

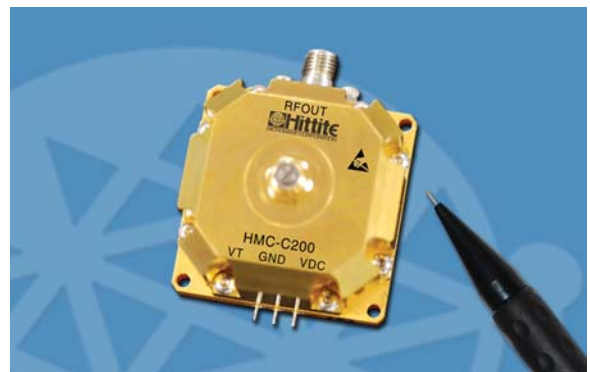
# HITTITE LAUNCHES INDUSTRY LEADING COMMERCIAL DRO PRODUCT LINE

*Miniature, High Stability Commercial DRO Module Offers Ultra Low Phase Noise*

**O**scillators are the fundamental element of microwave communication and sensor systems, from radar or optical telecom to test and measurement equipment.

A typical microwave oscillator comprises an active non-linear device (a diode or a transistor) and passive frequency-determining resonant elements. Microwave oscillators operate at extremely high frequencies, and the Dielectric Resonator Oscillator (DRO) has emerged as a viable microwave oscillator solution since it offers low phase noise, compact size, and good frequency stability over temperature. These characteristics make DROs a natural choice in a multitude of applications in fixed tuned or narrowband tunable configurations, as both fundamental oscillators and as the sources for oscillators that are phase-locked to reference frequencies.

If DROs are to be used as a clock reference in high speed fiber optic or microwave digital links, then clock stability and inherent clock jitter will determine the basic performance level possible. DROs with the best phase noise performance will produce systems with lowest possible transmitter/

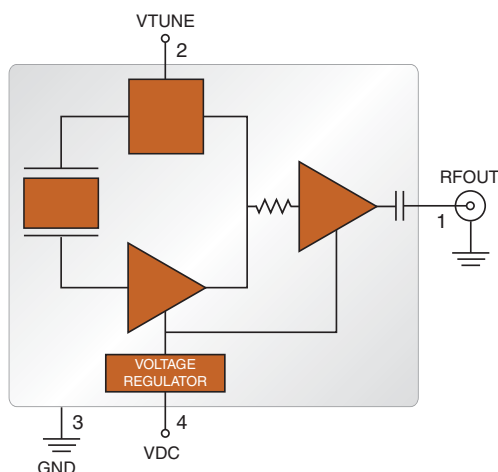


**Figure 1: The HMC-C200 Dielectric Resonator Oscillator (DRO) module covers 8.0 to 8.3 GHz.**

receiver noise and inherent system jitter. Today, optical communications systems are routinely operating at 10 and 40 Gbps, and speeds up to 100 Gbps, are expected with the advent of the new 100 GbE standards. Consequently, these higher data transmission speeds will only translate to more stringent phase noise and frequency stability performance requirements for future generations of DROs.

Marking the launch of yet another new frequency generation product line, the HMC-C200 DRO is the first of a new family of DRO products from Hittite. For designers looking for a highly stable frequency source with extremely low phase noise, the HMC-C200 represents a compact, cost-effective solution which features a customizable tuning frequency from 8.0 to 8.3 GHz. Hittite will release additional DRO standard products covering 8 GHz to 12 GHz over the coming months.

