

12.5 MHz – 6.4 GHz RF Signal Generator

Features

- Calibrated RF output
- Thumb drive sized
- Open source Labview GUI software control
- Run hardware functions with or without a PC
- USB or UART control via USB3 connector
- Trigger and Modulation via USB3 connector
- Open source USB breakout board sold separately
- As good as 0.2dB amplitude resolution
- 0.01Hz frequency resolution
- 100uS RF lock time standard
- 250uS per step typical sweep speed
- Up to +8dBm output power
- Over 40dB of power control
- 2.5ppm internal reference accuracy
- -115dBc/Hz phase noise at 1GHz @ 10KHz offset
- Internal and External FM, AM, Pulse Modulation
- External sweep, step and modulation trigger
- 500 point frequency and amplitude hop table
- 32-bit ARM processor on board
- Low Power 100mA typical
- Designed, manufactured, and supported in the USA

Applications

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

Overview Description

The Windfreak Technologies SynthUSB3 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 SynthUSB3 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.



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1 USB / UART WARNING

The SynthUSB3 was designed to work with a USB 2 port, or a USB 2 cable which can be plugged into either a USB 2 or USB3 port. Use a USB 3 cable only when tapping into the UART and Trigger signals for 3.3V COM port control of the SynthUSB3 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 SynthUSB3 UART signals and vv. See UART app note for UART usage instructions.

A USB 2 to USB 3 breakout adapter board is available for easier access to the UART and Trigger / Modulation connections.

UART and Trigger signals are isolated with series 500 ohm resistors to protect hardware.

2 Characteristics

2.1 Electrical Characteristics

| Characteristic | Notes | Min. | Typ. | Max. | Unit |
|--------------------------------|--|------|------|------|----------|
| Supply Voltage | Suggested 300mA minimum | 4.7 | 5 | 5.5 | V |
| Supply Current | 0dBm RF at 1GHz | | 100 | | mA |
| Standby Supply Current | RF output OFF | | 10 | | mA |
| RF Output Frequency Range | | 12.5 | - | 6400 | MHz |
| Calibrated Frequency Range | | 12.5 | | 6400 | MHz |
| RF Output Power Maximum | See graph | | 8 | | dBm |
| RF Output Power Minimum | See graph | | -50 | | dBm |
| RF OFF Output Power | 100% shutdown of RF section | | | -80 | dBm |
| RF Output Frequency Resolution | Default is 0.1Hz selectable by Channel Spacing Setting | 0.01 | | | Hz |
| RF Output Power Resolution | Best Case – Non Monotonic | 0.25 | | | dB |
| RF Output Impedance | | | 50 | | Ω |
| Internal Reference Frequency | | | 27 | | MHz |
| Internal Reference Tolerance | | | 2.5 | | ppm |
| Trigger | Internally pulled up 5V tolerant | -0.3 | 3.3 | 5 | V |
| UART | 3.3V native, 5V tolerant | -0.3 | 3.3 | 5.0 | V |
| RF Connector | Normally Polarized Female SMA | | | | |
| Weight | | | 10 | | g |

2.2 Thermal Operating Characteristics

| Description | Notes | Min | Max | Unit |
|-----------------------|-------|-----|-----|--------------------|
| Operating Temperature | | -40 | 70 | $^{\circ}\text{C}$ |

3 Software and Hardware

3.1 Open Source Software GUI

The included GUI is written in LabVIEW™ and source code vi's are supplied with purchase of hardware. Also supplied is a Windows installer for users that do not own the LabVIEW™ development environment. All functions of the hardware are accessible by the software. Custom software developers see the windfreaktech.com website for a download of the easy to use API document.

