

# OFF-THE-SHELF

SPRING/SUMMER 2001

HITTITE MICROWAVE CORPORATION

## New Prescalar Product Line Meets The Demands of Broadband Markets!

Hittite announces ten (10) new prescalar standard products that operate from DC to 13GHz. Standard division ratios of two, four, and eight have been introduced, and are available in both surface mount packages and chip form. The product line is designed to support high frequency telecommunication radios, microwave instrumentations, and optical subsystems

(Continued on pg. 11)

Description		Frequency Range (GHz)	SSB Phase Noise @ 100 KHz	Part Number
÷ 2	High Efficiency Med. Output Power	DC - 11.0	-148 dBc/Hz	HMC361
		DC - 10.0	-148 dBc/Hz	HMC361S8G
÷ 2	High Frequency High Output Power	DC - 13.0	-145 dBc/Hz	HMC364
		DC - 12.5	-145 dBc/Hz	HMC364S8G
÷ 4	High Efficiency Med. Output Power	DC - 12.0	-149 dBc/Hz	HMC362
		DC - 12.0	-149 dBc/Hz	HMC362S8G
÷ 4	High Frequency High Output Power	DC - 13.0	-151 dBc/Hz	HMC365
		DC - 12.5	-151 dBc/Hz	HMC365S8G
÷ 8	High Efficiency Med. Output Power	DC - 12.0	-153 dBc/Hz	HMC363
		DC - 12.0	-153 dBc/Hz	HMC363S8G

## High Performance Synthesizers Enabled with New Digital Phase Frequency Detector and Programmable 5-BIT Counter!

Producing a low phase noise microwave frequency synthesizer depends heavily on the availability of high performance low phase noise PLL components. Hittite's two new standard products offer extremely high frequency and low phase noise performance and are targeting high performance synthesizer circuits in the microwave radio, VSAT, and optical markets.

(Continued on pg. 8)

## INSIDE.....

### \* 18 NEW PRODUCTS RELEASED!

- \* Prescalers
- \* GaAs MMIC Low Noise Amplifiers
- \* GaAs MMIC Sub-Harmonically Pumped Mixers
- \* Programmable 5-Bit Counter
- \* Digital Phase Frequency Detector

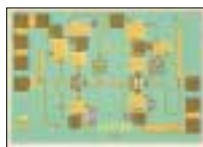
## ....COVERING

- \* Point to Point Radio
- \* Fiber Optics
- \* LMDS
- \* VSAT

### \* PRODUCT DATASHEETS AVAILABLE ONLINE AT:

[www.hittite.com](http://www.hittite.com)

### GaAs MMIC Low Noise Amplifier

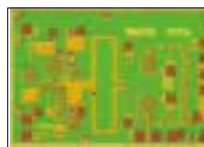


HMC341

- 24 - 30 GHz
- Noise Figure: 2.5 dB
- Gain: 13 dB
- Single Supply: +3V @ 30 mA

See Page 5

### LMDS Band Sub-Harmonic Image Rejection Mixer



HMC404

- 26 - 34 GHz
- Required LO Drive: +2 dBm
- Image Rejection: > 22 dB
- Single Supply: +4V @ 28 mA

See Page 7

### InGaP GaAs HBT Programmable 5-Bit Counter



HMC394LP4

- DC - 2.2 GHz
- Low SSB Phase Noise: -153 dBc/Hz @ 100 KHz
- Programmable Division States: 2 to 32
- Parallel 5-Bit Control

See Page 8

## HMC361

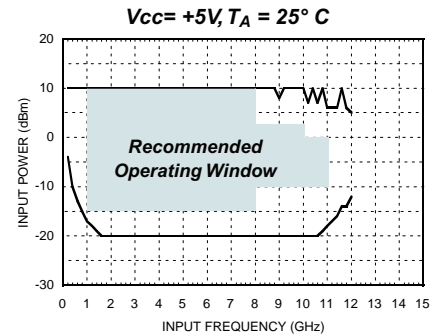
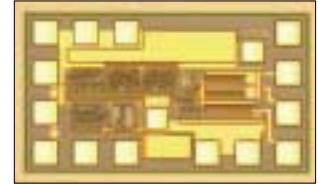
**GaAs HBT MMIC**  
Divide-by-2, DC - 11.0 GHz

### General Description

The HMC361 is a low noise Divide-by-2 Static Divider with InGaP GaAs HBT technology that has a small size of 0.686 mm x 1.143 mm. This device operates from DC (with a square wave input) to 11 GHz input frequency with a single +5.0V DC supply. The low additive SSB phase noise of -148 dBc/Hz at 100 KHz offset helps the user maintain good system noise performance. The HMC361 is ideal for Microwave Radio, Fiber Optic, and VSAT low phase noise PLL circuitry applications.

### Features

- Ultra Low SSB  
Phase Noise: -148 dBc/Hz
- Wide Bandwidth  
Output Power: 4 dBm
- Selectable Output Power  
Bias Option
- Small Size:  
0.686 mm x 1.143 mm



## HMC361S8G

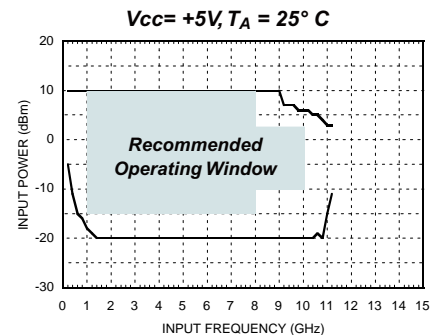
**SMT GaAs HBT MMIC**  
Divide-by-2, DC - 10.0 GHz

### General Description

The HMC361S8G is a low noise Divide-by-2 Static Divider with InGaP GaAs HBT technology in an 8 lead surface mount plastic package. This device operates from DC (with a square wave input) to 10 GHz input frequency with a single +5.0V DC supply. The low additive SSB phase noise of -148 dBc/Hz at 100 KHz offset helps the user maintain good system noise performance. The HMC361S8G is ideal for Microwave Radio, Fiber Optic, and VSAT low phase noise PLL circuitry applications.

