

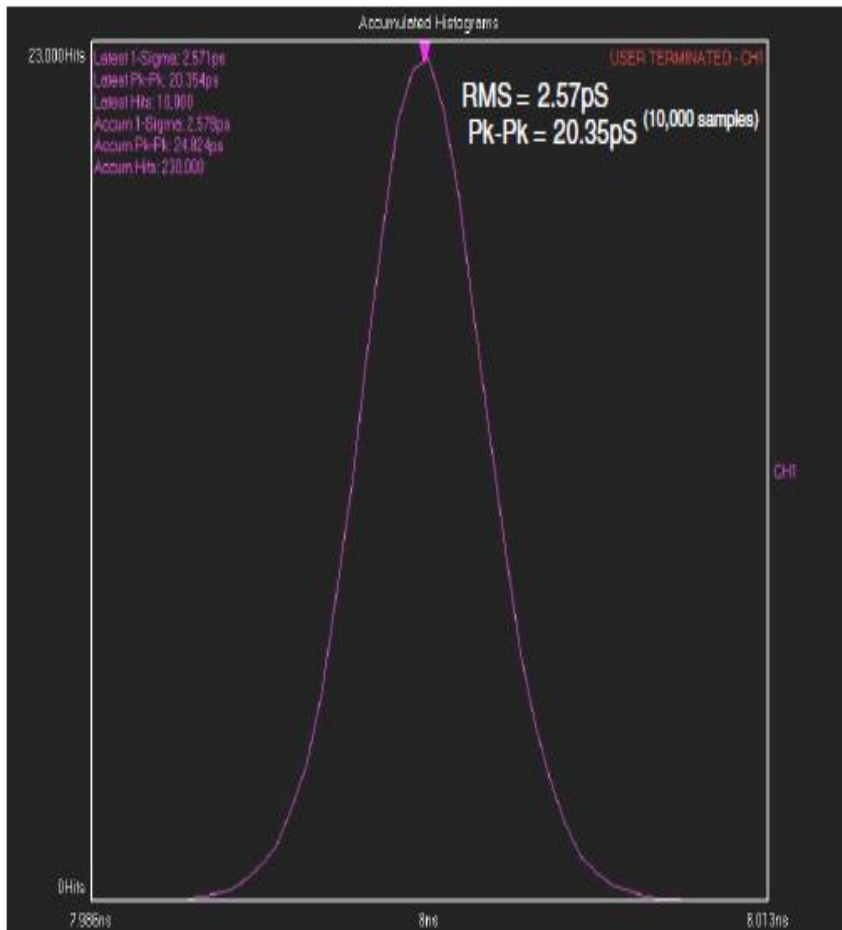
Mercury EMI Reducing Spread Spectrum clock oscillators

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Mercury United Electronics Inc.
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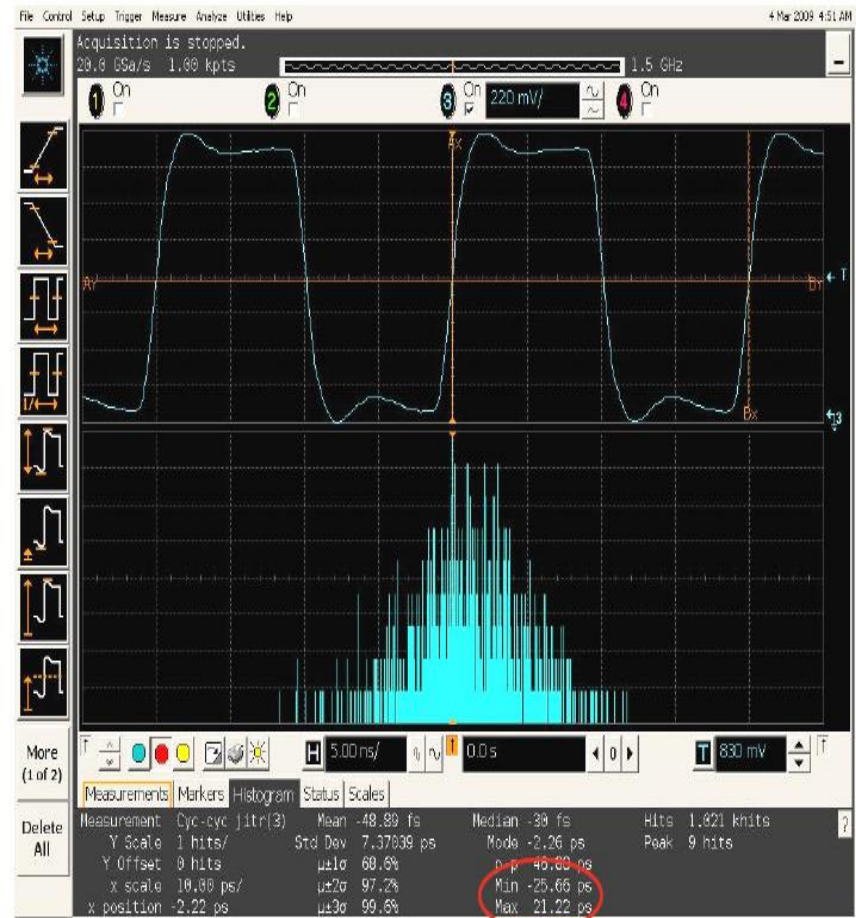
Modulation = Jitter