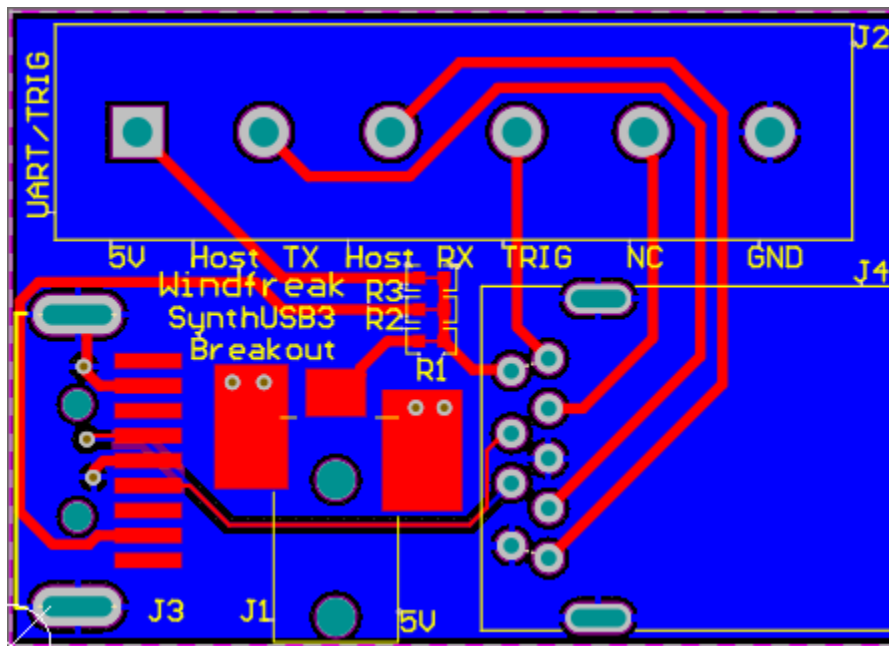
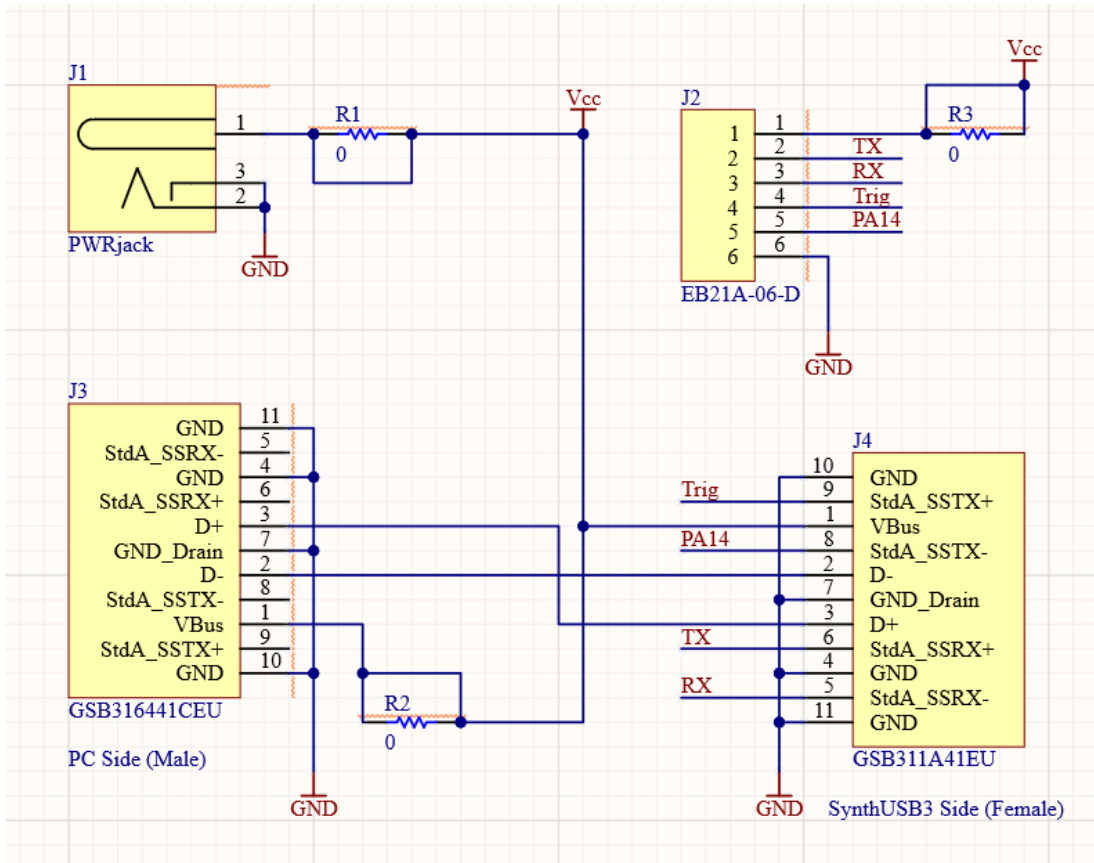


3.2 USB3 Connector Pinout

The USB3 connector is used in an unconventional way to allow access to UART and Trigger Signals. As mentioned above, avoid connecting this device directly to a USB3 port on your PC. Use a USB 2 extension cable instead.

| USB3 Pin # | Signal Name | Description |
|------------|-------------|------------------------------------|
| 1 | VBUS | Power |
| 2 | USB D- | USB 2.0 differential pair |
| 3 | USB D+ | |
| 4 | GND | Ground |
| 5 | UART Tx | UART SynthUSB TX (hook to host RX) |
| 6 | UART Rx | UART SynthUSB RX (hook to host TX) |
| 7 | GND_DRAIN | Ground |
| 8 | N/C | To Processor I/O for future use |
| 9 | Trigger | Trigger Input |