### Features

- Ultra Low SSB  
Phase Noise: -148 dBc/Hz
- Wide Bandwidth  
Output Power: 4 dBm
- S8G SMT Package



## HMC362

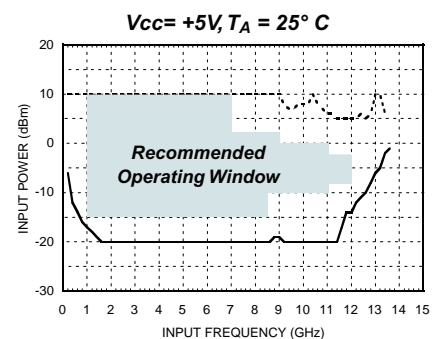
**GaAs HBT MMIC**  
Divide-by-4, DC - 11.0 GHz

### General Description

The HMC362 is a low noise Divide-by-4 Static Divider with InGaP GaAs HBT technology that has a small size of 0.686 mm x 1.295 mm. This device operates from DC (with a square wave input) to 12 GHz input frequency with a single +5.0V DC supply. The low additive SSB phase noise of -149 dBc/Hz at 100 KHz offset helps the user maintain good system noise performance. The HMC362 is ideal for Microwave Radio, Fiber Optic, and VSAT low phase noise PLL circuitry applications.

### Features

- Ultra Low SSB  
Phase Noise: -149 dBc/Hz
- Wide Bandwidth  
Output Power: -6 dBm
- Selectable Output Power  
Bias Option
- Small Size:  
0.686 mm x 1.295 mm



## HMC362S8G

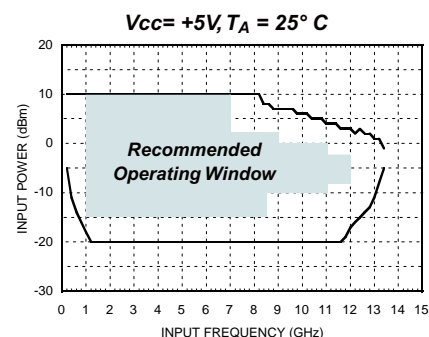
**SMT GaAs HBT MMIC**  
Divide-by-4, DC - 12.0 GHz

### General Description

The HMC362S8G is a low noise Divide-by-4 Static Divider with InGaP GaAs HBT technology in an 8 lead surface mount plastic package. This device operates from DC (with a square wave input) to 10 GHz input frequency with a single +5.0V DC supply. The low additive SSB phase noise of -149 dBc/Hz at 100 KHz offset helps the user maintain good system noise performance. The HMC362S8G is ideal for Microwave Radio, Fiber Optic, and VSAT low phase noise PLL circuitry applications.

### Features

- Ultra Low SSB  
Phase Noise: -149 dBc/Hz
- Wide Bandwidth  
Output Power: -6 dBm
- S8G SMT Package



## HMC363

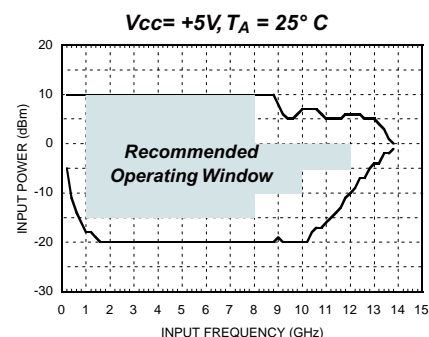
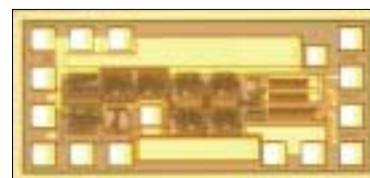
**GaAs HBT MMIC**  
Divide-by-8, DC - 12.0 GHz

### General Description

The HMC363 is a low noise Divide-by-8 Static Divider with InGaP GaAs HBT technology that has a small size of 0.686 mm x 1.448 mm. This device operates from DC (with a square wave input) to 12 GHz input frequency with a single +5.0V DC supply. The low additive SSB phase noise of -153 dBc/Hz at 100 KHz offset helps the user maintain good system noise performance. The HMC363 is ideal for Microwave Radio, Fiber Optic, and VSAT low phase noise PLL circuitry applications.

### Features

- Ultra Low SSB  
Phase Noise: -153 dBc/Hz
- Wide Bandwidth  
Output Power: -6 dBm
- Selectable Output Power  
Bias Option
- Small Size:  
0.686 mm x 1.448 mm



## HMC363S8G

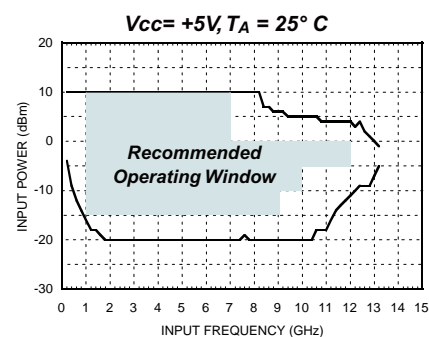
**SMT GaAs HBT MMIC**  
Divide-by-8, DC - 12.0 GHz

### General Description

The HMC363S8G is a low noise Divide-by-8 Static Divider with InGaP GaAs HBT technology in an 8 lead surface mount plastic package. This device operates from DC (with a square wave input) to 12 GHz input frequency with a single +5.0V DC supply. The low additive SSB phase noise of -153 dBc/Hz at 100 KHz offset helps the user maintain good system noise performance. The HMC363S8G is ideal for Microwave Radio, Fiber Optic, and VSAT low phase noise PLL circuitry applications.

### Features

- Ultra Low SSB  
Phase Noise: -153 dBc/Hz
- Wide Bandwidth  
Output Power: -6 dBm
- S8G SMT Package



## HMC364

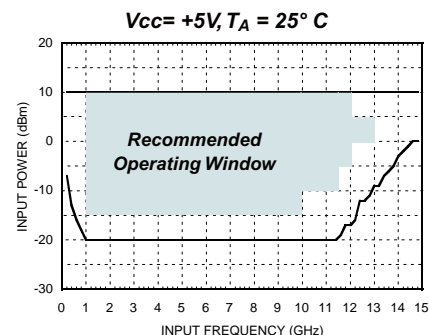
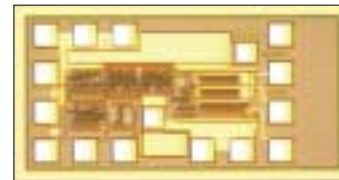
GaAs HBT MMIC  
Divide-by-2, DC - 13.0 GHz

### General Description

The HMC364 is a low noise Divide-by-2 Static Divider with InGaP GaAs HBT technology that has a small size of 0.686 mm x 1.295 mm. This device operates from DC (with a square wave input) to 13 GHz input frequency with a single +5.0V DC supply. The low additive SSB phase noise of -145 dBc/Hz at 100 KHz offset helps the user maintain good system noise performance. The HMC364 is ideal for Microwave Radio, Fiber Optic, and VSAT low phase noise PLL circuitry applications.

