

# Surface Mount Monolithic Amplifier

## DC-1 GHz

### Product Features

- Wideband, DC to 1 GHz
- Exact footprint substitute for Avago's MSA-0486
- Internally Matched to 50 Ohms
- Unconditionally stable
- Protected by US Patent, 6,943,629



Generic photo used for illustration purposes only

### Typical Applications

- Cellular
- Instrumentation
- VHF/UHF transmitters/receivers

## MAR-4SM+

CASE STYLE: WW107

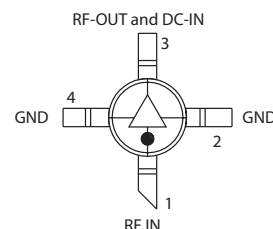
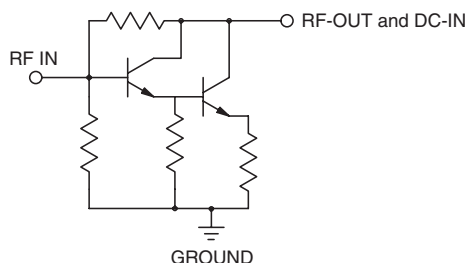
**+RoHS Compliant**

The +Suffix identifies RoHS Compliance. See our web site for RoHS Compliance methodologies and qualifications

### General Description

MAR-4SM+ (RoHS compliant) is a wideband amplifier offering high dynamic range. It has repeatable performance from lot to lot. It is enclosed in a Micro-X package. MAR-4SM+ uses Darlington configuration and is fabricated using InGaP HBT technology. Expected MTTF is 900 years at 85°C case temperature.

### simplified schematic and pin description



| Function         | Pin Number | Description  |
|------------------|------------|--|
| RF IN            | 1          | RF input pin. This pin requires the use of an external DC blocking capacitor chosen for the frequency of operation.  |
| RF-OUT and DC-IN | 3          | RF output and bias pin. DC voltage is present on this pin; therefore a DC blocking capacitor is necessary for proper operation. An RF choke is needed to feed DC bias without loss of RF signal due to the bias connection, as shown in "Recommended Application Circuit". |
| GND              | 2,4        | Connections to ground. Use via holes as shown in "Suggested Layout for PCB Design" to reduce ground path inductance for best performance.  |

#### Notes

- A. Performance and quality attributes and conditions not expressly stated in this specification document are intended to be excluded and do not form a part of this specification document.  
B. Electrical specifications and performance data contained in this specification document are based on Mini-Circuit's applicable established test performance criteria and measurement instructions.  
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MAR-4SM+  
200820  
Page 1 of 4

## Electrical Specifications at 25°C and 50mA, unless noted

| Parameter   |                      | Min.                  | Typ.       | Max.   | Units |
|---|----------------------|-----------------------|------------|--------|-------|
| Frequency Range*                                  |                      | DC                    |            | 1      | GHz   |
| Gain  | f=0.1 GHz<br>f=1 GHz | —<br>7.0 <sup>2</sup> | 8.3<br>8.0 | —<br>— | dB    |
| Input Return Loss                                 | f=DC to 1 GHz        |                       | 14         |        | dB    |
| Output Return Loss                                | f=DC to 1 GHz        |                       | 10         |        | dB    |
| Output Power @ 1 dB compression                   | f= 1 GHz             |                       | +12.5      |        | dBm   |
| Output IP3  | f=1 GHz              |                       | +25.5      |        | dBm   |
| Noise Figure                                      | f=1 GHz              |                       | 6.0        |        | dB    |
| Recommended Device Operating Current              |                      |                       | 50         |        | mA    |
| Device Operating Voltage                          |                      |                       | 5.25       |        | V     |
| Device Voltage Variation vs. Temperature at 50 mA |                      |                       | -2.2       |        | mV/°C |
| Device Voltage Variation vs. Current at 25°C      |                      |                       | 23.0       |        | mV/mA |
| Thermal Resistance, junction-to-case <sup>1</sup> |                      |                       | 157        |        | °C/W  |

\*Guaranteed specification DC-1 GHz. Low frequency cut off determined by external coupling capacitors.

