R&S®SGMA PRODUCT FAMILY

Compact – fast – reliable

R&S®SGS100A SGMA RF Source
R&S®SGU100A SGMA Upconverter

Product Brochure
Version 06.00

ROHDE&SCHWARZ
Make ideas real

AT A GLANCE

The R&S®SGS100A is an RF source designed to meet the requirements of automated test systems. It is available as a continuous wave (CW) source or as a vector signal generator with an integrated I/Q modulator. With its frequency range of up to 12.75 GHz, the vector signal generator version covers the essential digital signals. The CW version can be used as a flexible local oscillator as well as for interference testing against mobile radio standards. The R&S®SGU100A upconverter extends the frequency range to 40 GHz.

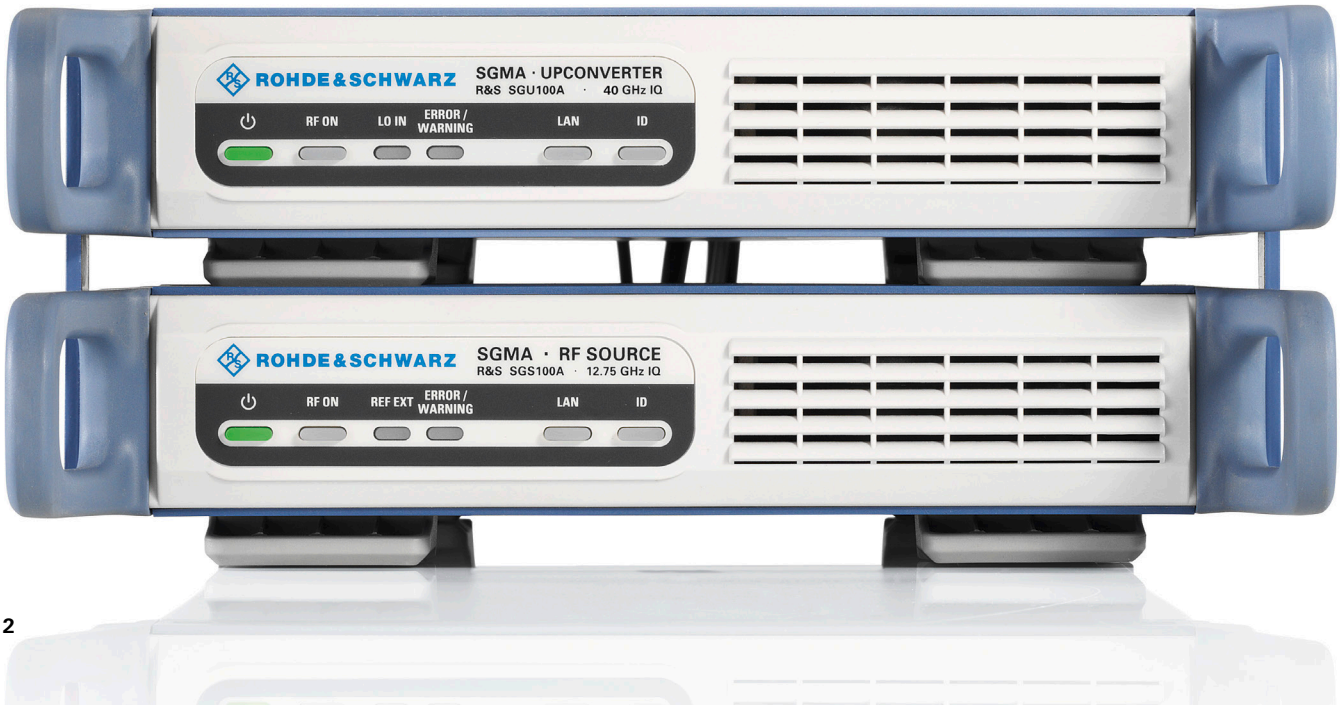
The very compact dimensions of only one height unit and ½ 19" rack width and the extremely fast frequency and level setting times are two features that demonstrate how consistently the R&S®SGS100A and the R&S®SGU100A have been designed for use in systems. They can also be used in all applications that require either multiple RF signal sources, such as beamforming applications, or where an extremely compact RF generator is needed, e.g. an operating source in customer systems.

Though compact, the R&S®SGS100A together with the R&S®SGU100A provides uncompromising signal purity and level accuracy. It offers performance usually available only from high-end instruments, including high output power, level repeatability and modulation bandwidth. During development, particular emphasis was placed on the total cost of ownership. A long calibration interval, excellent serviceability and options for expansion maximize the availability of the RF source.

Since the RF source is typically remote controlled, the front panels of the R&S®SGS100A and the R&S®SGU100A have a minimalist design. However, they offer status LEDs as well as all of the keys necessary for controlling generator operation. When used as a benchtop instrument, the R&S®SGS100A and the R&S®SGU100A are operated manually using the R&S®SGMA-GUI software that comes with the instrument.

