Broadband DC to 4 GHz Digital Attenuators Offer Low Bit Error

Control of signal strength while maintaining signal integrity in the transmit and receive paths of wireless systems has always been a concern of RF design engineers. Hittite Microwave has introduced a family of seven low cost 2, 3, & 5 Bit Digital Attenuator (DATT) GaAs ICs. These products offer unprecedented bandwidth from DC to 4 GHz, positive bias & control and ± 0.2 to ± 0.5 dB typical accuracy in plastic packages as small as a 6 lead SOT26. Excellent input IP3 performance of +44 to +54 dBm characterizes these attenuators, satisfying today’s linearity requirements for cellular/PCS/3G/ISM and broadband datacom systems.

GaAs IC Digital Attenuator Product Line

<table>
<thead>
<tr>
<th>Part Number</th>
<th>Features</th>
<th>Freq. Range (GHz)</th>
<th>Attenu. Step Sizes (dB)</th>
<th>Bit Error (dB)</th>
<th>Input IP3 (dBm)</th>
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</thead>
<tbody>
<tr>
<td>HMC273MS10G</td>
<td>5 Bit 1 to 31dB Pos. Bias</td>
<td>0.7 - 3.7</td>
<td>1, 2, 4, 8, 16</td>
<td>± 0.5</td>
<td>48</td>
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<tr>
<td>HMC307QS16G</td>
<td>5 Bit 1 to 31dB Neg. Bias</td>
<td>DC - 4</td>
<td>1, 2, 4, 8, 16</td>
<td>± 0.5</td>
<td>44</td>
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<tr>
<td>HMC306MS10G</td>
<td>5 Bit 0.5 to 15.5dB Pos. Bias</td>
<td>0.7 - 3.7</td>
<td>0.5, 1, 2, 4, 8</td>
<td>± 0.25</td>
<td>52</td>
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<tr>
<td>HMC230MS8</td>
<td>3 Bit 4 to 28 dB Pos. Bias</td>
<td>0.75 - 2</td>
<td>4, 8, 16</td>
<td>± 0.5</td>
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<tr>
<td>HMC288MS8</td>
<td>3 Bit 2 to 14 dB Pos. Bias</td>
<td>0.7 - 3.7</td>
<td>2, 4, 8</td>
<td>± 0.3</td>
<td>51</td>
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<tr>
<td>HMC291</td>
<td>2 Bit 4 to 12 dB Pos. Bias</td>
<td>0.7 - 4</td>
<td>4, 8</td>
<td>± 0.2</td>
<td>54</td>
</tr>
<tr>
<td>HMC290</td>
<td>2 Bit 2 to 6 dB Pos. Bias</td>
<td>0.7 - 4</td>
<td>2, 4</td>
<td>± 0.2</td>
<td>52</td>
</tr>
</tbody>
</table>

* All data is mid-band typical.

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HMC273MS10G

1 dB LSB GaAs IC 5-BIT DIGITAL ATTENUATOR 0.7-3.7 GHz

General Description
The HMC273MS10G is a broadband 5-bit positive control GaAs IC digital attenuator in a 10 lead MSOP surface mount plastic package. Covering 0.7 to 3.7 GHz, the insertion loss is typically less than 2 dB. The attenuator bit values are 1 [LSB], 2, 4, 8, and 16 dB for a total attenuation of 31 dB. Accuracy is excellent at ± 0.5 dB typical with an IIP3 of up to +48 dBm. Five individual bit control voltage inputs, toggled between 0 and +3 to +5 volts, are used to select each attenuation state at less than 50 uA each. A single Vdd bias of +3 to +5 volts applied through an external 5KΩ resistor is required. The HMC273MS10G is ideal for cellular, PCS, ISM, MMDS, and WLL applications and is an excellent alternative to the HMC235QS16G. Occupying less than 14.8 mm², this is the smallest 5-bit digital attenuator available.

HMC307QS16G

1 dB LSB GaAs IC 5-BIT DIGITAL ATTENUATOR DC-4 GHz

General Description
The HMC307QS16G is a broadband 5-bit GaAs IC digital attenuator in a 16 lead QSOPT grounded base surface mount plastic package. Covering DC to 4 GHz, the insertion loss is less than 2 dB typical. The attenuator bit values are 1 [LSB], 2, 4, 8, and 16 dB for a total attenuation of 31 dB. Attenuation accuracy is excellent at ± 0.5 dB typical with an IIP3 of up to +44 dBm. Five bit control voltage inputs, toggled between 0 and -5V, are used to select each attenuation state at less than 50 uA each. A single Vee bias of -5V allows operation down to DC, satisfying CATV, cable modem, and all IF applications. The HMC307QS16G is also ideal for cellular, PCS, ISM, MMDS, and WLL applications. This product is an excellent alternative to the HMC235QS16G.