### Features

- Ultra Low SSB  
Phase Noise: -145 dBc/Hz
- Wide Bandwidth  
Output Power: 4 dBm
- Selectable Output Power  
Bias Option
- Small Size:  
0.686 mm x 1.295 mm



## HMC364S8G

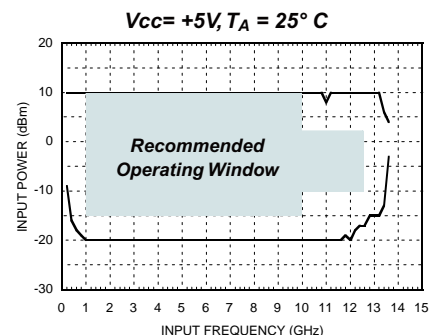
SMT GaAs HBT MMIC  
Divide-by-2, DC - 12.5 GHz

### General Description

The HMC364S8G is a low noise Divide-by-2 Static Divider with InGaP GaAs HBT technology in an 8 lead surface mount plastic package. This device operates from DC (with a square wave input) to 12.5 GHz input frequency with a single +5.0V DC supply. The low additive SSB phase noise of -145 dBc/Hz at 100 KHz offset helps the user maintain good system noise performance. The HMC364S8G is ideal for Microwave Radio, Fiber Optic, and VSAT low phase noise PLL circuitry applications.

### Features

- Ultra Low SSB  
Phase Noise: -145 dBc/Hz
- Wide Bandwidth  
Output Power: 4 dBm
- S8G SMT Package



## HMC365

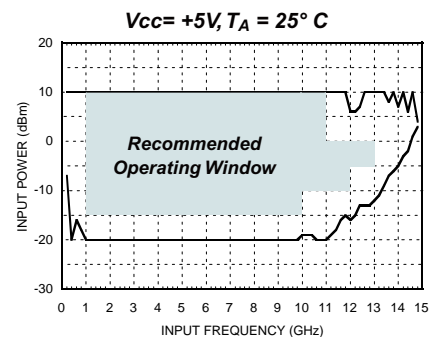
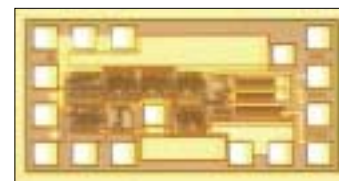
GaAs HBT MMIC  
Divide-by-4, DC - 13.0 GHz

### General Description

The HMC365 is a low noise Divide-by-4 Static Divider with InGaP GaAs HBT technology that has a small size of 0.686 mm x 1.295 mm. This device operates from DC (with a square wave input) to 13 GHz input frequency with a single +5.0V DC supply. The low additive SSB phase noise of -151 dBc/Hz at 100 KHz offset helps the user maintain good system noise performance. The HMC365 is ideal for Microwave Radio, Fiber Optic, and VSAT low phase noise PLL circuitry applications.

### Features

- Ultra Low SSB  
Phase Noise: -151 dBc/Hz
- Wide Bandwidth  
Output Power: 5 dBm
- Selectable Output Power  
Bias Option
- Small Size:  
0.686 mm x 1.295 mm





## HMC365S8G

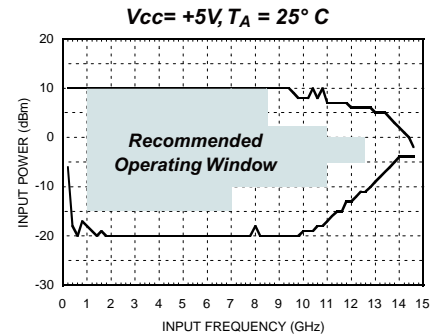
**SMT GaAs HBT MMIC**  
Divide-by-4, DC - 12.5 GHz

### General Description

The HMC365S8G is a low noise Divide-by-4 Static Divider with InGaP GaAs HBT technology in an 8 lead surface mount plastic package. This device operates from DC (with a square wave input) to 12.5 GHz input frequency with a single +5.0V DC supply. The low additive SSB phase noise of -151 dBc/Hz at 100 KHz offset helps the user maintain good system noise performance. The HMC365S8G is ideal for Microwave Radio, Fiber Optic, and VSAT low phase noise PLL circuitry applications.

### Features

- Ultra Low SSB
- Phase Noise: -151 dBc/Hz
- Wide Bandwidth
- Output Power: 4 dBm
- S8G SMT Package



## HMC341

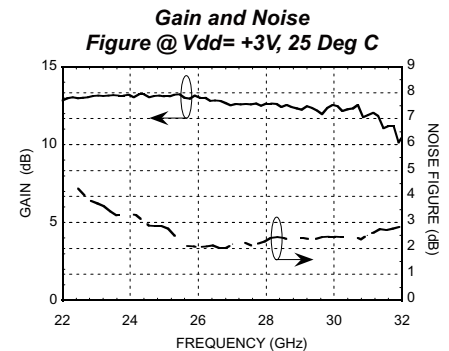
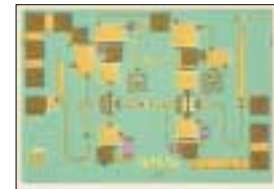
**GaAs MMIC Low Noise Amplifier, 24 - 30 GHz**

### General Description

The HMC341 chip is a GaAs MMIC Low Noise Amplifier (LNA) which covers the frequency range of 24 to 30 GHz. The chip can easily be integrated into Multi-Chip Modules (MCMs) due to its small (1.51 mm<sup>2</sup>) size. The chip utilizes a GaAs PHEMT process offering 13 dB gain from a single bias supply of +3V @ 30 mA with a noise figure of 2.5 dB. This LNA can be used in millimeterwave point-to-point radios, Local Multi-Point Distribution Systems (LMDS), VSAT, and other SATCOM applications. All data is with the chip in a 50 ohm test fixture connected via 0.025 mm (1 mil) diameter wire bonds of minimal length 0.31 mm (<12 mils).