Key facts

- Smallest fully integrated vector signal generator on the market, space-saving design for system integration
- Enables high throughput due to very short frequency and level setting times of typ. 280 µs via PCIe/Ethernet interface
- Excellent RF performance in a compact format
- Maximum output level of typ. +22 dBm (for the R&S®SGS100A) for compensating losses in the setup
- Closed ALC loop for CW and I/Q modes for highest level repeatability
- Wear-free electronic attenuator for high reliability up to 12.75 GHz
- Cost-efficient and compact frequency extension to 40 GHz with the R&S®SGU100A upconverter
- Low initial costs and low cost of ownership



BENEFITS AND KEY FEATURES

Dedicated ATE signal source

- Smallest integrated signal generator: 1 HU, ½ 19" for minimized required space in the test system
- Very fast setting times via PCIe/Ethernet interface for high throughput
- High maximum level for compensating losses in the setup
  - Maximum level of typ. +22 dBm up to 12 GHz (with R&S®SGS-B26 electronic step attenuator option)
  - Maximum level of typ. +17 dBm up to 40 GHz (with the combination of the R&S®SGS100A and the R&S®SGU100A)
- Optional wear-free electronic attenuator up to 12.75 GHz for reliable operation

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High performance in the right package

- Very high level linearity and repeatability thanks to a closed ALC loop with I/Q modulation up to 40 GHz for constant test conditions
- Low SSB phase noise of typ. –133 dBc (20 kHz carrier offset, f = 1 GHz, 1 Hz measurement bandwidth)
- Optional high-stability reference oscillator for easy integration of a standard into the test system
- High modulation bandwidth of 2 GHz above 12 GHz carrier frequency with the R&S®SGU100A

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Minimized total cost of ownership

- Attractive initial cost
- Straightforward modular design for short repair times, minimizing test system downtime
- Long calibration interval for minimized service costs

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Connectivity

- Simple integration into a test system
- Multiple remote control options
- R&S®SGMA-GUI PC software

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Frequency extension to 40 GHz with the R&S®SGU100A upconverter

- Two instruments into one: one RF output for the entire frequency range
- Seamless integration into existing user interfaces
- Lowest form factor and power consumption on the market
- High performance up to microwave frequencies

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R&S®SGS100A and R&S®SGU100A model overview

R&S®SGS100A alone			
CW source as local oscillator		**Vector signal generator for generating digital signals with an external baseband signal**	
1 MHz to 6 GHz	**1 MHz to 12.75 GHz**	**80 MHz to 6 GHz**	**80 MHz to 12.75 GHz**
with R&S®SGS-B106	with R&S®SGS-B106 and R&S®SGS-B112	with R&S®SGS-B106V	with R&S®SGS-B106V and R&S®SGS-B112V
R&S®SGS100A together with R&S®SGU100A			
CW source as local oscillator		**Vector signal generator for generating digital signals with an external baseband signal**	
10 MHz to 20 GHz	**10 MHz to 40 GHz**	**80 MHz to 20 GHz**	**80 MHz to 40 GHz**
with R&S®SGS-B106, R&S®SGS-B112 and R&S®SGU-B120	with R&S®SGS-B106, R&S®SGS-B112, R&S®SGU-B120 and R&S®SGU-B140	with R&S®SGS-B106V, R&S®SGS-B112V and R&S®SGU-B120V	with R&S®SGS-B106V, R&S®SGS-B112V, R&S®SGU-B120V and R&S®SGU-B140V

DEDICATED FOR ATE

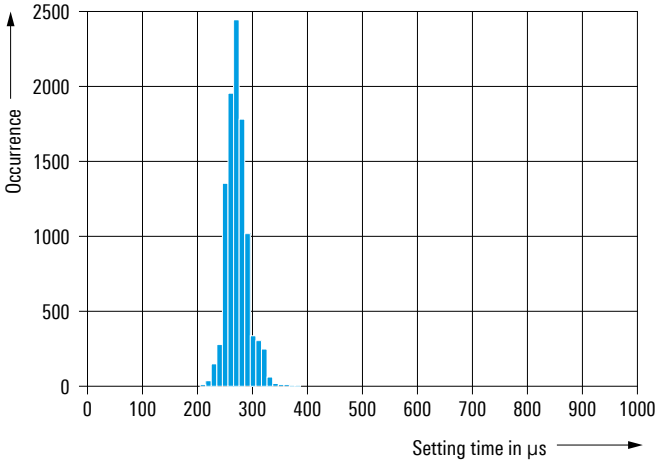
Smallest integrated signal generator: 1 HU, ½ 19" for minimized required space in the test system

A look at the R&S®SGS100A and the R&S®SGU100A confirms that they have been designed specifically for use in an automated environment. The small size of only one height unit and ½ 19" rack width per instrument saves space in the test system, and also reduces costs. Four RF paths up to 12.75 GHz can now be placed in the space previously needed for one RF path on average – a clear space management advantage. This makes the R&S®SGS100A ideal for automated test equipment (ATE) applications, even where multiple RF sources are required simultaneously, such as when testing phased array antenna systems. Low power consumption and the corresponding low heat dissipation make it possible to place the instruments of the R&S®SGMA product family close to one another. The connectors are arranged as standard on the back of the instrument to allow simple integration and cabling. Status LEDs on the front panel clearly indicate the instrument operating status.

Very fast setting times via PCIe/Ethernet interface for high throughput

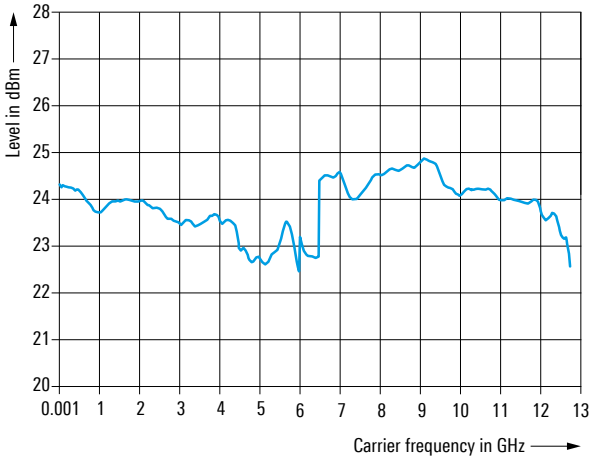
Production applications require speed during testing to ensure high throughput. The R&S®SGS100A meets this requirement in several ways. Its internal architecture and the software are designed for top speed and the PCIe/Ethernet interface transmits the remote control commands at maximum speed. Special commands (based on a Rohde&Schwarz driver) can be used to control the generator directly. This eliminates the need for a time-consuming translation of high-level commands in the instrument, again increasing the speed. With these optimizations, the R&S®SGS100A is able to achieve frequency and level setting times of typ. 280 µs. This was previously possible only by using vector signal generators with List modes, but not when issuing individual remote control commands directly. The test sequence can be adapted flexibly in the software without having to renew the frequency lists and the level lists.

