Datasheet

SC5309A & SC5310A

100 kHz to 2.5 GHz RF Downconverter

support@signalcore.com

PRODUCT SPECIFICATIONS

Definition of Terms

The following terms are used throughout this datasheet to define specific conditions:

Specification (spec) Defines expected statistical performance within specified parameters which account for measurement uncertainties and changes in performance due to environmental conditions. Protected by warranty.

Typical data (typ) Defines the expected performance of an average unit without specified parameters. Not protected by warranty.

Nominal values (nom) Defines the average performance of a representative value for a given parameter. Not protected by warranty.

Measured values (meas) Defines the expected product performance from the measured results gained from individual samples.

Specifications are subject to change without notice. For the most recent product specifications, visit www.signalcore.com.

Spectral Specifications

RF input range

RF amplifier disabled .... 100 kHz to 2.5 GHz
RF amplifier enabled .... 1 MHz to 2.5 GHz

IF output center frequency [1]

Last (3rd) stage conversion enabled .... 5 MHz to 100MHz

IF output polarity [2] .... Non-inverted/Inverted

IF bandwidth (3 dB) [3]

Options .... 20, 40 MHz

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[1] The final IF may be selected from either the input RF, second, or third conversion stages. If the input RF port is selected, the signal from the RF port is directly routed to the final IF port, bypassing the conversion process entirely. The frequency range of this path is 100 kHz to 500 MHz. When the second stage is selected, the final IF is fixed at 1.25 GHz and the spectrum is inverted. When the third stage is selected, the IF center frequency is tunable from 1 MHz to 500 MHz in 5 MHz steps. Although the tuning range provides flexibility, the IF bandwidth may practically limit the center frequency.

[2] The IF output polarity refers to the conversion polarity of the downconverter. When the polarity is inverted, the spectral content of the output is inverted with respect to the input. This process is commonly known as “spectral inversion” or “spectral flipping”. The selection depends on the application. For digitizers that are sampling the IF in the even order Nyquist zones that naturally invert spectra, having the IF polarity inverted will produce non-inverted baseband and vice-versa. However, this is only a convenience in this application case because inverted spectrum, once digitized, can easily be re-inverted mathematically. This inversion is only available when the third conversion stage is selected. When the final IF signal is taken from the second IF stage (2 stage conversion), the output spectrum is always inverted.

[3] The IF2 section has 2 switchable filter options. For IF center frequencies higher than 15 MHz, bandwidths up to 20 MHz can be supported. For center frequencies ≥ 70 MHz, bandwidths up to 40 MHz can be supported. Selection of IF filter BW is dependent on the final IF center frequency. Please consult with the factory to determine if the IF center frequency could support the desired bandwidths. The standard offering is equipped with a single 20 MHz filter.

RF tuning

Frequency step resolution .... 1 Hz

Lock and settling times [4] .... 1 ms typical

Figure 1. Typical relative output IF responses of bandpass filters measured at a tuned center IF of 70 MHz. The noise floor of the power meter limits the out-of-band rejection measurement.

Frequency reference [5]

Technology .... Temperature compensated crystal oscillator

Accuracy .... ± [(aging x last adjustment time lapse) + temp stability + cal accuracy]

Initial calibration accuracy .... ±0.05 ppm

Temperature stability [6]

35 °C to 45 °C .... ±0.25 ppm

0 °C to 70 °C .... ±1.0 ppm

Aging .... ±1 ppm for first year @ 40 °C

Frequency accuracy [7] .... ± (frequency reference accuracy * (RF input frequency + 3.625e9)) Hz

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[4] The frequency settled to 1ppm of its LO1 frequency. The limits for the LO tuning range are 3.625 GHz to 6.125 GHz to cover 0 Hz to 2.5 GHz.

[5] The frequency reference refers to the device's internal 10 MHz TCXO time-base. Accuracy is in parts-per-million or ppm ($1x10^{-6}$).

[6] Users must apply sufficient cooling to the device to keep the unit temperature as read from its internal temperature sensor within the range of 40 °C to 45 °C at an ambient temperature of 25 °C.

[7] Accuracy of the device for any given input RF signal.

