Fast and precise measurement of low RF levels

Some measurements require very low and highly accurate RF levels (typically –100 dBm to –110 dBm), eg for the BER (bit error rate) of digital communication receivers. This test hint summarizes how to calibrate extremely precisely the levels of signal generators and communication testers used for BER measurements.

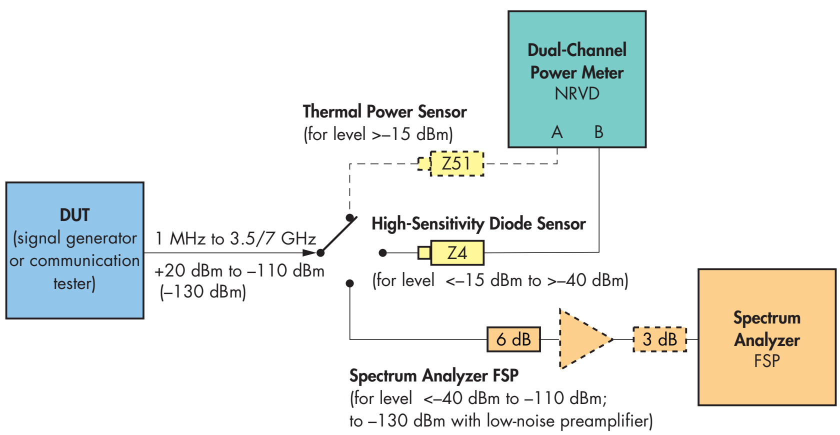

FIG 1 Suggested test setup to determine small RF levels

Certain digitally modulated signals, such as IS-95 or WCDMA, exhibit a high crest factor. A power meter with a thermal sensor is best suited for determining their levels. For this purpose, Rohde & Schwarz offers Dual-Channel Power Meter NRVD with Thermal Power Sensor NRV-Z51 or NRV-Z52. Due to the limited sensitivity of thermal power sensors, only relatively high levels can be measured (typ. >–30 dBm).

Diode sensors provide comparable measurement accuracy for RF levels down to about –50 dBm due to higher sensitivity. Care should be taken, however, that they are only used in the square law region. Extra measurement uncertainties can otherwise occur in the case of signals with high crest factor or with harmonics. For High-Sensitivity Diode Sensor NRV-Z4 such effects are negligible in the level range –40 dBm ±10 dB.

The significantly lower RF levels necessary for BER measurements can only be measured with a selective RF receiver or a spectrum analyzer. But their absolute measurement uncertainty – even that of a state-of-the art spectrum analyzer like FSP – is higher (0.5 dB) compared to high-quality power meters.

The point of this test hint is to eliminate the absolute error of FSP by calibrating Spectrum Analyzer FSP to Dual-Channel Power Meter NRVD with High-Sensitivity Diode Sensor NRV-Z4 for a reference level of approx. –40 dBm (FIG 1). When measuring tiny levels, only the very small linearity error of FSP that occurs with digital bandwidths adds to the measurement uncertainty of the power meter (FIG 2). Thus a total measurement uncertainty of 0.26 dB can be achieved when measuring a level of –110 dBm.

If necessary, the measurement range can be extended to approx. –130 dBm by means of a low-noise preamplifier. Using the zero span measurement and integration in the time domain (time domain power rms) of FSP, the maximum possible measurement speed can be obtained for a given S/N ratio.

Application Note 1MA21 provides a detailed description of this procedure and can be downloaded from the Rohde & Schwarz Internet pages.

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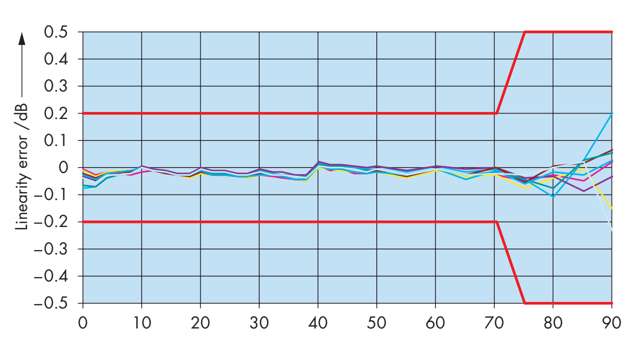

FIG 2 Linearity error of Spectrum Analyzer FSP, measured on eight different units (resolution bandwidth 300 Hz)