

# R&S® SGU100A

## SGMA Upconverter

### Specifications



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## Key features

### Modular frequency extension unit with I/Q upconversion

- I/Q-modulated – or pure LO – frequency extension from 12 GHz to 40 GHz
- External software (R&S®SGMA GUI) for remote control
- Vector modulated solution from 80 MHz to 40 GHz with R&S®SGS100A acting as one combined instrument for manual and automated use once connected
- Extends existing analog Rohde & Schwarz signal generators (R&S®SMF100A, R&S®SMB100A) up to 40 GHz and adds vector modulation capabilities above 12 GHz
- Optional step attenuator with high dynamic range down to –120 dBm

### Space-saving operation due to small dimensions

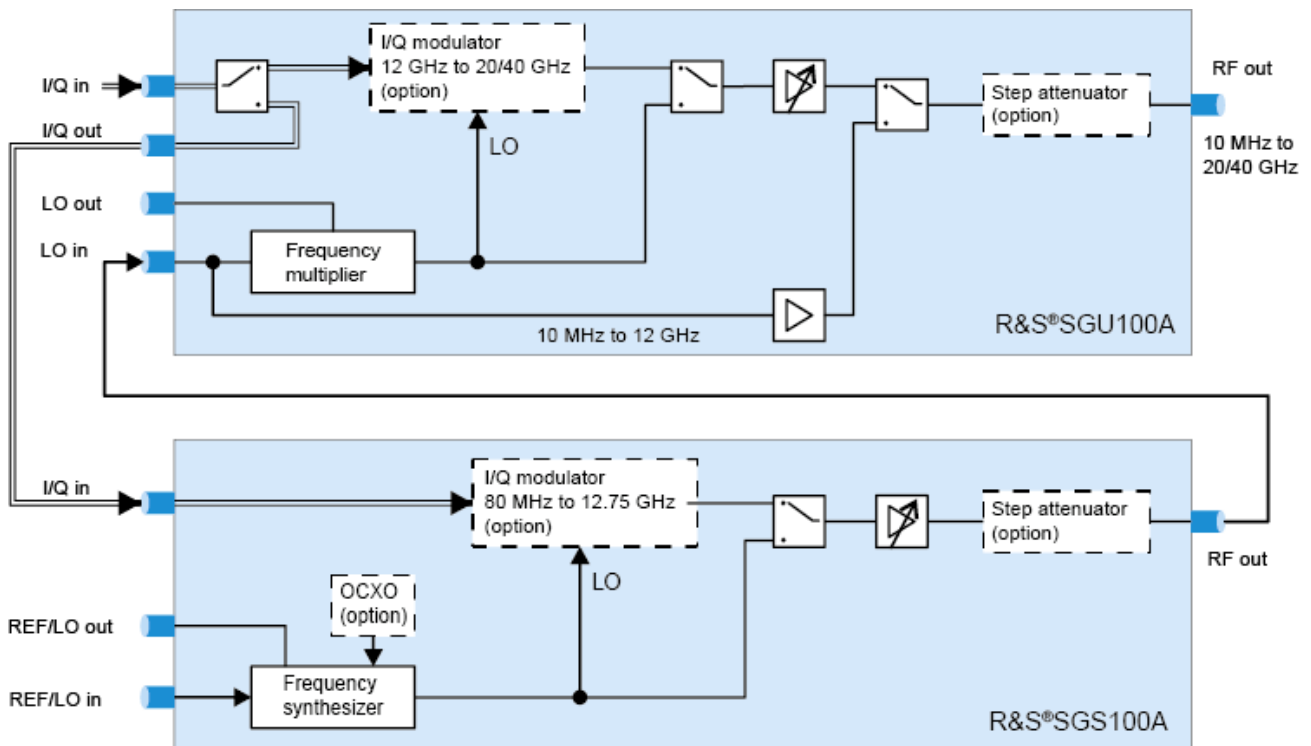
- Only ½ 19", 1 HU
- Lightweight

### High performance at an attractive price

- Maximum output level of +21 dBm (typ.) (f = 20 GHz, with options R&S®SGU-B120/-B120V and R&S®SGU-B26)
- Maximum output level of +17 dBm (typ.) (f = 40 GHz, with options R&S®SGU-B140/-B140V and R&S®SGU-B26)
- Subharmonics of < –65 dBc (typ.)
- High RF modulation bandwidth of 2 GHz
- Very high level accuracy and linearity thanks to closed ALC loop, even with I/Q modulation

### Minimized total cost of ownership

- Attractive initial cost
- Long calibration interval of 3 years
- Simplified error diagnostics through built-in selftests



Functional diagram of R&S®SGU100A in combination with R&S®SGS100A signal generator.

