# Cascadable Silicon Bipolar MMIC Amplifier

## Technical Data

**MSA-1100**

### Features

- **High Dynamic Range Cascadable 50 Ω or 75 Ω Gain Block**
- **3 dB Bandwidth:** 50 MHz to 1.6 GHz
- **17.5 dBm Typical $P_{1dB}$ at 0.5 GHz**
- **12 dB Typical 50 Ω Gain at 0.5 GHz**
- **3.5 dB Typical Noise Figure at 0.5 GHz**

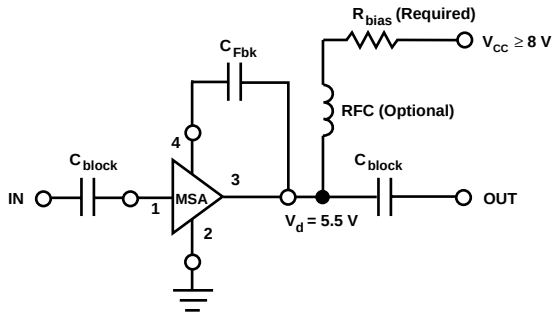
### Description

The MSA-1100 is a high performance silicon bipolar Monolithic Microwave Integrated Circuit (MMIC) chip. This MMIC is designed for high dynamic range in either 50 or 75 Ω systems by combining low noise figure with high $IP_3$. Typical applications include narrow and broadband linear amplifiers in industrial and military systems.

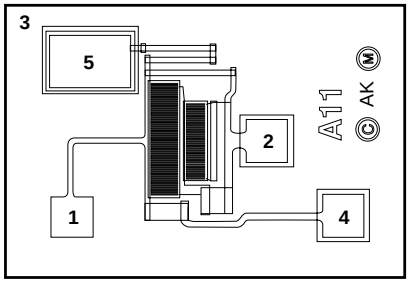
The MSA-series is fabricated using HP's 10 GHz $f_T$, 25 GHz $f_{MAX}$, silicon bipolar MMIC process which uses nitride self-alignment, ion implantation, and gold metallization to achieve excellent performance, uniformity and reliability. The use of an external bias resistor for temperature and current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

### Typical Biasing Configuration




### Chip Outline[1]




This chip is intended to be used with an external blocking capacitor completing the shunt feedback path (closed loop). Data sheet characterization is given for a 200 pF capacitor. Low frequency performance can be extended by using a larger valued capacitor.[1]

**Note:**

1. Refer to the APPLICATIONS section "Silicon MMIC Chip Use" for additional information.

## MSA-1100 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]:**
$\theta_{jc}$[2] = 57°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 17.5 mW/°C for $T_{Mounting\ Surface}$ > 163°C.
4. The small spot size of this technique results in a higher, though more accurate determination of $\theta_{jc}$ than do alternate methods.

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

| Symbol | Parameters and Test Conditions[2]: $I_d$ = 60 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 1.0 GHz | dB | | ±0.7 | |
| $f_{3\ dB}$ | 3 dB Bandwidth[3] | | GHz | | 1.6 | |
| VSWR | Input VSWR | f = 0.1 to 1.0 GHz | | | 1.7:1 | |
| | Output VSWR | f = 0.1 to 1.0 GHz | | | 1.9:1 | |
| NF | 50 Ω Noise Figure | f = 0.5 GHz | dB | | 3.5 | |
| $P_{1\ dB}$ | Output Power at 1 dB Gain Compression | f = 0.5 GHz | dBm | | 17.5 | |
| $IP_3$ | Third Order Intercept Point | f = 0.5 GHz | dBm | | 30.0 | |
| $t_D$ | Group Delay | f = 0.5 GHz | psec | | 125 | |
| $V_d$ | Device Voltage | | V | 4.5 | 5.5 | 6.5 |
| dV/dT | Device Voltage Temperature Coefficient | | mV/°C | | –8.0 | |

**Notes:**
1. The recommended operating current range for this device is 40 to 75 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.
3. Referenced from 0.05 GHz gain ($G_P$).

