Windfreak Technologies

SynthHD v1.4

Preliminary Data Sheet v0.2b

54 MHz – 13.6 GHz Dual Channel RF Signal Generator

Features

- Open source Labveiw GUI software control via USB
- Run hardware functions with or without a PC
- 96MHz 32 bit ARM processor on board
- Two channel frequency, phase and amplitude control
- Quadrature (or other phase) LO signal generation
- 0.1Hz or less frequency resolution
- 2.5ppm generator frequency accuracy
- .01 degree phase control on each channel
- 4mS RF lock time standard
- 70uS RF lock time (TBD) (subject to export control)
- Up to +20dBm output power
- 16 bit 0.01dB amplitude resolution
- Over 50dB of power control
- Absolute power display on Software GUI
- Calibration option
- 10MHz – 100MHz external reference input
- Selectable 10 or 27 MHz internal reference output
- Internal and external FM, AM, Pulse Modulation
- Pulsed FMCW Chirp
- External Sweep, Step and modulation Trigger
- 100 point Frequency and Amplitude Hop Table
- Dual Channel Frequency and Amplitude Lock
- Daughter card expandability (custom applications)
- Channel enable / disable saves energy
- 7 Ultra Low Noise linear regulators on board
- 2.75 X 2.15 inches not including mounting flanges

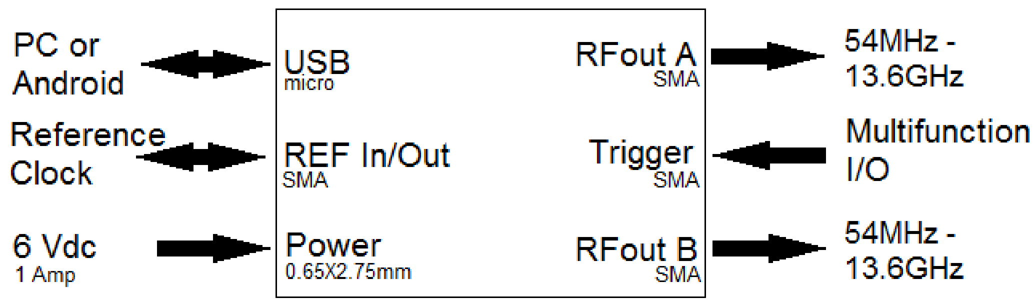
Overview Description

The Windfreak Technologies SynthHD is a 54 MHz to 13.6 GHz dual channel software tunable RF signal generator and frequency sweeper controlled and powered by a device running Windows or Android via its USB port. The SynthHD's dual independent channels can be configured to run as two different frequencies, or the same frequency with different phases. This allows its use in antenna beam steering applications or quadrature signal generation commonly used in image reject frequency conversion. The SynthHD also has nonvolatile on board memory so it can be programmed to fire up by itself on any frequency, power, sweep or modulation setting (and combinations thereof) to run stand alone 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
- Antenna beam steering
- Quadrature LO for image reject mixers
- 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
- IP3 Two Tone Intermodulation Distortion Testing
- Quantum device research
- Plasma physics

SynthHD Functional Diagram



Windfreak Technologies, LLC.

Contents

1 Characteristics

1.1 Electrical Characteristics

Characteristic	Notes	Min.	Typ.	Max.	Unit
Supply Voltage		5.5	6	6.5	V
Supply Current	370mA per Channel		800		mA
Standby Supply Current	Both RF Channels OFF		70		mA
RF Output Frequency Range		54	-	13999.9	MHz
RF Output Power Maximum	See Graph	6	18	20	dBm
RF Output Power Minimum	See Graph	-80	-50	-30	dBm
RF OFF Output Power	100% Shutdown of RF Section			-90	dBm
RF Output Power Resolution	16 Bit Drive	0.01			dB
RF Output Impedance			50		Ω
Internal Reference Frequency	Selectable		10 or 27		MHz
Internal Reference Tolerance			2.5		ppm
External Reference Frequency		10	-	110	MHz
External Reference Level			+10		dBm
Trigger	Internally Pulled Up	-0.3		3.3	V

1.2 Thermal Operating Characteristics

Description	Notes	Min	Max	Unit
Operating Temperature	Without Airflow	-40	30	°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