Sideband noise (dBc/Hz) [8]

RF Frequency

Offset	100 MHz	1000 MHz	2000 MHz	2500 MHz
100 Hz	-80	-78	-76	-74
1 kHz	-97	-95	-93	-91
10 kHz	-105	-103	-101	-100
100 kHz	-107	-105	-102	-101
1 MHz	-132	-130	-129	-127
10 MHz	-150	-149	-147	-145

TBD

Figure 2. Typical measured sideband noise. [9]

[8] Sideband phase noise as specified is based on measured sideband noise which includes both phase noise and amplitude noise contributions. Sideband noise is specified for the downconverter under normal mode for loop gain setting.

[9] These results are obtained with input signal levels of 0 dBm at the mixer (no RF attenuation). The output IF level is set to 3 dBm.

LO related sideband spurious signals [10]

< 200 kHz .... -70 dBc

> 200 kHz .... -75 dBc

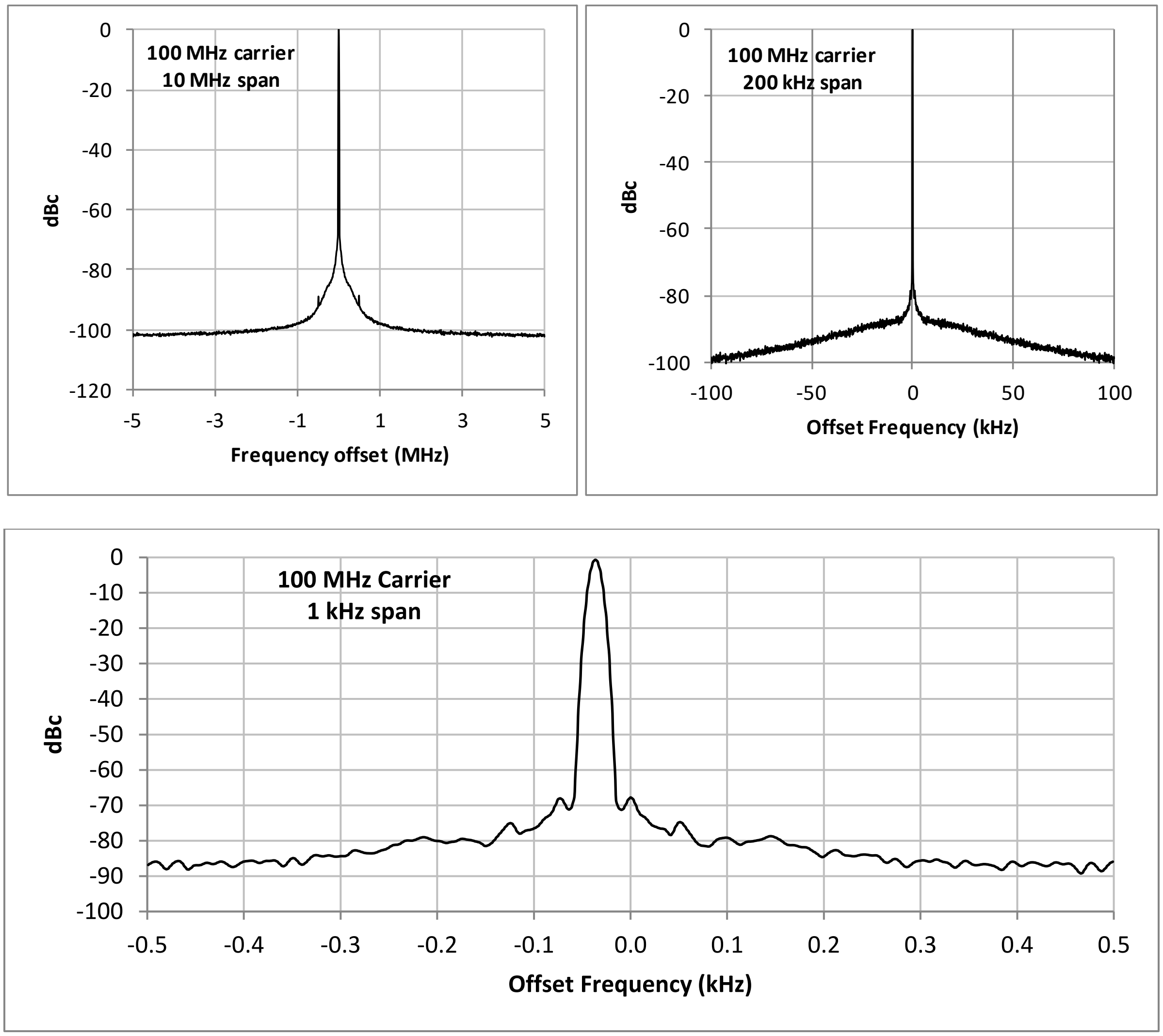

Figure 3. Plots show the raw spectral purity for a 100 MHz input RF signal (LO = 3.725 GHz). Note that the power supply noise of 60 Hz and its harmonics are in the noise. The measurement instrument is not phase-locked to the unit under test.

[10] Sideband spurious signals are usually the result of the local oscillators in the device. Sources of sideband spurious signals in the synthesized local oscillators are primarily due to fractional-N spurious products in the PLLs, DDS noise sources, and intermodulation between oscillators within the multiple-loop PLL synthesizers. Tuning steps of 500 kHz or greater result in lower spur levels.

Amplitude Specifications

Input range

AC (preamplifier disabled) .... +27 dBm max
AC (preamplifier enabled) .... +20 dBm max
DC [11] .... 0 V

Attenuation range

RF .... 0 to 60 in 0.25 dB steps
IF [12] .... 0 to 60 in 0.25 dB steps

Input voltage standing wave ratio (VSWR)

Preamp off, 0 dB input RF attenuation

