Measuring Receiver R&S®FSMR

Compact solution for calibrating signal generators with a single-box instrument

The 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-box, compact instrument. Outstanding characteristics for accuracy and measurement speed make it ideal for use in calibration labs.

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. Highly accurate level measurements across a wide dynamic range are definitely one of the most demanding measurement tasks. Apart from a measuring receiver, you previously needed additional downconverters and generators.

The R&S®FSMR makes these setups unnecessary; conventional ideas of test setups consisting of multiple instruments for calibrating signal generators or attenuators have become a thing of the past. This is because the Measuring Receiver R&S®FSMR from Rohde&Schwarz features outstanding characteristics for calibrating signal gen-

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

erators and attenuators. Plus, it combines all the necessary equipment in a single, compact instrument:

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

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

The Measuring Receiver R&S®FSMR is based on the spectrum analyzers of the R&S®FSU 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. Depending on the model, the R&S®FSMR's 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. Demodulating analog-modulated signal sources via digital signal processing has long been possible with the spectrum analyzers from Rohde&Schwarz. An audio input for frequencies up to 1 MHz complements the scope of functions.

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. The R&S®NRP-Z27 and R&S®NRP-Z37 power sensors from the R&S®NRP family enable you to perform high-precision power measurements. Due to the power splitters integrated in the power sensors, you can perform all other measuring receiver measurements and determine the signal power with just one fixture. These power splitters feed a portion of the signal to the sensor test cell, while the other portion is forwarded to the Measuring Receiver R&S®FSMR via a high-end microwave cable. If, however, the measuring receiver and the power meter are separate instruments, the fixture needs to be changed when you switch between the instruments. The power splitters integrated in the R&S®NRP-Z27 and R&S®NRP-Z37 make this change unnecessary, thus eliminating any uncertainty regarding mismatch. Plus they facilitate

Level measurement procedure with adjacent-range calibration

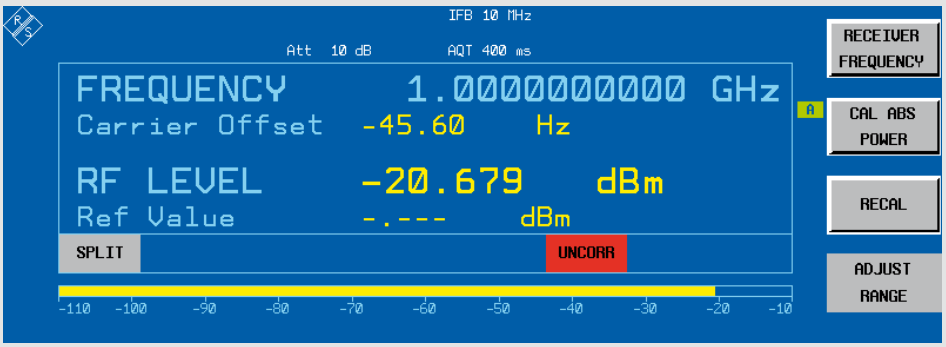

FIG 2a If absolute calibration has not been performed, the R&S®FSMR activates the red UNCORR field to warn you that the measurements may be inaccurate.

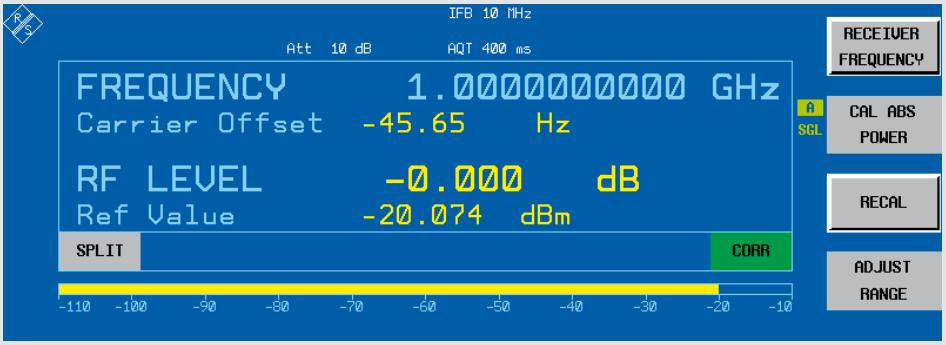

FIG 2b After absolute calibration with the power meter, the measuring receiver is ready for high-precision level measurements, which is indicated via the green CORR field.