HMC306MS10

0.5 dB LSB GaAs IC 5-BIT DIGITAL ATTENUATOR 0.7-4 GHz

General Description
The HMC306MS10 is a broadband 5-bit positive control GaAs IC digital attenuator in a 10 lead MSOP surface mount plastic package. Covering 0.7 to 4 GHz, the insertion loss is typically less than 1.5 to 2.3 dB. The attenuator bit values are 0.5 (LSB), 1, 2, 4 and 8 for a total attenuation of 15.5 dB. Attenuation accuracy is excellent at ± 0.3 dB typical with an IIP3 of up to +52 dBm. Five bit control voltage inputs, toggled between 0 and +3 to +5V, are used to select each attenuation state at less than 50 uA each. A single Vdd bias of +3 to +5V applied through an external 5KΩ resistor is required. The HMC306MS10 is ideal for cellular, PCS, ISM, MMDS, and WLL applications while occupying less than 14.8 mm².
**For Wireless Applications**

### HMC230MS8

**4 dB LSB GaAs IC 3 - BIT DIGITAL ATTENUATOR 0.7 - 2.0 GHz**

**Features**
- 4 dB LSB STEPS to 28 dB
- SINGLE POSITIVE CONTROL PER BIT
- +/- 0.5 dB TYPICAL BIT ERROR
- PIN - FOR - PIN REPLACEMENT TO AA100-59 ATTENUATOR

**General Description**

The HMC230MS8 is a broadband 3-bit positive control GaAs IC digital attenuator in an 8 lead MSOP surface mount plastic package. Covering 0.7 to 2 GHz the insertion loss is typically less than 2 dB. The attenuator bit values are 4 (LSB), 8, and 16 dB for a total attenuation of 28 dB. Accuracy is excellent at ± 0.5 dB typical with an IIP3 of up to +48 dBm. Three bit control voltage inputs, toggled between 0 and +3 to +5 volts, are used to select each attenuation state at less than 50 uA each. A single Vdd bias of +3 to +5 volts applied through an external 5kΩ resistor is required. The HMC230MS8 is ideal for cellular, PCS, ISM, MMDS, and WLL handset & basestation applications.

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### HMC288MS8

**2 dB LSB GaAs IC 3 - BIT DIGITAL ATTENUATOR 0.7 - 3.7 GHz**

**Features**
- 2 dB LSB STEPS to 14 dB
- SINGLE POSITIVE CONTROL PER BIT
- LOW DISTORTION: +51 dBm IIP3
- MONOTONIC: ±0.3 dB Bit Error Typical

**General Description**

The HMC288MS8 is a broadband 3-bit positive control GaAs IC digital attenuator in an 8 lead MSOP surface mount plastic package. Covering 0.7 to 3.7 GHz the insertion loss is typically less than 1.2 to 1.8 dB. The attenuator bit values are 2 (LSB), 4, and 8 for a total attenuation of 14 dB. Accuracy is excellent at ± 0.3 dB typical with an IIP3 of up to +51 dBm. Three bit control voltage inputs, toggled between 0 and +3 to +5V, are used to select each attenuation state at less than 50 uA each. A single Vdd bias of +3 to +5V applied through an external 5kΩ resistor is required. The HMC288MS8 is ideal for cellular, PCS, ISM, MMDS, and WLL applications while occupying less than 14.8 mm².