## Absolute Maximum Ratings

| Parameter             | Ratings        |
|-----------------------|----------------|
| Operating Temperature | -40°C to 85°C  |
| Storage Temperature   | -55°C to 100°C |
| Operating Current     | 85mA           |
| Power Dissipation     | 500mW          |
| Input Power           | 13dBm          |

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

These ratings are not intended for continuous normal operation.

<sup>1</sup>Case is defined as ground leads.

<sup>2</sup>Full temperature range.

## Notes

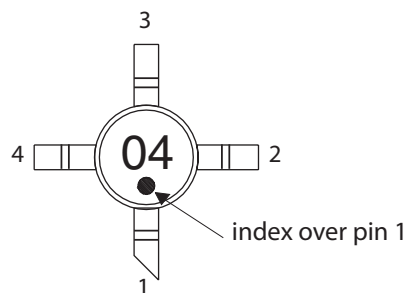
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## Product Marking



Markings in addition to model number designation may appear for internal quality control purposes.

## Additional Detailed Technical Information

Additional information is available on our web site. To access this information enter the model number on our web site home page.

## Performance data, graphs, s-parameter data set (.zip file)

### Case Style: WW107

Plastic micro-x, .085 body diameter, lead finish: Matte-Tin

### Tape & Reel: F4

7" Reels with 20, 50, 100, 200, 500, 1K devices

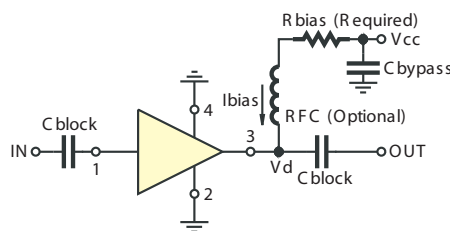
13" Reels with 2K, 4K devices

## Suggested Layout for PCB Design: PL-253

## Evaluation Board: TB-411-4+

## Environmental Ratings: ENV08T3

## Recommended Application Circuit



Test Board includes case, connectors, and components (in bold) soldered to PCB

| R BIAS |  |
|--------|--|
| Vcc    | "1%" Res. Values (ohms)<br>for Optimum Biasing |
| 7      | 34.8   |
| 8      | 54.9   |
| 9      | 75   |
| 10     | 95.3   |
| 11     | 115  |
| 12     | 133  |
| 13     | 154  |
| 14     | 174  |
| 15     | 196  |

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**ESD Rating**

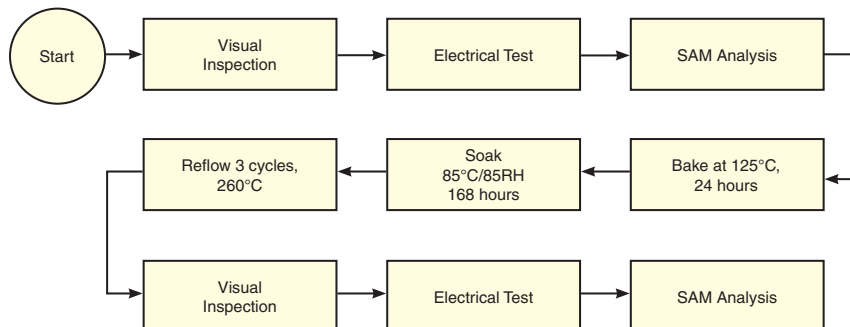
Human Body Model (HBM): Class 1B (500 v to < 1000 v) in accordance with ANSI/ESD STM 5.1 - 2001

Machine Model (MM): Class M1 (<100 v) in accordance with ANSI/ESD STM 5.2 - 1999

**MSL Rating**

Moisture Sensitivity: MSL1 in accordance with IPC/JEDECJ-STD-020C

| No. | Test Required                   | Condition   | Standard                       | Quantity |
|-----|---------------------------------|---|--------------------------------|----------|
| 1   | Visual Inspection               | Low Power Microscope<br>Magnification 40x   | MIP-IN-0003<br>(MCT spec)      | 45 units |
| 2   | Electrical Test                 | Room Temperature  | SCD<br>(MCL spec)              | 45 units |
| 3   | SAM Analysis                    | Less than 10% growth in term of<br>delamination   | J-Std-020C<br>(Jedec Standard) | 45 units |
| 4   | Moisture Sensitivity<br>Level 1 | Bake at 125°C for 24 hours<br>Soak at 85°C/85%RH for 168 hours<br>Reflow 3 cycles at 260°C peak | J-Std-020C<br>(Jedec Standard) | 45 units |

