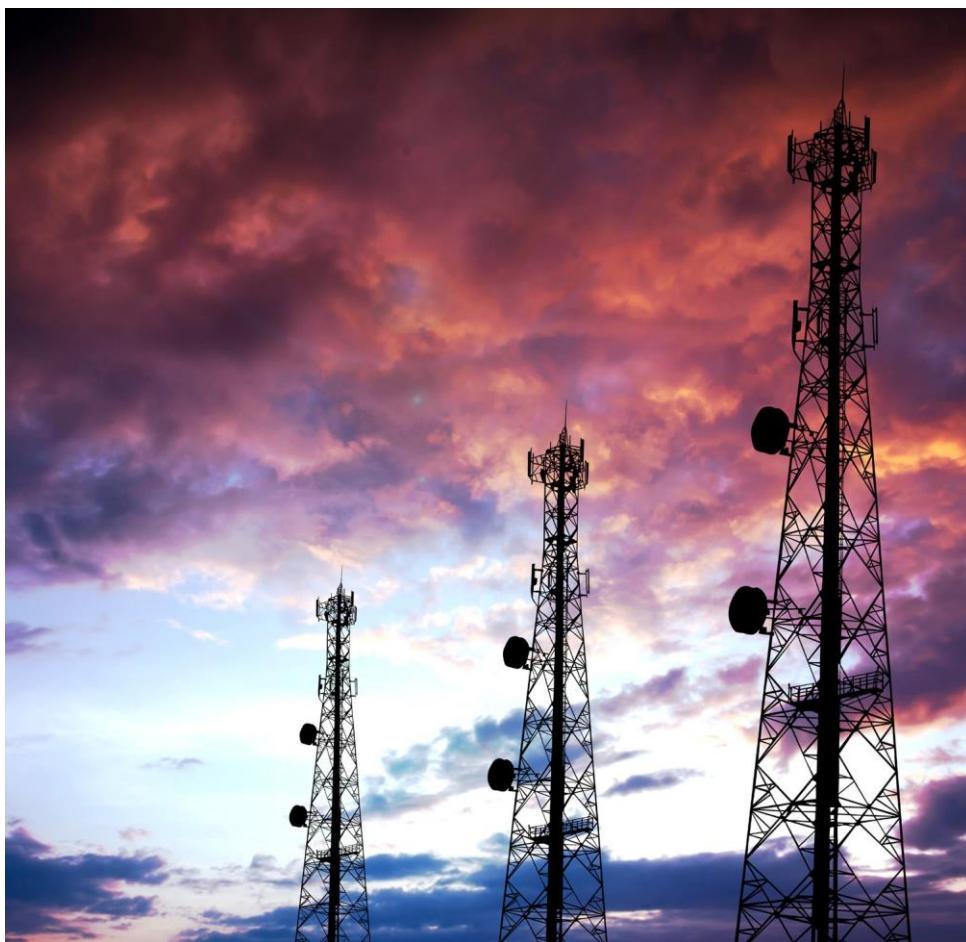


# Model 875 Vector Signal Generator



## Features

- Excellent Phase Noise
- Ultra-Fast Switching
- Ultra High I/Q data Rates, Deep Internal Memory
- Various Digital Modulation Supported

## Applications

- Arbitrary I/Q Waveform
- Radar Signal Simulation
- Receiver Testing
- Avionic Modulation Emulation
- High Speed Antenna Testing



## Model 875 Datasheet v1.14

10 MHz to 4, 6, 20, and 40 GHz  
Ultra-Agile Vector Signal Generator

## DEFINITIONS

The specifications in the following pages describe the warranted performance of the instrument for 23 ±5 °C after a 30-minute warm-up period

**Typical:** Expected mean values, not warranted performance

**Min and Max:** Parameter range that is guaranteed by product design, and/or production tested. Warranted performance specifications include guard-bands to account for the expected statistical performance distribution, measurement uncertainties, and changes in performance due to environmental conditions.

## INTRODUCTION

### Ultra-Agile Vector Signal Generator

The Model 875 is an ultra-fast-switching vector-modulated signal source covering a continuous frequency ranges from 10 MHz to 4, 6, 20, or 40 GHz, respectively, with 0.001 Hz resolution, and 500 MHz RF modulation bandwidth.

The standard Model 875 enables ultra-fast CW frequency sweeping, chirping, intra-pulse modulation, pulse shaping with very low phase noise.

A high performance internal I/Q modulator enables customized modulation waveforms and supports dedicated modulation schemes including avionics modulation.

All Model 875s operate with ultra-stable temperature compensated frequency reference (OCXO) ensuring minimal drift, and can be phase-locked to an external reference.

The compact unit allows for full front panel control via touch panel display, and PC GUI Software supported operation via ETHERNET, USB or GPIB communication ports.

#### **The following options are supported:**

- **PE4:** Electrical step attenuator
- **LN:** Improved close-in phase noise behavior
- **UFS:** Ultra-fast switching
- **VREF:** Programmable external reference
- **AVIO:** Avioniques modulations (DME, ILS, VOR, ...)
- **FCP:** Fast control port for parallel programming
- **EIQ:** External I/Q inputs
- **MOD:** Analog modulations

# FACTS & FIGURES & SPECIFICATIONS

## Signal Specifications

PARAMETER	MIN	TYPICAL	MAX	NOTE
<b>Frequency Range</b>	10 MHz		4 GHz 6 GHz 20 GHz 40 GHz	875-4 875-6 875-20 875-40
<b>Frequency Resolution</b>		0.001 Hz		
<b>Phase Resolution</b>		0.01 deg		
<b>Frequency &amp; Amplitude Switching / Settling Time</b>		1.5 ms 500 µs 200 ns 800 ns		valid signal after SCPI received List sweep 500 MHz BW, Option UFS any step Option UFS
<b>Output Power Level</b>				
0.01 to 4 GHz	-65 dBm		+15 dBm	
4 to 6 GHz	-20 dBm		+20 dBm	
6 to 20 GHz	-20 dBm		+18 dBm	
20 to 40 GHz	-20 dBm		+15 dBm	
<b>Output Power Level (Option PE4)</b>				
4 to 6 GHz	-90 dBm		+10 dBm	
6 to 20 GHz	-60 dBm		+13 dBm	
20 to 40 GHz	-50 dBm		+10 dBm	
<b>Power Resolution</b>		0.01 dB		
<b>Power Level Uncertainty</b>				Digital ALC on, -20dBm to P <sub>max</sub>
<4 GHz	0.25 dB	1.2 dB		
4 to 6 GHz	0.3 dB	1.3 dB		
6 to 20 GHz	0.3 dB	1.6 dB		
20 to 40 GHz		2.0 dB		
<b>Reverse Power Protection</b>				
DC Voltage		±10 V		
RF Power		+26 dBm		
<b>Output Impedance</b>		50 Ω		
VSWR		1.8		See measurement Figure 5
<b>SSB Phase Noise at 1 GHz and 10 dBm</b>				See measurement Figure 1
at 10 Hz from carrier	-87 dBc/Hz -100 dBc/Hz			Option LN
at 1 kHz from carrier	-130 dBc/Hz			
at 20 kHz from carrier	-145 dBc/Hz			
at 100 kHz from carrier	-150 dBc/Hz			
<b>SSB Phase Noise at 4 GHz and 10 dBm</b>				See measurement Figure 1
at 10 Hz from carrier	-74 dBc/Hz -90 dBc/Hz			Option LN
at 1 kHz from carrier	-121 dBc/Hz			
at 20 kHz from carrier	-133 dBc/Hz			
at 100 kHz from carrier	-138 dBc/Hz			
<b>SSB Phase Noise at 10 GHz and 10 dBm</b>				See measurement Figure 1
at 10 Hz from carrier	-67 dBc/Hz -80 dBc/Hz			Option LN
at 1 kHz from carrier	-113 dBc/Hz			