2 Typical Performance

2.1 RF Output Power

The typical output power (per channel) of the SynthHD is shown below. This graph is of raw unleveled operation at both the maximum and minimum gain settings of the output variable gain section. Gain is set via a 16 bit D/A allowing output power levels anywhere in the range between the minimum and maximum levels shown below. Each RF channel power and frequency is independent of each other. Power levels are settable in dBm with 0.01dB increments. On board calibration is attained through a user programmable look up table, plus two overall bias constants. Full unique device calibration can be performed at the factory and stored in onboard EEPROM. All parts of the signal chain have high quality voltage regulation, and the D/A's driving the VGAs have a 1% voltage reference controlling their outputs. The SynthHD can measure its own temperature, so the possibility for excellent power and frequency control over temperature is there.

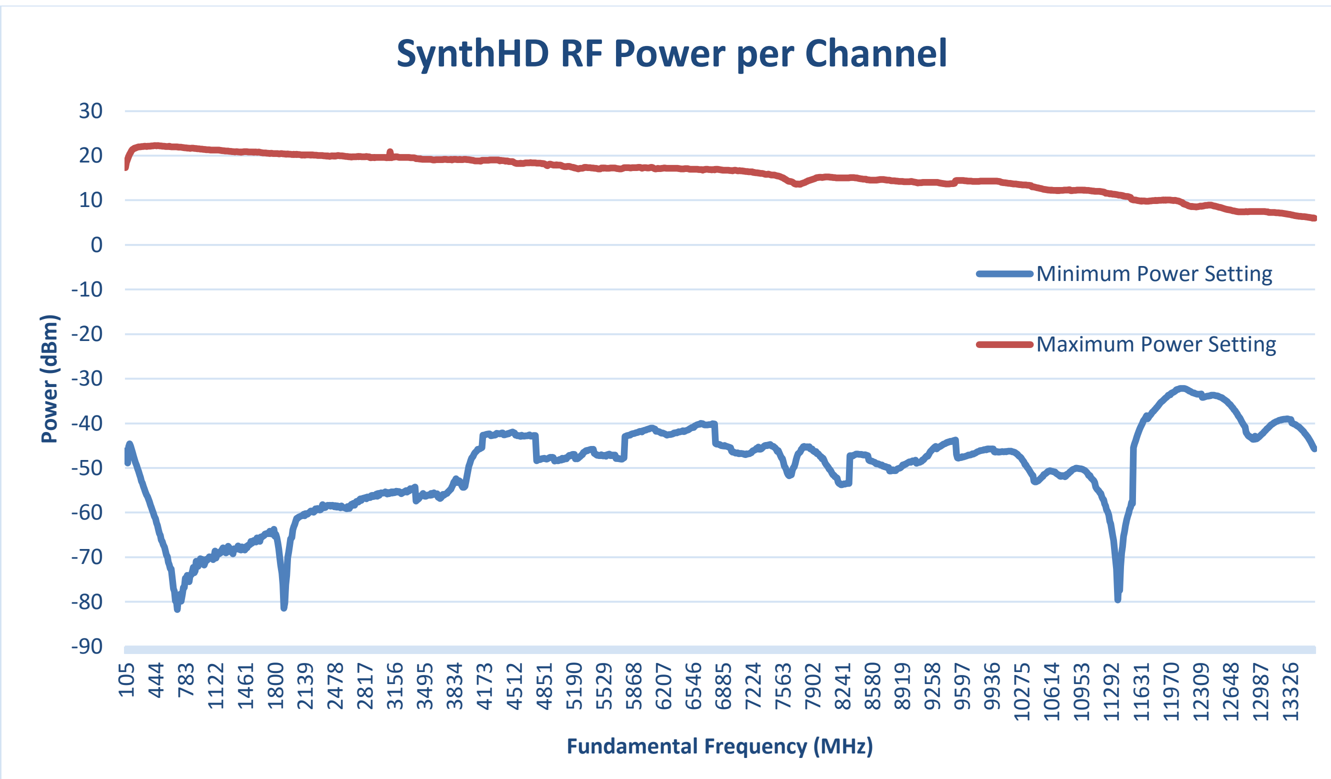


Figure 1. Output Power over Frequency at Room Temperature

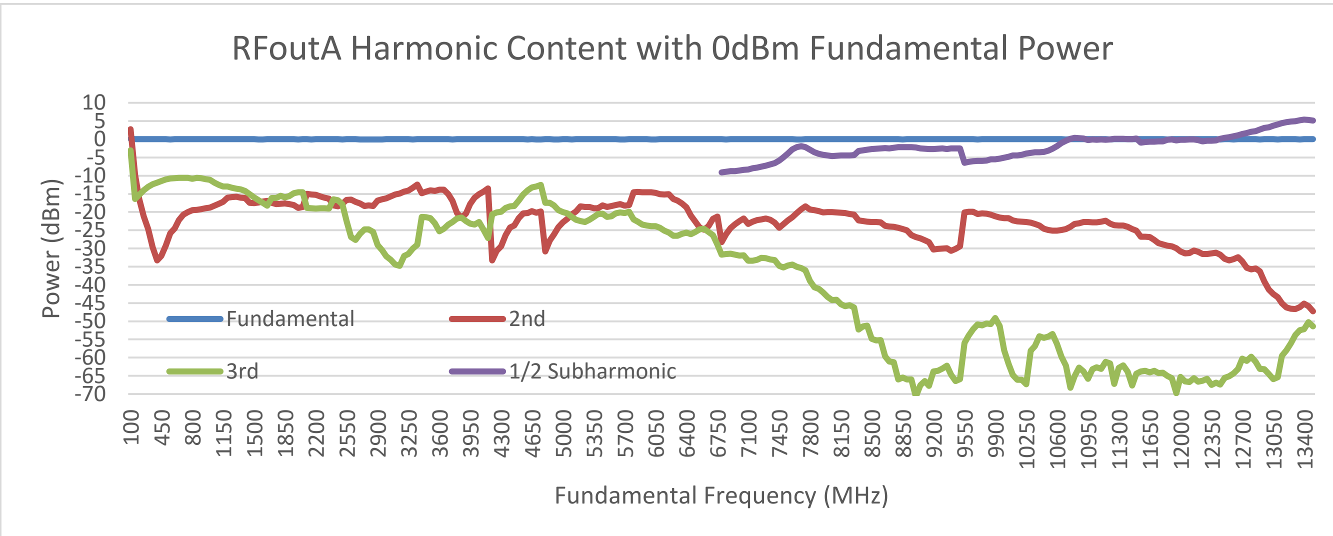
2.2 RF Output Harmonic Content

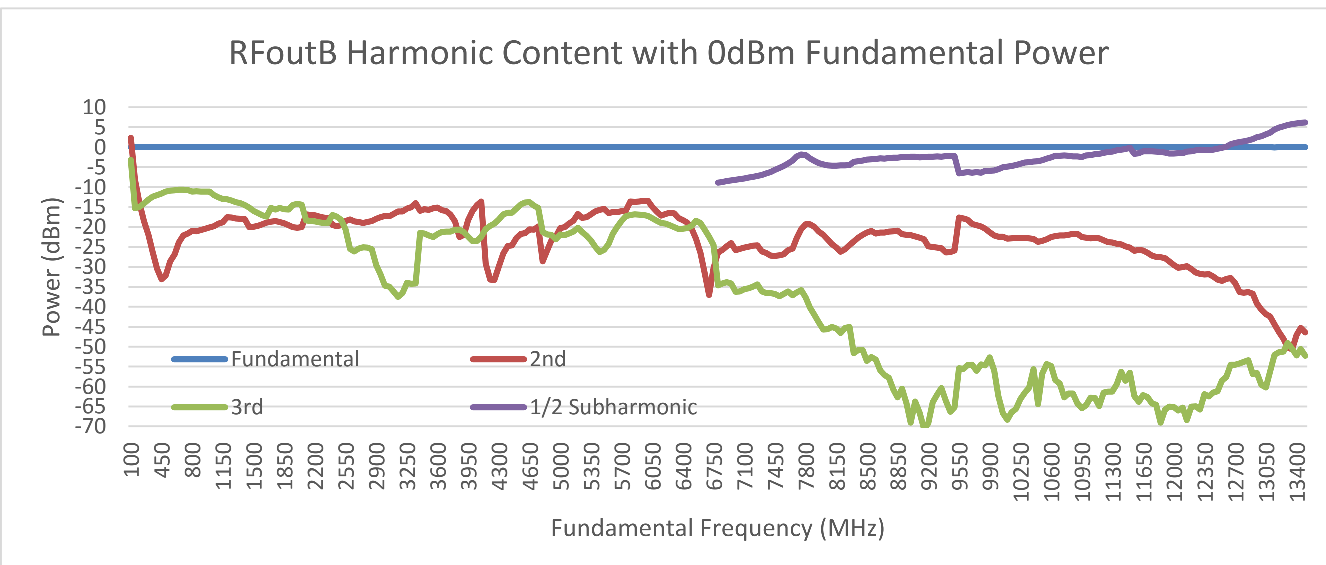
The typical SynthHD harmonic distortion is shown below for the second and third harmonics. Also shown is a subharmonic created when generating fundamental frequencies above 6800MHz. All frequencies above 6800MHz are generated with an RF doubler. This data is taken at a leveled fundamental power of 0dBm.