**MSL Test Flow Chart****Notes**

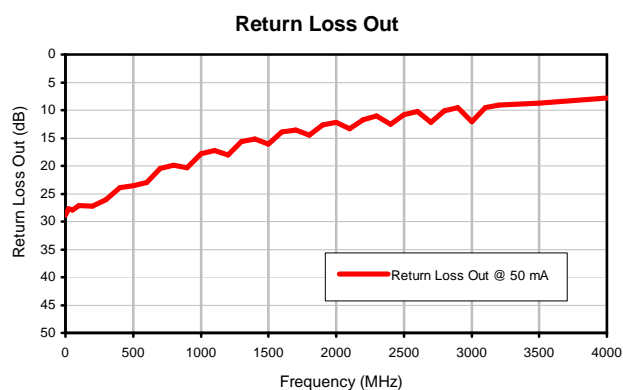
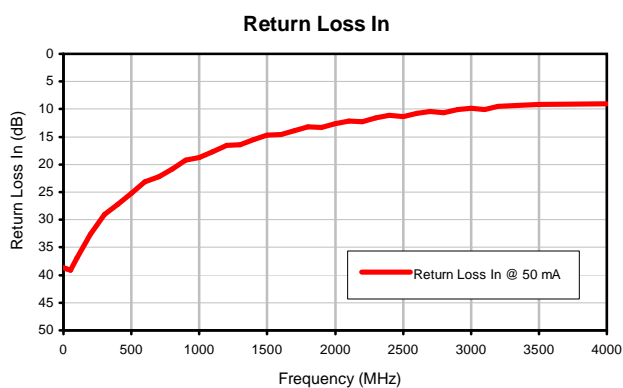
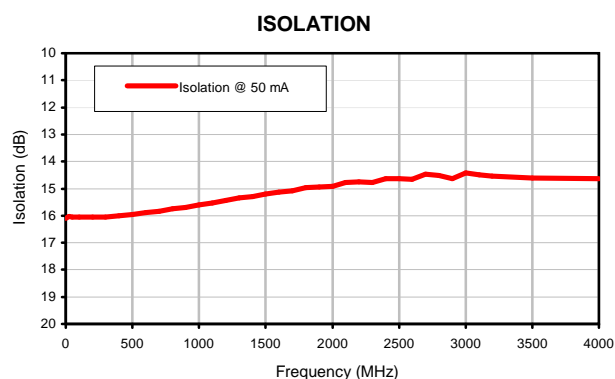
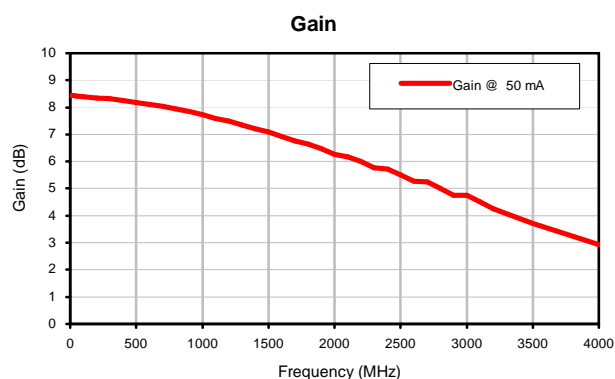
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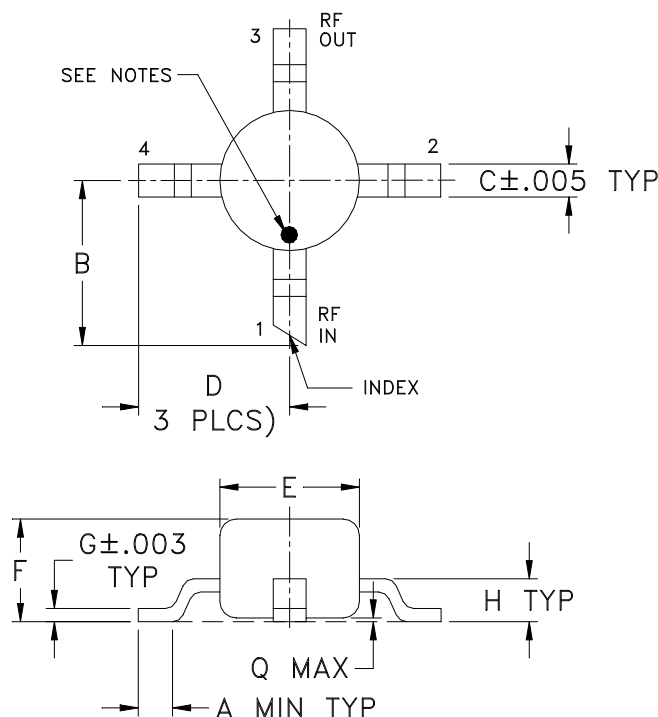
**Typical Performance Data**

