Model 855 RF / Multi-Channel Microwave Signal Generator

Features

- Very low phase noise
- 25 µs Fast switching
- Phase coherent switching option
- 2 to 8 phase coherent outputs
- USB, LAN, GPIB interfaces

Applications

- Radar simulation
- Quantum computing
- High volume automated testing
- Phased array antenna / beamforming
- Electronic warfare

Model 855 Datasheet v1.56

300 kHz to 40 GHz RF / Multi-Channel Microwave Signal Generator

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Model 855

Introduction

The Model 855 is a phase coherent multiple-output ultra-fast switching and low phase noise signal generator with a frequency range from 300 kHz to 6, 12, 20, or 40 GHz. It is ideally suited for a wide range of applications, where good signal quality, accurate and wide output power range and very stable phase coherence among all outputs are required are required. Excellent phase noise is combined with good spurious, harmonic rejection and a leading-edge switching speed of 25 µs.

A high-stability OCXO reference provides excellent frequency accuracy and stability. The generator accepts a wide range of external references including the commonly used 10, 100 MHz and 1 GHz for higher phase synchronization, and flexible reference choice in the range of 1-250 MHz for those applications with customer - or system-specific reference frequencies. The Model 855 features a pair of high-frequency 3 GHz SYSREF ports (one input and one output) that enables excellent phase synchronization among the outputs from multiple Model 855 modules.

The Model 855 comes in a standard 19 inch 1U (up to 4 channels) rack-mountable module form and offers various control interfaces like USB, LAN or GPIB. Each interface allows easy and fast communication using SCPI 1999 command set. Remote control of the instrument can be quickly attained from any host system. A customer-supplied application programming interface (API) or programming examples for Matlab, Labview, C++ and other commercially available tools make implementation very straightforward.

The following options are supported:

- **PE**: electrical step attenuator
- **ULN**: ultra low phase noise
- **IPM**: intra-pulse modulation (not with ULN)
- **PHS:** phase coherent switching (requires ULN)
- **VREF:** Flexible reference frequency support in the range of 1 to 250 MHz
- **MOD**: Amplitude, Frequency, Phase modulations added.
- **GPIB:** IEEE-488.2,1987 programming interface

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CW Specifications

The specifications in the following pages describe the warranted performance of the signal generator for 25 ± 8 °C after a 30 minute warm-up period. Typical specifications describe expected, but not warranted performance. Min and Max specifications are warranted.

Each channel acts as a fully independent source and can be configured in frequency, power, phase, and modulation independently.

Parameter	Min.	Typ.	Max.	Note
Frequency Range	300 kHz 300 kHz 300 kHz 300 kHz		6 GHz 12 GHz 20 GHz 40 GHz	855-6 855-12 855-20 855-40 (ULN option always included)
Resolution		1 Hz 0.001 Hz		Standard **Option ULN**
Switching speed Frequency / Amplitude settling time		0.01 ms	0.025 ms 0.015 ms	
Phase Range	0 deg		360 deg	Individually adjustable per channel
Phase resolution		0.1 deg		
SSB Phase Noise at 1 GHz (output power 10 dBm)				Scales with frequency at 20 dB/dec, see also plots on pg 12
At 10 Hz from carrier 1 kHz 100 kHz		-100 dBc/Hz -115 dBc/Hz -140 dBc/Hz		Standard
At 10 Hz from carrier 1 kHz 100 kHz		-100 dBc/Hz -130 dBc/Hz -150 dBc/Hz		**Option ULN**
Power level				
Settable Range	-20 dBm -20 dBm -20 dBm -20 dBm -20 dBm		+20 dBm +25 dBm +23 dBm +20 dBm +15 dBm	0.3 to 10 MHz 10 MHz to 6 GHz 6 to 18 GHz 18 to 20 GHz > 20 GHz
Settable Range with option PE4	-80 dBm -80 dBm -80 dBm		+20 dBm +18 dBm +15 dBm	0.3 to 12 GHz 12 to 15 GHz 15 to 20 GHz
Resolution		0.01 dB		
Thermal drift		0.015 dB / degC		

Parameter	Min.	Typ.	Max.	Note
Level uncertainty		0.25 dB ±3.5 dB	±1.0 dB ±1.6 dB	>- 20 dBm to +20 dBm Option PE4, -60 to - 20 dBm Option PE4, <- 60 dBm
Output impedance		50 Ohms		
VSWR		1.7		
Reverse Power Protection				
DC Voltage		15 V		
RF power			+26 dBm	
Spectral Purity Output harmonics		 -30 dBc -35 dBc -40 dBc -45 dBc	 -25 dBc -30 dBc -30 dBc -35 dBc	at + 10 dBm output power < 100 MHz > 100 MHz to 6.5 GHz 6.5 to 12 GHz > 12 GHz
Non-harmonic spurious		-65 dBc -75 dBc		offsets > 1 kHz **Option ULN**
Channel to Channel Isolation Relative Phase stability: Between channels in a single module Between channels from different modules Phase coherent switching,	70 dB	> 90 dB 80 dB see Plot pg 13 30 mrad 3 mrad 40 mrad 5 mrad		< 3 GHz 3 to 6 GHz > 6 GHz 855-20, over 5 hours, at 5 GHz Standard **Option ULN** Standard (100 MHz phase locked **Option ULN (3 GHz SYSREF locked)**
Power consumption	10 W + 12 W per channel			

1) Phase coherent switching maintains phase relation between individual channels and also with respect to the internal (or external) reference signal.