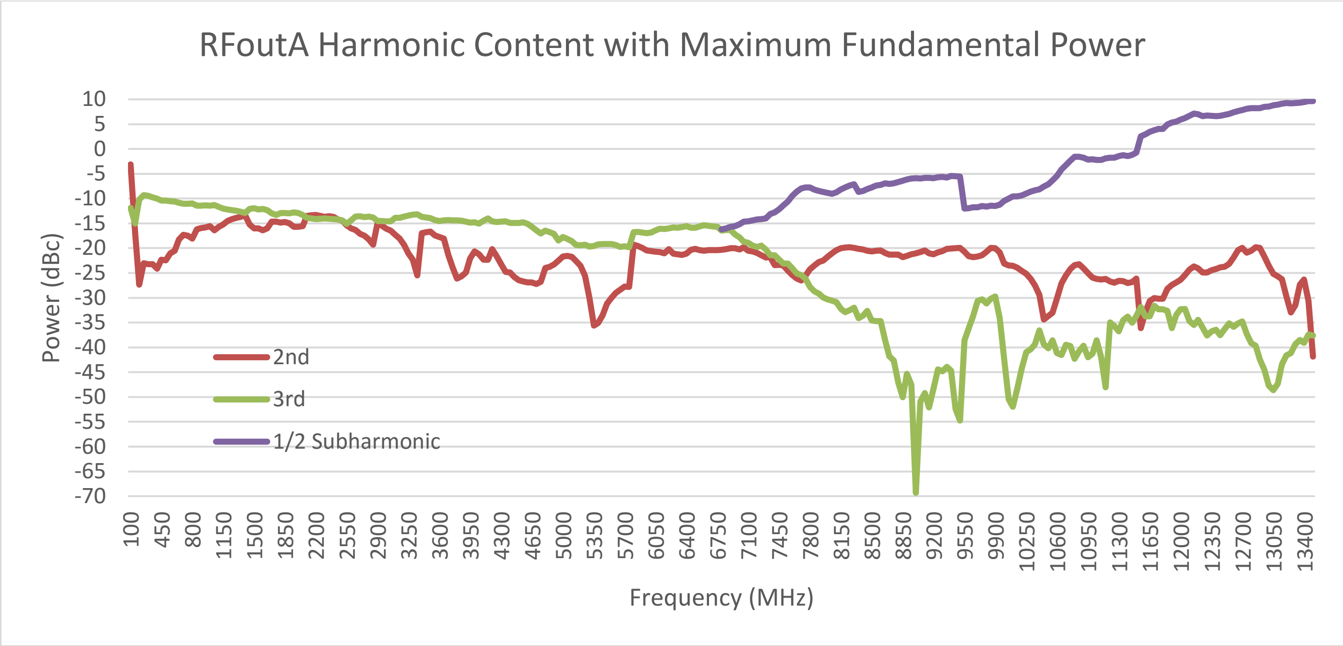
If lower harmonic and subharmonic levels are needed, Windfreak Technologies suggest the use of low cost SMA filters from Crystek and Minicircuits.