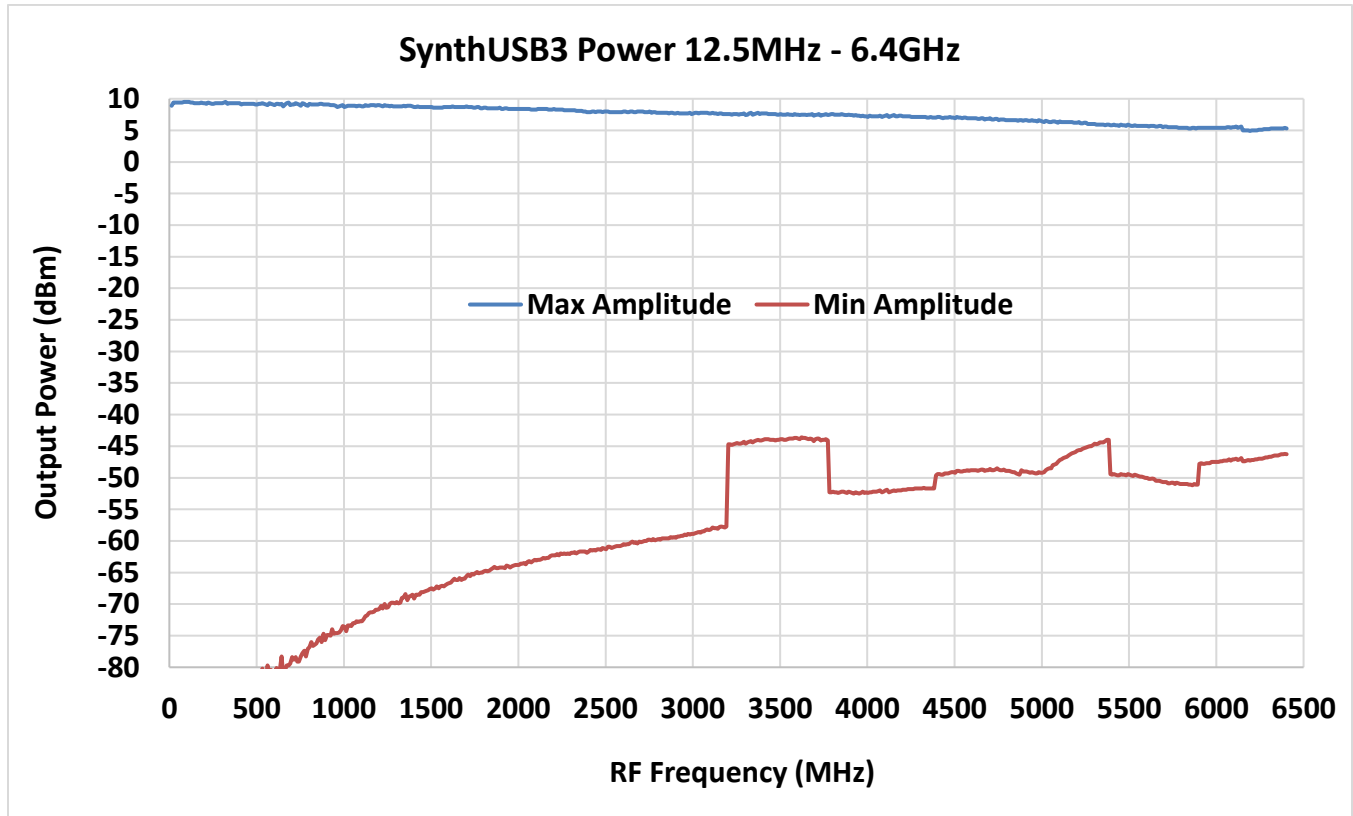
3.3 Recommended UART / Trigger Breakout Circuit



4 Typical Performance

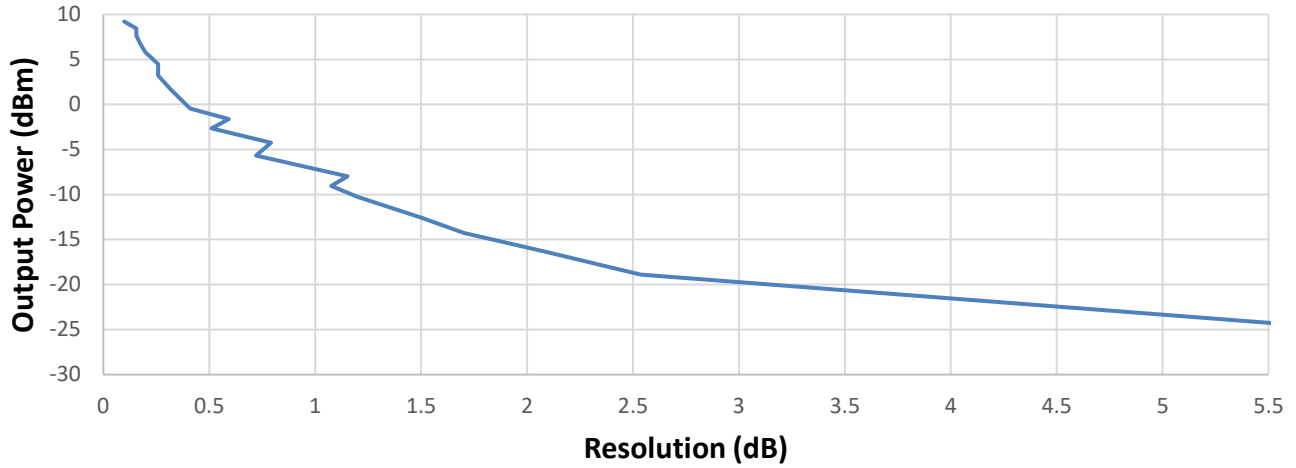
4.1 RF Output Power

The typical maximum and minimum output power of the SynthUSB3 is shown below. This graph is of unlevelled operation at the maximum and minimum RF power settings.