## Part Number Ordering Information

| Part Number | Devices Per Tray |
|---|---|
| MSA-1100-GP4 | 100 |

## MSA-1100 Typical Scattering Parameters[1,2] ($T_A$ = 25°C, $I_d$ = 60 mA)

| Freq. | $S_{11}$ | | $S_{21}$ | | | $S_{12}$ | | | $S_{22}$ | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| GHz | Mag | Ang | dB | Mag | Ang | dB | Mag | Ang | Mag | Ang | k |
| 0.001 | .72 | –26 | 19.3 | 9.23 | 168 | –23.4 | .067 | 46 | .72 | –27 | .52 |
| 0.005 | .19 | –73 | 14.1 | 5.09 | 165 | –16.7 | .147 | 11 | .19 | –77 | .96 |
| 0.010 | .16 | –69 | 13.9 | 4.97 | 168 | –16.6 | .148 | 9 | .16 | –79 | .99 |
| 0.050 | .04 | –59 | 12.8 | 4.39 | 175 | –16.0 | .159 | 3 | .04 | –102 | 1.06 |
| 0.100 | .05 | –66 | 12.8 | 4.38 | 175 | –16.0 | .158 | 2 | .05 | –100 | 1.06 |
| 0.200 | .07 | –78 | 12.8 | 4.36 | 170 | –15.9 | .161 | 4 | .08 | –100 | 1.05 |
| 0.400 | .14 | –92 | 12.7 | 4.31 | 162 | –15.6 | .165 | 7 | .14 | –105 | 1.01 |
| 0.600 | .19 | –102 | 12.5 | 4.22 | 153 | –15.3 | .171 | 10 | .21 | –111 | .96 |
| 0.800 | .25 | –110 | 12.3 | 4.11 | 144 | –14.9 | .180 | 13 | .27 | –116 | .90 |
| 1.000 | .31 | –117 | 12.0 | 4.00 | 137 | –14.4 | .190 | 14 | .33 | –122 | .83 |
| 1.500 | .40 | –132 | 10.9 | 3.52 | 117 | –13.4 | .214 | 15 | .42 | –136 | .70 |
| 2.000 | .47 | –145 | 9.6 | 3.01 | 100 | –12.6 | .235 | 14 | .46 | –148 | .64 |
| 2.500 | .50 | –150 | 8.3 | 2.60 | 89 | –12.0 | .251 | 16 | .45 | –152 | .63 |
| 3.000 | .52 | –158 | 7.0 | 2.23 | 77 | –11.6 | .263 | 17 | .42 | –156 | .66 |
| 3.500 | .51 | –164 | 5.7 | 1.92 | 68 | –11.1 | .278 | 19 | .38 | –155 | .73 |
| 4.000 | .50 | –169 | 4.6 | 1.70 | 61 | –10.5 | .297 | 22 | .34 | –152 | .79 |

**Notes:**

1. S-parameters are de-embedded from 200 mil BeO package measured data using the package model found in the DEVICE MODELS section.
2. S-parameter data assumes an external 200 pF capacitor. Low frequency performance can be extended using a larger valued capacitor.

## Typical Performance, $T_A$ = 25°C

(Unless otherwise noted, performance is for a MSA-1100 used with an external 200 pF capacitor. See bonding diagram.)

