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Technical Note 47

Effect of Driver Amplifier Harmonics on Load Pull Measurement Accuracy and Linearity

Spurious harmonic signals do falsify RF power measurements. A properly designed Load Pull System should be free of such parasitics. However, in many setups more attention is being paid to the tuner accuracy, the maximum reflection factors attained and the software options, than the purity of the source signal. Not enough attention is being paid to the quality and performance of the signal driver amplifiers. In some cases setups do not even include two driver amplifiers when designed to measure Intermod. All this will cause accuracy problems at certain source power levels, which, in the worst case will falsify the test results in an unidentifiable way until after the tests have been made.

It is strongly recommended to test the linearity of the setup using a Thru Line standard before starting any transistor measurements up to the maximum allowed source power. This can easily be done using the Power Sweep feature of WinPower. The risk of false measurements is especially high when diode power detectors are used in the power meter of the setup. This is currently done because measurement speed is much higher than with bolometer power heads.

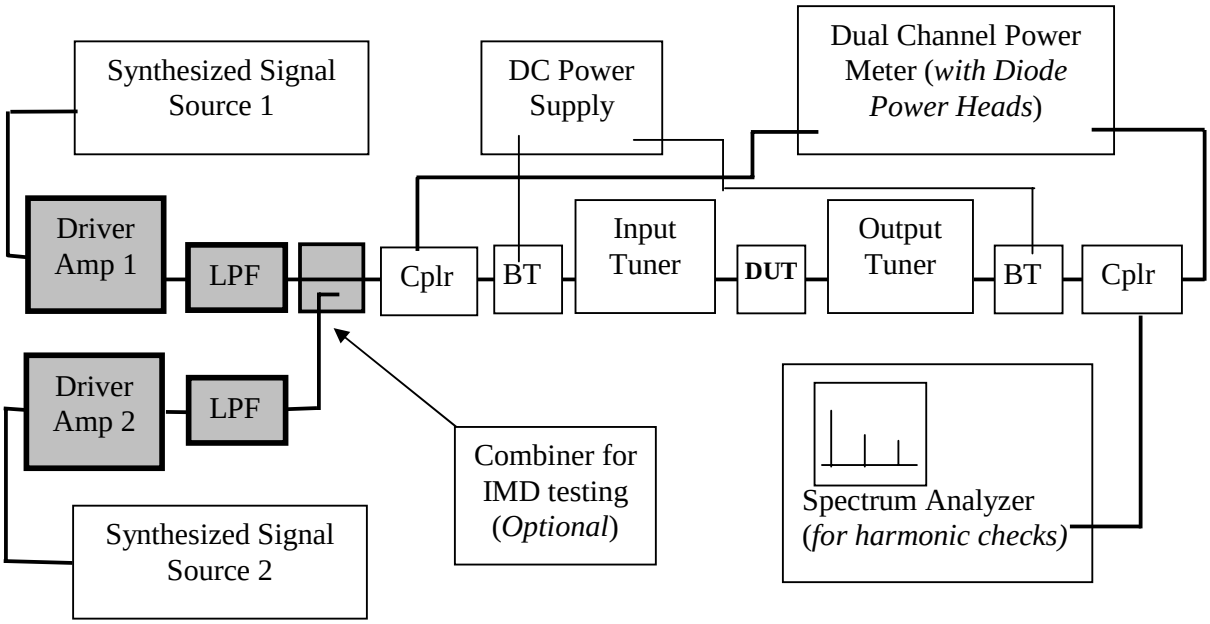

Figure 1: A typical load pull system including high power driver amplifiers and low pass filters.

Figure 1 shows a typical Load Pull setup. It includes a synthesized signal source, a driver amplifier and a low pass filter (LPF). Our experiments in this Note show that using such a LP filter with a cutoff frequency just above the maximum test frequency improves the measurement accuracy of the system considerably.

The effect on measurement accuracy cannot be verified on a real DUT, like a transistor, since we do not know in advance the correct test result. It must be checked on a "known" DUT, like a simple Thru Line. Figures 2 and 3 show such tests.