10 MHz to 1.0 GHz .... < 1.7
1.0 GHz to 2.5 GHz .... < 2.5

Preamp on, 0 dB input RF attenuation

10 MHz to 1.0 GHz .... < 1.8
1.0 GHz to 2.5 GHz .... < 2.0

Gain range (@ 1GHz) [13]

Minimum [14] .... -90 dB typical
Maximum [15] (preamplifier disabled) .... 30 dB typical
Maximum [15] (preamplifier enabled) .... 50 dB typical

Preamplifier gain .... 20 dB typical

[11] Large and fast DC transients could damage the input solid state devices. A slow ramp up of DC to 10 V is sustainable.
[12] There are two RF and two IF attenuators in total, each having 30 dB of attenuation.
[13] These are typical gain specifications. The gain of the device is calibrated and stored in the device calibration EEPROM.
[14] Minimum conversion gain is specified when all attenuators are set to their maximum values and the RF pre-amplifier is disabled.
[15] Maximum conversion gain is specified when all the attenuators are set to 0 dB attenuation.

RF amplitude response (15 °C to 35 °C ambient)

RF gain flatness response (uncorrected) .... 4 dB typical

RF gain flatness response (corrected[16]) .... ±0.75 dB

Absolute gain accuracy (corrected[16]) .... ±1.0 dB (±0.75 dB typical)

IF flatness (15 °C to 35 °C ambient)

IF in-band response flatness .... 3 dB typical

Figure 4. Typical RF conversion gain response @ 40 °C device temperature.

RF to IF group delay (80% of IF bandwidth)

With IF3 SAW filter .... up to 1200 ns typical

Without IF3 filter .... up to 600 ns typical

[16] Correction stored in the calibration EEPROM must be applied properly. Users are not obligated to use the calibration provided; they may devise their own method of calibration and correction. User methods of calibration and application may improve on the accuracies specified.

