MMICs for Millimeter Wave Radios

from Hittite Microwave

For applications in the emerging market for Ka-band communication terminals, Hittite Microwave Corporation has introduced a family of 5 new millimeter wave MMIC converter and amplifier chip products. The new 14 to 40 GHz HMC258, HMC259, HMC264, and HMC265 frequency converters offer sub-harmonic (x2) local oscillator inputs (7 to 20 GHz), excellent isolation between terminals, and rejection of higher order products. Converters are available with LO amplifiers and IF amplifiers utilizing MESFET and PHEMT processes. Hittite Microwave also introduces a 20 to 40 GHz PHEMT distributed amplifier, HMC261, with 13 dB gain and +12 dBm output power. This family of mm wave converters and amplifiers are designed specifically for applications in Local Multi-point Distribution Systems (LMDS), K/Ka-band satellite ground terminals, and Ka-band point-to-point radios for performance improvement and size/cost reduction.

New MMIC Products Introduced at the WIRELESS SYMPOSIUM 99’

The 1999 Wireless Symposium/Portable by Design Show held in San Jose, CA (February 22-26) marked the introduction of 10 new MMIC products, covering DC-40 GHz, from Hittite Microwave and the new FEBRUARY 1999 standard products catalog. Also featured was the recently re-designed HMC web site, www.hittite.com.

The products include 5 new millimeter wave MMIC chips (featured in the above article) for the emerging LMDS market, promising high capacity data links, and the established SATCOM & mmWave radio markets. The HMC256 I/Q mixer will provide a fresh monolithic approach to SSB up & down conversion for PT-PT microwave radio & VSAT manufacturers. For cellular, W-CDMA, WLL, and MMDS engineers the HMC235QS16G digital

(con't on pg 6)
HMC265
GaAs MMIC SUB-HARMONICALLY PUMPED DOWNCONVERTER 20 - 32 GHz

General Description
The HMC265 chip is a sub-harmonically pumped (x2) MMIC downconverter with integrated LO & IF amplifiers. The chip utilizes a GaAs PHEMT technology that results in a small overall chip area of 1.74 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 -4dBm nominal drive requirement. This mixer chip is designed to be used in Local Multi-Point Distribution (LMDS) systems, microwave point-to-point radios, and 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). This downconverter IC is an excellent, smaller, and more reliable replacement to hybrid diode based downconverter MIC assemblies.

Features
- INTEGRATED LO AMPLIFIER:
  -4dBm INPUT
- SUB-HARMONICALLY PUMPED (x2) LO
- INTEGRATED IF AMPLIFIER:
  > 13 dB GAIN
- SMALL SIZE:
  1.32mm x 1.32mm

Conversion Gain vs. Temperature @ LO = -4 dBm Vdd= +4V

HMC264
GaAs MMIC SUB-HARMONICALLY PUMPED MIXER 20 - 32 GHz

General Description
The HMC264 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 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 -4dBm nominal drive requirement. This mixer chip is designed to be used in local multi-point distribution (LMDS) systems, microwave point-to-point radios, and SATCOM applications. All data is measured 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
- INTEGRATED LO AMPLIFIER:
  -4dBm INPUT
- SUB-HARMONICALLY PUMPED (x2) LO
- HIGH 2LO/RF ISOLATION:
  > 35 dB
- SMALL SIZE:
  0.97mm x 1.32mm

Conversion Gain vs. Temperature @ LO = -4 dBm Vdd= +4V

HMC261
GaAs MMIC MEDIUM POWER DISTRIBUTED AMPLIFIER 20 - 40 GHz

General Description
The HMC261 chip is a GaAs MMIC distributed amplifier which covers the frequency range of 20 to 40 GHz. The chip can easily be integrated into MultiChip Modules (MCMs) due to its small [2.21 mm$^2$] size. The chip utilizes a GaAs PHEMT process, operating from a single bias supply of + 3 to +4V with a P1dB output power of +12 dBm. This amplifier can be used in microwave & millimeter wave 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). The HMC261 may be used to drive the LOs of HMC mixers such as the HMC203.

Features
- STABLE GAIN vs. TEMPERATURE:
  14dB ± 1.5 dB
- HIGH REVERSE ISOLATION:
  40 - 50 dB
- P1dB OUTPUT POWER:
  +12 dBm
- SMALL SIZE:
  1.3mm x 1.7mm

Gain vs. Temperature @ Vdd= +4V
The HMC259 chip is a broadband sub-harmonically pumped (x2) balanced MMIC passive mixer which can be used as an upconverter or downconverter. The chip utilizes a GaAs MESFET process resulting in a small overall chip area of 1.9 mm$^2$. This chip has a very wide IF bandwidth of DC-13 GHz. The 2LO to RF isolation is excellent eliminating the need for additional filtering. This mixer chip is designed to be used in 38GHz point to point radios, Local Multi-Point Distribution Systems (LMDS), and 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). This device is a much smaller and more reliable replacement to hybrid diode mixer designs.

