Introducing the new SG380 Series RF Signal Generators — finally, high performance, affordable RF sources.

The SG380 Series RF Signal Generators use a unique, innovative architecture (Rational Approximation Frequency Synthesis) to deliver ultra-high frequency resolution (1 µHz), excellent phase noise, and versatile modulation capabilities (AM, FM, ΦM, pulse modulation and sweeps) at a fraction of the cost of competing designs.

The standard models produce sine waves from DC to 2.025 GHz (SG382), 4.05 GHz (SG384) and 6.075 GHz (SG386). There is an optional frequency doubler (Opt. 02) that extends the frequency range of the SG384 and SG386 to 8.10 GHz. Low-jitter differential clock outputs (Opt. 01) are available, and an external I/Q modulation input (Opt. 03) is also offered. For demanding applications, the SG380 Series can be ordered with a rubidium timebase (Opt. 04).

On the Front Panel

The SG380 Series Signal Generators have two front-panel outputs with overlapping frequency ranges. A BNC provides outputs from DC to 62.5 MHz with adjustable offsets and amplitudes from 1 mV to 1 Vrms into a 50 Ω load. An N-type output supplies frequencies from 950 kHz to the upper frequency limit of each model, with power from +16.5 dBm to –110 dBm (1 Vrms to 0.707 µVrms) into a 50 Ω load.

SG380 Series RF Signal Generators

- DC to 2 GHz, 4 GHz or 6 GHz
- 1 µHz resolution
- AM, FM, ΦM, PM and sweeps
- OCXO timebase (std.)
- −116 dBc/Hz SSB phase noise (20 kHz offset, f = 1 GHz)
- Rubidium timebase (opt.)
- Square wave clock outputs (opt.)
- Analog I/Q inputs (opt.)
- Ethernet, GPIB, and RS-232

- SG382 ... $3,900 (U.S. list)
- SG384 ... $5,900 (U.S. list)
- SG386 ... $6,900 (U.S. list)
Modulation

The SG380 Signal Generators offer a wide variety of modulation capabilities. Modes include amplitude modulation (AM), frequency modulation (FM), phase modulation (ΦM), and pulse modulation. There is an internal modulation source as well as an external modulation input. The internal modulation source produces sine, ramp, saw, square, and noise waveforms. An external modulation signal may be applied to the rear-panel modulation input. The internal modulation generator is available as an output on the rear panel.

Unlike traditional analog signal generators, the SG380 Series can sweep continuously from DC to 62.5 MHz. And for frequencies above 62.5 MHz, each sweep range covers more than an octave.

OCXO or Rubidium Timebase

The SG380 Series come with a oven-controlled crystal oscillator (OCXO) timebase. The timebase uses a third-overtone stress-compensated 10 MHz resonator in a thermostatically controlled oven. The timebase provides very low phase noise and very low aging. An optional rubidium oscillator (Opt. 04) may be ordered to substantially reduce frequency aging and improve temperature stability.

The internal 10 MHz timebase (either the standard OCXO or the optional rubidium reference) is available on a rear-panel output. An external 10 MHz timebase reference may be supplied to the rear-panel timebase input.

Square Wave Clock Outputs

Optional differential clock outputs (Opt. 01) are available on the rear panel which makes your SG380 a precision clock.
generator in addition to a signal generator. Transition times are typically 35 ps, and both the offset and amplitude of the clock outputs can be adjusted for compliance with PECL, ECL, RSECL, LVDS, CML, and NIM levels.

I/Q Inputs

Optional I/Q inputs (Opt. 03) allow I & Q baseband signals to modulate carriers from 400 MHz to the upper frequency limit of your instrument. This option also allows the I/Q modulator to be driven by an internal noise generator with adjustable bandwidth. Rear-panel outputs allow the noise source to be viewed or used for other purposes.