Histogram of 10 000 frequency setting times



Histogram of 10 000 frequency setting times measured via PCIe/Ethernet interface, setting characteristic: AUTO, R&S®SGS100A alone

Maximum available level for a CW signal



Maximum available level for a CW signal, setting characteristic: AUTO, R&S®SGS100A with R&S®SGS-B26 electronic step attenuator option (measured)

High maximum level for compensating losses in the setup

In a complex test system, typical level losses of several decibel occur between signal generator and DUT. These result from the cable loss of long cables and from the use of switching matrices and filters. With its output level of typ. +22 dBm, the R&S®SGS100A provides sufficient margin to compensate for such losses. In combination with the R&S®SGU100A, the high level capability is extended all the way to 40 GHz, where typ. +17 dBm are still available. This eliminates the need for additional amplifiers that would not only increase the cost and take up more space, but also negatively affect signal purity, including wideband noise, level stability and impedance matching.

Optional wear-free electronic attenuator up to 12.75 GHz for reliable operation

The attenuator (R&S®SGS-B26 option) up to 12.75 GHz is fully electronic and wear-free. This allows continuous, long-term use in a test system, even when there is very frequent level switching, and, as a result, also minimizes service costs.

The R&S®SGS100A in a test system

HIGH PERFORMANCE IN THE RIGHT PACKAGE

Very high level linearity and repeatability for constant test conditions

The R&S®SGS100A, designed for speed and compactness, offers performance previously available only from high-end benchtop instruments. One example is the maximum output power of typ. +22 dBm with an electronic attenuator up to 12.75 GHz that can be used to compensate for losses in the system.

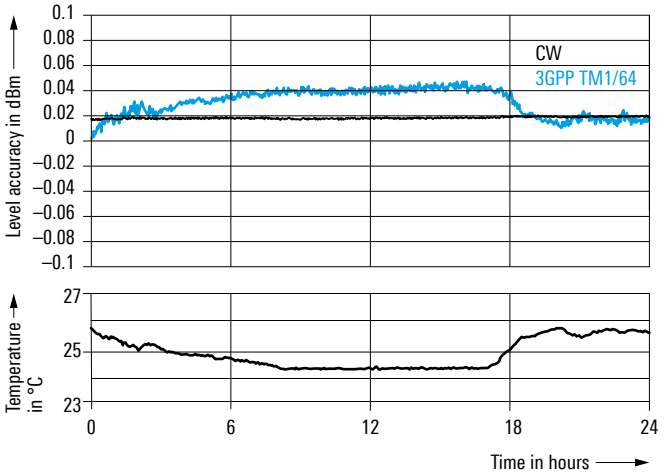
But maximum level isn't everything. Especially in a calibrated test system, level repeatability and linearity are essential for a generator. High level repeatability ensures consistent test conditions and makes it possible to reduce tolerances when defining test limits. With narrower test limits, production yield increases. Level linearity is particularly important when testing amplifier chips to exactly determine their compression point across level. This requires precise mapping of even very small level steps. Thanks to the closed ALC loop with I/Q modulation up to 40 GHz, the R&S®SGS100A and the R&S®SGU100A are ideal for this task.

Low SSB phase noise of typ. –133 dBc (20 kHz carrier offset, f = 1 GHz, 1 Hz measurement bandwidth)

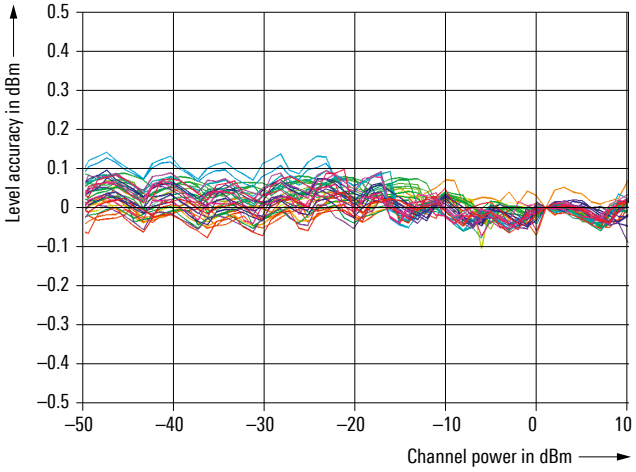
An important characteristic for the signal quality of RF signal generators is SSB phase noise. This value is important for CW applications, for example when searching for a pure local oscillator, and also for digital modulations. SSB phase noise directly influences the error vector magnitude (EVM) of digital signals, a parameter that is significant for advanced OFDM-based systems such as LTE.

For interference and intermodulation tests, very low non-harmonics are an indispensable characteristic for the test source. The R&S®SGS100A is ahead of the game here as well, offering excellent values otherwise seen only with high-end instruments: At an output frequency lower than 1.5 GHz, the R&S®SGS100A achieves < –76 dBc (offset > 10 kHz).

