

## NOTES ON OCXO PHASE NOISE MEASUREMENT

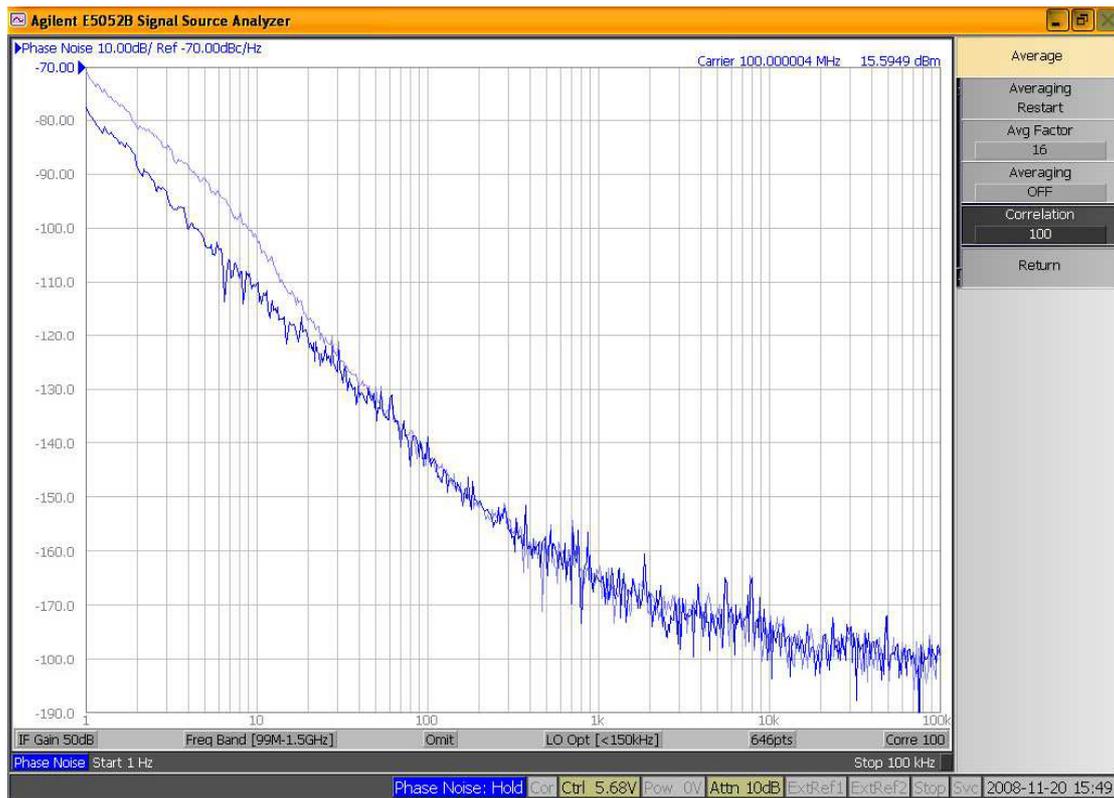
The Pascall OCXO design combines very low phase noise with a relatively wide tuning range. As a result, care needs to be taken when measuring (or using) the oscillators if the full performance is to be obtained.

Commercially available phase noise test equipment typically provides a voltage output to tune the DUT. This is generally fine for testing oscillators with moderate performance but can significantly increase the measured close-to-carrier noise of very low-noise sources, owing to noise voltage on the DC.

Degradation of phase noise at  $\llsim 100\text{Hz}$  offset has been observed with the HP3048 and Aeroflex PN9000 systems and with the E5052B SSA. It seems likely that other test systems, such as the E5500 and FSUP will cause similar problems.

With '2-oscillator' measurement systems such as the HP3048 and PN9000 where the tune voltage output is used to lock one of the sources, filtering is not applicable as it would interfere with the phase locked loop. One approach that has been used successfully here, is to make a low-noise variable DC source and add it to a 'potted down' tune voltage output from the test set. The DC source is used to tune the oscillator on to frequency, ready for the test system to do the required calibration and close the loop. A 10:1 pot down for example, will give 20dB reduction in the close-in noise added by the test set.

With the E5052B, the test set locks its internal sources on to the DUT, so a simple RC filter can be used to attenuate the low-frequency noise on its tune voltage output. The plot below shows two phase noise measurements on the same Pascall 100MHz OCXO, one using the 'raw' tune voltage and the other with it filtered via 3.9k $\Omega$  / 470 $\mu\text{F}$ .



This shows up to 10dB close-in degradation due to unfiltered tune voltage noise. (Indicated phase noise in the ~1-10kHz range is increased due to the small number of measurement correlations used.)

The same considerations apply when incorporating low-noise OCXOs in a system design. Care needs to be taken to ensure that the oscillator's inherently low phase noise is not compromised by noise on the tune voltage, whether it is supplied by a potentiometer, DAC or PLL. The tuning sensitivity of Pascall 100MHz OCXOs is typically in the range 200-300 Hz/V. Simple calculations will determine the required tune voltage noise limits to meet a given system specification.

Power supply quality is often neglected by system designers until it is too late! Whilst low-noise OCXOs should include supply regulation and filtering, it can't provide infinite rejection of supply noise and ripple. In addition, some factors such as earth loops are outside the oscillator designer's control and can cause problems irrespective of the oscillator's supply rejection. It is therefore advisable to integrate an OCXO into a representative system at the earliest opportunity, so any potential problems can be identified and dealt with.