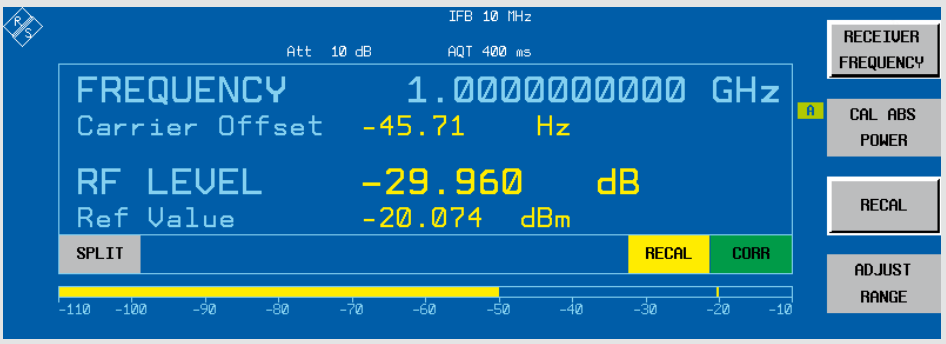

FIG 2c If the level is changed and the measurement range limits have been reached, the R&S®FSMR activates the yellow RECAL field to inform you that you need to calibrate the adjacent range.

handling, minimizing the time needed for preparing measurements. An integrated mismatch correction reduces the feedback between measuring receiver and sensor to a minimum, decreasing the measurement system's susceptibility to errors. This is a clear advantage over using discrete power splitters.

For measuring lower levels, a frequency-selective measuring receiver is used 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 (>140 dB). 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 national metrology institute (Physikalisch-Technische Bundesanstalt, PTB) (FIG 3).

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 φM and their distortion such as signal-to-noise and distortion (SINAD) or total harmonic distortion (THD). In addition, the quality of the modulation signal (audio signal) needs to be measured. For this purpose, the R&S®FSMR includes a complete modulation analyzer, which either measures the demodulated RF signal or the AF signal on the high-impedance audio input. Its digital demodulation of the input signal ensures unprecedented accuracy and flexibility in modulation analysis – special calibration signals are not required. All conventional 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 purely numeric values, you can also choose between time-domain display 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 features. Equipped with the R&S®FS-K40 option, the R&S®FSMR conveniently determines the phase noise and residual FM of a signal generator (FIG 5).

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, e.g. on 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. Plus, the R&S®FSMR is future-proof because the digital implementation of all primary parts of the circuitry allows it to be adapted to future requirements at any time simply by updating its firmware.

Kay-Uwe Sander

FIG 3
By using the Calibration Kit R&S®FSMR-Z2, you can compare the data of the measuring receiver with the specifications. A calibration certificate of the PTB is also supplied.

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.

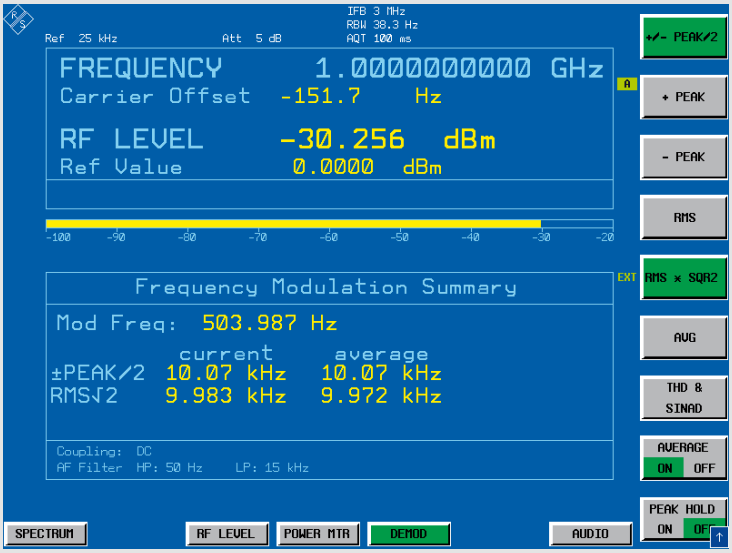

FIG 5
Phase noise measurement on a signal source. The vertical red lines mark the range limits for residual FM/φM measurements. Results are displayed in the top center of the screen under Residual Noise.

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