Reference Frequency

REF IN input and REF OUT output are at rear panel

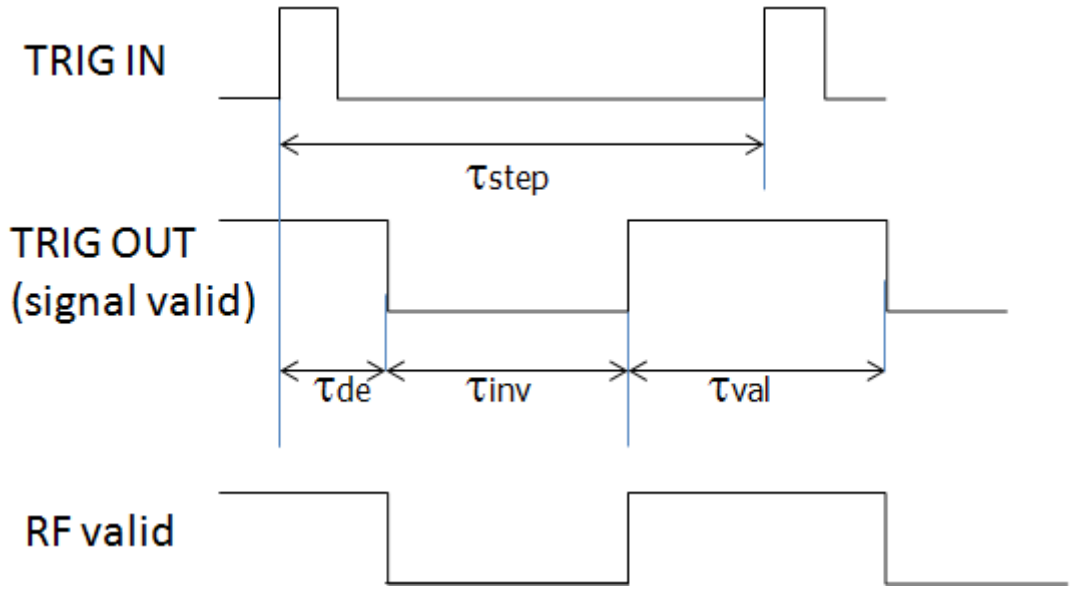
Parameter	Min.	Typ.	Max.	Note
Internal Reference Frequency		10 / 100 MHz		
Initial accuracy			±20 ppb	calibrated at 23 ± 3 °C at time of calibration , user adjustable
Temperature stability (0 to 50 degC)			±20 ppb	
Aging 1st year		0.1 ppm		
Aging per day (after 30days operations)		3 ppb		

Warm-Up time		5 min		
Reference OUT - REF OUT - SYSREF OUT Output Power - REF OUT - SYREF OUT Output impedance		10/100 MHz 3 GHz 9 dBm 0 dBm 50 Ohms		**Option ULN**
Reference IN -REF in -SYSREF IN		10 / 100 MHz 1-250 MHz 1 GHz 3 GHz		**Option VREF** Standard **Option ULN**
Reference input level 10 MHz 1-250 MHz 100 MHz 1 GHz 3 GHz	 -5 dBm -5 dBm 5 dBm 0 dBm -5 dBm	 0 dBm 0 dBm	 +13 dBm +13 dBm +13 dBm +13 dBm +13 dBm	 **Option VREF** Standard **Option ULN**
Phase Lock to External Reference	1	10 MHz Integer MHz 100 MHz	250	**Option VREF**
Lock Range 10 MHz 100 MHz 1 GHz 3 GHz			 ±1.5 ppm >100 ppm >100 ppm >100 ppm	 Standard **Option ULN**
Reference input impedance		50 Ohms		

Sweeping Capability

Parameter	Min.	Typ.	Max.	Note
Digital Power / Frequency / List Sweeps Sweep type: linear, logarithmic, random All channels can be programmed and run independently or fully synchronized.				
Step time (t_{step})	25 µs		200 s	For 1 channel, if more than one channels are swept synchronously, minimum step time is 40 µs
Dwell time (t_{val})	10 µs		100 s	
Off-time (incl. transient time) (t_{off})	0		100 s	
Transient time (t_{inv}) `			15 µs	
Timing delay (t_{de})		50 ns		

Parameter	Min.	Typ.	Max.	Note
Time resolution		5 ns		
Timing accuracy per point		5 ns		



Modulation Capabilities

Parameter	Min.	Typ.	Max.	Note
Pulse Modulation Modulation source		Internal/ External Internal External		Selectable for each channel Individual modulation for each channel Independent external modulation input for each channel
External input amplitude		TTL		
Pulse rise/fall time		10 ns		
On/off ratio		90 dB 80 dB		at +10 dBm , <10 GHz at +10 dBm , >10 GHz
Pulse overshoot			10 %	
Pulse delay		20 ns		
Pulse polarity		Normal, inverse		selectable
Internal pulse generator Repetition frequency (PRF)	0.1 Hz		20 MHz	
Duty cycle		1 % to 99 % in 1 % steps		within specified minimum pulse width
Minimum pulse width	30 ns			
Pulse Pattern Modulation & Staggered PRF				Using internal pattern generator

