RESIDUAL PHASE NOISE MEASUREMENTS

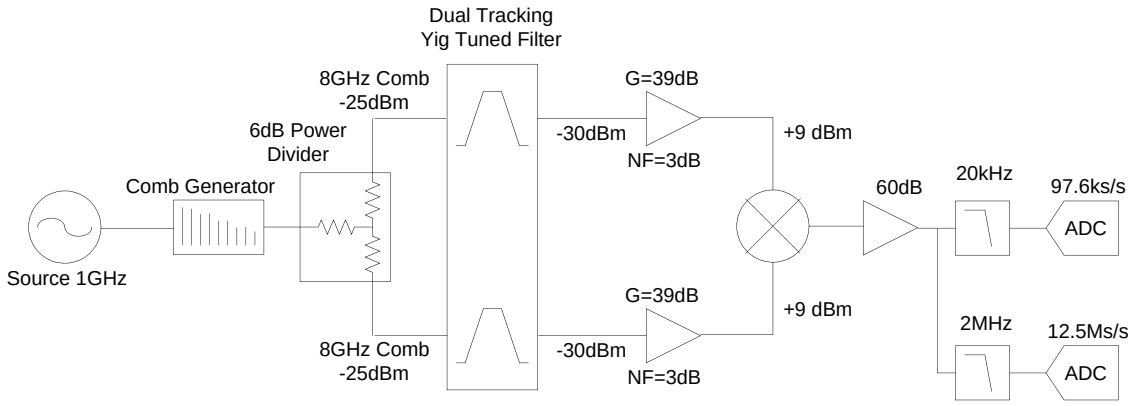
LOW PHASE NOISE COMB GENERATORS

The phase noise of **PSPL's Low Phase Noise (LPN) Comb Generators** has been characterized with a residual phase measurement system. The measurement highlights are:

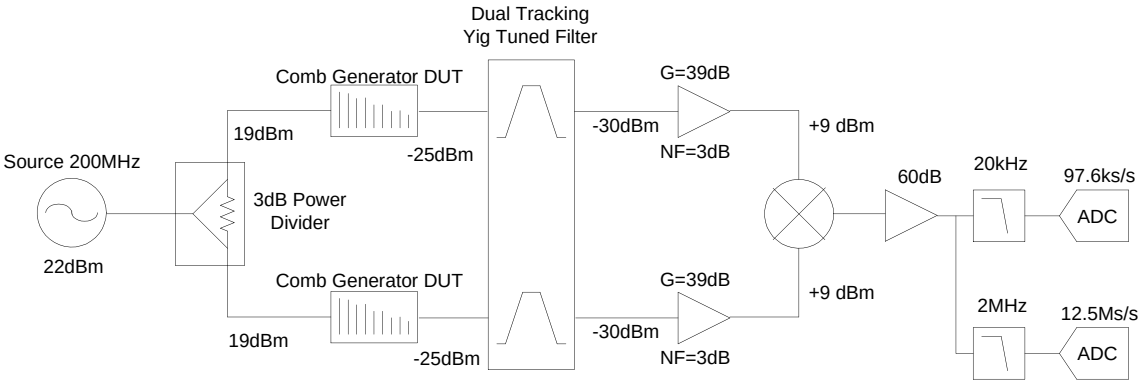
- LPN Comb Generators have residual phase noise **below** the noise floor of the measurement system (thermally limited)
- The Comb Generators have residual phase noise of **< -140dBc/Hz** at 10kHz offset
- These comb generators would **not add any appreciable phase noise** to a 100MHz source with **–**165dBc/Hz phase noise at 10kHz offset

Following are the details of PSPL's residual phase noise measurement system along with some measurement results and analysis.

The residual phase noise measurement system was configured two different ways, **first,** to characterize the noise floor of the measurement system (amplifiers, mixer, etc.) and **second**, to measure the residual phase noise of the LPN Comb Generators. Both configurations are shown below.



