



Mini-Circuits

USB & ETHERNET & DAISY-CHAIN

Signal Generator

SSG-8N12G-RC

50Ω 8 to 12.5 GHz -55 dBm to +23 dBm SMA Female

THE BIG DEAL

- Cost effective X-band signal generator
- High output power, +23 dBm
- Excellent harmonics & phase noise
- CW, pulsed, AM, FM & chirp outputs
- Compact design for bench top use
- Power over Ethernet (PoE) enabled
- Daisy-chain for multi-module dynamic control

APPLICATIONS

- Semiconductor high power burn-in & life testing
- Benchtop signal generator
- Automated production test systems
- X-band radar testing
- Quantum computing

PRODUCT OVERVIEW

Mini-Circuits' SSG-8N12G-RC is a wide-band signal generator operating from 8 to 12.5 GHz. With up to +23 dBm typical output power, it is an ideal signal source for characterization of millimeter wave components and systems at high power. Configure CW / single-tone outputs, flexible pulse sequences, AM, FM and Chirp modulations, or automated frequency / power sweep & hop sequences.

SSG-8N12G-RC has been developed in a compact package with powerful software control and automation to provide a cost effective X-band signal generator and LO source for any bench or production test application. This is a high quality, repeatable and reliable signal source with low phase noise and excellent harmonic rejection.

The generator can be controlled via USB or Ethernet (supporting SSH, HTTP & Telnet protocols). A USB cable with screw lock fastens the cable securely to the module. Full software support is provided, including our user-friendly GUI application for Windows, flexible API and programming instructions for Windows and Linux environments. The daisy-chain control interface with "dynamic addressing" simplifies control integration and allows multiple units to be combined into a multi-channel signal source with control through a single software interface.

KEY FEATURES

Feature	Advantages
High quality signal source	Outstanding combination of fine frequency and power resolution, low phase noise, excellent harmonic rejection, and low spurious signals in a compact package; suited to a wide range of test applications.
Flexible pulse, AM, FM and Chirp modulation	Configure various analog modulations according to your needs
Sweep & Hop sequences	Configure custom CW output frequency and power sequences to run unaided for high speed, automated test applications.
Dynamic daisy-chain control	Simplify control software and interconnections and develop low-cost, multi-channel signal generator systems by daisy-chaining multiple units with control through a single interface.
USB & Ethernet control	USB HID and Ethernet (HTTP / Telnet / SSH) interfaces provide easy compatibility with a wide range of software setups and programming environments.

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ELECTRICAL SPECIFICATIONS ¹, +25°C

Parameter	Condition (GHz)		Min.	Typ.	Max.	Unit
Output Frequency	-		8	-	12.5	GHz
Frequency Resolution ²	8 - 12.5		-	1	-	Hz
Frequency Accuracy	Using internal reference		-	±1	-	ppm
Return Loss	8 - 12.5		-	-10	-	dB
Output Power Max	8 - 12.5		+20	+23	-	dBm
Output Power Min	8 - 12.5		-	-55	-50	dBm
Power Resolution (nominal)	8 - 12.5		-	0.1	-	dB
Output Power Accuracy	-50 to +20 dBm	8 - 12.5	-	±0.5	±1.0	dB
RF Output Leakage	RF Off	8 - 12.5	-	-80	-	dBm
Harmonics	-50 to +20 dBm	8 - 12.5	-	-30	-	dBc
Non-Harmonic Spurious	0 dBm to Max Power	Offsets 100 kHz to 150 MHz	-	-70	-	dBc
Boundary Spurs		8 - 12.5	-	-40	-	
Settling Time ^{3,4}	Hop mode ⁵	8 - 12.5	-	0.12	0.20	ms
	Frequency sweep	8 - 12.5	-	0.15	0.22	
	Power transition (at set frequency)		-	0.015	-	
	PC (external) control		-	2	-	
Dwell Time (nominal) ^{4,6}	-		0.01	-	10,000	ms
Phase Offset Range	-		0	-	359	deg
Phase Offset Resolution	-		-	1	-	

1. Specifications are after 15 minutes warm-up time.

2. Frequency Resolution is tested with 10 MHz external reference.

3. Settling Time - transition time between 2 output states. During the transition, RF output is turned off to avoid transient outputs.

4. Generator response time is Dwell Time + Settling Time.

5. For hop sequences pre-loaded into internal memory (high-speed mode).

6. Dwell Time - duration of each signal point in a Sweep or Hop sequence set by user. Default is minimum dwell time.

PHASE NOISE (SSB), +25°C

Frequency Offset (kHz)	Carrier Frequency (GHz)					
	8.0		10.0		12.5	
	Typ.	Max	Typ.	Max	Typ.	Max
1	-94.5	-92.5	-92.5	-90.5	-91.0	-88.5
10	-105.5	-103.0	-103.5	-101.0	-101.5	-99.0
100	-113.5	-111.0	-111.0	-108.5	-109.5	-107.0
1,000	-120.5	-117.5	-118.5	-116.0	-111.5	-109.0
10,000	-144.0	-140.0	-145.0	-141.0	-144.0	-141.0
Noise Floor	-150.0	-146.0	-150.0	-146.0	-150.0	-146.0



REFERENCE, TRIGGER & DC POWER, +25°C

Parameter	Condition		Min.	Typ.	Max.	Unit
Aging	Using internal reference		-	2	-	ppm/yr
Reference In	Frequency	-	-	10	-	MHz
	Power	-	-3.5	-	+12.5	dBm
	Phase noise	10 kHz Offset	-	-135	-	dBc/Hz
Reference Out	Frequency	-	-	10	-	MHz
	Frequency accuracy	Using internal reference	-	±1	-	ppm
	Power	-	-	+10	-	dBm
	Phase noise	10 kHz Offset	-	-140	-	dBc/Hz
Trigger Out ¹⁵	Low		0	-	0.4	V
	High		3.0	-	5.0	
	Pulse width		-	100	-	μs
Trigger In	Low		0	-	0.4	V
	High		3.0	-	5.0	
	Pulse width		-	1	-	μs
Supply Voltage (V_{DC})	DC Input port ⁸		5.7	6.0	6.3	V_{DC}
Supply Current (I_{DC})			-	1.3	1.8	A
Supply Current (I_{DC})	USB port ⁸		-	20	-	mA
Supply Voltage (V_{DC})	LAN port ^{8,9}		50	53	57	V_{DC}
Supply Current (I_{DC})			-	300	450	mA

7. Trigger out voltage specified with impedance load of 10 kΩ minimum.

8. Power must be provided via the 2.1 mm DC Input or LAN port (using PoE systems) before connecting the unit to USB. The same is true in reverse, disconnect unit from USB before disconnecting power supply.

9. Compliant with IEEE 802.3at mode A and mode B.

ABSOLUTE MAXIMUM RATINGS

Operating Temperature	0°C to 50°C
Storage Temperature	-20°C to 60°C
Power in @ Reference in	+15 dBm
Reverse Voltage (DC) @ Reference out	8 V_{DC}
Reverse Voltage (DC) @ RF out	15 V_{DC}
Reverse Power (RF) @ RF out	+24 dBm
Voltage input to trigger ports	-0.3 V_{DC} to +5.5 V_{DC}

Permanent damage may occur if any of these limits are exceeded. Operating in the range between operating power limits and absolute maximum ratings for extended periods of time may result in reduced life and reliability.