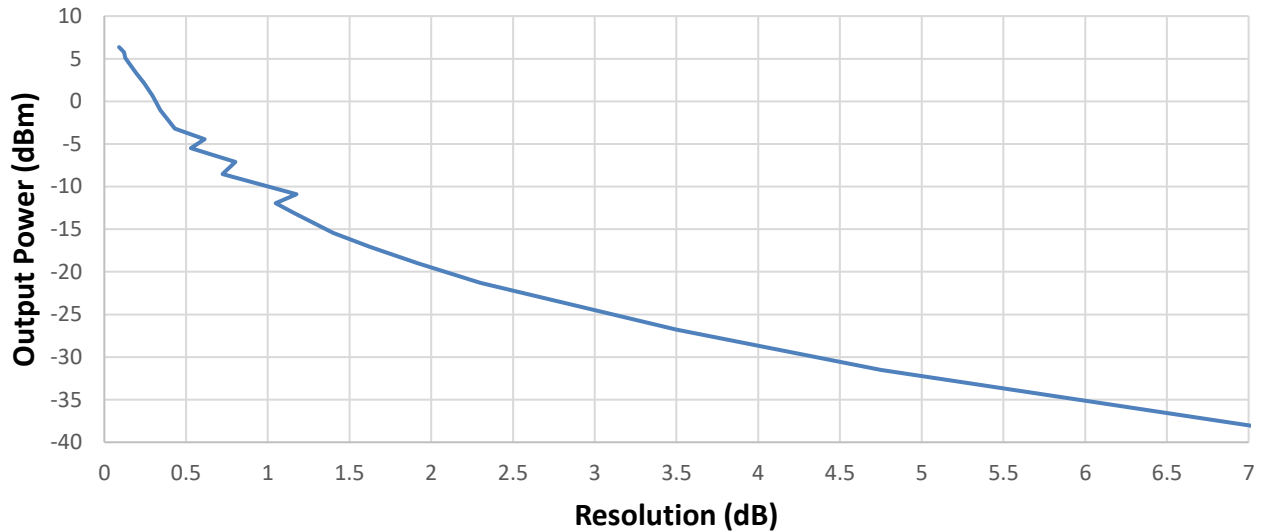


Power levels are settable in 0.1dBm increments via software, but actual RF resolution and thus accuracy are dependent on amplitude. RF power setting resolution is non-linear with finer resolution at higher output powers. On board calibration is attained through a look up table unique to each device. Device calibration is performed at the factory and stored in onboard flash memory. Calibration is good from 12.5MHz to 6.4GHz.