Dynamic Range Specifications

Spurious response [17]

Residual spurious signals [18]

RF < 1 GHz .... < -90 dBm

RF > 1 GHz .... < -90 dBm

RF induced spurious signals [19] .... < -75 dBc

Image rejection [20] .... < -100 dBc

IF rejection [21] .... < -100 dBc

IF harmonics [22] .... < -65 dBc

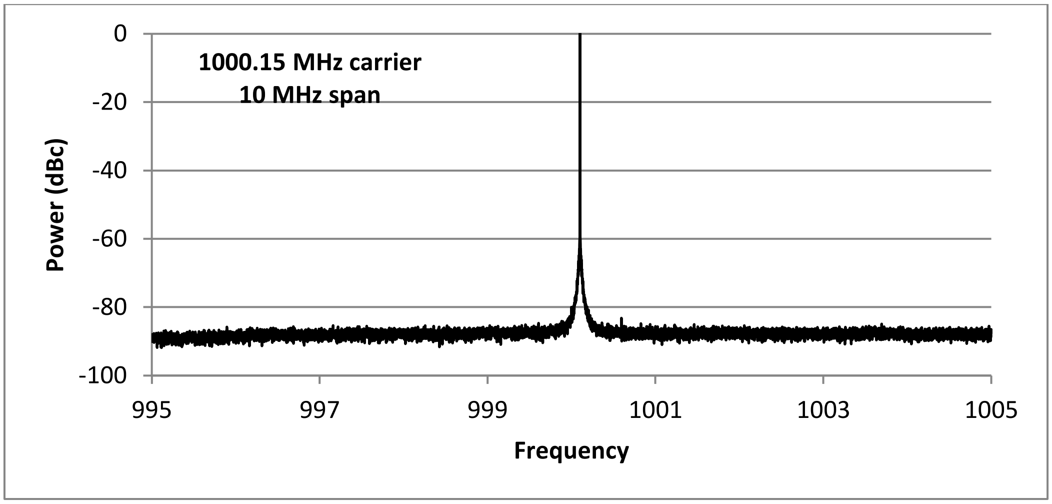

Figure 5. Spectrum showing low LO related spurious signals for an input signal of 1000.15 MHz.

[17] Spurious responses are unwanted signals appearing at the IF output. All spurious products are referenced to the RF input, meaning that they are treated as if they originate at the input port of the device.

[18] Residual spurious signals are observed and referenced to the RF input of the device when the RF input is terminated with a matched load. The RF attenuators are set to 0 dB attenuation and the final IF attenuators were adjusted to obtain an overall device gain of 20 dB. The preamplifier is disabled.

[19] LO related spurious signals are unwanted signals produced at the IF output due to intermodulation of the local oscillators. These spurious signals are measured relative to an RF signal present at the input. The specification referenced here is for a device configuration of -20 dBm at the mixer, 0 dBm at the IF output, and a total gain of 20 dB.

[20] Image rejection is the ability of the device to reject an image signal of the RF frequency that would otherwise produce the same result as the desired RF signal. The image of the desired RF signal is calculated as: $RF_{image} = RF + 2IF_1$, where $IF_1 = 3.625$ GHz.

[21] IF rejection is the ability of the device to reject RF signals at any of the IF frequencies while the device is tuned elsewhere. The signal level at the mixer is -20 dBm and total gain is 20 dB.

[22] For options with no 3rd IF filter, the harmonics can appear in the passband on the LPF.

Input noise density (15 °C to 30 °C ambient) [23]

Preamplifier disabled [24]

	100 MHz	1000 MHz	2000 MHz
Noise floor (dBm/Hz)	-153	-153	-150
Noise figure (dB)	21	21	24

Preamplifier enabled [25]

	100 MHz	1000 MHz	2000 MHz
Noise floor (dBm/Hz)	-170	-170	-168
Noise figure (dB)	4	4	6

TBD

Figure 6. Measured noise density of the average of two lots.

Input third-order intermodulation (IIP3, dBm) [26]

[23] Noise (thermal) is referred to the input of the device. In spectrum analyzer and signal analyzer applications this is also commonly referred to as the Displayed Average Noise Level (DANL). This assumes that the digitizer used does not limit the performance of the device.

[24] The device is configured with 0 dB RF attenuation and IF attenuators adjusted to set the gain to 20 dB. This setting is made to be consistent with the configuration for other specifications such as linearity and spurious responses so that the user may obtain a clearer picture of the specified performance of the device. The RF input is terminated with a matched 50 Ω load.

[25] The device is set to maximum gain: RF and IF attenuators set to 0 and RF preamplifier turned on.