at 20 kHz from carrier		-124 dBc/Hz		
at 100 kHz from carrier		-130 dBc/Hz		
<b>SSB Phase Noise at 40 GHz and 10 dBm</b>				See measurement Figure 1
at 10 Hz from carrier		-55 dBc/Hz -68 dBc/Hz		Option LN
at 1 kHz from carrier		-101 dBc/Hz		
at 20 kHz from carrier		-112 dBc/Hz		
at 100 kHz from carrier		-118 dBc/Hz		
<b>Harmonics (at 0 dBm output)</b>		-40 dBc -50 dBc -55 dBc tbd tbd	-45 dBc -50 dBc tbd tbd	< 0.5 GHz 0.5 to 4 GHz 4 to 6 GHz 6 to 20 GHz 20 to 40 GHz
<b>Sub-Harmonics (at 0 dBm output)</b>		-75 dBc tbd tbd		< 6 GHz 6 to 20 GHz > 20 GHz
<b>Non-Harmonic Spurious (at 0 dBm output, &gt; 10 kHz offset)</b>		-90 dBc -92 dBc -90 dBc -84 dBc -80 dBc -70 dBc	-85 dBc -88 dBc -86 dBc -80 dBc -74 dBc -66 dBc	< 1.2 GHz 1.2 to 2.5 GHz 2.5 to 5 GHz 10 to 10 GHz 10 to 20 GHz > 20 GHz

## Modulation Capability (Digital)

PARAMETER	MIN	TYPICAL	MAX	NOTE
<b>I/Q Modulator</b>				
RF modulation bandwidth		400 MHz		
Carrier leakage		< -70 dBc		
Image sideband rejection		< -65 dBc		
<b>Internal I/Q Baseband Generator</b>	1 channel for I and Q			Arbitrary data from memory
Resolution		16 bits		For I and Q each
Waveform clock (sample rate)		500 MHz		
Resolution		0.1 Hz		
Aliasing filter				
Accuracy	Same as timebase			
Triggering				See trigger section
<b>Marker Signals</b>	Up to 3			Optional
Operating modes				
<b>Waveform Segments</b>	1		1024	
Waveform sequencer playlist	1		2048	
Trigger modes	Same segment, next segment			
Waveform Memory for Playback		125 MSa 250 MSa		Optional
<b>External analog I/Q Data Inputs</b>				Option EIQ, rear I and Q inputs (BNC female)
Analog bandwidth	DC		100 MHz	
Voltage range	-0.5 V		0.5 V	
Input impedance		50 Ω		

Full scale voltage		0.5 Vrms		$\sqrt{I^2+Q^2}$
<b>Multicarrier generation</b>				
Number of carriers	1		1024	
Frequency offset	-200 MHz		200 MHz	
Power offset	-60 dB		0 dB	0.1 dB resolution
Tone initial phase offset	0 deg		360 deg	0.1 deg resolution
<b>Internal modulation supported</b>				
	ASK, PSK, N-FSK, QAM		Option IVM	
ASK depth	0 %		100 %	0.1 % resolution
FSK deviation	10 Hz		200 MHz	0.1 Hz resolution
Symbol rate	100 Hz		100 MHz	
<b>AVIO Modulation DME</b>				
Operating modes	interrogation & reply			
DME channel	X, Y			
Frequency range	960 MHz		1215 MHz	
Pulse on/off ratio		80 dB	70 dB	
Pulse rise/fall times	100 ns		50 us	100 ns resolution
Pulse width	100 ns		100 us	100 ns resolution
Pulse spacing	100 ns		300 us	100 ns resolution
Pulse rate	10 Hz		10 kHz	1 Hz resolution
Pulse shaping	cos, cos <sup>2</sup> linear, gauss			individually settable for rising & falling edge
ID code				
ID rate				
<b>AVIO Modulation VOR</b>				
	108 to 118 MHz			
Bearing accuracy		$\pm 2\% / \pm 0.5$ deg		
Subcarrier frequency accuracy		$9960 \pm 2$ Hz		
AM accuracy		$30 \pm 1\%$		
AM distortion (THD)			2%	
FM accuracy		$480 \pm 1$ Hz		
<b>AVIO Modulation ILS</b>				
	108 MHz		112 MHz	
AM accuracy		$40 \pm 1\%$		
AM distortion				
DDM resolution		0.0002 0.0004		Localizer Glide Slope
DDM accuracy		0.0004 0.0008		Localizer Glide Slope
<b>Marker Beacon</b>				
AM tone accuracy (95% AM)		5% of setting		
AM tone distortion (95% AM)		5%		

## Modulation Capability (Analog)

PARAMETER	MIN	TYPICAL	MAX	NOTE
<b>Pulse Modulation</b>				
Modulation source		Internal / External		
Pulse rise/fall time		5 ns		10% / 90% of amplitude
On/off ratio		80 dB 75 dB	70 dB 60 dB	< 5.5 GHz elsewhere
Pulse overshoot			1 dB	
Pulse Repetition Frequency (PRF)	0.1 Hz		100 MHz	= 1/T
Minimum pulse settling range	10 ns		20 s	
Pulse Pattern Modulation & Staggered PRF				Using internal pattern generator
Programmable pattern length	2		65536	
Duty cycle	0.05%		99.95%	In 0.05% step
Pulse width resolution		2 ns		
Pulse period (T) accuracy		same as timebase		
Pulse width accuracy		same as timebase		
Pulse jitter			1 ns	
Polarity		selectable		
<b>Amplitude Modulation</b>				
Modulation source		Internal / External		External requires option EIQ
Modulation depth	0%		100%	Output is clipped at max power level
Deviation accuracy		0.5%	2%	1 kHz rate, 30% depth
Deviation resolution		0.1%		
Distortion (THD)			1%	1 kHz rate, 30% depth
Modulation frequency range	DC		100 MHz	
Modulation waveforms		Sine, Square		
<b>Frequency Modulation</b>				
Modulation source		Internal / External		External requires option EIQ
Maximum frequency deviation (peak)		400 MHz		
Deviation accuracy		0.5%	1%	
Distortion (THD)		< 1 %		1 kHz rate, 10 kHz deviation
Modulation frequency range	0.1 Hz		100 MHz	
Modulation waveforms		Sine, square		
<b>Phase Modulation</b>				
Modulation source		Internal / External		External requires option EIQ
Phase deviation (peak)	0		300 rad	
Deviation accuracy		0.5%	1%	
Modulation frequency range	0.1 Hz		100 MHz	
Modulation waveforms		Sine		

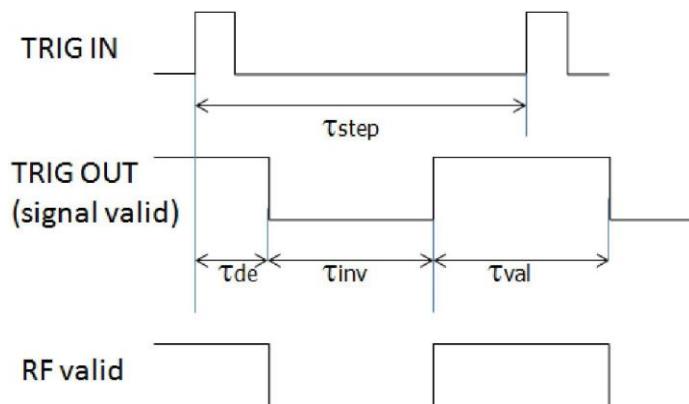
Distortion (THD)	< 1%	1 kHz rate & N x rad deviation
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## Frequency Reference

