PicoPak Clock Measurement Module Noise versus Reference and Signal Input Power

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- **PicoPak Noise versus Signal Power**

The coherent noise level of the PicoPak clock measurement module depends somewhat on the applied RF reference and signal input power level. The nominal power level for its reference and signal inputs is +7 dBm, with a specified range between +10 dBm and 0 dBm. The reference input is used to clock the internal DDS, to generate a 2.5 kHz measurement sampling rate, and serves as the PIC Timer1 clock for period measurements. The signal input is applied, after a 3.5 dB gain RF buffer amplifier, to one input of the analog phase detector, and also drives the PIC Timer0 clock for frequency measurements. The DDS reference and phase detector signal input levels would be expected to have some effect on the coherent noise floor, while the timer and sampling rate divider inputs are relatively insensitive to power level because they are associated only with digital clocks.

- **PicoPak Noise versus Reference Power Measurements**

A series of ≈ 1-hour noise floor measurements were made at four levels of reference input power ranging from +9 to 0 dBm in 3 dB steps, all with the signal input power at a relatively high +9 dBm. The resulting 1-second ADEV stability versus signal power level is shown in Table I.

Table I. Noise Floor versus Reference Input Power

Reference Input Power dBm	1-Second ADEV $pp10^{11}$	Fit to 1s W PM Noise $pp10^{11}$
+9	1.15	1.19
+6	1.48	1.52
+3	1.68	1.70
0	1.97	2.05

It appears that the reference input power should be relatively high for the lowest noise floor, presumably to better clock the DDS, and that the nominal +7 dBm is insufficient for best performance.

- **PicoPak Noise versus Signal Power Measurements**

A series of ≈ 1-hour noise floor measurements were made at six levels of signal input power ranging from +9 to -6 dBm in 3 dB steps, all with the reference input power at a relatively high +9 dBm. The resulting 1-second ADEV stability versus signal power level is shown in Table II.

Table II. Noise Floor versus Signal Power Input		
Signal Input Power dBm	1-Second ADEV pp10^{11}	Fit to 1s W PM Noise pp10^{11}
+9	1.30	1.28
+6	1.32	1.34
+3	1.14	1.14
0	1.06	1.20
-3	1.15	1.19
-6	1.19	1.21

The PicoPak noise floor, somewhat unexpectedly, is not better with higher signal power, but rather seems to prefer a relatively low 0 dBm signal power. That conclusion is qualified however by the excellent initial noise result of Table I with both inputs at +9 dBm. There seems to be an additional factor involved that may be associated with small noise spikes that can vary from run to run.

A plot of the PicoPak coherent 10 MHz noise floor is shown in Figure 2 for the "best" +9 dBm reference and 0 dBm signal input power levels. The 1-second stability is 1.11×10^{-11} and the fit to the white PM short-term noise is 1.17×10^{-11} at 1 second.

The all-tau stability plot shows some slight cyclic behavior, apparently due to the small noise spikes that tend to occur in the frequency record (see Figure 1), perhaps caused by coherent interference between the 10 MHz inputs and the slightly-offset DDS frequency which has a full beat period of 107 seconds. It is possible that the "best" 0 dBm signal power is the one that minimizes that component in the phase detector output while still providing adequate DC sensitivity.

The all-tau plot from this overnight measurement run also shows some flattening at long tau, a probable result of sensitivity to room temperature variations.