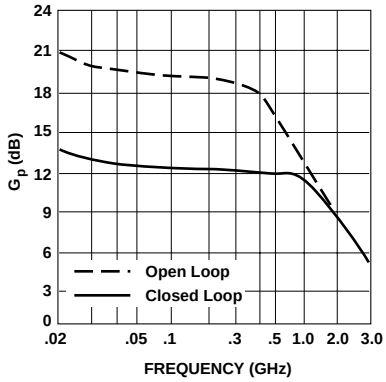



**Figure 1. Typical Power Gain vs. Frequency, $I_d$ = 60 mA.**

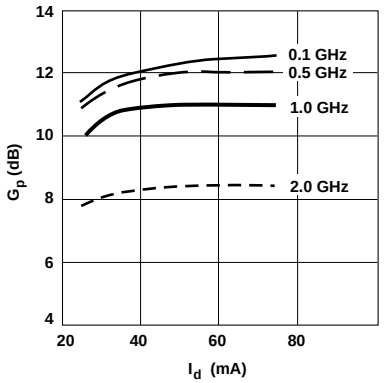



**Figure 2. Power Gain vs. Current.**

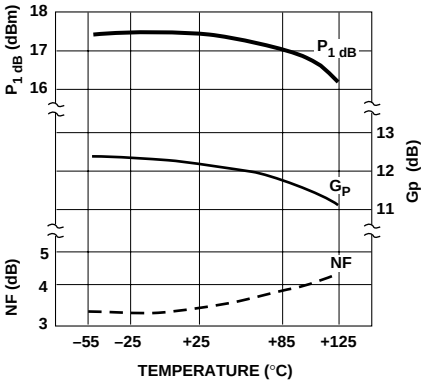



**Figure 3. Output Power at 1 dB Gain Compression, Noise Figure and Power Gain vs. Case Temperature, f = 0.5 GHz, $I_d$ = 60 mA.**

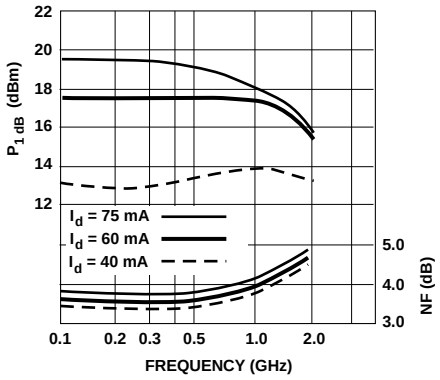
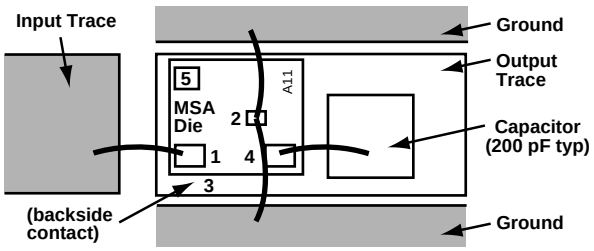


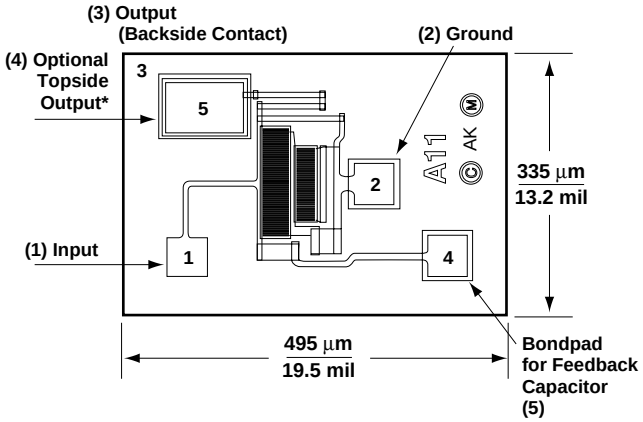

**Figure 4. Output Power at 1 dB Gain Compression and Noise Figure vs. Frequency.**

## MSA-1100 Bonding Diagram




Numbers refer to pin contacts listed on the Chip Outline.

## MSA-1100 Chip Dimensions




**Unless otherwise specified, tolerances are ±13 μm/±0.5 mils. Chip thickness is 114 μm/4.5 mil. Bond Pads are 41 μm/1.6 mil typical on each side.**

*** Output contact is made by die attaching the backside of the die.**