# Definitions

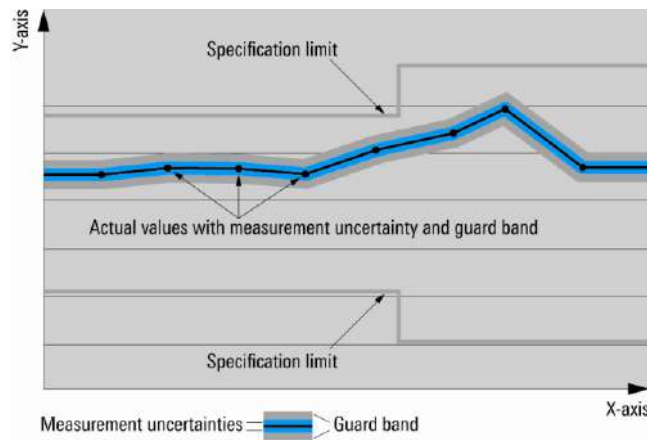
## General

Product data applies under the following conditions:

- Three hours storage at ambient temperature followed by 30 minutes warm-up operation
- Specified environmental conditions met
- Recommended calibration interval adhered to
- All internal automatic adjustments performed, if applicable

## Specifications with limits

Represent warranted product performance by means of a range of values for the specified parameter. These specifications are marked with limiting symbols such as  $<$ ,  $\leq$ ,  $>$ ,  $\geq$ ,  $\pm$ , or descriptions such as maximum, limit of, minimum. Compliance is ensured by testing or is derived from the design. Test limits are narrowed by guard bands to take into account measurement uncertainties, drift and aging, if applicable.



## Specifications without limits

Represent warranted product performance for the specified parameter. These specifications are not specially marked and represent values with no or negligible deviations from the given value (e.g. dimensions or resolution of a setting parameter). Compliance is ensured by design.

## Typical data (typ.)

Characterizes product performance by means of representative information for the given parameter. When marked with  $<$ ,  $>$  or as a range, it represents the performance met by approximately 80 % of the instruments at production time. Otherwise, it represents the mean value.

## Nominal values (nom.)

Characterize product performance by means of a representative value for the given parameter (e.g. nominal impedance). In contrast to typical data, a statistical evaluation does not take place and the parameter is not tested during production.

## Measured values (meas.)

Characterize expected product performance by means of measurement results gained from individual samples.

## Uncertainties

Represent limits of measurement uncertainty for a given measured. Uncertainty is defined with a coverage factor of 2 and has been calculated in line with the rules of the Guide to the Expression of Uncertainty in Measurement (GUM), taking into account environmental conditions, aging, wear and tear.

Device settings and GUI parameters are indicated as follows: "parameter: value".

Typical data as well as nominal and measured values are not warranted by Rohde & Schwarz.

# Specifications

## RF performance

### Frequency

Output frequency range	with R&S®SGU-B120, R&S®SGU-B120V options	10 MHz to 20 GHz
	with R&S®SGU-B140, R&S®SGU-B140V options	10 MHz to 40 GHz
Input frequency range	For frequency settings below 12 GHz the CW or modulated input signal is amplified and sent to the output of the instrument or to the optional step attenuator. For frequency settings > 12 GHz, the input CW signal is used to generate the I/Q modulator LO or CW output RF signal.	10 MHz to 12.75 GHz
Setting time	to within $< 2 \times 10^{-7}$ for $f > 500$ MHz or $< 100$ Hz for $f \leq 500$ MHz, without switching of mechanical step attenuator	
	with PCIe remote control <sup>1</sup>	< 2 ms