The HMC-C200 is a miniature, high performance DRO offering ultra-low phase noise. Hittite Microwave has combined years of advanced frequency generation MMIC and hybrid MIC product development experience with ultra-low phase noise technology and incorporated them into its new high performance DRO. The HMC-C200 is a truly exciting new product which is one of the lowest phase noise X-band DRO products in the industry today. Previously, larger and more expensive competitive DRO products



**Figure 2: The HMC-C200 DRO module functional diagram**

# HMC-C200 DIELECTRIC RESONATOR OSCILLATOR

operating at X-band were only capable of providing phase noise of -124 dBc/Hz at 100 kHz offset. Hittite Microwave has far exceeded that performance with the HMC-C200, which exhibits -140 dBc/Hz at 100 kHz offset. Figure 3 shows the typical SSB phase noise performance of the HMC-C200 DRO over the -40°C to +85°C operating temperature range at 8.0 GHz. The phase noise performance at 10 kHz offset is -124 dBc/Hz, which is 25 to 30 dB better than existing DRO solutions of similar size, output power and frequency range. Table 2 shows a comparison of the key specifications of the HMC-C200 with DROs from four other suppliers. The HMC-C200 SSB phase noise performance is equally impressive at 100 kHz offset and at 1 MHz offset, delivering SSB phase noise of -140 and -150 dBc/Hz, respectively.

This phase noise performance will be particularly advantageous for radar system designers working in the X-band region. Depending upon a given system application, the SSB phase noise may be more important close-in to the carrier or much further away from the carrier. In addition to radar systems designers, the HMC-C200 is also ideal for a wide range of industrial, medical, military, test and measurement markets that require enhanced phase noise performance.

This cutting-edge HMC-C200 DRO also satisfies the stringent system performance requirements of SDH/SONET

communications, digital radio, cable TV link, and satellite communications end-markets, which require very stable reference frequencies with low thermal drift. The frequency may be initially set in the 8.0 to 8.3 GHz range with a typical accuracy of  $\pm 0.25$  MHz, and with internal temperature compensation, the frequency drift is maintained to only 2 ppm/°C, over the -40°C to +85°C operating temperature range.

The end user has the ability to tune the center frequency to approximately  $\pm 20$  MHz via a mechanical tuner located on the top cover. The Vtune port accepts an analog voltage from

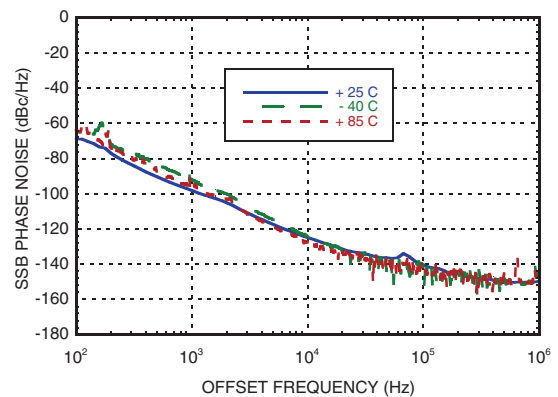


Figure 3: SSB Phase Noise Performance of the HMC-C200 DRO Module at 8 GHz

Table 1: HMC-C200 Key Performance Specifications

Parameter	Minimum	Typical	Maximum	Units
Frequency Range	8	8.2	8.3	GHz
Frequency Accuracy		$\pm 0.25$		MHz
Power Output, Center Frequency	13	14.5		dBm
Tuning Voltage (Vtune)	5	9	12	V
Mechanical Tuning		$\pm 20$		MHz
Electrical Tuning Range		$\pm 1$		MHz
2nd Harmonic (2Fo)		-28		dBc
3rd Harmonic (3Fo)		-35		dBc
Frequency Stability		2		ppm/°C
Frequency Pushing		5		kHz/V
Frequency Pulling		5		kHz/pp
Output Return Loss		12		dB
SSB Phase Noise @ 1 kHz Offset, Center Frequency		-95		dBc/Hz
SSB Phase Noise @ 10 kHz Offset, Center Frequency		-122		dBc/Hz
SSB Phase Noise @ 100 kHz Offset, Center Frequency		-140		dBc/Hz
SSB Phase Noise @ 1 MHz Offset, Center Frequency		-150		dBc/Hz
Supply Voltage (Vdc)	6		15	V
Supply Current		125		mA