### Features

- Excellent Noise Figure : 2.5 dB
- Gain: 13 dB
- Single Supply : +3V @ 30 mA
- Small Size: 1.06 mm x 1.42 mm



## HMC342

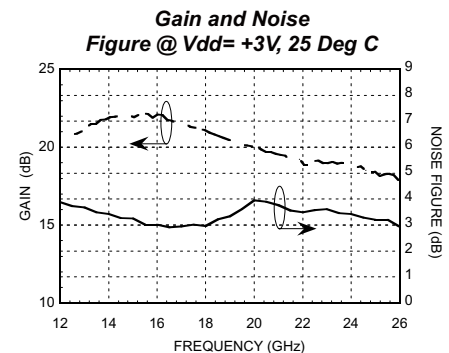
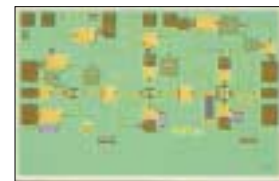
**GaAs MMIC Low Noise Amplifier, 13 - 25 GHz**

### General Description

The HMC342 chip is a GaAs MMIC Low Noise Amplifier (LNA) which covers the frequency range of 13 to 25 GHz. The chip can easily be integrated into Multi-Chip Modules (MCMs) due to its small (2.14 mm<sup>2</sup>) size. The chip utilizes a GaAs PHEMT process offering 20 dB gain typical from a single bias supply of +3.5V @ 30 mA with a noise figure of 2.5 dB. This LNA can be used in millimeterwave point-to-point radios, Local Multi-Point Distribution Systems (LMDS), VSAT, and other SATCOM applications. All data is with the chip in a 50 ohm test fixture connected via 0.025 mm (1 mil) diameter wire bonds of minimal length 0.31 mm (<12 mils).

### Features

- Noise Figure : 3.5 dB
- Gain: >20 dB
- Single Supply : +3V @ 36 mA
- Small Size: 1.06 mm x 2.02 mm



## HMC337

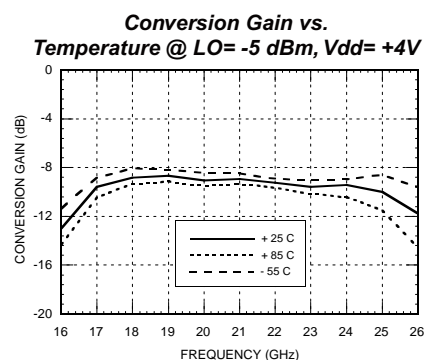
*GaAs MMIC Sub-Harmonically Pumped Mixer, 17 - 25 GHz*

### General Description

The HMC337 chip is a sub-harmonically pumped (x2) MMIC mixer with an integrated LO amplifier which can be used as an upconverter or downconverter. The chip utilizes a GaAs PHEMT technology that results in a small overall chip area of  $1.28\text{mm}^2$ . The 2LO to RF isolation is excellent eliminating the need for additional filtering. The LO amplifier is a single bias (+3V to +4V) two stage design with only -5 dBm nominal drive requirement. This mixer chip is designed to be used in 17 - 25 GHz microwave radios, up and downconverter for point-to-point radios, and satellite communications systems applications.

### Features

- Required LO Drive: -5 dBm
- Sub-Harmonically Pumped (x2) LO
- High 2LO/RF Isolation: > 28 dB
- Small Size: 0.97mm x 1.32 mm



## HMC338

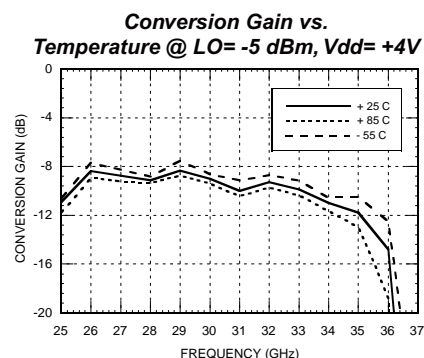
*GaAs MMIC Sub-Harmonically Pumped Mixer, 25 - 33 GHz*

### General Description

The HMC338 chip is a sub-harmonically pumped (x2) MMIC mixer with an integrated LO amplifier which can be used as an upconverter or downconverter. The chip utilizes a GaAs PHEMT technology that results in a small overall chip area of  $1.28\text{mm}^2$ . The 2LO to RF isolation is excellent eliminating the need for additional filtering. The LO amplifier is a single bias (+3V to +4V) two stage design with only -5 dBm nominal drive requirement. This mixer chip is designed to be used in 25 - 33 GHz microwave radios, up and downconverter for point-to-point radios, and satellite communications systems applications.

### Features

- Required LO Drive: -5 dBm
- Sub-Harmonically Pumped (x2) LO
- High 2LO/RF Isolation: > 33 dB
- Small Size: 0.97mm x 1.32 mm



## HMC339

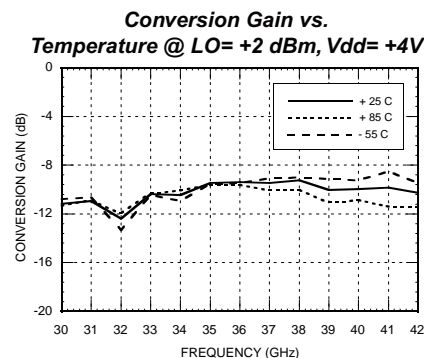
*GaAs MMIC Sub-Harmonically Pumped Mixer, 32 - 42 GHz*

### General Description

The HMC339 chip is a sub-harmonically pumped (x2) MMIC mixer with an integrated LO amplifier which can be used as an upconverter or downconverter. The chip utilizes a GaAs PHEMT technology that results in a small overall chip area of  $1.07\text{mm}^2$ . The 2LO to RF isolation is excellent eliminating the need for additional filtering. The LO amplifier is a single bias (+3V to +4V) two stage design with only +2 dBm nominal drive requirement. This mixer chip is designed to be used in 32 - 42 GHz microwave radios, up and downconverter for point-to-point radios, and satellite communications systems applications.

