

Model 845 Specification 2.49

Portable 12, 20, & 26.5 GHz Microwave Signal Generator

with options HP, PE, R, LN, FS & LO



Berkeley Nucleonics
Test, Measurement and Nuclear Instrumentation since 1963

Introduction

The Model 845 Series is a series of low-noise and fast-switching microwave signal generators covering a continuous frequency ranges from as low as 100 kHz up to 12, 20, and 26.5 GHz, respectively, with a 0.001 Hz resolution.

The 845 Series provide an accurately levelled output power range and high spurious suppression. Advanced frequency synthesis with fractional-N divider makes for low SSB phase noise and micro-Hz resolution.

Available Options:

- HP** delivers higher maximum output power to a level up to +27 dBm.
- PE** is an optional power level extension to accurately level below -90 dBm.
- LN** provides ultra low phase noise and further improves frequency stability
- FS** substantially reduces the switching speed
- LO** removes all built-in modulation capabilities if not needed (845-20, 845-26 only)
- RB** adds an internal rechargeable battery module
- R** modifies form-factor to a 19" rack-mountable 1HU enclosure
- TP** modifies form-factor to a 3HU 19" bench-top enclosure with touch-display control

The standard Model 845 includes amplitude modulation (AM), DC-coupled, low distortion wideband frequency modulation (FM), PM, FSK and PSK, frequency chirp, and fast pulse modulation with internal pulse train generator. Three internal modulations sources are available.

All modulation modes of the Model 845 can be combined. This allows the generation of complex modulation signals for modern communication and location systems. The combination of pulse modulation and FM simulates Doppler effects or chirp signals. Simultaneous AM and pulse modulation provides the types of signal occurring in pulse radar applications with rotating antenna. The combination of FM and AM can be used to check fading effects of FM receivers.

All Model 845 allow fast analog and digital sweeps including flexible list sweeps, where frequency, power and dwell times can be set individually. A flexible triggering capability simplifies synchronization within test environments.

All Model 845's operate with an ultra-stable temperature compensated 100 MHz reference (OCXO) to ensure minimal drift, and can be phase-locked to any stable external reference in a range from 1 to 250 MHz. Additionally, optimum phase synchronous signals can be achieved by bypassing internal and feeding a 100 MHz signal directly as reference. The Model 845 supports various standard interfaces such as USB-TMC, LAN, and GPIB.

Applications for the Model 845 Series include

- R&D low noise microwave source
- Production testing (industry-leading switching times; high dynamic range)
- Service and maintenance (battery operation)
- Signal simulation (Radar, WiMax, UWB)
- Aerospace & Defence (Pulse modulator, Chirps)

Signal Specifications

The specifications in the following pages describe the warranted performance of the signal generator for $23 \pm 10^\circ\text{C}$ after a 30 minute warm-up period and for all configurations (options PE3 if not explicitly stated). Typical specifications describe expected, but not warranted performance. Min and Max specifications are warranted.

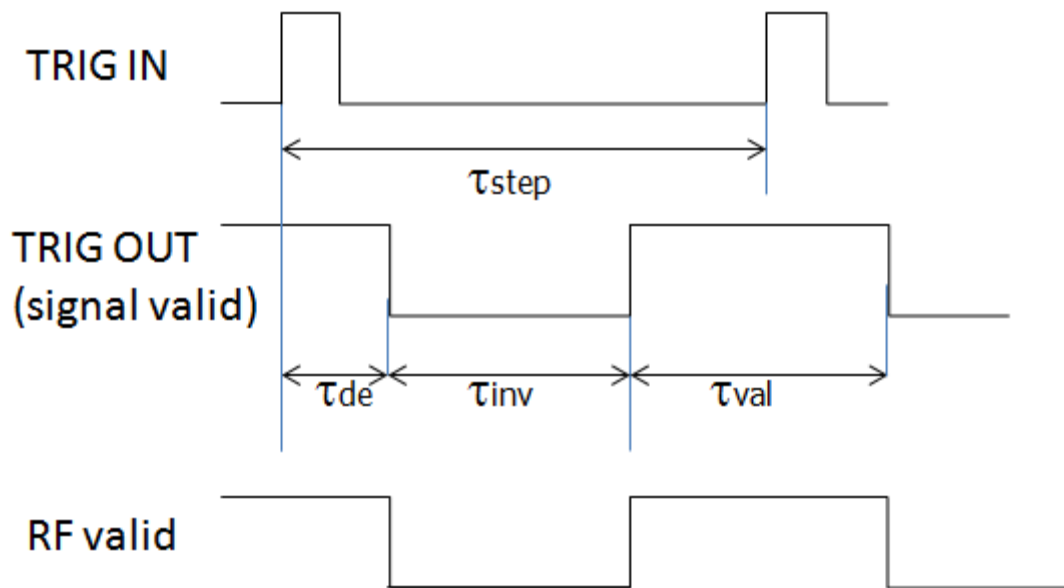
| Parameter | Min. | Typ. | Max. | Note |
|-------------------------------------|-------------------------------|-------------------------|---------------------------------------|---|
| CW mode | | | | |
| Frequency range | 100 kHz 100 kHz 100 kHz | | 12.0 GHz 20.0 GHz 26.5 GHz | 845-12 845-20, settable to 20.5 GHz 845-26, settable to 30 GHz |
| resolution | | 0.001 Hz | | |
| Phase resolution | | 0.1 deg | | |
| Frequency / Amplitude settling time | | 200 μs | 300 μs 30 μs | time from receipt of SCPI command option FS |
| SSB Phase noise (standard) | | | | |
| 500 MHz | | | | |
| 10 Hz offset | | -74 dBc/Hz | | |
| 1kHz offset | | -126 dBc/Hz | | |
| 100 kHz offset | | -137 dBc/Hz | | |
| 4 GHz | | | | |
| 10 Hz offset | | -68 dBc/Hz | | |
| 1kHz offset | | -108 dBc/Hz | | |
| 100 kHz offset | | -119 dBc/Hz | | |
| 20 GHz | | | | |
| 10 Hz offset | | -51 dBc/Hz | | |
| 1kHz offset | | -91 dBc/Hz | | |
| 100 kHz offset | | -104 dBc/Hz | | |
| Wideband noise | | -150 dBc/ Hz | | |
| SSB Phase noise (option LN) | | | | |
| 200 MHz | | | | |
| 1 Hz offset | | -89 dBc/Hz | | |
| 10 Hz offset | | -115 dBc/Hz | | |
| 1kHz offset | | -133 dBc/Hz | | |
| 100 kHz offset | | -152 dBc/Hz | | |
| 10 MHz offset | | -158 dBc/Hz | | |
| 4 GHz | | | | |
| 1 Hz offset | | -62 dBc/Hz | | |
| 10 Hz offset | | -88 dBc/Hz | | |
| 1kHz offset | | -115 dBc/Hz | | |
| 100 kHz offset | | -126 dBc/Hz | | |
| 10 MHz offset | | -145 dBc/Hz | | |
| 20 GHz | | | | |
| 10 Hz offset | | -74 dBc/Hz | | |
| 1kHz offset | | -100 dBc/Hz | | |
| 100 kHz offset | | -113 dBc/Hz | | |
| 10 Mhz | | -130 dBc/Hz | | |
| Amplitude Noise at 10 GHz | | -130 dBc/Hz -140 dBm | | Pout=+10 dBm, 100 kHz offset noise floor |

