

SMT Wideband MMIC VCOs Tune from 4 to 12.5 GHz

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This issue's cover features a new fully-integrated VCO product line offering low phase noise, in 4x4 mm RoHS compliant packages

Whether based on analog or digital modulation, all microwave communication systems require a local oscillator signal source in order to impress

information onto an RF carrier. The amount of data which can be carried by a modulated RF signal of fixed bandwidth is directly related to the quality of the local oscillator signal source. There are many different architectures in use, but one of the most common methods of generating a local oscillator source is a phase locked loop (PLL) frequency source that locks the sampled output of a voltage controlled oscillator (VCO) with the output of a low phase noise reference oscillator. The output signal of the phase locked VCO can then be multiplied and amplified as required in order to drive each of the RF conversion elements within the system such as mixers, modulators and demodulators.

New VCO Family

A new family of frequency generation products is now available from Hittite Microwave, which allows designers to reach new levels of integration and space efficiency. Hittite has developed an innovative technique for producing VCOs which offer wide tuning bandwidth coupled with consistent output power, very fast modulation bandwidths, low DC power consumption, and low single sideband (SSB) phase noise. This new line of MMIC-based wideband VCOs complements the company's broad line of MMIC-based LO generation and distribution components.

Many different VCO topologies can work



Figure 1 - Photograph of the HMC588LC4B Wideband VCO in a 4 x 4 mm SMT package, mounted to a PC board.

well in narrow band radio transceivers which require less than 10 percent tuning bandwidth; however, other applications such as industrial/medical test and measurement equipment, military communications, electronic warfare (EW), and electronic countermeasures (ECM) can require frequency generation sources which provide up to and beyond one octave bandwidth. Until now, RF designers seeking to produce a high quality, wideband reference frequency source have been forced to use topologies which either switch between multiple sources tuned for different frequencies, or use other complicated techniques to artificially extend the bandwidth of an inherently narrow band source.

This new VCO family is introduced with three devices. The HMC586LC4B is a 4 to 8 GHz VCO that exhibits a very low SSB phase noise of -105 dBc/Hz at 100 kHz offset and delivers +5 dBm of output power with ± 1.0 dB

WIDEBAND VCOs

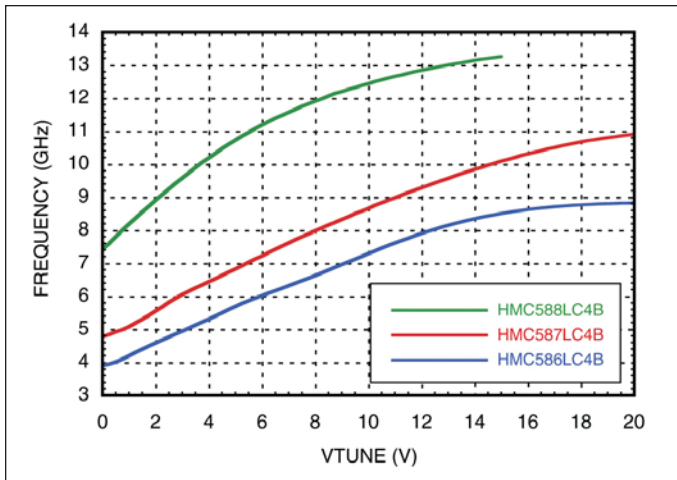


Figure 2 · Output frequency vs. tuning voltage for the HMC586LC4B, HMC587LC4B, and HMC588LC4B wideband VCOs.