Output Frequency Doubler

The SG384 and SG386 can be ordered with a frequency doubler (Opt. 02) that extends the frequency range to 8.10 GHz. The amplitude of the rear-panel RF output can be adjusted from –10 dBm to +13 dBm. This option also comes with a bias source output which can be set with 5 mV resolution over ±10 VDC.

Easy Communication

Remote operation is supported with GPIB, RS-232 and Ethernet interfaces. All instrument functions can be controlled and read over any of the interfaces. Up to nine instrument configurations can be saved in non-volatile memory.

A New Frequency Synthesis Technique

The SG380 Series Signal Generators are based on a new frequency synthesis technique called Rational Approximation Frequency Synthesis (RAFS). RAFS uses small integer divisors in a conventional phase-locked loop (PLL) to synthesize a frequency that would be close to the desired frequency (typically within ±100 ppm) using the nominal PLL reference frequency. The PLL reference frequency, which is sourced by a voltage controlled crystal oscillator that is phase locked to a dithered direct digital synthesizer, is adjusted so that the PLL generates the exact frequency. Doing so provides a high phase comparison frequency (typically 25 MHz) yielding low phase noise while moving the PLL reference spurs far from the carrier where they can be easily removed. The end result is an agile RF source with low phase noise, essentially infinite frequency resolution, without the spurs of fractional-N synthesis or the cost of a YIG oscillator.

The SG380 Series outputs exhibit low phase noise and low spurious content. In this direct measurement taken with 100 Hz RBW, the noise floor of the spectrum analyzer dominates over most of the 200 kHz span.

Outputs below 62.5 MHz are generated by direct-digital synthesis with a sample frequency of 1 GHz. In this example, a 50 MHz carrier is frequency modulated at a rate of 10 kHz and a deviation of 24.0477 kHz, for a modulation index $\beta = 2.40477$. The carrier amplitude is proportional to the Bessel function $J_0(\beta)$, which has its first zero at 2.40477.
The polar plot shows the trajectory of a signal in the I/Q plane. An unmodulated carrier at the analyzer’s reference frequency (1 GHz in this case) appears as a single dot in the I/Q plane. When the carrier frequency is offset, the single dot moves in a circle about the center of the I/Q plane. The pattern shown occurs when the carrier amplitude is modulated with 100 % depth at a rate of five times the carrier offset frequency (creating five lobes). The symmetry of the lobes indicates that there is no residual phase distortion (AM to FM conversion) in the amplitude modulator. The narrow line of the trajectory is indicative of low phase and amplitude noise.

**Ordering Information**

<table>
<thead>
<tr>
<th>Model</th>
<th>Description</th>
<th>Price</th>
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</thead>
<tbody>
<tr>
<td>SG382</td>
<td>2 GHz signal generator</td>
<td>$3,900</td>
</tr>
<tr>
<td>SG384</td>
<td>4 GHz signal generator</td>
<td>$5,900</td>
</tr>
<tr>
<td>SG386</td>
<td>6 GHz signal generator</td>
<td>$6,900</td>
</tr>
<tr>
<td>Option 01</td>
<td>Rear-panel clock outputs</td>
<td>$750</td>
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<tr>
<td>Option 02</td>
<td>8 GHz doubler &amp; DC bias</td>
<td>$750</td>
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<td></td>
<td>(SG384 and SG386 only)</td>
<td></td>
</tr>
<tr>
<td>Option 03</td>
<td>External I/Q modulation</td>
<td>$750</td>
</tr>
<tr>
<td>Option 04</td>
<td>Rubidium timebase</td>
<td>$1750</td>
</tr>
<tr>
<td>RM2U-S</td>
<td>Single rack mount kit</td>
<td>$100</td>
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<tr>
<td>RM2U-D</td>
<td>Dual rack mount kit</td>
<td>$100</td>
</tr>
</tbody>
</table>