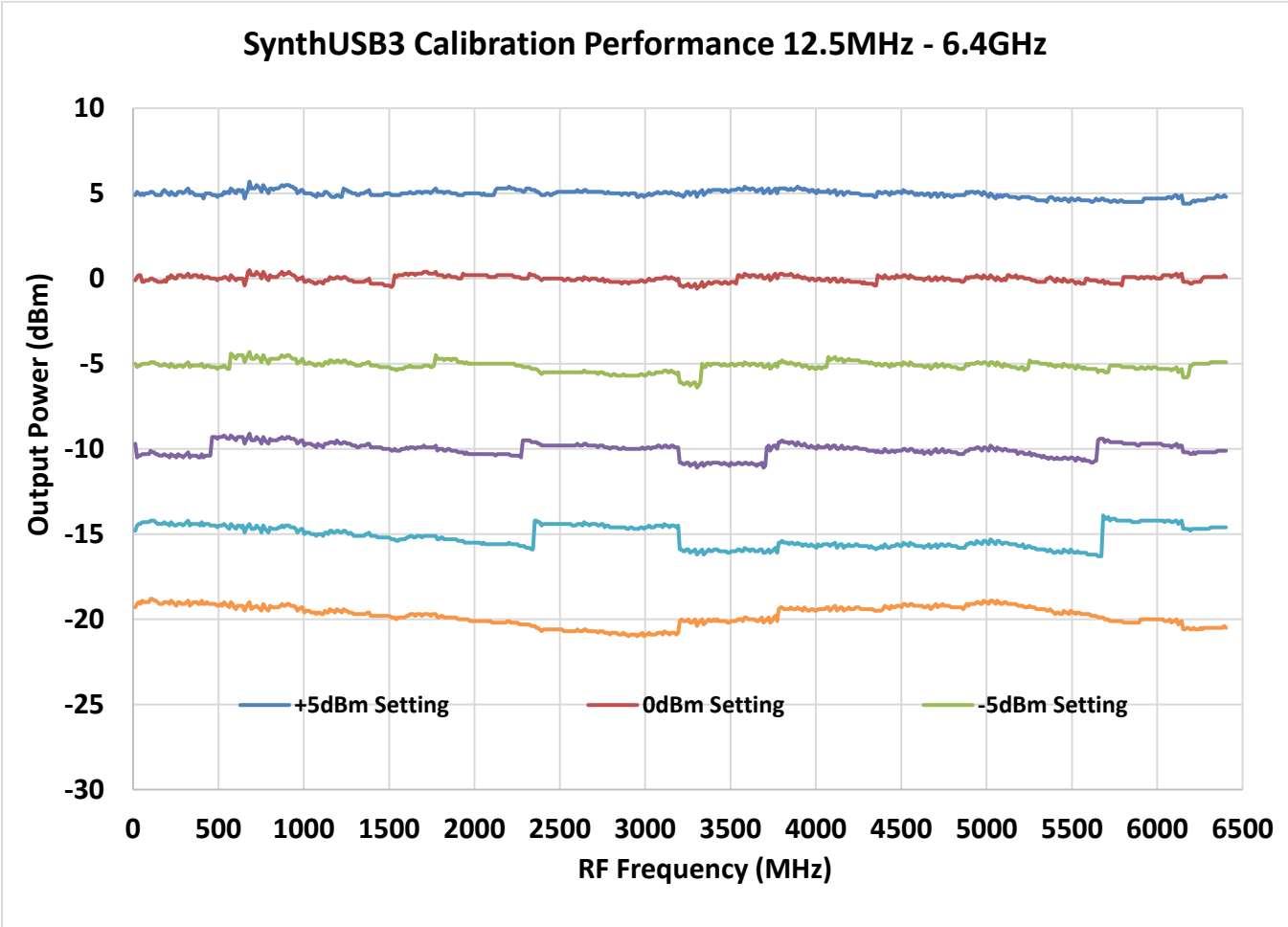
Amplitude Resolution vs Power at 100MHz



Amplitude Resolution vs Power at 5GHz



For example, in the Resolution vs Power at 100MHz chart above, resolution at +5dBm of output power is around 0.2dB, which would give a theoretical accuracy of +/- 0.1dB. With a setting of -20dBm the output power resolution is 3dB, which gives a theoretical accuracy of +/- 1.5dB.

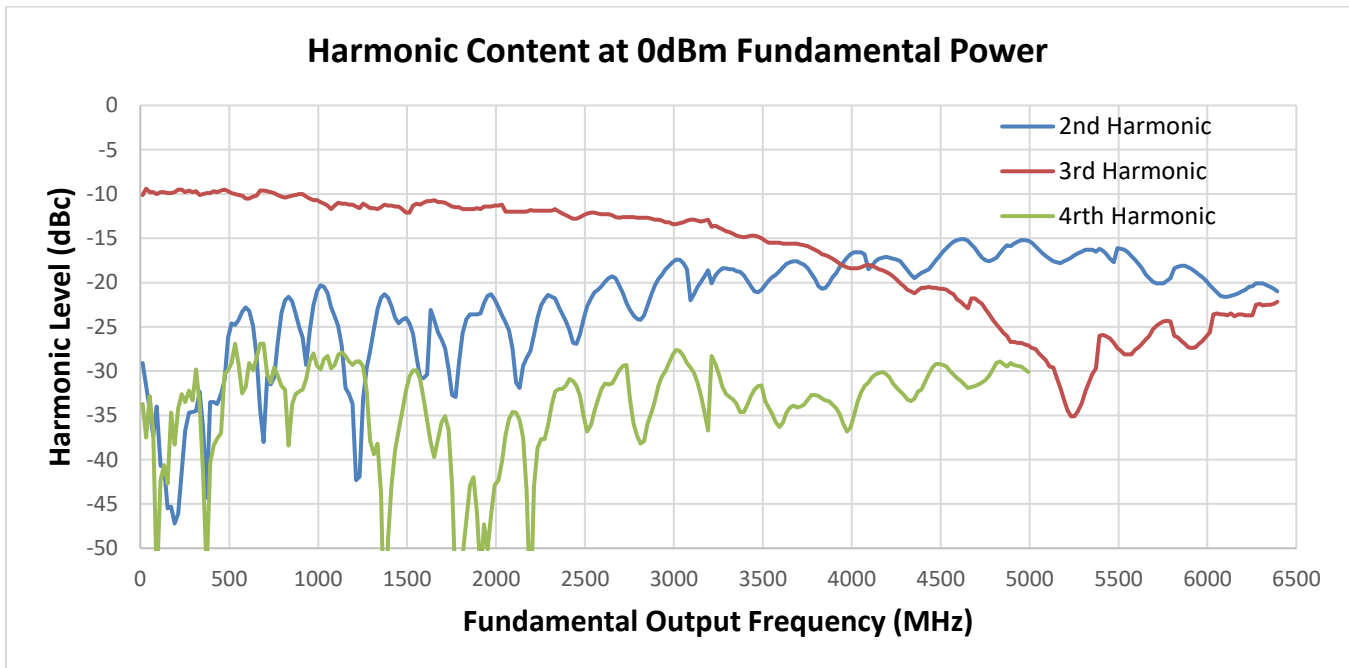


4.2 RF Output Harmonic Content

The typical SynthUSB3 harmonic distortion is shown below. 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