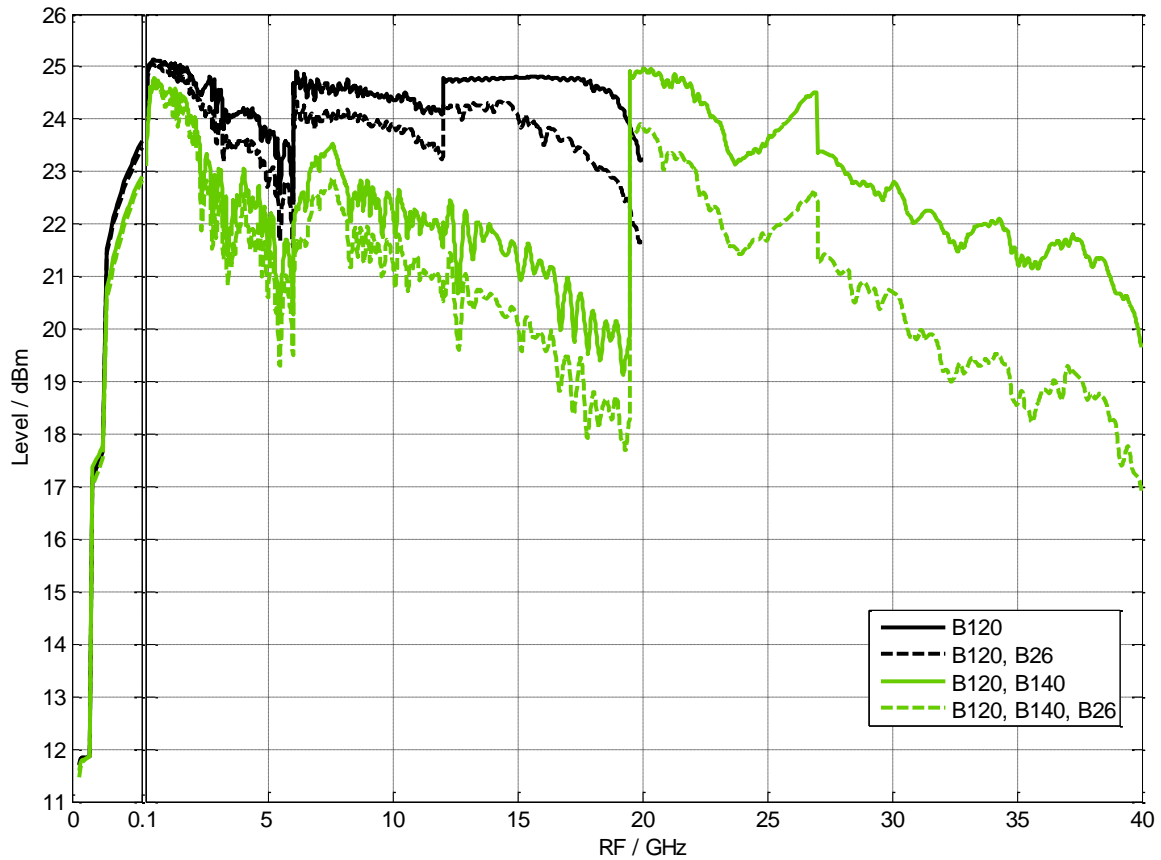
### Level

**Setting characteristic AUTO:** The step attenuator is switched over automatically. This mode maximizes the specified level range.

**Setting characteristic uninterrupted level setting:** The level is set without switching the step attenuator. The step attenuator is thus fixed to the current setting. Level changes are performed without interruption. The recommended interruption-free setting range is indicated by the instrument depending on the frequency, level and modulation settings. If this range is exceeded, the spectral purity of the output signal may decrease.

Setting range	$10 \text{ MHz} \leq f < 30 \text{ MHz}$	-20 dBm to +12 dBm
	$30 \text{ MHz} \leq f < 50 \text{ MHz}$	-20 dBm to +18 dBm
	$f \geq 50 \text{ MHz}$	-20 dBm to +25 dBm
	instruments equipped with R&S®SGU-B26 option	
	$10 \text{ MHz} \leq f < 30 \text{ MHz}$	-120 dBm to +12 dBm
	$30 \text{ MHz} \leq f < 50 \text{ MHz}$	-120 dBm to +18 dBm
	$f \geq 50 \text{ MHz}$	-120 dBm to +25 dBm
Specified level range <sup>1</sup>	instruments equipped with R&S®SGU-B120 or R&S®SGU-B120V, without option R&S®SGU-B26	
	$10 \text{ MHz} < f \leq 50 \text{ MHz}$ (bypass mode)	-10 dBm to +8 dBm (PEP)
	$50 \text{ MHz} < f \leq 12 \text{ GHz}$ (bypass mode)	-10 dBm to +15 dBm (PEP)
	$12 \text{ GHz} < f \leq 20 \text{ GHz}$	-10 dBm to +17 dBm (PEP)
	with R&S®SGU-B26 option	
	$10 \text{ MHz} < f \leq 50 \text{ MHz}$ (bypass mode)	-100 dBm to +8 dBm (PEP)
	$50 \text{ MHz} < f \leq 12 \text{ GHz}$ (bypass mode)	-100 dBm to +13 dBm (PEP)
	$12 \text{ GHz} < f \leq 20 \text{ GHz}$	-100 dBm to +15 dBm (PEP)
	instruments equipped with R&S®SGU-B140 or R&S®SGU-B140V, without option R&S®SGU-B26	
	$10 \text{ MHz} < f \leq 50 \text{ MHz}$ (bypass mode)	-10 dBm to +7 dBm (PEP)
	$50 \text{ MHz} < f \leq 12 \text{ GHz}$ (bypass mode)	-10 dBm to +13 dBm (PEP)
	$12 \text{ GHz} < f \leq 40 \text{ GHz}$	-10 dBm to +15 dBm (PEP)
	with R&S®SGU-B26 option	
	$10 \text{ MHz} < f \leq 50 \text{ MHz}$ (bypass mode)	-100 dBm to +7 dBm (PEP)
$50 \text{ MHz} < f \leq 12 \text{ GHz}$ (bypass mode)	-100 dBm to +11 dBm (PEP)	
$12 \text{ GHz} < f \leq 40 \text{ GHz}$	-100 dBm to +13 dBm (PEP)	
Resolution of setting		0.01 dB