| Parameter | Min. | Typ. | Max. | Note |
|---|--|--|--|--|
| Output power | | | | Check maximum output power plots on page 10 |
| Standard 100 kHz to fmax | -20 dBm | | +15 dBm | |
| Option PE3 only 100 kHz to fmax | -90 dBm | | +13 dBm | |
| Option HP only | -20 dBm -20 dBm -20 dBm | | +25 dBm +23 dBm +18 dBm | 0.2 to 10 GHz 10 to 16 GHz, see plot >18 GHz, see plot |
| Options HP and PE3 | -90 dBm -90 dBm -90 dBm -90 dBm | | +22 dBm +20 dBm +18 dBm +15 dBm | < 10 GHz 10 to 16 GHz 16 to 20 GHz >20 GHz |
| Level resolution | 0.01 dB | | | |
| Level uncertainty, ALC on | | 0.3 dB 0.6 dB 3.0 dB | 1.0 dB 1.5 dB 3.0 dB | -15 to +15 dBm -65 dBm to -15 dBm , option PE3 < -65 dBm, f<10 GHz option PE3 < -65 dBm, f>10 GHz option PE3 > 15 dBm to Pmax, option HP |
| Temperature effects | | 0.015 dB/ °C up to 2000 points | | 0 to 45 °C |
| User flatness correction | | | | |
| Output impedance | 50 Ω | | | |
| VSWR | 2.0 | | | |
| Reverse Power Protection | | | | |
| DC Voltage | | | ±15 V | |
| RF power | | | 30 dBm | |
| Spectral purity at + 5 dBm | | | | |
| Output harmonics | | -40 dBc | -30 dBc | See plot |
| Sub-harmonics | | -75 dBc -50 dBc | -65 dBc -40 dBc | < 20 GHz > 20 GHz |
| Non-harmonic spurious < 312 MHz > 312 to 625 MHz > 625 MHz to 1.5 GHz > 1.5 GHz to 2.5 GHz > 2.5 GHz to 5 GHz > 5 GHz to 10 GHz > 10 GHz to 20 GHz > 20 GHz | | -80 dBc -75 dBc -75 dBc -70 dBc -65 dBc -60 dBc -55 dBc -50 dBc | -66 dBc -70 dBc -65 dBc -65 dBc -60 dBc -55 dBc -50 dBc -45 dBc | CW +10 dBm, > 3 kHz offset |
| Residual FM @ 10 GHz | | 15 Hz | | 0.3 kHz to 3 kHz, weighted (ITU-T), RMS |
| Residual AM @ 10 GHz | | 0.02 % | | RMS value (0.01 kHz to 15 kHz) |

Sweeping Capability

Sweeps can be performed with combined internal or external AM/FM/PM/pulse modulation running. With modulation enabled, the minimum step time increases to 2 ms.

| Parameter | Min. | Typ. | Max. | Note |
|--|---------------------------|--------------------------|---------------------------|-----------|
| Digital power / frequency / list sweeps | | | | |
| Sweep type: linear, logarithmic, random | | | | |
| Step time (τ_{step}) | 400 μ s 40 μ s | | 19998 s | Option FS |
| Dwell time (τ_{val}) | 10 μ s | | 9999 s | |
| Off-time (incl. transient time) (t_{off}) | 0 | | 9999 s | |
| Transient time (τ_{inv}) | | | 270 μ s 30 μ s | Option FS |
| Timing delay (τ_{de}) | | 2 to 10 μ s 50 ns | | Option FS |
| Time resolution | | 0.1 μ s 5 ns | | Option FS |
| Timing accuracy per point | | 3 μ s 5 ns | | Option FS |



Frequency Chirps

(linear ramp, up/down)

| | | | | |
|----------------------------|-------|--|-------------------|----------------------|
| Bandwidth | 10 % | | | of carrier frequency |
| Dwell time (t_{dwell}) | 10 ns | | 10000 μ s | |
| Slope | | | 100 MHz / μ s | |
| Number of frequencies | | | 65'000 | |