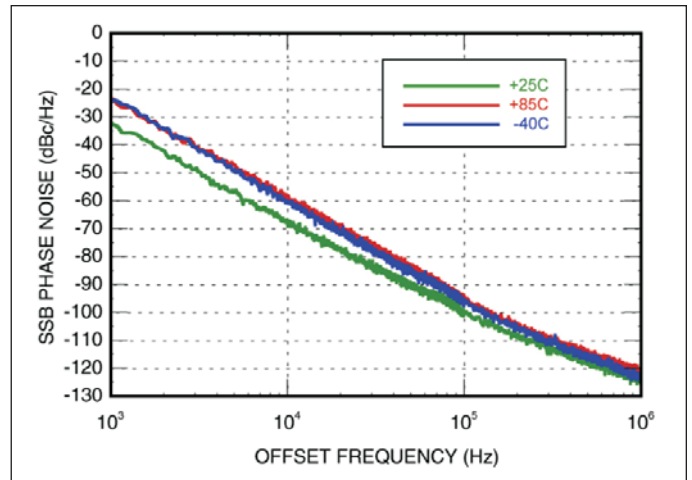


Figure 3 · HMC588LC4B wideband VCO SSB phase noise vs. temperature plot ($f_{out} = 12.5$ GHz).

variation across the entire tuning bandwidth. The HMC587LC4B is a 5 to 10 GHz VCO with an output power of +5 dBm and -98 dBc/Hz SSB phase noise at 100 kHz offset. Finally, the HMC588LC4B is an 8.0 to 12.5 GHz VCO which delivers a very low SSB phase noise of -93 dBc/Hz at 100 kHz offset and high output power of +5 dBm.

These fully integrated wide tuning bandwidth VCOs incorporate the resonator, negative resistance device, and the varactor diode in a single package. Output power and phase noise performance are excellent over temperature due to the monolithic construction. Power output is very consistent versus frequency, with typically ± 0.5 dB of variation across the output tuning bandwidth. The V_{tune} port of these wideband VCOs accepts a single positive analog tuning voltage between 0V and +20V, and accommodates very fast modulation

with bandwidths of up to 65 MHz.

Hittite wideband VCOs uniquely combine the attributes of low phase noise, low power consumption, and ultra small size, making them ideal for numerous small form factor applications including industrial/medical test and measurement equipment and military communications, electronic warfare (EW), and electronic countermeasures (ECM). Compared to discrete hybrid VCOs, Hittite's integrated MMIC VCOs help designers achieve their goals for high reliability, low power consumption, small size, and consistent performance. For example, the HMC586LC4B, which requires no external matching or tuning components, has an ultra small PCB footprint of 16 mm^2 , and consumes less than 300 mW of power. A competing hybrid VCO with similar tuning range consumes 1300 mW, and occupies 130 mm^2 of PC board area. Lower power consumption means

that minimal heat sinking is required, while reduced footprint area means that designers can dramatically shrink their oscillator designs; both advantages lead to lower cost and quicker time to market.

Hybrid-based VCOs typically employ a fiberglass-based substrate material such as FR4, and a stamped metal cover. This assembly technique can create problems in users' systems, including unwanted coupling effects and challenges related to RF grounding. Each of Hittite's wideband VCOs are housed in industry standard SMT compatible ceramic 4×4 mm QFN leadless packages which are inherently RoHS compliant and are very familiar in high speed, high volume SMT lines. Also, all three VCOs employ an identical package pinout, facilitating a common PCB approach.

Operating temperatures can play a crucial role in the performance of

Frequency (GHz)	Tuning Voltage (V)	Output Power (dBm)	10 kHz SSB Phase Noise (dBc/Hz)	100 kHz SSB Phase Noise (dBc/Hz)	Tuning Port Bandwidth (MHz)	Bias Supply	Part Number
4 - 8	0 to +20	+5	-75	-105	30	+5V@55mA	HMC586LC4B
5 - 10	0 to +20	+5	-73	-98	30	+5V@55mA	HMC587LC4B
8 - 12.5	0 to +15	+5	-63	-93	65	+5V@55mA	HMC588LC4B

Table 1 · HMC586LC4B, HMC587LC4B and HMC588LC4B VCO product line performance summary.