Level error <sup>1</sup>	setting characteristic: AUTO, temperature range from +18 °C to +33 °C, CW or I/Q mode with full scale modulation	
	10 MHz < f ≤ 12 GHz	< 0.9 dB (meas.)
	12 GHz < f ≤ 20 GHz	
	> -30 dBm	< 0.9 dB
	≤ -30 dBm	< 1.1 dB
	20 GHz < f ≤ 40 GHz	
	> -30 dBm	< 0.9 dB
	-70 dBm to -30 dBm	< 1.1 dB
< -70 dBm	< 1.5 dB	
Additional level error <sup>1</sup>	ALC state off (table)	< 0.5 dB (meas.)
Output impedance VSWR in 50 Ω system <sup>1</sup>	instruments equipped with R&S®SGU-B120 or R&S®SGU-B120V	< 1.7 (meas.)
	with option R&S®SGU-B26	< 1.7 (meas.)
	instruments equipped with R&S®SGU-B140 or R&S®SGU-B140V	< 2.0 (meas.)
	with option R&S®SGU-B26	< 1.8 (meas.)
Setting time <sup>1</sup>	to < 0.2 dB deviation from final value, PCIe remote control	
	without switching of mechanical step attenuator	< 2 ms
	with switching of mechanical step attenuator	< 25 ms
Reverse power from 50 Ω	maximum permissible RF power in output	0.5 W
Maximum permissible DC voltage		0 V