Reference Frequency

REF IN input and REF OUT output are at rear panel

| Parameter | Min. | Typ. | Max. | Note |
|---|--|-------------------------|---------------------|--|
| Internal reference frequency | | 100 MHz 10 / 100 MHz | | Option LN |
| Initial accuracy | | | ±40 ppb | calibrated at 23 ± 3 °C at time of calibration , user adjustable |
| Temperature stability (0 to 50 degC) | | | ±100 ppb ±20 ppb | Option LN |
| Aging 1 st year | | 0.5 ppm 0.1 ppm | | Option LN |
| Aging per day (after 30days operations) | | | 5 ppb tbm | Option LN |
| Warm-Up time | | 5 min | | |
| Output of internal reference | | 10 MHz 10/100 MHz | | |
| Output power | | 0 dBm | | |
| Output impedance | | 50 Ohms | | |
| Bypass Internal reference Input | 100 MHz, -5 to +10 dBm 100 MHz, 1 GHz | | | High phase synchronous mode Option LN |
| Phase Lock to External Reference External Input Range | 1 MHz | | 250 MHz | User programmable |
| Reference input level | -5 dBm | 0 dBm | +13 dBm | |
| Lock Range | | | ±1.5 ppm | |
| Reference input impedance | | 50 Ohms | | |

Multi Purpose Output (FUNC OUT)

Output is FUNC OUT at rear panel

| 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 | | | Option FS |

Trigger Input (TRIG IN)

Input is TRIG IN at rear panel

| Parameter | Min. | Typ. | Max. | Note |
|---------------------------|---|--------------------|--------------|-----------------------------------|
| Trigger Types | Continuous, single, gated, gated direction | | | |
| Trigger Source | RF key, external, bus (GPIB, LAN, USB) | | | |
| Trigger Modes | Continuous free run, trigger and run, reset and run | | | |
| Trigger latency | | 2 μ s 5 ns | | Option FS |
| Trigger uncertainty | | 5 μ s 10 ns | | Option FS |
| External Trigger delay | 50 μ s 50 ns | | 40 s 10 s | programmable Option FS |
| External Delay Resolution | | 15 ns 10 ns | | Option FS |
| Trigger Modulo | 1 | | 255 | Execute only on Nth trigger event |
| Trigger Polarity | Rising, falling | | | |

Trigger Output (TRIG OUT)

see Multi Purpose Output (FUNC OUT)

Modulation Capabilities (not with option LO)

Combined AM/PM/FM/PULSE possible (see user manual)

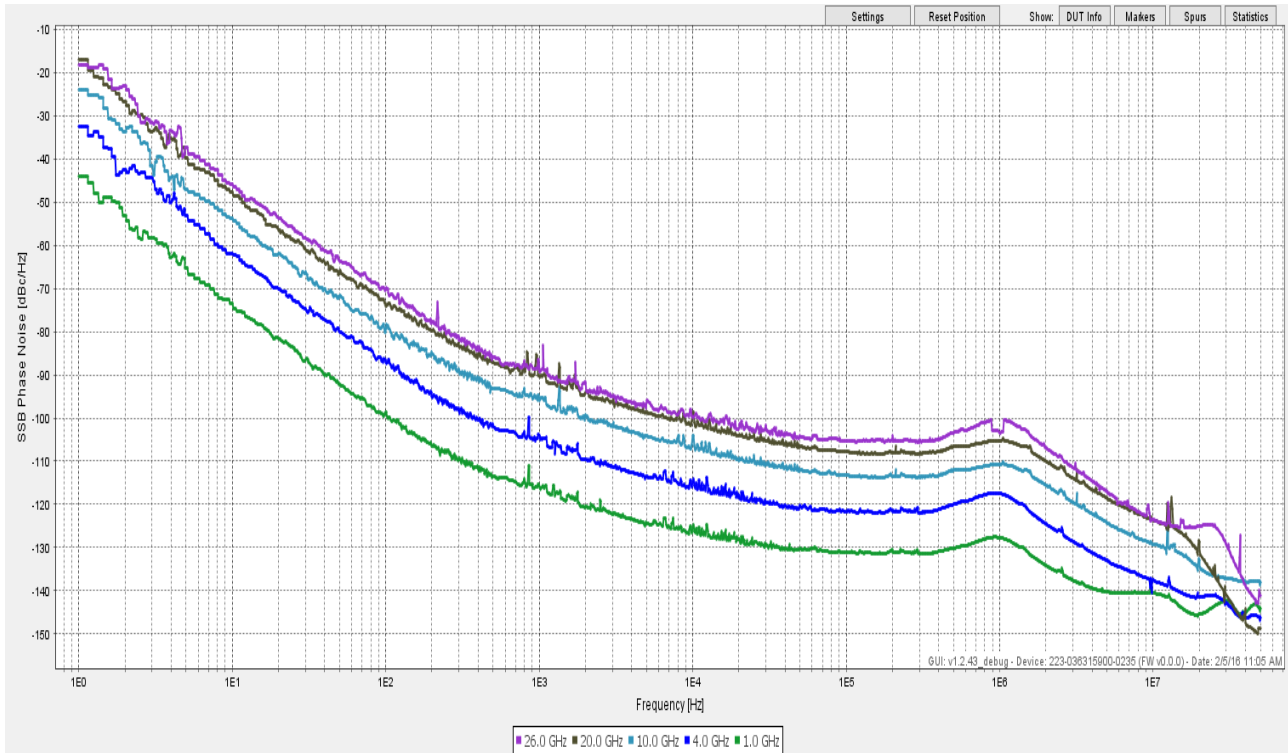
| Parameter | Min. | Typ. | Max. | Note |
|--|----------------------|-------------------------|--------------------------|---|
| Multifunction Generator sine, triangle, square wave Output is FUNC OUT at rear panel | | | | |
| Frequency range | 1 Hz 1 Hz | | 3 MHz 1 MHz 50 kHz | sine triangle square |
| 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 |
| Pulse Modulation | | | | |
| On/off ratio | | 70 dB | | at +10 dBm |
| Repetition frequency | DC | | 10 MHz | |
| Pulse width | 30 ns 500 ns | | | ALC hold ALC on |
| Pulse rise/fall time | | 7 ns | | |
| Pulse width | 30 ns | | 5 s | |
| Duty cycle | 0.05 % | | 99.95 % | |
| Pulse resolution | | 15 ns | | |
| Polarity | | selectable | | |
| External input amplitude | | 1 V TTL | | AC DC |
| Pulse Pattern Modulation | | | | |
| On/off ratio | | 70 dB | | Using internal pattern generator at +10 dBm |
| Pulse bit width | 30 ns 500 ns | | | ALC hold ALC on |
| Pulse rise/fall time | | 7 ns | | |
| Programmable pattern length | 2 | | 4192 | |
| Pulse width | 30 ns | | 5 s | |
| Duty cycle | 0.05 % | | 99.95 % | |
| Pulse bit resolution | | 15 ns | | |
| Polarity | | selectable | | |
| Frequency Modulation | | | | |
| Maximum Frequency deviation (peak) | | > 0.05·f N · 200 MHz | | < 1.25 GHz 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) |
| Deviation accuracy (1kHz rate, 50 kHz deviation) | | < 2% | | |
| Modulation rate | DC | | 800 kHz | > -3dB frequency response |
| Modulation waveforms | Sine, triangle, FSK | | | |
| External input sensitivity | | | | |
| AC | 0 to N · 200 MHz / V | | | adjustable for ±1 V range |
| DC | 0 to N · 100 MHz / V | | | discr. values ; ±5 V range |