- With SS, strong spur at phase noise plot. If modulation rate (carrier frequency, dither rate) is 30 KHz, spur found at 30 KHz and all its harmonics such as 60 KHz, 90 KHz, etc.
- Difficult for E5052B to “lock” the signal
- **Period jitter:** 100 MHz SSXO with $\pm 1\%$ magnitude as an example. Signal period is varying between 9.9 ns and 10.1 ns → Period jitter = 0.2 ns = 200 ps peak-to-peak.
- **Cycle-to-cycle jitter:** Modulation is moving relatively slow compared to the clock frequency, it is better to look at “cycle-to-cycle” jitter

Period Jitter and Cycle-to-Cycle Jitter Measurement



Period Jitter Measurement

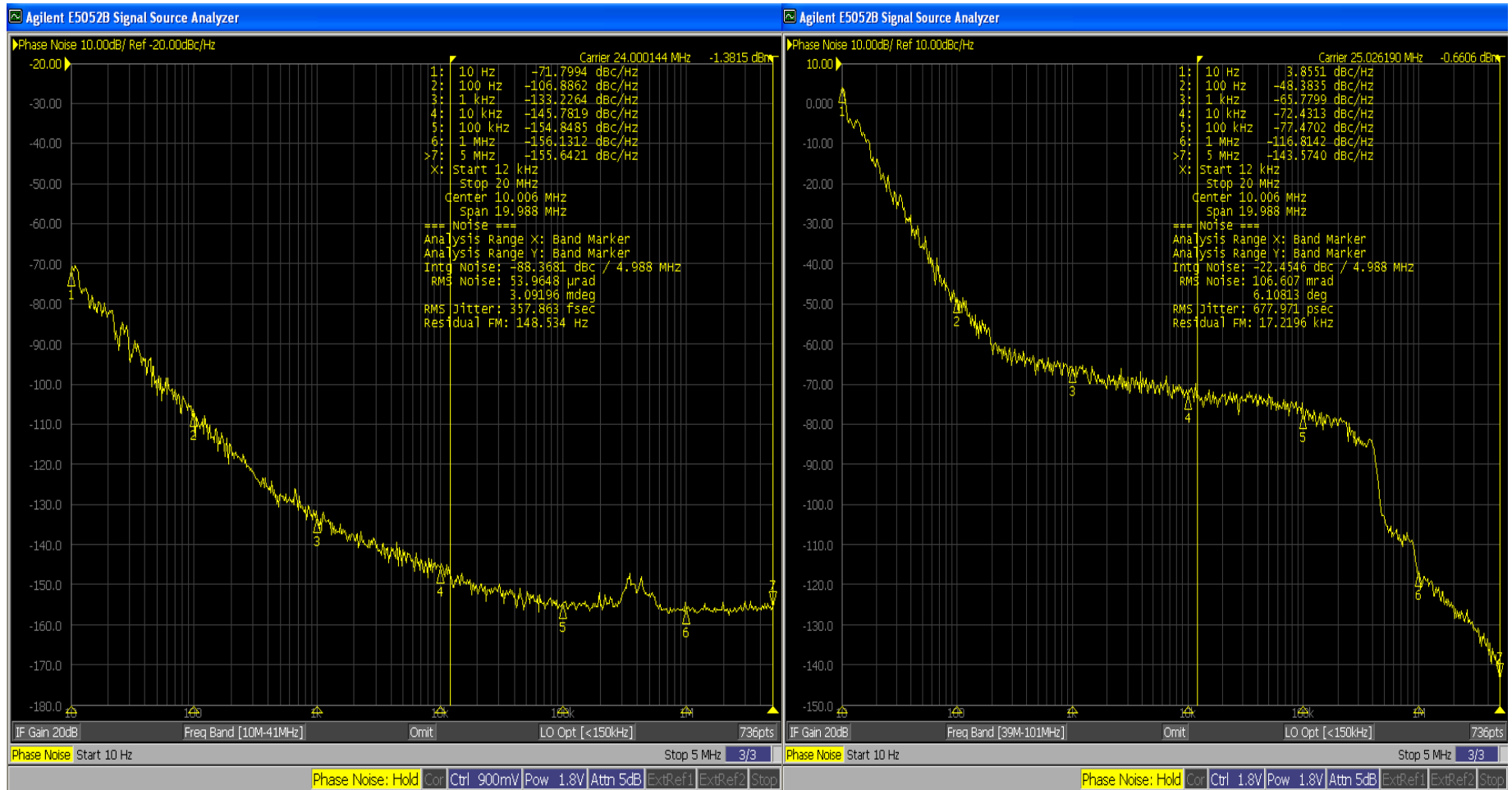


Period Jitter Measurement

Jitter (Cycle-to-Cycle) Spec. of Mercury SSXOs

Group	VDD	Available Frequency Range	Jitter (Cycle-to-Cycle)
Group F	1.8V	12.5 ~ 42 MHz	100 ps max.
Group R	3.3V	3.5 ~ 160 MHz	300 ps max.
Group P	3.3V	13 ~ 220 MHz	100 ps max.
TBD	2.5V/3.3V	~ 200 MHz	100 ps max.

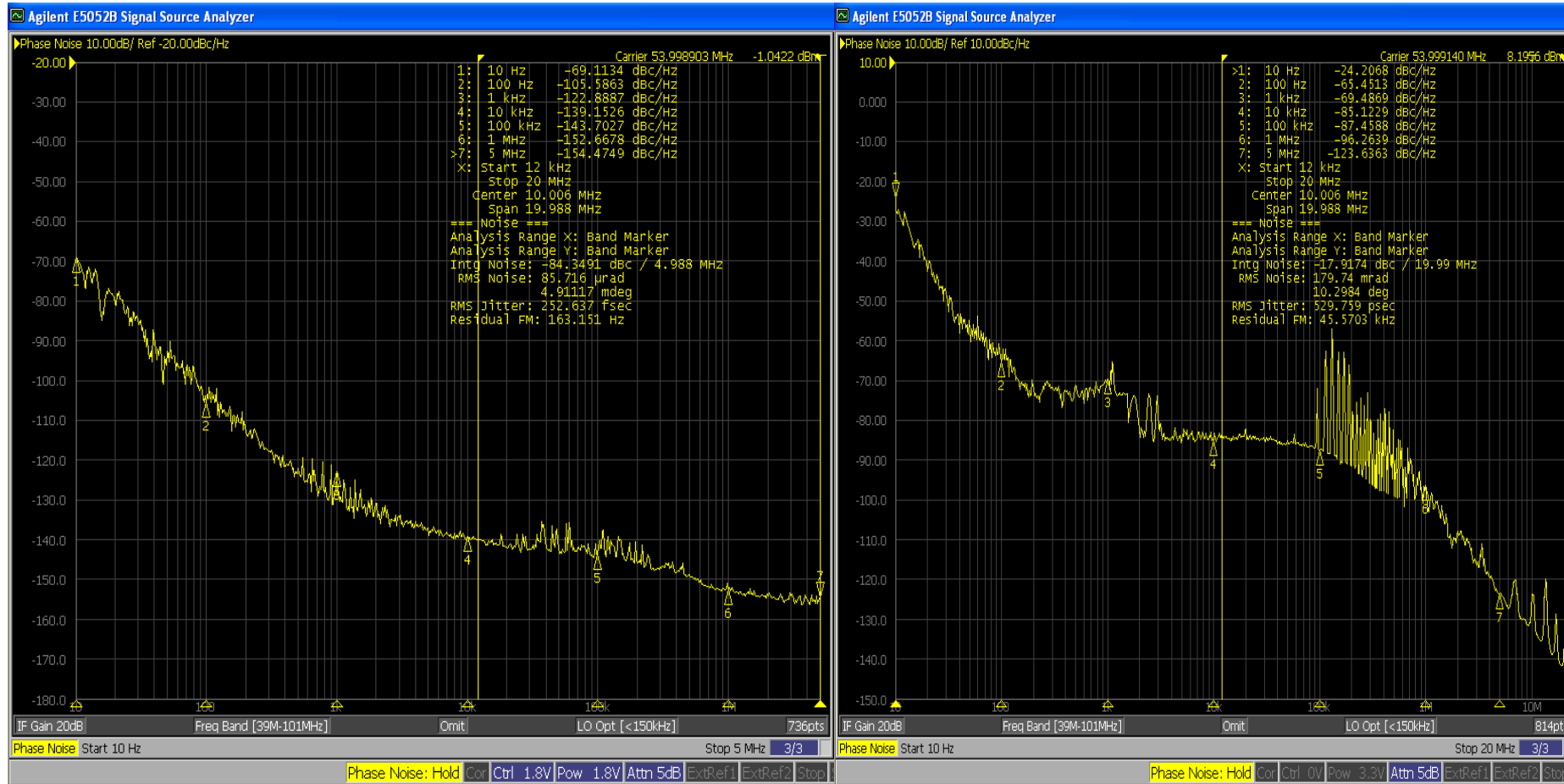
XO (18H32-24.000) vs SSXO (18HM57-25.000) Phase Noise Comparison



