

Measuring Receiver R&S®FSMR

Single, compact instrument for calibrating signal generators

The new Measuring Receiver R&S®FSMR (FIG 1) is the first instrument to combine a wide variety of functions for signal generator calibration in a single, compact instrument. Featuring excellent characteristics in measurement accuracy and measurement speed, it is ideal for use in calibration labs as well as for mobile applications.

Complete calibration test setup in one instrument

One of the primary tasks when calibrating signal sources or attenuators is the highly accurate measurement of RF power traceable to calibration standards. Although power meters are best suited for this purpose, their intrinsically limited dynamic range only allows precise measurements of relatively high levels. Very low levels, wide dynamic range or high attenuation require frequency-selective methods.

Rohde & Schwarz has now introduced an instrument with outstanding characteristics for calibrating signal generators and attenuators – the Measuring Receiver R&S®FSMR. With a maximum upper frequency limit of 50 GHz, it is the first solution to combine a wide range of different equipment in a single, compact measuring instrument:

- ◆ High-precision measuring receiver
- ◆ Power meter
- ◆ Modulation analyzer
- ◆ High-end spectrum analyzer

The Measuring Receiver R&S®FSMR is based on the spectrum analyzers of the R&S®FSU [1] family. To ensure highly accurate level measurements, all components that may cause level error or level drift are systematically switched off or bypassed in the measuring receiver mode. Demodulating analog-modulated signal sources via digital signal processing has long been possible with the spectrum analyzers from Rohde & Schwarz. High-precision power measurements are performed by using a power sensor from the R&S®NRP family that is connected directly to the receiver. An audio input for frequencies up to 1 MHz complements the scope of functions. The conventional image of a test setup consisting of multiple instru-



FIG 1
Test setups consisting of multiple instruments for signal generator calibration have become a thing of the past. The compact R&S®FSMR contains all functions for high-precision calibrations.

ments for signal generator calibration has become a thing of the past. The R&S®FSMR's minimum space requirements, compact design and low weight also make it ideal for mobile use.

Measurement uncertainty at the limits of verification

Highly accurate level measurements across a wide dynamic range are definitely one of the most demanding measurement tasks when calibrating signal generators and attenuators. Apart from a measuring receiver, you previously needed additional downconverters and generators. The R&S®FSMR makes these setups unnecessary. Depending on the model, its RF input seamlessly covers the frequency range from 20 Hz to 3.6 GHz, 26.5 GHz or 50 GHz; all necessary converters are already integrated in the instrument.

Modern signal generators provide output levels of +10 dBm to -130 dBm, which must be accurately measured by the receiver. Power sensors undoubtedly yield the most precise measurement results; however, their wide bandwidth limits their use to levels above approx. -50 dBm. At lower levels, you have to use a frequency-selective measuring receiver whose absolute level error is corrected by a power meter. The measurement bandwidth and the noise figure of the receiver determine the lower measurement limit of the level measurement; the measurement error mainly depends on the display linearity of the receiver. The R&S®FSMR digitizes the input signal after it has been converted to the IF by means of a fast A/D converter. A patented dither method from Rohde & Schwarz ensures extremely high linearity of the digital IF signal. Further processing such as IF filtering, logarithmic conversion or power calculation is purely digital in ASICs so that virtually no additional measurement errors occur.

The measuring receiver achieves its full dynamic range by automatically switching the measurement range and correcting the resulting error by again referencing to the power meter (FIG 2).

Three measurement ranges and early switchover at good signal-to-noise ratios enable the R&S®FSMR to achieve virtually constant measurement accuracy across the entire measurement range

Level measurement procedure with adjacent-range calibrations



FIG 2a If no absolute calibration has been performed, the R&S®FSMR activates the red UNCORR field to warn you that the measurements may be inaccurate.



FIG 2b After absolute calibration with the power meter, the measuring receiver is ready for high-precision level measurements, which is indicated via the green CORR field.

