POWER METERS & MONITORS

narda
microwave-east

an L3 communications company

Table of Contents

General

Power measurements at RF and microwave frequencies may be divided into low, medium and high power levels. At low levels power is measured directly using diode or thermocouple detection elements. At medium (1 Watt) power levels an attenuator is inserted between the source and detector. For high power measurements, or when power is measured “in-line” a directional coupler is used to sample a portion of the power being developed. Accurate power measurements depend not only on the accuracy of the detection element itself but more importantly on the total measurement uncertainty of all the components (adapters, couplers, cables, etc.) that are used to make the measurement.

Design Of The Detector

The power absorbed by a mount when connected to a “perfect” 50 ohm source is, by definition, true power. Any power reflected due to the VSWR (Voltage Standing Wave Ratio) of the mount, any variation in the amount of reflected or absorbed power with frequency, and any variation in the conversion efficiency of the mount with frequency are accounted for in the calibration factor. Calibration factor is the ratio of the measured (or indicated) power at a given frequency to the true (or actual) power which would be delivered from a perfect 50 ohm source. A detector’s ability to measure power accurately is based on the design of the complete structure. Power that is reflected due to the VSWR and power that is absorbed into the walls and connections within the mount all degrade the efficiency and accuracy of the detector.

Mismatch Uncertainty

When making power measurements, if the VSWR of both source and detector are not equal to 1.0:1 (which is impossible), there can be additional power reflected due to the impedence mismatch. This leads to a potential source of measurement error called mismatch uncertainty. From the example to the right it can be seen that an accurate power measurement depends on the VSWR of the source and the detector. A simple method to improve the accuracy of this measurement is to use a high quality, low VSWR attenuator such as the Narda Model 779 or 4779 Series Attenuators. Readings would be adjusted by the amount of attenuation added. Mismatch uncertainties become more complex when performing reflected power measurements. On the right is the method for calculating these uncertainties. What can be rapidly seen from the equation is that directivity is the most critical value when performing reflected power measurements on a low reflection device. Conversly, the source VSWR will be the most critical factor when measuring devices with a high reflection. The figure on the right depicts the effects of directivity on a reflection measurement. When measuring a device with a reflection value of approximately 25 dBr (1.12:1 VSWR), the uncertainty of your measurement would be reasonable only if your measurement directivity is at least 35 dB. The example on the right depicts how overall accuracy degrades as the real return loss value approaches the directivity value. While it's not a significant error for 5 or 10 dBr, it becomes significant at 20 dBr and critical at 25 dBr. A general rule that can be employed is you'll need at least 10 dB more in directivity than the value of return loss you are testing for, in order to obtain accurate results. The Narda Model 8450 specifies a minimum of 30 dB directivity therefore, it's accurate to measure cellular systems where the antennas are typically specified at a 1.4:1 VSWR (15.5 dBr).

435 Moreland Road • Hauppauge, New York 11788
TEL: (631) 231-1700 • FAX: (631) 231-1711
www.nardamicrowave.com • EMAIL: nardaeast@L-3com.com

Power Meter Measurement Uncertainty

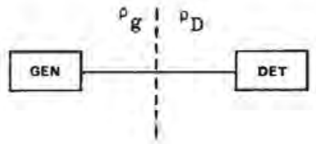
The Mismatch Uncertainty for this measurement in dB is:

$$M_{\mu dB} = 20 \log (1 \pm \rho_g \, \rho_D)$$

where: M_{μ} = mismatch uncertainty (maximum) in dB.

ρ_g = Generator Reflection Coefficient, RHO.

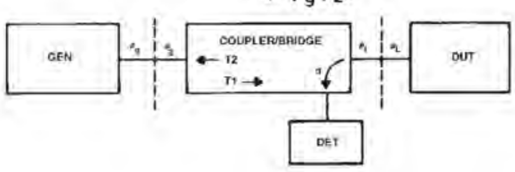
ρ_D = Load (Detector) Reflection Coefficient, RHO.



Reflection Measurement Uncertainty

A typical reflection measurement set-up is shown below. The measurement uncertainty of this set up, in terms of a measurement of a reflection coefficient, RHO is:

$$M\mu = d \pm \frac{(\rho_g T_1 T_2 + \rho_1)}{(1 - \rho_g \, \rho_2)} \rho_L^2$$



" Through transmission of coupler/bridge $= 10 \left(\frac{\text{-Ins. Loss in dB}}{20}\right)$

" Directivity of coupler/bridge $= 10 \left(\frac{\text{-Directivity in dB}}{20}\right)$