Level repeatability for a 3GPP TM1/64 signal with a crest factor of 10.55 dB, at 5 dBm (measured)



Level linearity for a 3GPP TM1/64 signal with a crest factor of 10.55 dB; the different colors are for different RF frequencies (measured)

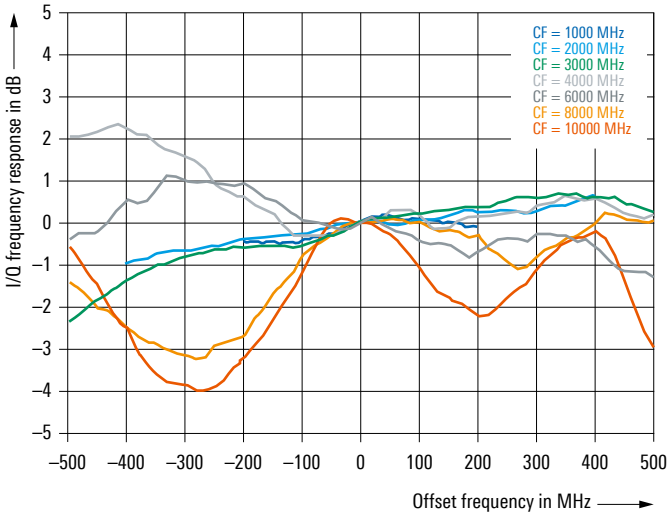


Optional high-stability reference oscillator for easy integration of a standard into the test system

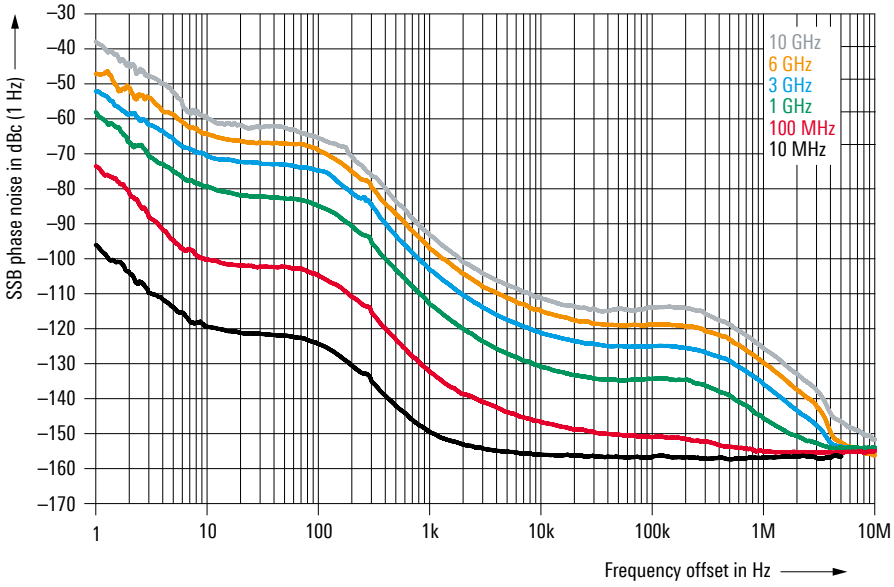
All of the test instruments in a system are typically linked via a 10 MHz reference so that their frequencies can be synchronized. The R&S®SGS100A can be used for this purpose when equipped with an optional, highly stable 10 MHz reference source. In addition, the R&S®SGS100A uses external reference signals of 13 MHz, 100 MHz and 1 GHz for synchronization. The higher frequency ensures a more stable instrument interconnection, not only with respect to frequency but also with respect to phase stability. Using the R&S®SGS100A together with the R&S®SGU100A, this fully applies for signals all the way up to 40 GHz covering various applications in the Ku band. When running tests (for example, beamforming applications) that require absolutely phase-locked connections between multiple signal sources, the R&S®SGS100A can also be equipped with the R&S®SGS-K90 option that offers a coherent LO input and output.

With its very high I/Q modulation bandwidth, the R&S®SGS100A is not only flexible, it is also a secure investment. It is capable of generating signals with an RF bandwidth of 1 GHz above a 2.5 GHz carrier frequency and up to 2 GHz RF bandwidth with the R&S®SGU100A (above 12 GHz carrier frequency). This covers all modern wideband communications standards. This bandwidth not only allows predistortion, it also makes it possible to obtain an exact description of digitally generated pulses with steep pulse edges for aerospace and defense applications.

Frequency response of the I/Q modulator in the R&S®SGS100A (measured)



SSB phase noise of the R&S®SGS100A with R&S®SGS-B1 internal OCXO option (measured)



MINIMIZED TOTAL COST OF OWNERSHIP

Attractive initial cost

The total cost of ownership includes not only attractive initial costs, but also the service and calibration costs. The R&S®SGMA product family is designed for optimal stability and minimal service effort. This is an important factor in ensuring maximum availability in the system. The low power consumption of 70 W for the R&S®SGS100A and 40 W for the R&S®SGU100A (equipped with R&S®SGU-B120V) has several benefits: The instrument temperature is decreased, which reduces component wear and tear and minimizes heat dissipation that would require venting throughout the system. The low power consumption translates into low operating costs.

Straightforward modular design for short repair times, minimizing test system downtime

If a repair is needed, the internal selftest identifies the affected component and minimizes troubleshooting time and effort. The low number of modules makes service even faster and easier.

Long calibration interval for minimized service costs

Another factor is the long-term stability of the generator: The longer the instrument operates without drift, the longer the calibration interval that can be selected. This is important because each time an instrument is calibrated, it must be removed from the test setup and sent to a calibration lab. The recommended calibration interval is three years, ensuring long availability.

Inside view of the R&S®SGS100A

CONNECTIVITY

Simple integration into a test system

All of the connectors are arranged as standard on the back of the instrument to allow simple integration into a test system. SMA ports provide functional connections, including RF output and analog I/Q inputs. The typically small cable diameters of this space-saving design facilitate cabling throughout the system.