XO (18H32-24.000) vs SSXO (18HM57-25.000) Phase Noise Comparison

	XO, 18H32-24.000 1.8V, 24.0 MHz	SSXO 18HM57-25.000 1.8V, 25.0 MHz
10 Hz offset	-71.7 dBc/Hz	3.8 dBc/Hz
100 Hz offset	-106	-48
1 KHz offset	-133	-65
10 KHz offset	-145	-72
100 KHz offset	-154	-77
1 MHz offset	-156	-116
5 MHz offset	-155	-143
RMS Phase Jitter (12 KHz ~ 20 MHz)	357 fs	677 ps

XO (18H32-54.000) vs SSXO (3HM57-54.000) Phase Noise Comparison

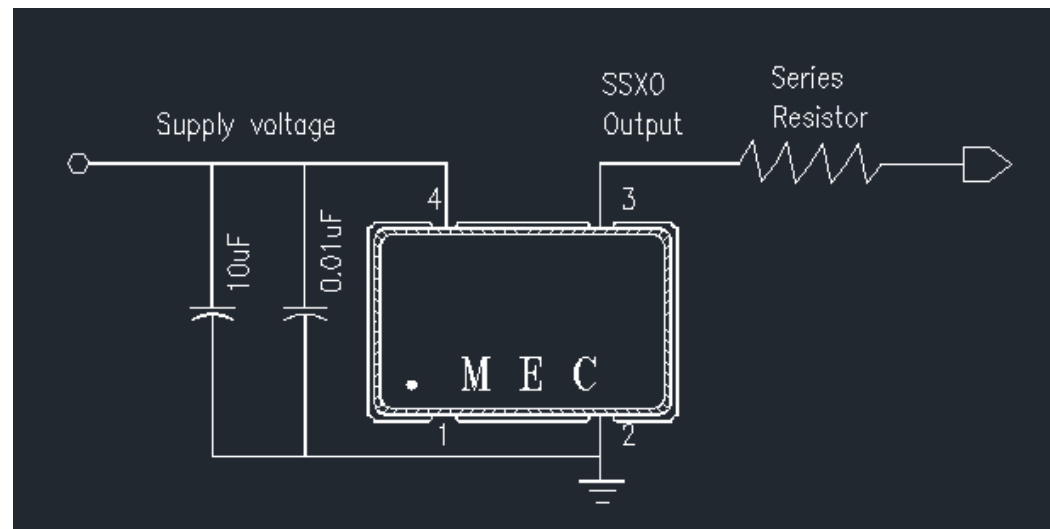


XO (18H32-54.000) vs SSXO (18HM57-25.000) Phase Noise Comparison

	XO, 18H32-54.000 1.8V, 54.0 MHz	SSXO, 3HM57-54.000 3.3V, 54.0 MHz
10 Hz offset	-69 dBc/Hz	-24 dBc/Hz
100 Hz offset	-105	-65
1 KHz offset	-122	-69
10 KHz offset	-139	-85
100 KHz offset	-143	-87
1 MHz offset	-152	-96
5 MHz offset	-154	-123
RMS Phase Jitter (12 KHz ~ 20 MHz)	252 fs	529 ps