| FREQUENCY<br>(MHz) | GAIN<br>(dB)<br>50 mA | ISOLATION<br>(dB)<br>50 mA | RETURN LOSS<br>IN<br>(dB)<br>50 mA | RETURN LOSS<br>OUT<br>(dB)<br>50 mA |
|--------------------|-----------------------|----------------------------|------------------------------------|-------------------------------------|
| 1                  | 8.45                  | 16.09                      | 38.70                              | 28.85                               |
| 25                 | 8.45                  | 16.04                      | 38.91                              | 27.67                               |
| 50                 | 8.41                  | 16.06                      | 39.15                              | 27.93                               |
| 100                | 8.39                  | 16.06                      | 36.95                              | 27.14                               |
| 200                | 8.34                  | 16.06                      | 32.68                              | 27.20                               |
| 300                | 8.31                  | 16.05                      | 29.07                              | 26.14                               |
| 400                | 8.25                  | 16.00                      | 27.16                              | 23.91                               |
| 500                | 8.19                  | 15.95                      | 25.18                              | 23.51                               |
| 600                | 8.12                  | 15.89                      | 23.11                              | 22.95                               |
| 700                | 8.04                  | 15.83                      | 22.17                              | 20.48                               |
| 800                | 7.94                  | 15.75                      | 20.79                              | 19.93                               |
| 900                | 7.85                  | 15.69                      | 19.24                              | 20.30                               |
| 1000               | 7.73                  | 15.60                      | 18.77                              | 17.80                               |
| 1100               | 7.59                  | 15.53                      | 17.75                              | 17.20                               |
| 1200               | 7.50                  | 15.43                      | 16.60                              | 18.04                               |
| 1300               | 7.36                  | 15.34                      | 16.41                              | 15.60                               |
| 1400               | 7.21                  | 15.29                      | 15.53                              | 15.17                               |
| 1500               | 7.09                  | 15.19                      | 14.67                              | 16.06                               |
| 1600               | 6.93                  | 15.12                      | 14.64                              | 13.89                               |
| 1700               | 6.75                  | 15.08                      | 13.87                              | 13.52                               |
| 1800               | 6.65                  | 14.97                      | 13.24                              | 14.45                               |
| 1900               | 6.48                  | 14.93                      | 13.28                              | 12.62                               |
| 2000               | 6.27                  | 14.91                      | 12.60                              | 12.20                               |
| 2100               | 6.18                  | 14.77                      | 12.13                              | 13.32                               |
| 2200               | 6.00                  | 14.76                      | 12.25                              | 11.68                               |
| 2300               | 5.78                  | 14.77                      | 11.56                              | 11.07                               |
| 2400               | 5.71                  | 14.63                      | 11.13                              | 12.58                               |
| 2500               | 5.50                  | 14.63                      | 11.34                              | 10.82                               |
| 2600               | 5.28                  | 14.65                      | 10.75                              | 10.23                               |
| 2700               | 5.24                  | 14.47                      | 10.39                              | 12.19                               |
| 2800               | 5.01                  | 14.52                      | 10.62                              | 10.14                               |
| 2900               | 4.74                  | 14.63                      | 10.02                              | 9.58                                |
| 3000               | 4.74                  | 14.43                      | 9.86                               | 12.08                               |
| 3100               | 4.51                  | 14.50                      | 10.12                              | 9.52                                |
| 3200               | 4.25                  | 14.55                      | 9.53                               | 9.11                                |
| 3500               | 3.70                  | 14.62                      | 9.13                               | 8.78                                |
| 4000               | 2.93                  | 14.64                      | 8.98                               | 7.81                                |