Parameter	Min.	Typ.	Max.	Note
Pulse width	30 ns 300 ns		1 µs 5 s	ALC hold ALC on
Programmable pattern length	2		4096	
Duty cycle	0.05 %		99.95 %	
Pulse width resolution		5 ns		
Polarity		selectable		
Intra-Pulse Modulation	Polyphase, BPSK, QPSK, linear & non-linear FM chirps			**Option IPM**
Chirp to pulse timing alignment		5 ns		
Chirp to pulse delay (adjustable) Timing steps	0	 4 ns	200 µs	
Chirp bandwidth	0		8 %	Of carrier frequency
Dwell time (t_{dwell})	1 µs		10000 µs	
Chirp Rate Rate resolution		TBD		
Polyphase codes pulse				Up to 32 phase codes, Barker codes, QPSK, BPSK
Pulse to Pulse Frequency Hopping		ramp or list		**Option IPM**
Pulse rate	0.1 Hz		50 kHz	
Pulse width	40 ns		1 s	
Bandwidth		Full instrument range		
Amplitude		Settable per pulse		
Frequency Modulation Modulation source		Internal		**Requires option MOD**
Maximum Frequency deviation (peak)	N · 20 MHz			< 1.25 GHz (N=1) 1.25 GHz to 2.5 GHz (N=0.125) 2.5 GHz to 5 GHz (N=0.25) 5 GHz to 10 GHz (N=0.5) 10 GHz to 20 GHz (N=1) 20 GHz to 40 GHz (N=2)
Deviation accuracy < 100 kHz rate > 100 kHz rate		 0.5 % 2 %	 2 % 5 %	
Distortion		< 1 %		1 kHz rate, 50 kHz deviation
Modulation rate	DC		600 kHz	> -3dB frequency response
Modulation waveforms	Sine, triangle, FSK			
Total harmonic distortion	< 1%			1 kHz rate & N · 1 MHz deviation

Parameter	Min.	Typ.	Max.	Note
Phase Modulation Modulation source		Internal		**Option MOD**
Phase deviation (peak)	0		N·10 rad	
Modulation rate	DC		600 kHz	> -3dB frequency response Max. phase deviation degrades above 20 kHz modulation rate
Modulation waveforms	Sine, triangle, FSK			
Total harmonic distortion	< 1%			1 kHz rate & N x 100 rad deviation
Amplitude Modulation Modulation source		Internal		**Option MOD**
Modulation rate	0.1 Hz		40 kHz	
Modulation waveforms	Sine, square			
Modulation depth	0 %		90 %	settable
Distortion (sine wave)		2 %		at 80 % modulation depth
Accuracy (1kHz rate, 80%, 0dBm)		3 %		

Trigger Output (TRIG OUT)

Output is TRIG OUT at rear panel has multiple operating modes.

Parameter	Min.	Typ.	Max.	Note
Multifunction Generator	sine, triangle, square wave			
Frequency range	1 Hz 1 Hz		3 MHz 1 MHz 50 kHz	sine triangle square
Frequency resolution		0.1 Hz		
Output voltage amplitude peak-peak	10 mV	5V	2 V	Sine, triangle Square (CMOS output)
Harmonic Distortion		1 %		< 100 kHz, 1 Vpp
Output impedance		50 Ohms CMOS		Sine, triangle square wave
Video Output (of internal pulse modulator)				
Output		CMOS		
Period	30 ns		50 s	
Pulse Width	15 ns		50 s	

Parameter	Min.	Typ.	Max.	Note
RF delay		10 ns		
Trigger Out	**Synchronization mode for multiple sources**			
Modes	Trigger on sweep start Trigger on each point Signal valid			
Trigger waveform pulse width	100 ns			

Trigger (TRIG IN)

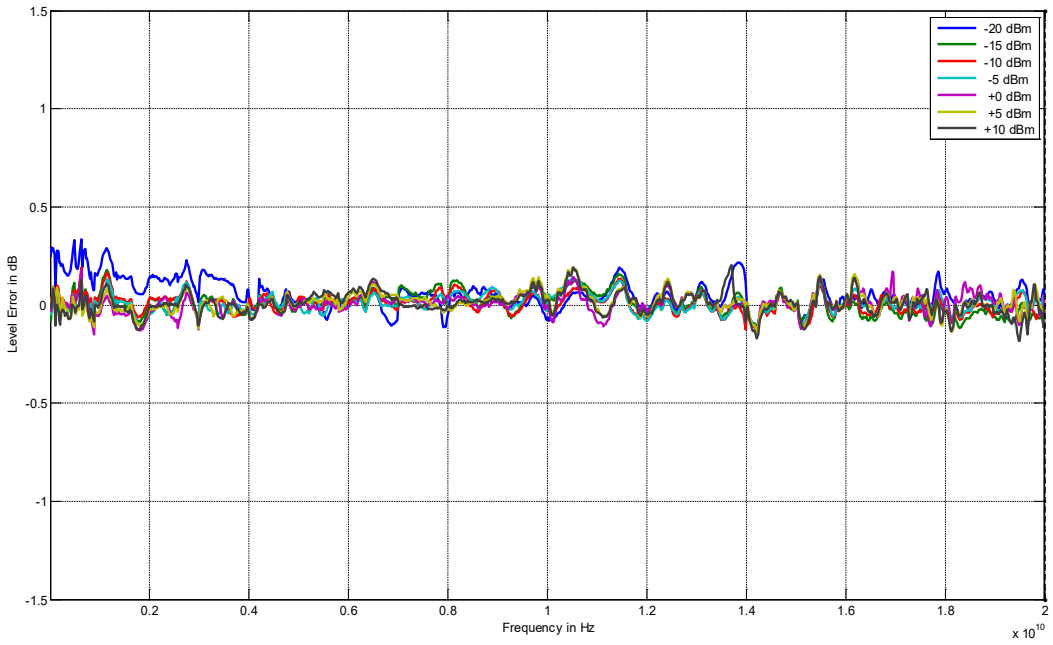
Input is TRIG IN at rear panel

Parameter	Min.	Typ.	Max.	Note
Trigger Types	Continuous, single, gated, gated direction			
Trigger Source	External or bus (GPIB, LAN, USB)			
Trigger Modes	Continuous free run, trigger and run, reset and run			
Trigger latency		5 ns		
Trigger uncertainty		10 ns		
External trigger delay	50 ns		10 s	programmable
External delay Resolution		10 ns		
Trigger Modulo	1		255	Execute only on Nth trigger event
Trigger Polarity	Rising, falling			

