

SpikeStrip™

PROGRAMMABLE MICROWAVE FREQUENCY COMB GENERATOR

Status:
SAMPLING

GENERAL DESCRIPTION

SpikeStrip™ is a CMOS multi-tone oscillator-based comb generator distinguished by wide programmability of comb bandwidth, spectral envelope, and line spacing. Comb bandwidth is tunable from 1 MHz to 15 GHz, with line spacing programmable from 100 kHz to 1 GHz. SpikeStrip™ requires no external microwave source, is programmed using sub-800 MHz control sequences, and consumes less than 50 mW DC power. These capabilities enable secure frequency-hopping spread-spectrum (FHSS) communications, controlled jamming, RF calibration, and broadband spectrum synthesis.

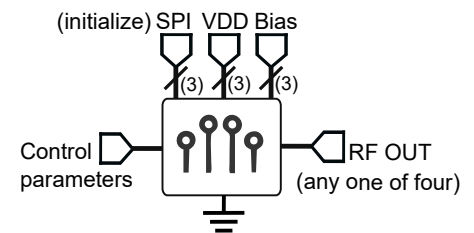
FEATURES

- 1 MHz to 15 GHz tunable bandwidth
- 100 kHz to 1 GHz tunable line spacing
- Tunable comb envelope shape
- < 800 MHz comb tuning parameters
- 40 mW DC power consumption
- Temperature compensation bias input; Characterized range: 25°C to 100°C

TYPICAL APPLICATIONS

- Frequency comb-line generator
- Spread-spectrum communication
- Controlled jamming
- RF system calibration
- Broadband spectrum synthesis

FUNCTIONAL DIAGRAM



Electrical Specifications, $T_A = 25^\circ\text{C}$

Parameter		Minimum	Typical	Maximum	Units
Comb bandwidth		0.001	—	15	GHz
Comb center frequency		10.1	—	11.2	GHz
Comb-line spacing		0.001	—	1	GHz
RF power per comb-line		-70	—	-10	dBm
Control parameters	Sequence	2	8 to 16	100	bits
	Amplitude	0	0.75	1.5	V
	DC offset	-1	0.75	1	V
	Bit-speed	0	150	800	MHz
RF core supply current		30	59	85	mA
RF core supply voltage		0.4	0.6	0.7	V
Nonlinearity bias voltage (V_C)		0	1	1.4	V

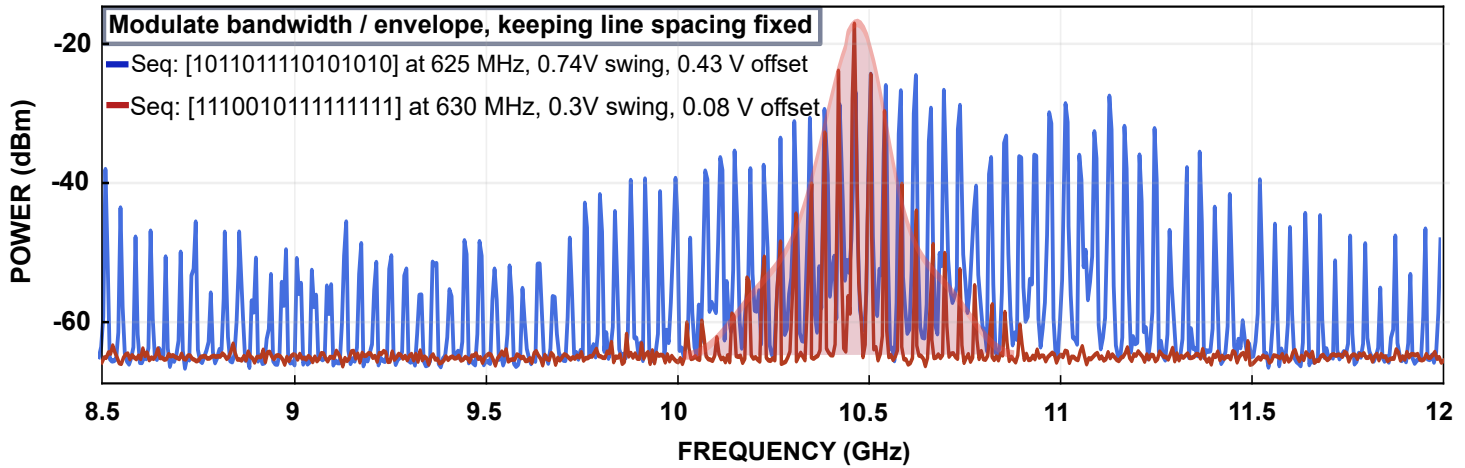
Unless otherwise noted, specifications are characterized values and are not production-tested.