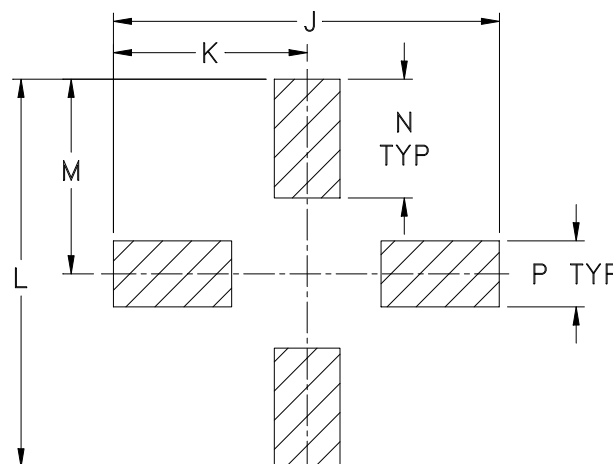
## Typical Performance Curves



## Outline Dimensions



## PCB Land Pattern



Suggested Layout,  
Tolerance to be within  $\pm.002$

| CASE# | A              | B             | C              | D              | E              | F              | G              | H              | J              | K              | L              | M              | N              | P              | Q              | WT.<br>GRAMS |
|-------|----------------|---------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|--------------|
| WW107 | .012<br>(0.30) | .10<br>(2.54) | .020<br>(0.51) | .092<br>(2.34) | .085<br>(2.16) | .060<br>(1.52) | .007<br>(0.18) | .026<br>(0.66) | .235<br>(5.97) | .118<br>(3.00) | .235<br>(5.97) | .118<br>(3.00) | .072<br>(1.83) | .040<br>(1.02) | .020<br>(0.51) | .015         |

Dimensions are in inches (mm). Tolerances: 2 Pl.  $\pm .03$ ; 3 Pl.  $\pm .015$

### Notes:

- Case material: Plastic.
- Termination finish:  
For RoHS Case Styles: Matte tin Plate.  
For RoHS-5 Case Styles: Tin-Lead plate.
- RF input termination (1) identified by one or both of the following at factory option:
  - diagonally cut termination, which may be  $45^\circ$  (ref) in either direction;
  - orientation mark on the case. Model dash number is identified by color dot or alphanumeric code on case. See specification data sheet.



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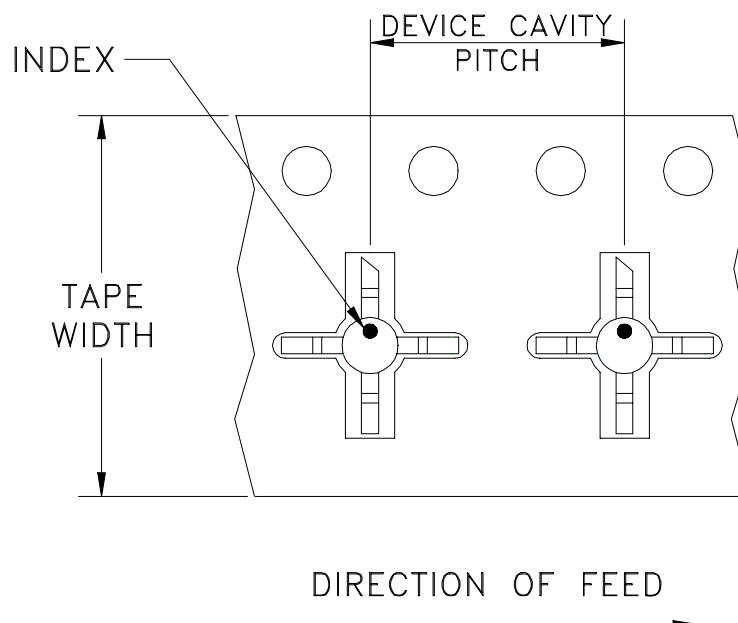
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# Tape & Reel Packaging TR-F4

## DEVICE ORIENTATION IN T&R



| Tape Width,<br>mm | Device Cavity<br>Pitch, mm | Reel Size,<br>inches | Devices per Reel                             |      |
|-------------------|----------------------------|----------------------|--|------|
| 12                | 8                          | 7                    | Small<br>quantity<br>standards<br>(see note) | 20   |
|                   |                            |                      |  | 50   |
|                   |                            |                      |  | 100  |
|                   |                            |                      |  | 200  |
|                   |                            |                      |  | 500  |
|                   |                            | 7                    | Standard                                     | 1000 |

Note: Please Consult individual model data sheet to determine device per reel availability.