*SG384 rear panel*  
*SG384 front panel*
SG380 Series Specifications

Frequency Setting

Frequency ranges  
SG382  DC to 62.5 MHz (BNC output, all models)  
SG382  950 kHz to 2.025 GHz (N-type output)  
SG384  950 kHz to 4.050 GHz (N-type output)  
SG386  950 kHz to 6.075 GHz (N-type output)

Power output  
SG382  +16.5 dBm to -110 dBm  
SG384  +16.5 dBm to -110 dBm (<3 GHz)  
SG386  +16.5 dBm to -110 dBm (<4 GHz)

Voltage output  
SG382  1.5 Vrms to 0.7 μVrms  
SG384  1.5 Vrms to 0.7 μVrms (<3 GHz)  
SG386  1.5 Vrms to 0.7 μVrms (<4 GHz)

Power resolution  0.01 dBm

Power accuracy  ±1 dB

Output coupling  AC, 50 Ω

User load  50 Ω

VSWR  <1.6

Reverse protection  30 VDC, +25 dBm RF

Spectral Purity of the RF Output Referenced to 1 GHz*

Sub harmonics  None

Harmonics  <-25 dBc (<-7 dBm, N-type output)

Spurious  
<10 kHz offset  <-65 dBc

>10 kHz offset  <-75 dBc

Phase noise (typ.)  
10 Hz offset  <-80 dBc/Hz

1 kHz offset  <-102 dBc/Hz

20 kHz offset  -116 dBc/Hz (SG382 & SG384)  
-114 dBc/Hz (SG386)

1 MHz offset  -130 dBc/Hz (SG382 & SG384)  
-124 dBc/Hz (SG386)

Residual FM (typ.)  1 Hz rms (300 Hz to 3 kHz BW)

Residual AM (typ.)  0.006% rms (300 Hz to 3 kHz BW)

* Spurs, phase noise and residual FM scale by 6 dB/octave to other carrier frequencies

Phase Setting on Front-Panel Outputs

Max. phase step  ±360°

Phase resolution  0.01° (DC to 100 MHz)

0.1° (100 MHz to 1 GHz)

1.0° (1 GHz to 8.1 GHz)

Standard OCXO Timebase

Oscillator type  Oven controlled, 3rd OT, SC-cut crystal

Stability (0 to 45°C)  <±0.002 ppm

Aging  <±0.001 ppm/year

Rubidium Timebase (Opt. 04)

Oscillator type  Oven controlled, 3rd OT, SC-cut crystal

Physics package  Rb vapor frequency discriminator

Stability (0 to 45°C)  <±0.0001 ppm

Aging  <±0.001 ppm/year

Timebase Input

Frequency  10 MHz, ±2 ppm

Amplitude  0.5 to 4 Vpp (–2 dBm to +16 dBm)

Input impedance  50 Ω, AC coupled

Timebase Output

Frequency  10 MHz, sine

Source  50 Ω, DC transformer coupled

Amplitude  1.75 Vpp ±10% (8.8 dBm ±1 dBm)

Internal Modulation Source

Waveforms  Sine, ramp, saw, square, pulse, noise

Sine THD  <–80 dBc (typ. at 20 kHz)

Ramp linearity  <0.05% (1 kHz)

Rate  1 µHz to 500 kHz

(f_c ≤ 62.5 MHz (SG382 & SG384))

(f_c ≤ 93.75 MHz (SG386))

1 µHz to 50 kHz

(f_c > 62.5 MHz (SG382 & SG384))

(f_c > 93.75 MHz (SG386))

Rate resolution  1 µHz

Rate error  1.211 + timebase error

Noise function  White Gaussian noise (rms = dev / 5)

Noise bandwidth  1 µHz < ENBW < 50 kHz

Pulse generator period  1 µs to 10 s
SG380 Series Specifications

Pulse generator width 100 ns to 9999.9999 ms
Pulse timing resolution 5 ns
Pulse noise function PRBS 2^3 – 2^19. Bit period (100 + 5N) ns