**features**
- **_sub-harmonically pumped (x2) lo**
- **high 2lo/rf isolation:** > 35 dB
- **small size:** 1.24 mm x 1.55 mm
- **ideal for 38 ghz radios, e1 & t1**

**general description**
The HMC259 chip is a broadband sub-harmonically pumped (x2) balanced MMIC passive mixer which can be used as an upconverter or downconverter. The chip utilizes a GaAs MESFET process resulting in a small overall chip area of 1.9 mm$^2$. This chip has a very wide IF bandwidth of DC-13 GHz. The 2LO to RF isolation is excellent eliminating the need for additional filtering. This mixer chip is designed to be used in 38GHz point to point radios, Local Multi-Point Distribution Systems (LMDS), and 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). This device is a much smaller and more reliable replacement to hybrid diode mixer designs.

**features**
- **Integrated LO Amplifier:** 0dBm Drive
- **Sub-harmonically Pumped (x2) LO**
- **High 2LO/RF Isolation:** > 35 dB
- **Small Size:** 0.8 mm x 1.1 mm

**general description**
The HMC258 chip is a compact sub-harmonically pumped (x2) single ended MMIC mixer with an integrated LO amplifier which can be used as an upconverter or downconverter. The chip utilizes a GaAs MESFET technology that results in a small overall chip area of 0.9 mm$^2$. The 2LO to RF isolation is excellent eliminating the need for additional filtering. The LO amplifier is a single bias (+5V) two stage design with only 0dBm drive requirement. A less stringent oscillator design is made possible by the low LO drive and sub-harmonic nature of the chip. This mixer chip is designed to be used in microwave point to point radios, 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**
- **Integrated LO Amplifier:** 0dBm Drive
- **Sub-harmonically Pumped (x2) LO**
- **High 2LO/RF Isolation:** > 35 dB
- **Small Size:** 0.8 mm x 1.1 mm

**general description**
The HMC256 chip is a compact, 2.08 mm$^2$, I/Q Mixer MMIC which can be used as an Image Reject Mixer (IRM), SSB upconverter or downconverter. The chip utilizes two standard Hittite double-balanced mixer cells and a Lange coupler realized in GaAs MESFET technology. This IRM MMIC is designed to be used in microwave point-to-point radios, 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). A low frequency quadrature hybrid was used to interface the MMIC IF ports to a 120 MHz IF USB output. This provides an example of the I/Q Mixer in an IRM application. The IF may be used from 1 to 1500 MHz. This I/Q Mixer is a more reliable, much smaller replacement to hybrid drop-in style I/Q Mixer assemblies.

**features**
- **High Image Rejection:** >30 dB
- **Input IP3:** +18 dBm
- **Small Size:** 1.3 mm x 1.6 mm
HMC235QS16G
GaAs MMIC SMT 5 - BIT DIGITAL ATTENUATOR DC - 4 GHz

General Description
The HMC235QS16G is a broadband 5-bit digital attenuator in a 16-lead (narrow pitch) surface mount QSOP plastic package with an exposed ground slug. This package occupies the same area as an 8 lead SOIC package. The 1, 2, 4 and 8 dB bits have less than 10 degrees relative phase shift. The five primary attenuation states can be activated independently, or collectively for attenuation levels of 1 to 31 dB. The HMC235QS16G is ideal for cellular, PCS, WLL, LMDS and IF applications. This is the smallest 5 bit digital attenuator available.

Features
WIDE BANDWIDTH:
DC - 4 GHz
ATTENUATION BITS:
1, 2, 4, 8, 16 dB
MINIATURE QSOP-16 PACKAGE

HMC213MS8
GaAs MMIC SMT DOUBLE-BALANCED MIXER 1.5 - 4.5 GHz

General Description
The HMC213MS8 is an ultra miniature double-balanced mixer in an 8 lead plastic surface mount Mini Small Outline Package (MSOP). This passive MMIC mixer is constructed of GaAs Schottky diodes and novel planar transformer baluns on the chip. The device can be used as an up or downconverter, bi-phase (de)modulator, or phase comparator for 1900, 2400, 3500 MHz applications. It is especially suited for miniature basestations, PCMCIA transceivers, and WLL applications because of its high dynamic input signal range, small size, and zero DC bias requirement. The consistent MMIC performance will improve system operation and assure regulatory compliance. The MSOP8 package is the smallest footprint available for a complete double-balanced mixer, 0.118" x 0.190" (3.0mm x 4.9mm). At a height of 0.040" (1.0mm) this is the thinnest mixer package available today.

