

## GaAs MMIC MSOP8 T/R SWITCH DC - 3 GHz

FEBRUARY 2001

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### Features

ULTRA SMALL PACKAGE: MSOP8  
HIGH THIRD ORDER INTERCEPT: +60 dBm  
SINGLE POSITIVE SUPPLY: +3 TO +10V  
HIGH RF POWER CAPABILITY

### General Description

The HMC174MS8 is a low-cost SPDT switch in an 8-lead MSOP package for use in transmit-receive applications which require very low distortion at high signal power levels. The device can control signals from DC to 3.0 GHz and is especially suited for 900 MHz, 1.8-2.2 GHz, and 2.4GHz ISM applications with only 0.5 dB loss. The design provides exceptional intermodulation performance; providing a +60dBm third order intercept at 8 Volt bias. RF1 or RF2 is a reflective short when "Off". On-chip circuitry allows single positive supply operation at very low DC current with control inputs compatible with CMOS and most TTL logic families. They are especially suited for PCMCIA wireless card and cellular phone applications.



### Guaranteed Performance, $V_{dd} = +5 V_{dc}$ , 50 Ohm System, -40 to +85 deg C

| Parameter                                                                                 | Frequency     | Min. | Typ. | Max. | Units |
|-------------------------------------------------------------------------------------------|---------------|------|------|------|-------|
| Insertion Loss                                                                            | DC - 1.0 GHz  |      | 0.5  | 0.7  | dB    |
|                                                                                           | DC - 2.0 GHz  |      | 0.5  | 0.8  | dB    |
|                                                                                           | DC - 2.5 GHz  |      | 0.7  | 1.0  | dB    |
|                                                                                           | DC - 3.0 GHz  |      | 1.4  | 1.8  | dB    |
| Isolation                                                                                 | DC - 1.0 GHz  | 22   | 25   |      | dB    |
|                                                                                           | DC - 2.0 GHz  | 20   | 24   |      | dB    |
|                                                                                           | DC - 2.5 GHz  | 17   | 21   |      | dB    |
|                                                                                           | DC - 3.0 GHz  | 13   | 17   |      | dB    |
| Return Loss                                                                               | DC - 1.0 GHz  | 20   | 28   |      | dB    |
|                                                                                           | DC - 2.0 GHz  | 16   | 21   |      | dB    |
|                                                                                           | DC - 2.5 GHz  | 13   | 17   |      | dB    |
|                                                                                           | DC - 3.0 GHz  | 9    | 11   |      | dB    |
| Input Power for 1dB Compression      0/8V Control                                         | 0.5 - 1.0 GHz | 35   | 39   |      | dBm   |
|                                                                                           | 0.5 - 3.0 GHz | 34   | 38   |      | dBm   |
| Input Third Order Intercept      0/8V Control                                             | 0.5 - 1.0 GHz | 55   | 60   |      | dBm   |
|                                                                                           | 0.5 - 3.0 GHz | 55   | 60   |      | dBm   |
| Switching Characteristics<br>tRISE, tFALL (10/90% RF)<br>tON, tOFF (50% CTL to 10/90% RF) | DC - 3.0 GHz  |      | 10   |      | nS    |
|                                                                                           |               |      | 24   |      | nS    |