Mini-Circuits carrier tape materials provide protection from ESD (Electro-Static Discharge) during handling and transportation. Tapes are static dissipative and comply with industry standards EIA-481/EIA-541.

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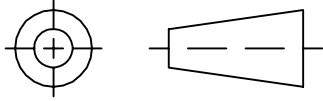
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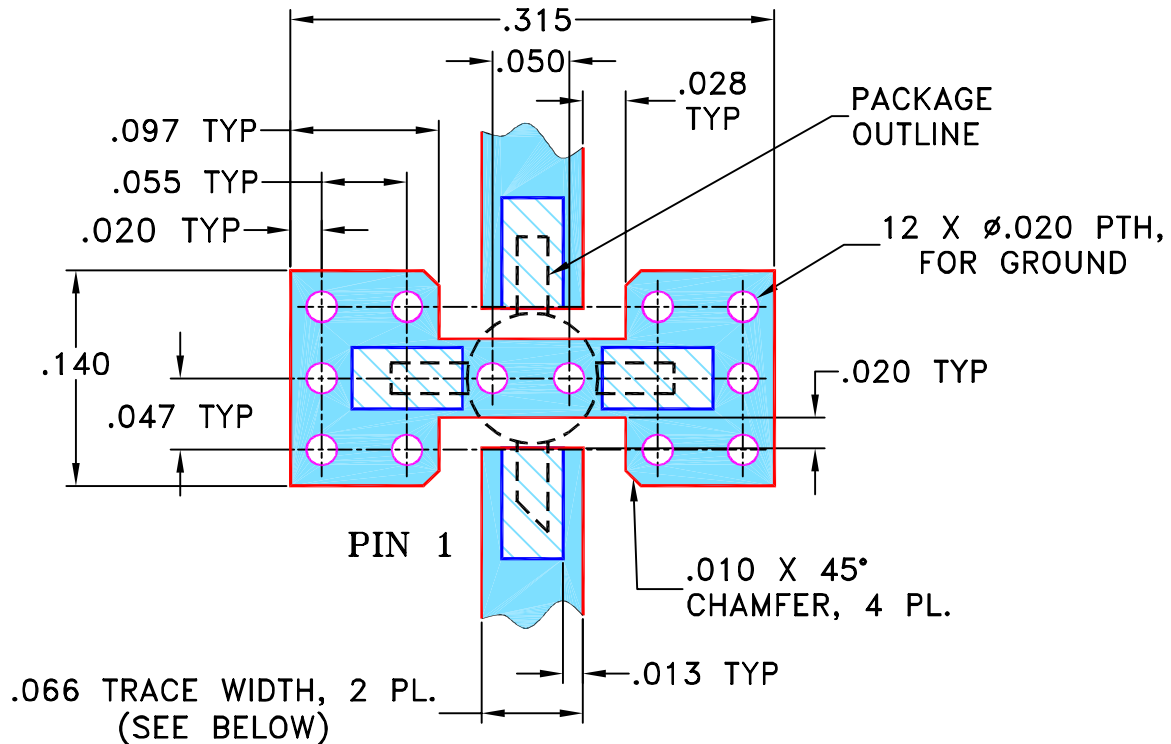
## THIRD ANGLE PROJECTION



## REVISIONS

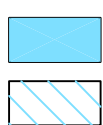
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|--------|---------|-------------|----------|----|------|
|        | M108436 | NEW RELEASE | 11/14/06 | PW | IG   |
|        |         |             |          |    |      |
|        |         |             |          |    |      |