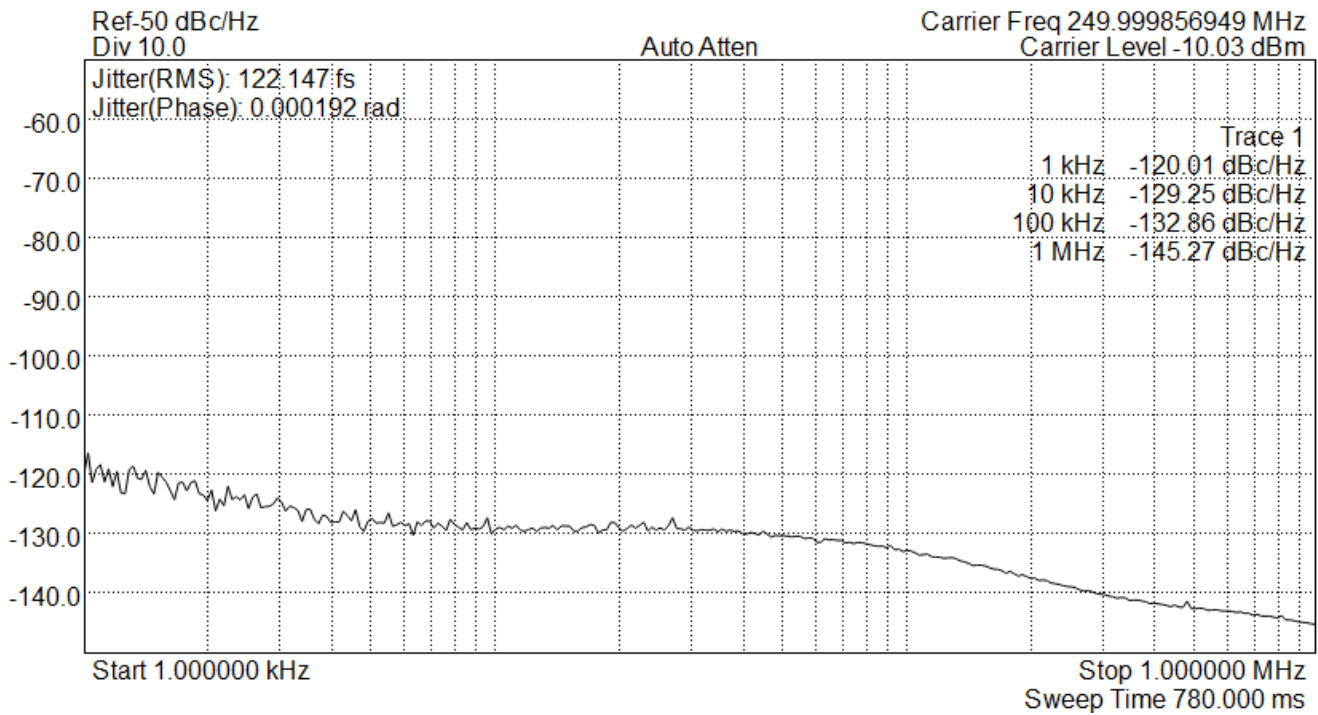
4.3 Integer Boundary Spurs

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 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 roughly 50KHz wide.

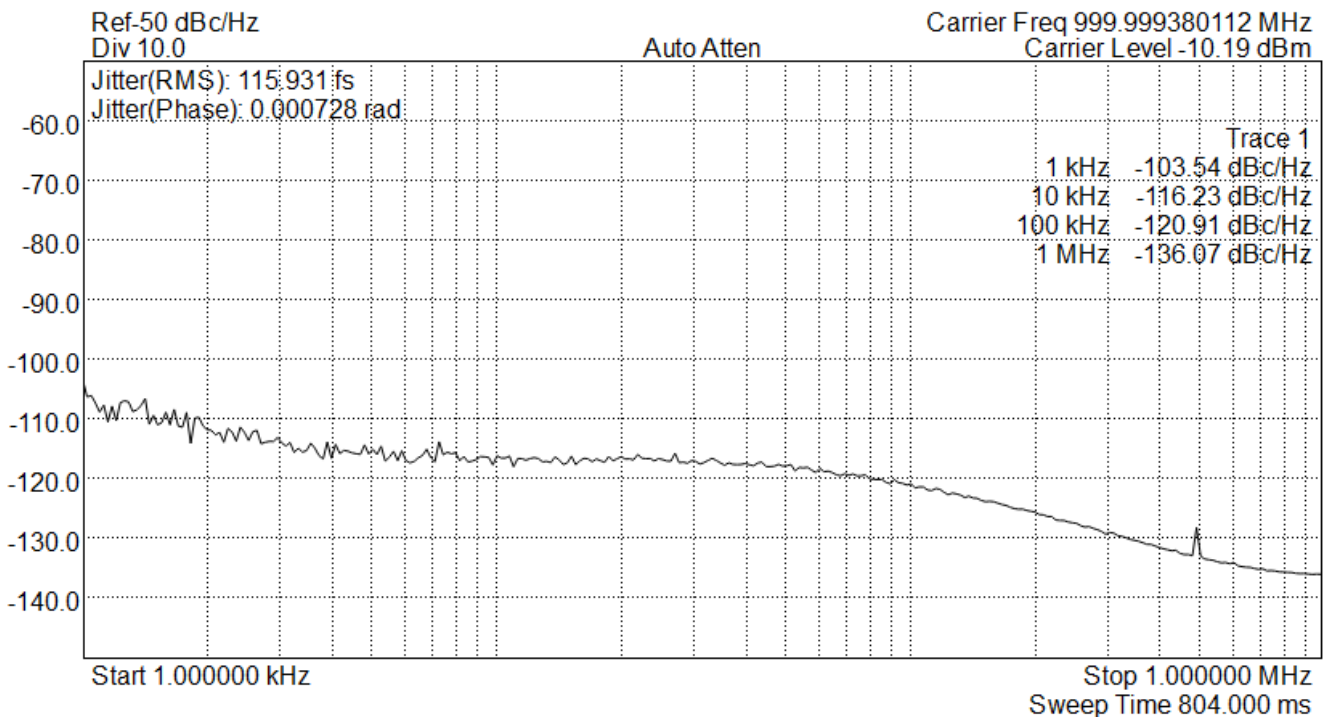
Example if using the SynthUSB3 27MHz internal reference: For the fundamental VCO range of 3200MHz to 6400MHz the first integer boundary happens at $27\text{MHz} \times 119 = 3213\text{MHz}$, the next at $27\text{MHz} \times 120 = 3240\text{MHz}$ and every 27MHz thereafter up to 6399MHz. Below the fundamental VCO band the spacing will be affected by the RF divider.