**CHIRP MODULATION, +25°C**

FMCW chirp signals are repeating pulses of ascending frequency from a specified start to stop value. The SSG supports chirp signals with triangular or sawtooth waveform and external trigger input / output options for synchronisation.

Chirps must be configured within the frequency bands noted in the "Chirp Frequency Bands" table below (limited by the internal oscillators) and will have a linear response when kept within the noted sub-bandwidth limits.

The minimum chirp duration varies with frequency and bandwidth, but typical examples are summarised below. Even lower durations can be set in practice with some degradation of the waveform shape.

Parameter	Condition (Start/Stop GHz)		Min.	Typ.	Max.	Unit
Modulation Shape	Triangle or sawtooth signal					
Chirp Duration (nominal) ¹⁰	8.3	8.4	–	50	655	µs
	10.0	10.1	–	40	655	
	12.0	12.1	–	50	655	
Trigger Input Options	Free running					
Trigger Output Profile	Trigger out toggles high and low once to indicate start of chirp					

10. Chirp Duration limits of example frequencies were tested at 0 dBm.

CHIRP FREQUENCY BANDS¹¹

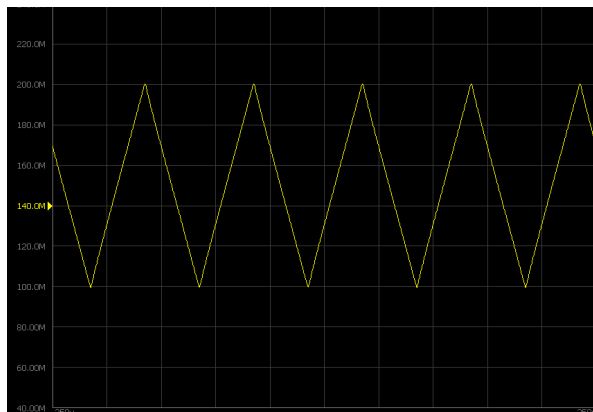
#	Frequency (GHz)		Sub-bandwidth (GHz)
	Start	End	
1	8.00	12.50	0.12

11. Going over the chirp sub-bandwidth will introduce signal noise (see example images).

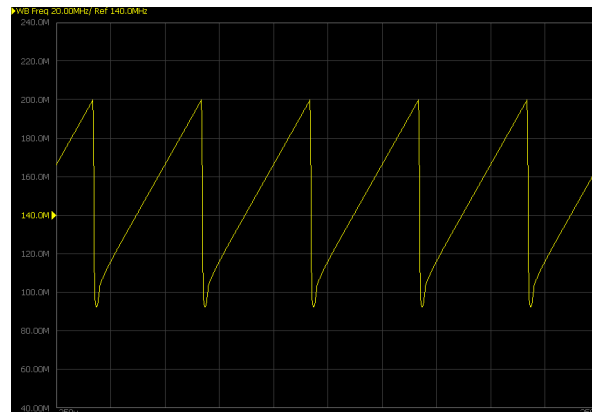
The screenshot shows the 'Select Modulation' window with 'Chirp' selected. Below, the 'Chirp Modulation' section includes a 'Chirp ranges' button, 'Power Level (dBm):' set to 0, 'Start Freq (MHz):' set to 11000, and 'End Freq (MHz):' set to 11100. Under 'Sawtooth' and 'Symmetrical Triangle' radio buttons, 'Symmetrical Triangle' is selected. The 'Duration (usec):' is set to 50. At the bottom, there are 'OFF' and 'Apply' buttons.



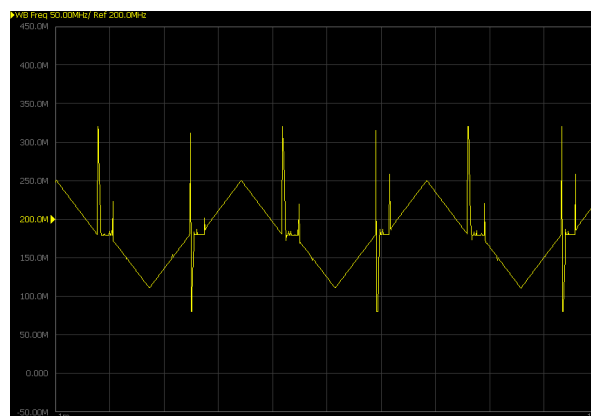
CHIRP MODULATION, +25°C (CONTINUED)



Triangle signal, 12.0 - 12.1 GHz, 50 μs, within sub-band width



Sawtooth signal, 12.0 - 12.1 GHz, 100 μs, within sub-band width



Triangle signal, 12.00 - 12.14 GHz, 300 μs, over sub-band width

PULSE MODULATION, +25°C

Parameter	Condition	Min.	Typ.	Max.	Unit
Pulse Width ^{12, 13}	Measured at 50% of pulse level	5	–	10e6	μs
Pulse Width Resolution	Nominal value	0.05	–	–	μs
Pulse Width Accuracy ¹⁴	Measured at 50% of pulse level	–	±10	–	%
Rise / Fall Time ^{15, 16}	Measured between 10% and 90% of pulse level	–	180 / 150	–	ns
Pulse Power Ratio	PWR _{OUT} = +20 dBm, FREQ _{OUT} = 8 GHz	–	70	–	dB
	PWR _{OUT} = +20 dBm, FREQ _{OUT} = 12.5 GHz	–	70	–	

12. Pulse Width must be less than pulse period by at least 0.5 μs with Internal pulse modulation and by 2 μs in external pulse modulation.

13. Pulse Widths below 0.5 μs can be set, however performance is only guaranteed for the ranges noted in the table.

14. Pulse Width Accuracy is 10% of pulse width, or ±100 ns, whichever is greater.

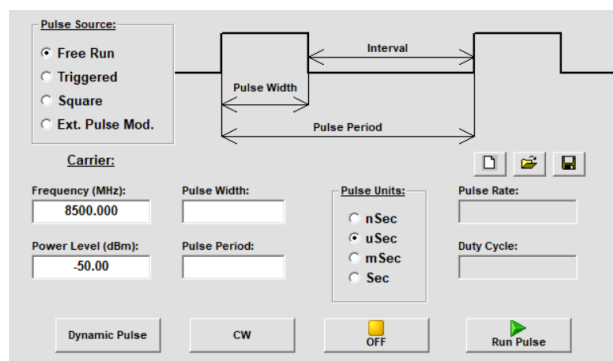
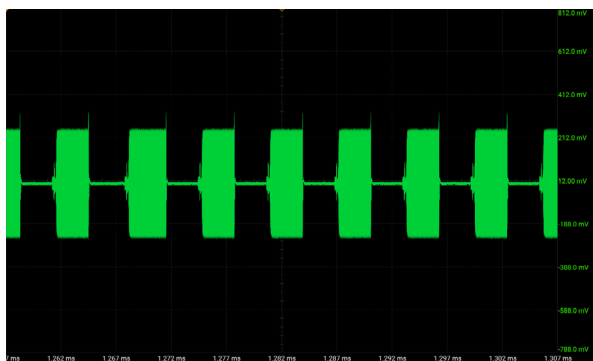
15. Pulse Rise time will increase with pulse interval under 3 μs.