PARAMETER	MIN	TYPICAL	MAX	NOTE
<b>Internal Reference Frequency</b>		100 MHz 10 MHz		Option LN
Initial calibrated accuracy			±20 ppb	At 23 ± 3 °C
Temperature stability			±100 ppb ±30 ppb	0 to 50 °C Option LN
Aging after 1st year			1 ppm 0.3 ppm	Option LN
Aging per day			5 ppb 0.5 ppb	after 30 days operation Option LN
Warm-up time		5 min		
Output of internal reference		100 MHz 10/100 MHz		Option LN
Output power		0 dBm		
Output impedance		50 Ω		
<b>Bypass Internal reference Input</b>		100 MHz		High phase synchronous mode
<b>Phase Lock to External Reference</b>	5	10 MHz integer MHz 100 MHz	250	Option VREF
Bypass Mode				
<b>Reference input level</b>				
10 MHz or 1-250 MHz	-5 dBm	0 dBm	+10 dBm	
100 MHz	5 dBm		+15 dBm	
<b>Lock Range</b>				
10 MHz or 1-250 MHz			±1.5 ppm	
100 MHz			>100 ppm	
<b>Reference input impedance</b>		50 Ω		

## Sweeping Capability

PARAMETER	MIN	TYPICAL	MAX	NOTE
<b>Sweep Type</b>		List, linear, logarithmic, sawtooth, triangle, random		
<b>Frequency Sweep Range</b>		Full range		
<b>Sweep Parameters</b>		Frequency, power, phase		
Step time ( $t_{step}$ )	500 μs 200 ns 800 ns		19998 s 19998 s	Option UFS, within +/- 225 MHz Option UFS, Freq step > +/- 225 MHz
Settling time ( $t_{inv}$ )				To stabilize phase and amplitude, depends on frequency step
Trigger latency ( $t_{de}$ )		10 ns		Time from trigger to initiate signal transient
Time resolution		2 ns		
Timing accuracy per point		2 ns		



## Trigger Capability

PARAMETER	MIN	TYPICAL	MAX	NOTE
Trigger Types		Continuous, single (point), gated, gated direction		
Trigger Source		external, bus (LAN, USB)		
Trigger Modes		Continuous free run, trigger and run, reset and run		
Trigger latency		10 ns		
Trigger uncertainty		2 ns		
External trigger delay	0		10 s	Settable
External delay resolution		2 ns		
Trigger Polarity		Rising, falling		

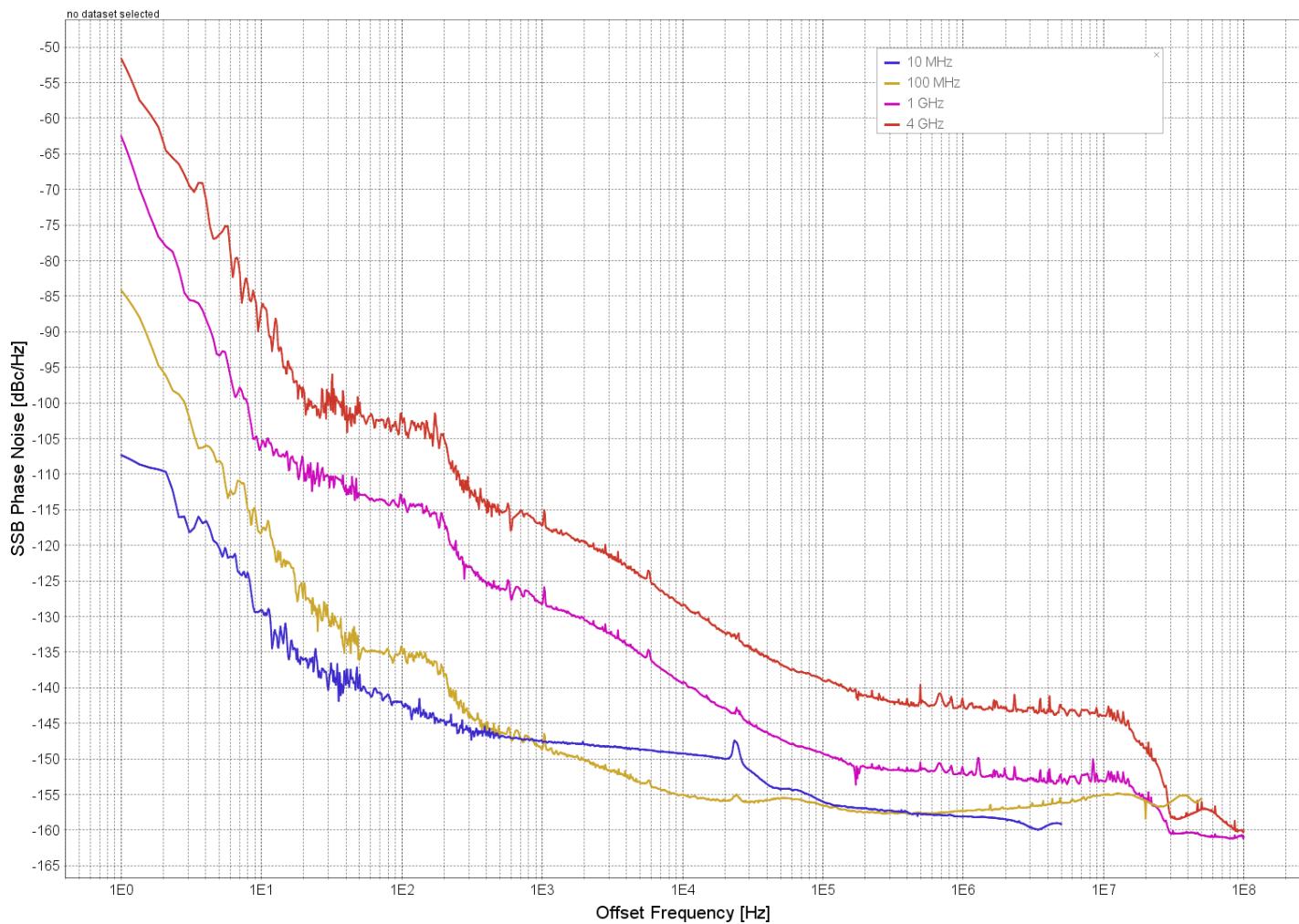
## Fast Control Port (Option FCP)

Parallel hardware interface for high speed programming using PDW (Pulse descriptor words) or for external digital or analog (option EIQ) IQ data input

Mode	Normal or Stream
Interface	LVDS
Sampling Rate	125 MHz
Latency	80 ns
Input	40 bits data 6 bits address 1 bit strobe
Output	3 bits trigger / marker
Connector Type	Mini D-type, 100 pin
Normal Mode	Frequency / Amplitude / Phase
Stream	32 bits I/Q data