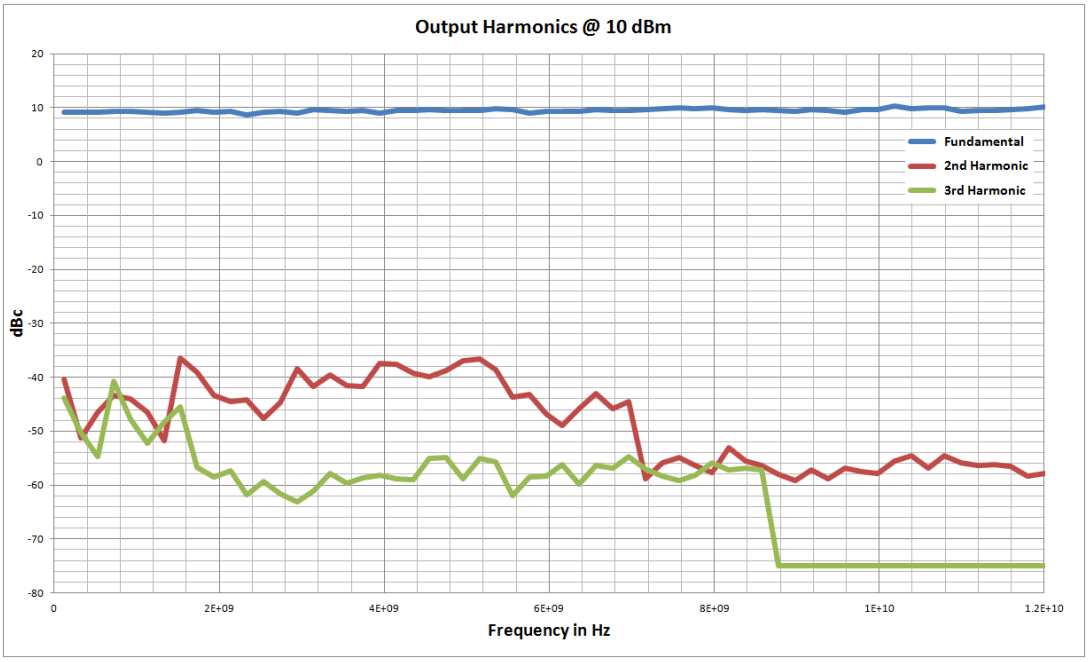
Model 855

Typical Performance

Output Power Accuracy



Harmonic Distortion



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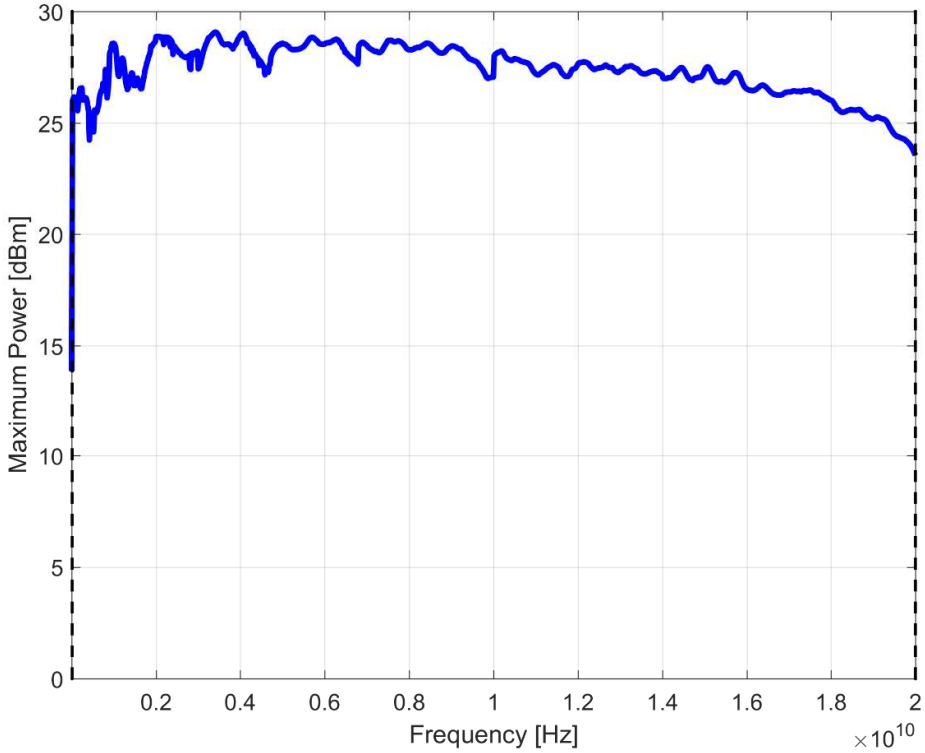
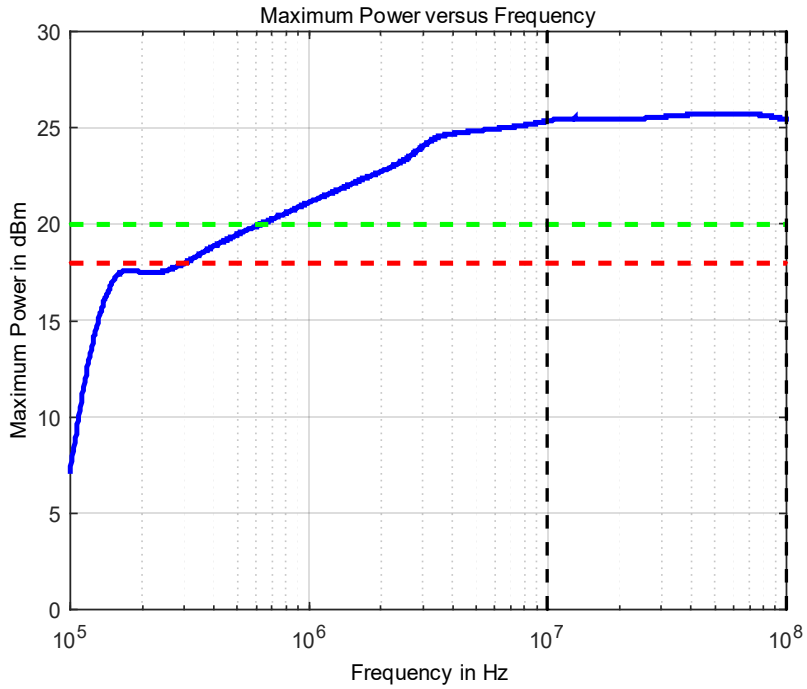
Maximum Output Power 855-20G



