Technical Note

Anritsu

Calibration Accuracy

S31xD, S33xD, S3xxE

Site Master

MT8212B, MT8212E

Cell Master

Introduction

The ICN50B InstaCal module provides field users with a convenient and fast way to perform the calibration as it eliminates the need to change the connection to measure the Open, Short, and Load. When comparing the ICN50 InstaCal module with Anritsu's precision calibration components, it is important to understand the trade offs and the impact this could have on the overall measurement accuracy. The intent of this paper is to explain in simple terms the performance differences between the precision cal component and the InstaCal module. To aid the reader, this paper includes three graphs, one that gives users an easy way to estimate the error based on the measured return loss. The other two graphs compares the return loss measurement of a 3 dB pad and a 20 dB offset using both the InstaCal and OSLN50-1 precision cal components.

Directivity

Today when you look up the instrument accuracy or the accuracy of the InstaCal or precision Cal tee, you will find that the accuracy is specified in terms of directivity. It is useful to have a good understanding of directivity as it is usually the largest contributor to measurement uncertainty. It can therefore be used to estimate the measurement uncertainties associated with these two different calibration techniques.

The directivity can be seen as an extra leakage component added to the measurement vector as a result of deviations from the ideal. A directivity of 42 dB will add less measurement uncertainty than a directivity component of 35 dB. From this we can conclude that the better the directivity, the better the overall accuracy. A good rule of thumb for field use is to make sure that the measured return loss is at least 10 dB greater than the directivity. For instance, if you use a poor calibration component with a directivity specification of 30 dB and you try to measure a system with 25 dB Return Loss, your signal is only 5 dB greater than the leakage component and large errors will be introduced to this measurement.

The directivity of the ICN50B is 38 dB. If we use the InstaCal to make a return loss measurement of a cable and antenna system with a RL of 18 dB, then the signal will be 20 dB greater than the directivity of the device. With the help of math or an RF measurement chart, we can then figure out what the resulting measurement uncertainty is as a result of directivity components changing the amplitude and phase of the desired signal.

Similarly, the directivity of the precision load is 42 dB. If we use this to make the same 18 dB return loss measurement, the signal would be 24 dB greater than the directivity of the device.

Derive the Accuracy Using Graphs

Ideally it would be nice if the accuracy could be summarized with a single number for all measurements. Unfortunately it is not that simple because the estimated uncertainties will be different depending on the measured return loss. Instead of getting out the calculator for every scenario, a graph can be helpful here to estimate the uncertainty for different return loss levels.

Looking at the graph, we can see that the worst case error would be a about -1 dB and +1.1 dB error for a 20 dB InstaCal measurement and about ± 0.6 dB for a 20 dB measurement using the precision cal tee.

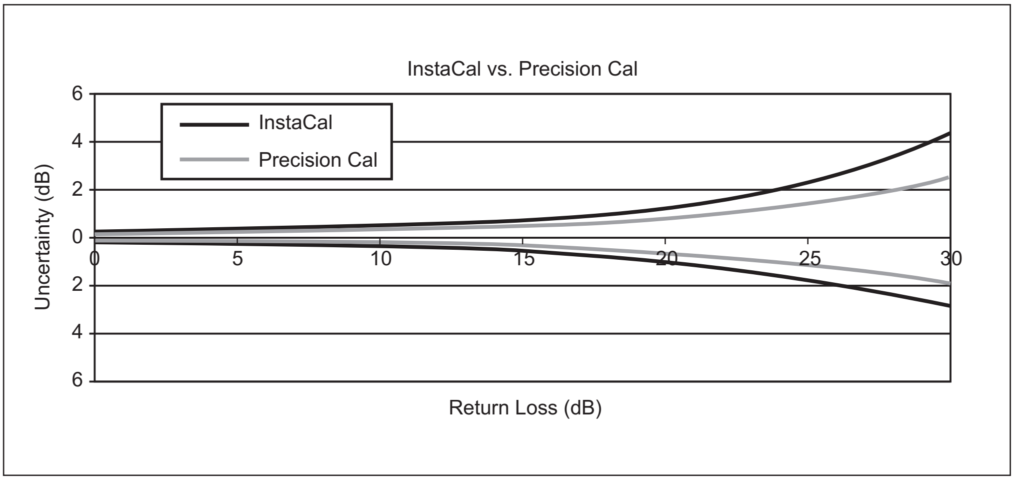

Figure 1: Estimated InstaCal Uncertainties vs. Precision Cal Uncertainties.

Comparing Traces

While the curves in Figure 1 can be helpful, a practical measurement can be more helpful to compare the data. Figure 2 shows a 20 dB offset measured with both the OSLN50-1 and InstaCal module. The small difference correlates with Figure 1.