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### HMC291

**4 dB LSB GaAs IC 2 - BIT DIGITAL ATTENUATOR 0.7 - 4 GHz**

**Features**
- 2 dB LSB STEPS to 6 dB
- SINGLE POSITIVE CONTROL PER BIT, 0/+3V
- +/- 0.2 dB TYPICAL BIT ERROR
- MINIATURE SOT-26 PACKAGE: 9 mm²

**General Description**

The HMC291 is a broadband 2-bit positive control GaAs IC digital attenuator in a 6 lead SOT26 surface mount plastic package. Covering 0.7 to 4 GHz the insertion loss is typically less than 0.9 to 1.3 dB. The attenuator bit values are 4 (LSB) and 8 dB for a total attenuation of 12 dB. Accuracy is excellent at ± 0.2 dB typical with an IIP3 of up to +54 dBm. Two bit control voltage inputs, toggled between 0 and +3 to +5 volts, are used to select each attenuation state at less than 50 uA each. A single Vdd bias of +3 to +5 volts applied through an external 5kΩ resistor is required. The HMC291 is ideal for cellular, PCS, ISM, MMDS, and WLL handset & basestation applications. Occupying less than 9 mm², this is the smallest 2-bit digital attenuator available.
HMC290

**General Description**
The HMC290 is a broadband 2-bit positive control GaAs IC digital attenuator in a 6-lead SOT26 surface mount plastic package. Covering 0.7 to 4 GHz the insertion loss is typically less than 0.7 dB. The attenuator bit values are 2 [LSB] and 4 dB for a total attenuation of 6 dB. Accuracy is excellent at ±0.2 dB typical with an IP3 of up to ±52 dBm. Two bit control voltage inputs, toggled between 0 and +3 to +5 volts, are used to select each attenuation state at less than 50 uA each. A single Vdd bias of +3 to +5 volts applied through an external 5kΩ resistor is required. The HMC290 is ideal for cellular, PCS, ISM, MMDS, and WLL handset & base station applications. Occupying less than 9 mm², this is the smallest 2-bit digital attenuator available.

### Features
- 2 dB LSB STEPS to 6 dB
- SINGLE POSITIVE CONTROL PER BIT, 0/+3V
- +/- 0.2 dB TYPICAL BIT ERROR
- MINIATURE SOT-26 PACKAGE: 9 mm²

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HMC199MS8

**HMC199MS8 MSOP8 DUAL SPDT SWITCH DC-2.5 GHz**

**General Description**
The HMC199MS8 is a low-cost dual SPDT GaAs “bypass” switch in an 8-lead MSOP package covering DC to 2.5 GHz. This four RF port component integrates two SPDT switches and a through line onto a single IC. The design provides low insertion loss of less than 0.5 dB while switching passive or active external circuit components in and out of the signal path. Port to port isolations are typically 35 to 20 dB. On-chip circuitry enables positive voltage control operation at very low DC currents with control inputs compatible with CMOS and most TTL logic families. Applications include LNA or filter bypass switching and single bit attenuator switching for cellular, PCS, and ISM systems.

### Features
- INTEGRATED DUAL SPDTs
- LOW INSERTION LOSS:
  - < 0.5 dB @ 2.0 GHz
- POSITIVE CONTROL:
  - 0/+5V
- ULTRA SMALL MSOP8 PACKAGE:
  - 14.8 mm²

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HMC270MS8G

**GaAs SPDT NON-REFLECTIVE SWITCH DC-8.0 GHz**

**General Description**
The HMC270MS8G is a broadband non-reflective GaAs SPDT switch in an 8 lead MSOP grounded base surface mount plastic package. Covering DC to 8 GHz the switch offers excellent isolation, from 70 to 35 dB. The negative control voltage of -5 volts allows operation down to DC, satisfying CATV, cable modem, and all IF applications. Instrumentation applications can also take advantage of the wide bandwidth. The HMC270MS8G is ideal for cellular, PCS, ISM (2.4 & 5.8 GHz), MMDS, and WLL. If positive control is required along with high isolation see the DC to 3.5 GHz HMC284MS8G non-reflective SPDT.

### Features
- BROADBAND PERFORMANCE:
  - DC – 8 GHz
- VERY HIGH ISOLATION:
  - 55 dB @ 2 GHz
- NON-REFLECTIVE DESIGN
- LOW COST MSOP-8 PACKAGE:
  - 14.8 mm²

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**Insertion Loss and Isolation**

**Insertion Loss and Normalized Attenuation**
HMC278MS8G
100mW MEDIUM POWER GaAs IC AMPLIFIER 1.5 – 3.0 GHz

General Description
The HMC278MS8G is a 100mW GaAs MMIC medium power amplifier covering 1.5 to 3 GHz. The device is packaged in a low cost, surface mount 8 lead MSOP plastic package with an exposed base paddle for improved RF ground and thermal dissipation. The amplifier provides 21 dB of gain and +20 dBm P1dB output power while operating from a single positive supply of Vdd= +5V @ 120 mA. At Vdd = +3V the gain is 19 dB with a P1dB of +16dBm. With RF I/Os matched to 50Ω, external component requirements are minimal. At a height of 0.040” (1.0mm), the MSOP8 package is ideal for low profile portable wireless devices. The HMC278MS8G with the HMC309MS8 integrated LNA and TxRx switch front-end for BLUETOOTH Class I, HomeRF, 802.11 WLAN, and ISM 2.4 GHz radios.