Low Frequency Response (100 kHz to 100 MHz)



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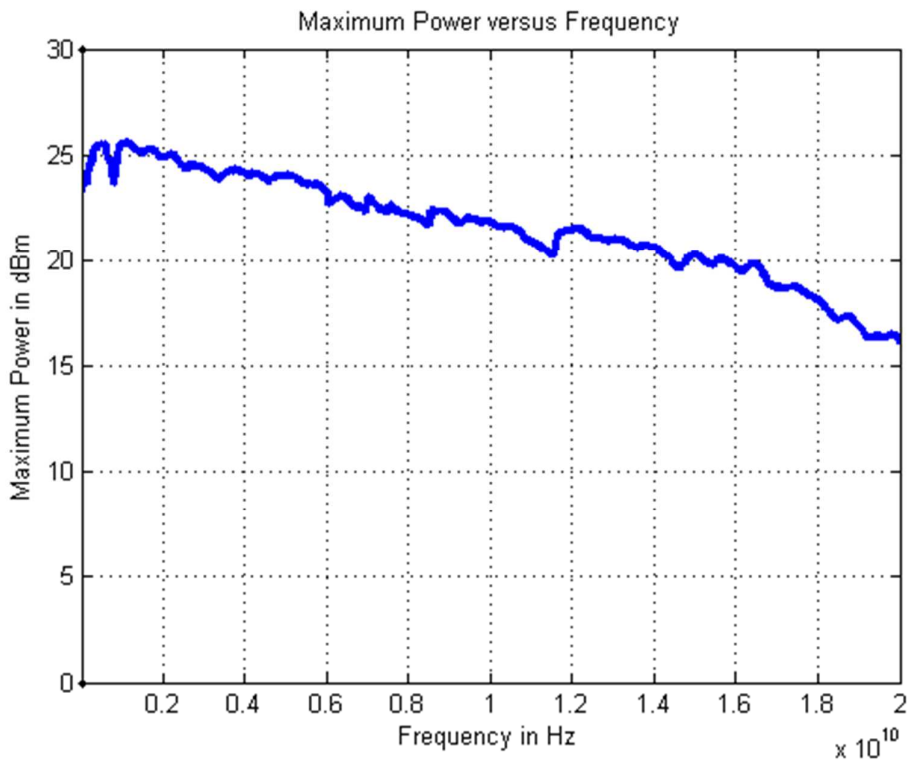
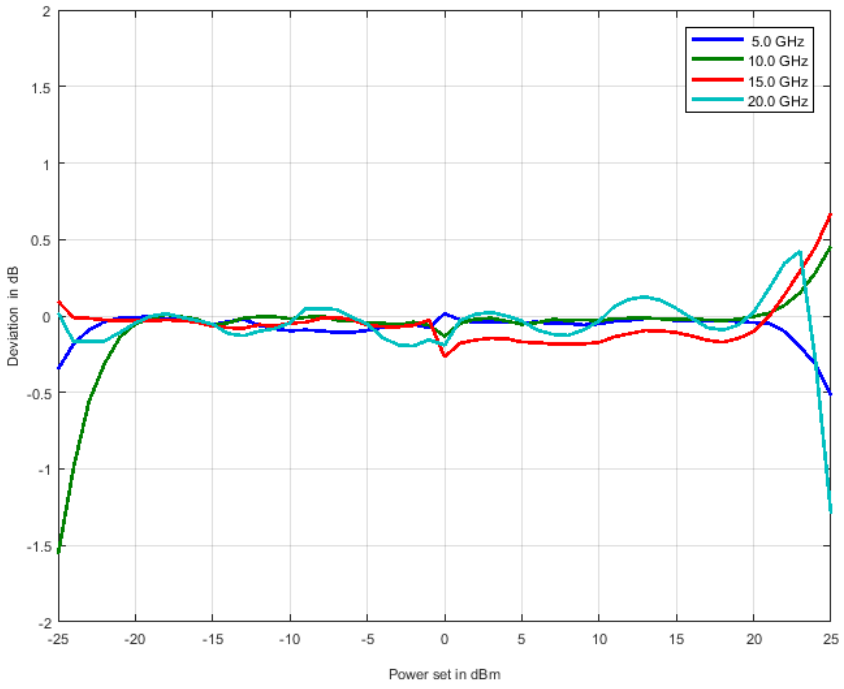
Maximum Output Power 855-20 (with option PE4)