Features
ULTRA SMALL PACKAGE:
MSOP8
CONVERSION LOSS:
8 dB
LO/RF ISOLATION:
40 dB
VSAT & LMDS SOLUTION

HMC188MS8
GaAs MMIC SMT FREQUENCY DOUBLER 1.25 - 3.0 GHz

General Description
The HMC188MS8 is a miniature frequency doubler in a plastic 8-lead MSOP package. The suppression of the undesired fundamental and higher order harmonics is typically 45 to 50 dB with respect to input signal levels. The doubler uses same diode/balun structures used in Hittite MMIC mixers. The doubler is ideal for high volume applications where frequency doubling of a lower frequency is more economical than directly generating a higher frequency. The passive Schottky diode doubler technology contributes no measurable additive phase noise onto the multiplied signal.

Features
CONVERSION LOSS:
15 dB
Fo, 3Fo, 4Fo ISOLATION:
40 dB
INPUT DRIVE LEVEL:
+10 to +20 dBm
HMC272MS8

General Description
The HMC272MS8 is an ultra miniature single balanced mixer in an 8-lead plastic surface mount Mini Small Outline Package (MSOP). This passive MMIC mixer is constructed of GaAs Schottky diodes and a novel planar transformer balun on the chip. The RF port is balanced via the MMIC balun while the LO port is connected directly to the diodes. The device can be used as an up or downconverter for PCS, W-CDMA, 2.4 ISM, or MMDS applications. The consistent MMIC performance will improve system operation and assure regulatory compliance. The MSOP8 package is the smallest footprint available for a complete single-balanced mixer, 0.118" x 0.190" (3.0mm x 4.9mm). At a height of 0.040" (1.0mm) this is the thinnest mixer package available today.

Features
- Ultra Small Package: MSOP8
- LO/RF Isolation: 35 dB
- IP3 (Input): +20 dBm
- Ideal for MMDS & W-CDMA

Conversion Gain vs. Temperature @ LO = +10 dBm

HMC251MS8

General Description
The HMC251MS8 is a low noise divide-by-2 GaAs MMIC prescaler in an 8-lead surface mount MSOP plastic package. This device operates from 3.0 to 6.5 GHz (input frequency) with a single +5.0 V DC supply while drawing only 27 mA of current. The low residual phase noise of this prescaler helps the user maintain good system noise performance. The HMC251MS8 is ideal for WLL, UNII, ISM and VSAT applications. This is the smallest divide-by-two prescaler available.

Features
- Divide-by-Two
- Low Phase Noise: -130 dBc/Hz @ 10KHz Offset
- Single Positive Bias Voltage: +5V @ 27 mA
- Miniature Small Outline Package: MSOP8

Output Power vs. Frequency @ Minimum Input Power Level

HMC210MS8

General Description
The HMC210MS8 is a miniature absorptive voltage variable attenuator in an 8-lead MSOP package. The device operates with a positive supply voltage (+2.5V), and a positive control voltage. A unique feature is the third order intercept point for all attenuation states. The HMC210MS8 is ideal for operation in PCS applications at 1.9 GHz and W-CDMA applications through 2.2 GHz. Operation up to 2.3 GHz is possible, with a reduced attenuation range of 31 dB.

Features
- Single Positive Voltage Control: 0 to +2.5V
- High Attenuation Range: >50 dB @ 1.9 GHz
- High Input IP3: +15 dBm TYPICAL (All Attenuation States)
- Ultra Small Package: MSOP8

Relative Attenuation vs. Control Voltage @ 1.9 and 2.2 GHz
Hittite Microwave offers Class S screening for MMIC die covering DC-40 GHz. We design and supply custom microwave ASICs as well as standard product die to satellite OEMs and their sub-contractors in small to high volumes. HMC MMICs are currently flown on several commercial & military payloads, offering high reliability and performance. We offer unique approaches to linear mixer/modulator designs with on-chip transformers, multi-throw switches with on-chip decoder/drivers, linear & phase compensated attenuators, phase shifters, frequency multipliers & dividers, and amplifiers (variable & fixed). These designs enable our customers to improve system performance and cost while saving valuable payload volume and weight.

Screening individual wafer lots is done to meet MIL-STD-883 Method 5007 wafer lot acceptance requirements. Measurements of internal wafer metal thicknesses and overall wafer thickness is done post wafer front & backside processing. Hittite Microwave Corporation conducts 100% RF Probe on wafer test [dc – 40 GHz] and visual inspection in a class 100 environment, per MIL-STD-883 Method 2010A. This is achieved by implementing laminar flow hoods in the production test and inspection areas to realize particle counts of Class 100 or less. Software controlled test stands allow for S-parameter and spectrum related data to be collected over specific customer frequencies. This data is presented to the customer in print and/or electronic format at the time of flight hardware is delivered. Die are shipped at customer request in either conductive standard Gel-Paks or conductive standard Waffle-Paks. Shipment of fully tested, diced, and inspected wafers on film frames is available for high volume requirements.

