FLUKE®

Calibration

Applying RF correction factors correctly

Application Note

The need to apply correction factors is commonplace in RF and microwave calibration; for example, when applying values from a certificate of calibration for standards, correcting for device/system characteristics derived during measurement such as adapter insertion loss, splitter tracking error, etc.

Simple human errors may occur when performing or developing measurement and calibration procedures. Incorrect arithmetic and algorithms may be implemented or embedded in automated calculations within spreadsheets and software. Mistakes can often go undetected when applied corrections are small, as problems with small values may give apparently believable results. However, the results will be in error and any measurement uncertainty estimates will be invalid. Unexpected results are more obvious when large corrections are wrongly applied. It is good practice to test and validate any calculations (including formulae and algorithms in spreadsheets and software) with deliberately large numbers to make the effect of applying correction factors more easily observed.

Care is needed to apply "signed" quantities appropriately and consistently. For example, attenuation values: 20 dB or -20 dB? Avoid confusion between "errors" and "corrections," usually considered to have opposite signs. The key to avoiding incorrect results is to derive and propagate correction factors consistently, testing the algorithms and calculations with values that will clearly demonstrate their correctness or otherwise.

Consider the following simple example of a 20 dB coaxial attenuator, used to reduce the signal level of a source to be calibrated within the range of an available power sensor, as shown in figure 1. Attenuation data from the attenuator's calibration certificate appears in table 1.

The attenuator could be said to have an attenuation of approximately 19.9 dB, corresponding to an error of -0.1 dB from the nominal 20 dB, which also could be interpreted as requiring a correction of +0.1 dB to be applied to a measurement result (if corrections have opposite signs to errors). In this example, the power meter reads +5.25 dBm, so the signal source power output is nominally (+5.25 + 20) = +25.25 dBm. But the attenuator has an error of -0.1 dB from nominal, so the actual signal source output is 5.25+(20-0.1) = +25.15 dBm. Simply applying (adding) a correction of +0.1 dB to the nominal +25.25 dBm result would give +25.35 dBm, clearly incorrect, demonstrating the caution needed to appropriately and consistently propagate and apply calibrated values, errors and corrections. Note that the certificate of calibration avoids any ambiguity by stating measured values, not errors or corrections.

Figure 1. Using a 20 dB attenuator to reduce a signal source output level to within the power sensor input level range.

Frequency (MHz)	Attenuation (dB)	Attenuation Uncertainty (± dB)
0.10	19.903	0.003
0.30	19.903	0.003
0.34	19.903	0.003
0.50	19.903	0.003
1.00	19.903	0.003
2.00	19.904	0.003
5.00	19.905	0.003
10.00	19.906	0.003
20.00	19.907	0.003
30.00	19.907	0.003
40.00	19.909	0.003
50.00	19.909	0.003

Table 1. Calibration data for the 20 dB attenuator in the example shown in Figure 1.

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