### Features

- Required LO Drive: +2 dBm
- Sub-Harmonically Pumped (x2) LO
- High 2LO/RF Isolation: > 37 dB
- Small Size: 0.81mm x 1.32 mm



## HMC404

GaAs MMIC Sub-Harmonically Pumped IRM, 26 - 34 GHz

### General Description

The HMC404 chip is a sub-harmonically pumped (x2) MMIC image rejection mixer with an integrated LO amplifier which can be used as an upconverter or downconverter. The chip utilizes a GaAs PHEMT technology that results in a small overall chip area of 2.31mm<sup>2</sup>. The on-chip 90° hybrid provides excellent amplitude and phase balance resulting in greater than 22 dB of image rejection. The LO amplifier is a single bias (+3V to +4V) two stage design with only +2 dBm nominal drive required. This mixer chip is designed to be used in 26 - 34 GHz microwave radios, up and downconverter for point-to-point radios, and satellite communications systems applications.

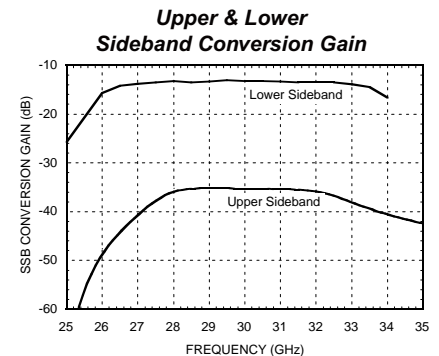
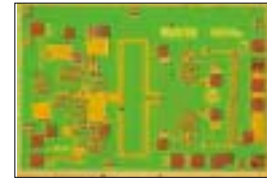
### Features

Required LO Drive: +2 dBm

Sub-Harmonically Pumped (x2) LO

Image Rejection:  
22 dB Typical

Small Size: 1.24mm x 1.86 mm

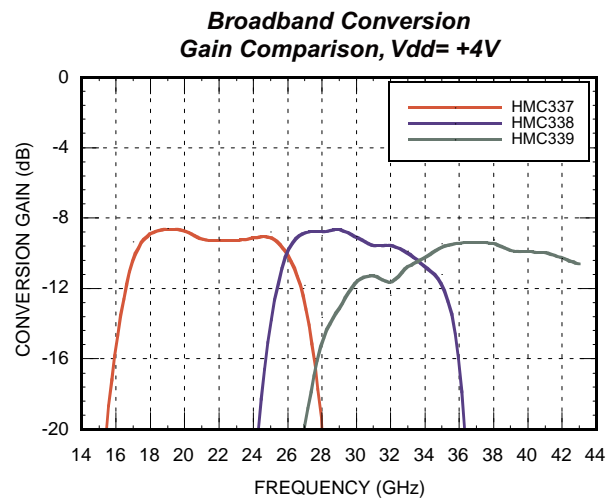


## Hittite Expands MMW Subharmonic Mixer Product Line by Adding Four New Designs!

Four new MMW subharmonic mixers, HMC337, HMC338, HMC339, and HMC404 provide complete up and down converter coverage of MMW microwave radio, USAT and VSAT radio bands between 17 and 42 GHz. Each design offers an on board LO amplifier that provides power to drive the passive subharmonic diode based mixer. The LO amplifiers are self biased designs, and operate from

### Typical Midband Performance

Parameter	HMC337	HMC338	HMC339
RF Frequency	17 - 25 GHz	25 - 33 GHz	32 - 42 GHz
LO Frequency	8.5 - 12.5 GHz	13.0 - 16.5 GHz	16.5 - 21 GHz
IF Frequency	DC - 3 GHz	DC - 2.5 GHz	DC - 3 GHz
Conversion Loss	9 dB	9 dB	10 dB
2LO to RF Isolation	28 dB	33 dB	37 dB
2LO to IF Isolation	45 dB	40 dB	40 dB
IP3 (Input)	12 dBm	12 dBm	10 dBm
LO Drive	-3 dBm	-3 dBm	+2 dBm
Supply Voltage	4V	4V	4V
Supply Current	28 mA	28 mA	28 mA



either a +3V or +4V rail. The drive level required at the LO port is -3.0 dBm to -5.0 dBm (HMC337 and HMC338) or +2.0 dBm (HMC339) typically. Hittite has designed these mixers in PHEMT technology to reduce the overall chip area to reduce cost, and to optimize the LO amplifier performance.

The HMC337 targets the 18, 23, and 24 GHz radio bands while the HMC338 and HMC339 target the 26, 27, 32, 38, and 42 GHz radio bands. These three new designs are similar in functionality to the previously introduced HMC264 subharmonic mixer (20 to 32 GHz), but offer superior return loss, and third order intercept (IP3) performance at certain bands.

The HMC404 mixer is the industries first subharmonic image reject mixer that supports 25 to 34 GHz microwave radio applications.

(Continued on pg. 10)

## HMC394LP4

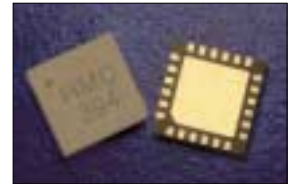
**InGaP GaAs HBT**  
**Programmable 5-Bit Counter, DC - 2.2 GHz**

### General Description

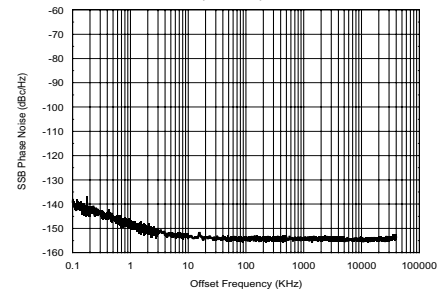
The HMC394LP4 is a low noise GaAs HBT programmable 5-bit counter in a surface mount LP4 plastic package. This device allows continuous division from  $N = 2$  to 32 at input frequencies up to 2.2 GHz. The output voltage swing is 800 mV with a duty cycle inversely proportional to  $N$ . The low additive SSB phase noise of -153 dBc/Hz at 100 KHz offset makes this counter an excellent choice for low noise synthesizer applications including Pt to Pt, Pt to MPt, LMDS, VSAT, and Optical applications.