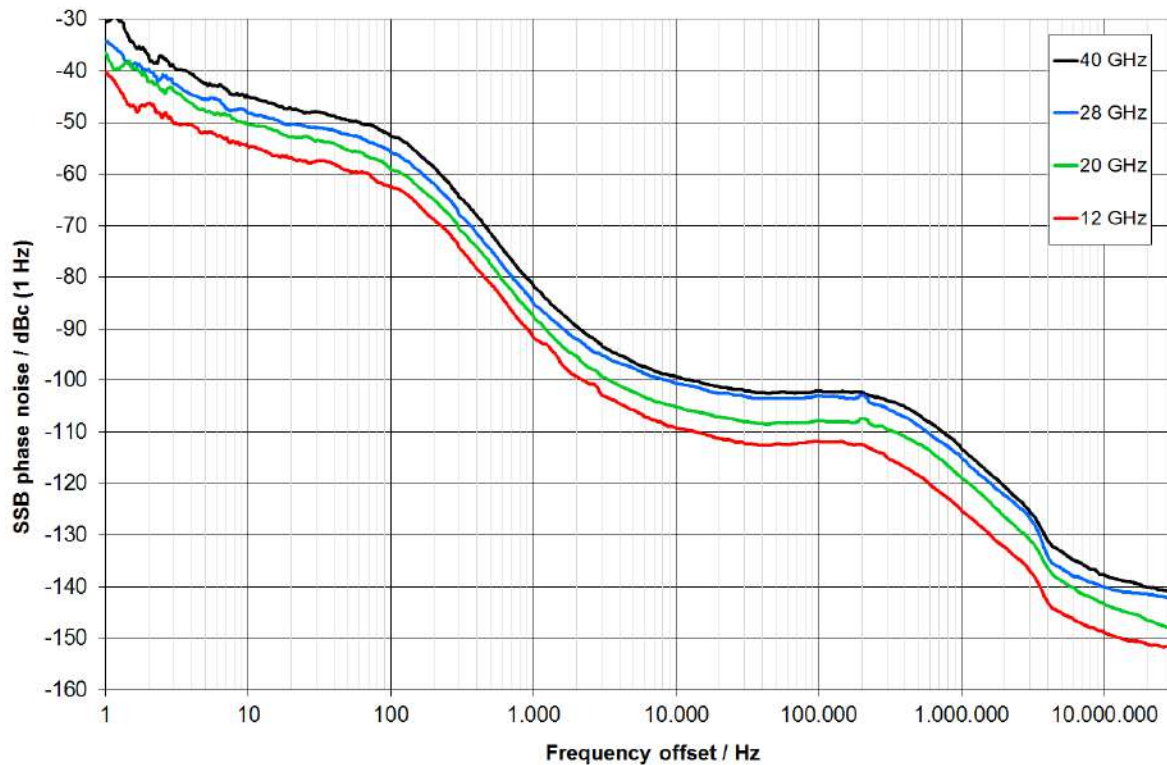


Maximum available level in combination with R&S®SGS100A (meas.)

<sup>1</sup> In combination with R&S®SGS100A.

## Spectral purity

Harmonics	$f > 12 \text{ GHz}$ , level $\leq 8 \text{ dBm}$	$< -30 \text{ dBc}$
Nonharmonics <sup>2</sup>	level $> -10 \text{ dBm}$ , offset $> 10 \text{ kHz}$ from carrier	
	$12 \text{ GHz} < f \leq 20 \text{ GHz}$	$< -56 \text{ dBc}$ (meas.)
	$f > 20 \text{ GHz}$	$< -50 \text{ dBc}$ (meas.)
Subharmonics	$f > 12 \text{ GHz}$	$< -55 \text{ dBc}$ , $< -65 \text{ dBc}$ (typ.)
Wideband noise <sup>2</sup>	carrier offset = 30 MHz, level = 10 dBm, measurement bandwidth 1 Hz	
	instruments equipped with R&S®SGU-B120 or R&S®SGU-B120V	
	CW, $f \leq 12 \text{ GHz}$	$< -140 \text{ dBc}$ (meas.)
	CW, $f > 12 \text{ GHz}$	$< -142 \text{ dBc}$
	vector modulation with full scale DC input, $f > 12 \text{ GHz}$	$< -135 \text{ dBc}$ , $< -138 \text{ dBc}$ (typ.)
	instruments equipped with R&S®SGU-B140 or R&S®SGU-B140V	
	CW, $f \leq 12 \text{ GHz}$	$< -140 \text{ dBc}$ (meas.)
	CW, $12 \text{ GHz} < f \leq 19.5 \text{ GHz}$	$< -142 \text{ dBc}$
	CW, $f > 19.5 \text{ GHz}$	$< -136 \text{ dBc}$ , $< -139 \text{ dBc}$ (typ.)
	vector modulation with full scale DC input, $12 \text{ GHz} < f \leq 19.5 \text{ GHz}$	$< -135 \text{ dBc}$ , $< -138 \text{ dBc}$ (typ.)
	vector modulation with full scale DC input, $f > 19.5 \text{ GHz}$	$< -134 \text{ dBc}$ , $< -137 \text{ dBc}$ (typ.)



SSB phase noise in combination with R&amp;S®SGS100A (meas.)

<sup>2</sup> In combination with R&S®SGS100A.

## LO input

For frequency settings > 12 GHz, the local oscillator signal for the I/Q modulator of the R&S®SGU100A is derived from the RF signal fed into the LO input. CW or modulated signals up to 12 GHz can also be amplified and bypassed from LO input to the RF output of the instrument or to the optional step attenuator.

Input frequency range	instruments with R&S®SGU-B120 or R&S®SGU-B120V	
	10 MHz ≤ f ≤ 12 GHz, bypass operation, CW or modulated	10 MHz to 12 GHz
	12 GHz < f ≤ 12.75 GHz	12 GHz to 12.75 GHz
	12.75 GHz < f ≤ 20 GHz	6.375 GHz to 10 GHz
	instruments equipped with R&S®SGU-B140 or R&S®SGU-B140V	
	10 MHz ≤ f ≤ 12 GHz, bypass operation, CW or modulated	10 MHz to 12 GHz
	12 GHz < f ≤ 12.75 GHz	12 GHz to 12.75 GHz
	12.75 GHz < f ≤ 25.5 GHz	6.375 GHz to 12.75 GHz
25.5 GHz < f ≤ 40 GHz	6.375 GHz to 10 GHz	
Connector type	LO IN on rear panel	SMA female
Input impedance		50 Ω (nom.)
Input level range	upconverter operation, f > 12 GHz	+7 dBm to +13 dBm
Input damage level	upconverter operation, f > 12 GHz	+18 dBm
	bypass operation, f ≤ 12 GHz	+25 dBm