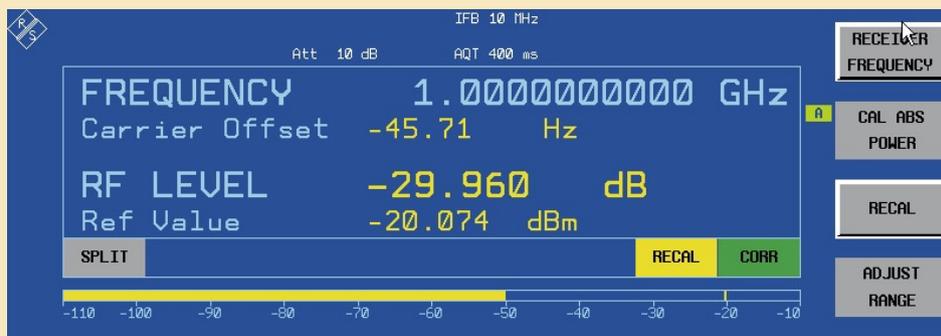


FIG 2c If the level is changed and the measurement range limits have been reached, the R&S®FSMR activates the yellow RECAL field to inform you that you need to calibrate the adjacent range.

- ▶ (>140 dB) (FIG 3). You can verify the measurement accuracy by using, for example, calibrated attenuators whose attenuation is traceable to national standards. Rohde & Schwarz offers the Calibration Kit R&S®FSMR-Z2 for this purpose; it consists of several attenuators certified by the German Standards Laboratory (PTB).

Modulation measurements and audio analysis

The calibration of a signal generator usually also requires extensive measurements of analog modulation parameters such as AM, FM and ϕ M and their distortion such as signal-to-noise and distortion (SINAD) or total harmonic distortion (THD). In addition to the modulation parameters of the RF signal, the quality of the modulation signal (audio signal) has to be measured. To make this possible, the R&S®FSMR comes with a complete modulation analyzer [2]. The receiver measures either the demodulated RF signal or the AF signal at the high-impedance audio input. Its digital demodulation of the input signal ensures unprecedented accuracy and flexibility – special calibration signals are not required. All common filters (highpass and lowpass filters), detectors (+peak, –peak, RMS, AVG) and deemphasis are available for audio analysis. Modulation distortion is simultaneously measured as THD and SINAD; tuning to the fundamental frequency is performed automatically within the measurement bandwidth.

The modulation analyzer in the R&S®FSMR offers a wide variety of straightforward result displays (FIG 4). In addition to displaying pure numeric values, you can also choose between time-domain display (FIG 5) and spectral display of the modulation signal. Several consecutive results can also be averaged.

High-end spectrum analyzer

To calibrate signal generators, the frequency and level as well as the spectral purity of the output signal (phase noise, harmonics) must be determined. These measurements call for a high-end spectrum analyzer, which the Measuring Receiver R&S®FSMR already includes. It is based on the tried-and-tested R&S®FSU family of instruments, which offers a wide variety of functions and technical features.

Maximum flexibility, yet easy to operate

Instruments with a wide variety of functions pose a challenge for the operating concept. The R&S®FSMR provides a very good solution: You can always directly access its main operating modes via hotkeys at the bottom of the screen. This makes menu structures flat and allows you to almost always access important settings via the main menu. Operating the R&S®FSMR is thus very similar to operating a conventional instrument with function keys on the front panel.

The R&S®FSMR automatically uses the optimum settings for each measurement. However, you are free to configure everything manually to ensure the maximum possible measurement accuracy for specific tasks. This flexibility is required, for example, when calibrating signal generators with large residual FM where a wider measurement bandwidth is necessary in order to accurately measure the level of the signal generator. The R&S®FSMR offers bandwidths up to 10 MHz, which also enable it to measure sources with low frequency stability. You can save all instrument settings as a configuration for later use. Storage media are the disk drive or USB memory sticks. You can remote-control the measuring receiver either via IEC/IEEE bus or a LAN interface.

Future-proof due to digital concept

The R&S®FSMR does an excellent job of meeting the increasing demand for compact calibration instruments. As a combination of a spectrum analyzer and a measuring receiver, it is a universal solution for numerous measurement tasks. The digital implementation of all primary parts of the circuitry allows the R&S®FSMR to be adapted to future requirements at any time simply by updating its firmware.

Kay-Uwe Sander

Ref 25 kHz

FIG 3
Typical measurement results of a level measurement across a wide level range and comparison with the limit values of the industrial standard.