	100 MHz – 1 GHz	1 GHz – 2 GHz	2 GHz – 2.5 GHz
Preamplifier disabled [27]	16 [17 typ]	16.5 [18 typ]	16 [17 typ]
Preamplifier enabled [28]	-3.0 [-2 typ]	-2.0 [-1 typ]	-2.0 [0 typ]

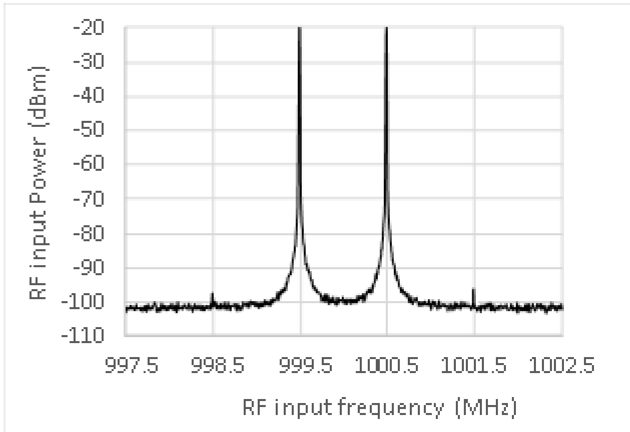

Figure 7. Plots show the typical IMD performance with two -20 dBm signals at the input, 0 dB RF attenuation, preamp disabled, gain of 20 dB, and IF frequency of 70 MHz.

Input second harmonic distortion (SHI, dBm)

Input second harmonic intercept point (dBm)	200 MHz	800 MHz	1.2 GHz
Preamplifier disabled	62	62	58
Preamplifier enabled	32	33	30

[26] These are in-band measurements and not out-of-band measurements. Out-of-band signal tones exist outside the IF filter bandwidth of the device, and thus may provide better IP3 measurements. However, using in-band signal tones provides better estimation of the device's non-linear effects on broadband signals.
[27] Specifications are based on 0 dB RF attenuation, 0 dB IF1 attenuation, two -20 dBm tones with 1 MHz separation at the mixer, and final IF attenuators set to maintain 0 dBm at the IF output. The IF frequency is set at 240 MHz.
[28] Specifications are based on 0 dB RF attenuation, 0 dB IF1 attenuation, two -30 dBm tones with 1 MHz separation at the mixer, and final IF attenuators set to maintain 0 dBm at the IF output. The IF frequency is set at 240 MHz.

Input compression point (dBm)

	100 MHz – 1.0 GHz	1.0 GHz – 2.0 GHz	2.0 GHz – 2.5 GHz
Preamplifier disabled (RF Atten = 0, Gain = 10)	> 7	> 8	> 7
Preamplifier enabled	-23	-20	-19