### Features

- Ultra Low SSB  
Phase Noise: -153 dBc/Hz
- Programmable Division  
States: 2 to 32
- Parallel 5-Bit Control
- Wide Input Power Range:  
-15 to +10 dBm
- Single +5V Bias



**SSB Phase Noise**  
 **$F_{in} = 1 \text{ GHz}, N = 4, T = 25^\circ \text{ C}$**



## HMC403S8G

**InGaP GaAs HBT Digital**  
**Phase Frequency Detector, DC - 1.3 GHz**

### General Description

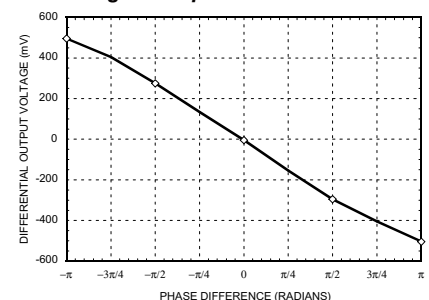
The HMC403S8G is a digital phase-frequency detector intended for use in low noise phase-locked loop applications. Its combination of high frequency of operation along with its low phase noise floor make possible synthesizers with wide loop bandwidth and low  $N$  resulting in fast switching and very low phase noise. When used in conjunction with a differential loop amplifier, the HMC403S8G generates an output voltage that can be used to phase lock a VCO to a reference oscillator. The device is available in a small outline 8-lead SOIC plastic package.

### Features

- 1.3 GHz Operation
- Ultra Low SSB  
Phase Noise: -135 dBc/Hz  
with a 100 MHz Reference
- Single Ended Input/  
Differential Output
- Output Buffer Amplifiers
- S8G SMT Package



**Average Differential Output  
Voltage vs. Input Phase Difference**



### High Performance Synthesizers Enabled with New Digital Phase Frequency Detector and Programmable 5-BIT Counter! (Continued from pg. 1)

The **HMC394LP4** programmable 5-BIT counter operates up to 2200MHz. The user can program the divide ratio with a parallel logic CMOS control command. The HMC394LP4 produces division ratios from 2 to 32. The HMC394LP4 operates with input signal between -15 dBm to +10 dBm, and will provide an output voltage swing of 800 mV with a duty cycle that is inversely proportional to  $N$ , the division ratio. A low additive single side band (SSB) phase noise of -153 dBc/Hz at 100 KHz will support high performance synthesizer equipment. The HMC394LP4 is packaged in a 4x4 mm 24-pin plastic surface mount LPCC package.

The **HMC403S8G** digital phase frequency detector (PFD) is able to operate with a high (up to 1.3 GHz) reference frequency oscillator/VCO, features single ended input and differential output, and offers low phase noise floor performance. The HMC403S8G is designed to provide a differential voltage that can phase lock a VCO to a reference oscillator. Because of its high frequency and low phase noise performance, it supports the design of fast switching (wide loop bandwidth), low  $N$  (minimizing phase noise) phase lock loop architectures. The HMC403S8G is packaged in an eight-leaded SOIC-8 plastic package with an exposed ground paddle. The device operates from a single five volt (+5.0V) rail.

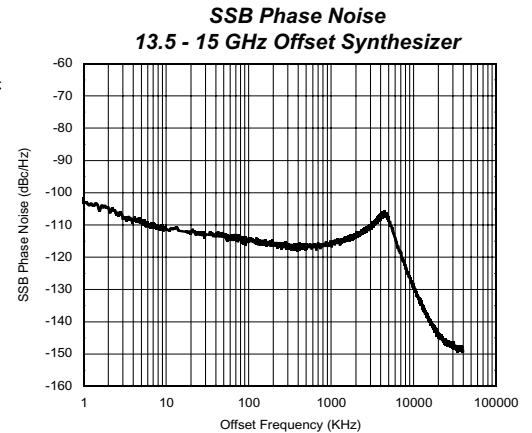
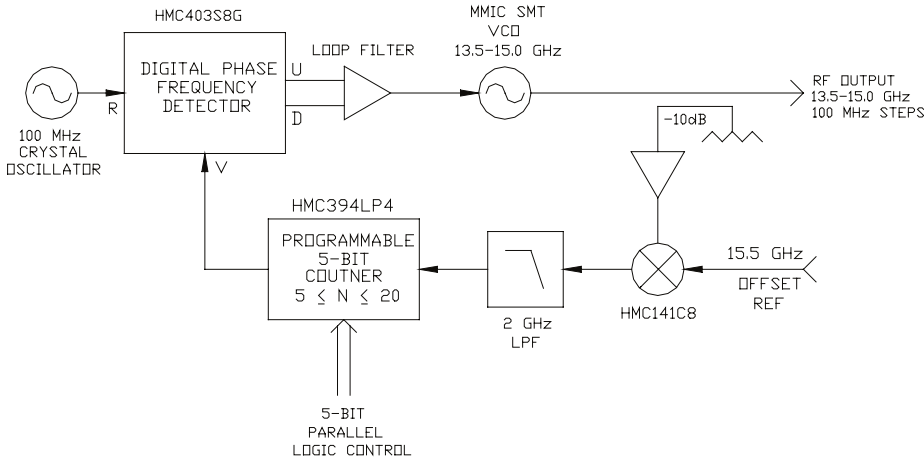
Hittite has produced reference designs that illustrate two architectures as provided in Example 1 and Example 2. These designs are based on 100% Hittite surface mount plastic encapsulated products.

(Cont. on pg. 9)



