Reference Oscillator Measurement / Calibration

Two methods are given to measure and calibrate the internal reference oscillator in a ‘Device Under Test’ (DUT). The first method (analog) is simpler, requiring only a scope and a traceable frequency standard. It also offers instant visual feedback of the result of the tuning adjustment. The second method (digital) requires more equipment but is faster and yields a more accurate number.

Analog Method
Equipment. You will need the following test equipment:

Traceable 10 MHz Frequency Standard (GPS disciplined Rubidium, Cesium, etc.)
100 MHz Oscilloscope

Setup. Connect the equipment as illustrated below in Figure 1. Set the scope to show 1 to 5 cycles of a 10 MHz signal. Connect the 10 MHz signal from the Frequency Standard to Channel \`A/1' of the scope and trigger on Channel \`A/1'. Connect channel \`B/2' of the scope to the \`REF OSC OUT' BNC connector on the back of the DUT. Watch the scope's display and note the time it takes for one complete cycle of channel \`B/2' to drift one cycle compared to channel \`A/1'.

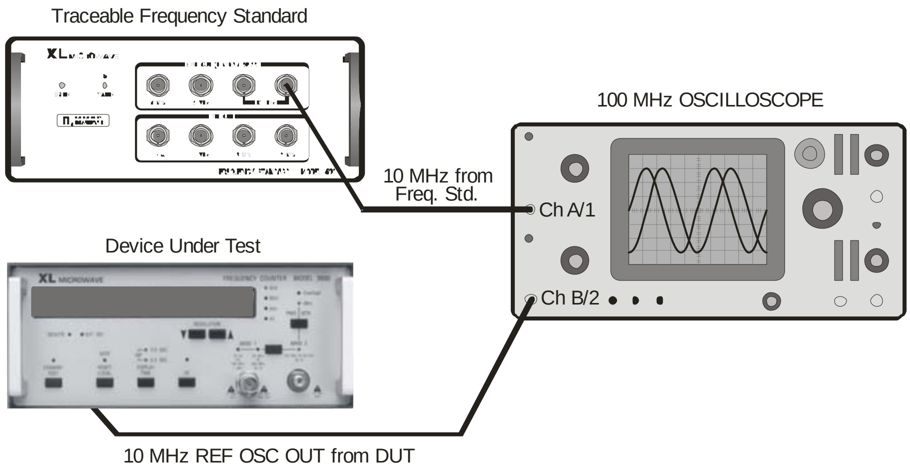

Figure 1. Reference Oscillator Test Setup, Analog version.

Calibrate. On the DUT oscillator, adjust the internal reference oscillator trimpot for minimum drift of the signal on the oscilloscope display using a nonconductive tuning tool (remove the tool when noting drift as the tool will affect the observation).

Measurement Results.

Accuracy = (for a one-cycle drift)
1 second drift/cycle = 10E-7;
10 second drift/cycle = 10E-8;
100 second drift/cycle = 10E-9.

Digital Method

Equipment. You will need the following test equipment:

Traceable 10 MHz Frequency Standard (GPS disciplined Rubidium, Cesium, etc.)
40 GHz Synthesized Signal Generator
40 GHz Frequency Counter with 11 digits of resolution at 40 GHz (Hz resolution)

Setup. Connect the equipment as illustrated below in Figure 2. The 10 MHz signal from the traceable Frequency Standard is connected to the Synthesizer's external reference input. Set the Synthesizer to 40 GHz (or the highest frequency that the test counter can count). Set the output of the Synthesizer to 40 GHz, and connect this signal to the microwave input of the test counter. Connect the 'Internal Reference Oscillator 10 MHz Out' signal from the DUT to the 'External Reference Oscillator Input' on the test counter. Set the resolution on the test counter to display the greatest resolution possible.

This method effectively multiplies-up the traceable Frequency Standard's 10 MHz output to a traceable 40 GHz signal into the test counter's microwave input (with the accuracy of the frequency standard). The accuracy of the test counter's readout of this 40 GHz signal is now dependant on the accuracy of the 10 MHz internal oscillator in the DUT.

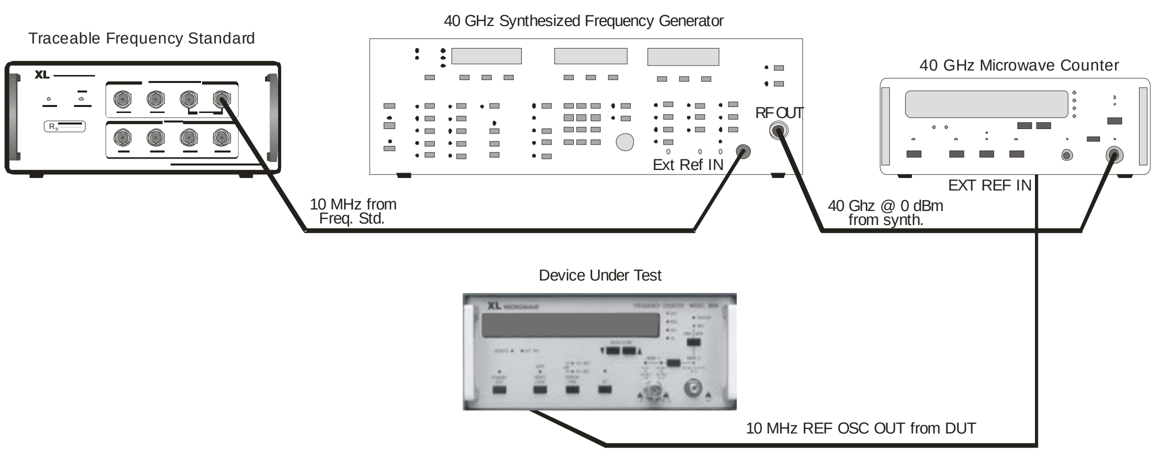

Figure 2. Reference Oscillator Test Setup, Digital version.

Calibrate. On the DUT, adjust the internal reference oscillator trimpot for the closest possible reading to 40.000000000 GHz on the test counter's display. Use a nonconductive tuning tool (remove the tool when noting reading as the tool will affect the observation).

Measurement Results. A well designed GPS disciplined Rubidium Oscillator should have short-term Allen Variance stability in parts to E-12 or better (100 seconds or less).

To interpret the accuracy of the adjustment of the internal reference oscillator, or another 10 MHz oscillator (DUT), a reading on the test counter of:

40.000 000 005 GHz is equivalent to 7.5 parts in 10E-11
40.000 000 023 GHz is equivalent to 5.8 parts in 10E-10
40.000 000 040 GHz is equivalent to 1 part in 10E-9
40.000 000 800 GHz is equivalent to 2 parts in 10E-8
40.000 006 000 GHz is equivalent to 1.5 parts in 10E-7