Modulation Waveform Output

Output impedance 50 Ω (for reverse termination)
User load Unterminated 50 Ω coax
AM, FM, ΦM ±1 V for ± full deviation
Pulse/Blank “Low” = 0 V, “High” = 3.3 VDC

Maximum (SG386) 4.050 MHz
Minimum 0.1 MHz (f_c = 1 kHz)
Deviation source Internal or external
Deviation distortion <–60 dB (f_c = 100 MHz, f_m = f_d = 1 kHz)
Ext. FM carrier offset <1:1,000 of deviation
Modulation bandwidth 500 kHz

AM, FM, Pulse/Blank threshold +1
Input offset <500 µV
Modulation bandwidth >100 kHz

Amplitude Modulation

Range 0 to 100 % (decreases above +7 dBm)
Resolution 0.1 %
Modulation source Internal or external
Modulation distortion BNC output <1 % (f_c < 62.5 MHz, f_m = 1 kHz)
N-type output <3 % (f_c > 62.5 MHz, f_m = 1 kHz)
Modulation bandwidth >100 kHz

Frequency Modulation

Frequency deviation Minimum 0.1 Hz
Maximum (SG382 & SG384)

62.5 MHz to 126.5625 MHz
126.5625 MHz to 253.125 MHz
253.125 MHz to 506.25 MHz
506.25 MHz to 1.0125 GHz
1.0125 GHz to 2.025 GHz
2.025 GHz to 4.050 GHz (SG384)
4.050 GHz to 8.100 GHz (opt. 2)

Maximum (SG386)

93.75 MHz to 189.0625 MHz
189.0625 MHz to 379.6875 MHz
379.6875 MHz to 759.375 MHz
759.375 MHz to 1518.75 MHz
1518.75 MHz to 3037.5 GHz
3037.5 GHz to 6075 MHz
6075 MHz to 12150 MHz (opt. 2)

Deviation resolution 0.1 Hz

Frequency Sweeps (Phase Continuous)

Frequency span 10 Hz to entire sweep range
Sweep ranges

SG382 & SG384 DC to 64 MHz
59.375 MHz to 128.125 MHz
118.75 MHz to 256.25 MHz
237.5 MHz to 512.5 MHz
475 MHz to 1025 MHz
950 MHz to 2050 MHz
1900 MHz to 4100 MHz (SG384)
3800 MHz to 8200 MHz (Opt. 02)

SG386 DC to 96 MHz
89.0625 MHz to 192.188 MHz
178.125 MHz to 384.375 MHz
356.25 MHz to 768.75 MHz
712.5 MHz to 1537.5 MHz
1425 MHz to 3075 MHz
2850 MHz to 6150 MHz
5950 MHz to 8150 MHz (Opt. 02)

Deviation source Internal or external
Deviation distortion <0.1 Hz + (deviation / 1,000)
Deviation offset <1:1,000 of deviation
Deviation function Triangle, ramp or sine up to 120 Hz

Phase Modulation

Deviation 0 to 360°
Deviation resolution 0.01° to 100 MHz, 0.1° to 1 GHz
1° above 1 GHz
Deviation accuracy <0.1 %

Modulation source Internal or external
Modulation distortion <–60 dB (f_c = 100 MHz, f_m = f_d = 1 kHz)
Modulation bandwidth 500 kHz

SG382 & SG384 (f_c ≤ 62.5 MHz (SG382 & SG384))
(f_c ≤ 93.75 MHz (SG386))
SG386 (f_c > 62.5 MHz (SG382 & SG384))
(f_c > 93.75 MHz (SG386))
**SG380 Series Specifications**

### Pulse/Blank Modulation

- **Pulse mode**: Logic “High” turns RF “on”
- **Blank mode**: Logic “High” turns RF “off”
- **On/Off ratio**
  - BNC output: 70 dB
  - Type-N output: 40 dB (1 GHz ≤ $f_c$ < 4 GHz), 35 dB ($f_c$ ≥ 4 GHz)
- **Pulse feed-through**: 10% of carrier for 20 ns at turn on (typ.)
- **Turn on/off delay**: 60 ns
- **RF rise/fall time**: 20 ns
- **Modulation source**: Internal or external pulse