Multiple remote control options

Though small in size, the R&S®SGMA product family provides multiple remote control options. PCIe or Ethernet is recommended for maximum setting speed together with a corresponding instrument driver from Rohde&Schwarz, which is available for Windows and Linux. The two additional remote control interfaces, i.e. LAN (Gigabit Ethernet) and USB 2.0, offer high speed to ensure short test times and high throughput.

R&S®SGMA-GUI PC software

The R&S®SGMA-GUI PC software, which comes with the instrument, is used for manual operation. It can control up to twelve R&S®SGS100A simultaneously, and also provides access to all instrument functions and settings via all interfaces.

The R&S®SGS100A with the R&S®SGMA-GUI PC software for controlling up to twelve instruments

Ports on the rear panel

FREQUENCY EXTENSION TO 40 GHz WITH THE R&S®SGU100A UPCONVERTER

Two instruments into one: one RF output for the entire frequency range

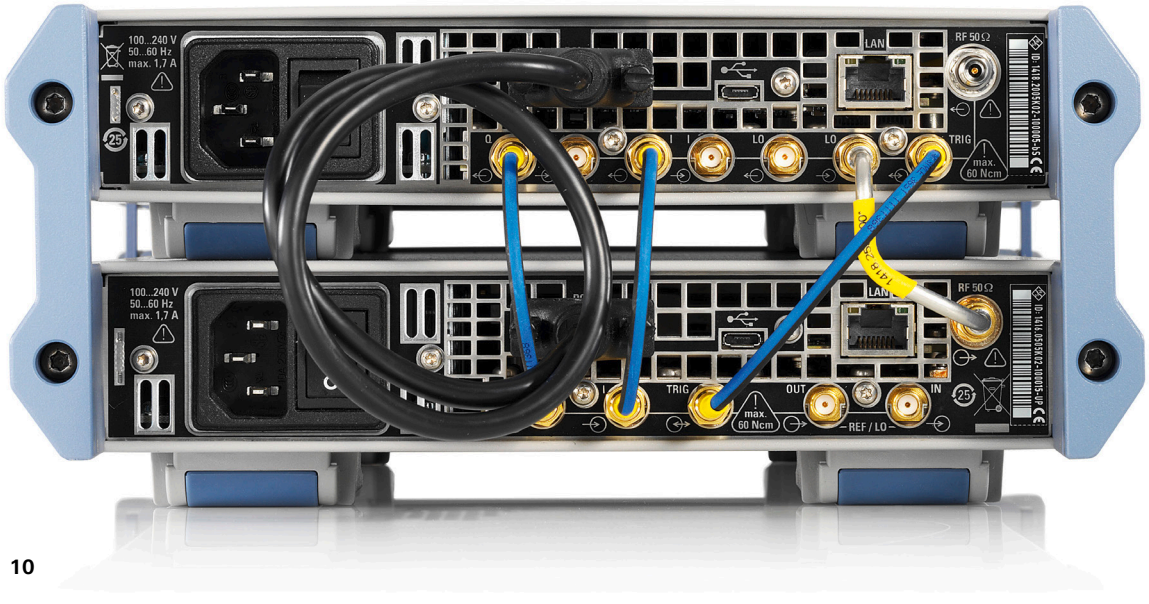
When the R&S®SGS100A and the R&S®SGU100A are connected, they act as a single instrument for both remote control and manual operation via the R&S®SGMA-GUI PC software. The R&S®SGU-Z4 extension kit provides the required electrical connections and mechanical stabilization on the front and rear panel. The combined instruments offer the same connections as the R&S®SGS100A itself: one RF output for the entire frequency range and one analog I/Q input for vector modulation.

In this setup, tasks are spread automatically and transparently between the two instruments so that users feel as if they are operating one instrument instead of two.

Seamless integration into existing user interfaces

When connected via LAN or PCIe, the R&S®SGU100A is controlled completely via the R&S®SGS100A. The R&S®SGMA-GUI PC software displays the R&S®SGU100A as an extension to the R&S®SGS100A and adjusts the maximum settable frequency range.

Equipped with the R&S®SGU100A, the R&S®SGS100A covers the entire frequency range from 10 MHz to 40 GHz without modulation, and from 80 MHz to 40 GHz with vector modulation.



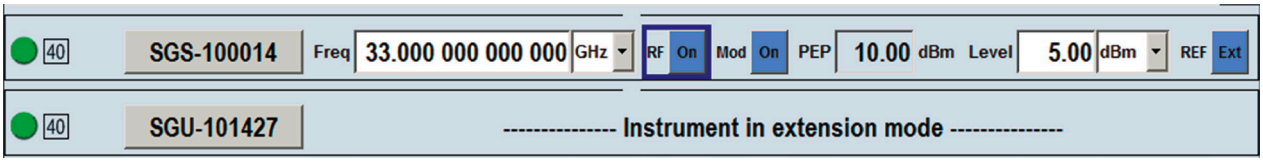
Connections between the R&S®SGS100A and the R&S®SGU100A