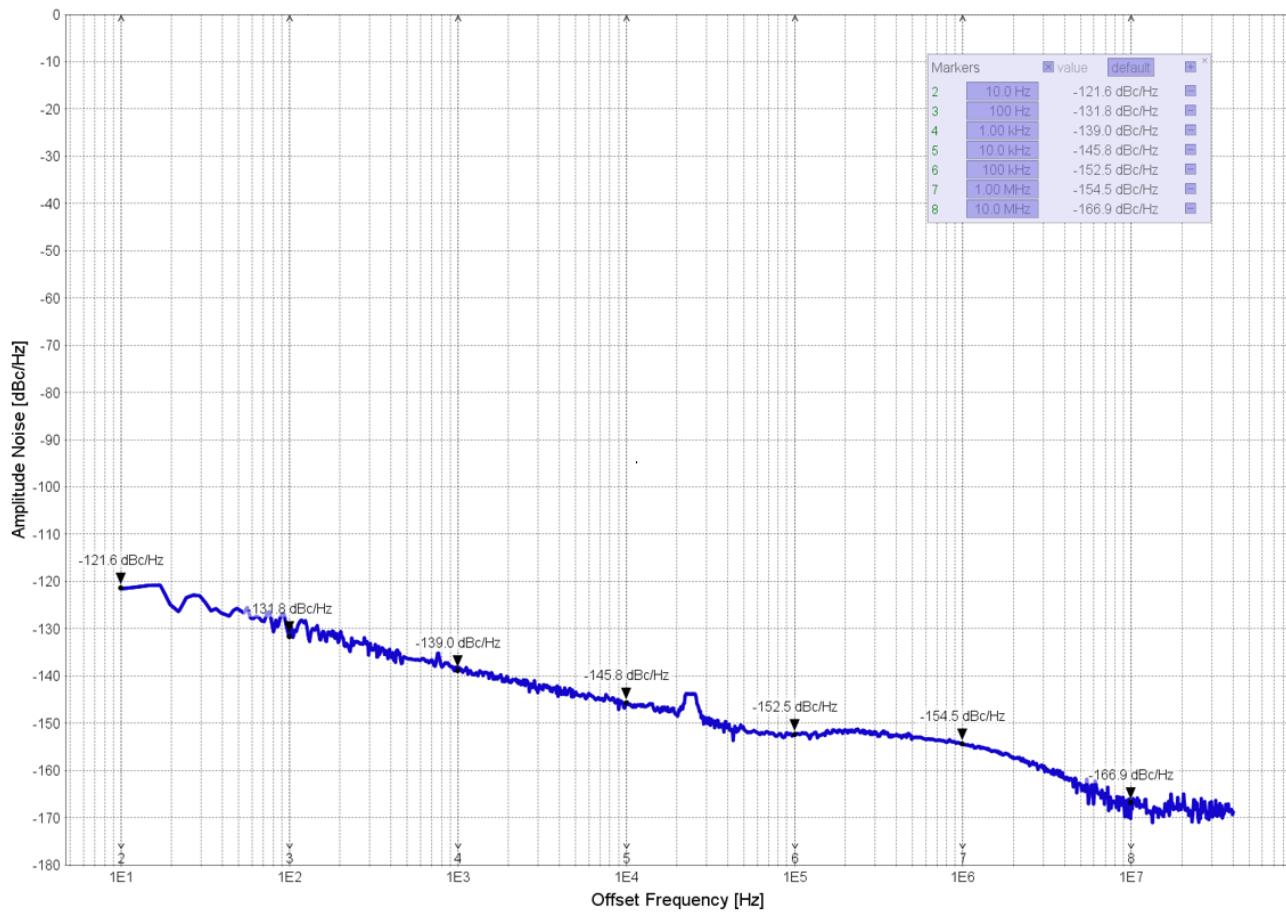
## TYPICAL PERFORMANCE CURVES

Figure 1: SSB Phase Noise Performance, CW with option LN, Pout=10 dBm

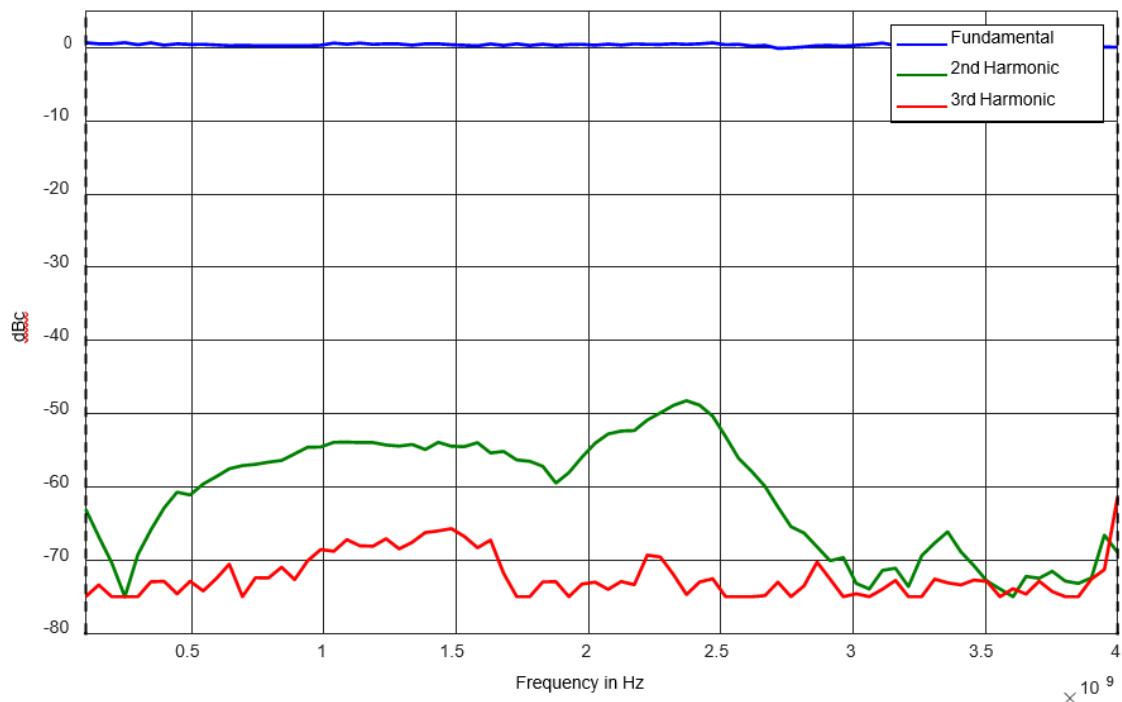


Offset → RF ↓	1 Hz	10 Hz	100 Hz	1 kHz	10 kHz	100 kHz	1 MHz	floor
10 MHz		-133	-141	-149	-150	-156	-158	-158
100 MHz		-119	-135	-148	-155	-156	-158	-159
1 GHz		-100	-114	-129	-140	-150	-152	-160
2 GHz		-93	-108	-124	-135	-145	-146	-155
4 GHz		-87	-102	-118	-129	-139	-140	-151
6 GHz		tbd	tbd	tbd	tbd	tbd	tbd	tbd
10 GHz		tbd	tbd	tbd	tbd	tbd	tbd	tbd
20 GHz		tbd	tbd	tbd	tbd	tbd	tbd	tbd
40 GHz		tbd	tbd	tbd	tbd	tbd	tbd	tbd