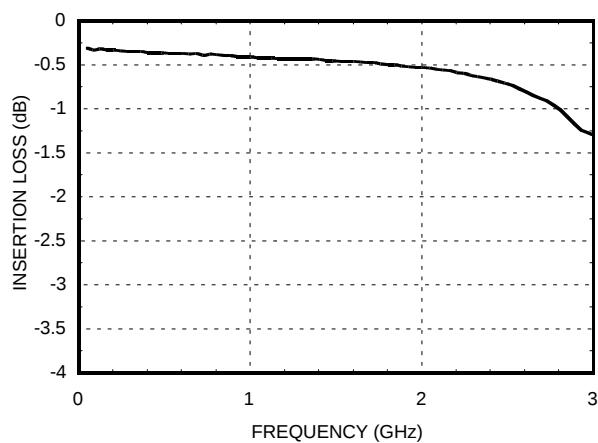


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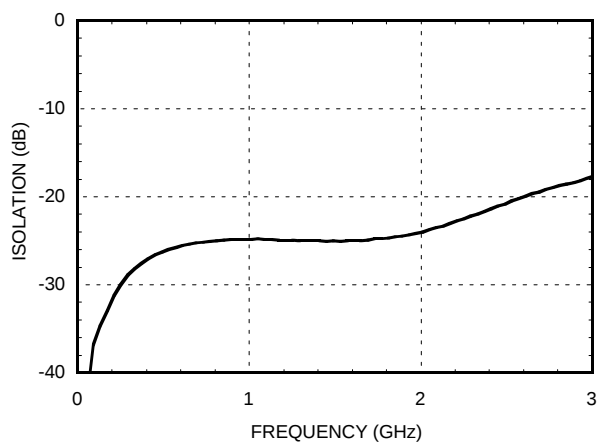
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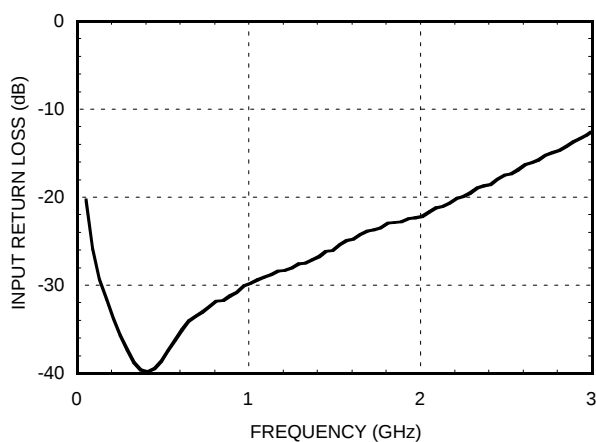
### Insertion Loss



### Isolation



### Return Loss



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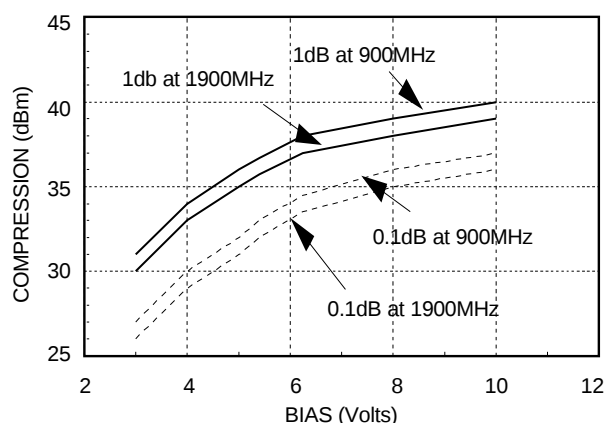


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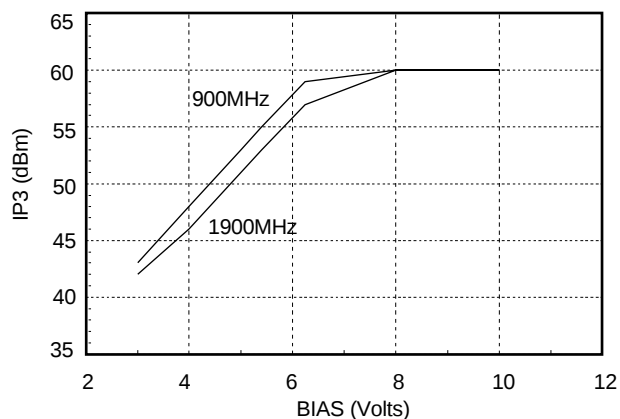
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### Input 0.1 and 1.0 dB Compression vs Bias Voltage



### Input Third Order Intercept vs Bias Voltage



### Compression vs Bias Voltage

| Bias<br>Vdd<br>(Volts) | Carrier at 900MHz                       |                                       | Carrier at 1900MHz                      |                                       |
|------------------------|-----------------------------------------|---------------------------------------|-----------------------------------------|---------------------------------------|
|                        | Input Power<br>for 0.1dB<br>Compression | Input Power<br>for 1dB<br>Compression | Input Power<br>for 0.1dB<br>Compression | Input Power<br>for 1dB<br>Compression |
|                        | (dBm)                                   | (dBm)                                 | (dBm)                                   | (dBm)                                 |
| 3                      | 27                                      | 31                                    | 26                                      | 30                                    |
| 4                      | 30                                      | 34                                    | 29                                      | 33                                    |
| 5                      | 32                                      | 36                                    | 31                                      | 35                                    |
| 8                      | 36                                      | 39                                    | 35                                      | 38                                    |
| 10                     | 37                                      | 40                                    | 36                                      | 39                                    |