| Parameter | Min. | Typ. | Max. | Note |
|--|--|------|-----------|--|
| Modulation waveforms | Sine, triangle, FSK | | | |
| External input sensitivity AC coupled DC coupled | 0 to N · 200 MHz / V 0 to N · 100 MHz / V | | | adjustable for ±1 V range discr. values ; ±5 V range |
| Total harmonic distortion | < 1% | | | 1 kHz rate & N · 1 MHz deviation |
| Phase Modulation | | | | |
| Phase deviation (peak) | 0 | | N·300 rad | |
| Modulation rate | DC | | 800 kHz | > -3dB frequency response Max. phase deviation degrades above 20 kHz modulation rate |
| Modulation waveforms | Sine, triangle, FSK | | | |
| External Input sensitivity | Settable 0.1 rad/V to 360 rad/V | | | |
| Total harmonic distortion | < 1% | | | 1 kHz rate & N x 100 rad deviation |
| Amplitude Modulation | | | | |
| Modulation rate | 0.1 Hz | | 50 kHz | |
| Modulation waveforms | Sine, triangle, square | | | |
| Modulation depth | 0 % | | 90 % | settable |
| Distortion (sine wave) | | 2 % | | at 60% modulation depth |
| Accuracy (1kHz rate, 80%, 0dBm) | | | | |
| < 5 GHz | X - 4% | X | X + 4% | |
| > 5 GHz | X - 6% | X | X + 6% | |

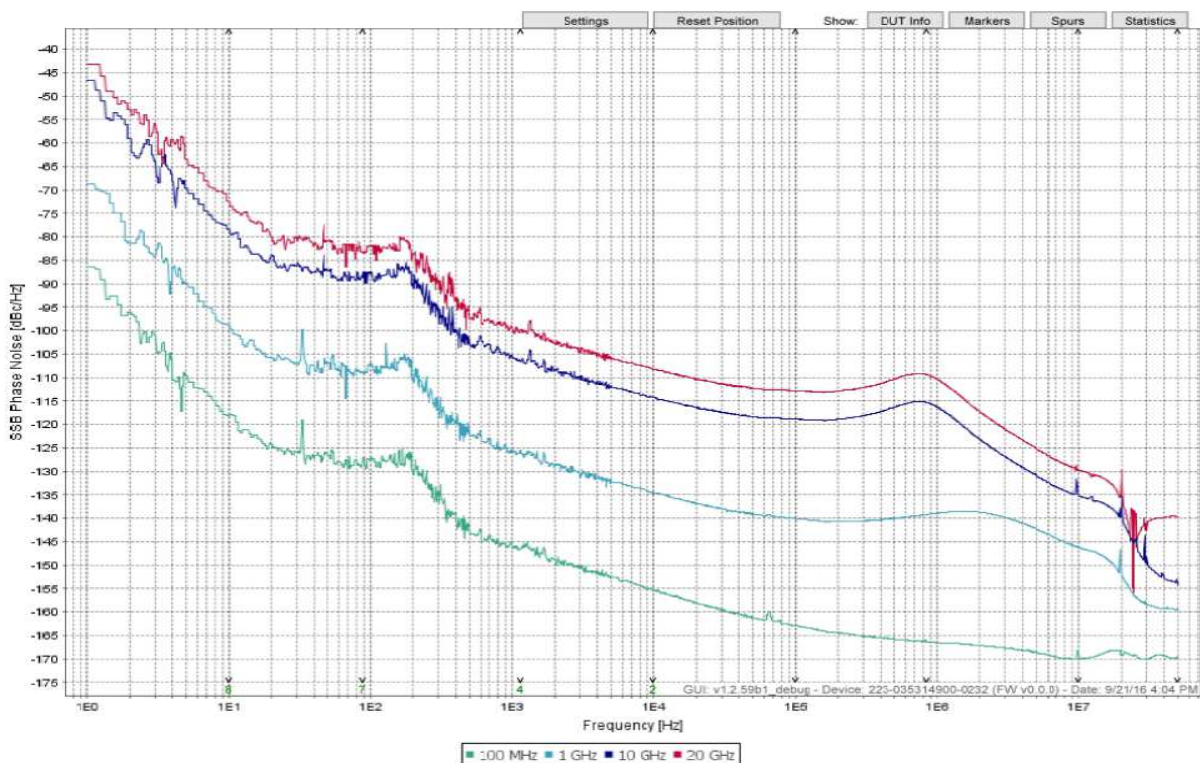
Notes:

Typical performance curves

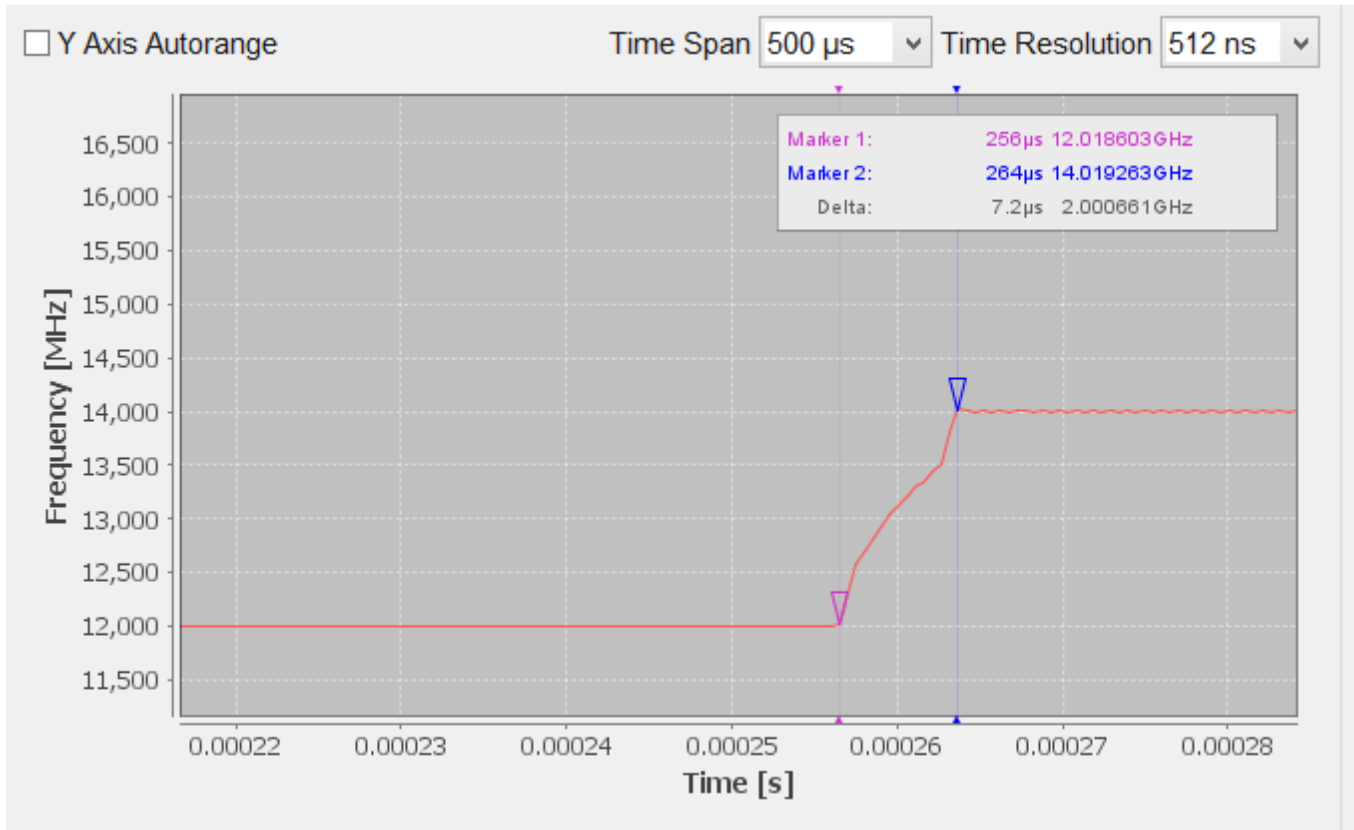
Phase Noise Performance (10 Hz to 50 MHz offset) at 1,4,13 and 26 GHz