# SYNTHESIZER APPLICATION NOTE!

## Example #1: Offset Synthesizer Architecture for VSAT, LMDS, Point to Point Radio Markets



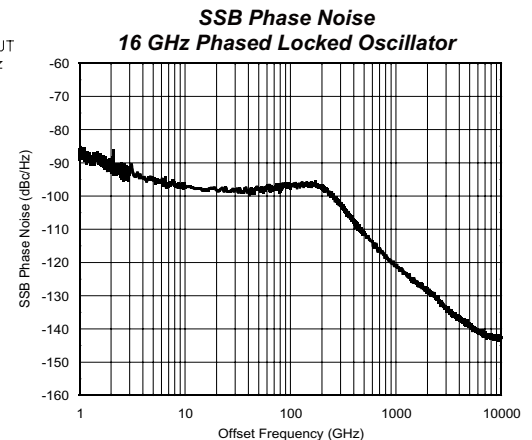
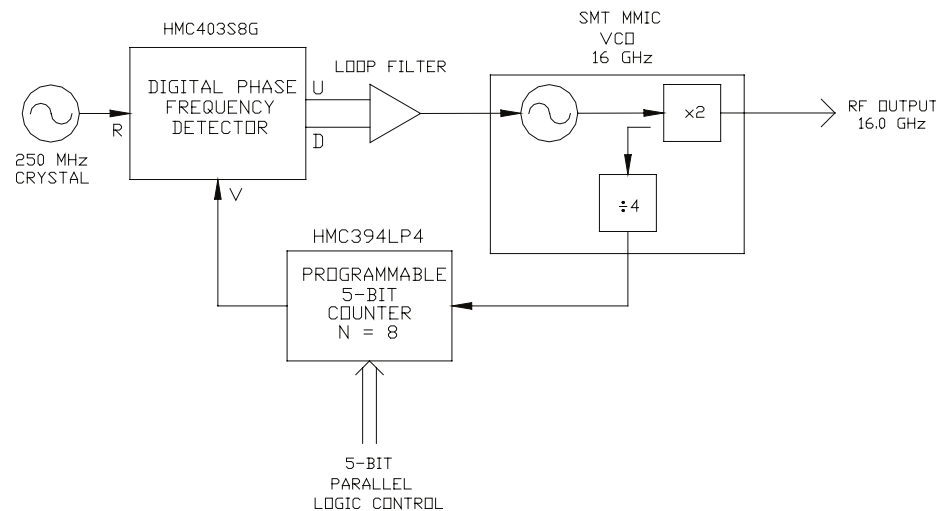
A low noise 13.5 to 15 GHz indirect-analog synthesizer with fast settling time has been realized by combining a variety of Hittite standard products. The HMC394LP4 programmable divider and the HMC403S8 digital phase frequency detector in conjunction with Hittite's other MMICs have produced a completely surface mount MMIC based synthesizer.

The offset synthesizer architecture produces an output frequency from 13.5 to 15.0 GHz with 100 MHz steps. The mixer uses a low noise reference of 15.5 GHz to down convert the output frequency to a range within the bandwidth of the programmable counter.

Low phase noise performance is obtained by keeping the loop division ratio (N) very small (5 to 20) as the Hittite VCO tunes over the full operating band. The output phase noise of the synthesizer can be estimated as the noise floor of the phase-frequency detector + the phase noise degradation due to division or  $-135 \text{ dBc/Hz} + 20\log(N)$ . For this example, the output phase noise at 15 GHz is:  $-135 + 20\log(5)$  or  $-121 \text{ dBc/Hz}$ . Likewise, at 13.5 GHz is:  $-135 + 20\log(15)$  or  $-111 \text{ dBc/Hz}$ .

Fast settling time is obtained by using a phase comparison frequency of 100 MHz which allows for a loop bandwidth near 1 MHz, resulting in a settling time of a few micro-seconds.

## Example #2: Fixed Divider Synthesizer Architecture for VSAT, LMDS, and Point to Point Radio Markets



A low noise 16 GHz indirect-analog synthesizer architecture has been realized by combining Hittite's HMC403S8G digital phase frequency detector, a HMC394LP4 programmable 5-bit counter, and a divide-by-4 prescaler. The example uses a 250 MHz reference frequency as shown in above.

In this example, the 16 GHz Hittite oscillator has an available half frequency output resulting from the push-push VCO architecture and this output feeds into the divide-by-4 prescaler. The output phase noise of the synthesizer can be estimated as the noise floor of the phase-frequency detector + the phase noise degradation due to division or  $-135 \text{ dBc/Hz} + 20\log(N)$ . For this example, the output phase noise at 16 GHz is:  $-135 + 20\log(64)$  or  $-99 \text{ dBc/Hz}$ .

## Hittite Expands MMW Subharmonic Mixer Product Line by Adding Four New Designs! (Cont. from pg. 7)

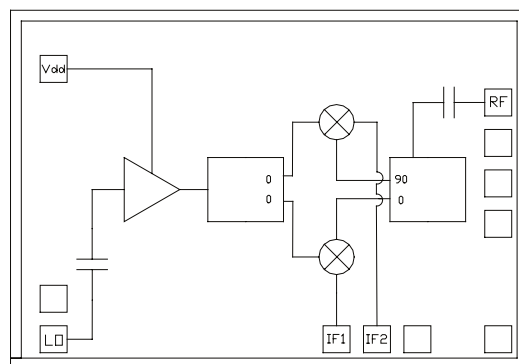
Figure 1 below, shows the functional diagram of the HMC404. The MMIC mixer contains an LO amplifier, a zero degree LO power splitter, two mixers, and ninety degree RF hybrid. The LO amplifier is a self-biased two stage amplifier that requires 28 mA from a +4V supply, which is sufficient to drive both mixers. Each mixer has been designed to minimize the second LO harmonic feed through to RF and IF ports. Adding the LO amplifier to the mixer adds tremendous value because it simplifies the need for additional amplification in the LO chain which would be further complicated by a two mixer configuration.

Using an IRM provides many benefits to the system designer. Due to the balanced configuration, the IIP3 and conversion loss will improve by approximately 3 dB when power combining in an external ninety degree IF hybrid, thus improving the linearity and supporting higher RF and IF operating input powers.

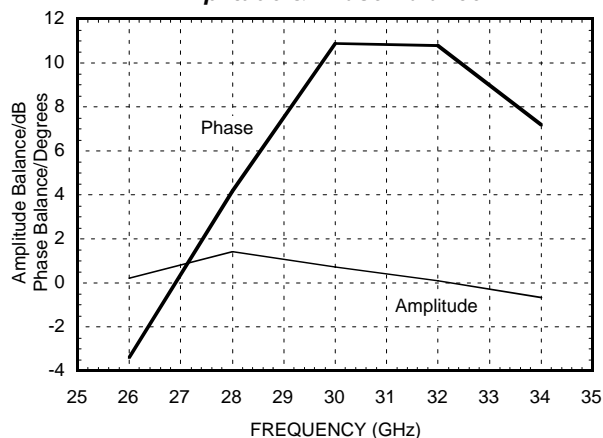
### Typical Mid-band Performance

Parameter	HMC404
RF Frequency	26 - 34 GHz
LO Frequency	12 - 16.5 GHz
IF Frequency	DC - 2 GHz
Single Side Band Conversion Loss	13.5 dB
Image Rejection	22 - 24 dB
Amplitude Balance	±1 dB
Phase Balance	10 degrees
LO Drive Required	+2 dBm
P1dB	0 dBm
Input IP3	17 dBm
Supply Voltage	+4.0V
Supply Current	28 mA

**Figure 1. Functional Diagram**



### Amplitude & Phase Balance



The system designer can select either the upper or lower sideband signals by modifying which port of his IF hybrid is the output. Alternatively, some systems may require the usage of both IF signals, which can also be accomplished with the HMC404 by eliminating the IF hybrid altogether.

