# Cascadable Silicon Bipolar MMIC Amplifier

# Technical Data

**MSA-0470**

## Features

- **Cascadable 50 Ω Gain Block**
- **3 dB Bandwidth:**
  DC to 4.0 GHz
- **12.5 dBm Typical $P_{1\,dB}$ at 1.0 GHz**
- **8.5 dB Typical Gain at 1.0 GHz**
- **Unconditionally Stable (k>1)**
- **Hermetic Gold-ceramic Microstrip Package**

## Description

The MSA-0470 is a high perfor-mance silicon bipolar Monolithic Microwave Integrated Circuit (MMIC) housed in a hermetic, high reliability package. 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 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 metalli-zation to achieve excellent performance, uniformity and reliability. The use of an external bias resistor for temperature and current stability also allows bias flexibility.

**70 mil Package**
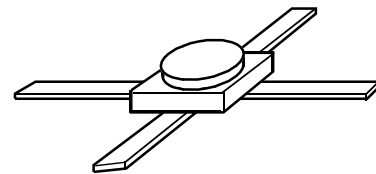
## Typical Biasing Configuration
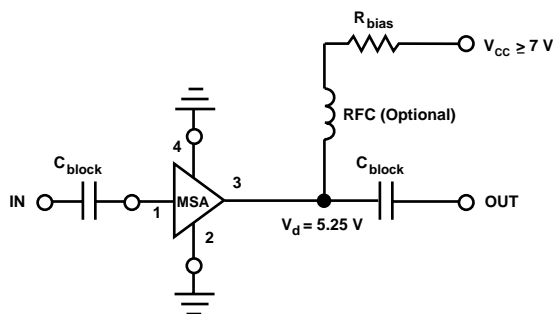
## MSA-0470 Absolute Maximum Ratings

| Parameter | Absolute Maximum[1] |
|---|---|
| Device Current | 100 mA |
| Power Dissipation[2,3] | 650 mW |
| RF Input Power | +13 dBm |
| Junction Temperature | 200°C |
| Storage Temperature | −65 to 200°C |

| Thermal Resistance[2,4]: |
|---|
| $\theta_{jc} = 115°C/W$ |

**Notes:**

1. Permanent damage may occur if any of these limits are exceeded.

2. $T_{CASE} = 25°C$.

3. Derate at 8.7 mW/°C for $T_C > 125°C$.

4. The small spot size of this technique results in a higher, though more accurate determination of $\theta_{jc}$ than do alternate methods. See MEASURE-MENTS section "Thermal Resistance" for more information.

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

| Symbol | Parameters and Test Conditions: $I_d$ = 50 mA, $Z_O$ = 50 Ω | | Units | Min. | Typ. | Max. |
|---|---|---|---|---|---|---|
| $G_P$ | Power Gain ($|S_{21}|^2$) | f = 0.1 GHz | dB | 7.5 | 8.5 | 9.5 |
| $\Delta G_P$ | Gain Flatness | f = 0.1 to 2.5 GHz | dB | | ± 0.6 | ± 1.0 |
| $f_{3\,dB}$ | 3 dB Bandwidth | | GHz | | 4.0 | |
| VSWR | Input VSWR | f = 0.1 to 2.5 GHz | | | 1.7:1 | |
| | Output VSWR | f = 0.1 to 2.5 GHz | | | 2.0:1 | |
| NF | 50 Ω Noise Figure | f = 1.0 GHz | dB | | 6.5 | |
| $P_{1\,dB}$ | Output Power at 1 dB Gain Compression | f = 1.0 GHz | dBm | | 12.5 | |
| $IP_3$ | Third Order Intercept Point | f = 1.0 GHz | dBm | | 25.5 | |
| $t_D$ | Group Delay | f = 1.0 GHz | psec | | 125 | |
| $V_d$ | Device Voltage | | V | 4.75 | 5.25 | 5.75 |
| dV/dT | Device Voltage Temperature Coefficient | | mV/°C | | −8.0 | |

**Note:**

1. The recommended operating current range for this device is 30 to 70 mA. Typical performance as a function of current is on the following page.

## MSA-0470 Typical Scattering Parameters ($Z_O = 50 \Omega$, $T_A = 25°C$, $I_d = 50$ mA)

| Freq. GHz | $S_{11}$ | | $S_{21}$ | | | $S_{12}$ | | | $S_{22}$ | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Mag | Ang | dB | Mag | Ang | dB | Mag | Ang | Mag | Ang |
| 0.1 | .18 | 179 | 8.5 | 2.67 | 176 | −16.4 | .151 | 1 | .10 | −14 |
| 0.2 | .18 | 179 | 8.5 | 2.67 | 172 | −16.4 | .151 | 2 | .10 | −30 |
| 0.4 | .18 | 179 | 8.5 | 2.67 | 163 | −16.4 | .152 | 3 | .13 | −50 |
| 0.6 | .17 | −179 | 8.5 | 2.65 | 155 | −16.2 | .155 | 5 | .16 | −67 |
| 0.8 | .16 | −176 | 8.4 | 2.64 | 147 | −16.1 | .158 | 8 | .19 | −79 |
| 1.0 | .16 | −174 | 8.3 | 2.61 | 138 | −15.9 | .161 | 6 | .22 | −90 |
| 1.5 | .16 | −166 | 8.2 | 2.56 | 117 | −15.5 | .169 | 9 | .29 | −111 |
| 2.0 | .21 | −163 | 7.8 | 2.46 | 97 | −14.6 | .186 | 9 | .33 | −131 |
| 2.5 | .26 | −162 | 7.3 | 2.33 | 83 | −13.8 | .204 | 12 | .36 | −142 |
| 3.0 | .32 | −170 | 6.5 | 2.12 | 65 | −13.5 | .212 | 10 | .40 | −156 |
| 3.5 | .37 | −177 | 5.7 | 1.93 | 38 | −13.2 | .220 | 7 | .40 | −164 |
| 4.0 | .40 | 175 | 4.7 | 1.73 | 33 | −12.6 | .234 | 3 | .40 | −170 |
| 4.5 | .41 | 166 | 3.9 | 1.57 | 20 | −12.4 | .239 | −1 | .39 | −173 |
| 5.0 | .42 | 155 | 3.1 | 1.44 | 7 | −11.9 | .255 | −6 | .37 | −176 |