Output Power Linearity (without option PE4)



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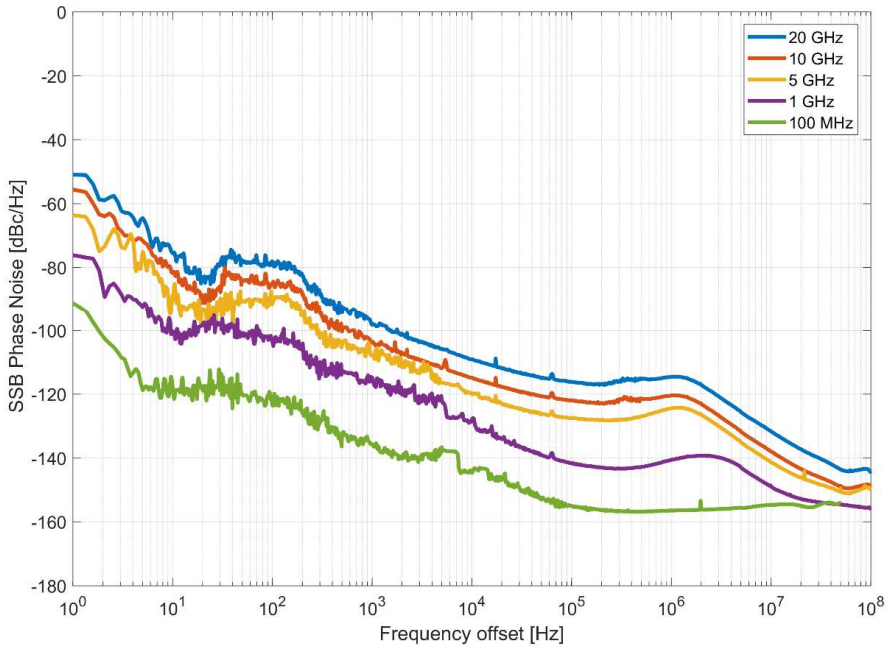
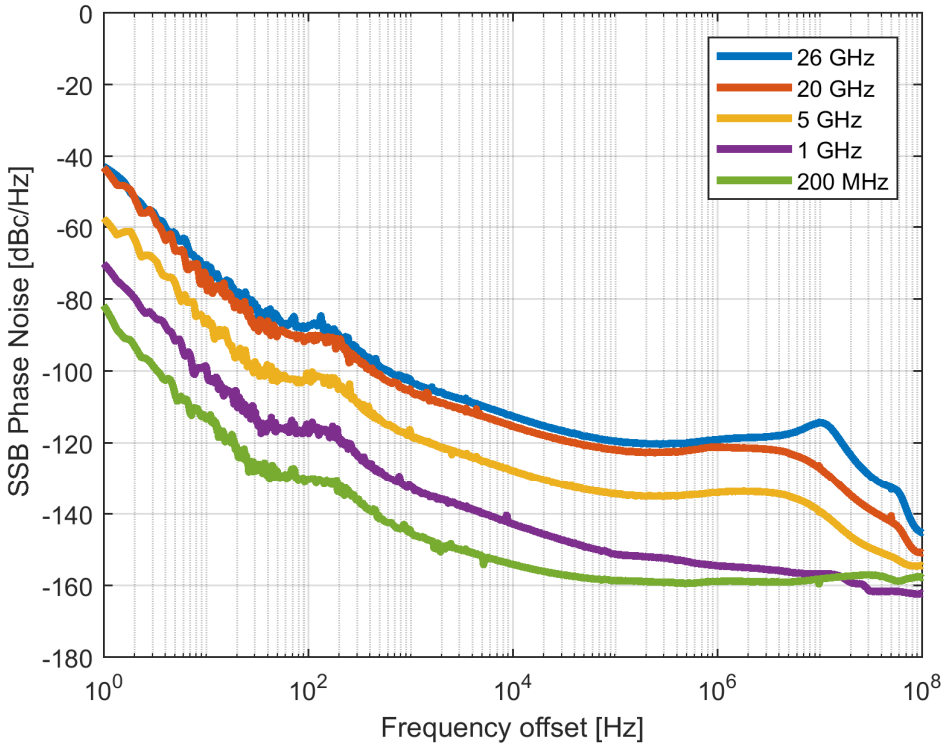
SSB Phase Noise (standard)

Single Cross-Correlation output power set to 10 dBm



SSB Phase Noise (with option ULN)