Lowest form factor and power consumption on the market

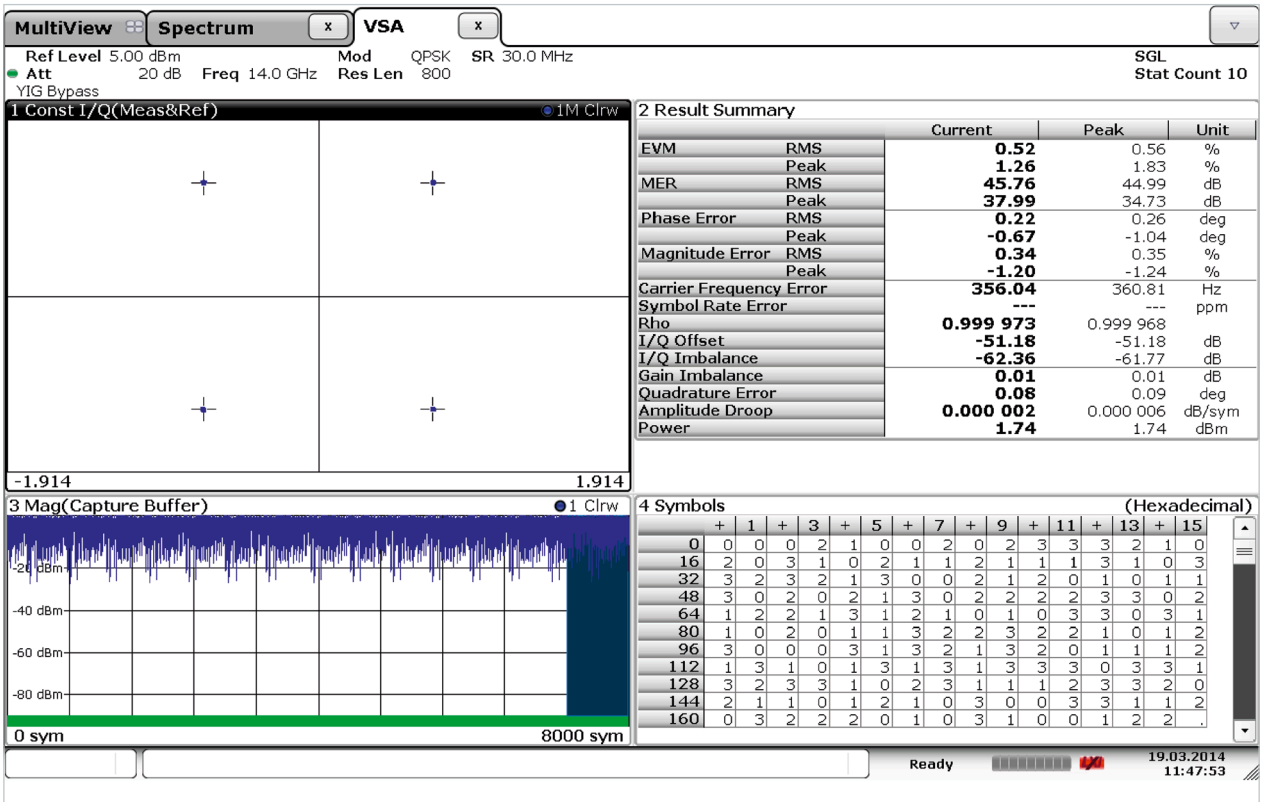
With two height units and ½ 19" rack width (or one height unit and full 19" rack width), the combination of the R&S®SGS100A and the R&S®SGU100A provides the lowest form factor on the market for 40 GHz vector signal generation. This is particularly important for applications with limited rack space, such as in production or in system setups.

The instruments are designed for continuous operation and feature low energy consumption. With power consumption less than 110 W, the combination is ideal for use in locations without direct access to normal power supply where battery operation using a DC converter is required.

R&S®SGMA-GUI PC software with the R&S®SGS100A connected to the R&S®SGU100A upconverter



EVM performance measurement using the R&S®SGS100A/R&S®SGU100A combination driven by an R&S®AFQ100A at 14 GHz



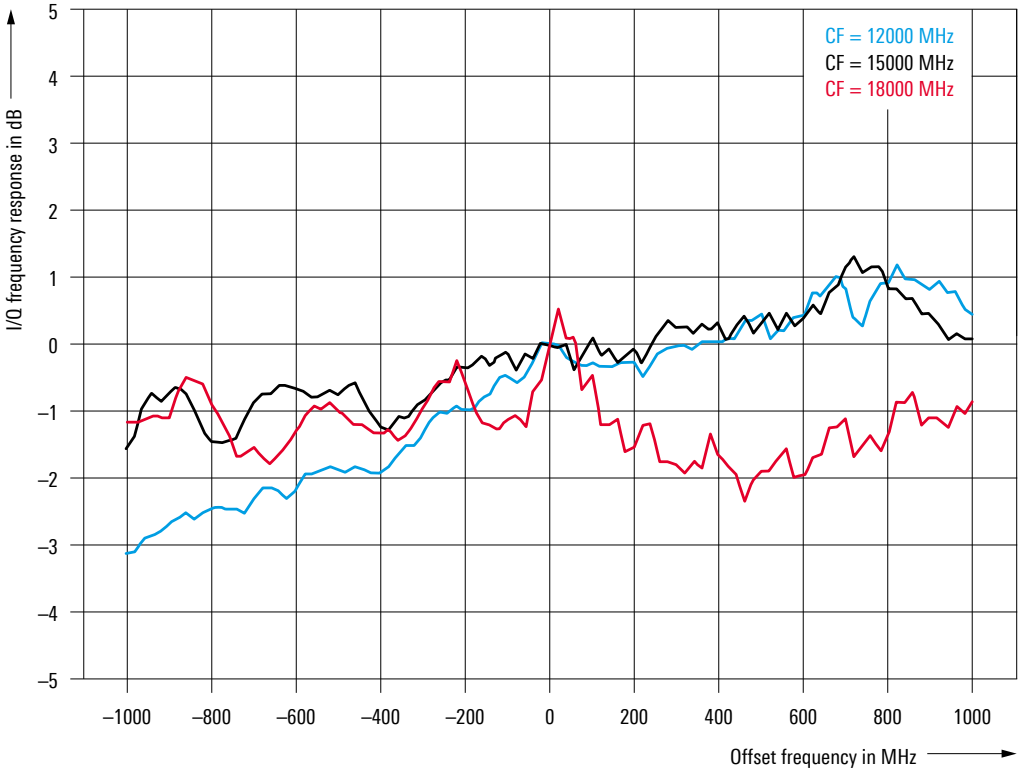
High performance up to microwave frequencies

The instrument combination has a small form factor yet offers high performance. For example, 0.5 % error vector magnitude for a QPSK signal with 30 Msymbol/s and a center frequency of 14 GHz.

