12.5 MHz – 6.4 GHz RF Signal Generator plus RF Detector

Features

- Calibrated RF input and output
- Low harmonic distortion
- Instantaneous, peak, and average power detector
- Open source Labveiw GUI software control via USB
- Open source Labveiw Network Analyzer application
- Run hardware functions with or without a PC
- Generator frequency, phase and amplitude control
- Generator 0.01dB amplitude resolution
- 0.1Hz frequency resolution
- 0.01 degree phase control
- 100uS RF lock time standard
- 250uS per step typical sweep speed
- Up to +15dBm output power
- Over 50dB of power control
- 10MHz – 100MHz external reference input
- Selectable 10 or 27 MHz internal reference output
- 2.5ppm internal reference accuracy
- Internal and external FM, AM, Pulse Modulation
- Pulsed FMCW Chirp
- External sweep, step and modulation trigger
- 500 point frequency and amplitude hop table
- Channel enable / disable saves energy
- 3.5 X 2.15 inches not including RF connectors
- USB or UART control via USB-C connector
- Power by USB-C or 5V connector
- 32-bit ARM processor on board

Overview Description

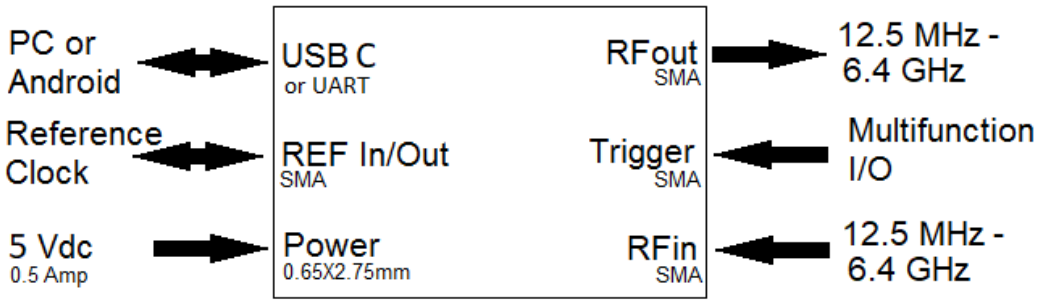
The Windfreak Technologies SynthNV Pro is a 12.5 MHz to 6.4 GHz software tunable RF signal generator and frequency sweeper controlled and powered by a device running Windows, Linux or Android via its USB port. The SynthNV Pro also has a broadband RF Detector port allowing it to measure RF power in dBm up to 6.4GHz and over 50dB of range. The RF generator side has a multiband agile switching low pass filter to help attenuate output harmonics.

The SynthNV Pro also has nonvolatile on-board flash memory so it can be programmed to fire up by itself on any frequency, power, sweep or modulation setting (and combinations thereof) to run without a PC in the field. This makes for a highly mobile, low power and light weight solution for your RF signal generation needs.

Applications

- Wireless communications systems
- Scalar Network Analysis
- RF and Microwave radios
- Software Defined Radio (SDR)
- Radar including FMCW
- Automated Test Equipment (ATE)
- EMC - radiated immunity pre-compliance testing
- Electronic Warfare (EW) and Law Enforcement
- Quantum computing and device research
- Plasma physics

SynthNV Pro Functional Diagram



Windfreak Technologies, LLC.

Contents

1 USB / UART WARNING

The SynthNV Pro was designed to work with, and ships with, a USB 2 cable. Use a USB 3 cable only when tapping into the UART signals for 3.3V COM port control of the SynthNV Pro with your own microcontroller circuit. Using a USB 3 cable attached to a USB 3 port on a PC may have unknown consequences as the PC is not designed to see the SynthNV Pro UART signals and vv. See UART app note for UART usage instructions.

2 Characteristics

2.1 Electrical Characteristics

Characteristic	Notes	Min.	Typ.	Max.	Unit
Supply Voltage	Suggested 1A minimum	4.7	5	5.5	V
Supply Current			250		mA
Standby Supply Current	RF output OFF		60		mA
RF Input / Output Frequency Range		12.5	-	6400	MHz
Calibrated Frequency Range		12.5		6400	MHz
RF Output Power Maximum	See graph	6	11	15	dBm
RF Output Power Minimum	See graph		-45		dBm
RF Input Power Range	Max is +20dBm before damage	-40		15	dBm
RF OFF Output Power	100% shutdown of RF section			-80	dBm
RF Output Frequency Resolution	Default is 100Hz selectable by Channel Spacing Setting	0.1			Hz
RF Output Power Resolution		0.01			dB
RF Phase Resolution	** See note 1	0.01			°
RF Output Impedance			50		Ω
Internal Reference Frequency	Selectable		10 or 27		MHz
Internal Reference Tolerance			2.5		ppm
External Reference Frequency	Keep phase comparator less than 100MHz	10	-	100	MHz
External Reference Level	Keep below 3.3Vpp	-10	+10		dBm
Trigger	Internally pulled up	-0.3		3.3	V
UART	3.3V native, 5V tolerant	-0.3	3.3	5.0	V

Note 1: Phase tuning speed, phase resolution and carrier frequency are inter-related. Phase tuning speed slows as RF carrier frequency and Channel Spacing settings decrease. Smaller Channel Spacing will have higher phase and frequency resolutions but slower phase tuning speed. Going below 100MHz carrier with smaller Channel Spacing than 100Hz may be prohibitively slow and/or erratic.