Single cross-correlation, output power set to 10 dBm



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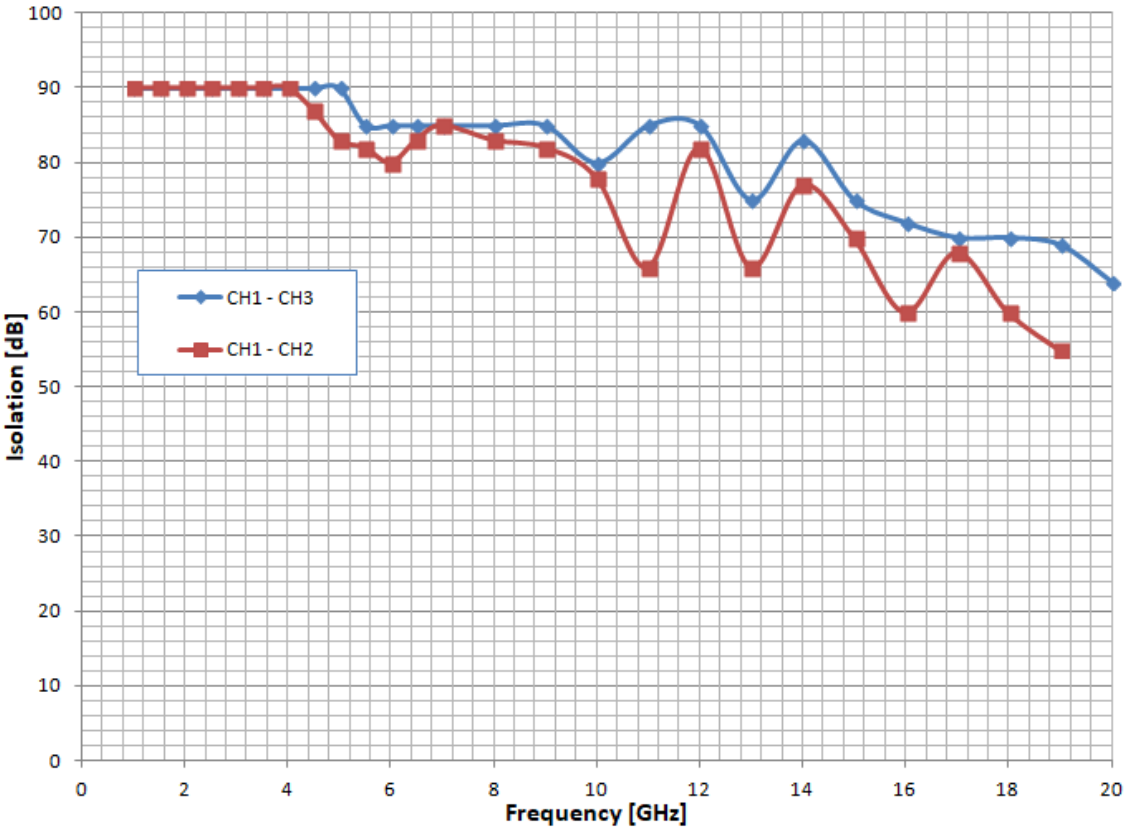
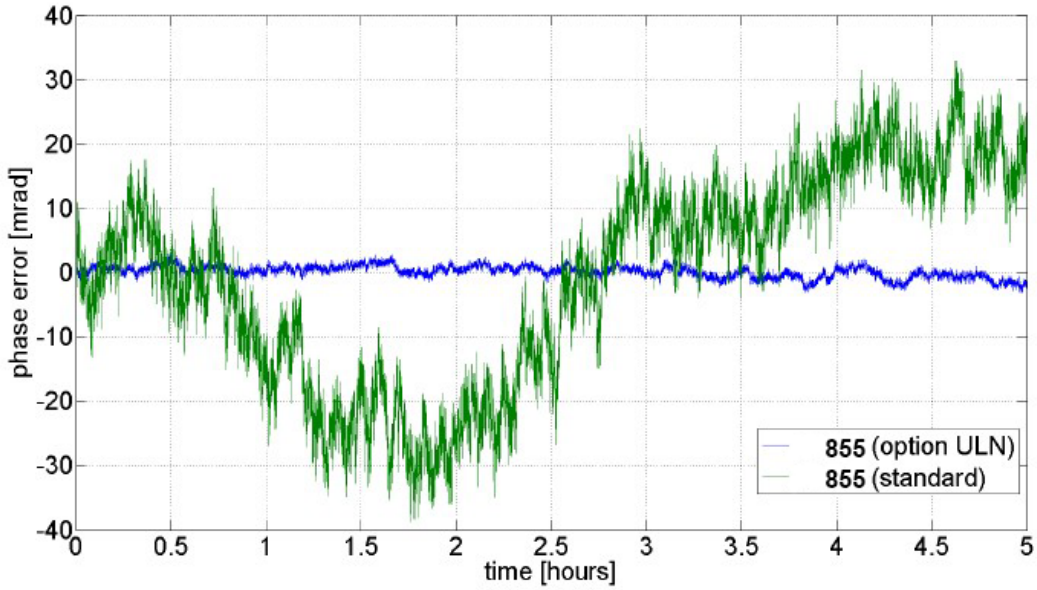
Channel to Channel Isolation (P=10 dBm, 10 MHz spacing)



Phase Stability at 5 GHz: 855 Standard (green) vs 855-ULN (blue)

