Measuring Receiver R&S®FSMR

High-precision sensor modules for convenient measurements

The new Power Sensor Modules R&S®NRP-Z27 and -Z37 for the Measuring Receiver R&S®FSMR (FIG 1) enable absolute level measurements with utmost precision and convenience, eliminating the need for switching between the measuring receiver and the power sensor.

Level calibration with utmost precision

The Measuring Receiver R&S®FSMR [*] combines a power meter, a modulation and audio analyzer and a high-grade spectrum analyzer in a single unit. It is a specialist for high-precision measurements for calibrating signal generators and attenuators. The R&S®FSMR is ideal for measuring the output level of signal sources with levels typically ranging from +10 dBm to –130 dBm. The new power sensor modules for the R&S®FSMR enable high-precision level measurements at maximum user convenience as they include a power sensor and a power splitter, which makes the tedious and error-prone switching between the power sensor and the measuring receiver unnecessary.

Previously, such measurements were performed as follows: First, the power sensor was connected to the device under test (DUT) and the absolute power determined; the resulting value was used as a reference for the subsequent measurements. Second, the power sensor was screwed off, and the RF inputs of the measuring receiver and the DUT were connected via a cable. With the generator settings remaining unchanged, the level was measured with the measuring receiver and normalized to the reference value previously determined. Based on this normalization, it was possible to perform absolute measurements with utmost precision – due to the R&S®FSMR's extremely high linearity and large measurement range. If several frequencies had to be covered, these steps had to be repeated for each test frequency involved.

The new Power Sensor Modules R&S®NRP-Z27 and -Z37 now greatly enhance the convenience as well as accuracy of such measurements, because the power sensor and the measuring receiver are connected in parallel via an integrated power splitter. The time-consuming and error-prone switching between the power sensor and the measuring receiver is thus a thing of the past. And the power sensor modules offer an additional advantage: They perform all necessary corrections automatically (see box). So why choose a tedious method when a convenient one is available?

Michael Wöhrle

FIG 1 The R&S®FSMR with the Power Sensor Module R&S®NRP-Z37.

Accuracy is what counts:
What distinguishes the power sensor modules for the Measuring Receiver R&S®FSMR

At first glance, the new power sensor modules do not seem to include any striking features: They contain a power splitter that routes part of the DUT output power to the measuring receiver, and a thermal power sensor that measures the DUT power (FIG 2). A common setup used before, of identical or slightly varied design. Accepting this solution, however, means putting up with a loss in accuracy.

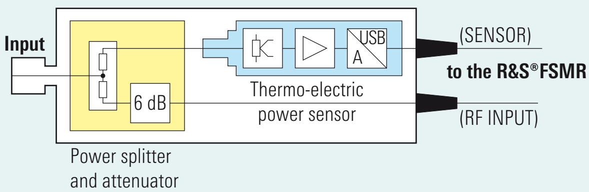

FIG 2 Block diagram of the Power Sensor Modules R&S®NRP-Z27 and -Z37.

The core of the problem is inadequate isolation between the outputs of the power splitter. As a result, the power sensor will be affected by any mismatch of the other output, as well as any variation of such mismatch. Even slightly bending the connection cable or switching the attenuator of the measuring receiver, let alone replacing the measuring receiver, will immediately increase measurement uncertainty. Calibrating the setup would necessitate calibration points every 10 MHz – assuming spline interpolation between the calibration points.

In its Power Sensor Modules R&S®NRP-Z27 and -Z37, Rohde & Schwarz combines several measures to ensure that the modules offer unequaled measuring convenience while still featuring extremely high accuracy. A 6 dB attenuator integrated into the power splitter increases isolation by 12 dB. This reduces the uncertainty of the power display caused by the aforementioned effects by a factor of four. The level reduction involved in this method is fully compensated for by the unparalleled sensitivity of the R&S®FSMR.

The nominal isolation of 24 dB achieved in this way is still insufficient; numeric compensation measures are therefore used to increase it further. This requires full characterization of the power splitter at a spacing of 12.5 MHz, knowledge of the complex reflection coefficient of the R&S®FSMR, and use of a phase-stable connection cable. A set of calibration data for the power splitter is created once during production and then used as an integral part of the power sensor. The specific reflection coefficients of each Measuring Receiver R&S®FSMR are likewise determined during production and can be updated if required. Compensation is performed by the intelligent power sensor itself: It corrects the effects of mismatch using the stored calibration data of the power splitter and the R&S®FSMR reflection coefficient. The measuring receiver communicates the reflection coefficient to the power sensor via USB, and also keeps the attenuator fixed at 10 dB during the power measurement. An armored, phase-stable microwave cable from the leading manufacturer is used as a connection cable. It is robust and reliable, and will even withstand your accidentally stepping on it.

The result yielded by the combination of these measures is impressive in every respect (FIG 3). Moreover, the characterization of the power splitter has a positive side effect: The frequency spacing for the calibration of the power sensor as a whole could be increased to 100 MHz. This ensures cost-efficient recalibration, even when customer-specific power calibration systems are used.

Thomas Reichel

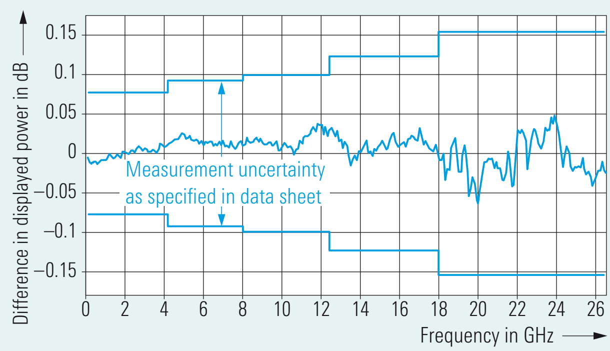

FIG 3 Result of a comparison measurement between a Power Sensor Module R&S®NRP-Z37 and an R&S®NRV-Z55 terminating power sensor, where the latter is used as a reference. The R&S®NRV-Z55 is directly traceable to a primary standard of the PTB, Germany's national metrology institute, i.e. it was calibrated there. The Power Sensor Module R&S®NRP-Z37 is also traceable to primary standards of the PTB. However, different standards were used in this case, and three calibration hierarchies introduced in between. The small differences obtained in the two measurements demonstrate the high quality of the Power Sensor Module R&S®NRP-Z37 and the calibration chain involved..

More information at www.rohde-schwarz.com
(search term: NRP-Z27 / -Z37)

REFERENCES

[*] Measuring Receiver R&S®FSMR – Single, compact instrument for calibrating signal generators. News from Rohde & Schwarz (2005) No.185, pp 18–21

– Measurement Uncertainties in RF Level Measurements Using the Measuring Receiver R&S®FSMR. Application Note 1MA92 from Rohde & Schwarz

Condensed data of the R&S®NRP-Z27

Frequency range	DC to 18 GHz
Level range	–24 dBm to +26 dBm
Connector	N male

Condensed data of the R&S®NRP-Z37

Frequency range	DC to 26.5 GHz
Level range	–24 dBm to +26 dBm
Connector	3.5 mm, male