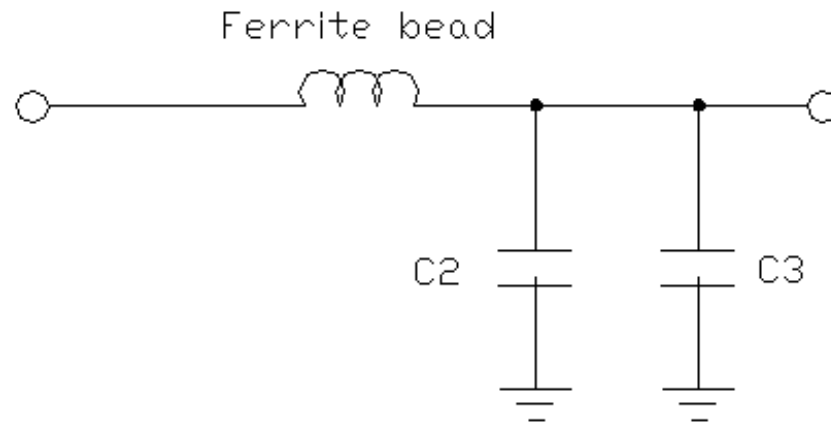
To Suppress Unwanted Ring Back at Output

- Impedance matching at Output: Add a series resistor to suppress the high frequency noise due to overshoot and undershoot
- Mercury 1.8V SSXO group “F” has output impedance of 30 ohms. A series resistor of 20 ohms at SSXO output is recommended.



Power Supply Filtering Configuration

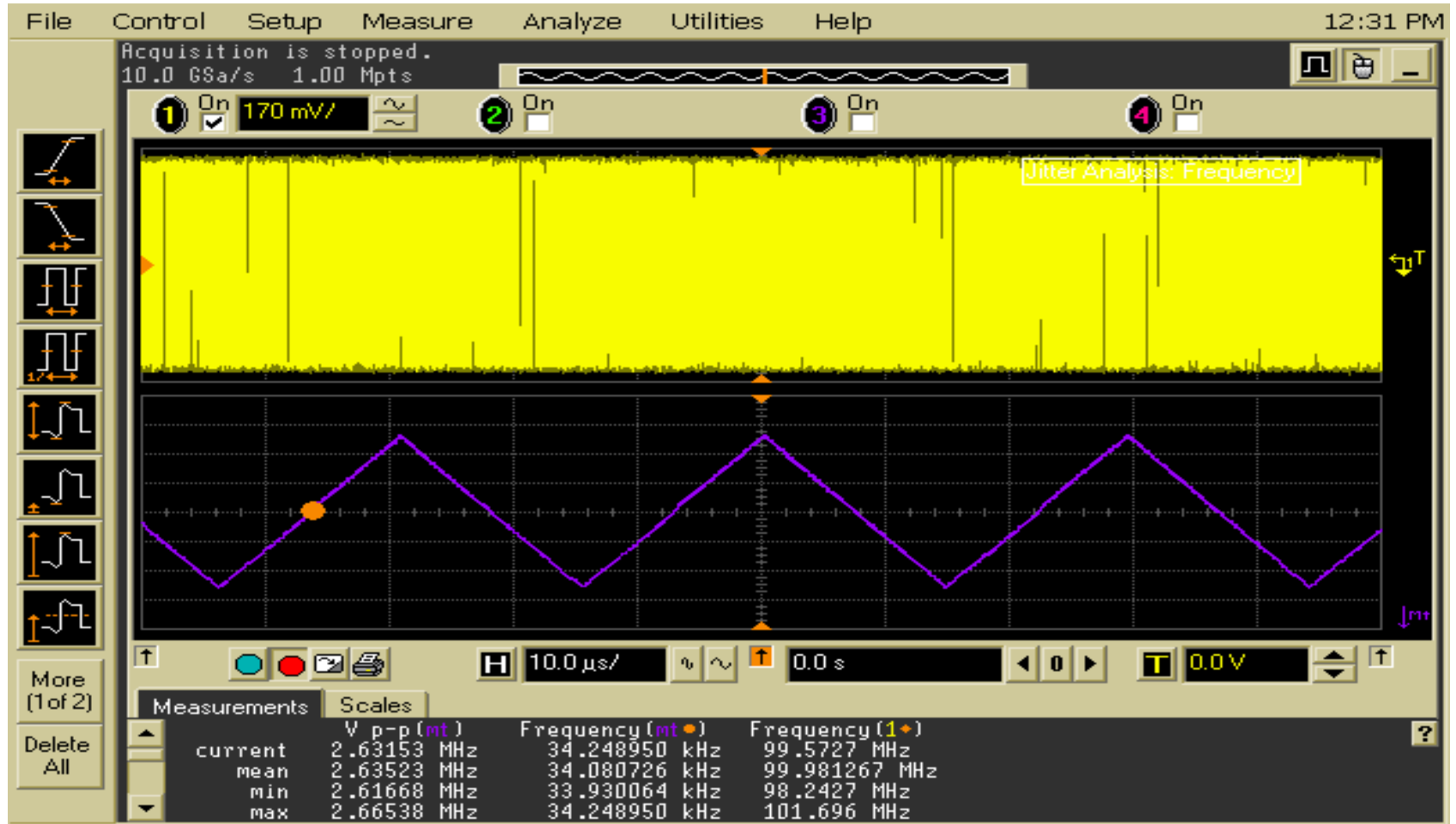
- Low pass Π filter can remove power supply noise and prevent clock noise from feeding back to the supply.
- C2: Low frequency supply decoupling capacitor. Tantalum or electrolytic 10 μF or 22 μF (4.7 μF min.)
- C3: High frequency supply decoupling capacitor. 0.1 μF ceramic chip capacitor.