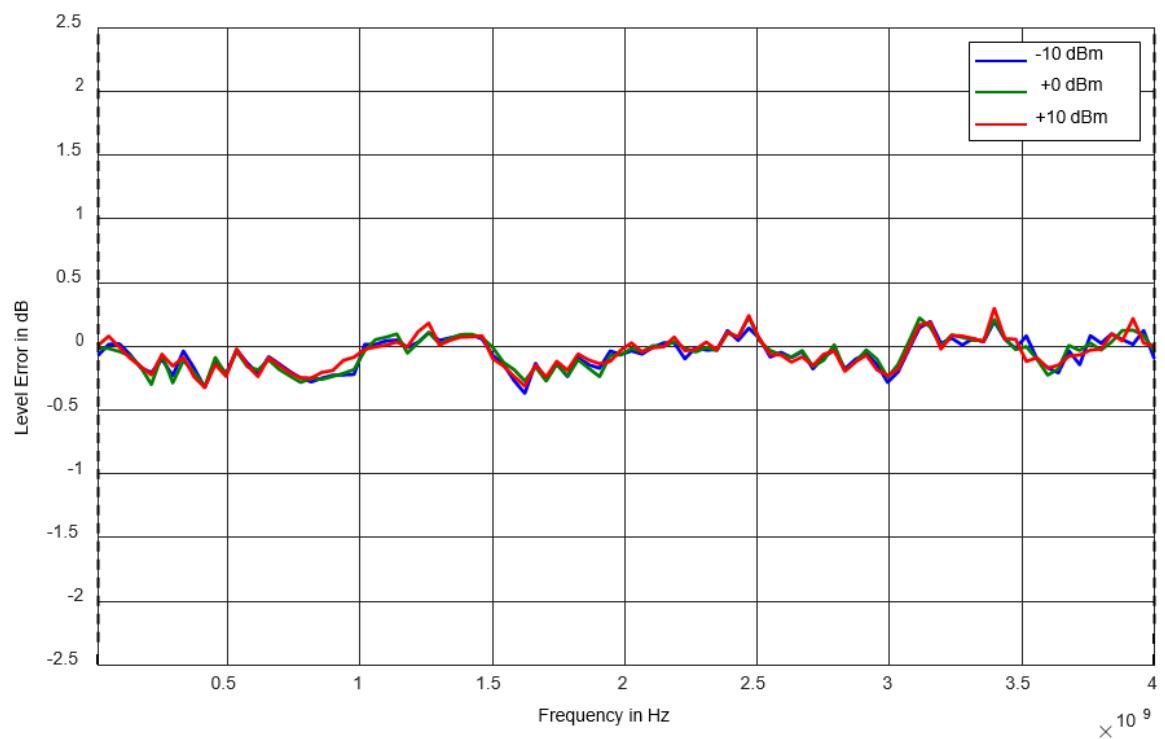
**Figure 2: Amplitude Noise, 2 GHz, Pout=10 dBm**



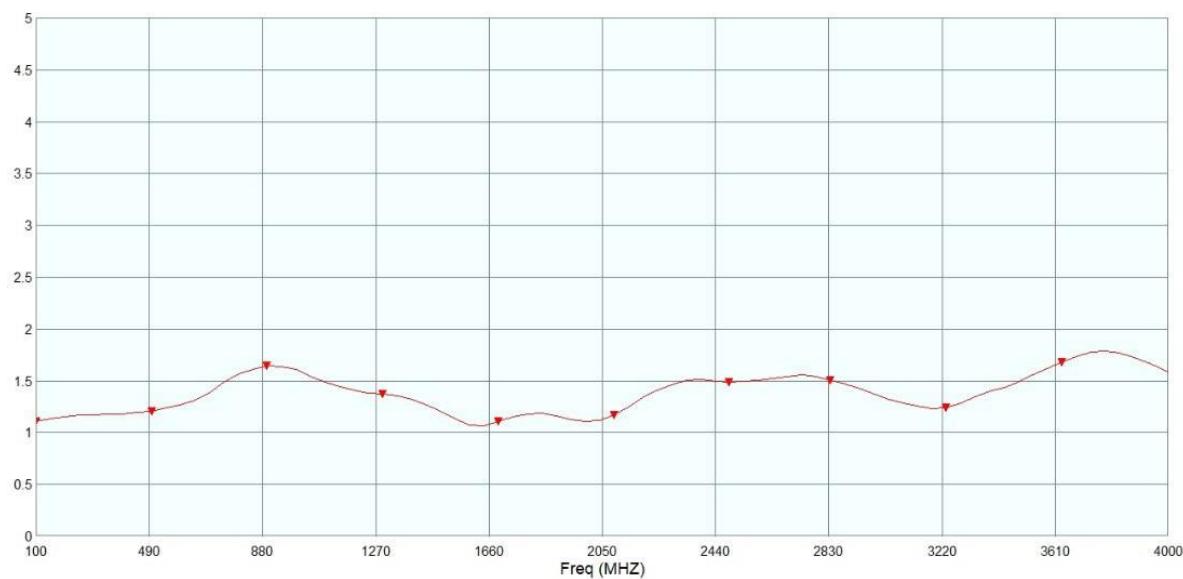
**Figure 3: Harmonic performance at 0 dBm**