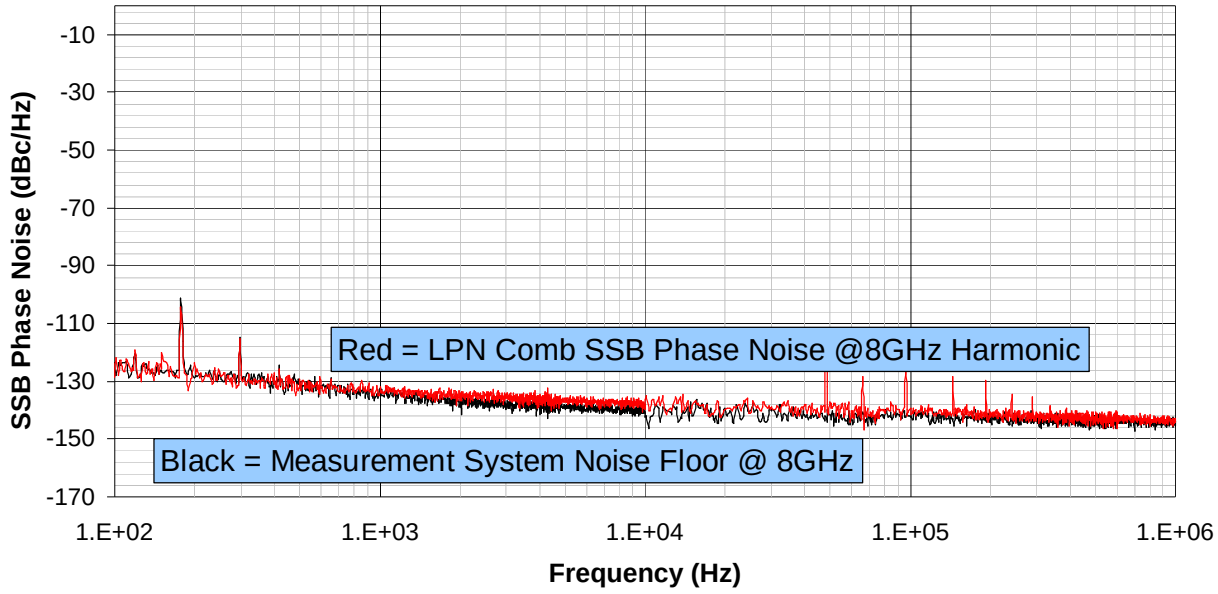
Configuration for System Noise Floor Characterization Configuration



Configuration for LPN Comb Generator Measurement

The residual phase noise was measured at the 4GHz, 6GHz, and 8GHz harmonics with a 100MHz and 200MHz input. The results for the 8GHz harmonic are shown below. This plot demonstrates that the measured residual phase noise overlays the measurement system noise floor.

Comb Generator SSB Phase Noise
200MHz 19dBm input, -25dBm 8GHz Output



The theoretical thermal noise floor limit may be calculated with the following equation:

Noise Floor (dBc) = -177(dBm) **–** Pout(dBm) + NF(dB) + Filter(dB)