Depending on the type of detector used (bolometer or diode), the actual source power, the type of driver amplifier etc the results vary. We show here only an example: Normally the Gain (Pin) curve should remain flat over the entire Pin range. It is obvious that this is not the case. Since we always refer to Pin, the power really injected into the DUT and not to Psource, the insertion loss of the LPF does not interfere and the data of figures 2 and 3 can be compared directly.

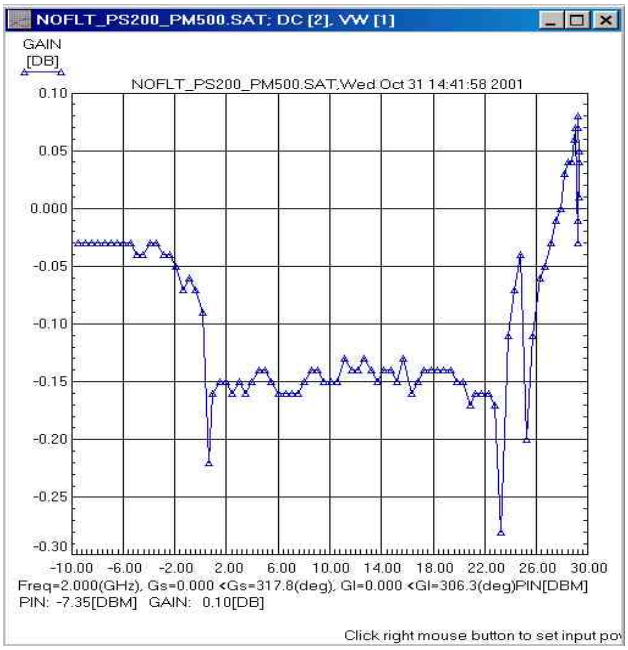

Figure 2: Thru Line Gain power sweep <u>without</u> Low Pass Filter.

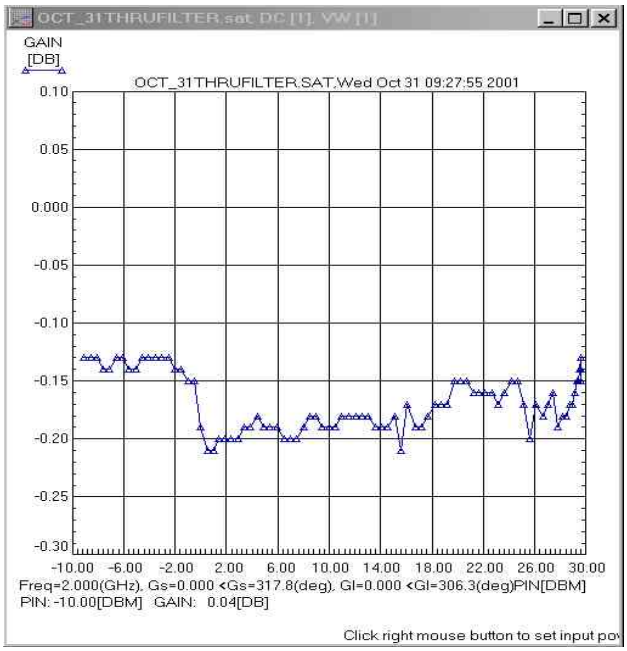

Figure 3: Thru Line Gain power sweep <u>with</u> LPF.

Obviously these errors can be reduced with higher quality and linearity of the driver amplifiers. The amplifier used in this setup is a low cost unit rated P-1dB at 1Watt (30dBm) output power. From this we must subtract around 3dB input loss (setup, input tuner and test fixture) to reach the DUT (=Pin), corresponding to around 27dBm. We can see from figure 2 that this is the area where some serious spurious response occurs.

Further on, some load pull setups <u>do not use two driver amplifiers when testing Intermod</u>. This is a mistake. It is very difficult to predict exactly the level of spurious signals in an amplifier when we inject a two-tone signal, despite all specifications. In real life you will be demanded to increase signal power in order to saturate your DUT and it is best to have the freedom to do so without jeopardizing the quality of the injected signal.

Figure 1 shows how such a setup should be configured, in order to be able to use the driver amplifiers up to the maximum of their performance, without worrying about the purity of the injected signal.

Also, in case of high power and performance solid-state instrumentation amplifiers, <u>it is in general cheaper and safer to purchase two amplifier units of X watts instead of one unit of 2X watts.</u>

November 2001