16. For signals at same power & frequency.

**REGULAR PULSE MODULATION, +25°C**

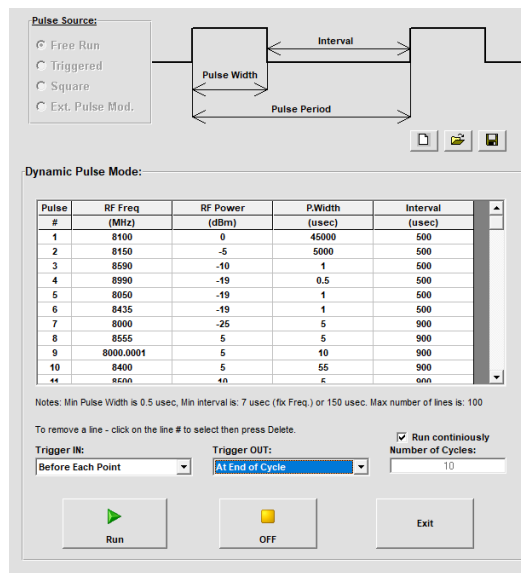
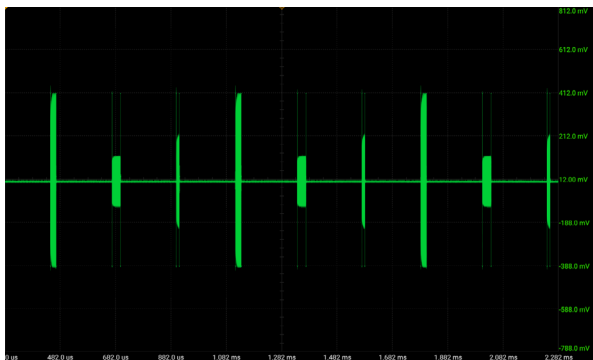
Repetitive RF pulse sequences with fixed frequency and power, supporting internal or external modulation and input / output trigger options.

Parameter	Condition	Min.	Typ.	Max.	Unit
Pulse Period	Measured at 50% of pulse level	10	–	10e6	μs
Trigger Response Delay	Trigger edge to 50% of pulse level	Internal pulse modulation	1	–	μs
		External pulse modulation	2	–	
External pulse modulation input threshold	External pulse modulation	3	–	–	V
Trigger Input Options	Free running, triggered or external modulation source (continuous)				
Trigger Output Profile	–				

**DYNAMIC PULSE MODULATION, +25°C**

Flexible RF pulse sequences with varying frequency, power, pulse width and pulse repetition interval (PRI).

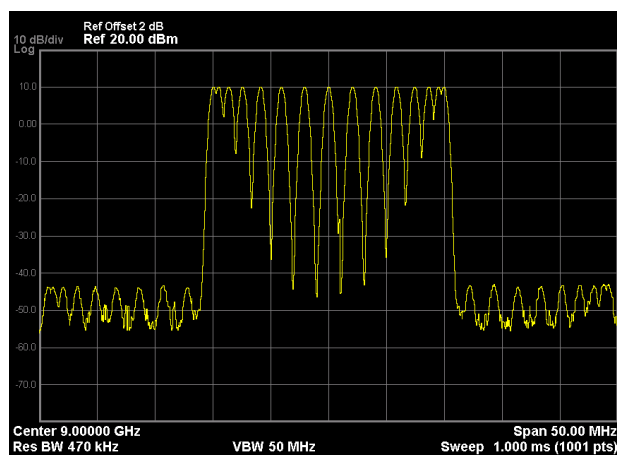
Parameter	Condition	Min.	Typ.	Max.	Unit
Pulse Interval	Measured at 50% of pulse level	Fixed freq. & Power	7	–	μs
		Varying freq. & Power	150	–	
Duty Cycle (in Free Run)	Pulse width divided by Pulse period	0.1	–	99.9	%
Trigger Input Options	Free running or triggered (single or continuous)				
Trigger Output Profile	After each pulse or cycle				





FM MODULATION, +25°C

Parameter	Condition	Min.	Typ.	Max.	Unit
Modulation Shape	Sine or triangle wave				
Modulating Frequency	3 dB point	-	-	5	kHz
Max Frequency Deviation	-	-	10	-	MHz
Trigger Input Options	Free running				
Trigger Output Profile	-				



Select Modulation:

PULSE AM **FM** Chirp Main Control

FM Modulation:

Carrier

Frequency (MHz): 8500.0

Power Level (dBm): -50.00

FM

FM Frequency (Hz): 1000

FM Deviation (kHz): 100 (Max: 50000 kHz)

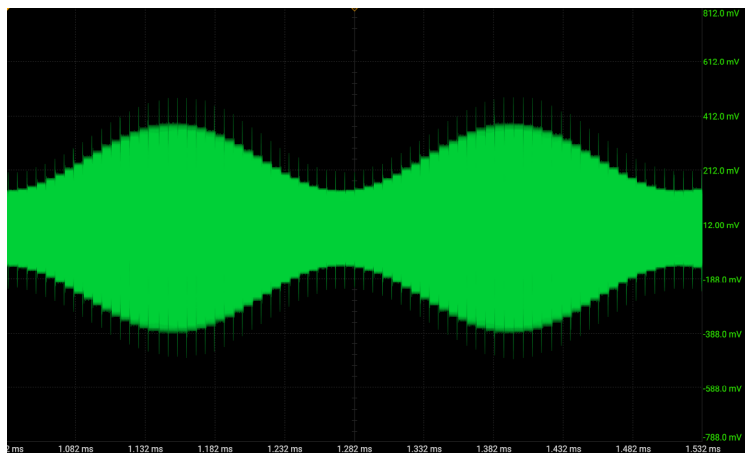
FM Function: Sine

OFF Apply

AM MODULATION, +25°C

Parameter	Condition	Min.	Typ.	Max.	Unit
Modulation Depth ¹⁷	-	0	-	100	%
Modulating Frequency	3 dB point	-	-	5	kHz
Trigger Input Options	Free running				
Trigger Output Profile	-				

17. Allow sufficient margin between the carrier power and generator's min / max limit to prevent signal distortion (eg: a modulation depth of 50% translates to a power range of +1.76 dB to -3.01 dB around the carrier level).