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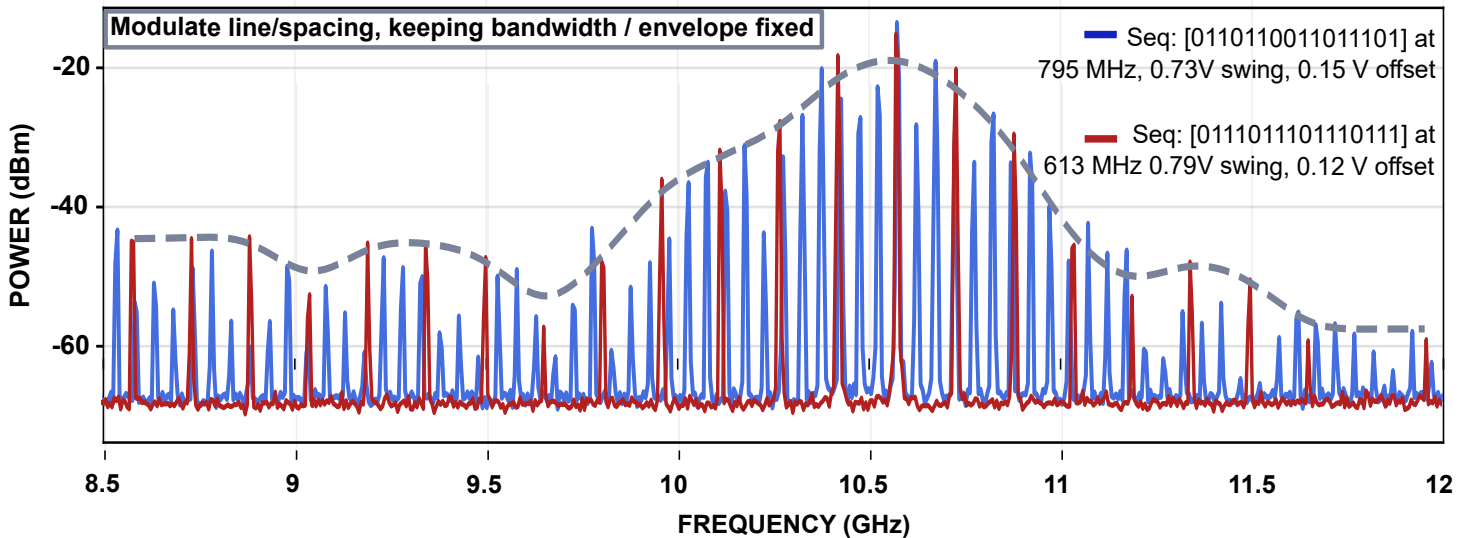
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COMB BANDWIDTH PROGRAMMABILITY ($V_{DD_{core}} = 0.6 \text{ V}$, $T_A = 25 \text{ }^{\circ}\text{C}$)



COMB LINE-SPACING PROGRAMMABILITY ($V_{DD_{core}} = 0.6 \text{ V}$, $T_A = 25 \text{ }^{\circ}\text{C}$)



DEVICE INITIALIZATION AND COMB PROGRAMMING

- Power-up.** Apply the specified RF-core and control supplies and allow them to settle.
- Initialize through SPI.** Apply the provided initialization bitstream through CLK, LOAD and DATA to configure the device.
- Apply comb-control parameters.** Set the desired sequence, cycling frequency, voltage swing, and DC offset to control comb bandwidth, line spacing, and spectral envelope. No embedded firmware is required.
- Parameter-input interface.** The input is analog-compatible. Characterization uses digitally cycled bit sequences from a 50 Ω source.