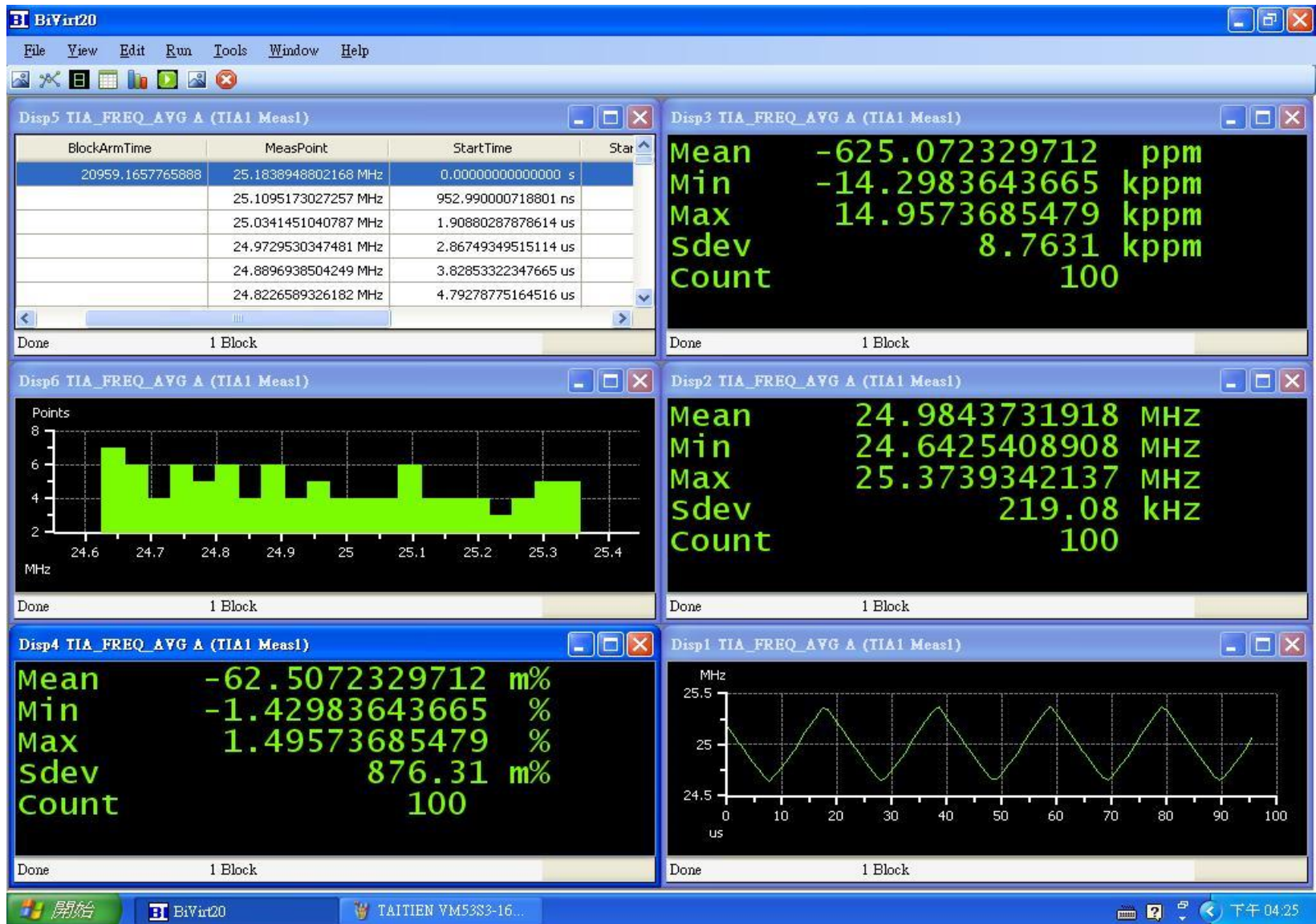
How Modulation works in a PLL

- Modulation rate is equal to the phase detector frequency,
- This is the trick to “hide” the modulation for the PLL so the PLL will not counter act the modulation.
- The PLL will lock to the average frequency.