### Distortion vs Bias Voltage

| Bias<br>Vdd<br>(Volts) | 1 Watt Carrier at 900MHz    |                              |                    | 1 Watt Carrier at 1900MHz   |                              |                    |
|------------------------|-----------------------------|------------------------------|--------------------|-----------------------------|------------------------------|--------------------|
|                        | Third<br>Order<br>Intercept | Second<br>Order<br>Intercept | Second<br>Harmonic | Third<br>Order<br>Intercept | Second<br>Order<br>Intercept | Second<br>Harmonic |
|                        | (dBm)                       | (dBm)                        | (dBc)              | (dBm)                       | (dBm)                        | (dBc)              |
| 3                      | 43                          | 71                           | 45                 | 42                          | 78                           | 55                 |
| 4                      | 48                          | 85                           | 55                 | 46                          | 88                           | 65                 |
| 5                      | 53                          | 90                           | 56                 | 51                          | 87                           | 58                 |
| 8                      | 60                          | 90                           | 58                 | 60                          | 90                           | 59                 |
| 10                     | 60                          | 90                           | 59                 | 60                          | 90                           | 60                 |

Caution: Do not operate in 1dB compression at power levels above +35dBm and do not 'hot switch' power levels greater than +23dBm ( $V_{dd} = +5Vdc$ ).

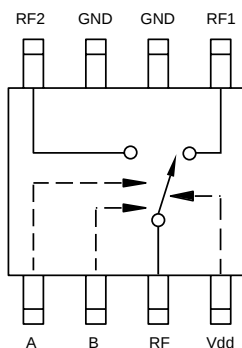


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### Functional Diagram



### Truth Table

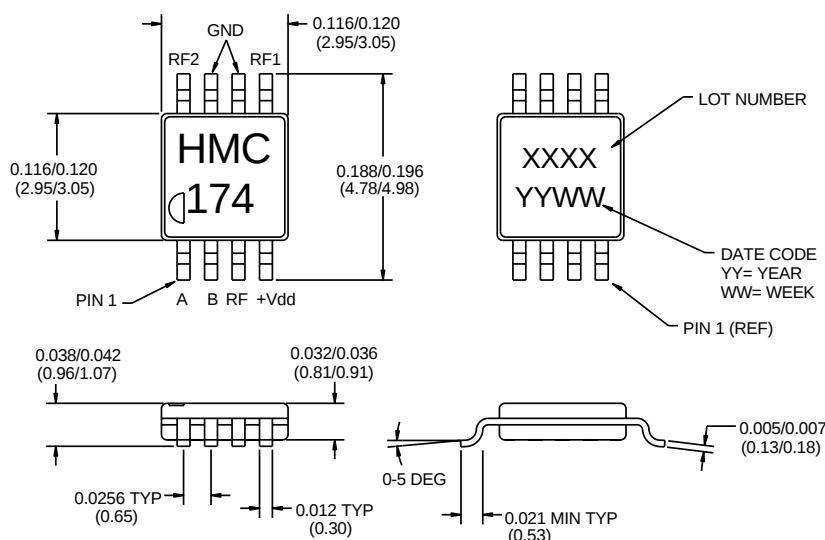
\*Control Input Voltage Tolerances are  $\pm 0.2$  Vdc