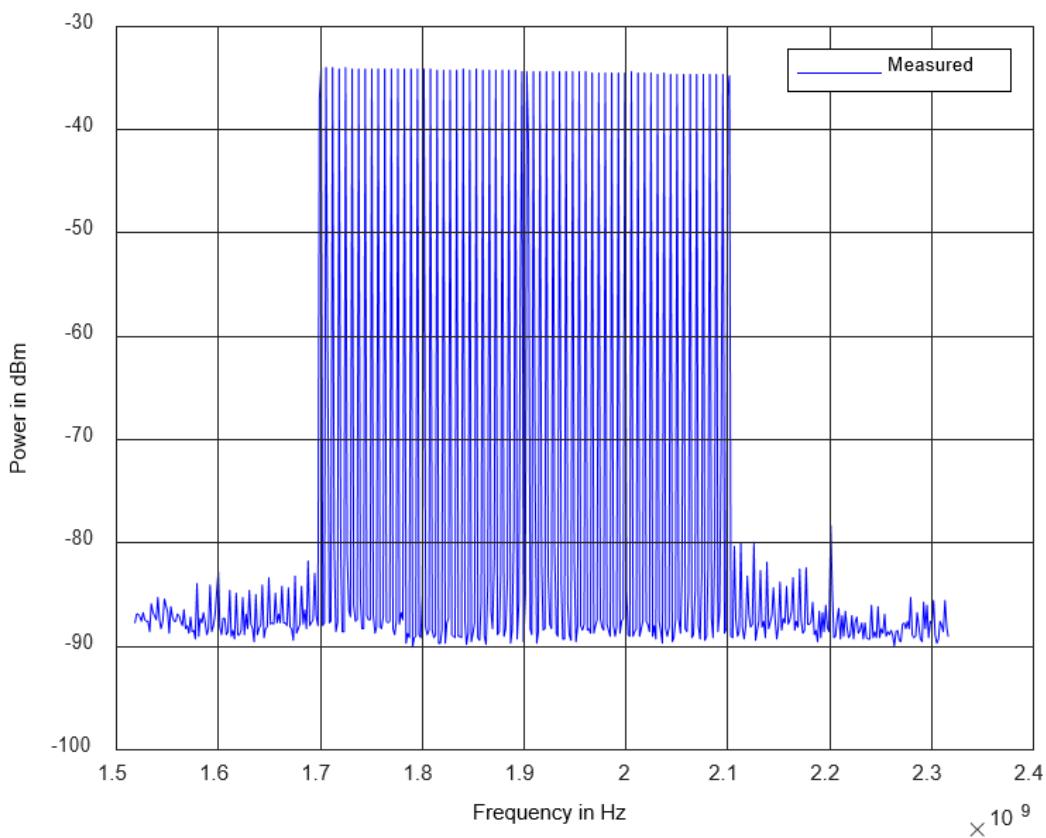
**Figure 4: Level accuracy**



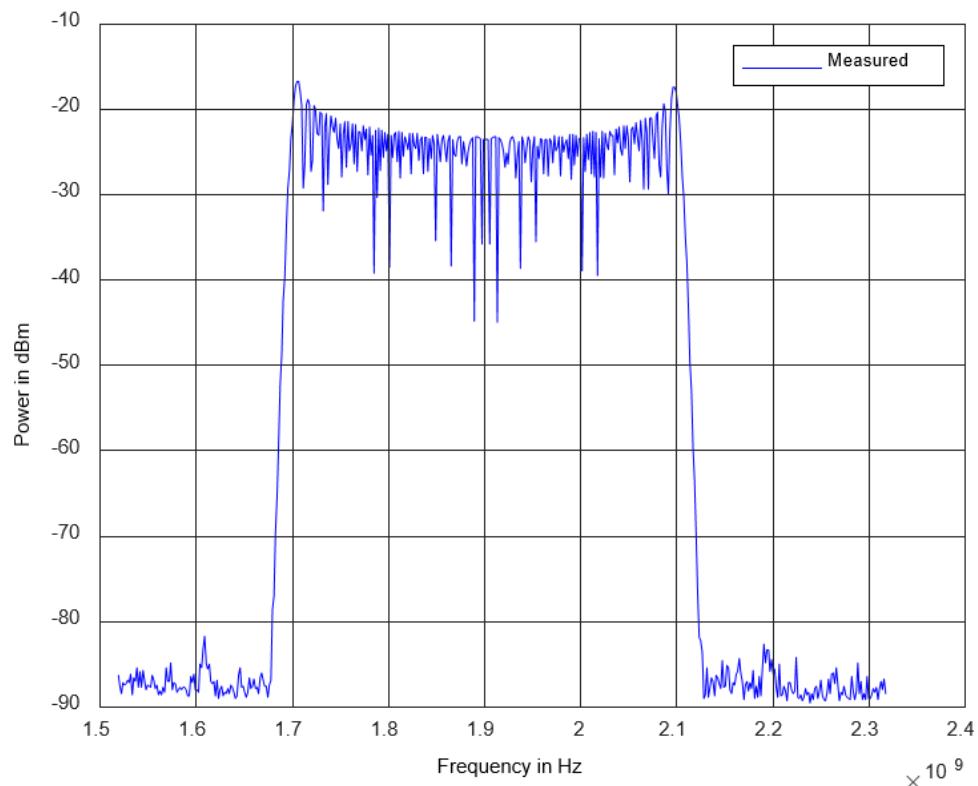
**Figure 5: Typical VSWR (875-4)**



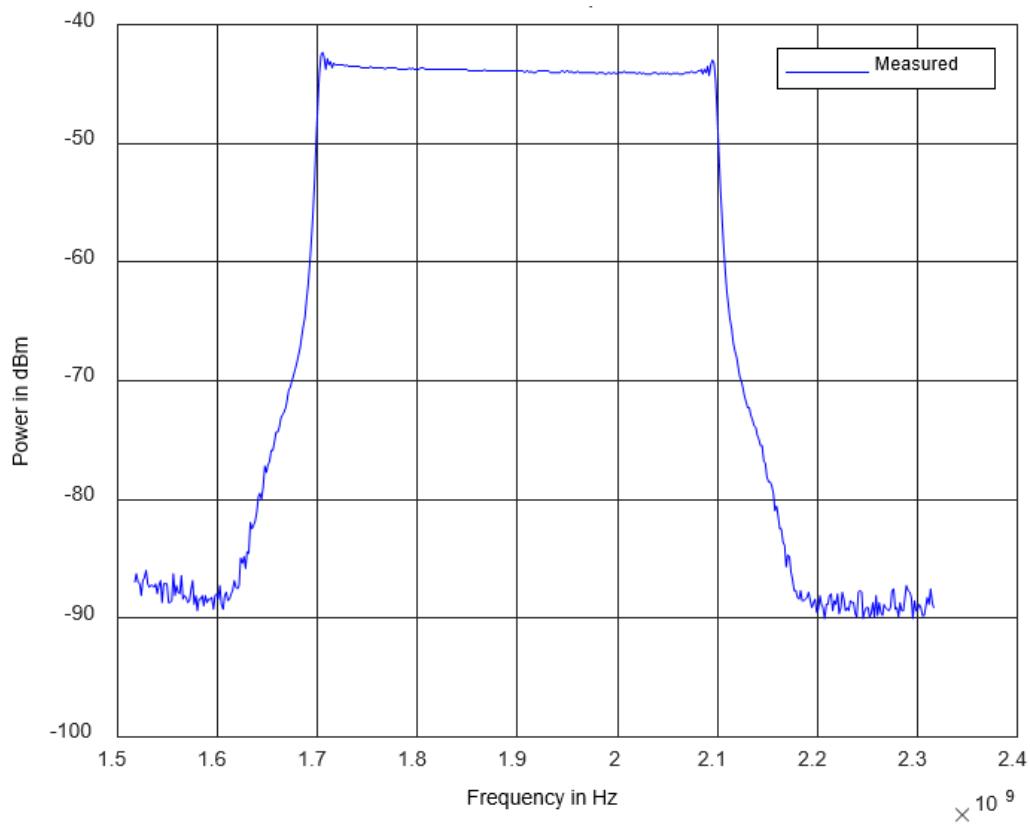
## 64-Tone 400 MHz Bandwidth Signal



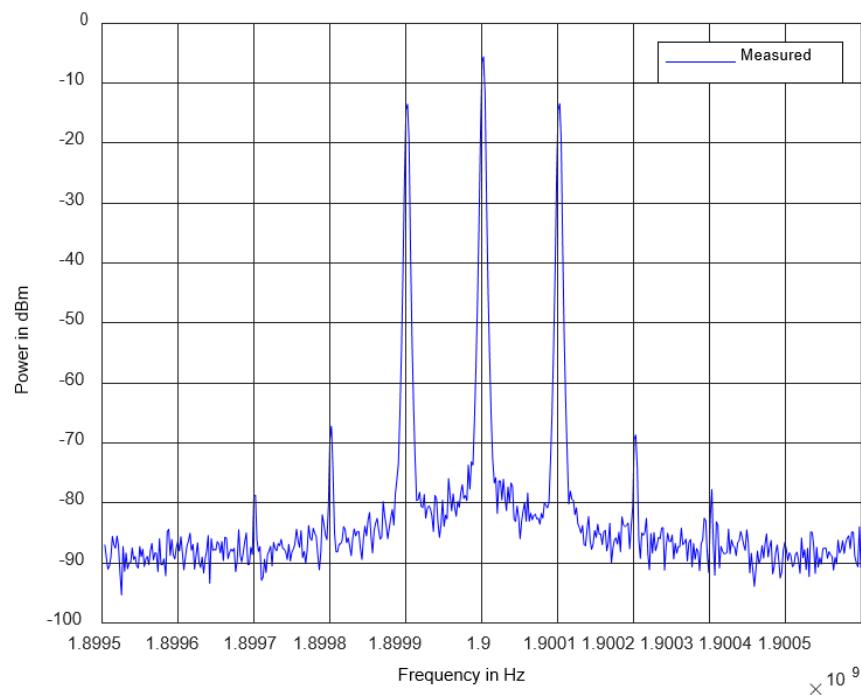
## Wideband FM (1MHz rate, 200 MHz deviation)