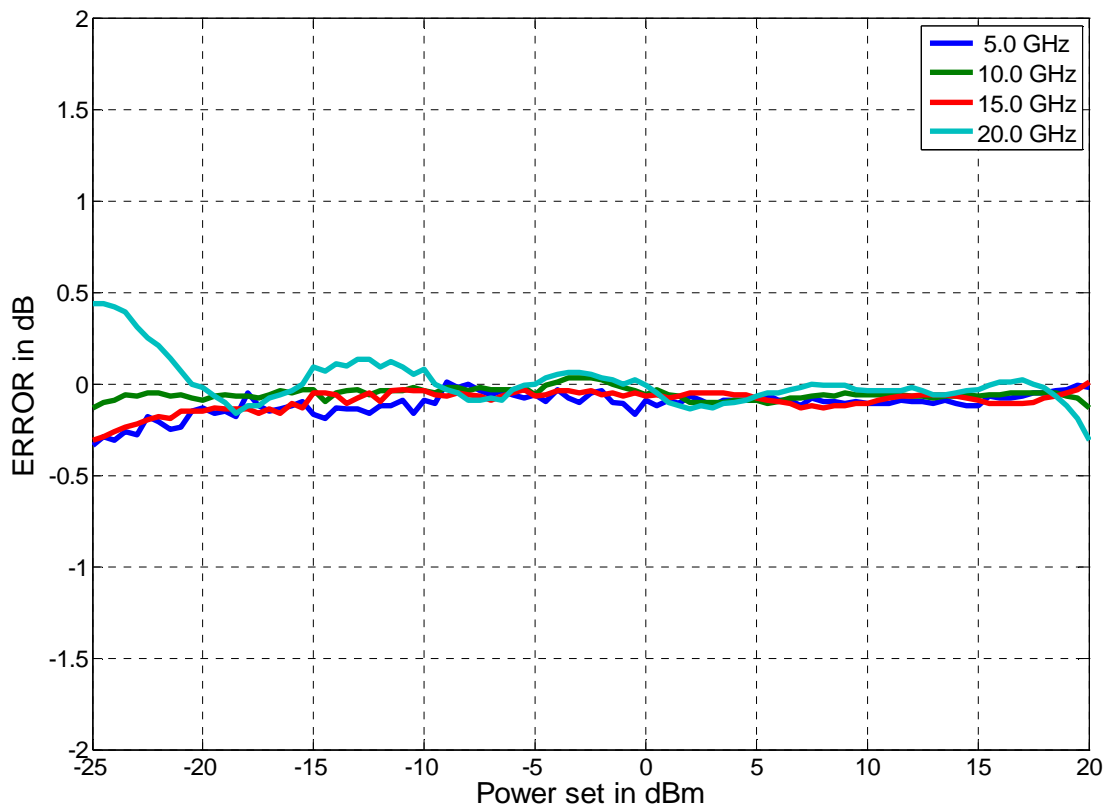
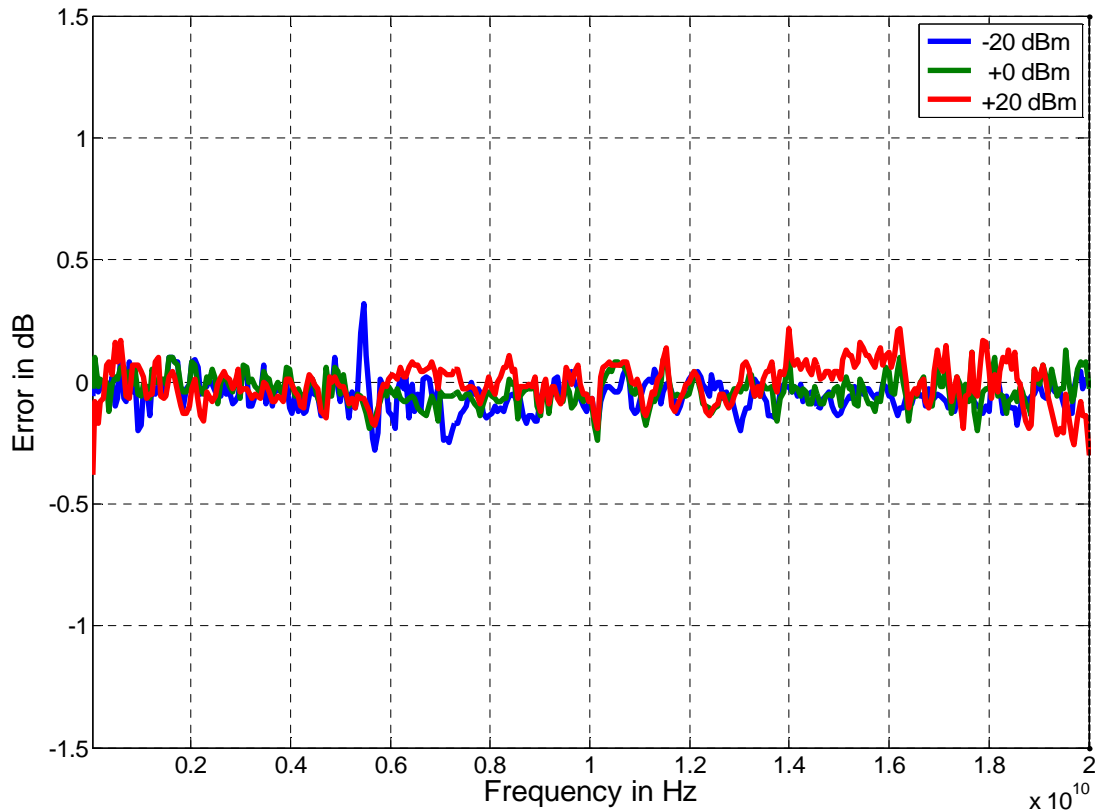
Phase Noise with Option LN



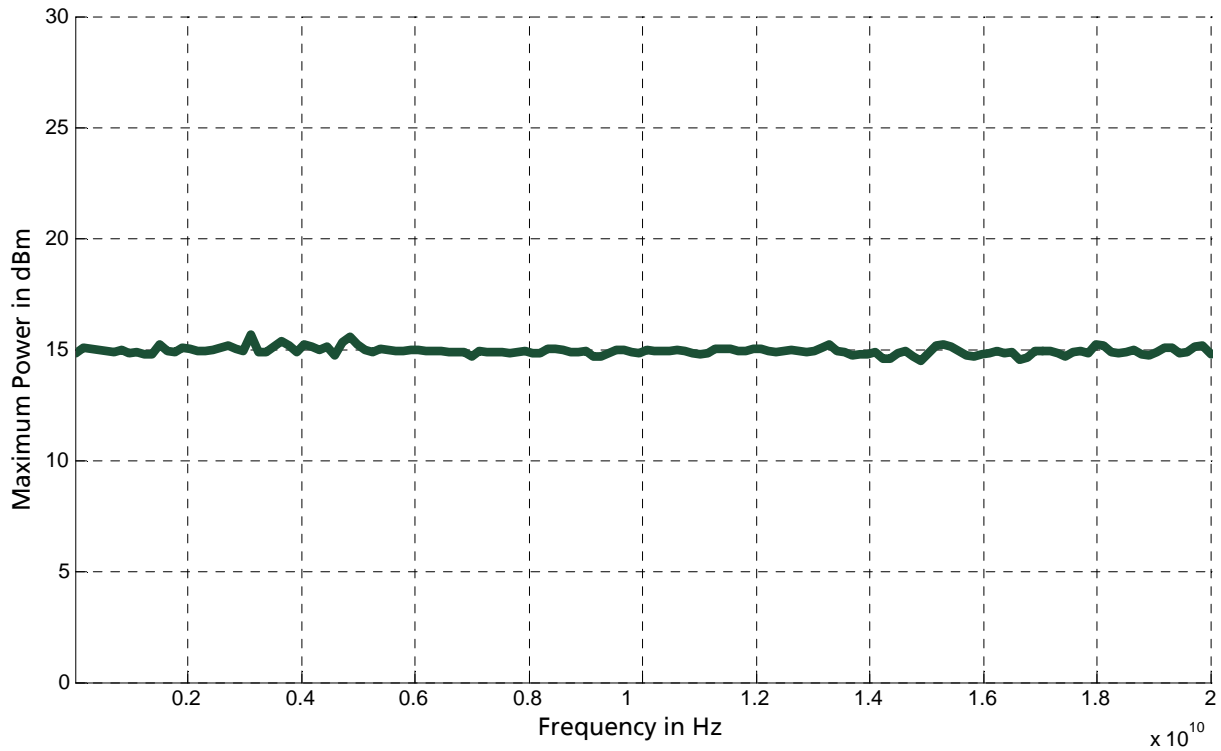
Typical Switching transient from 12 GHz to 14 GHz step