Select Modulation:

PULSE **AM** FM Chirp Main Control

AM Modulation:

Carrier

Frequency (MHz): 8500.0

Power Level (dBm): -50.00

AM

AM Frequency (Hz): 1000

AM Depth (%): 10 (Max: 50%)

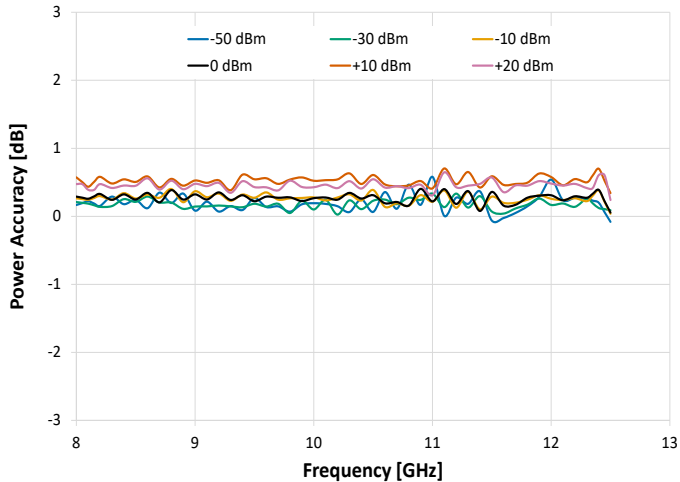
Wave Shape: Sine

OFF Apply

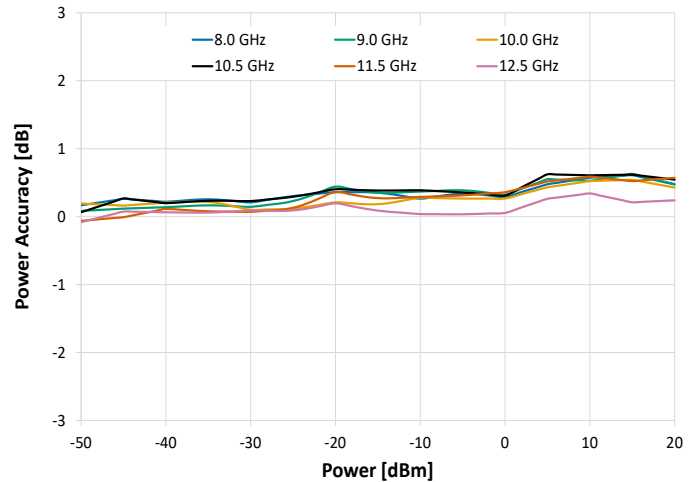


TYPICAL PERFORMANCE GRAPHS

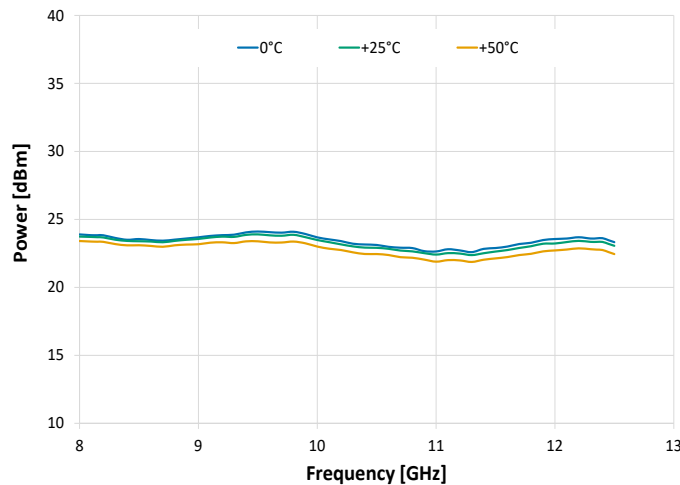
Power Accuracy vs. Output Frequency



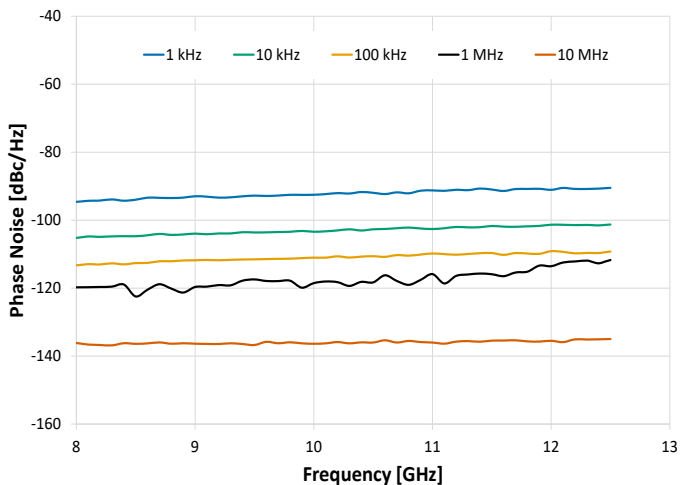
Power Accuracy vs. Output Power



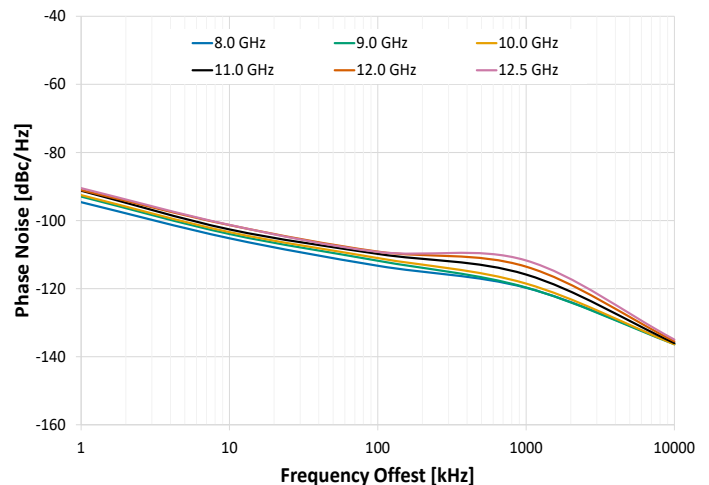
Max Power vs. Output Frequency



Phase Noise vs. Output Frequency



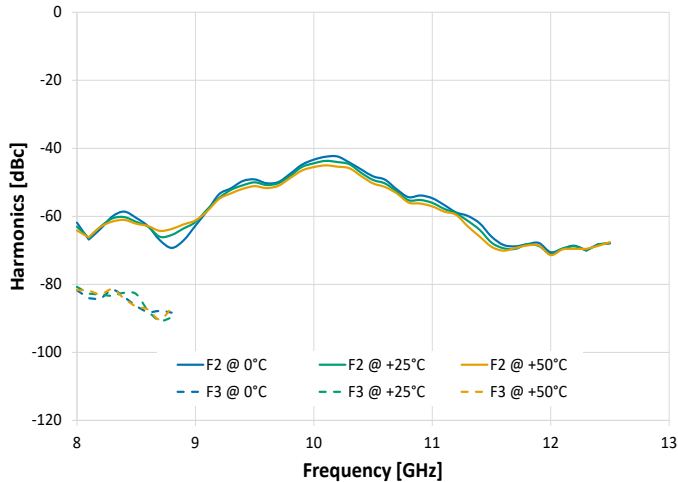
Phase Noise vs. Offset Frequency



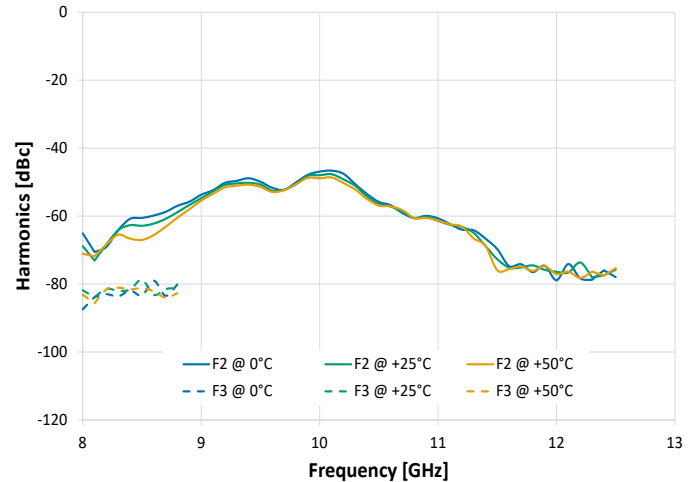


TYPICAL PERFORMANCE GRAPHS (CONTINUED)