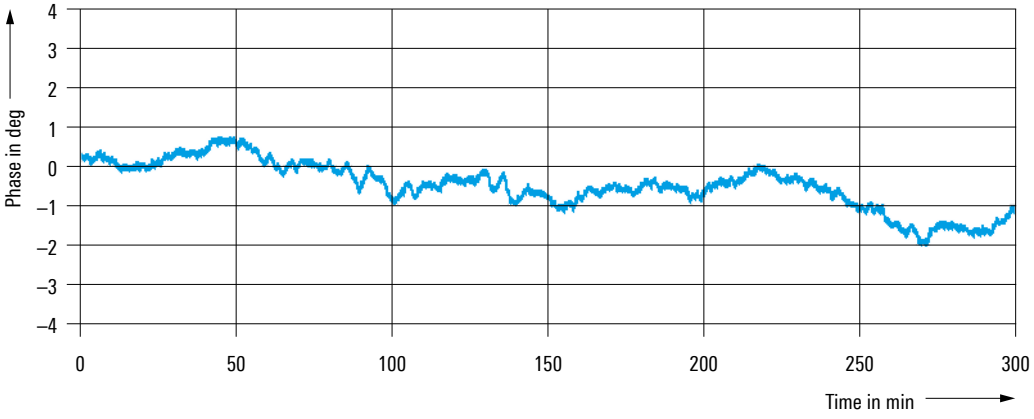
Above 12 GHz, the R&S®SGU100A features an I/Q modulation bandwidth of 2 GHz, making it ideal for very wideband aerospace and defense applications with extremely short pulses.

Beamforming applications and phased antenna array systems require high-quality phase-coherent test signals. The R&S®SGU100A provides the ideal framework for these tasks. The instruments can be connected with a very precise 1 GHz reference frequency and the synthesizers of multiple instruments can be coupled using the phase coherence option. As a result, the relative phases remain stable over a long time period.

Frequency response of the I/Q modulator in the R&S®SGU100A (measured)



Phase difference of the R&S®SGS100A/R&S®SGU100A at 18 GHz in I/Q mode, synchronized using a 4.5 GHz LO chain



SPECIFICATIONS IN BRIEF

Specifications in brief		
Frequency		
Frequency range	with the R&S®SGS-B106 option	1 MHz to 6 GHz
	with the R&S®SGS-B106 and R&S®SGS-B112 options	1 MHz to 12.75 GHz
	with the R&S®SGS-B106 and R&S®SGS-B112 options plus the R&S®SGU100A with the R&S®SGU-B120 option	10 MHz to 20 GHz
	with the R&S®SGS-B106 and R&S®SGS-B112 options plus the R&S®SGU100A with the R&S®SGU-B120 option and R&S®SGU-B140 option	10 MHz to 40 GHz
	with the R&S®SGS-B106V option	80 MHz to 6 GHz
	with the R&S®SGS-B106V and R&S®SGS-B112V options	80 MHz to 12.75 GHz
	with the R&S®SGS-B106V and R&S®SGS-B112V options plus the R&S®SGU100A with the R&S®SGU-B120V option	80 MHz to 20 GHz
	with the R&S®SGS-B106V and R&S®SGS B112V options plus the R&S®SGU100A with the R&S®SGU-B120V option and the R&S®SGU-B140V	80 MHz to 40 GHz
Setting time	with PCIe/Ethernet remote control	
	R&S®SGS100A alone	< 500 µs
	R&S®SGS100A together with R&S®SGU100A	< 2 ms
Input frequency for external reference	into R&S®SGS100A	10 MHz, 13 MHz, 100 MHz, 1000 MHz
Level		
Specified level range	for the R&S®SGS100A	–10 dBm to +15 dBm (PEP) [1]
	with the R&S®SGS-B26 option	–120 dBm to +15 dBm (PEP) [1]
	for the R&S®SGS100A together with the R&S®SGU100A	
	50 MHz < f ≤ 12 GHz (bypass mode)	–10 dBm to +15 dBm (PEP) [1]
	12 GHz < f ≤ 20 GHz	–10 dBm to +17 dBm (PEP) [1]
	12 GHz < f ≤ 40 GHz (with R&S®SGU-B140/B140V)	–10 dBm to +15 dBm (PEP) [1]
Level error	Setting Characteristic: AUTO; temperature range from +18 °C to +33 °C	
	1 MHz ≤ f ≤ 3 GHz (R&S®SGS100A alone)	< 0.5 dB
	3 GHz < f ≤ 12.75 GHz (R&S®SGS100A alone)	< 0.9 dB
	12 GHz < f ≤ 40 GHz (R&S®SGS100A together with R&S®SGU100A), level > –30 dBm	< 0.9 dB
Output impedance VSWR in 50 Ω system	in full frequency range, with the R&S®SGS-B26 option (R&S®SGS100A alone)	< 1.8
	in full frequency range (R&S®SGS100A together with R&S®SGU100A)	< 1.7 (meas.)
Setting time	with PCIe/Ethernet remote control, setting characteristic: AUTO	
	R&S®SGS100A alone	< 500 µs
	R&S®SGS100A together with R&S®SGU100A	< 2 ms (without switching of the mechanical attenuator)
	R&S®SGS100A together with R&S®SGU100A plus R&S®SGU-B26	< 25 ms (with switching of the mechanical attenuator)
Spectral purity		
Harmonics	level ≤ 8 dBm, CW, I/Q wideband OFF	< –30 dBc
Nonharmonics	level > –10 dBm [2], offset > 10 kHz from carrier, f ≤ 1.5 GHz (for R&S®SGS100A)	< –76 dBc
Subharmonics	level > –10 dBm [2], f ≤ 3 GHz	< –76 dBc