Features
+ 20 dBm OUTPUT POWER

SINGLE SUPPLY:
+3V to +5V

IDEAL FOR PCS/3G, MMDS, HomeRF, & BLUETOOTH APPLICATIONS

ULTRA SMALL 8 LEAD MSOP: 14.8 mm² x 1mm HIGH

HMC309MS8
2.4 GHz INTEGRATED LNA & TxRx SWITCH FRONT-END

General Description
The HMC309MS8 is a versatile integrated low noise amplifier [LNA] and transmit/receive switch front-end for 2.4 to 2.5 GHz spread spectrum applications including BLUETOOTH, HomeRF, 802.11 WLAN, and 2.4 GHz ISM radios. The LNA offers 8 dB gain and 2.5 dB noise figure while the transmit switch path has 0.5 dB insertion loss and better than +30 dBm linear power handling. Using a single control line, the LNA is powered down when the switch Tx port is selected minimizing Idc current consumption to 5 mA in the Rx mode and 120 uA in the Tx mode at Vdd = +3V bias. The HMC309MS8 may be directly interfaced with popular 2.4 GHz transceiver chips. At a height of 0.040” (1.0mm), the MSOP8 package is ideal for low profile portable wireless devices.

Features
MONOLITHIC LNA & SWITCH IC

INTEGRATED POWER CONTROL: +3V OPERATION

IDEAL FOR 802.11, HomeRF, & BLUETOOTH APPLICATIONS

ULTRA SMALL 8 LEAD MSOP: 14.8 mm² x 1mm High

HMC304MS8
HIGH IP3 SINGLE BALANCED SMT MIXER IC 1.7 – 3.0 GHz

General Description
The HMC304MS8 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 novel planar transformer baluns on the chip while not requiring any external components. The RF port is balanced via the MMIC balun while the LO port is connected directly to the diodes. LO isolations are typically 20 to 30 dB. Excellent input IP3 performance of +27 to +32 dBm makes this device ideal for PCS, 3G, 2.4GHz ISM, or MMDS applications. The HMC304MS8 is the smallest high IP3 mixer available, 0.118” x 0.190” [3.0mm x 4.9mm].

Features
HIGH DYNAMIC RANGE:
+32 dBm IP3

NO EXTERNAL COMPONENTS REQUIRED

LO/RF ISOLATION:
28 dB

ULTRA SMALL MSOP8 PACKAGE:
14.8 mm²
Handling, Mounting, & Bonding GaAs MMIC Die

With the increasing emphasis on microwave and millimeter wave communication systems such as point to point & multi-point radios, LMDS, and SATCOM, the demand for die level product is rising.

HMC is a high volume supplier of commercial and space screened die. Here are some guidelines to handling, mounting, and bonding GaAs MMIC die. See the HMC catalog for a full version of this application note.

Handling Precautions

Follow these precautions to avoid permanent damage:

- Shipment & Storage: HMC packs and ships all die in either wafer-pack or vacuum release Gel-Pak™ carriers. A maximum of 25 die per pack is shipped. Store die-packs in a nitrogen dry box.
- Cleanliness: Handle the chips in a clean environment. DO NOT attempt to clean the chip using liquid cleaning systems.
- Static Sensitivity: Follow ESD precautions to protect against > ± 250V ESD strikes.
- Transients: Suppress instrument and bias supply transients while bias is applied.
- General Handling: Handle the chip along the edges with a vacuum collet or with a sharp pair of bent tweezers and avoid contact with the surface of the chip.

Mounting

Eutectic Die Attach: An 80/20 gold tin preform is recommended with a work surface temperature of 255 degC and a tool temperature of 265 degC. When hot 90/10 nitrogen/hydrogen gas is applied, tool tip temperature should be 290 degC. DO NOT expose the chip to a temperature greater than 320 degC for more than 20 seconds.

Epoxy Die Attach: Apply a minimum amount of epoxy to the mounting surface so that a thin epoxy fillet is observed around the perimeter of the chip once it is placed into position. Cure epoxy per the manufacturer’s schedule.