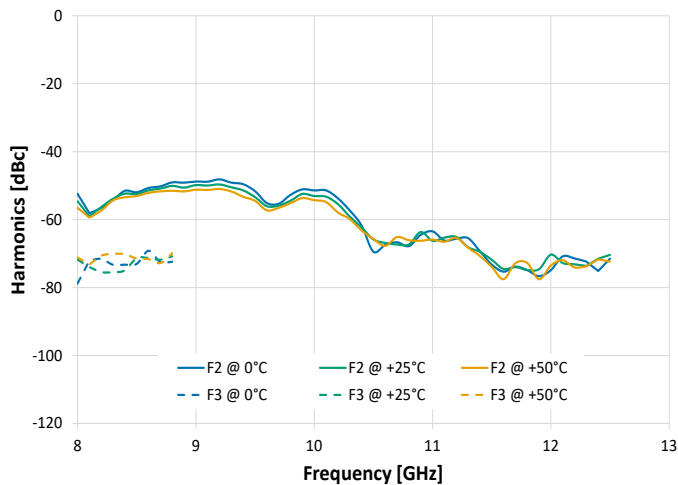
Harmonics vs. Output Frequency @ +20 dBm



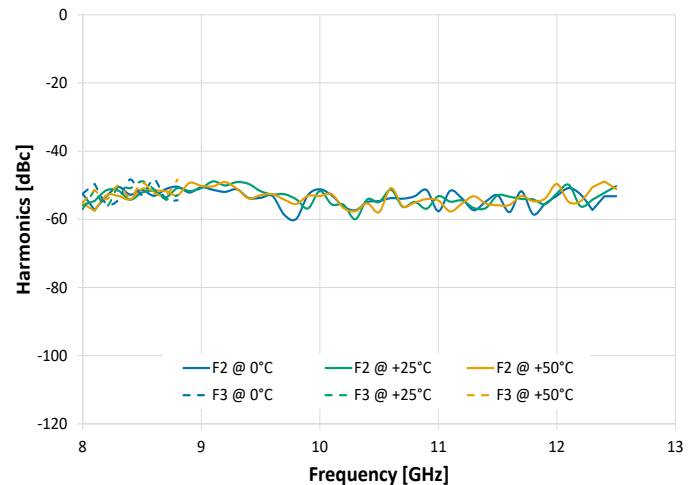
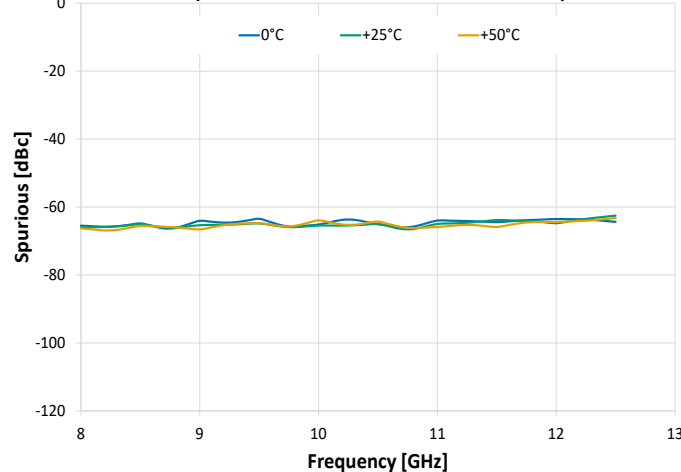
Harmonics vs. Output Frequency @ +10 dBm



Harmonics vs. Output Frequency @ 0 dBm



Harmonics vs. Output Frequency @ -20 dBm

Spurious vs. Output Frequency
(Offsets 100 kHz to 150 MHz @ +5 dBm)



CONTROL INTERFACES

Ethernet Control	Supported Protocols	TCP / IP, HTTP, Telnet, SSH, DHCP, UDP (limited)
	Max Data Rate	1 Gbps (1000 Base-T Full Duplex)
USB Control	Supported Protocols	HID (Human Interface Device) - High-speed
	Min Communication Time ¹⁸	400 μs typ (full transmit/receive cycle)

18. USB Min Communication Time is based on the polling interval of the USB HID protocol (125 μs polling interval, 64 bytes per packet), medium CPU load and no other high-speed USB devices using the USB bus.

SOFTWARE & DOCUMENTATION

Mini-Circuits' full software and support package including user guide, Windows GUI, API, programming manual and examples can be downloaded free of charge (refer to the last page for the download path).

A comprehensive set of software control options is provided:

- GUI for Windows – Simple software interface for control via Ethernet and USB.
- Programming / automation via Ethernet:
 - Complete set of control commands which can be sent via any supported protocol.
 - Simple to implement in the majority of modern programming environments.
- Programming / automation via USB:
 - DLL files provide a full API for Windows with a set of intuitive functions which can be implemented in any programming environment supporting .Net Framework or ActiveX.
 - Direct USB programming is possible in any other environment (not supporting .Net or ActiveX).

Please contact testsolutions@minicircuits.com for support.

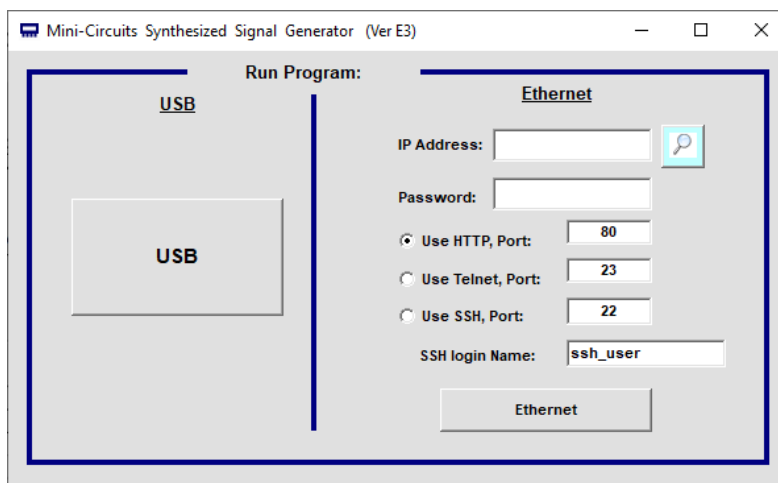
MINIMUM SYSTEM REQUIREMENTS

GUI	Windows 7 or later
USB API DLL	Windows 7 or later and programming environment with ActiveX or .NET support
USB Direct Programming	Linux, Windows 7 or later
HTTP, Telnet or SSH	Any computer with a network port and Ethernet-TCP/IP (HTTP, Telnet or SSH protocols) support
Hardware	Intel i3 (or equivalent) or later