## Phase coherence output

The R&S®SGU100A provides a phase coherent LO output signal. At instruments equipped with frequency option R&S®SGU-B140 or R&S®SGU-B140V, the LO output signal is set to the half output frequency for frequencies above 19.5 GHz.

Output frequency range	instruments with R&S®SGU-B120 or R&S®SGU-B120V	
	upconverter operation, 12 GHz < f ≤ 20 GHz	12 GHz to 20 GHz
	instruments equipped with R&S®SGU-B140 or R&S®SGU-B140V	
	upconverter operation, 12 GHz < f ≤ 19.5 GHz	12 GHz to 19.5 GHz
	upconverter operation, 19.5 GHz < f ≤ 40 GHz	9.75 GHz to 20 GHz
Connector type	LO OUT on rear panel	SMA female
Output impedance		50 Ω (nom.)
Output level range		+7 dBm to +13 dBm



## Pulse modulation

The R&S®SGU-B120 and R&S®SGU-B120V options include an internal pulse modulator for the frequency range from 12 GHz to 20 GHz.

For frequencies lower than 12 GHz, pulse modulation on the RF signal provided on the LO input is transferred to the RF output.

Instruments equipped with R&S®SGU-B140 or R&S®SGU-B140V include an internal pulse modulator for the frequency range from 12 GHz to 19.5 GHz. For frequencies from 19.5 GHz to 40 GHz, pulse modulation of the output signal can be accomplished by feeding an externally pulse modulated LO signal to the LO input of the instrument.

Once the R&S®SGU100A is connected to an R&S®SGS100A with pulse modulation capability, the required settings to realize internal and external pulse modulation over the full frequency range are automatically performed.

Modulation source		external
Connector type	TRIG on rear panel	SMA female
Input impedance		50 $\Omega$ (nom.), 10 k $\Omega$ (nom.)
On/off ratio <sup>3</sup>		> 80 dB
Rise/fall time <sup>3</sup>	10 %/90 % of RF amplitude	< 20 ns
Pulse repetition frequency <sup>3</sup>		0 Hz to 10 MHz
Video feedthrough <sup>3</sup>	setting characteristic: AUTO	
	level < 10 dBm with R&S®SGU-B26 option	< 10 % of RF
	level > 3 dBm and < 12 dBm without R&S®SGU-B26 option	< 10 % of RF
Pulse overshoot <sup>3</sup>		< 10 %

## I/Q modulation

### I/Q modulator

Modulation bandwidth	f > 12 GHz	up to $\pm 1000$ MHz
RF frequency response	up to $\pm 100$ MHz	< 2 dB (meas.)
	up to $\pm 1000$ MHz	< 6 dB (meas.)
Carrier leakage	without input signal, referenced to full-scale input 4	< -35 dBc, < -45 dBc (typ.)
Suppression of image sideband	up to $\pm 10$ MHz <sup>4</sup>	40 dB (meas.)
Error vector <sup>5</sup>	measured with 16QAM, filter root cosine, $\alpha = 0.5$ , symbol rate 10 MHz	
	f > 12 GHz, RMS	< (2 % + 0.04 % $\times$ f/GHz)
	f > 12 GHz, peak value	< (5 % + 0.1 % $\times$ f/GHz)
Two tone IMD (2 carriers)	level (PEP) = 0 dBm, up to 80 MHz carrier spacing	
	12 GHz < f $\leq$ 19.5 GHz	< -40 dBc (typ.)
	19.5 GHz < f $\leq$ 30 GHz	< -38 dBc (typ.)
	30 GHz < f $\leq$ 40 GHz	< -32 dBc (typ.)
<b>I/Q impairment settings</b>		
Offset setting range		-5 % to +5 %
Offset setting resolution		0.01 %
Gain imbalance setting range		-1.0 dB to +1.0 dB
Gain imbalance setting resolution		0.01 dB
Quadrature offset setting range		-8° to +8°
Quadrature offset setting resolution		0.01°

<sup>3</sup> In frequency range of internal pulse modulator

<sup>4</sup> Value applies after internal readjustment.