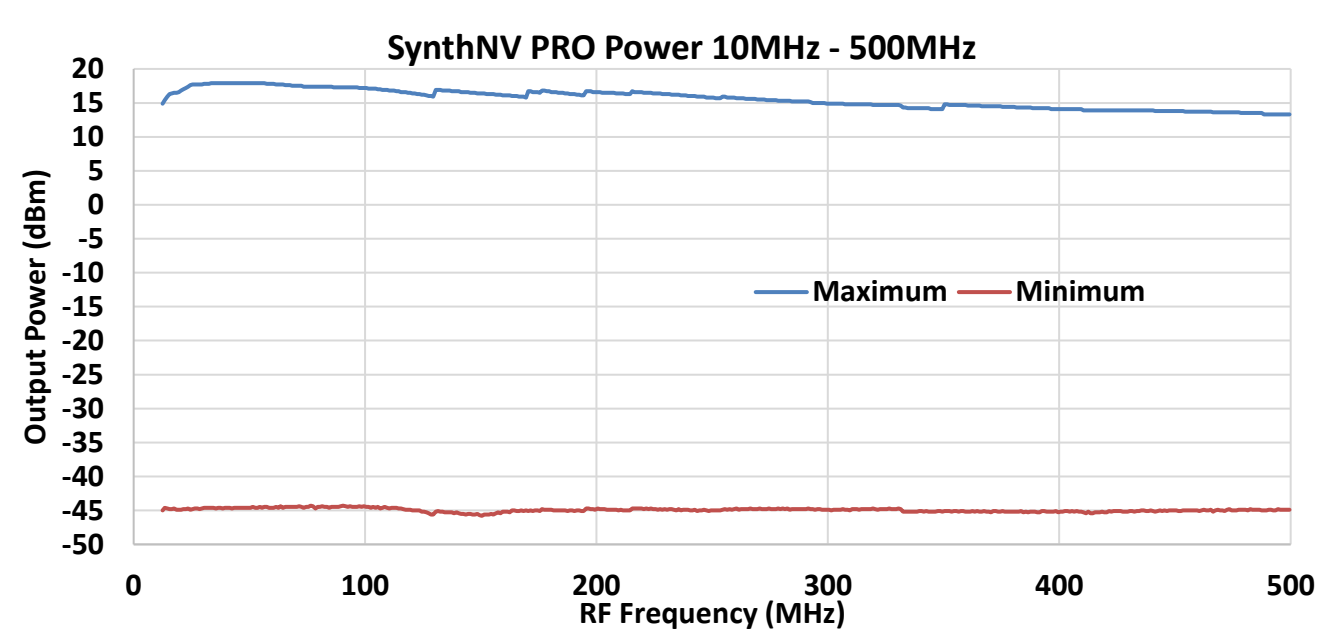
2.2 Thermal Operating Characteristics

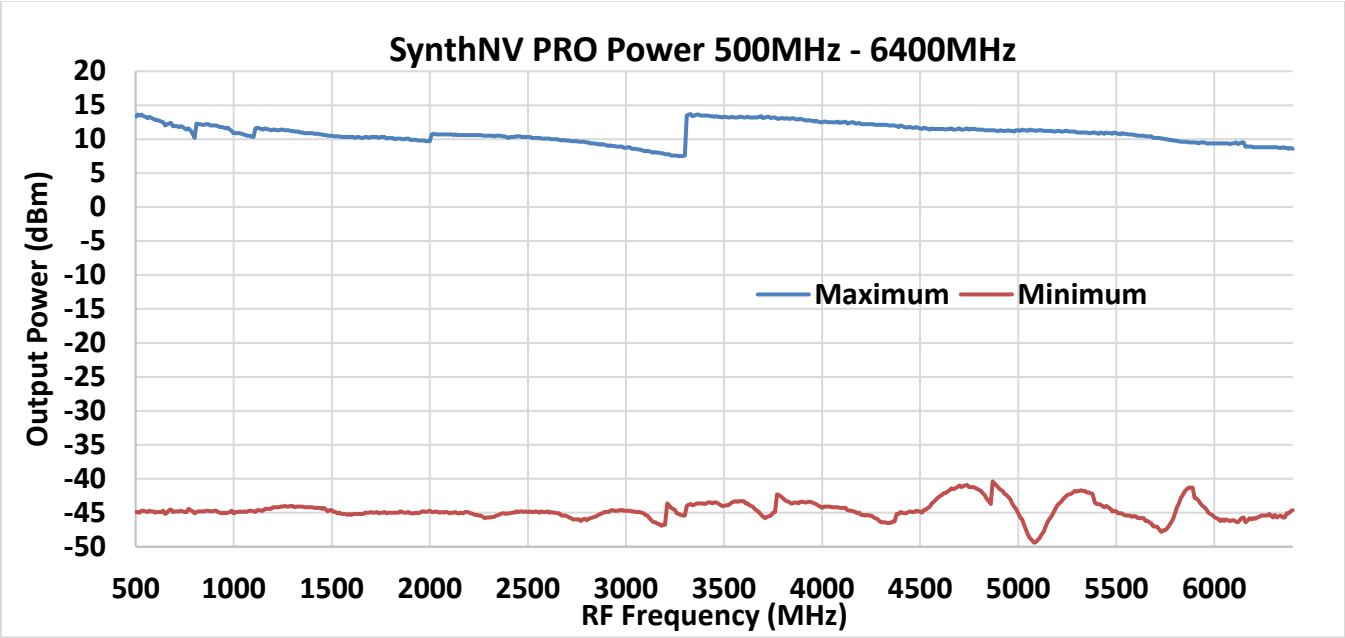
Description	Notes	Min	Max	Unit
Operating Temperature	Without airflow or heatsinking	-40	50	°C
Operating Temperature	Query internal temperature sensor with software and keep below 75C with airflow, heat sinking or limited duty cycle.	-40	75 Internal	°C

