HEWLETT PACKARD

# Cascadable Silicon Bipolar MMIC Amplifier

## Technical Data

**MSA-0300**

### Features

- **Cascadable 50 Ω Gain Block**
- **3 dB Bandwidth:** DC to 2.8 GHz
- **12.0 dB Typical Gain at 1.0 GHz**
- **10.0 dBm Typical $P_{1\,dB}$ at 1.0 GHz**

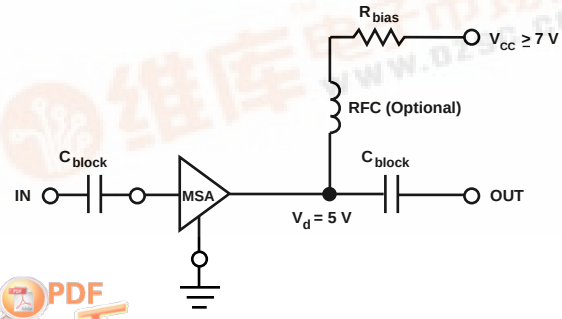
### Description

The MSA-0300 is a high performance silicon bipolar Monolithic Microwave Integrated Circuit (MMIC) chip. This MMIC is designed for use as a general purpose 50 Ω gain block. Typical applications include narrow and broad band IF and RF amplifiers in commercial, industrial and military applications.

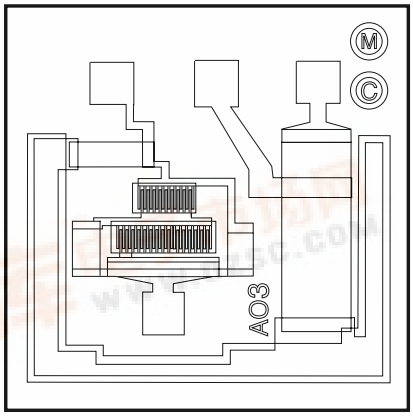
The MSA-series is fabricated using HP's 10 GHz $f_T$, 25 GHz $f_{MAX}$, silicon bipolar MMIC process which uses nitride self-alignment, ion implantation, and gold metallization to achieve excellent performance, uniformity and reliability. The use of an external bias resistor for temperature and current stability also allows bias flexibility.

The recommended assembly procedure is gold-eutectic die attach at 400°C and either wedge or ball bonding using 0.7 mil gold wire.[1] See APPLICATIONS section, "Chip Use".

### Typical Biasing Configuration




### Chip Outline[1]




**Note:**

1. This chip contains additional biasing options. The performance specified applies only to the bias option whose bond pads are indicated on the chip outline. Refer to the APPLICATIONS section "Silicon MMIC Chip Use" for additional information.

## MSA-0300 Absolute Maximum Ratings

| Parameter | Absolute Maximum[1] |
|---|---|
| Device Current | 80 mA |
| Power Dissipation[2,3] | 425 mW |
| RF Input Power | +13 dBm |
| Junction Temperature | 200°C |
| Storage Temperature | –65 to 200°C |

**Thermal Resistance[2,4]:**
$\theta_{jc} = 45°C/W$

**Notes:**
1. Permanent damage may occur if any of these limits are exceeded.
2. $T_{Mounting\ Surface}$ ($T_{MS}$) = 25°C.
3. Derate at 22.2 mW/°C for $T_C > 181°C$.
4. The small spot size of this technique results in a higher, though more accurate determination of $\theta_{jc}$ than do alternate methods. See MEASUREMENTS section "Thermal Resistance" for more information.