Wire Bonding

Use 1.0 mil diameter pure gold wire. Thermosonic wire bonding with a nominal stage temperature of 150 degC and a ball bonding force of 40 to 50 grams or wedge bonding force of 18 to 22 grams is recommended. Use the minimum level of ultrasonic energy to achieve reliable wirebonds. RF bonds should be as short as possible.

Broadband Digital Attenuators...

Data sheet specifications are targeted towards the frequency bands of 0.7 to 1.4 GHz (cellular, PDC, PHS), 1.4 to 2.3 GHz (PCN, 3G), 2.3 to 2.7 GHz (ISM, Home RF, Bluetooth, MMDS), and 2.7 to 3.7 GHz (WLL). Exceptional DC to 4 GHz performance allows the HMC307GS16G to address cable modem, instrumentation, and all IF applications down to “DC”.

The HMC306MS10 offers the least significant bit (LSB) step of 0.5 dB while maintaining a bit error of ± 0.25 dB. Both the HMC273MS10G and the HMC307GS16G offer traditional 1 dB LSB steps to a maximum of 31 dB. Occupying only 14.8 mm² in a 10 lead MSOP package, the HMC273MS10G is the smallest 5 bit 1 to 31 dB digital attenuator available today.

For minimal gain adjustment applications, the HMC290 and HMC291 provide 2 bit control in step sizes of 4 & 8 to 12 dB and 2 & 4 to 6 dB respectively. These products offer very low bit error of ± 0.2 dB typical with less than 0.9 dB reference insertion loss. Handset and basestation designers will find this performance a great alternative to lossy voltage variable attenuators.

All of the attenuators require a single control voltage for each attenuator bit, minimizing logic interface and package lead count. A single positive bias supplied through an external 5K ohm resistor is utilized by all products except the negative bias HMC307GS16G. Control and bias currents for each are 100 to 250 uA typical.

The seven digital attenuator ICs are manufactured on a high volume production GaAs MESFET process, resulting in a low cost family of products with consistent performance. Standard fine lead pitch plastic packaging minimizes the footprint of each part from between 9 to 29.4 mm².

Inside this issue of OFF-THE-SHELF each new product is featured. Full data sheets with Hitite Microwave’s Guarantee of Electrical Performance Over Temperature are available in the new June 2000 Catalog Supplement or on the web site. These products are available immediately from stock!
ISO Recertification

We are proud to announce that Hittite Microwave Corp. has achieved re-certification to the requirements of the ISO 9001 Quality System Standard. Hittite was originally certified to ISO 9001 in 1997 and has maintained this prestigious certification for the full 3-year certification cycle. TÜV Management Services of Danvers, MA conducted the certification audit of our Chelmsford, MA facility. This was a comprehensive re-certification audit to all of the 20 required elements of ISO 9001. This certification demonstrates the commitment of Hittite’s team to provide our customers with consistently high levels of quality in design, development, production and customer service.

LOW COST SWITCH AD FEATURED IN MAJOR TRADE PUBLICATIONS

YES! I WOULD LIKE TO RECEIVE THE FOLLOWING:

- Future issues of OFF-THE-SHELF
- September 1999 CD Catalog
- June 2000 Catalog Supplement
- Please have a Sales & Application Engineer contact me!

Company Name ____________________________ Title ____________________________
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Please fax this form to: HMC Sales Department. 978-250-3373

DID YOU KNOW?
Hittite has added 22 New Products in 2000,
Covering DC - 40 GHz!

WELCOME NEW SALES REPS!

Hittite Microwave is pleased to announce the following appointments:

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June 2000 Catalog Supplement

Sixteen of Hittite’s latest in-stock MMIC products are featured in our June 2000 Catalog Supplement, complementing the full line February 2000 catalog. Some of these are featured in this issue of OFF-THE-SHELF. Complete data sheets are detailed for: seven new Digital Attenuators covering DC to 4 GHz; Hi-IP Mixers; 2.4 GHz ISM & Bluetooth transceiver front-end ICs; broadband low cost switches covering up to 8 GHz; and Millimeter Wave SMT Packaged Low Noise & Power Amplifiers. Supplements can be requested by faxing the form below.
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. 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 novel design concepts, advanced fabrication technologies, and fully automated manufacturing & test methods.

Our standard MMIC product line consists of over 100 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, Cable Modem
- 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.