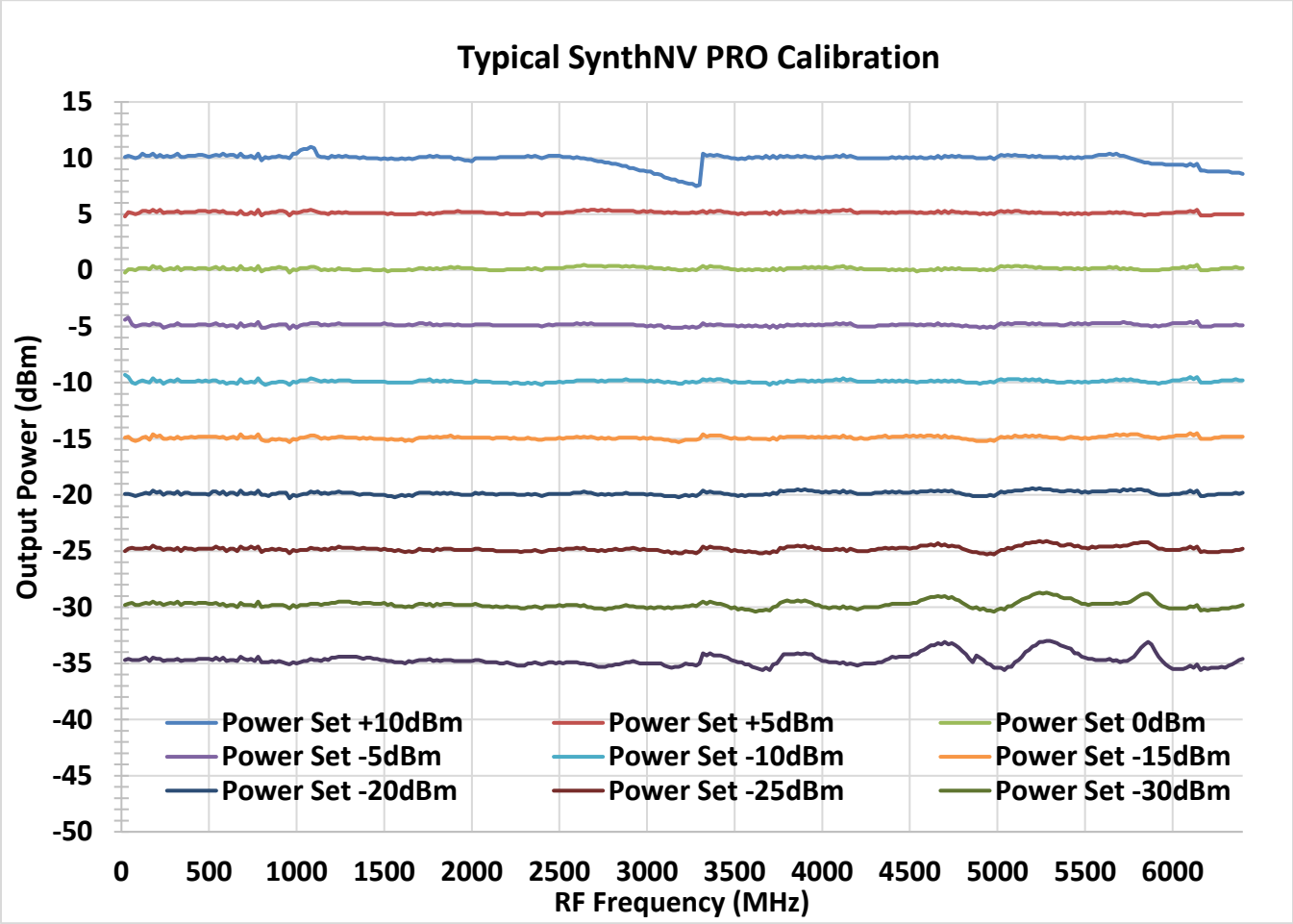
3 Typical Performance

3.1 RF Output Power

The typical output power of the SynthNV Pro is shown below. This graph is of unleveled operation at the maximum gain setting of the output and -45dBm for the minimum setting. Settings between these two levels will be controlled and uncalibrated levels can be attained below -45dBm. RF output power and frequency can be set independent of each other. Power levels are settable in 0.01dBm increments. On board calibration is attained through a look up table. Device calibration is performed at the factory and stored in onboard flash memory. Calibration is good from 12.5MHz to 6.4GHz. All parts of the signal chain have high quality voltage regulation, and the D/A driving the VGA have a 1% voltage reference controlling their outputs. Maximum power transitions in the graphs below are due to switch points in the switchable output harmonic filter and are not user controllable.




SynthNV PRO Power 500MHz - 6400MHz
Output Power (dBm)
20
15
10
5
0
-5
-10
-15
-20
-25
-30
-35
-40
-45
-50
Maximum
Minimum
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
5500
6000
RF Frequency (MHz)


Typical SynthNV PRO Calibration
Output Power (dBm)
15
10
5
0
-5
-10
-15
-20
-25
-30
-35
-40
-45
-50
Power Set +10dBm
Power Set +5dBm
Power Set 0dBm
Power Set -5dBm
Power Set -10dBm
Power Set -15dBm
Power Set -20dBm
Power Set -25dBm
Power Set -30dBm
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
5500
6000
RF Frequency (MHz)

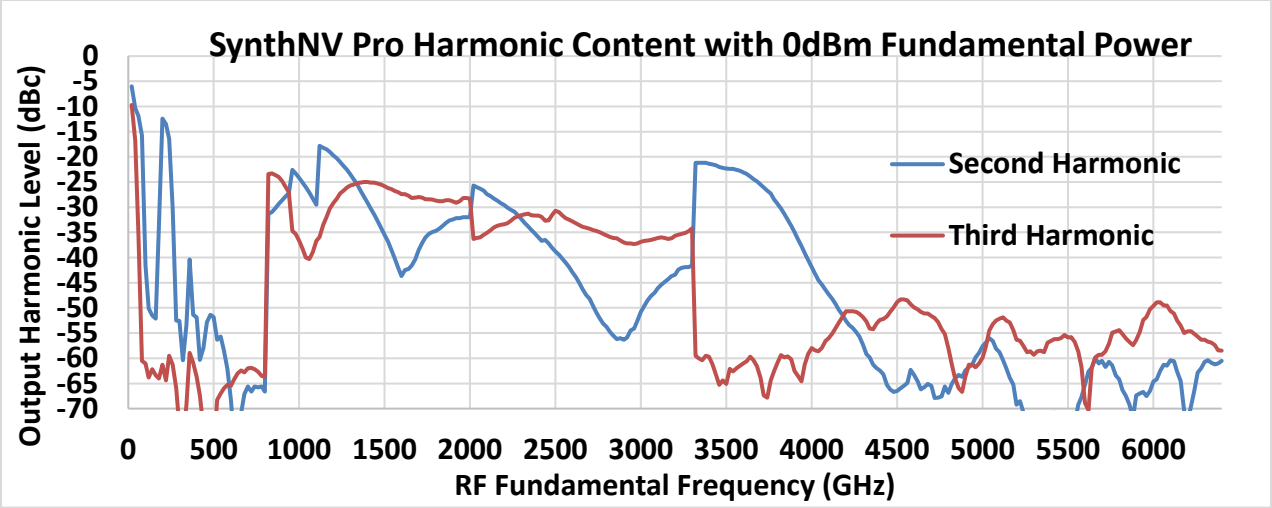
Note: +10dBm setting hitting max power limit in spots

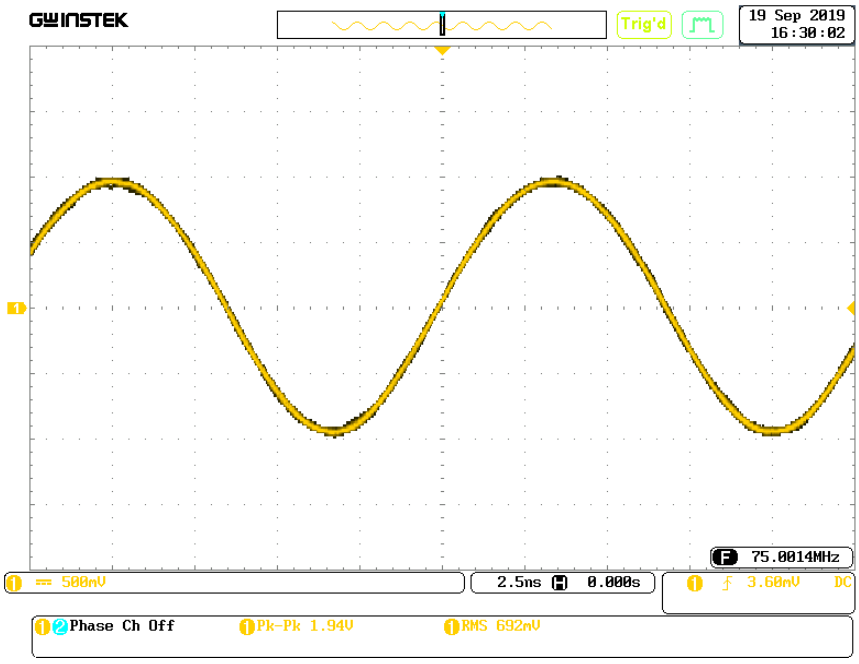
3.2 RF Output Harmonic Content

The typical SynthNV Pro harmonic distortion is shown below for the second and third harmonics. This data is taken at a leveled fundamental power of 0dBm.