Subharmonic: Minicircuits Highpass Filter, VHF-6010+, $25, stopband DC – 5200MHz

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

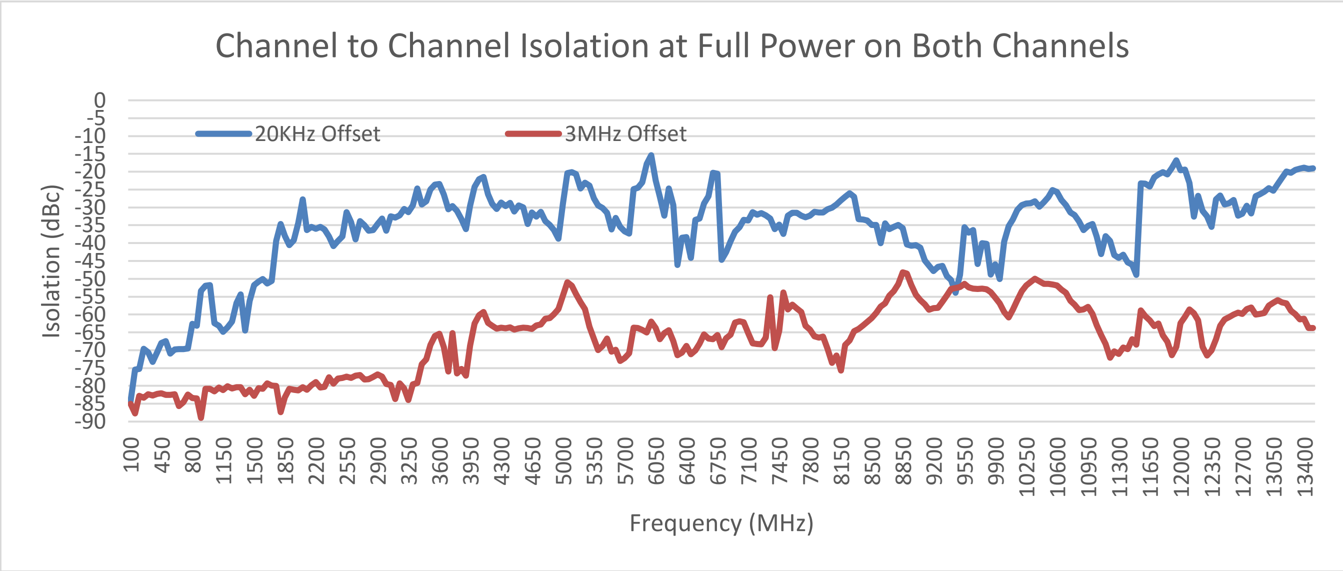


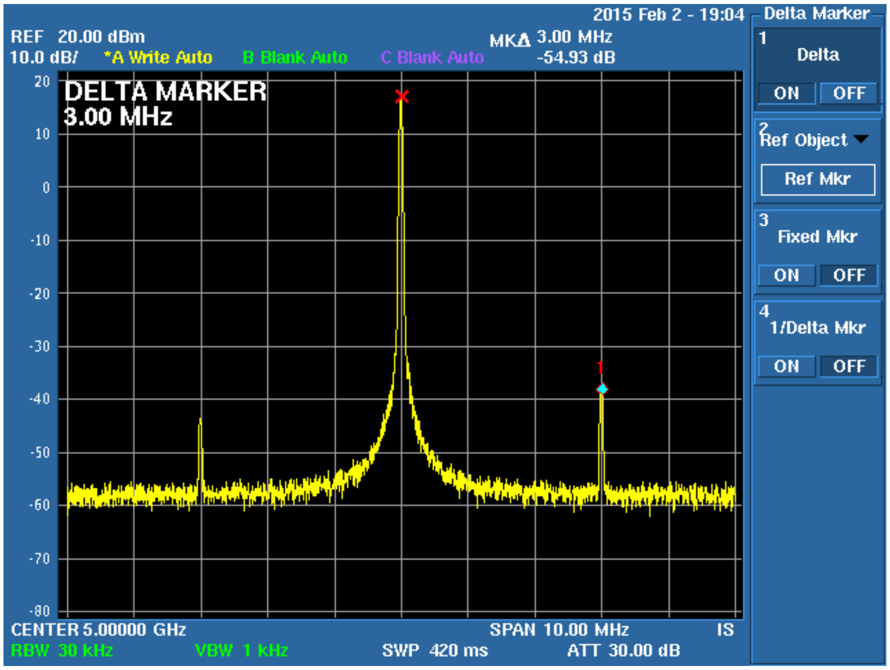




2.3 Channel to Channel Isolation

Channel to channel isolation is shown below with both channels dialed to full output power. One trace is taken with a 3MHz offset between channels. The other trace is taken with a 20KHz offset between channels. The 20KHz offset places each signal within each other's loop bandwidth and the leakage modulates each other's VCO control voltages where loop gain is high. This is why levels with offsets inside the loop bandwidth are higher.