NOTE: SPI is used for device initialization; normal comb reconfiguration is performed through the parameter input and does not require reloading the SPI configuration. Parameter sequences may be changed dynamically to reconfigure the output spectrum.

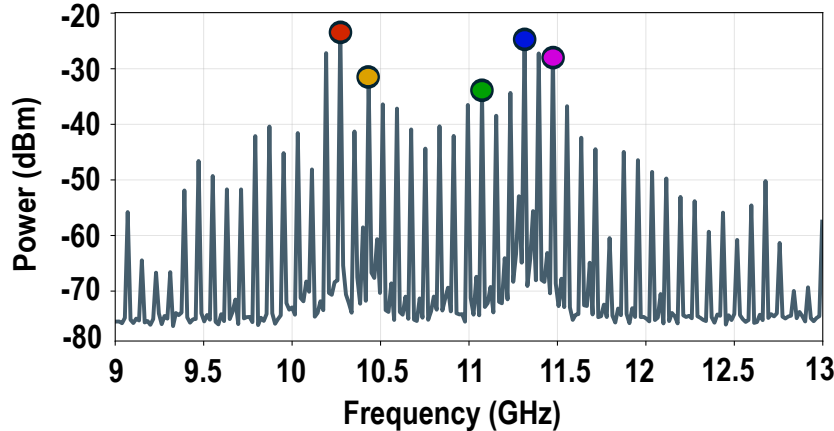
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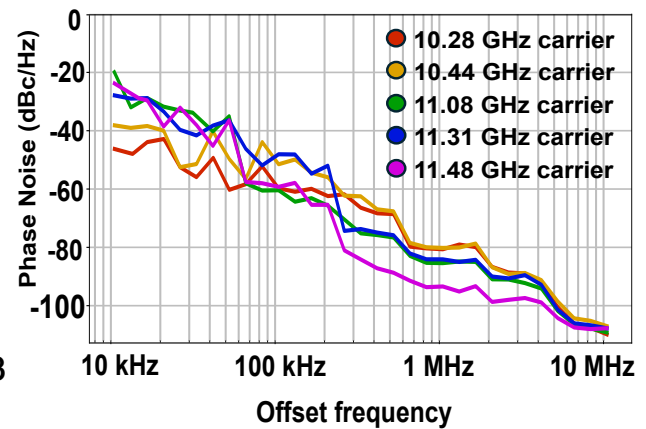
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FREE-RUNNING COMB PHASE NOISE (NO PLL)

Example comb spectrum (with control sequence: [1111000011] cycled at 400 MHz with 0.75 V swing, 1 V DC offset)



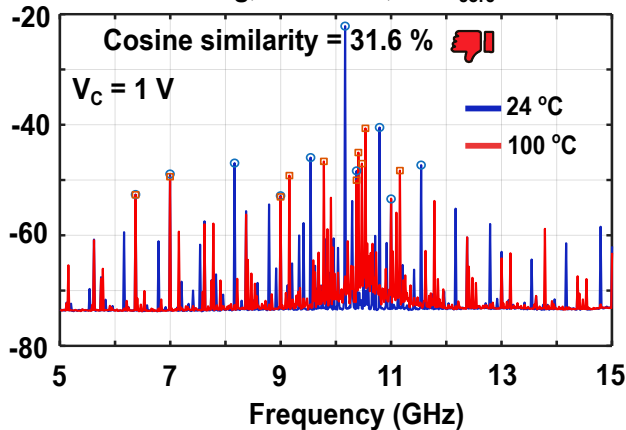
Phase Noise measured for five free-running comb-line carriers



COMB TEMPERATURE COMPENSATION ($V_{DD_{core}} = 0.6 \text{ V}$, $T_A = 25\text{--}100^\circ\text{C}$)