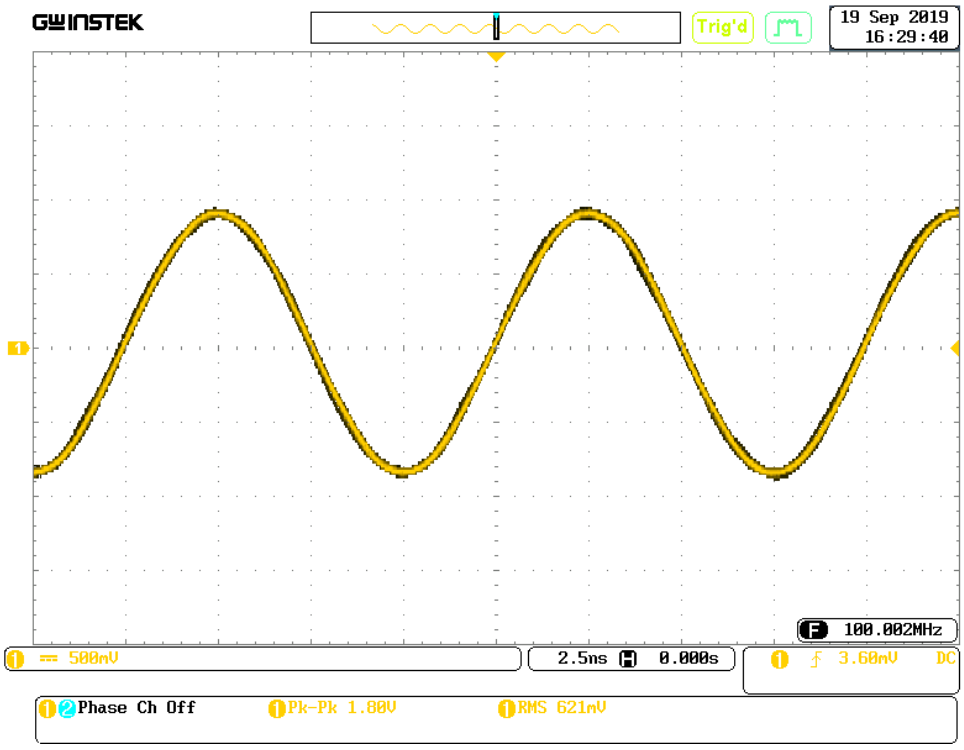
If lower harmonic levels are needed, Windfreak Technologies suggest the use of low cost SMA filters from Crystek and Minicircuits.

Example: Crystek Lowpass Filter – many cutoff frequencies, 1GHz example: CLPFL-1000, $25

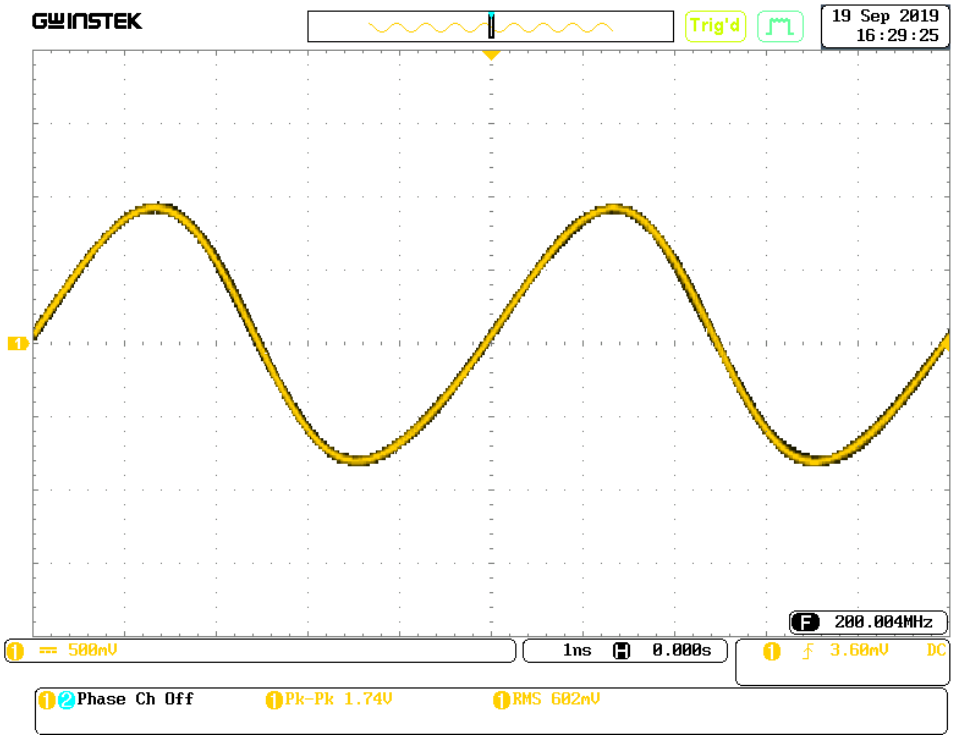




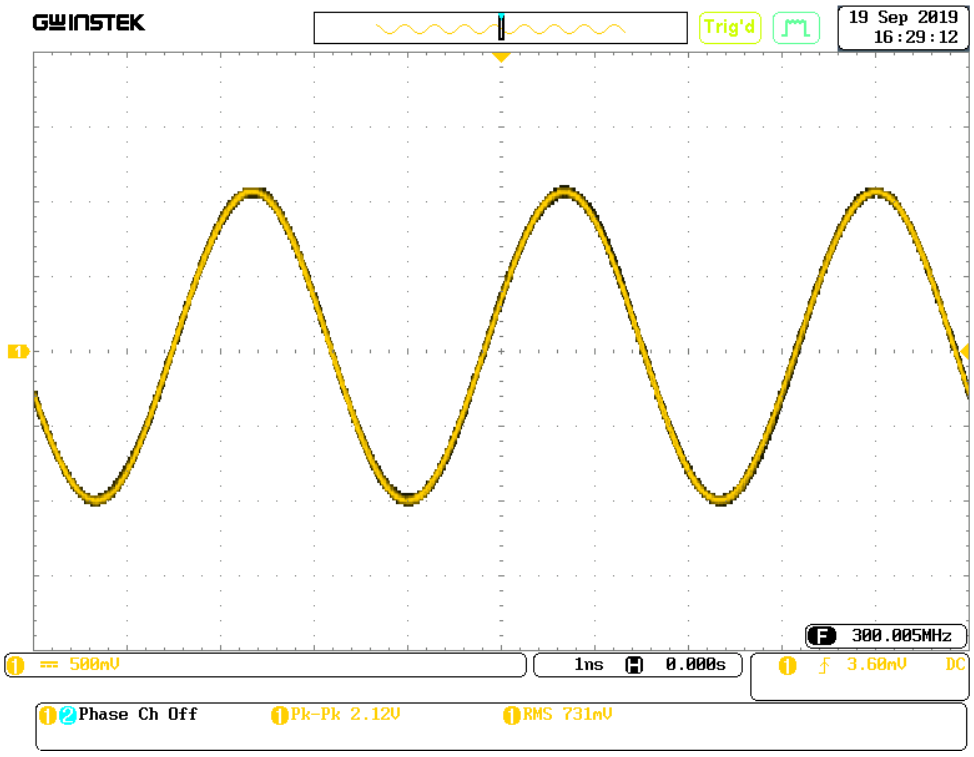
Typical 75MHz waveform (500MHz 4GS/s scope)