## Electrical Specifications[1], $T_A$ = 25°C

| Symbol | Parameters and Test Conditions[2]: $I_d$ = 35 mA, $Z_O$ = 50 Ω | | Units | Min. | Typ. | Max. |
|---|---|---|---|---|---|---|
| $G_P$ | Power Gain ($\|S_{21}\|^2$) | f = 0.1 GHz | dB | | 12.5 | |
| $\Delta G_P$ | Gain Flatness | f = 0.1 to 1.8 GHz | dB | | ±0.6 | |
| $f_{3\ dB}$ | 3 dB Bandwidth | | GHz | | 2.8 | |
| VSWR | Input VSWR | f = 0.1 to 3.0 GHz | | | 1.8:1 | |
| | Output VSWR | f = 0.1 to 3.0 GHz | | | 1.8:1 | |
| NF | 50 Ω Noise Figure | f = 1.0 GHz | dB | | 6.0 | |
| $P_{1\ dB}$ | Output Power at 1 dB Gain Compression | f = 1.0 GHz | dBm | | 10.0 | |
| $IP_3$ | Third Order Intercept Point | f = 1.0 GHz | dBm | | 23.0 | |
| $t_D$ | Group Delay | f = 1.0 GHz | psec | | 125 | |
| $V_d$ | Device Voltage | | V | 4.5 | 5.0 | 5.5 |
| dV/dT | Device Voltage Temperature Coefficient | | mV/°C | | –8.0 | |

**Notes:**
1. The recommended operating current range for this device is 20 to 50 mA. Typical performance as a function of current is on the following page.
2. RF performance of the chip is determined by packaging and testing 10 devices per wafer in a dual ground configuration.

## Part Number Ordering Information

| Part Number | Devices Per Tray |
|---|---|
| MSA-0300-GP4 | 100 |

## MSA-0300 Typical Scattering Parameters[1] ($Z_O$ = 50 Ω, $T_A$ = 25°C, $I_d$ = 35 mA)

| Freq. GHz | $S_{11}$ | | $S_{21}$ | | | $S_{12}$ | | | $S_{22}$ | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Mag | Ang | dB | Mag | Ang | dB | Mag | Ang | Mag | Ang | k |
| 0.1 | .13 | –179 | 12.6 | 4.28 | 177 | –18.6 | .118 | 2 | .09 | –13 | 1.21 |
| 0.2 | .13 | –179 | 12.6 | 4.27 | 172 | –18.3 | .121 | 3 | .10 | –27 | 1.19 |
| 0.4 | .12 | –179 | 12.5 | 4.24 | 165 | –18.3 | .121 | 5 | .12 | –48 | 1.19 |
| 0.6 | .11 | –177 | 12.5 | 4.22 | 158 | –18.2 | .123 | 8 | .14 | –65 | 1.18 |
| 0.8 | .11 | –172 | 12.4 | 4.19 | 152 | –17.8 | .129 | 11 | .17 | –76 | 1.15 |
| 1.0 | .10 | –166 | 12.4 | 4.15 | 144 | –17.7 | .130 | 1 | .20 | –85 | 1.14 |
| 1.5 | .11 | –145 | 12.0 | 4.00 | 126 | –17.1 | .139 | 1 | .24 | –104 | 1.09 |
| 2.0 | .16 | –140 | 11.5 | 3.76 | 109 | –16.2 | .154 | 2 | .27 | –122 | 1.03 |
| 2.5 | .23 | –141 | 10.8 | 3.47 | 97 | –15.6 | .166 | 2 | .28 | –133 | 0.99 |
| 3.0 | .29 | –149 | 9.8 | 3.10 | 82 | –15.2 | .173 | 24 | .28 | –145 | 0.99 |
| 3.5 | .35 | –157 | 8.7 | 2.72 | 67 | –14.5 | .188 | 21 | .27 | –148 | 0.97 |
| 4.0 | .38 | –164 | 7.6 | 2.40 | 55 | –14.3 | .193 | 22 | .25 | –146 | 1.00 |
| 5.0 | .41 | 179 | 5.5 | 1.88 | 35 | –13.7 | .206 | 17 | .21 | –134 | 1.14 |
| 6.0 | .43 | 153 | 3.6 | 1.51 | 18 | –13.3 | .217 | 14 | .21 | –137 | 1.27 |

**Note:**

1. S-parameters are de-embedded from 70 mil package measured data using the package model found in the DEVICE MODELS section.