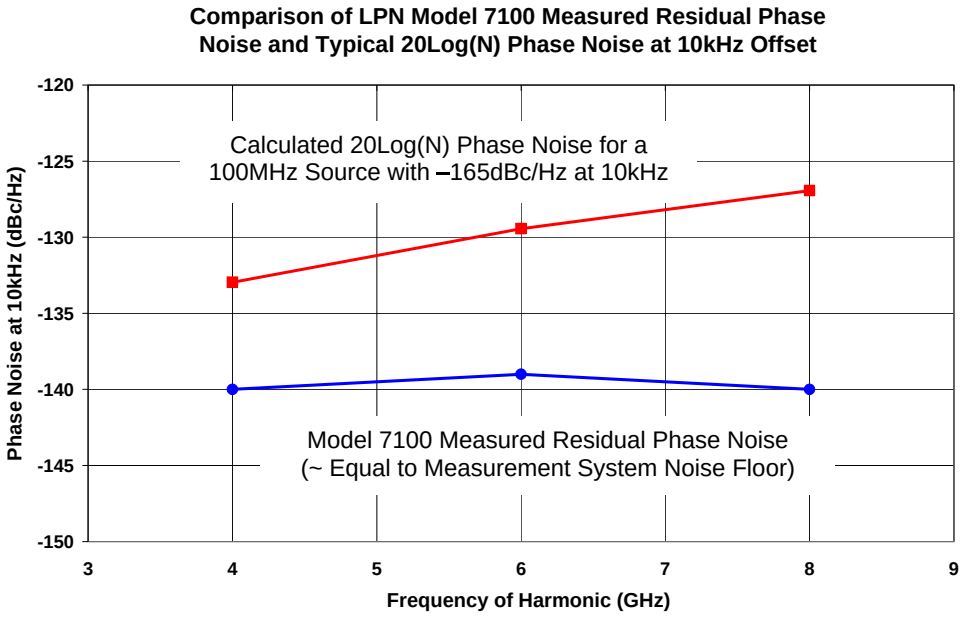
-144dBc = -177dBm + 25dBm + 3dB + 5dB

Where –177dBm is the thermal noise of a 50ohm resistor

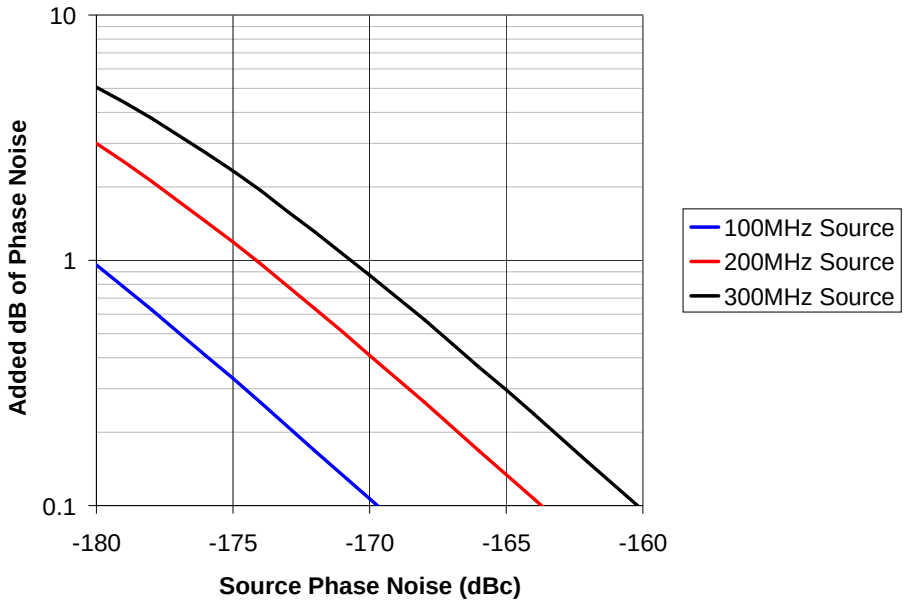
A comparison of the measured system noise floor results and the calculated theoretical thermal noise limit show that **the noise floor of the measurement system is thermally limited**.

The measured residual phase noise of the LPN Comb Generators at 4GHz, 6GHz, and 8GHz essentially overlay each other. For example, at a 10kHz offset the added phase noise is basically **–** 140dBc/Hz within a small margin of uncertainty (see following plot).

This data, along with the fact that the measured phase noise overlaps the noise floor of the measurement system, show that **the residual phase noise of these comb generators is below the noise floor of the measurement system**. If this were not the case, the measured phase noise would be increasing with the harmonic number, following the 20Log(N) rule. Also charted on the following plot is the comparable phase noise that a crystal oscillator (**–**165dBc/Hz phase noise at 10kHz) would have if multiplied up to the same harmonic with 20Log(N). This shows that the measured residual phase noise is well below the phase noise due to such a source at the same harmonic.



Another way of considering the phase noise that a comb generator would add to a typical source is to plot the added dB of phase noise for different sources with various amounts of phase noise. This plot assumes that the actual phase noise of the comb generator is –148dBc/Hz, the number may in fact be lower (measurement system noise floor was –140dBc/Hz).



The plot shows that for a –180dBc/Hz 100MHz source, the added phase noise would be **less than 1dB.** *This data demonstrates that the added phase noise is basically negligible for most practical sources.*