A typical case generating 3213.04MHz would give integer boundary spurs at a 40KHz offset at around 38dBc. A typical case generating 3213.40MHz would give integer boundary spurs at a 400KHz offset at around 52dBc. (These were measured with the reference doubler on and PLL ICP set at 15).

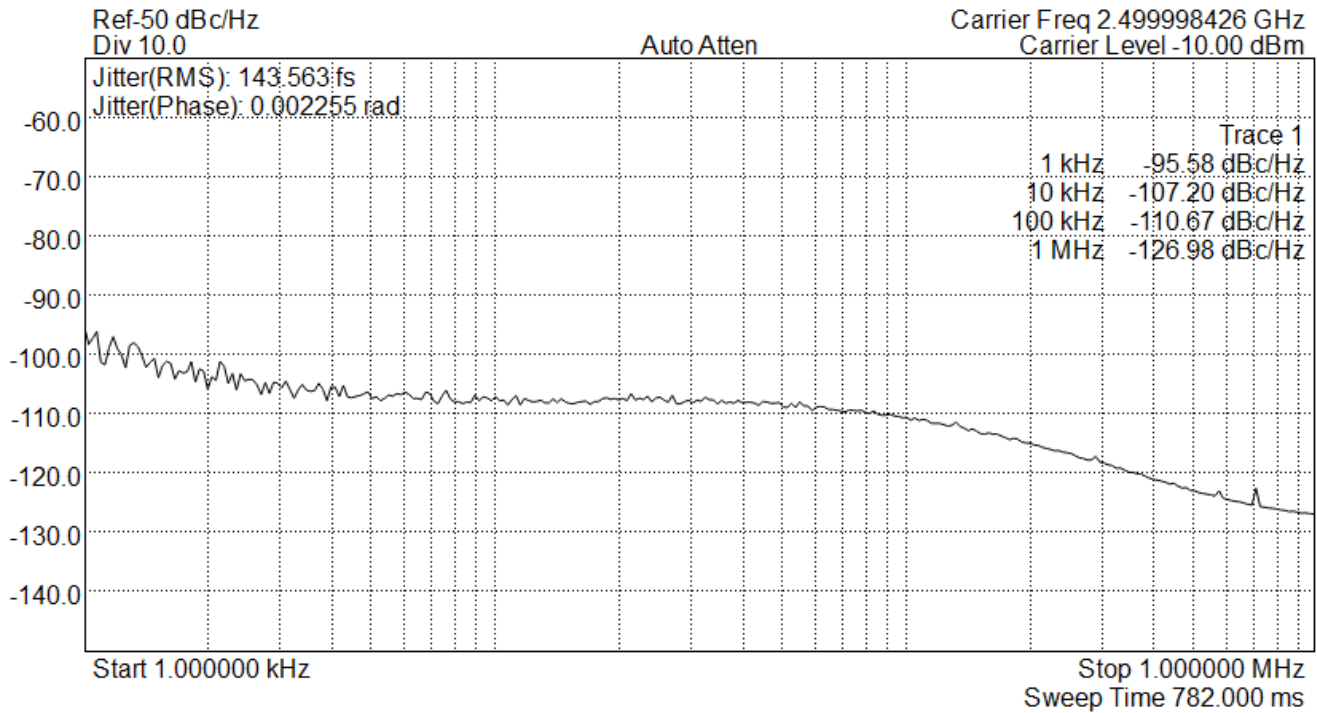
4.4 Phase Noise and Jitter



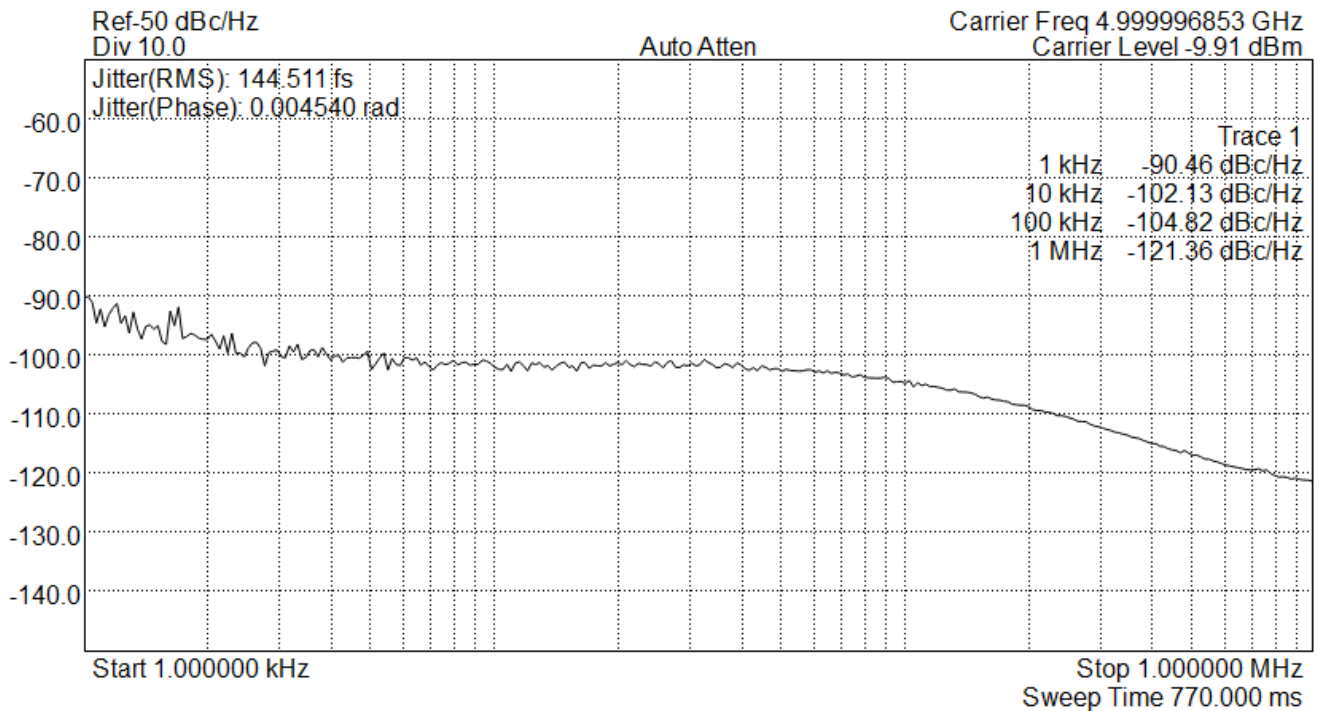