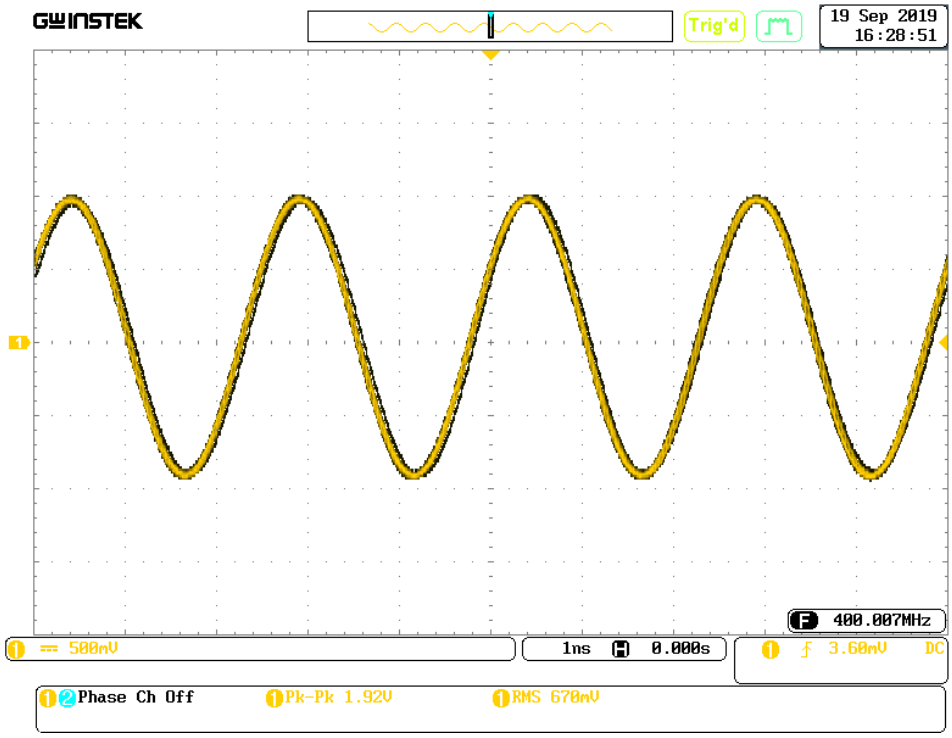
Typical 100MHz waveform (500MHz 4GS/s scope)



Typical 200MHz waveform (500MHz 4GS/s scope)



Typical 300MHz waveform (500MHz 4GS/s scope)



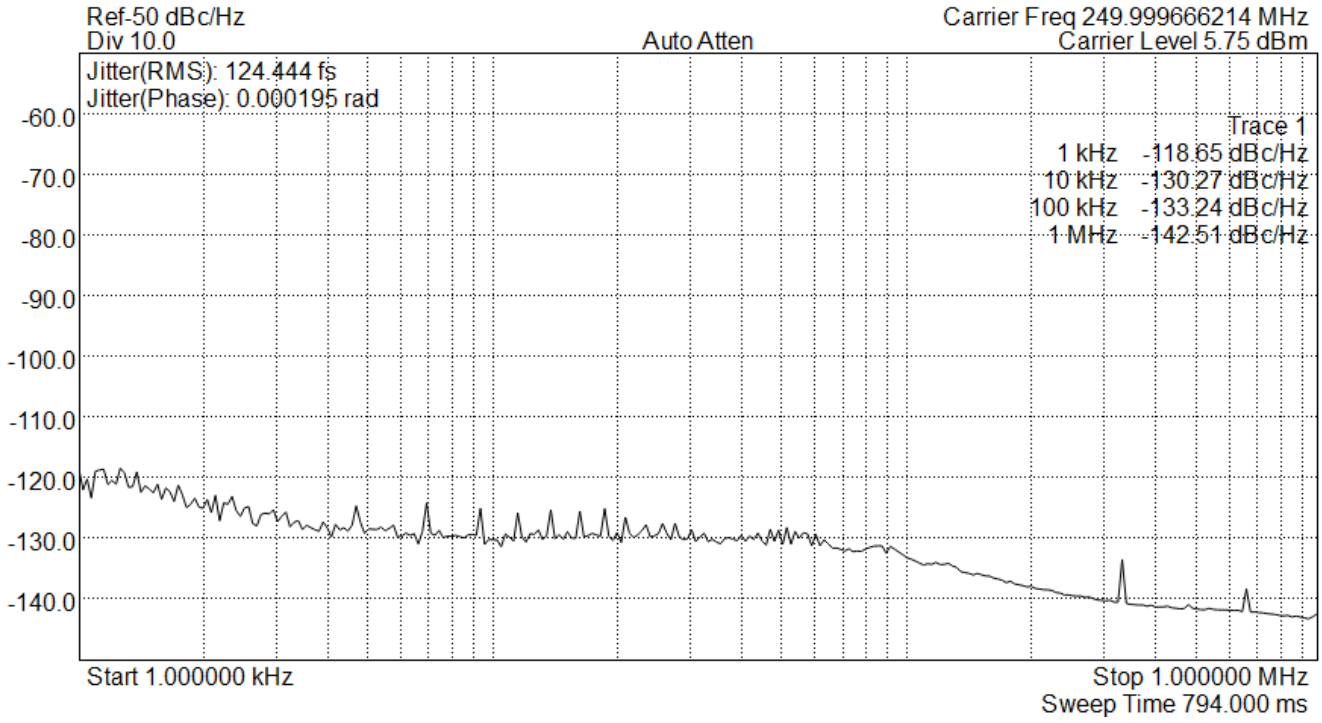
Typical 400MHz waveform (500MHz 4GS/s scope)