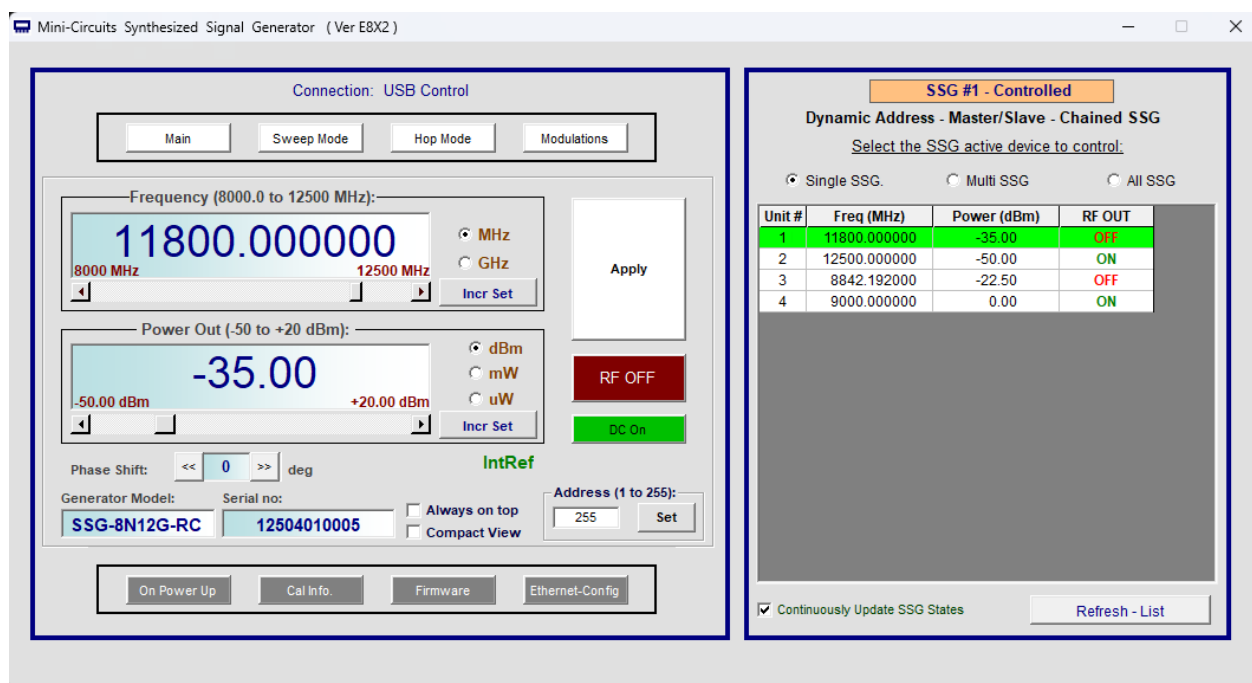


GRAPHICAL USER INTERFACE (GUI) FOR WINDOWS - KEY FEATURES

- Connect via USB or Ethernet
- Password protected access for safe remote usage over Ethernet



- Configure output power, frequency, pulse modulation
- Program timed signal output sequences (linear sweep and frequency hop)
- Control timed sequences in multiple generators simultaneously
- Track unit operation time since last calibration and setup calibration reminders





AUTOMATED SWEEP / HOP SEQUENCES

- Sweep across a frequency band at a fixed output power.
- Sweep output power levels at a fixed frequency.
- Hop through a list of pre-defined frequency / power settings.
- Set dwell times down to 10 μ s in high speed mode.
- Run on demand or in response to external triggers.
- Produce triggers to signal switching points or completing a run.

The screenshot shows the 'Sweep Mode - SSG timing control' window. It has three radio buttons: 'Freq Sweep', 'Power Sweep', and 'Hop Mode' (which is selected). To the right are fields for 'Generator Model: SSG-8N12G-RC' and 'Serial Number: 12410230014'. Below these are 'Main Control' and file operation icons. The 'Hop Mode' section features a table with 7 points, each with a frequency and power level. Below the table is a note about deleting points. Further down are settings for 'Trigger IN' (set to 'Before Each Point'), 'Dwell Time' (set to 100 μ s), 'Direction' (set to 'From Start of list'), and 'Trigger OUT' (set to 'At End of Cycle'). At the bottom are 'OFF' and 'Run Sweep' buttons, and a 'Go to Hopping - PC timing control...' button.

Point #	Freq (MHz)	Power (dBm)
1	12991.78	0.5
2	10504	5
3	10000	-15
4	12000	7.5
5	11001	-35
6	12005	10
7		

SIGNAL MODULATION

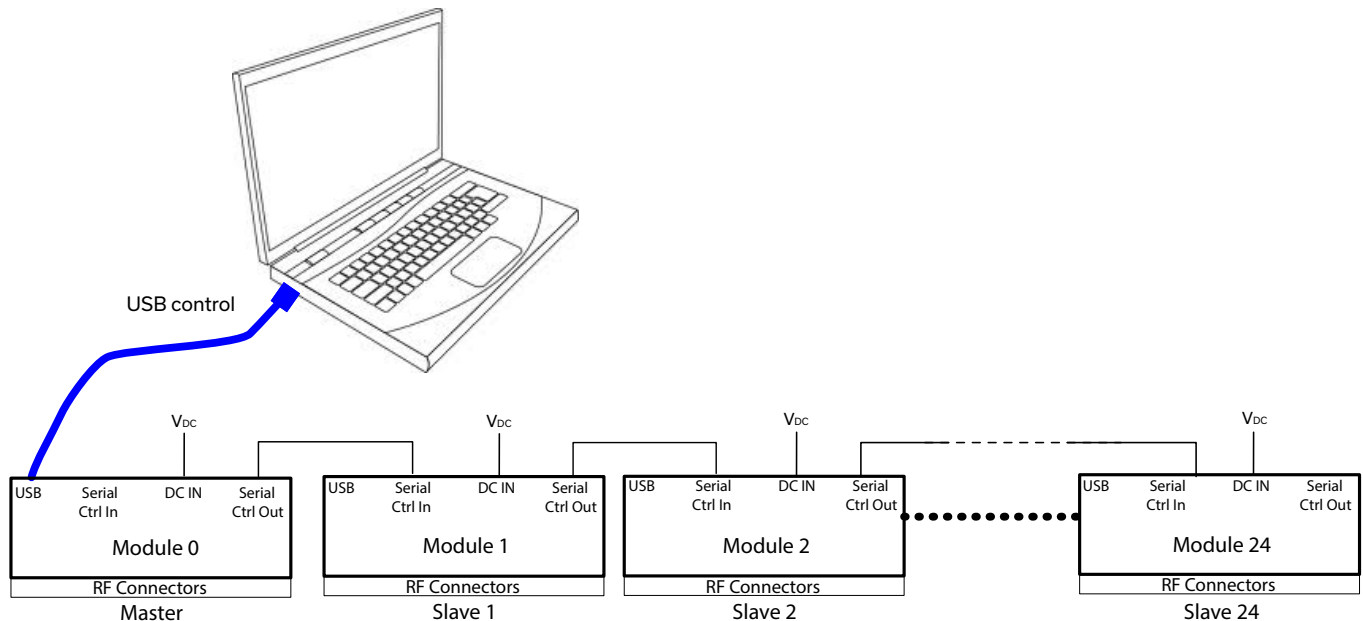
- Select AM, FM, Chirp or Pulse modulation
- In the individual screens for each modulation specify the parameters for the modulated signal

The screenshot shows the 'Modulation' window. It has a title bar and a close button. The main area is titled 'Select Modulation:' and contains five buttons: 'PULSE', 'AM', 'FM' (which is highlighted with a dashed border), 'Chirp', and 'Main Control'.