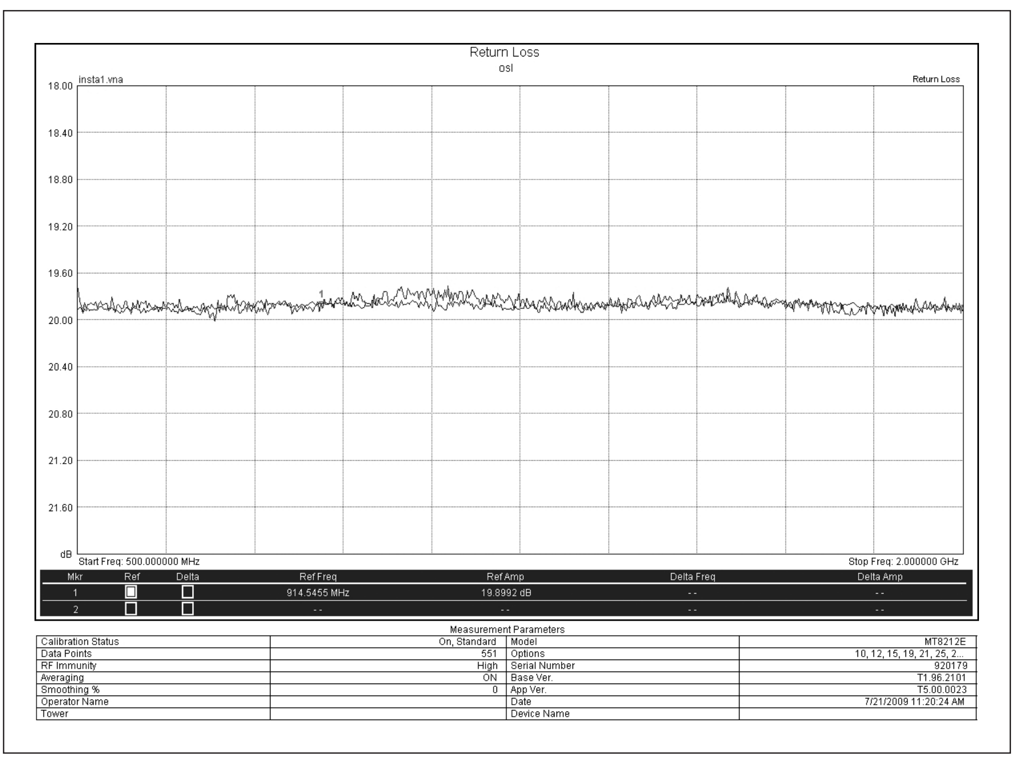

Figure 2: Comparing Two 20 dB Offset Measurements.

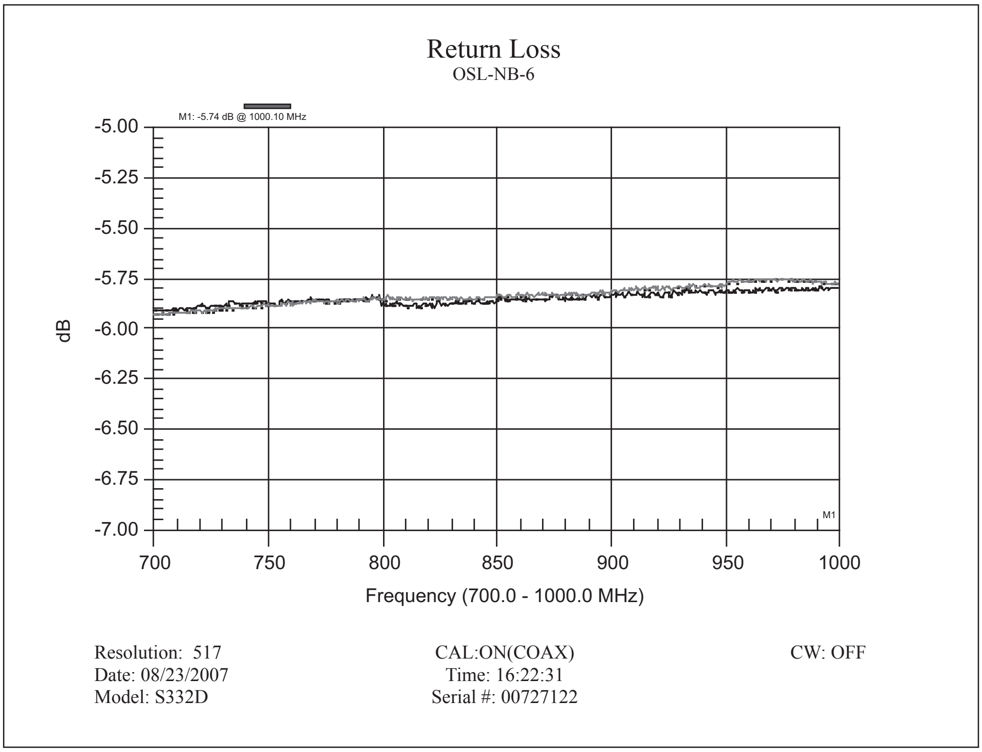

Figure 3: Comparing Two 3 dB Pad Measurements.

Figure 3 shows the same comparison but with a 3 dB pad. As expected, the graphs show less deviation because the errors are smaller since the measured signal is significantly greater than the specified directivity. The slope is a result of the pad performance.

Summary

Both the InstaCal and OSLN50-1 precision Cal components provide users with accurate calibrations. The InstaCal has the benefit of providing quick and easy calibrations and can result in significant time savings when troubleshooting cable and antenna systems in the field.

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