## Pulsed chirp (10 microseconds, 400 bandwidth)



## Amplitude modulation (1 kHz rate, 80% depth)

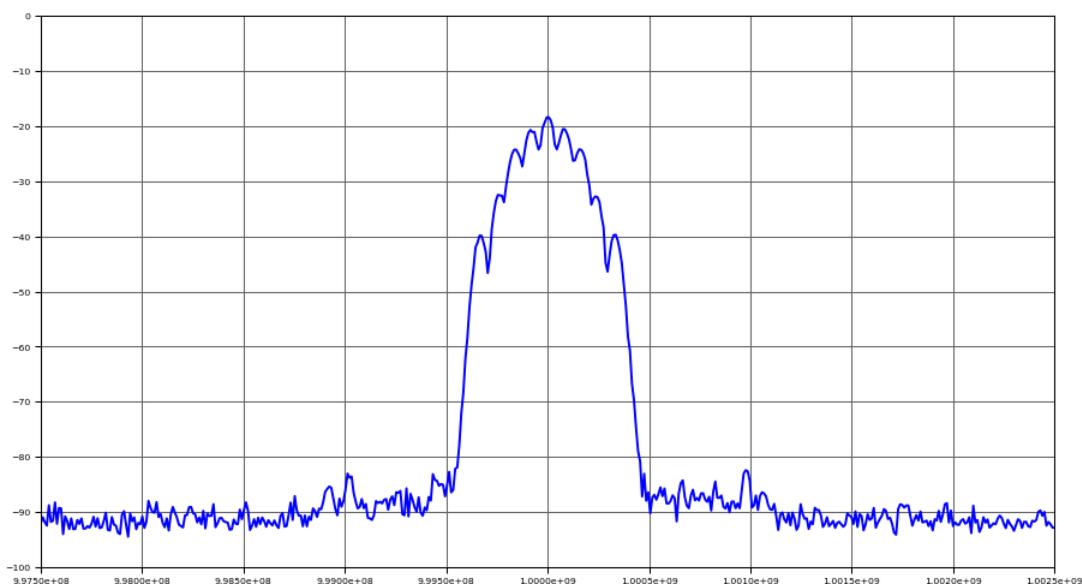


## DME Spectrum (X channel, raised cosine filter)

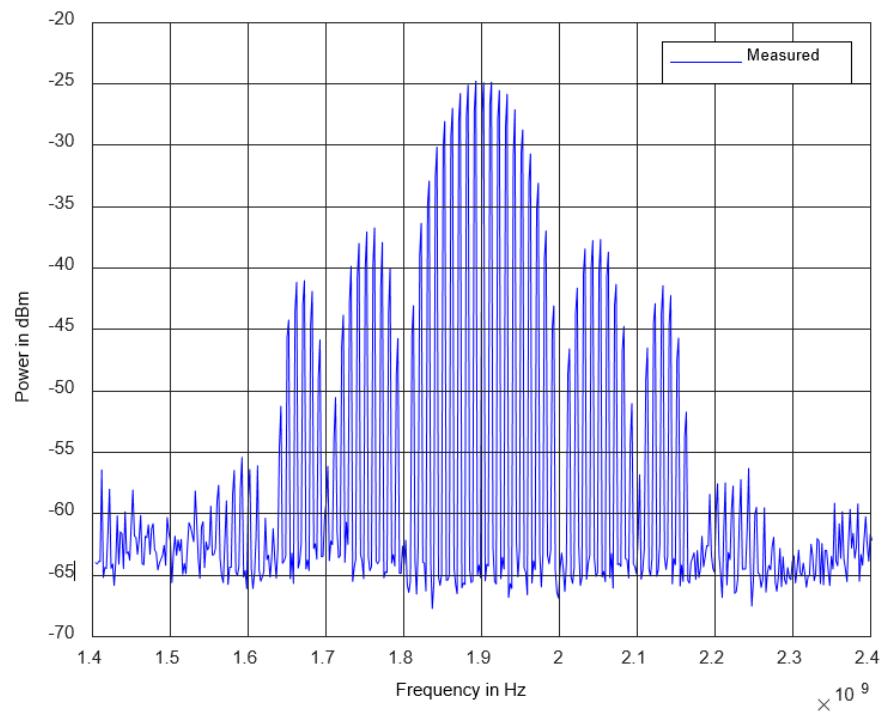
RF Att [dB]: 1.00e+01  
Ref Lvl [dBm]: 0.00e+00

VBW [Hz]: 1.00e+04  
RBW [Hz]: 3.00e+04

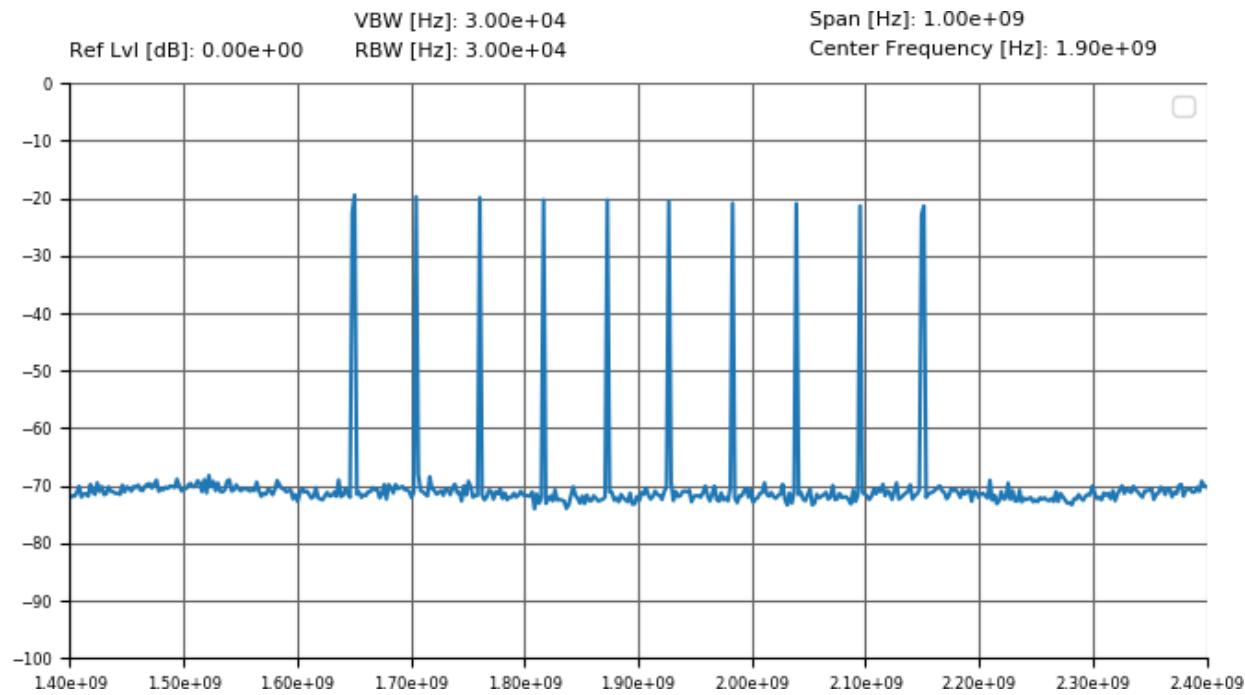
Span [Hz]: 5.00e+06  
Center Frequency [Hz]: 1.00e+09



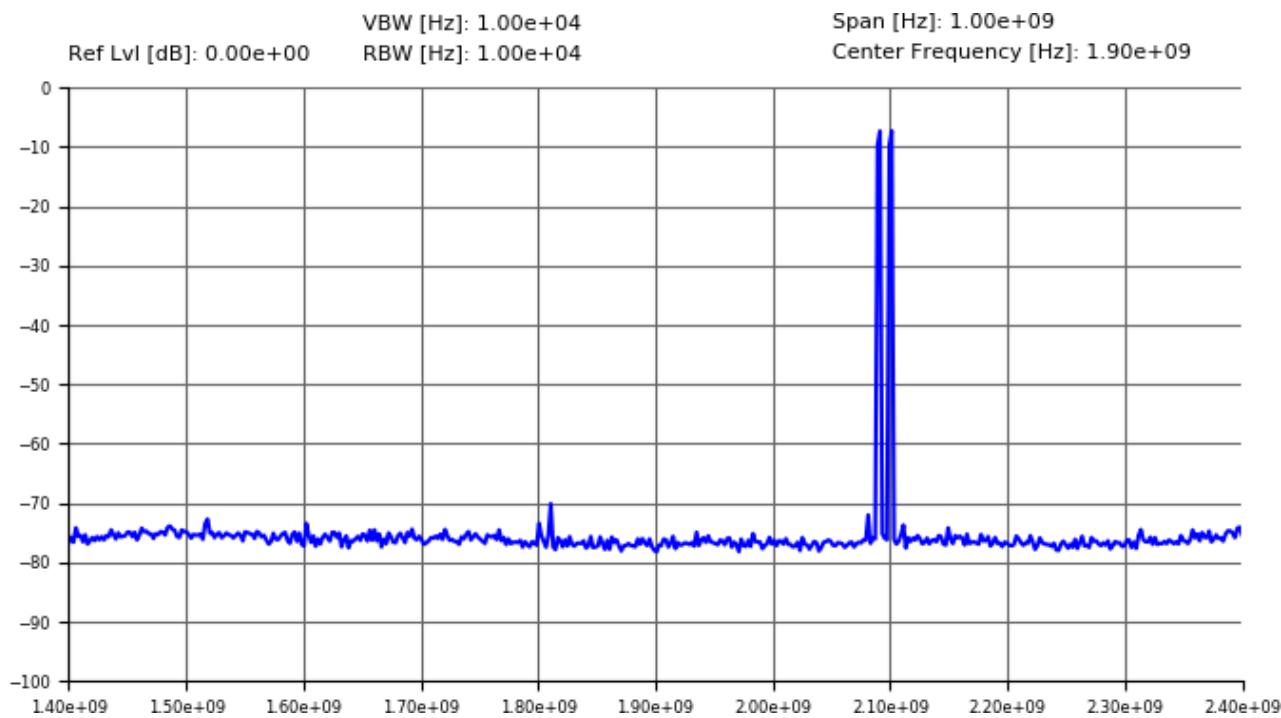
## Pulse modulation (10 MHz rate, 10 ns pulse width)