A model for this device is available in the DEVICE MODELS section.

## Typical Performance, $T_A = 25°C$
(unless otherwise noted)



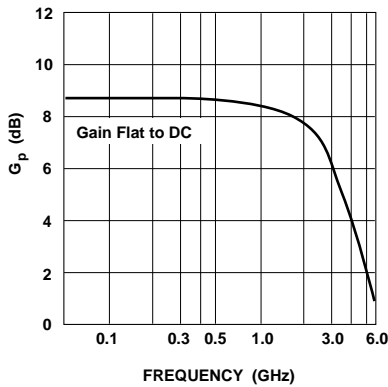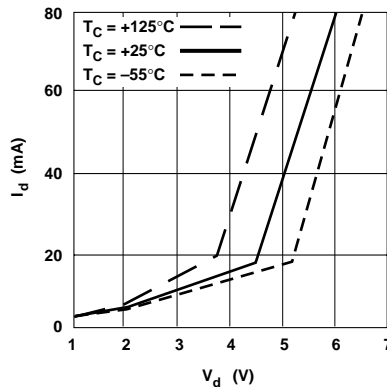**Figure 1. Typical Power Gain vs. Frequency, $T_A = 25°C$, $I_d = 50$ mA.**
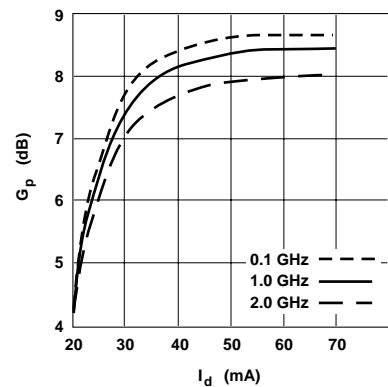


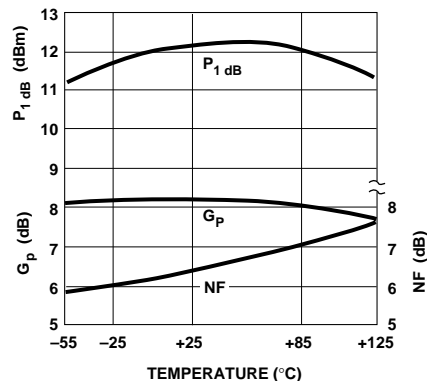**Figure 2. Device Current vs. Voltage.**



**Figure 3. Power Gain vs. Current.**



**Figure 4. Output Power at 1 dB Gain Compression, NF and Power Gain vs. Case Temperature, f = 1.0 GHz, $I_d$=50mA.**
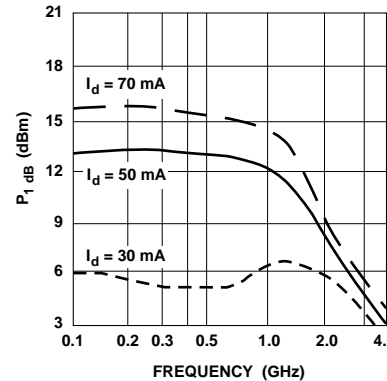


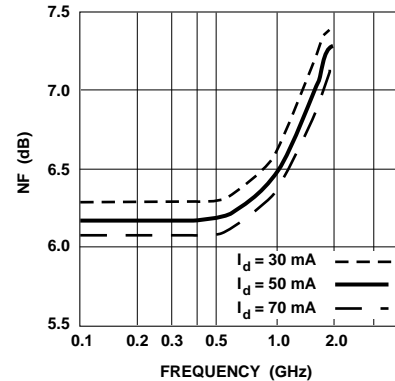**Figure 5. Output Power at 1 dB Gain Compression vs. Frequency.**



**Figure 6. Noise Figure vs. Frequency.**

## 70 mil Package Dimensions



$\frac{.040}{1.02}$

4 GROUND

$\frac{.020}{.508}$

RF INPUT

RF OUTPUT
AND BIAS

1

3

**Notes:**
**(unless otherwise specified)**
1. Dimensions are $\frac{in}{mm}$
2. Tolerances
    in .xxx = ± 0.005
    mm .xx = ± 0.13

2 GROUND

$\frac{.070}{1.70}$

$\frac{.004 \pm .002}{.10 \pm .05}$

$\frac{.495 \pm .030}{12.57 \pm .76}$

$\frac{.035}{.89}$