### SUGGESTED MOUNTING CONFIGURATION FOR WW107 CASE STYLE, "cb" PIN CONNECTION



## NOTES:

1. TRACE WIDTH IS SHOWN FOR ROGERS R04350B WITH DIELECTRIC THICKNESS  $.030'' \pm .002''$ ; COPPER: 1/2 OZ. EACH SIDE. FOR OTHER MATERIALS TRACE WIDTH MAY NEED TO BE MODIFIED.
2. BOTTOM SIDE OF THE PCB IS CONTINUOUS GROUND PLANE.
3. IF PCB DESIGN RULES ALLOW, PLACE GROUND VIAS UNDER THE LAND PATTERN FOR BETTER RF PERFORMANCE. OTHERWISE PLACE GROUND VIAS AS CLOSE TO LAND PATTERN AS POSSIBLE.



DENOTES PCB COPPER LAYOUT WITH SMOBC (SOLDER MASK OVER BARE COPPER)

DENOTES COPPER LAND PATTERN FREE OF SOLDER MASK

UNLESS OTHERWISE SPECIFIED

INITIALS

DATE

DIMENSIONS ARE IN INCHES

TOLERANCES ON:

2 PL DECIMALS  $\pm$ 3 PL DECIMALS  $\pm .005$ ANGLES  $\pm$ FRACTIONS  $\pm$ 

DRAWN

PW

11/11/06

CHECKED

IL

11/14/06

APPROVED

IG

11/14/06



Mini-Circuits®

13 Neptune Avenue  
Brooklyn NY 11235

PL, cb, WW107, MAR, TB-411-XX+

SIZE

A

CODE IDENT

15542

DRAWING NO:

98-PL-253

REV:

OR

FILE:

98PL253

SCALE:

8:1

SHEET:

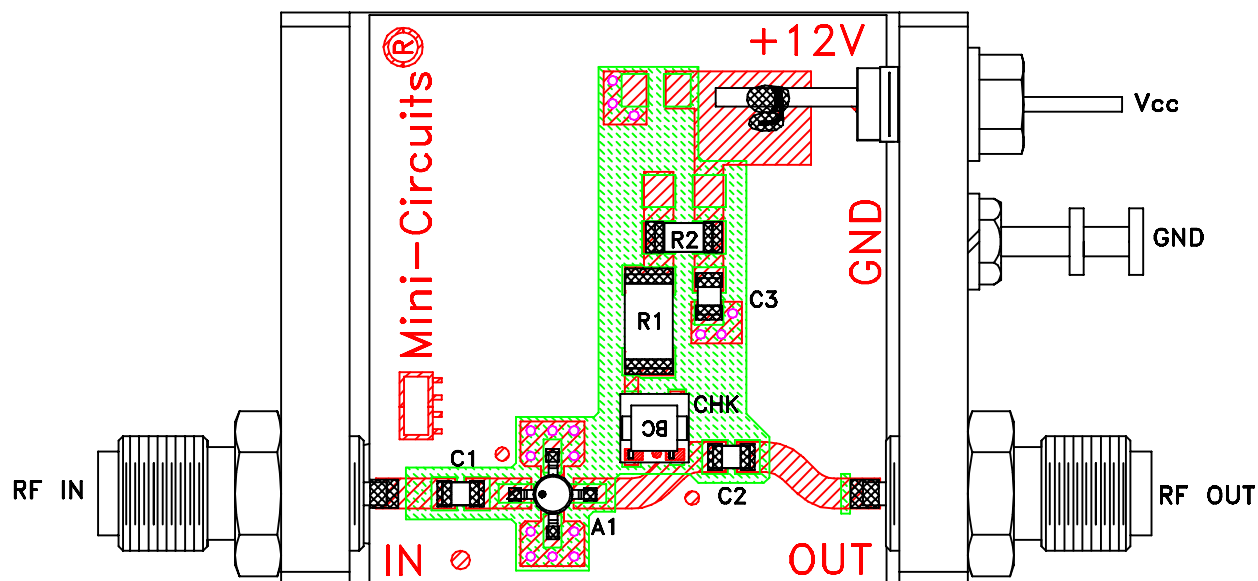
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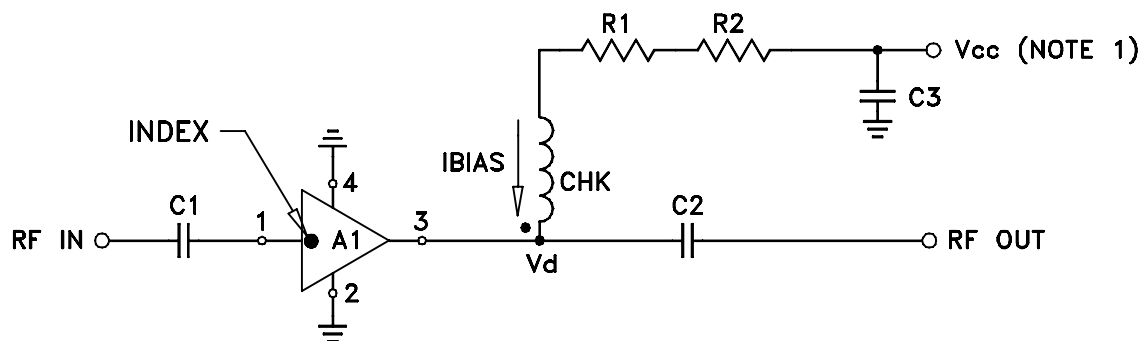
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# Evaluation Board and Circuit