<sup>5</sup> In combination with R&S®SGS100A.

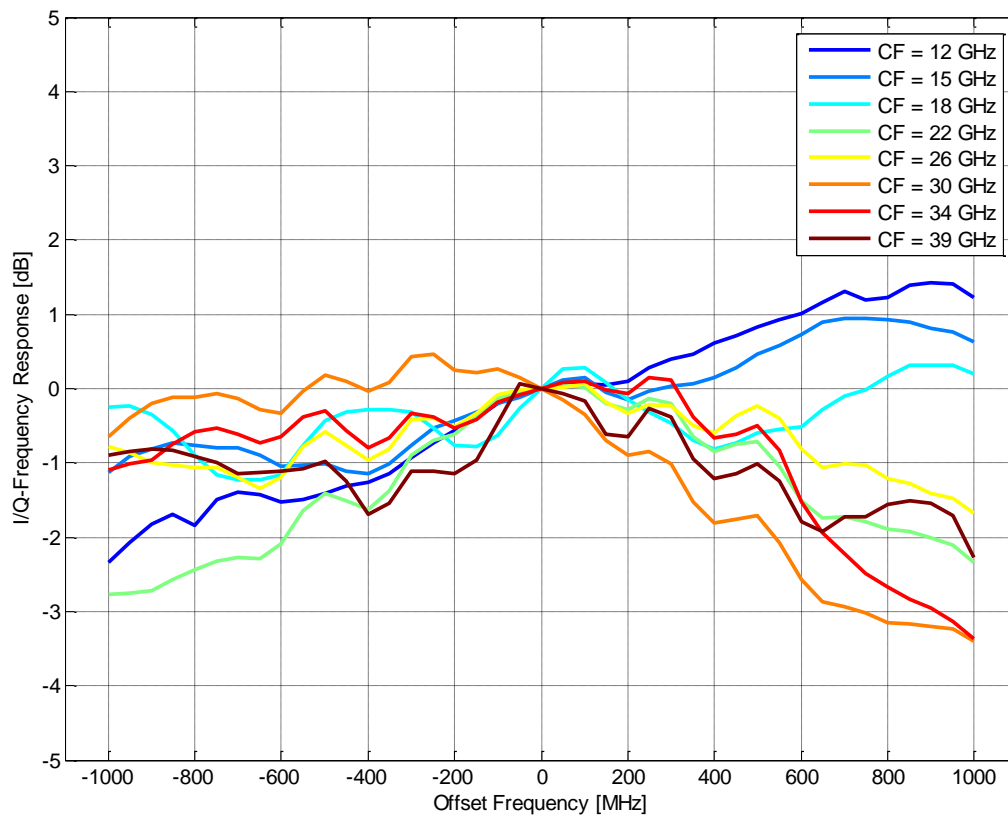
### I/Q inputs

Connector types	I in, Q in on rear panel	SMA female
Input impedance		50 Ω (nom.)
VSWR	f > 12 GHz	
	up to 100 MHz	< 1.3
	100 MHz up to 1000 MHz	< 1.5
Input voltage for full scale input		$\sqrt{V_i^2 + V_q^2} = 0.5 \text{ V}$ (nom.)
Input damage voltage	electronic input protection	± 5 V

### I/Q outputs

Allows routing of I and Q baseband signals to R&S®SGS100A for I/Q modulation below 12 GHz

Connector types	I out, Q out on rear panel	SMA female
Output impedance		50 Ω (nom.)
Losses in feedthrough path		< 2 dB (meas.)



I/Q modulation frequency response at various carrier frequencies (meas.)

## Remote control

Systems		PCIe (single lane)
		Ethernet (TCP/IP) 10/100/1000 Base-T
		USB 2.0
Command set	remote control via Ethernet, USB	SCPI 1999.5 or compatible command sets
	remote control via PCIe	Rohde & Schwarz instrument driver

## Connectors

### Rear panel connectors

RF 50 $\Omega$	RF output	K female
LO IN	RF/LO input	SMA female
LO OUT	coherent LO output signal	SMA female
I in, Q in	input connector for I and Q baseband signals	SMA female
I out, Q out	output connector for I and Q baseband signals (to R&S <sup>®</sup> SGS100A)	SMA female
TRIG	trigger input/output, pulse input	SMA female
USB IN	remote control of instrument	USB (micro USB, type B)
LAN	remote control of instrument	RJ-45
PCIe	remote control of instrument	single lane