Measured between 2 channels (5 GHz) from one single 855 unit



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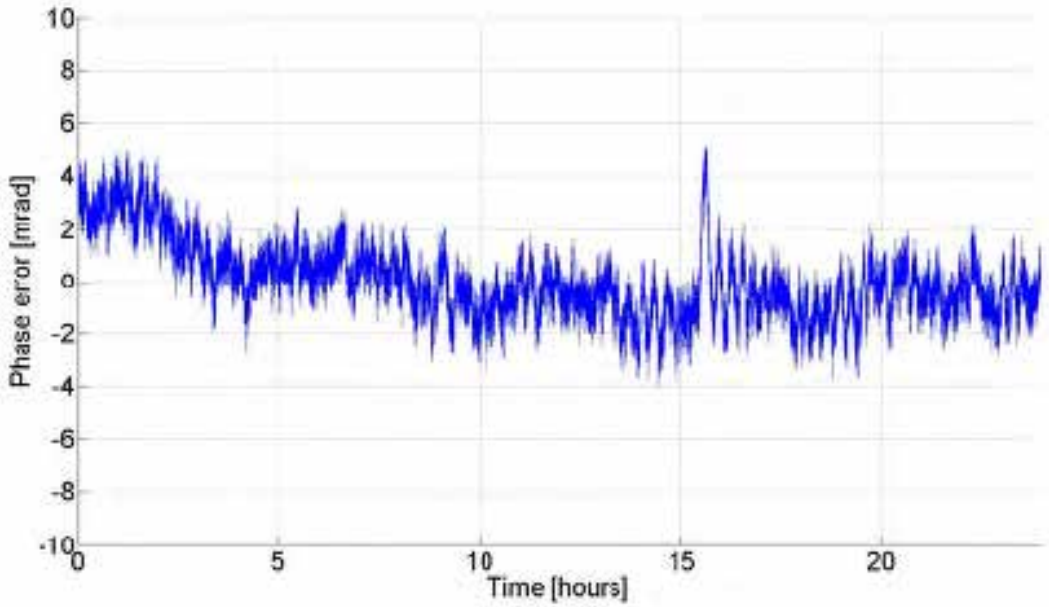
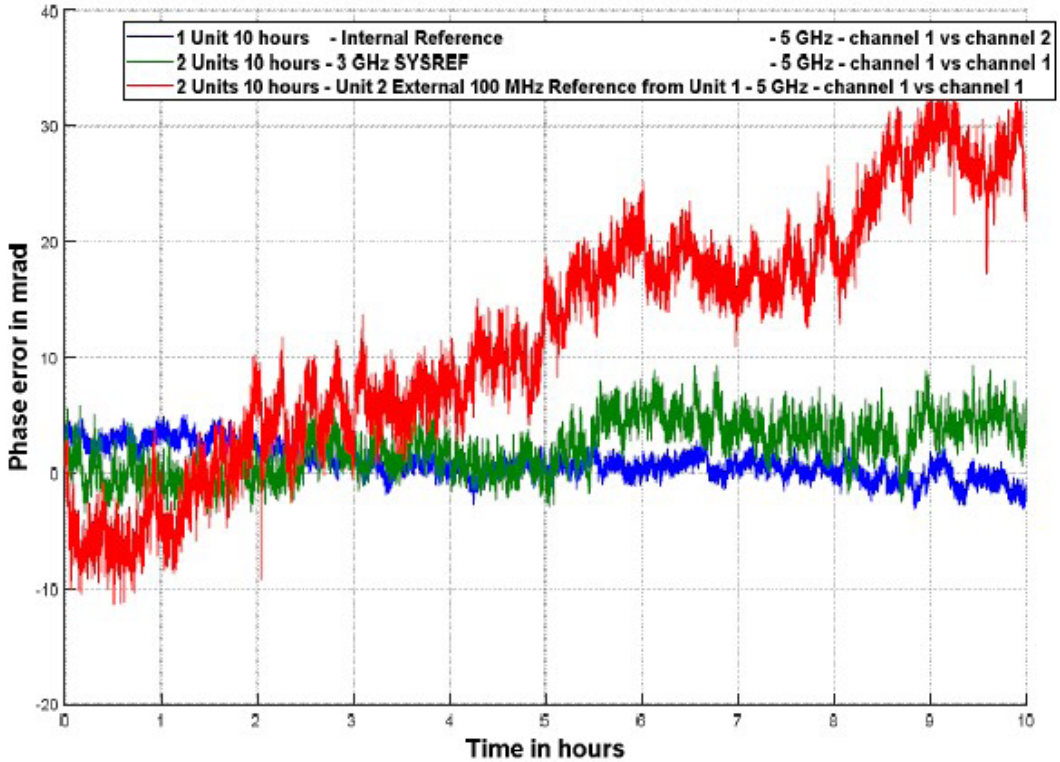
Phase Stability at 5 GHz over 24 hours for 855-ULN



Channel-to-Channel Phase Stability under Different Test Conditions



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Connectors

Front panel:

4 channel: (1U)

1. RF outputs 1 to N: SMA female
2. External pulse modulation inputs: BNC female
3. DC Power switch

Rear panel: (1U)

1. Internal reference output (SYSREF OUT): BNC female
2. External reference input (SYSREF IN): BNC female
3. Trigger output: BNC female
4. Trigger input: BNC female
5. Internal reference output (REF OUT): BNC female
6. External reference input (REF IN): BNC female
7. GPIB: IEEE-488.2, 1987 with listen and talk (optional)
8. FUSE (3.15 A)
9. USB 2.0 host and device
10. LAN connection: RJ-45
11. DC Power plug (24V, 6A)

Options

- **PE**: electrical step attenuator
- **ULN**: ultra low phase noise
- **IPM**: intra-pulse modulation (not with ULN)
- **PHS:** phase coherent switching (requires ULN)
- **VREF:** Flexible reference frequency support in the range of 1 to 250 MHz
- **MOD**: Amplitude, Frequency, Phase modulations added.
- **GPIB:** IEEE-488.2,1987 programming interface

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General Characteristics

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

Power requirements 100 or 240 VAC, 50 or 60 Hz
Operating temperature range 0 to 45 °C
Storage temperature range –40 to 70 °C
Operating and storage altitude up to 15,000 feet

Dimensions:
19” 1HE enclosure: 43 mm H x 426 mm W x 460 mm L [1.7 in H x 16.8 in W x 18.1 in L]
19” 3HE enclosure incl. rubber: 154 mm H x 467.5 mm W x 342 mm L [6.1 in H x 18.4 in W x 13.5 in L]

CE **notice**
Safety/EMC complies with applicable Safety and EMC regulations and directives.

Recommended calibration cycle 24 months
ISO compliant Instrument is manufactured in an ISO-9001 registered facility under high quality standards.

* Specifications subject to change

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