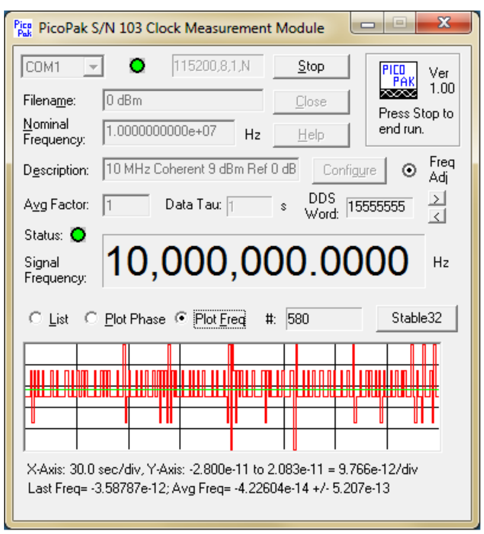

Figure 1. PicoPak Frequency Plot with Quasi-Periodic Noise Spikes

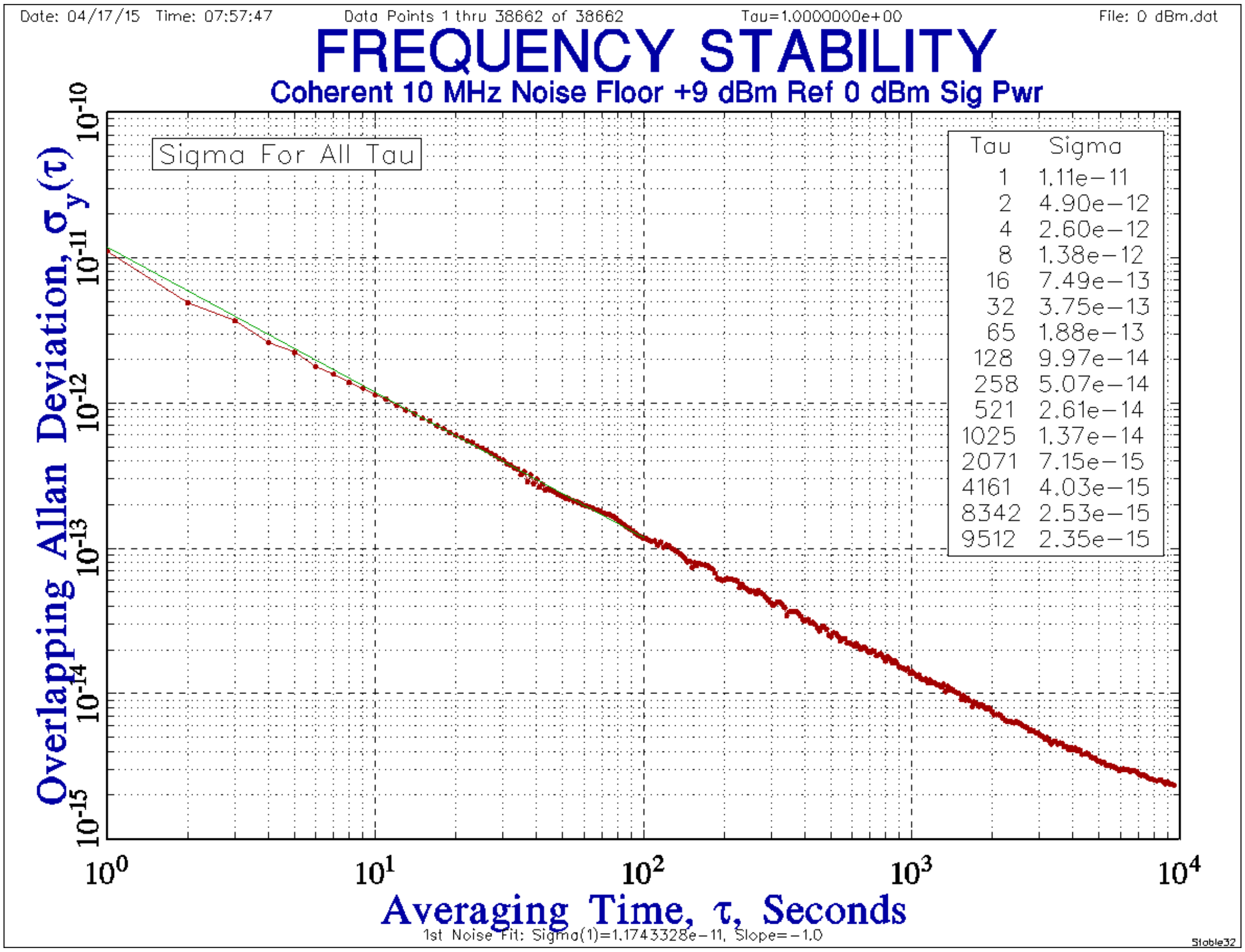

Figure 1. PicoPak S/N 103 10 MHz Noise Floor with +9 dBm Reference and 0 dBm Signal Input Power

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