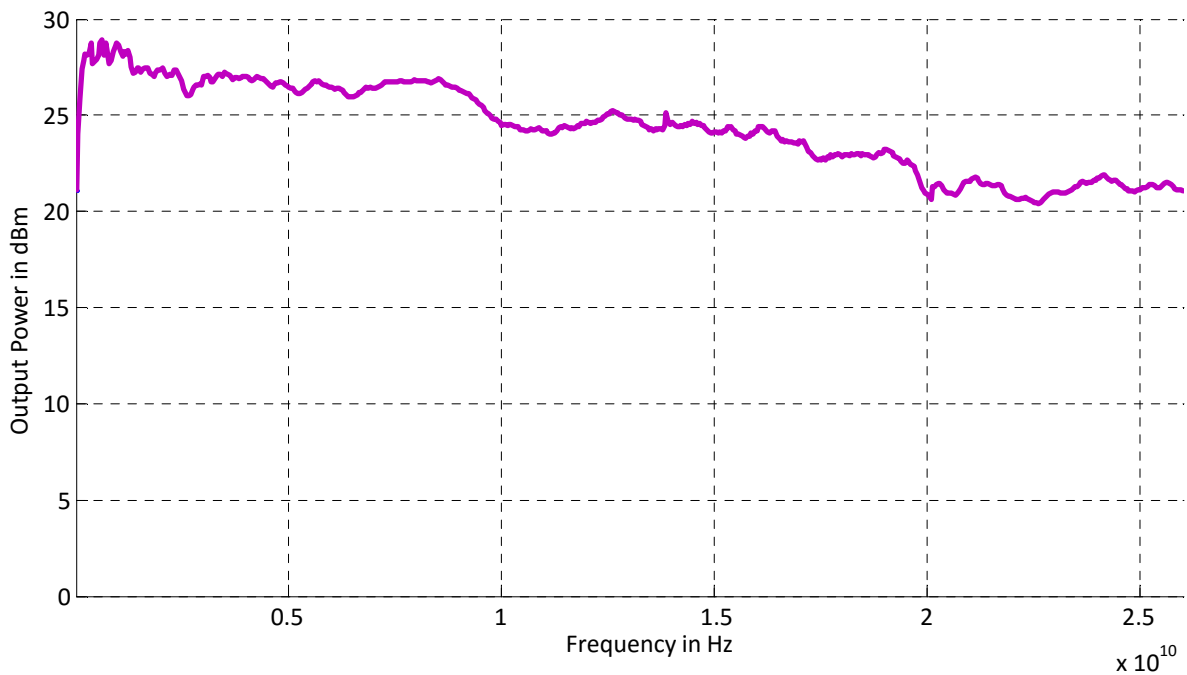
Typical Frequency Response 0 to 20 GHz at -20, 0, and +20 dBm



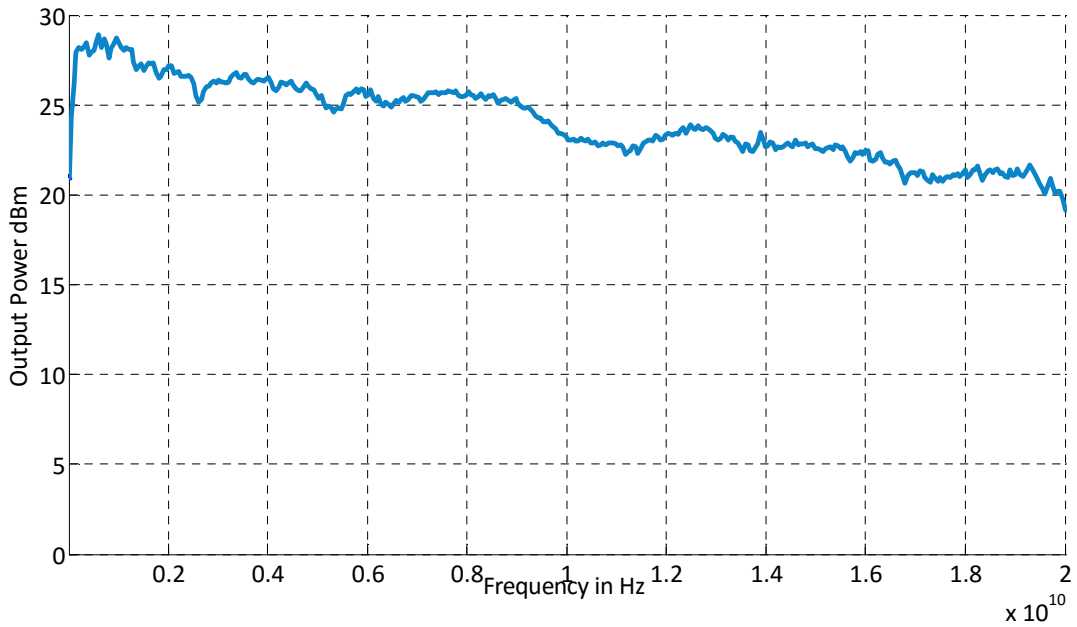
Typical Maximum Output Power (standard)