## Typical Performance, $T_A$ = 25°C

(unless otherwise noted)

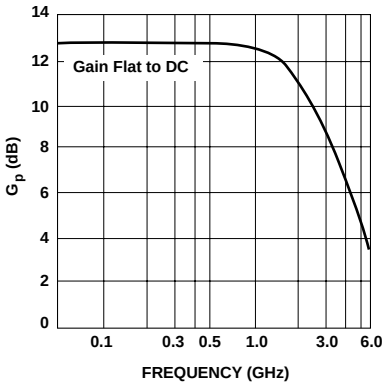



**Figure 1. Typical Power Gain vs. Frequency, $T_A$ = 25°C, $I_d$ = 35 mA.**

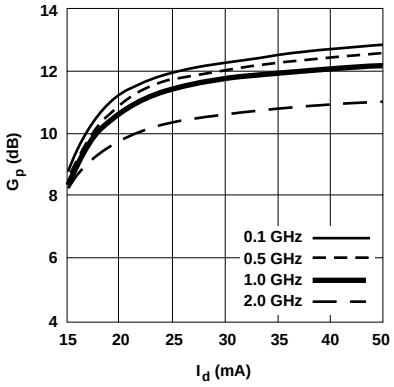



**Figure 2. Power Gain vs. Current.**

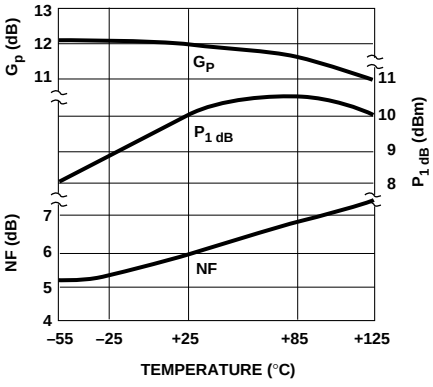



**Figure 3. Output Power at 1 dB Gain Compression, NF and Power Gain vs. Mounting Surface Temperature, f = 1.0 GHz, $I_d$ = 35 mA.**

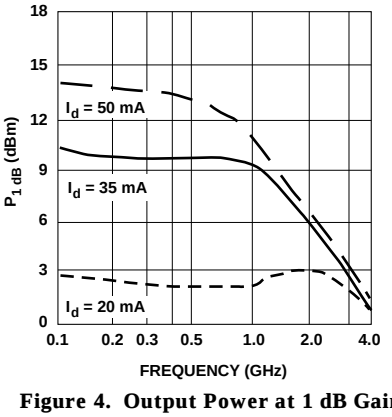



**Figure 4. Output Power at 1 dB Gain Compression vs. Frequency.**

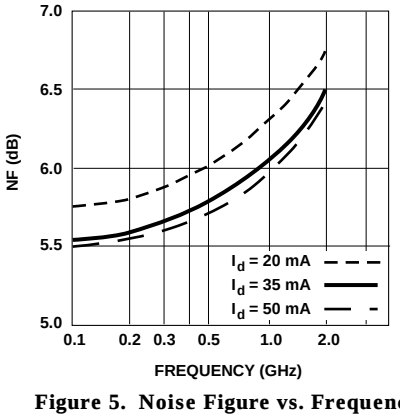
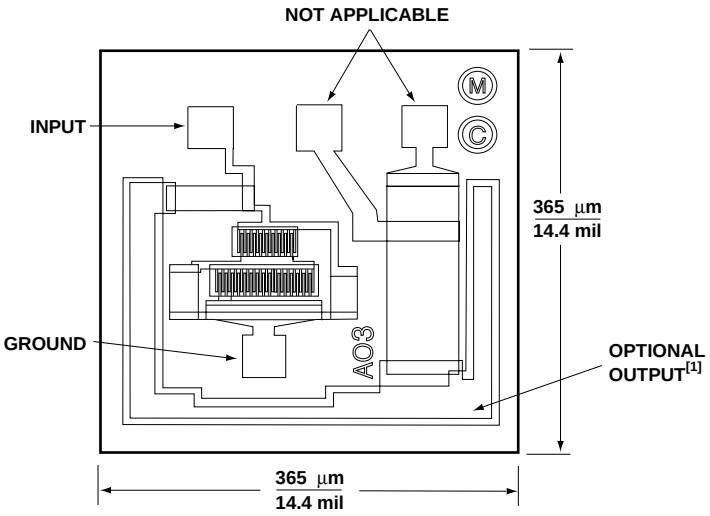



**Figure 5. Noise Figure vs. Frequency.**

## MSA-0300 Chip Dimensions




**Unless otherwise specified, tolerances are ±13 μm/±0.5 mils. Chip thickness is 5.5 ± 0.5 mils. Bond Pads are 41 μm/1.6 mil typical on each side.**
**Note 1: Output contact is made by die attaching the backside of the die.**