Microwave Signal Generator SMR

Ideal calibration source for weather radar receivers

Calibrated weather radar equipment is indispensable for precisely determining the precipitation probability, as well as the density of rain, snow or fog. The calibration method necessary for these applications requires a signal generator with a highly accurate output level. Thanks to its carefully thought-out design with firmware-supported level correction, the Microwave Signal Generator SMR (FIG 1) is the ideal signal source for this task.

Photo 43 264/3

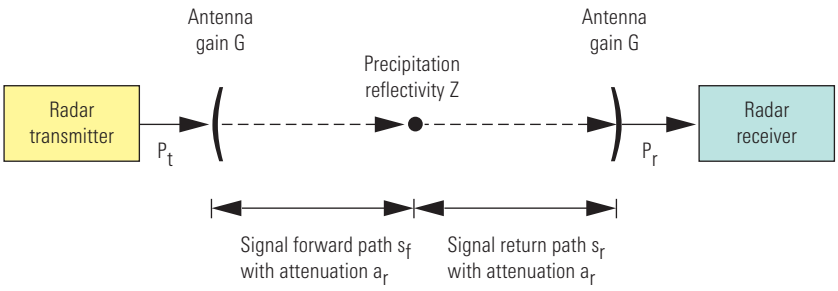
FIG 1 The Microwave Signal Generators SMR [*] are sought-after signal sources in research, development and production as well as in EMC measurements

What has radar to do with the weather?

Meteorologists use weather radar equipment primarily to analyze the dynamic structure of individual clouds or cloud systems, and for exhaustive, continuous precipitation measurement. An important parameter for exact weather forecasts is the precipitation intensity or rate of rain, which indicates the amount of rainwater that falls per time and square measure unit. Weather radar enables the precipitation activities to be monitored with high temporal and spatial resolution. Although radar equipment cannot measure precipitation intensity, it can directly measure reflectivity. Reflectivity is a unit for the backscattering cross section of targets, which can be monitored by means of radar equipment. It is proportional to the energy which is backscattered from all scattering particles in the radar beam to the antenna. The greater the number and size of raindrops in the air, the higher the reflectivity.

As FIG 2 shows, the quantitative determination of reflectivity is basically a two-port measurement with the radar transmitter as the signal source and the receiver as the selective power meter. The magnitude of the transmission factor of the transmission path from transmitter output to receiver input can be calculated from the known transmitted power P_t and the measured received power P_r. In addition to the antenna gain and the attenuation factor of the signal path from the antenna to the radar target, this transmission factor includes

FIG 2
Situation to determine the reflectivity Z



the target reflectivity to be determined. Since the antenna gain and the transmission loss are known, the reflectivity can be calculated. Antenna gain and transmission loss must be counted twice, because the radar signal passes through the antenna and the transmission path both on its way back and forth.

Radar transmitters usually generate sufficiently accurate output power to determine reflectivity according to the above method. With the receivers, this is more difficult. Their level change monitoring is usually highly accurate, but they are characteristically too inaccurate for absolute level measurements. However, since the behaviour of high-end receivers is in all other respects stable, accuracy can be increased by calibrating them with a Microwave Signal Generator SMR (with optional attenuator), which provides a precise output level.

How to calibrate

The radar signal received usually passes from the antenna directly to the receiver input via a circulator, which decouples transmitter and receiver. This connection is separated, and a directional coupler looped in. The SMR output signal thus reaches the receiver input virtually without interaction. The receiver sensitivity is only imperceptibly decreased due to the small transmission loss of the directional coupler. Of course, the transmission loss must be known so that it can be taken into account when the level of the signal generator is set, and the same applies to the total attenuation from the output of the signal generator to the receiver input. This calls for exact measurement.

A 16 dB coupler is recommended for looping-in. A 3 dB attenuator should be inserted between the coupling port of the directional coupler and the RF output of the SMR. In conjunction with the lines required, a total attenuation of almost exactly 20 dB is attained from the SMR RF output to the input of the radar receiver. If the RF level of the SMR is then varied from +10 dBm to –90 dBm, the range of –10 dBm to –110 dBm is covered, which is optimal for most radar receivers. As FIG 4 shows, the SMR has an accuracy of typically <0.45 dB (measured at 5620 MHz and room temperature, measurement accuracy 0.2 dB) for these levels.

If the directional coupler and attenuator have been correctly built in and measured, a receiver calibration can be performed. This is done as follows:

- Switch off transmitter of weather radar equipment
- Set the SMR to the frequency required (e.g. to 5620 MHz)
- Set sufficiently high SMR level (e.g. –10 dBm)
- The level value determined by the receiver is read via the control unit of the weather radar, which calculates a correction value for the receiver from this value and stores it
- Set sufficiently low level at the SMR (e.g. –70 dBm). The radar control unit again calculates a correction value and stores it
- Switch off the SMR. The radar equipment is again ready for regular operation

Since the receivers typically exhibit good relative level accuracy, the twoport calibration described is completely sufficient. Otherwise, it is advisable to use further calibration ports. Due to the high level accuracy of the SMR, even the lower sensitivity limits of the receiver (–110 dBm, for instance) can be reached. If the control unit of the weather radar does not support monitoring and storing of correction values for the receiver, an external PC with an appropriate program is necessary. The calibration intervals depend on the receiver's stability; they are usually monthly.

Wilhelm Kraemer

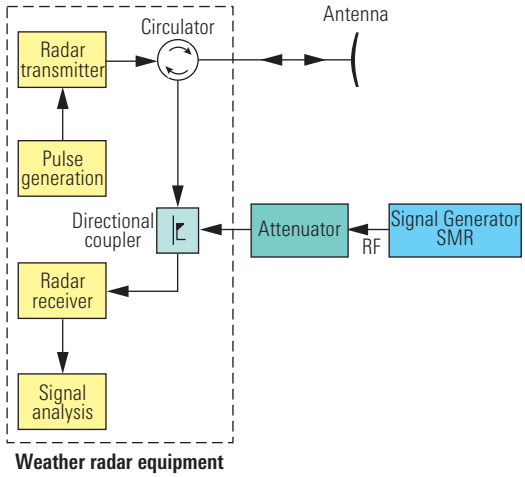


FIG 3 Calibrating the weather radar receiver

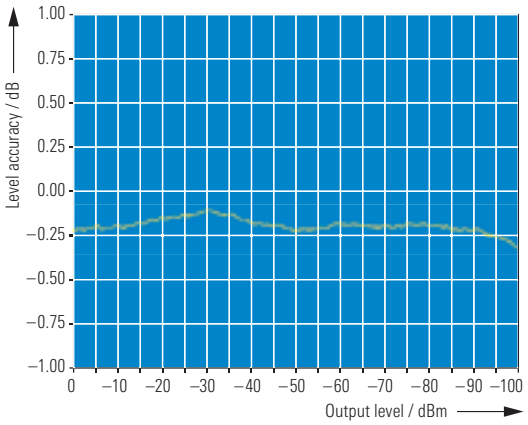
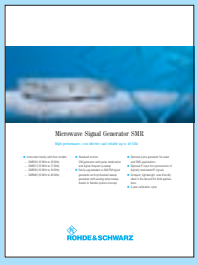


FIG 4 SMR level accuracy at 5620 MHz

More SMR information and data sheet at www.rohde-schwarz.com (search word: SMR)



Data sheet SMR

REFERENCES

[*] Microwave Signal Generators SMR: Microwave in handy size. News from Rohde & Schwarz (1999) No. 162, pp 4–6