## 10-tone 500 MHz bandwidth signal



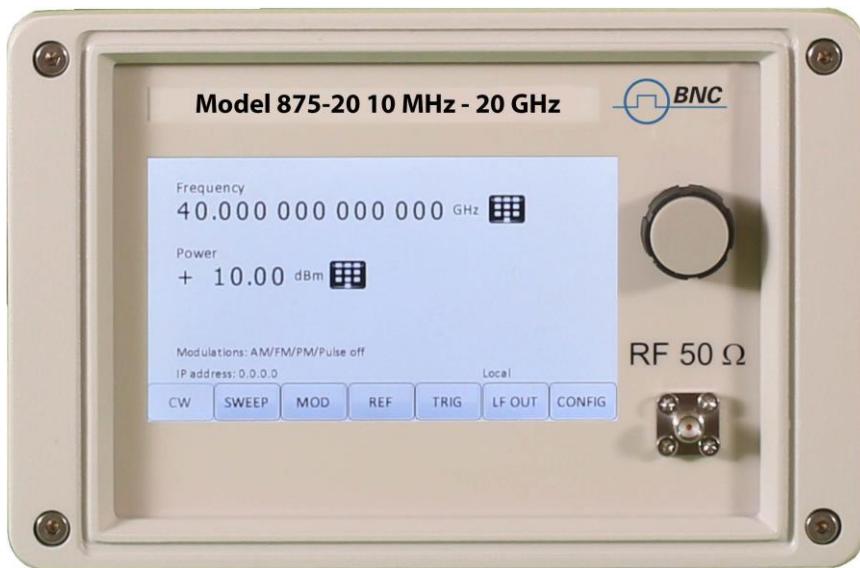
## Two-tone sideband rejection



# CONNECTORS, IOS

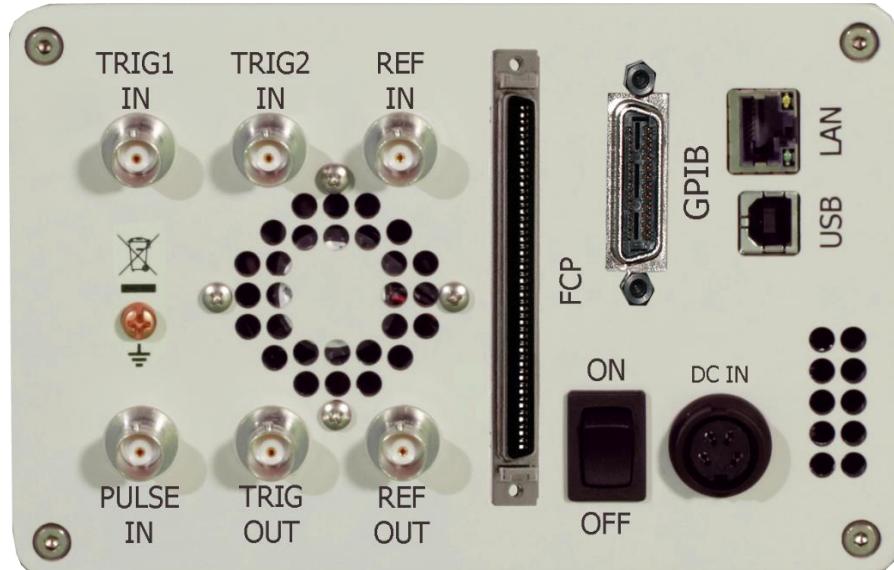
## Front panel:

RF output: 875-4/6/20: SMA female; 875-40: K (2.92 mm) female



## Rear panel:

TRIG 1 IN/ I (with option EIQ)	BNC female
TRIG 2 IN	BNC female
TRIG OUT	BNC female
PULS IN/ Q (with option EIQ)	BNC female
FCP	Mini D-type receptacle (optional)
REF IN	BNC female
REF OUT	BNC female
USB	USB B receptacle
LAN	RJ-45 receptacle
GPIB	GPIB receptacle (optional)
DC IN	



## ORDERING INFORMATION

HOST MODEL	PRODUCT	DESCRIPTION
875	<b>875-4</b>	4 GHz
875	<b>875-6</b>	6 GHz
875	<b>875-20</b>	20 GHz
875	<b>875-40</b>	40 GHz
875	<b>Option LN</b>	Enhanced close-in phase noise & frequency stability
875	<b>Option UFS</b>	Ultra-fast switching speed
875	<b>Option FCP</b>	Fast control port
875	<b>Option MOD</b>	Analog modulations
875	<b>Option PE4</b>	Electrical step attenuator
875	<b>Option AVIO</b>	Avionic modulations
875	<b>Option VREF</b>	Variable REF input
875	<b>Option EIQ</b>	External analog I/Q Inputs
875	<b>Option WE</b>	One year warranty extension
875	<b>Option ReCal</b>	Recalibration

## GENERAL CHARACTERISTICS

### Remote programming interfaces

- Ethernet 100BaseT LAN interface,
- USB 2.0 device
- GPIB (IEEE-488.2,1987) with listen and talk (optional)
- Control language SCPI Version 1999.0

**Power requirement:** 24V ± 3.0 V<sub>DC</sub>; 25 W max

**Mains adapter supplied:** 100 - 240 V<sub>AC</sub>; 24 V<sub>DC</sub> and / 2.7 A max

**Environmental** (Levels similar to MIL-PRF-28800F Class 3/4)

**Environmental stress** Samples of this product have been type tested to be robust against the environmental stresses of storage transportation, and end-use; those stresses to temperature, humidity, shock, vibration, altitude, and power line conditions.

**Operating temperature range:** 0 to 45 °C

**Storage temperature range:** -40 to 70 °C

**Operating and storage altitude** up to 15,000 feet (4600 m)



**EMC** complies to EMC regulations and directives for emission and immunity to interference (EN 61326-1 Industrial, EN/IEC 61326-2-1).

**Safety** complies to applicable safety regulation IEC/EN 61010-1.

This product complies with directive 2011/65/EU.

**Weight:** 6 lbs [2.5 kg] net, ≤ 8 lbs (4 kg) shipping

**Dimension (H x W x L):** 4.21 in x 6.77 in x 11.42 in [106 mm x 172 mm x 290 mm ] (incl. connectors)

**Recommended calibration cycle:** 24 month