Specifications in brief		
Wideband noise	1 MHz ≤ f ≤ 6 GHz and 10 MHz carrier offset, 6 GHz < f ≤ 12.75 GHz and 30 MHz carrier offset, auto mode, level > 5 dBm, 1 Hz measurement bandwidth, CW	
	R&S®SGS100A alone	< –145 dBc
	R&S®SGS100A together with R&S®SGU100A	
	CW, f ≤ 12 GHz	< –140 dBc (meas.)
	CW, f > 12 GHz	< –142 dBc
	CW, f > 19.5 GHz	< -139 dBc (typ.)
SSB phase noise	20 kHz carrier offset, 1 Hz measurement bandwidth	
	f = 1 GHz	< –126 dBc; –130 dBc (typ.)
	f = 10 GHz	< –106 dBc; –110 dBc (typ.)
I/Q modulation		
I/Q modulator bandwidth (RF)	100 MHz < f ≤ 2.5 GHz, I/Q wideband	40 % of carrier frequency
	2.5 GHz < f ≤ 12.25 GHz, I/Q wideband	1 GHz
	f > 12 GHz (R&S®SGS100A together with R&S®SGU100A)	2 GHz
Error vector	measured with 16QAM, filter root cosine α = 0.5, 10 kHz symbol rate	
	f > 80 MHz, RMS, 10 kHz symbol rate (R&S®SGS100A alone)	< (0.4 % + 0.2 % × f/GHz)
	f > 12 GHz, RMS, 10 MHz symbol rate (R&S®SGS100A together with R&S®SGU100A)	< (2 % + 0.04 % × f/GHz)
ACLR	WCDMA 3GPP FDD, TM 1/64, frequency range from 1800 MHz to 2200 MHz (R&S®SGS100A alone)	> 67 dB; 69.5 dB (meas.)
Baseband bypass mode		
Frequency range		1 MHz ≤ f ≤ 80 MHz
Specified level range	R&S®SGS100A alone	–5 dBm to +15 dBm
	with the R&S®SGS-B26 option	–120 dBm to +15 dBm
Remote control	using Rohde&Schwarz instrument driver	PCIe (single lane)
	using SCPI 1999.5 or compatible command sets	Ethernet (TCP/IP) 10/100/1000BaseT
	using SCPI 1999.5 or compatible command sets	USB 2.0
General data		
Power consumption	R&S®SGS100A alone	70 W (meas.)
	R&S®SGU100A alone	40 W (meas.)
Dimensions	W × H × D, per unit	250 mm × 52.5 mm × 401 mm (9.84 in × 2.07 in × 15.79 in) 1 HU, ½ 19" rack width
Weight	when fully equipped	4.0 kg (8.82 lb)

[1] PEP = peak envelope power.
[2] > 0 dBm for instruments without the R&S®SGS-B26 electronic step attenuator.

ORDERING INFORMATION

Designation	Type	Order No.
R&S®SGS100A SGMA RF source		
Base unit [1], including power cable and quick start guide	R&S®SGS100A	1416.0505.02
Options		
1 MHz to 6 GHz, CW (no modulation)	R&S®SGS-B106	1416.2308.02
1 MHz to 6 GHz, I/Q (with vector modulation)	R&S®SGS-B106V	1416.2350.02
Frequency extension to 12.75 GHz, CW [2]	R&S®SGS-B112	1416.1553.02
Frequency extension to 12.75 GHz, I/Q (with vector modulation) [3]	R&S®SGS-B112V	1416.1576.02
Electronic step attenuator	R&S®SGS-B26	1416.1353.02
Reference oscillator OCXO	R&S®SGS-B1	1416.2408.02
Phase coherent input/output	R&S®SGS-K90	1416.2608.02
R&S®SGU100A SGMA upconverter		
Base unit [4], including power cable and quick start guide	R&S®SGU100A	1418.2005.02
Options		
10 MHz to 20 GHz, CW (no modulation)	R&S®SGU-B120	1418.2605.02
10 MHz to 20 GHz, I/Q (with vector modulation)	R&S®SGU-B120V	1418.2657.02
10 MHz to 40 GHz, CW (no modulation)	R&S®SGU-B140	1418.2870.02
10 MHz to 40 GHz, I/Q (with vector modulation)	R&S®SGU-B140V	1418.2928.02
Mechanical step attenuator	R&S®SGU-B26	1418.3401.02
Recommended extras		
19" rack adapter (for two 1 HU instruments next to each other), suitable for installation of two R&S®SGMA instruments	R&S®ZZA-KN20	1175.3191.00
19" rack adapter (for one instrument and spacing module)	R&S®ZZA-KN21	1175.3204.00
Cable kit R&S®SGU100A to R&S®SGS100A (side-by-side)	R&S®SGU-Z3	1418.3801.02
Connection kit R&S®SGU100A to R&S®SGS100A	R&S®SGU-Z4	1418.3701.02
R&S®SGMA adapter	R&S®SGS-Z8	1416.2914.02
Accessories		
Documentation of calibration values	R&S®DCV-2	0240.2193.18