The above table presents the typical performance of the HMC404 when measured in a connectorized housing. The assembly uses 3.0 mil ribbon bonds on the RF and LO bond ports, and 0.7 mil wire bonds on the IF ports. All data shown is data that has been collected in fixture, and therefore includes all associated assembly parasitics.

The HMC404 achieves excellent phase and amplitude balance performance, and therefore when implemented with a well-balanced external hybrid the customer can expect image rejection greater than 20 dB. Hittite's measurements include upper side band and lower side band measurements after an external hybrid, as well as amplitude and phase measurements at the IF ports of the mixer.

Hittite's HMC404 is 100% RF tested and available for immediate delivery.

## New Prescalar Product Line Meets The Demands of Broadband Markets! (Cont. from pg. 1)

where low phase-noise PLL control circuitry or broadband frequency translation is necessary.

The phase noise performance of the product line will support most complex telecommunication applications. Single side band phase noise performance is between -145 dBc/Hz and -153 dBc/Hz at 100kHz offset is typical at 25 degrees Celsius, depending on the model.

The prescalars operate from a single positive five-volt (+5v) supply and therefore eliminate complex bypass circuitry and differential bias voltage configurations. Differential biasing is not required. The only external components required are DC blocks on the RF I/O ports, and a bypass capacitor on Vcc.

Chip versions (HMC361, HMC362, HMC363, HMC364, and HMC365) offer selectable output power biasing control, for optimizing output power and current consumption for the specific application. The chips' utilize via hole MMIC technology, and therefore require no ground "down wire bonds". The customer may manufacture using standard Microwave Integrated Circuit (MIC) assembly techniques.

The surface mount prescalars are designated with an "S8G" suffix, and are offered in an industry standard eight lead SOIC8 package with an exposed ground/heat sink. Products can be shipped in tubes or tape and reel for mass volume production, and can be mounted using standard high volume reflow processes.

Hittite's prescalar product line is designed to support high volume applications. All products are immediately available from Hittite.

## Hittite's HMC313 Is A Perfect Mixer LO Driver Amplifier

Hittite's passive mixers require up to +19 dBm of LO drive, depending on the model, the IP3 performance, and the frequency of operation. Hittite's low cost, broadband InGaP HBT amplifiers are suitable as local oscillator (LO) drive amplifiers for all of Hittite's passive mixers that operate below 6 GHz. Choosing a specific amplifier can be confusing due to the variety of mixer LO requirements, and the variations in amplifier characteristics.

A chart has been created to define the various HMC313 bias conditions for each Hittite mixer listed. Each of the bias recommendations will ensure (over temperature and over frequency) that the proper LO power is delivered to the mixer.

Market	Mixer	RF & LO Band Covered (GHz)	Required LO Drive for Mixer (dBm)	Input RF Level to LO Amplifier (dBm)	Required Bias and Voltage for HMC313
Cellular & 3G	HMC208MS8	0.7 to 2.0	+13	-3	+5V @ 48 mA
	HMC350MS8	0.7 to 1.2	+19	+3	+7V @ 85 mA
	HMC316MS8	1.5 to 3.0	+17	0	+7V @ 85 mA
MMDS	HMC285	1.7 to 3.5	+10	-7	+5V @ 47mA
WLL	HMC213MS8	1.5 to 4.5	+13	-1	+5V @ 48 mA
UNII and HyperLAN	HMC218MS8	4.5 to 6.5	+13	+2	+7V @ 85 mA

The HMC313 can operate from a fixed positive +5.0V or +7.0V Vcc supply with the addition of a few external components, and is offered in a small SOT-26 package. Using a separate LO driver amplifier allows the customer an additional degree of freedom for filtering, matching and LO distribution and routing, thereby optimizing performance for the specific application. Having a broadband LO driver amplifier that can operate over several bands will allow the designer to use a common part across many designs, further reducing system cost.

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## What We Do

Hittite Microwave Corporation designs and manufactures high volume integrated circuit (IC) products to support the expanding needs of high-speed voice and data transfer systems. Hittite's product line of RF to millimeter wave components is recognized across the world because it offers a unique variety of functions and solutions for systems that operate between DC and 40 GHz.

All of Hittite's high performance ICs are manufactured using cutting edge semiconductor processes, including GaAs InGaP HBT, SiGe, PHEMT, and MESFET technology. When designing a product, we select the most appropriate semiconductor and package technology, and then uniquely balance digital and RF integration techniques to produce a result that is easy and cost effective for our customers to use.

Hittite will continue to focus on revolutionizing IC design concepts for a variety of markets. Our reputation of leading the industry with MMIC mixers, switches, and surface mount millimeter wave components has opened up new opportunities for our customers. Regardless of frequency, we apply high volume manufacturing techniques across our amplifier, switch, mixer, attenuator and frequency generation products groups. Each year Hittite breaks through new technology barriers, and then applies the technology to produce millions of integrated circuits to satisfy our customers. Our customers can then address their existing markets, and create new markets for their products.

Products from our standard catalog are shipped to factories that are located across Asia, Australia, North America, South America, and Europe. Our customers manufacture many different types of systems for the wireless and telecommunications world including:

- Broadband Wireless Systems for *LAST MILE INTERNET* Radio Platforms
- Broadband Two-way MMDS, UNII and HyperLAN Radios Platforms
- GSM, PCS, and 3G Cellular Platforms
- Microwave Radio Links
- Cable Modem Systems for CATV
- DBS Consumer Electronic Systems
- Fiber Optic Systems from OC-48 to OC-192
- Two-way Pager Systems

Our products are recognized by their uncompromising high quality and by their unique functionality & performance. Additionally, we have maintained a reputation of always meeting and exceeding our customer's requirements from a price, performance, and delivery.