Spectrum impaired by high temperature

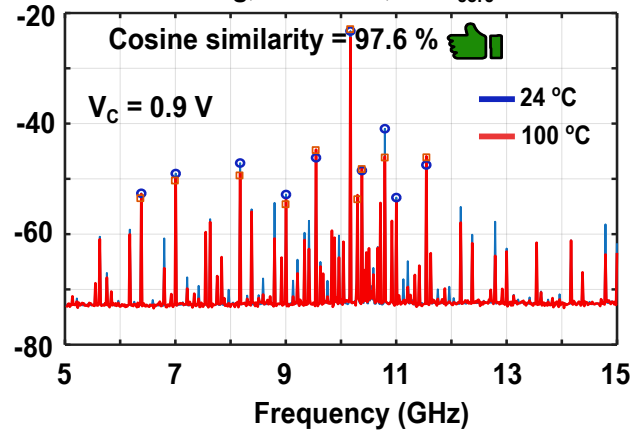
Control sequence: [1010101010]
at 0.75 V swing, 1 V offset, $V_{DD_{core}} = 0.65 \text{ V}$



Apply
Temperature-
Compensation
Bias (V_C)

Target spectrum regained

Control sequence: [1010101010]
at 0.75 V swing, 1 V offset, $V_{DD_{core}} = 0.65 \text{ V}$



TEMPERATURE COMPENSATION

- 1. Establish reference.** At startup, measure comb-line powers at selected reference frequencies.
- 2. Measure temperature.** Monitor the device temperature during operation.
- 3. Apply preset bias.** Select the pre-characterized V_C corresponding to the measured temperature.
- 4. Compare spectrum.** Compare measured comb-line powers with the startup reference values.
- 5. Fine-tune V_C .** Adjust V_C to minimize spectral error and recover the target comb spectrum; repeat as temperature changes.

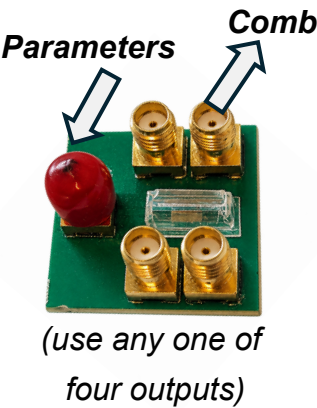
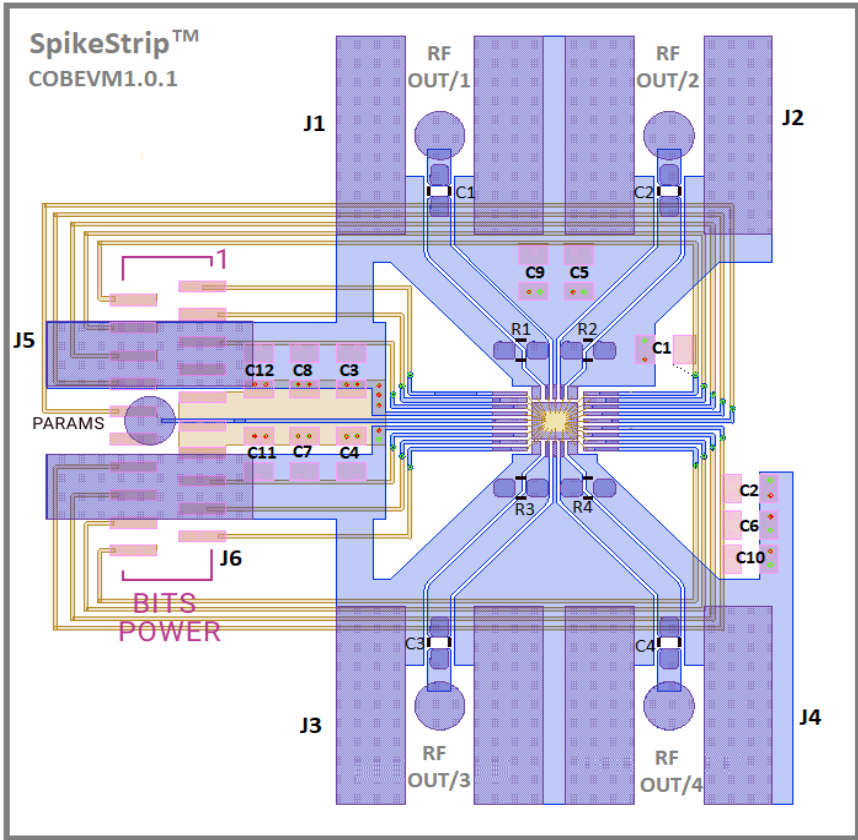
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Evaluation PCB



Bill of Materials for Evaluation PCB COBEVM1.0.1 ^[1]

Item	Description
J1 - J5	PCB Vertical SMA or MMBX RF connector
J6	20 pin, 0.5 mm pitch FPC jack for SPI, power
R1-R4	50 ohm resistors
C1-C4	1000 pF Capacitor, 0402 Pkg.
C5-C8	0.1 uF Capacitor, 0402 Pkg.
C9-C12	1 uF Capacitor, 0402 Pkg.