## General data

<b>Power supply</b>		
Input voltage range	AC	100 V to 240 V $\pm$ 10 %
Supply frequency	AC	50 Hz to 60 Hz, $-5\%/+5\%$
Max. input current		1.7 A
Power consumption	instruments equipped with R&S®SGU-B120 or R&S®SGU-B120V	40 W (meas.)
	instruments equipped with R&S®SGU-B140 or R&S®SGU-B140V	70 W (meas.)
Power factor correction		in line with EN 61000-3-2
<b>Electrical safety</b>		
Compliance		in line with IEC 61010-1, EN 61010-1, CAN/CSA-C22.2 No. 61010-1-04, UL 61010-1
Test mark		VDE-GS, cCSA <sub>US</sub>
<b>EMC</b>		
Electromagnetic compatibility		in line with EN 55011 class A, EN 61326-1 (industrial environment), EN 61326-2-1
<b>Mechanical resistance</b>		
Vibration	sinusoidal	5 Hz to 150 Hz, max. 2 g at 55 Hz, const. 0.5 g at 55 Hz to 150 Hz, in line with EN 60068-2-6
	random	10 Hz to 300 Hz, acceleration 1.2 g RMS, in line with EN 60068-2-64
Shock		40 g shock spectrum, in line with MIL-STD-810E, method no. 516.4, procedure I,
<b>Environmental conditions</b>		
Temperature range	operating	0 °C to +50 °C in line with EN 60068-2-1, EN 60068-2-2
	storage	-40 °C to +71 °C
Climatic resistance		+40 °C/95 % rel. humidity, in line with EN 60068-2-30
Altitude	operating	up to 4600 m
	storage	up to 4600 m
<b>Dimensions</b>	W x H x D	250 mm x 52.5 mm x 401 mm (9.84 in x 2.07 in x 15.79 in) 1 HU, ½ 19" rack width
<b>Weight</b>	when fully equipped	4.0 kg (8.82 lb) (nom.)
<b>Calibration interval</b>		
Recommended calibration interval	operation 40 h/week in the full range of the specified environmental conditions	3 years

## Ordering information

Designation	Type	Order No.
SGMA Upconverter, base unit <sup>6</sup>	R&S®SGU100A	1418.2005.02
Including power cable and quick start guide		
<b>Options</b>		
10 MHz to 20 GHz, CW (without vector 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
Frequency Extension to 40 GHz, CW	R&S®SGU-B140	1418.2870.02
Frequency Extension to 40 GHz, I/Q	R&S®SGU-B140V	1418.2928.02
Mechanical Step Attenuator	R&S®SGU-B26	1418.3401.02
Documentation of Calibration Values	R&S®DCV-2	0240.2193.18
<b>Recommended extras</b>		
Hardcopy manuals (in English)		1418.2070.02
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
19" Rack Adapter (for two 1 HU instruments next to each other), suitable for installation of two SGMA instruments	R&S®ZZA-KN20	1175.3191.00
19" Rack Adapter (for one instrument + spacing module)	R&S®ZZA-KN21	1175.3204.00

<b>Service options</b>		
Extended Warranty, one year	R&S®WE1	Please contact your local Rohde & Schwarz sales office.
Extended Warranty, two years	R&S®WE2	
Extended Warranty, three years	R&S®WE3	
Extended Warranty, four years	R&S®WE4	
Extended Warranty with Calibration Coverage, one year	R&S®CW1	
Extended Warranty with Calibration Coverage, two years	R&S®CW2	
Extended Warranty with Calibration Coverage, three years	R&S®CW3	
Extended Warranty with Calibration Coverage, four years	R&S®CW4	

### Extended warranty with a term of one to four years (WE1 to WE4)

Repairs carried out during the contract term are free of charge <sup>7</sup>. Necessary calibration and adjustments carried out during repairs are also covered. Simply contact the forwarding agent we name; your product will be picked up free of charge and returned to you in top condition a couple of days later.

### Extended warranty with calibration (CW1 to CW4)

Enhance your extended warranty by adding calibration coverage at a package price. This package ensures that your Rohde & Schwarz product is regularly calibrated, inspected and maintained during the term of the contract. It includes all repairs <sup>7</sup> and calibration at the recommended intervals as well as any calibration carried out during repairs or option upgrades.

<sup>6</sup> The base unit must be ordered together with an R&S®SGU-B120 or R&S®SGU-B120V frequency option.

<sup>7</sup> Excluding defects caused by incorrect operation or handling and force majeure. Wear-and-tear parts are not included.