250MHz Phase Noise (27MHz Internal Reference with REF Doubler Enabled)



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



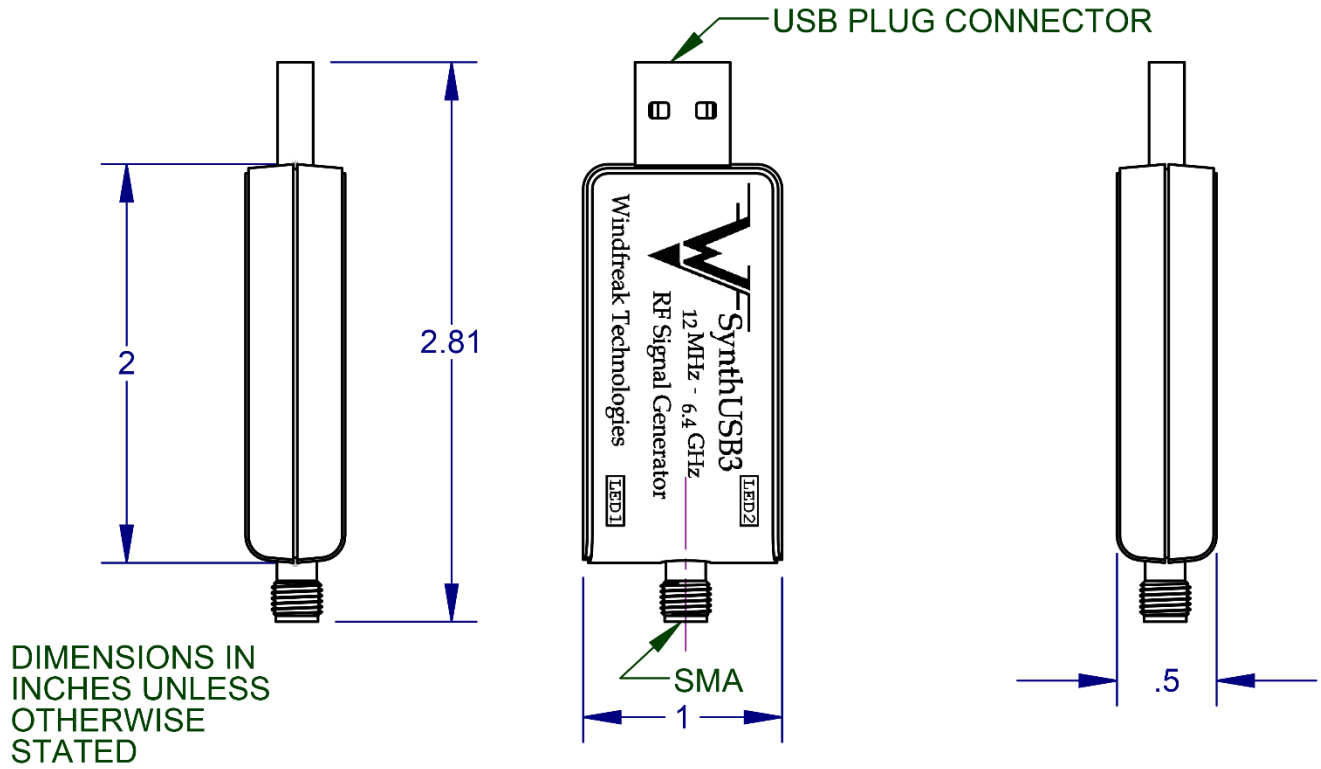
2.5GHz Phase Noise (27MHz Internal Reference with REF Doubler Enabled)



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

5 Device Information

5.1 Mechanical Dimensions (2" X 1" X 0.5" plastic case)



Weight is 0.7oz or 20 grams