3.3 Integer Boundary Spurs

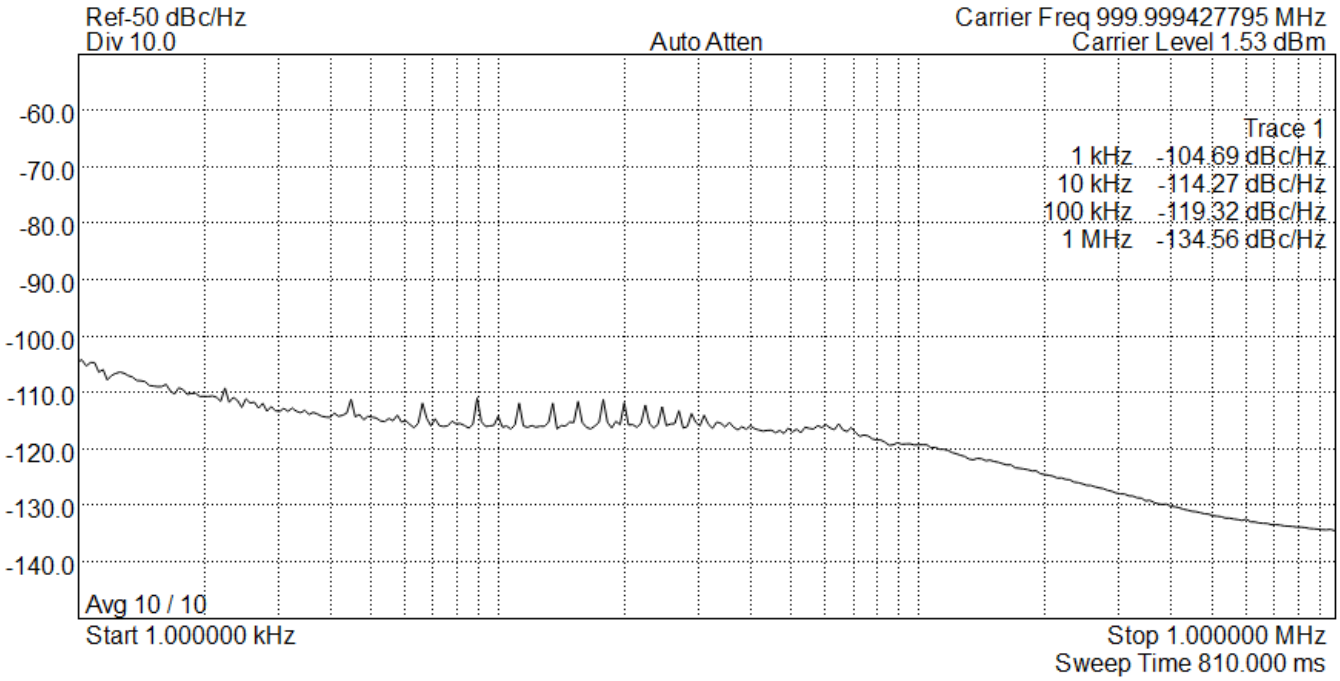
A mechanism for in band fractional spur creation in all fractional PLL's is the interactions between the RF VCO frequency and the internal 27MHz, internal 10MHz or arbitrary external reference frequency. When these frequencies are not integer related, spur sidebands appear on the VCO output spectrum at an offset frequency that corresponds to the difference in frequency between an integer multiple of the reference and the VCO frequency. These spurs are attenuated when outside the loop filter which is 30KHz wide. By having two selectable internal reference frequencies of 10MHz and 27MHz the problem is eliminated by switching reference frequencies when working around a boundary.

Example if using the SynthNV Pro 27MHz internal reference: For the fundamental VCO range of 3200MHz to 6400MHz the first integer boundary happens at 27MHz X 119 = 3213MHz, the next at 27MHz X 120 = 3240MHz and every 27MHz thereafter up to 6399MHz. Below the fundamental VCO band the spacing will be affected by the RF divider. If the desired VCO operating frequency is 3213.01MHz this would give spurs 10KHz on either side of the carrier that may be unacceptable. In this case, using the 10MHz reference would be suggested since its closest integer boundary is at 3210MHz. Spurs 3MHz away will be attenuated to satisfactory levels by the loop filter.

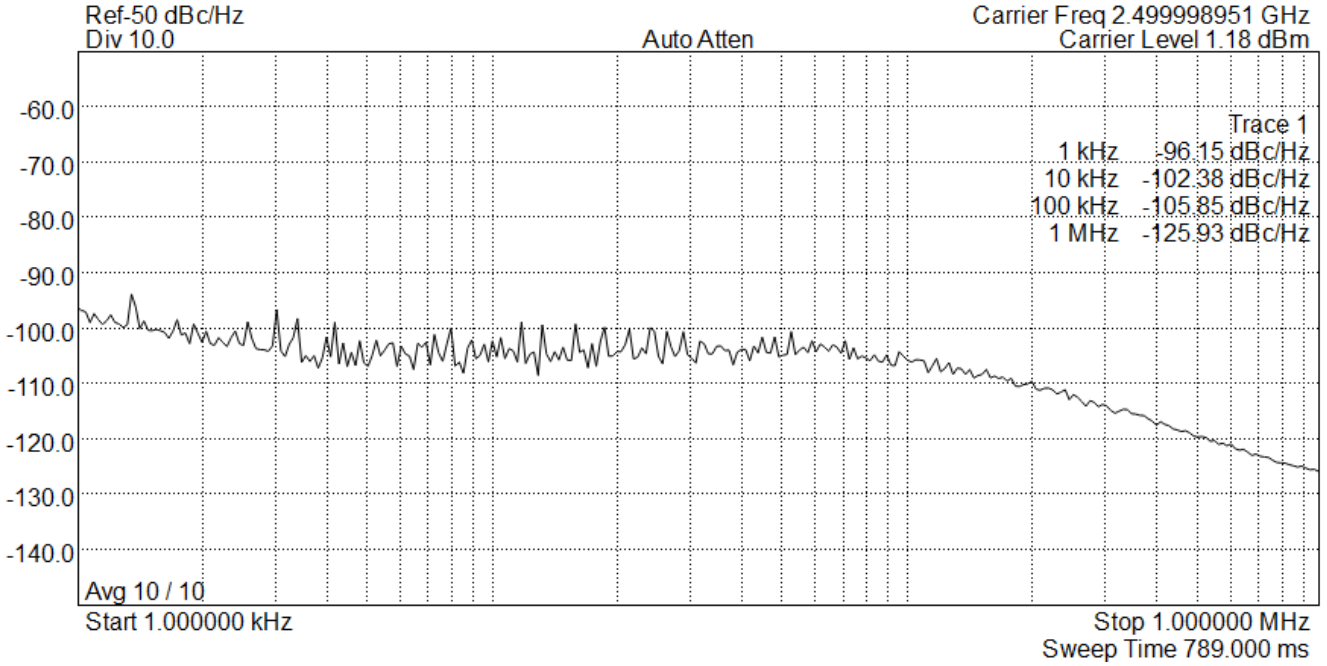
3.4 Phase Noise and Jitter



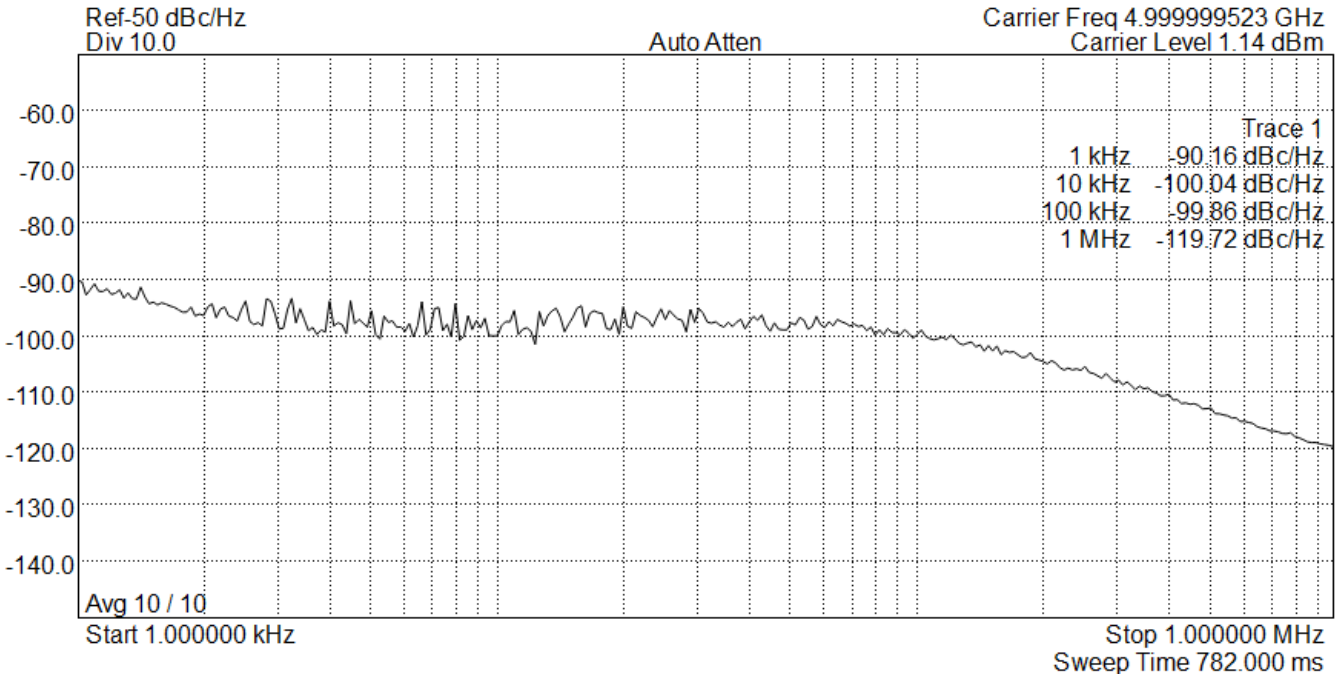
250MHz Phase Noise (27MHz Internal Reference with REF Doubler Enabled)