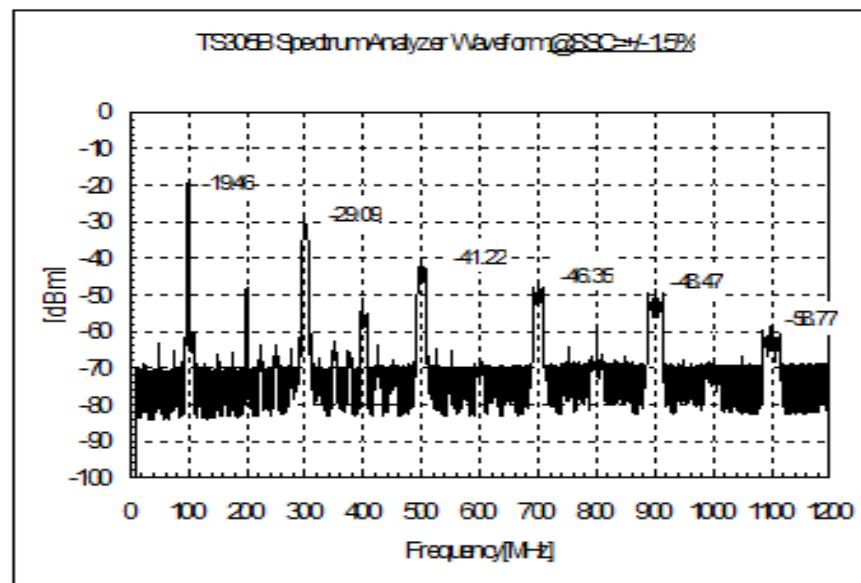
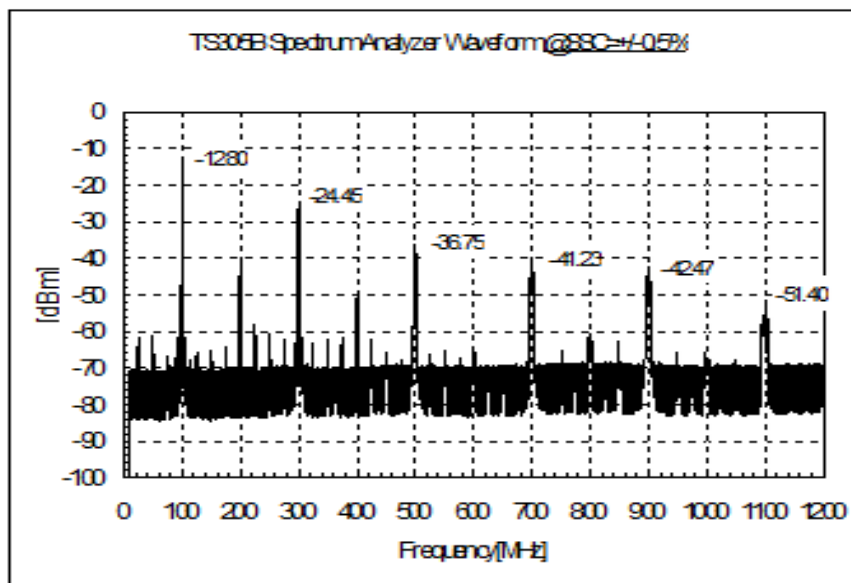
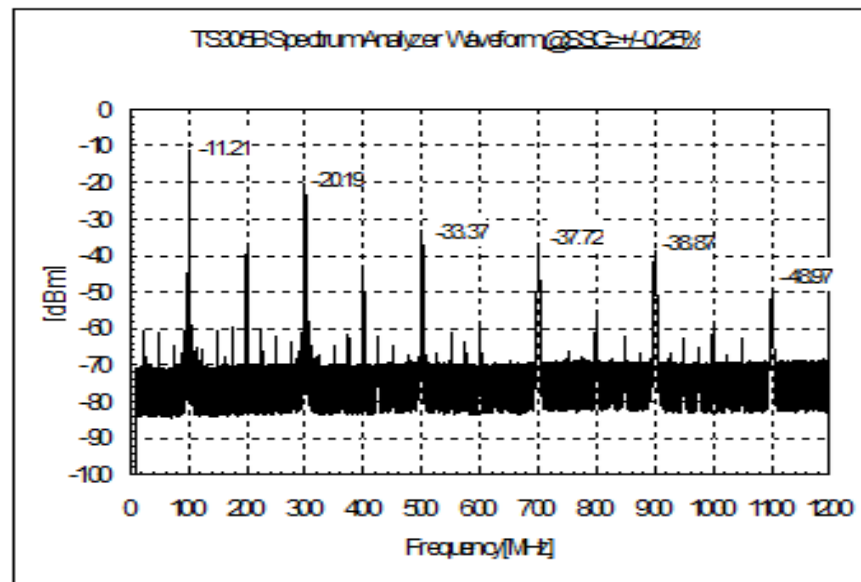
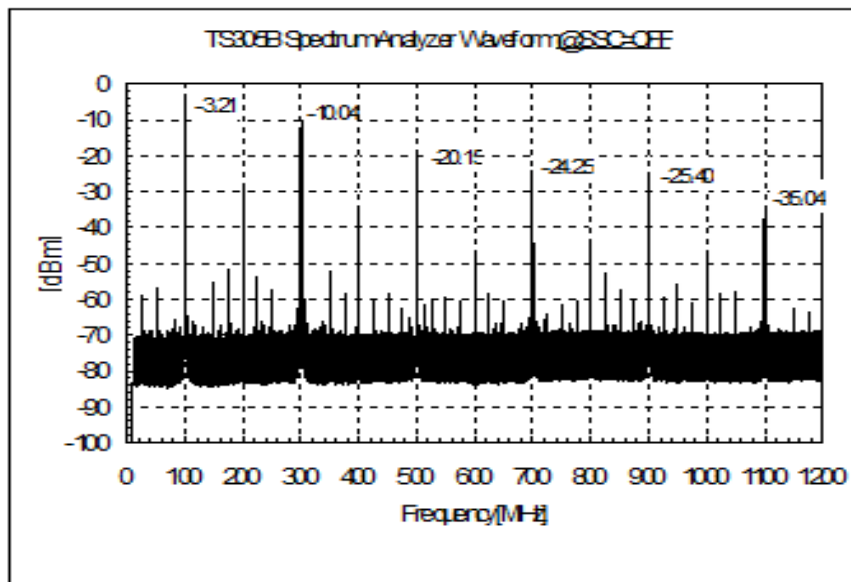
Measure SSX0 using Digital Oscilloscope



Measure SSX0 using Time Interval Analyzer



EMI Reduction is Applied to the Whole Spectra



Spread Spectrum Technology

“In a spread spectrum system, the transmitted signal is spread over a bandwidth that is much wider than the bandwidth required to transmit the information being sent (e.g., a voice channel of a few kHz bandwidth is spread over many MHz). This is accomplished by modulating a carrier signal with the information being sent, using a wideband pseudonoise (PN) encoding signal. A spread spectrum receiver with the appropriate PN code can demodulate and extract the information being sent. Those without the PN code may completely miss the signal, or if they detect the signal, it appears to them as noise.”

D. L. Schilling, R. L. Pickholtz and L. B. Milstein, "Spread Spectrum Goes Commercial," IEEE Spectrum, Vol. 27, pp. 40-45, 1990.