TB-411-4+




| COMPONENT   | VALUE                  |
|-------------|------------------------|
| A1          | MAR-4SM(+)             |
| C1 (NOTE 4) | 2400 pF                |
| C2 (NOTE 4) | 2400 pF                |
| C3 (bypass) | 0.1 uF                 |
| R1          | 133 Ohms, 0.75W        |
| R2          | 2.21 Ohms, 0.25W       |
| CHK         | Mini-Circuits TCCH-80+ |

Schematic Diagram

## NOTE:

1. Vcc voltage:  $+12 \pm 0.2V$ .
2. SMA Female connectors.
3. PCB material: Rogers R04350 or equivalent, dielectric constant=3.5, dielectric thickness=.030 inch.
4. Capacitors, C1 & C2 should be free of resonance up to the highest frequency specified.

 **Mini-Circuits®**



All Mini-Circuits products are manufactured under exacting quality assurance and control standards, and are capable of meeting published specifications after being subjected to any or all of the following physical and environmental test.

| Specification                  | Test/Inspection Condition  | Reference/Spec  |
|--------------------------------|--|---|
| Operating Temperature          | -40° to 85°C<br>Ambient Environment  | Individual Model Data Sheet                                     |
| Storage Temperature            | -55° to 100° C<br>Ambient Environment  | Individual Model Data Sheet                                     |
| Thermal Shock                  | -55° to 100°C, 100 cycles  | MIL-STD-202, Method 107, Condition A-3, except +100°C           |
| Mechanical Shock               | 1.5Kg, 0.5 ms, 5 shock pulses, Y1 direction only   | MIL-STD-883, Method 2002, Condition B, except Y1 direction only |
| Vibration (Variable Frequency) | 50g peak   | MIL-STD-883, Method 2007, Condition B                           |
| Autoclave                      | 15 psig, 100% RH, 121°C, 96 hours  | JESD22-A102, Condition C  |
| HAST                           | 130°C, 85% RH, 96 hours  | JESD22-A110   |
| Solderability                  | 10X Magnification  | J-STD-002, Para 4.2.5, Test S, 95% Coverage                     |
| Solder Reflow Heat             | Sn-Pb Eutetic Process: 240°C peak<br>Pb-Free Process: 260°C peak   | J-STD-020, Table 4-1, 4-2 and 5-2; Figure 5-1                   |
| Moisture Sensitivity: Level 1  | Bake at 125°C for 24 hours<br>Soak at 85°C/85% RH for 168 hours, Reflow 3 cycles at 260°C peak                                 | J-STD-020   |
| Marking Resistance to Solvents | Isopropyl alcohol + mineral spirits at 25°C; terpene defluxer at 25°C;<br>distilled water + proylene glycol monomethyl ether + | MIL-STD-202, Method 215   |



All Mini-Circuits products are manufactured under exacting quality assurance and control standards, and are capable of meeting published specifications after being subjected to any or all of the following physical and environmental test.

| Specification | Test/Inspection Condition        | Reference/Spec |
|---------------|----------------------------------|----------------|
|               | monoethanolamine at 63°C to 70°C |                |