### Frequency Doubler Output (Opt. 02)

- **Output**: Rear-panel SMA
- **Frequency range**: 4.05 GHz to 8.10 GHz (SG384), 6.075 GHz to 8.10 GHz (SG386)
- **RF amplitude**: –10 dBm to +13 dBm (4 GHz to 7 GHz), –10 dBm to +7 dBm (7 GHz to 8 GHz), +13 to +16.5 dBm (typ.)
- **Sub harmonic ($f_c/2$)**: <–25 dBc ($f_c$ < 6.5 GHz), <–12 dBc ($f_c$ < 8.1 GHz)
- **Mixing products (3$f_c$/2)**: <–20 dBc
- **Harmonics (n × $f_c$)**: <–25 dBc
- **Spurious (8 GHz)**: <–55 dBc (>10 kHz offset)
- **Phase noise (8 GHz)**: –98 dBc/Hz at 20 kHz offset (typ.)
- **Amplitude resolution**: 0.01 dBm
- **Amplitude accuracy**: ±1 dB (4.05 GHz to 6.5 GHz), ±2 dB (6.5 GHz to 8.1 GHz)
- **Modulation modes**: FM, ΦM, sweeps
- **Output coupling**: AC, 50 Ω
- **Reverse protection**: 30 VDC, +25 dBm RF

### DC Bias Source (comes with Opt. 02)

- **Output**: Rear-panel SMA
- **Voltage range**: ±10 V
- **Offset voltage**: <20 mV
- **DC accuracy**: ±0.2 %
- **DC resolution**: 5 mV
- **Output resistance**: 50 Ω
- **Current limit**: 20 mA

### General

- **Ethernet (LAN)**: 10/100 Base-T.TCP/IP & DHCP default
- **GPIB**: IEEE488.2
- **RS-232**: 4800 to 115,200 baud, RTS/CTS flow
- **Line power**: <90 W, 90 to 264 VAC, 47 to 63 Hz (with PFC)
- **Dimensions, weight**: 8.5“ × 3.5“ × 13” (WHD)
- **Weight**: 10 lbs.
- **Warranty**: One year parts and labor on defects in materials and workmanship

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**External I/Q Modulation (Opt. 03)**

- **Carrier frequency range**: 400 MHz to 2.025 GHz (SG382), 400 MHz to 4.05 GHz (SG384), 400 MHz to 6.075 GHz (SG386)
- **Modulated output**: Front-panel N-type only
- **I/Q inputs**
  - 50 Ω, ±0.5 V
  - <500 μV
- **I/Q full scale**: $(I^2 + Q^2)^{1/2} = 0.5$ V
- **Carrier suppression**: >40 dBc (>35 dBc above 4 GHz)
- **Modulation bandwidth**: 200 MHz (~3 dB)

### Square Wave Clock Outputs (Opt. 01)

- **Differential clocks**: Rear-panel SMAs drive 50 Ω loads
- **Frequency range**: DC to 4.05 GHz
- **Transition time (typ.)**: <35 ps (20% to 80%)
- **Jitter**
  - $f_c$ > 62.5 MHz: <300 fs rms (typ., 1 kHz to 5 MHz BW at 1 GHz)
  - $f_c$ ≤ 62.5 MHz: <10⁻⁴ U.L. (1 kHz to 5 MHz or $f_c/2$ BW)
- **Amplitude**: 0.4 Vpp to 1 Vpp
- **Offset**: ±2 VDC
- **Ampl/offset resolution**: 5 mV
- **Ampl/offset accuracy**: ±5 %
- **Output coupling**: DC, 50 Ω ±2 %
- **Compliance**: ECL, PECL, RSECL, CML, LVDS, NIM