5GHz Channel to Channel Isolation Spectrum with +3MHz Offset

2.4 Integer Boundary Spurs

A mechanism for inband 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 12KHz 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 SynthHD 27MHz internal reference: For the fundamental VCO range of 3400MHz to 6800MHz the first integer boundary happens at 27MHz X 126 = 3402MHz, the next at 27MHz X 127 = 3429MHz and every 27MHz thereafter up to 6777MHz. Above and below the fundamental VCO band the spacing will be affected by the RF doubler or RF divider respectively. If the desired VCO operating frequency is 3402.01MHz 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 3400MHz. Spurs 2MHz away will be attenuated to satisfactory levels by the loop filter.

2.5 Phase Noise

Typical phase noise at 1GHz

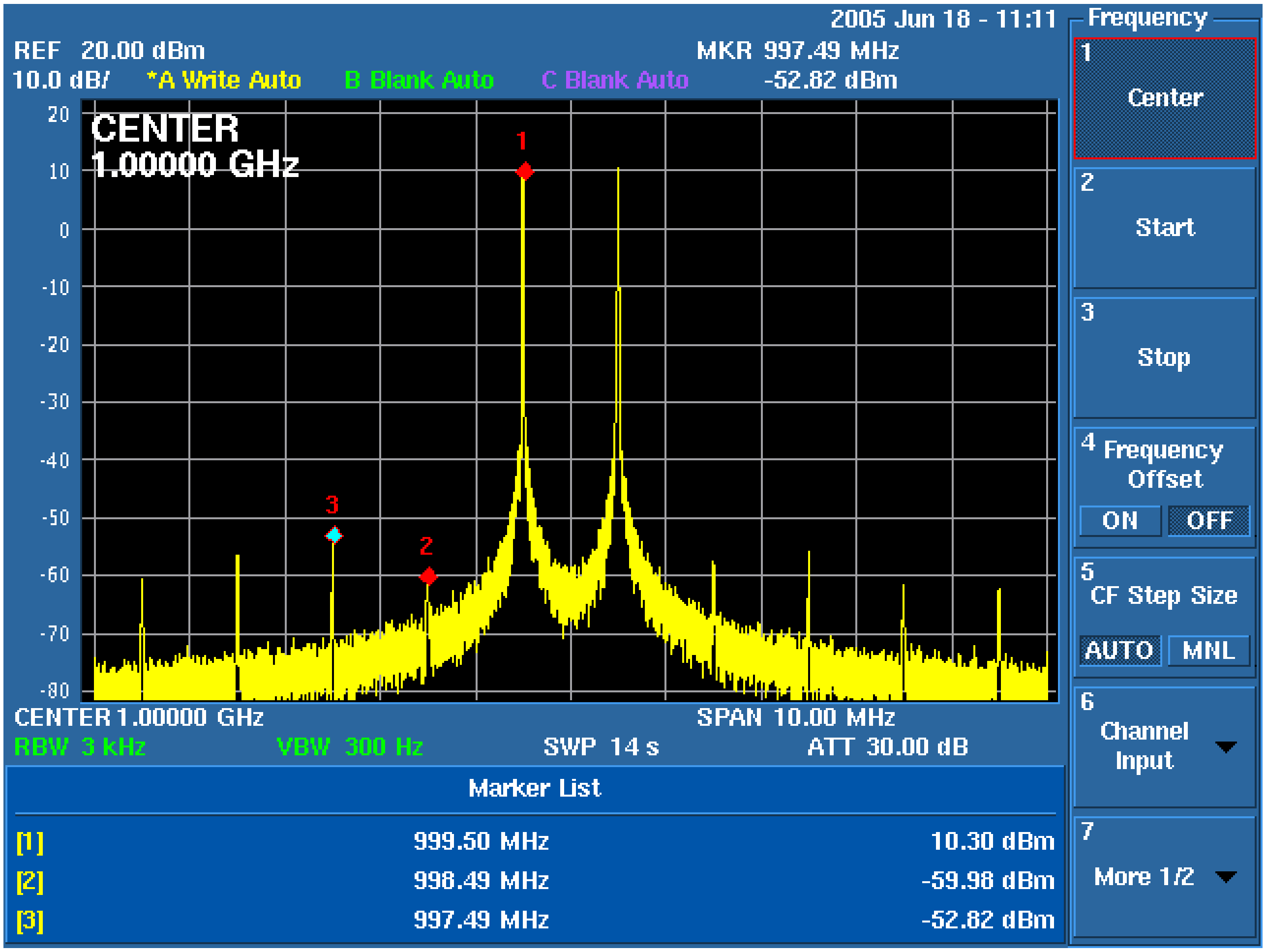
Typical phase noise at 5GHz

Typical phase noise at 10GHz

Typical phase noise at 13.6GHz

2.6 Intermodulation Distortion after an External Wilkinson Combiner

Its possible to lock both channels in both frequency and amplitude for easy tuning during IMD testing of IP3 in passive and active components. The plot below shows two tones combined with a YL-70 0.5-2.0 GHz KL combiner that has roughly 20dB of isolation between ports. The tones are centered at 1GHz and separated by 1MHz. This method will allow for IP3 testing below roughly +40dBm.