| Bias      | Control Input * |         | Bias Current    | Control Current | Control Current | Signal Path State |           |
|-----------|-----------------|---------|-----------------|-----------------|-----------------|-------------------|-----------|
| Vdd (Vdc) | A (Vdc)         | B (Vdc) | Ivdd ( $\mu$ A) | Ia ( $\mu$ A)   | Ib ( $\mu$ A)   | RF to RF1         | RF to RF2 |
| 3         | 0               | 0       | 30              | -15             | -15             | OFF               | OFF       |
| 3         | 0               | Vdd     | 25              | -25             | 0               | ON                | OFF       |
| 3         | Vdd             | 0       | 25              | 0               | -25             | OFF               | ON        |
| 5         | 0               | 0       | 110             | -55             | -55             | OFF               | OFF       |
| 5         | 0               | Vdd     | 115             | -100            | -15             | ON                | OFF       |
| 5         | Vdd             | 0       | 115             | -15             | -100            | OFF               | ON        |
| 10        | 0               | 0       | 380             | -190            | -190            | OFF               | OFF       |
| 10        | 0               | Vdd     | 495             | -275            | -220            | ON                | OFF       |
| 10        | Vdd             | 0       | 495             | -220            | -275            | OFF               | ON        |
| 5         | -Vdd            | Vdd     | 600             | -600            | 225             | ON                | OFF       |
| 5         | Vdd             | -Vdd    | 600             | 225             | -600            | OFF               | ON        |

### Absolute Maximum Ratings

|                               |                   |
|-------------------------------|-------------------|
| Bias Voltage Range (Vdd)      | -0.2 to +12 Vdc   |
| Control Voltage Range (A & B) | -0.2 to +Vdd Vdc  |
| Storage Temperature           | -65 to +150 deg C |
| Operating Temperature         | -40 to +85 deg C  |

### Outline



- 1) MATERIAL:  
A) PACKAGE BODY: LOW STRESS INJECTION MOLDED PLASTIC, SILICA & SILICONE IMPREGNATED  
B) LEADFRAME MATERIAL: COPPER ALLOY
2. PLATING: LEAD-TIN SOLDER PLATE
3. DIMENSIONS ARE IN INCHES (MILLIMETERS)

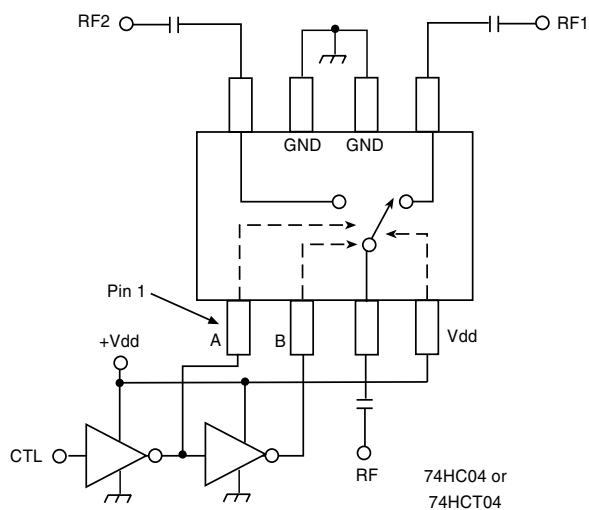


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### Typical Application Circuit



#### Notes:

1. Set logic gate and switch Vdd = +3V to +5V and use HCT series logic to provide a TTL driver interface.
2. Control inputs A/B can be driven directly with CMOS logic (HC) with Vdd of 3 to 8 Volts applied to the CMOS logic gates and to pin 4 of the RF switch.
3. DC Blocking capacitors are required for each RF port as shown. Capacitor value determines lowest frequency of operation.
4. Highest RF signal power capability is achieved with V set to +10V. The switch will operate properly (but at lower RF power capability) at bias voltages down to +3V.



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### *Evaluation Circuit Board*



The circuit board used in the final application should use RF circuit design techniques. Signal lines should have 50 ohm impedance while the package ground leads should be connected directly to the ground plane similar to that shown below. A sufficient number of VIA holes should be used to connect the top and bottom ground planes. The evaluation circuit board as shown is available from Hittite upon request.

### *Evaluation Circuit Board Layout Design Details*

|                          |                                        |
|--------------------------|----------------------------------------|
| Layout Technique         | Grounded Co-Planar Waveguide (GCPW)    |
| Material                 | FR4                                    |
| Dielectric Thickness     | 0.028" (0.71 mm)                       |
| 50 Ohm Line Width        | 0.037" (0.94 mm)                       |
| Gap to Ground Edge       | 0.010" (0.25 mm)                       |
| Ground VIA Hole Diameter | 0.014" (0.36 mm)                       |
| Connectors               | SMA-F ( EF - Johnson P/N 142-0701-806) |

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