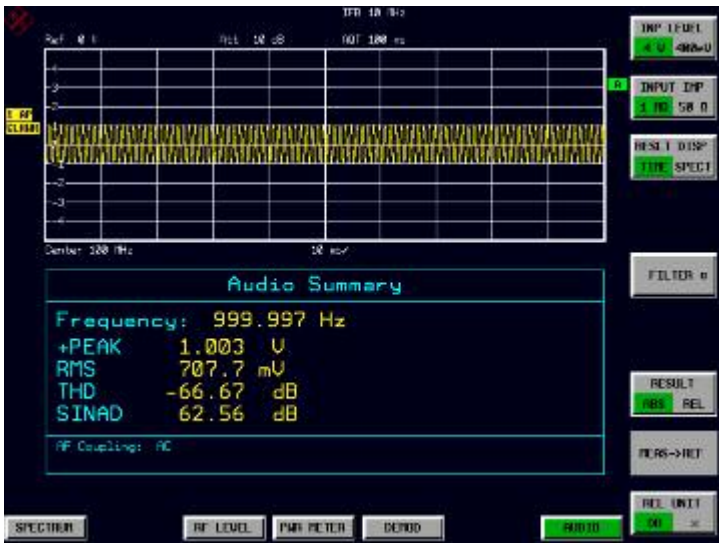
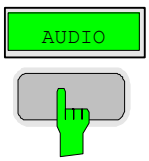
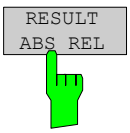


Fig.1-14 Audio measurement after Preset, Mode Audio





4. Relative Audio measurements

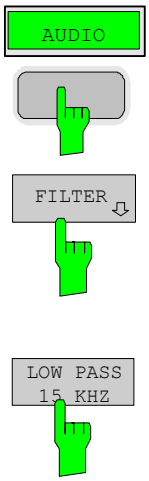
➢ Press the *AUDIO* hotkey.

The audio menu is displayed.

➢ In the AUDIO menu press the *RESULT ABS REL* softkey.

The relative measurement function is enabled.

The actual measurement value of the detector will be saved as a reference value and the result display will change to a relative reading (indicated with Δ 0.00 dB). The unit can be changed with the *REL UNIT DB %* softkey in the audio menu.



Limiting the bandwidth - Audio Filters

➢ Press the *AUDIO* hotkey.

The audio menu is displayed.

➢ In the AUDIO menu press the *FILTER* softkey.

The audio filter menu is displayed. To suppress unwanted broadband noise or harmonics of the signal, the bandwidth of the measurement can be limited with higpass and lowpass filters.

➢ In the FILTER menu press the *LOW PASS 15 KHZ* softkey.

Change the LF output frequency to 15 kHz

The following settings are used on the generator:

- Set the LF output frequency to 15 kHz.

The audio frequency is now changed to the bandwidth of the active 15 kHz low pass filter. In the following measurement the frequency response of the audio low pass filter is measured.

Fig.1-15 Audio measurement in relative mode