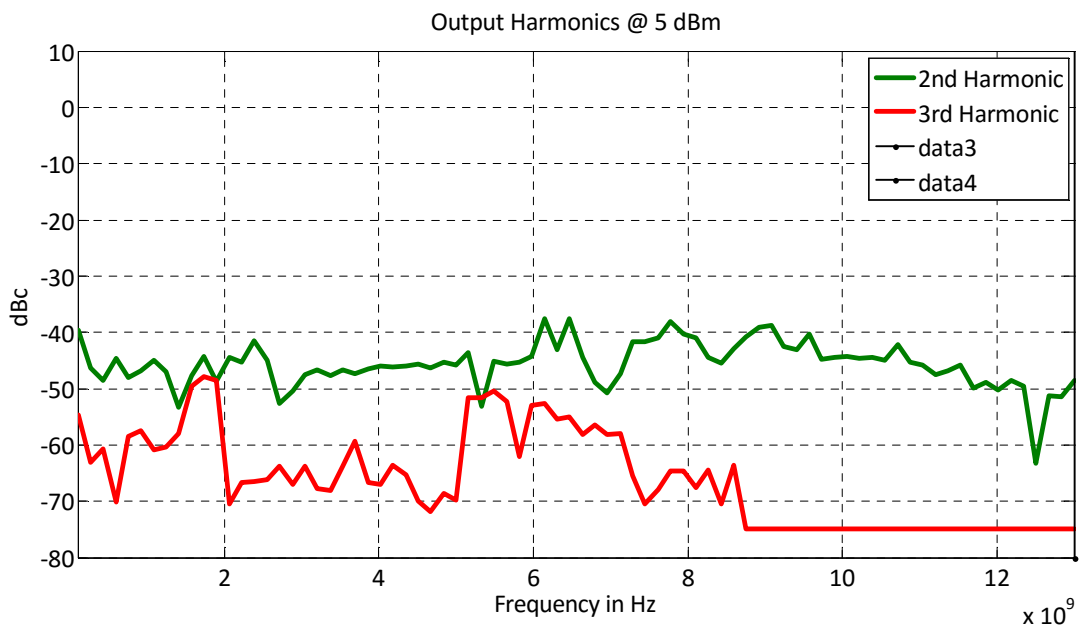
Typical Maximum Output Power (option HP)



Typical Maximum Output Power (options PE and HP)

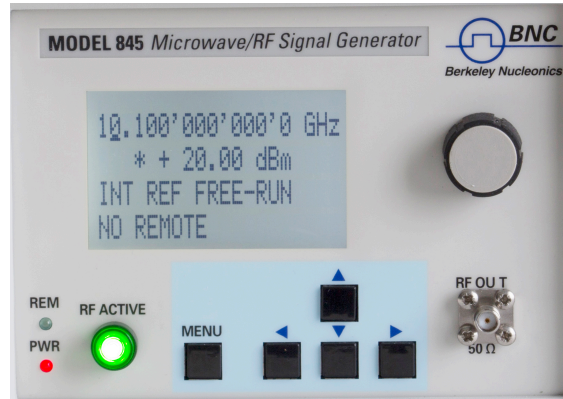


Harmonics (with option PE)



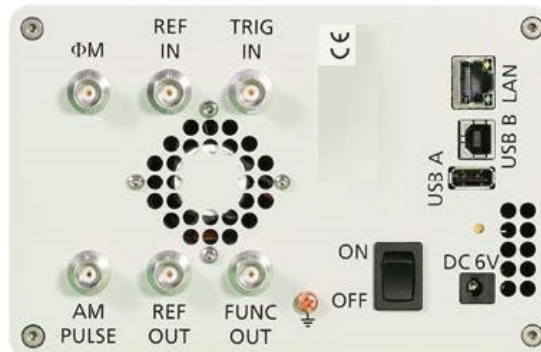
Connectors

Front panel:



1. RF output: SMA female
2. RF on/off button
3. Rotary knob
4. Menu and \downarrow \uparrow \leftarrow \rightarrow arrow keys

Rear panel:



1. Trigger input: BNC female
2. Function output: BNC female
3. External reference input: BNC female
4. Internal reference output: BNC female
5. FM/PM modulation input: BNC female
6. AM and Pulse modulation: BNC female
7. LAN connection: RJ-45
8. USB 2.0 host and device
9. GPIB: IEEE-488.2, 1987 with listen and talk (optional)
10. DC Power plug (6V, 6A)
11. DC power switch

General Characteristics

Remote programming interfaces

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

Power requirements 6.25 ± 0.2 VDC ; 20 W maximum

Mains adapter supplied: 100-240 VAC in/ 6 V 6.0 A DC out

Operating temperature range 0 to 40 °C

Storage temperature range -40 to 70 °C

Operating and storage altitude up to 15,000 feet



Safety/EMC complies with applicable Safety and EMC regulations and directives.

Weight ≤ 2.5 kg (6 lbs) net, ≤ 4 kg (8 lb.) shipping

Dimensions 106 mm H without bezels (111 mm H with bezels) x 172 mm W x 270 mm L (incl. connectors)
[4.21 in H without bezels (4.40 in H with bezels) x 6.77 in W x 10.63 in L]

Recommended calibration cycle 24 months

Options

- **HP:** High output power
- **PE:** Extended power range down to <-90 dBm) step attenuator module
- **LO:** remove modulation
- **LN:** ultra low phase noise, improved frequency stability
- **FS:** enhanced switching speed
- **RB:** battery module
- **TP:** 3HE enclosure with touch display
- **R:** 19" 1HE enclosure with rack-mount capability. **Dimensions** 42 mm H x 426 mm W x 360 mm L [1.7 in H x 16.8 in W x 14.2 in L]