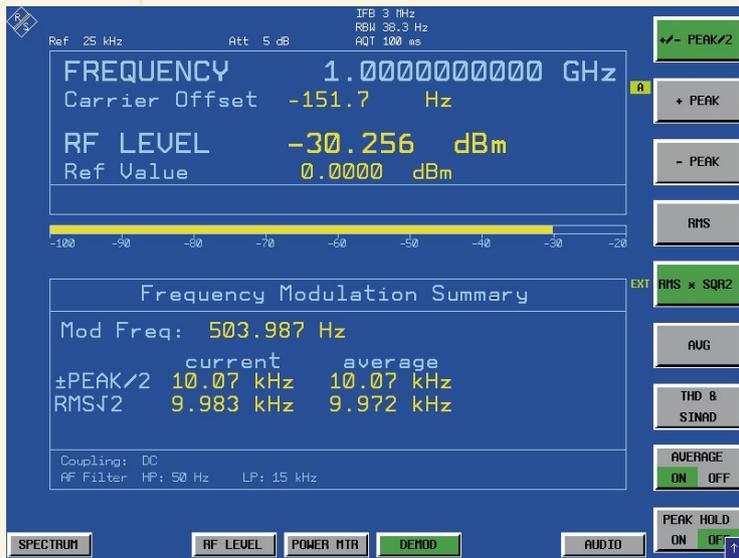
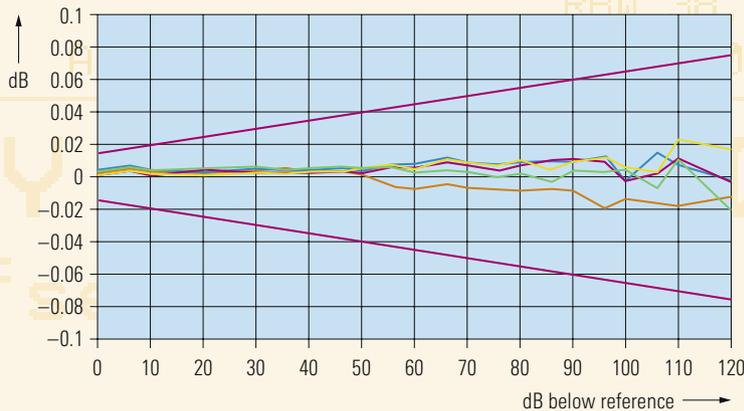


FIG 4 Frequency modulation measurement with the R&S®FSMR: All measurement results such as signal frequency error, input level, modulation frequency and modulation deviation are clearly displayed.

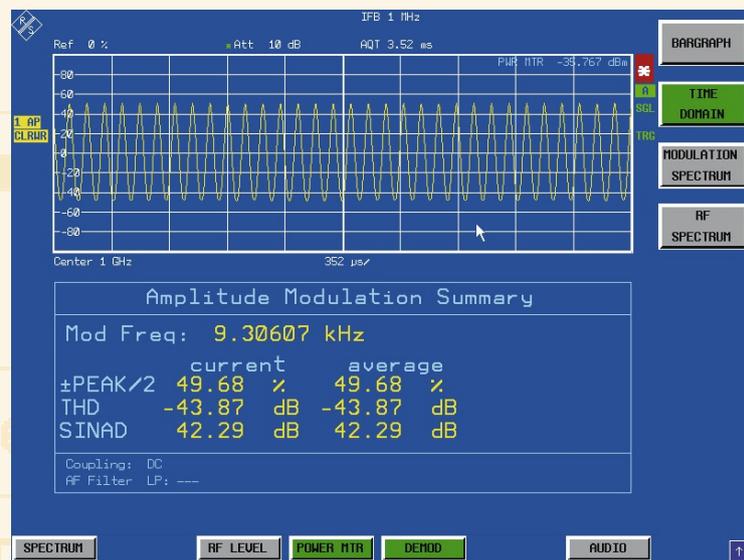


FIG 5 Amplitude modulation measurement: The R&S®FSMR measures the modulation depth and modulation frequency and can also determine the averaged modulation values if needed. The demodulated audio signal is displayed in the time domain.

More information at
www.rohde-schwarz.com
(search term: FSMR)



R&S®FSMR product brochure and specifications

REFERENCES

- [1] Spectrum and signal analyzers for every requirement – an overview. News from Rohde & Schwarz (2004) No. 182, pp 30–36
- [2] Spectrum and Signal Analyzers R&S®FSP / FSU / FSQ: Extended measurement functions for analog modulation analysis. News from Rohde & Schwarz (2004) No. 183, pp 24–25

Condensed data of the R&S®FSMR

Frequency range	20 Hz to 3.6 GHz / 26.5 GHz / 50 GHz
Level range	+10 dBm to -130 dBm
Level measurement uncertainty	0.01 dB + 0.005 dB per 10 dB
Demodulation	AM / FM / φM
AF frequency range	0 Hz to 100 kHz
Frequency deviation	max. 400 kHz
AM modulation depth	0% to 100%
Measurement uncertainty	1%
THD, SINAD measurement range	0 dB to 80 dB