The Lot Acceptance Test (LAT) is conducted on sample die from the deliverable wafer lot. Five die per wafer are subjected to a 240-hour burn-in followed by a 1,000-hour life test at elevated temperatures [125 °C and 150 °C respectively]. A 1000hr/150 °C test simulates over 50 billion hours of life at 40 °C. Tests are conducted with DC bias to the MMIC die, which is closely monitored during the life test. Pre and Post-HTOL test delta limits are set up on critical RF parameters and measured before and after the 1,000 hour HTOL. The results are reported in the final LAT test report.

Details of the S-level MMIC process flows can be found in the new Hittite Microwave FEBRUARY 1999 catalog, Quality Assurance section pages xxiii - xxvi. To discuss your RF and microwave IC space applications please contact us and a Sales and Application Engineer will assist you.

HMC is Your Source for S-Level MMIC Die

MMICs for Millimeter Wave Radios...

(con’t from pg 1)

These complement our existing 0.7 to 40 GHz MMIC mixer family, which along with our attenuators, switches, doublers & dividers can be used in the IF chain of the millimeter wave radios. Introduced in this issue of OFF-THE-SHELF, these new mm wave chip products are available in sample to production quantities from stock! Detailed data sheets can be found in our new February 1999 catalog or on our re-designed web site. www.hittite.com. Look for these same products offered in mm wave Ball Grid Array (BGA) SMT packages in May 99!

New MMIC Products Introduced....

(con’t from pg 1)

& HMC210MS8 voltage variable SMT attenuators and HMC272MS8 very low cost linear SMT mixer will provide excellent solutions for their designs. An industry first low cost divide-by-two prescaler, HMC251MS8, marks HMC’s first in divider products for frequency synthesis.

Inside this issue of OFF-THE-SHELF each new product is featured. Full data sheets with Hittite Microwave’s Guarantee of Electrical Performance Over Temperature are available in the new FEBRUARY 1999 catalog or on the web site. These products are available immediately from stock!
Hittite Microwave Corporation Y2K Statement

Hittite Microwave Corporation is an innovative designer and manufacturer of Monolithic Microwave Integrated Circuits (MMICs) and MMIC assemblies for RF and microwave applications from dc-40 GHz. Our standard product line consists of over 75 gallium arsenide (GaAs) MMIC die and packaged die components.

Our products do not contain software of any kind and are not therefore subject to latent defects due to the Year 2000 (Y2K) problem. All of our products are Y2K compliant.

We have verified that our internal accounting/manufacturing software, computer operating systems, customer contact software, financial & payroll services, manufacturing/test instrumentation software, design & simulation software, company networking hardware/software infrastructure, and utilities software & systems (fire/security/phone/ISP) are Y2K compliant. We have requested, received, and filed Y2K compliance statements from all of our major suppliers and sub-contractors. We achieved full Y2K compliance on February 1, 1999.

If you have any questions or concerns regarding Hittite Microwave Corporation’s Y2K compliance please contact HMC Sales by email (y2k@hittite.com), phone 781-933-7267, or fax 781-932-8903.
About Hittite Microwave

Hittite Microwave Corporation is an innovative designer and manufacturer of Monolithic Microwave Integrated Circuits (MMICs) and MMIC assemblies for RF and microwave applications. Founded in 1985, our company’s expertise in MMIC technology has enabled us to achieve the best price/performance value for each of the products we manufacture.

Hittite Microwave’s mission is to provide creative solutions for our customers:

We strive to be a leading and worldwide recognized supplier of microwave IC based products and components for both commercial, military, and space markets. Our products will be recognized both by their uncompromising high quality and by their unique functionality & performance. To achieve this goal, we shall rely on advanced design concepts, best available fabrication technology, and automated manufacturing & test methods.

Our standard MMIC product line consists of over 75 gallium arsenide (GaAs) MMIC die and packaged die products covering DC - 40 GHz. Our standard and custom products support a wide range of wireless and wired communications applications, including:

- **Voice**: Cellular, PCS, and Satellite Telephony
- **Data**: WLAN, GPS, RFID, Data Over Cable
- **Broadband/Video**: Microwave Telecom Link, VSAT, MMDS, LMDS, DBS, CATV
- **Sensor**: Military, Industrial, Commercial
- **Military**: C³, EW, ECM, RADAR
- **Space**: Switching Matrices, Up/Down Conversion, RADAR

Quality is the cornerstone of our corporate mission and our commitment to customers. We keep this commitment throughout our organization. Hittite Microwave is certified for ISO 9001, the accepted standard worldwide for quality.