[1] PCB material: Rogers 4350

The chip-on-board design should use microwave circuit design techniques. The comb generator chip is wirebonded directly to pads on the PCB. Signal lines should have 50 Ohm impedance while the package groundleads should be connected directly to the overall ground plane of the SPI and parameter-feeding equipment. A sufficient number of via holes should be used to connect the top and bottom ground planes. The evaluation circuit board shown is available from Sentinel Semiconductor upon request.

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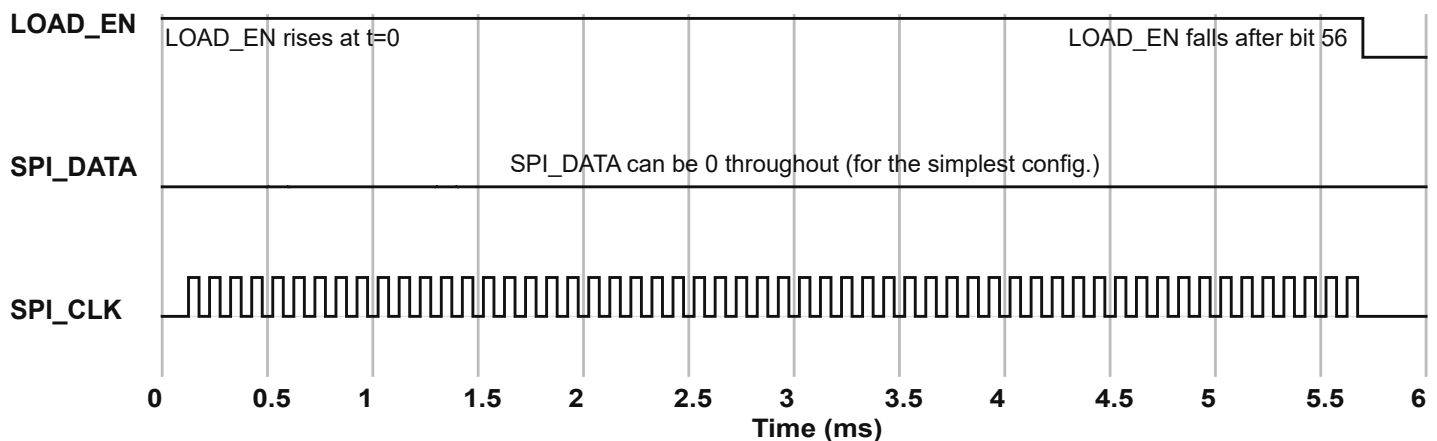
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Pin descriptions for J6 FPC Header

Pin	Description
1	Bandwidth fine-tuning. Range: 0 V to 1 V. Optional (it can be left floating)
2	SPI data buffer voltage. Set to 1.5 V. Min: 1.3 V, Max: 1.8 V
3, 17, 18, 19	Temperature Compensation Bias $V_{NL,1}$. Nominal: 1 V
4,20	SPI_CLK_OUT, SPI_DATA_OUT: Optional (they can be left floating)
5, 15	VDD_{core} : Comb oscillator supply voltage. Min: 0.4 V, Max: 0.8 V. Set to 0.6 V
7, 12	N/C: Not connected
6	SPI_RESET. For simplest config, connect to 1 V.
8	SPI_DATA: Loads data into on-chip registers to initialize comb
9,11,13	GND
10	SPI_CLK: Clock for SPI
14	VDD for SPI logic. Set to 1 V
16	LOAD_EN: Enable signal to load data into on-chip registers to initialize comb

Suggested SPI signals transmitted for comb initialization



Frame: 00001000 00001000 00000000 00000000 00000000 00000000 00000000

CLK = 10 kHz, rising-edge sample, MSB first

100 μ s DATA delay