AN124
Measuring Differential Amplifiers

Written by Bill Ashley for
AEA Technology Inc.
www.aeatechnology.com

Abstract:

This paper describes methods for measuring differential amplifiers using AEA Technology network analyzers. You may also apply these techniques to passive circuits.

Introduction:

The AEA Technology network analyzers support non-differential measurements. There are two methods described to use these instruments for differential testing. The first method uses baluns, the second uses superposition.

Baluns:

Baluns simply convert an unbalanced source to a balanced load (or vice versa). Considerations to check when using baluns:

1. insertion loss
2. BW
3. Impedance ratio

Try to use an impedance ratio of 1:1 for minimum confusion. Otherwise the readings on the network analyzer will need to be normalized to reflect the device under test. The BW issue is self explanatory. The easiest method to compensate for insertion loss: plot the data on a Smith chart, increase gamma magnitude by the insertion loss. Obviously, low insertion loss, wide BW, and 1:1 ratio create less degradation of the measurement.

The main drawback of baluns, besides needing to find baluns: you are unable to separate the two sides, thus imbalances in impedance or gain, or delay are not measurable.

Superposition:

The principle of superposition states that the response from the differential inputs equals the sum of the responses caused by each individual input. Superposition applies to situations where non linear effects are negligible. You Measure S11 in the usual manner, however, there are two S11's to observe. With the analyzer S11 port connected to the first input, measure both outputs, one at a time. You will need to use appropriate loads for all inputs and outputs for these tests. Now switch over to the other input and observe both outputs again. Sum both responses and input impedance's to find the differential input impedance and gain. You may also measure S12 and S22 by connecting the amplifier backwards.

1489 Poinsettia Ave. Suite 134 Vista, CA 92081 ◦ Phone (760) 798-9687 ◦ Fax (760) 798-9689 www.aeatechnology.com

Conclusion:

If you can not afford an expensive differential network analyzer, use the "poor man's" techniques outlined above. There are some limitations compared with true differential network analysis, baluns combine the data into one input impedance and one amplifier gain, superposition does not account for nonlinearities between the two halves.

References:

AN101 When to Use Cable Null, AEA Technology
AN120 Measuring Amplifier Gain, AEA Technology
AN121 Measuring Group Delay
AN122 Measuring Gain Compression, AEA Technology
AN125 Measuring AM to PM Conversion, AEA Technology

Keywords: How to measure differential gain tutorial, introduction to understanding differential gain fundamentals, using excel to calculate differential gain explained, about differential gain basics, differential amplifier measurement

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