CONNECTING MULTIPLE MODULES (DAISY CHAIN)

The model is designed to connect up to 25 modules in series (daisy chain) using dynamic addressing, meaning there is no need to specifically set the address of the modules. The addresses will be set automatically as part of establishing the communications with the computer. The module connected to the computer's USB port or Ethernet connection will be assigned address 0 (master), the first module connected to it will get address 1 (slave) and subsequent modules incrementing up to address 24 (slave).



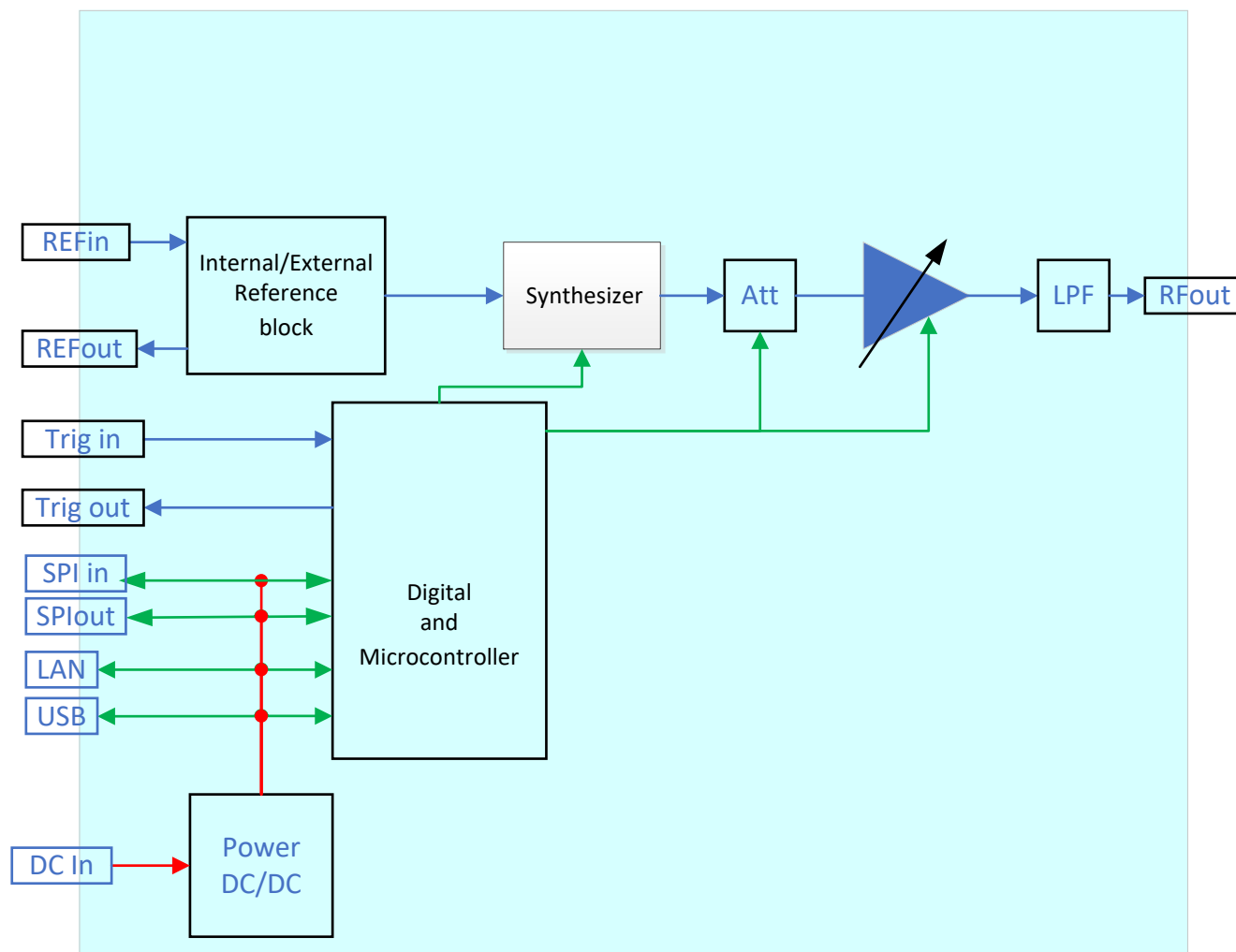
Connections between modules will be made using the serial in/out ports with the module connected to the PC act as a master and all other as slave modules. All control will be through the master module (address 0) which is the only one communicating with the PC or computer network. Serial control out port of each module should be connected to the serial control in port of the next module.

Power must be supplied to each module separately via their individual power supplies.

The serial master/slave bus allows connecting modules of different types to the same daisy chain as long as all support Mini-Circuits Dynamic addressing setup. To add a new module to the setup, simply connect the module and refresh the address listing, no need to reset any of the existing modules or assign addresses manually.