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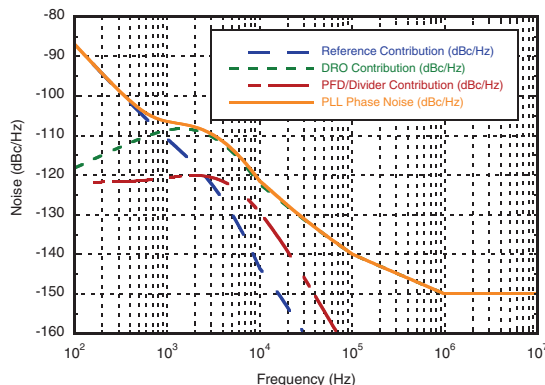
+5V to +12V, and provides a tuning range of  $\pm 1$  MHz from the center frequency. The HMC-C200 DRO is well suited for phase locked loop applications, and the tuning voltage port also allows the system designer to easily integrate this DRO into a phase locked loop (PLL) circuit. Each DRO is delivered pre-tuned to order with a  $\pm 1$  MHz offset from the specified center frequency, from 8.0 to 8.3 GHz.

The HMC-C200 is specified for operation from  $-40^{\circ}\text{C}$  to  $+85^{\circ}\text{C}$ , and is housed in a miniature 1.5" x 1.5" (36 x 36 mm) connectorized module that is moisture sealed and supplied with a field replaceable SMA connector. The HMC-C200 DRO can be used as a drop-in module if the SMA connector is not used.

Hittite Microwave's design philosophy involves the careful selection of the best semiconductor processes and design techniques available for each component solution, ensuring the delivery of market-leading product performance. This performance improvement allows the system designer to maximize the true potential of the design to ultimately deliver a superior product.

Taking advantage of this design philosophy, the HMC-C200 DRO may be combined with several additional standard Hittite Microwave components to generate a low phase noise single-loop-based Phase Locked Oscillator (PLO) design (Figure 4).

To create the phase locked loop, the HMC-C200 DRO is locked to a reference. Selection of the reference is critical



**Figure 4: Achievable Phase Noise Performance for the 8 GHz Phase Locked Oscillator (PLO)**  
Example Shown in Figure 4

as the reference phase noise characteristic will dominate the system phase noise below 100 Hz.

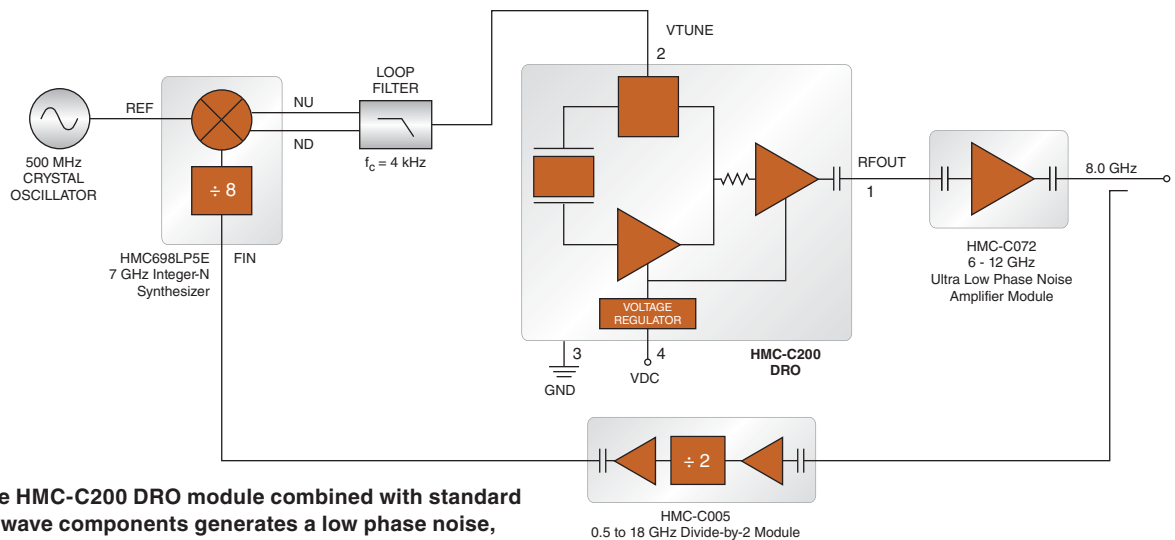
For the reference design example shown in Figure 4, a 500 MHz ovenized crystal oscillator with phase noise of  $-110$  dBc/Hz at 100 Hz offset is chosen. The HMC-C072 amplifier module exhibits one of the lowest recorded phase noise specifications in the industry. At  $-167$  dBc/Hz at 1 kHz offset, the HMC-C072 is ideal for buffering the DRO output, and provides  $+22$  dBm output power without adding any significant phase noise degradation.