1GHz Phase Noise (27MHz Internal Reference with REF Doubler Enabled)



2.5GHz Phase Noise (27MHz Internal Reference with REF Doubler Enabled)



5GHz Phase Noise (27MHz Internal Reference with REF Doubler Enabled)

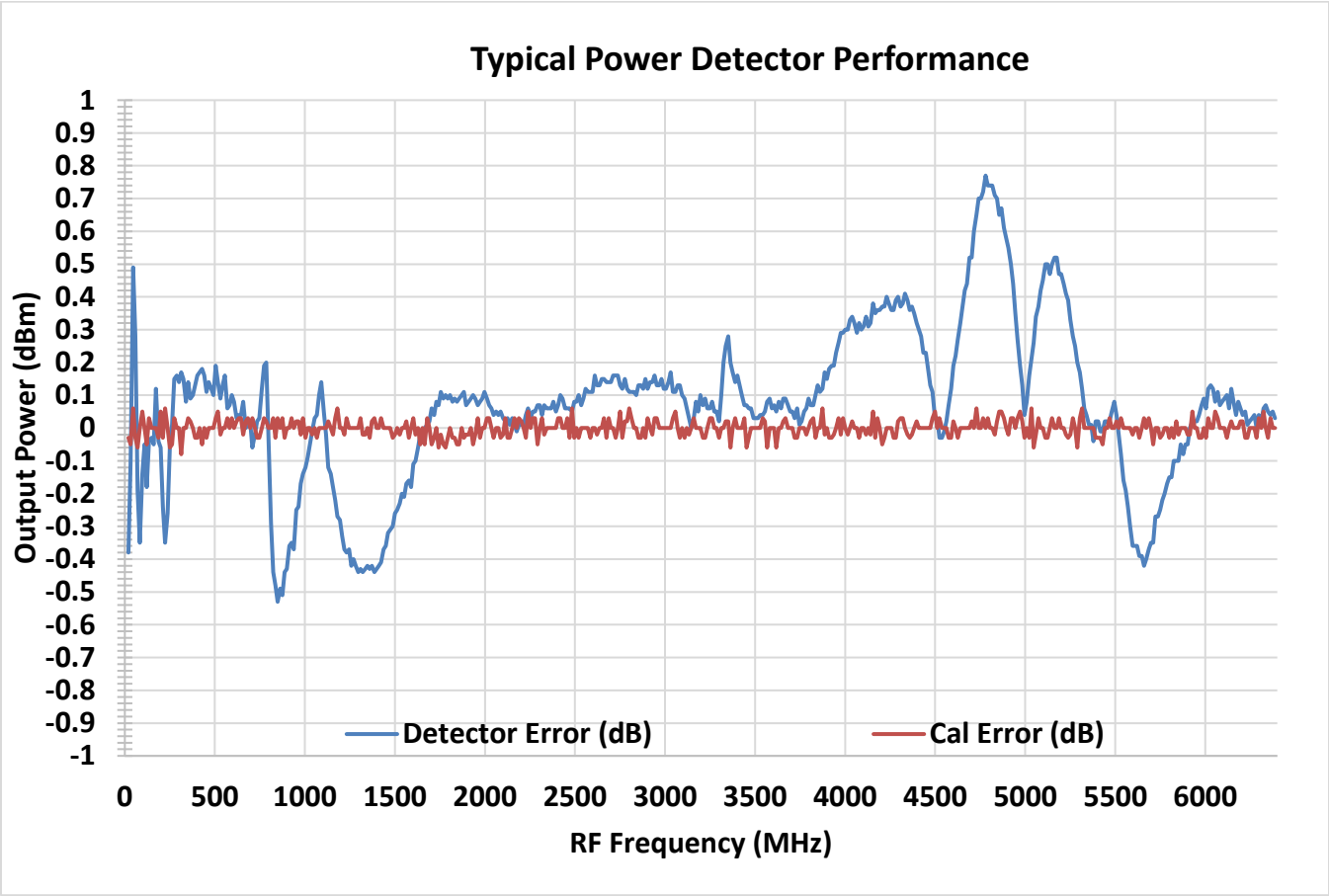
3.5 RF Power Detector

The power detector on the SynthNV Pro is comprised of a broadband log detector that is calibrated from 12.5MHz to 6.4GHz. Between it and the input SMA connector is a 10dB pad designed to give a broadband 50 ohm match, plus allow higher powers (up to 15dBm) into the detector. Between the log detector and the analog to digital converter are 3 selectable circuits for advanced users. The default is an instantaneous sample which samples the RF power at an indeterminate time quickly after its initiated. The other two involve 1) a resistor/capacitor averaging circuit and 2) a diode/capacitor peak detector circuit which is uncalibrated due to its diode voltage drop. The last two circuits specifics are TBD but may help in application with high peak to average RF power.

The detector knows nothing about the frequency content of the signal it is receiving. It only measures power and the power it measures is a summation of all content across its working spectrum. (It is not a spectrum analyzer.)