BLOCK DIAGRAM



CONNECTIONS

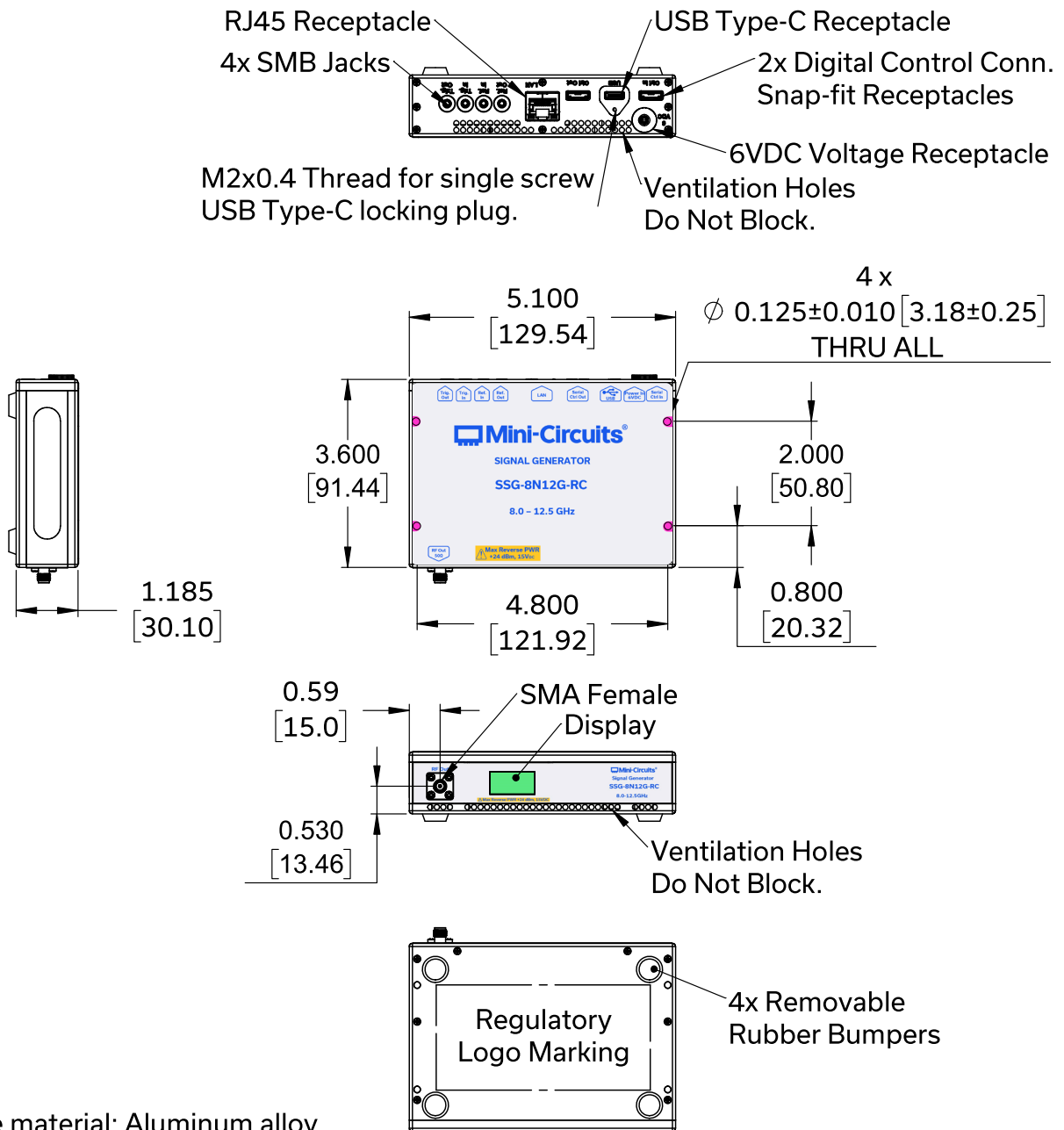
Port Name	Connector Type
RF output	SMA-Female
Reference in	J4 SMB-Male
Reference out	J5 SMB-Male
Trigger in	J3 SMB-Male
Trigger out	J2 SMB-Male
Power in ¹⁹	2.1 mm DC socket
USB port	USB type C female
Network (Ethernet/LAN)	RJ45 socket
Serial Out (Digital Control 1 port)	Digital Snap Fit Connector ²⁰
Serial In (Digital Control 2 port)	Digital Snap Fit Connector ²⁰

19. No power On/Off switch - SSG will power on as soon as power is connected, starting at the specified startup condition (factory default set to 12.5 GHz, -50 dBm, RF Off).

20. Mating connector is Hirose ST40X-10S-CV(30).



OUTLINE DRAWING (SL3643)



NOTES:

1. Case material: Aluminum alloy.
2. Case Finish: Nickel Plate.
3. Dimensions are in inches [mm]. Tolerances 2 Pl. ± 0.03 inch; 3 Pl. ± 0.015 inches.
4. Weight: 500 grams
5. Marking may contain other features or characters for internal lot control.



USB & ETHERNET & DAISY-CHAIN

Signal Generator

SSG-8N12G-RC

Mini-Circuits

50Ω 8 to 12.5 GHz -55 dBm to +23 dBm SMA Female

DETAILED MODEL INFORMATION IS AVAILABLE ON OUR WEBSITE

[CLICK HERE](#)

Performance Data & Graphs	Data Graphs
Case Style	SL3643
Environmental Rating	ENV55
Software, User Guide & Programming Manual	https://www.minicircuits.com/softwaredownload/sg.html
Regulatory Compliance	<p>Refer to user guide for compliance information</p> <p>CE UK CA</p> <p>https://www.minicircuits.com/app/AN49-003.pdf</p>
Support	testsolutions@minicircuits.com

INCLUDED ACCESSORIES ²¹

	Part No.	Description	Qty.
	AC/DC-6-3W	AC/DC Grounded Power adapter, 0°C to +40°C AC Input: 100-240 V, 50/60 Hz, I _{Max} = 1.2A DC Output 6±0.3 V, I _{Max} = 3A	1
(See images below)	CBL-3W-xx	AC Power Cord (Select one power cord from below with each unit)	1
	USB-CBL-AC-7SC+	6.5 ft (2.0 m) USB Cable: USB type A (Male) to USB type C (Male) Includes a screw lock to securely fasten the USB cable to the module	1
	CBL-5FT-BMSMB+	5.0 ft (1.5 m) Trigger cable: BNC (Male) to SMB (Female)	2

21. Additional quantities are available for purchase as optional accessories.

AC POWER CORD OPTIONS ²²




United States	Europe	United Kingdom	Australia and China	Israel
CBL-3W-US	CBL-3W-EU	CBL-3W-UK	CBL-3W-AU	CBL-3W-IL

22. Select one option from the list with each unit. Please contact testsolutions@minicircuits.com if your region is not listed.





OPTIONAL ACCESSORIES

	Part No.	Description
	CBL-RJ45-MM-5+	5.0 ft (1.5 m) Ethernet cable: RJ45 (Male) to RJ45 (Male) Cat 5E cable
	CBL-5FT-MMD+	5.0 ft (1.5 m) Cable assembly for serial control daisy chain with snap fit connectors
	CBL-1.5FT-MMD+	1.5 ft (0.45 m) Cable assembly for serial control daisy chain with snap fit connectors

CALIBRATION SERVICE

The recommended factory calibration interval is every 2 years. Mini-Circuits offers a proprietary factory calibration service using equipment with traceability to national standards. All units are calibrated to this standard prior to shipment.

Additionally, this model can be calibrated independently by accredited third-party calibration laboratories with options for ISO-17025 and on-site service. Contact testsolutions@minicircuits.com for recommendations or details of the calibration process.

Part No.	Description
CALSSG-8N12G-RC	Calibration Service for SSG-8N12G-RC CLICK HERE

NOTES:

- A. Performance and quality attributes and conditions not expressly stated in this specification document are intended to be excluded and do not form a part of this specification document.
- B. Electrical specifications and performance data contained in this specification document are based on Mini-Circuit's applicable established test performance criteria and measurement instructions.
- C. The parts covered by this specification document are subject to Mini-Circuits standard limited warranty and terms and conditions (collectively, "Standard Terms"); Purchasers of this part are entitled to the rights and benefits contained therein. For a full statement of the Standard Terms and the exclusive rights and remedies thereunder, please visit Mini-Circuits' website at <https://www.minicircuits.com/terms/viewterm.html>