Dynamic range

Measurement dynamic range [29] .... > 185 dB

Instantaneous dynamic range [30] .... > 150 dB

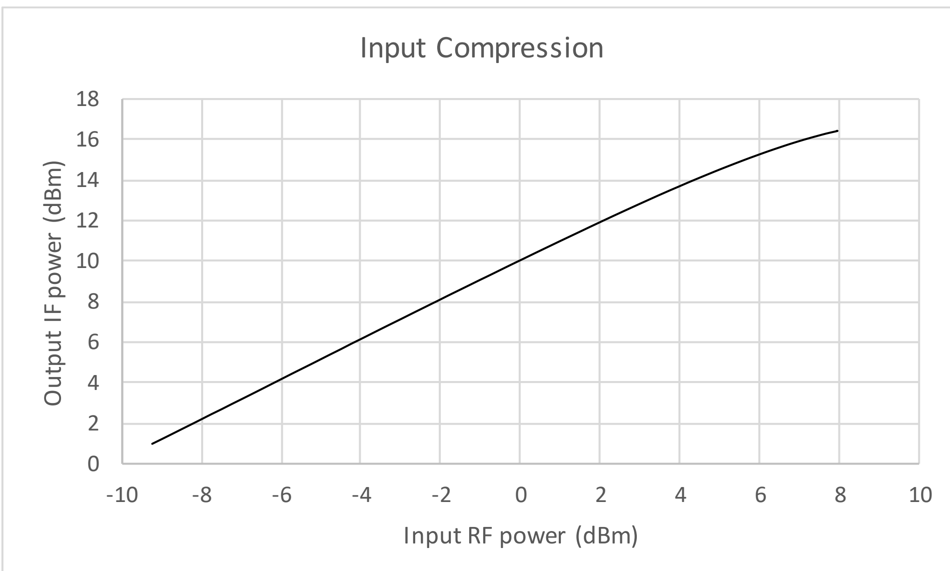

Figure 8. Output IF power vs Input RF power; RF =1 GHz, IF = 70 MHz, gain = 10 dB, RF Atten = 0 dB.

[29] Measurement dynamic range refers to the device SNR measurement capability using two or more configuration settings. For example, the user could set sufficient RF attenuation to capture the high level signals and then turn on the preamplifier to measure low level noise.

[30] Instantaneous dynamic range refers to the instantaneous device SNR measurement using a single configuration setting. For example, the user could set the downconverter to receive a 0 dBm signal at the mixer, while at the same setting be able to measure the signal noise floor to -150 dB below its peak.

Reference Input and Output Specifications

Reference output specifications

Center frequency [31] .... 10 MHz/100 MHz
Amplitude .... 3 dBm typ
Waveform .... Sine
Impedance .... 50 Ω nominal
Coupling .... AC
Connector type .... SMA female
Frequency accuracy .... See "Spectral Specifications" section

Reference input specifications

Center frequency .... 10 MHz
Amplitude .... -3 dBm min/ +10 dBm max
Phase-lock range .... ± 3 ppm (typ)
Impedance .... 50 Ω nominal
Coupling .... AC
Connector type .... SMA female

Port Specifications

RF input

Input impedance .... 50 Ω
Coupling .... AC
Connector type .... SMA female
LO leakage .... < -100 dBm

IF output

Output impedance .... 50 Ω
VSWR 1.6
Coupling .... AC
Connector type .... SMA female
Output amplitude .... 20 dBm max

[31] The output frequency may be selected programmatically for 10 MHz or 100 MHz.

General Specifications

Environmental

Operating temperature [32] .... 0 °C to +75 °C

Storage temperature .... -40 °C to +100 °C

Operating relative humidity .... 10% to 90%, non-condensing

Storage relative humidity .... 5% to 90%, non-condensing

Operating shock .... 30 g, half-sine pulse, 11 ms duration

Storage shock .... 50 g, half-sine pulse, 11 ms duration

Operating vibration .... 5 Hz to 500 Hz, 0.31 g_{rms}

Storage vibration .... 5 Hz to 500 Hz, 2.46 g_{rms}

Altitude .... 2,000 m maximum (maintaining 25 °C maximum ambient temperature)

Physical

Dimensions (W x H x D, max envelope) .... 3.7” x 1.4” x 6.1”

Weight .... 2.6 lbs

Input voltage .... 12 VDC

Power consumption .... 12 W typical

Communication interface .... PXIe/PXI, USB and RS-232/SPI

Safety .... Designed to meet the requirements of:

IEC 61010-1, EN 61010-1, UL 61010-1, CSA 61010-1

Electromagnetic Compatibility (EMC) .... Designed to meet the requirements of:

EN 61326-1 (IEC 61326-1): Class A emissions; Basic immunity 1, EN 55011 (CISPR 11) Group 1, Class A emissions, AS/NZS CISPR 11: Group 1, Class A emissions, FCC 47 CFR Part 15B: Class A emissions, ICES-001: Class A emissions

CE .... Meets the requirements of:

2006/95/EC; Electromagnetic Compatibility Directive (EMC Directive)

Warranty .... 3 years parts and labor on defects in materials or workmanship

[32] A user-provided cooling solution is required to keep the device less than 17 °C above the ambient temperature.

Revision Notes

Revision	Revision Date	Description
1.0	7/6/2018	Original document
2.0	8/11/2020	Updated picture Revised Definition of Terms Reformatted footnotes Removed Low Voltage Directive from CE requirements met