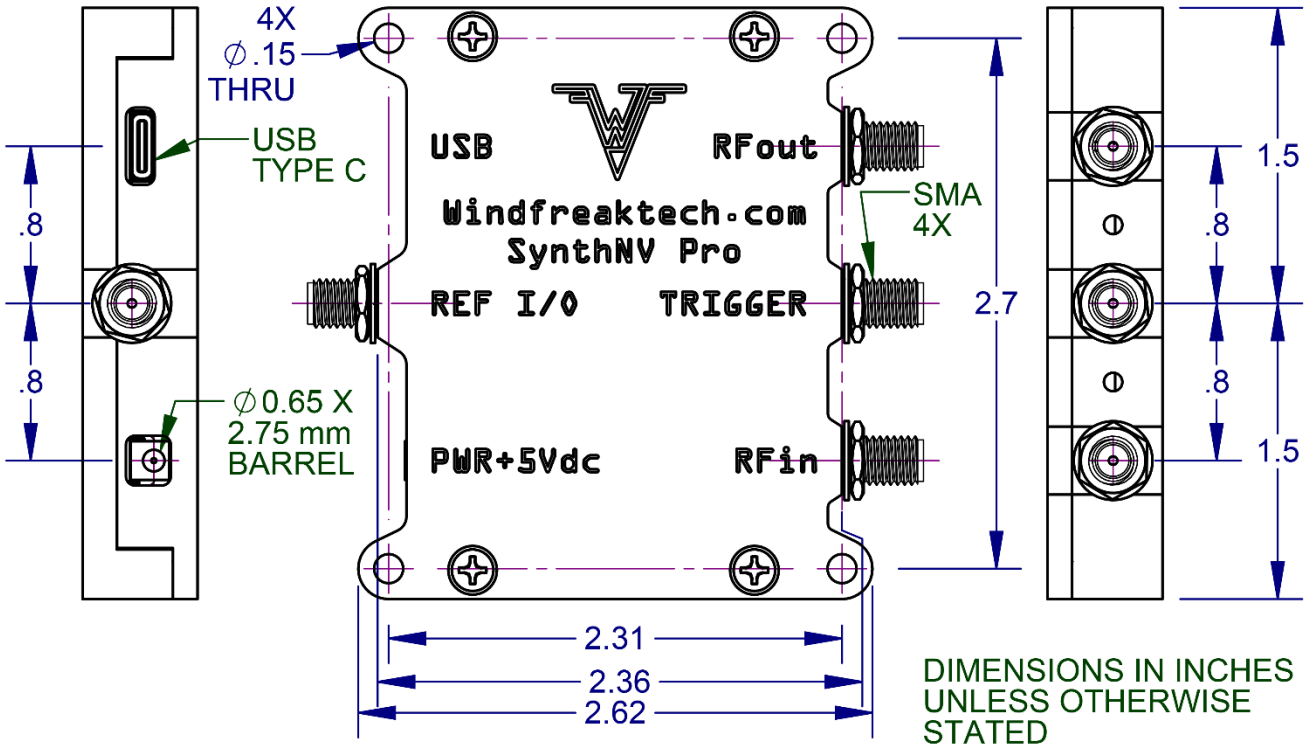
In closed systems using the signal generator and power detector, it is possible to know the frequency the detector is reading, plus calibrate out any amplitude error. This allows the device to function as a scalar network analyzer which can be used to sweep the frequency response of amplifiers, attenuators and filters. Its also possible to use an external directional coupler to measure the return loss of those types of devices.

The plot below shows a typical raw Detector Error trace relative to the calibrated output power of the signal generator side (which also has some embedded error). The Cal Error trace shows the error after a software calibration is performed with the supplied GUI Network Analyzer application.


Typical Power Detector Performance
Output Power (dBm)
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
-0.1
-0.2
-0.3
-0.4
-0.5
-0.6
-0.7
-0.8
-0.9
-1
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
5500
6000
RF Frequency (MHz)
Detector Error (dB)
Cal Error (dB)

4 Device Information

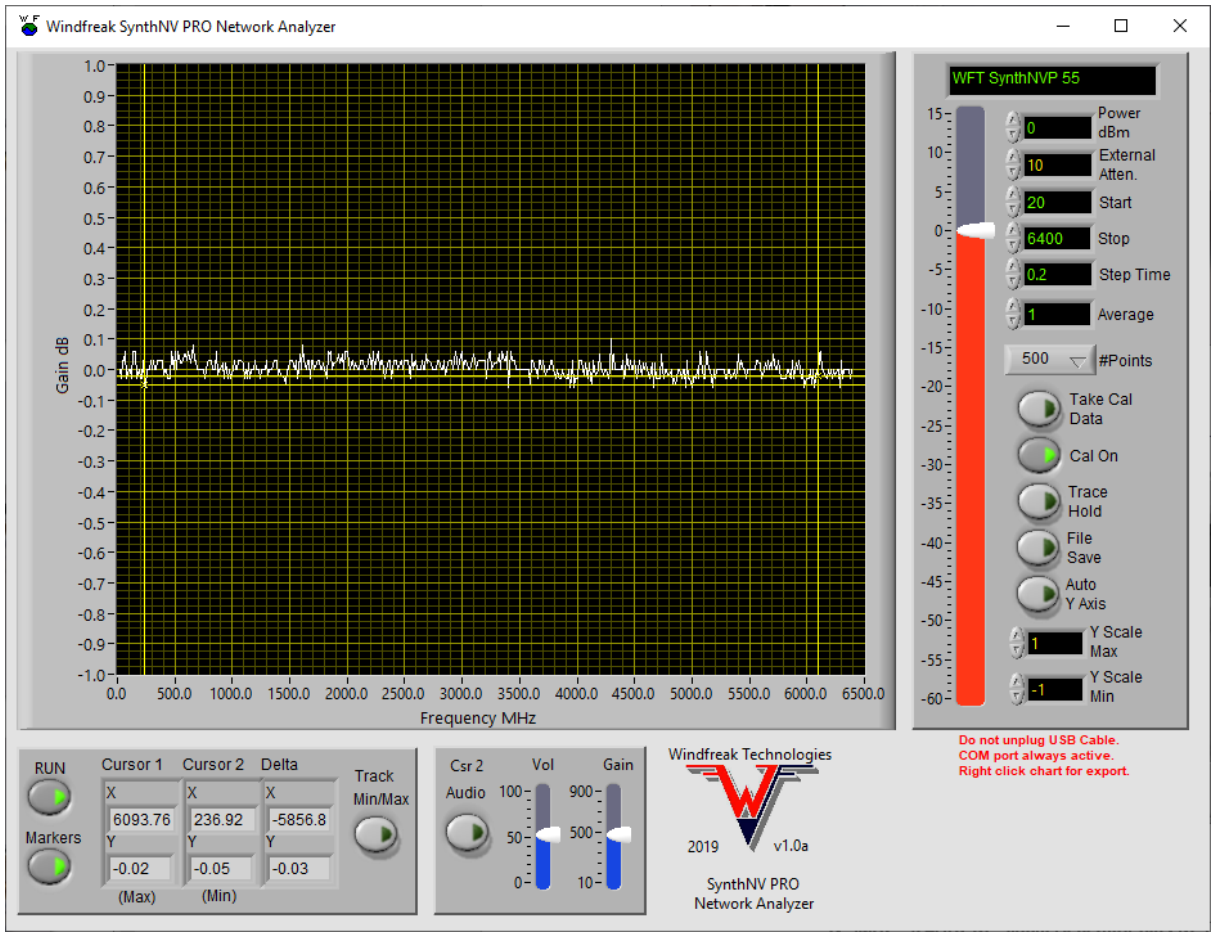
4.1 Mechanical Dimensions



4.2 Product Images

Note: Power input is +5Vdc.

Included Labview Signal Generator GUI



Included Labview Network Analyzer App (launched from Sig-Gen GUI)