Two Tone Generation via Wilkinson Combiner

3 Device Information

3.1 Mechanical Dimensions (inches)

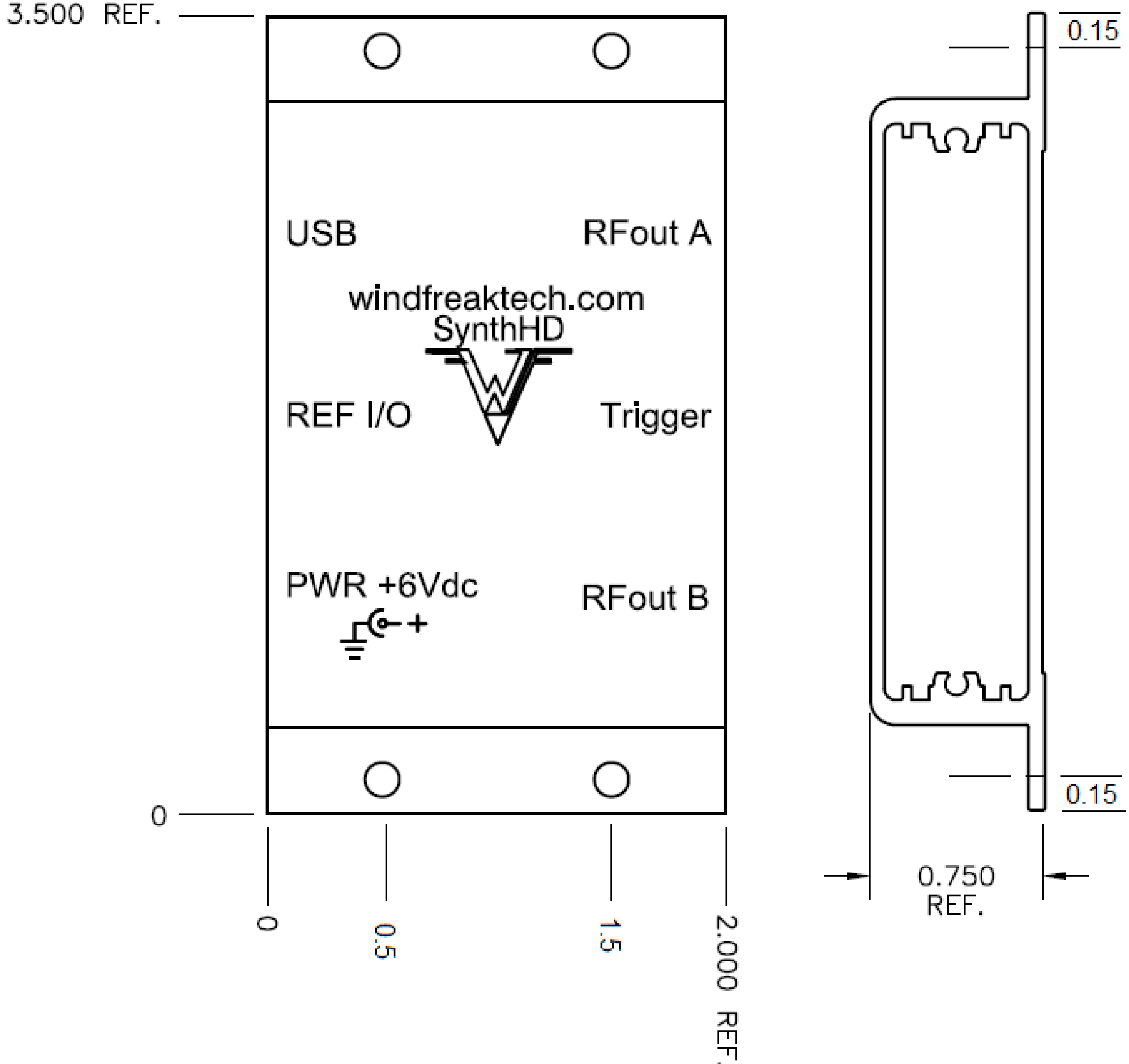