To lock the DRO to the reference signal, the HMC698LP5E, an integer-N synthesizer, was selected as it exhibits excellent

**Table 2: Key specifications comparison of the HMC-C200 with DROs from four other suppliers**

	Hittite HMC-C200	Supplier A	Supplier B	Supplier C	Supplier D	Units
Center Frequency	8.0 - 8.3	8.2	8	8	10.4	GHz
Phase Noise @ 1 kHz	-95	n/a	n/a	n/a	-85	dBc/Hz
Phase Noise @ 10 kHz	-122	-95	-80	-90	-110	dBc/Hz
Phase Noise @ 100 kHz	-140	-125	-115	n/a	-135	dBc/Hz
Mechanical Tuning	40	12	<160	20	40	MHz
Electrical Tuning	1	0	<20		<1	MHz
Output Power	14.5	10	14	17	12	dBm
Stability	<2	5	5	5	n/a	ppm/ $^{\circ}\text{C}$
Pushing	<5	<1	3.75	2	n/a	kHz/V
Pulling (into 2:1 VSWR)	<5	n/a	n/a	n/a	n/a	kHz/pp
Harmonics	28	-20	-25	-20	n/a	dBc
Bias (Vcc)	6 - 15	10 - 15	12 - 24	15	12 - 15	V
Current (Icc)	125	100	125	220	n/a	mA
Operating	-40 to +85	-40 to +85	-40 to +75	-20 to +70	n/a	$^{\circ}\text{C}$

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**Figure 5: The HMC-C200 DRO module combined with standard Hittite Microwave components generates a low phase noise, single-loop-based Phase Locked Oscillator (PLO).**

phase noise performance. The HMC698LP5E operates at a maximum comparison frequency of 1300 MHz and with RF input frequencies from 80 to 7000 MHz. It features division ratios on the RF input as low as 8, with continuous ratios from 12 to 259. Since the HMC698LP5E only accepts frequencies up to 7 GHz, the HMC-C005 connectorized, low noise frequency divider is chosen to scale down the coupled output signal to a frequency of 4 GHz.

Figure 5 shows the achievable phase noise performance of the 8.0 GHz PLL design. With careful loop filter design and a low noise 500 MHz reference crystal, this single-loop-based PLO design exhibits excellent phase noise performance of -122 dBc/Hz @ 10 kHz, -140 dBc/Hz @ 100 kHz, and -150 dBc/Hz @ 1 MHz.

## Summary

Hittite Microwave continues to lead the way with state-of-the-art innovations in low phase noise microwave components. The HMC-C200 raises the performance bar for off-the-shelf DROs by providing -122 dBc/Hz at 10 kHz offset. Coupled with other low phase noise components, the HMC-C200 can help realize low phase noise systems that provide a cost-effective alternative to prohibitively expensive SAW and Sapphire-based resonator synthesizers. Over the coming months, Hittite's new DRO product line will expand to include new standard products covering the 8 GHz to 12 GHz frequency range.

In addition to this new DRO product, Hittite Microwave is well known for providing high performance frequency

generation and distribution products, including dividers, multipliers, dynamic and static prescalers, VCOs, phase locked oscillators (PLOs) and complete synthesizers. More than 100 standard products are available from Hittite which can be utilized in signal generation loops from DC to 80 GHz. In addition, Hittite has developed hundreds of custom VCOs to meet demanding application specific requirements.

Designers can choose from more than 800 standard products offered by Hittite, including modulators, phase shifters, attenuators, amplifiers and switches. Data sheets and supporting information for all of Hittite's products are available online at [www.hittite.com](http://www.hittite.com).