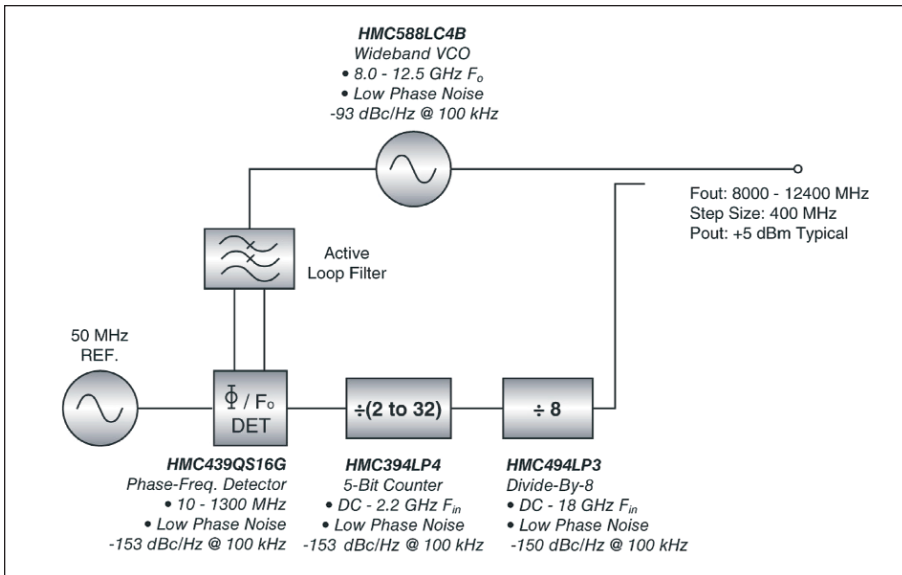


Figure 4 · An example of a wideband phase locked oscillator based on the HMC588LC4B Wideband MMIC VCO.

the VCO as well. Hittite wideband VCOs are rated for operation over the full commercial operating temperature range of -40°C to $+85^{\circ}\text{C}$, and custom test screening is available for wider operating temperatures, as well as customer specific min/max specification requirements. Hybrid VCOs based on fiberglass substrates and stamped metal covers are subject to parasitic effects which degrade performance over such wide temperature ranges.

Figure 4 illustrates an example of how the HMC588LC4B wideband VCO, the HMC494LP3 divide-by-8, the HMC394LP4 5-bit counter, and the HMC439QS16G phase-frequency detector can be used to quickly fabricate an all SMT, wideband PLL with +5 dBm of output power, very low SSB phase noise, and a 400 MHz step size.

As shown in the example, the coupled output of the HMC588LC4B is divided by a factor of 160 to 248, using the combination of the HMC494LP3 GaAs HBT fixed modulus divider, and the HMC394LP4 GaAs HBT programmable 5-bit counter. The HMC439QS16G phase frequency detector is used to phase

lock the output of the HMC394LP4, with that of an external 50 MHz reference oscillator. In the example shown, the HMC394LP4 5-bit counter is stepped through integer values from 20 to 31, in order to achieve the 400 MHz PLL step size.

Hittite's MMIC VCOs provide second harmonic rejection from -15 to -20 dBc, while sub-harmonic and spurious outputs are nonexistent. Such spectral purity allows designers to avoid having to use costly filtering approaches in order to meet system

spurious requirements.

Hittite Microwave is well known for providing high performance frequency generation and distribution products including: dividers, multipliers, dynamic prescalers, VCOs, phase locked oscillators (PLOs) and complete synthesizers. More than 50 standard products are available from Hittite which can be utilized in signal generation loops from DC to 80 GHz. Standard VCO products are based on a mature InGaP HBT MMIC process which delivers high output power and low single sideband phase noise, with relatively low DC power consumption. In addition, Hittite has developed hundreds of custom VCOs to meet application specific requirements.

Designers can choose from more than 376 standard products offered by Hittite including modulators, phase shifters, attenuators, gain block amplifiers and switches. Data sheets and supporting information for all of Hittite's products are available online at www.hittite.com.

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