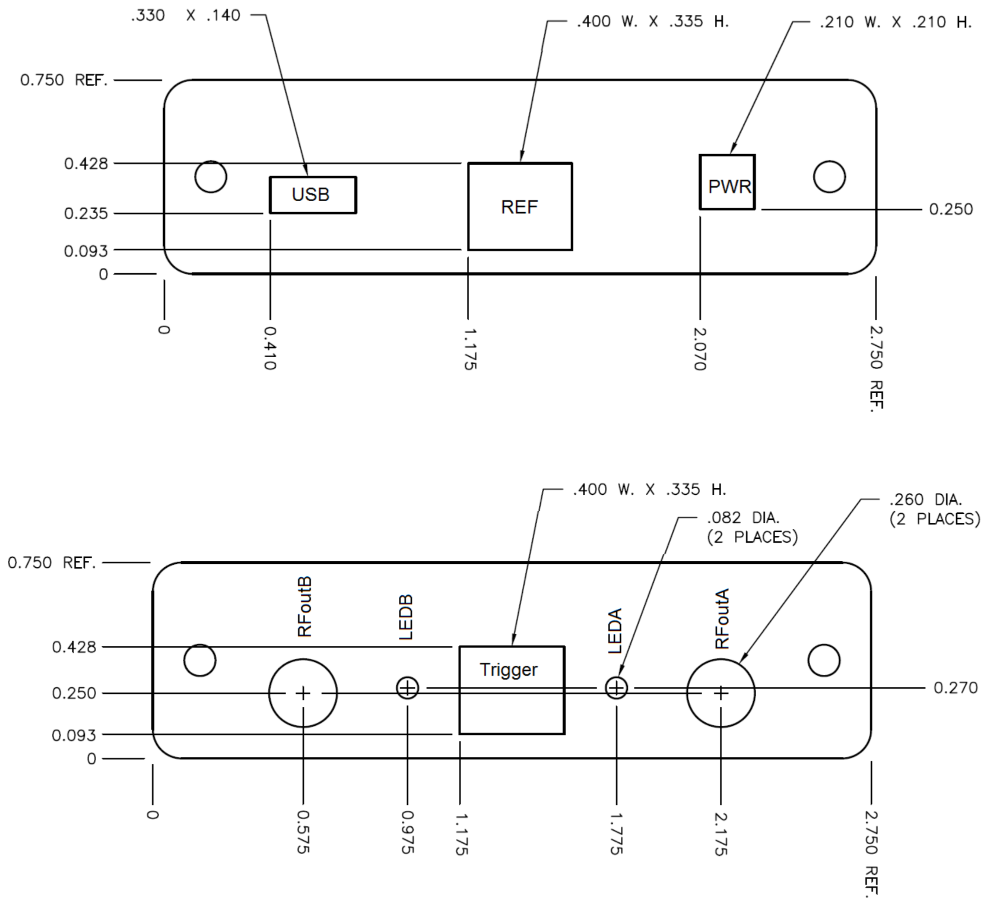


Figure 2. Outer Dimensions



Plates mount external to the extrusion and are 0.0615 inches thick.

Figure 3. End Panels

Figure 4. Picture