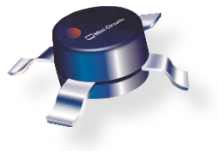
*Surface Mount*

# Monolithic Amplifier

## DC-4 GHz

### Product Features

- DC-4 GHz
- Single Voltage Supply
- Internally matched to 50 Ohm
- Unconditionally Stable
- Low Performance Variation Over Temperature
- Transient protected
- Protected by US Patent 6,943,629



**ERA-5SM+**
**ERA-5SM**

*+ RoHS compliant in accordance with EU Directive (2002/95/EC)*

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

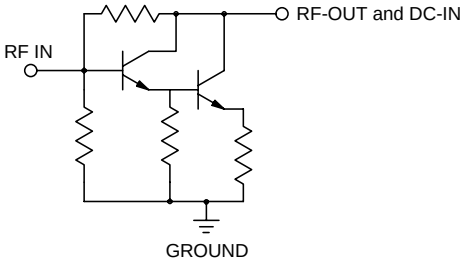
### Typical Applications

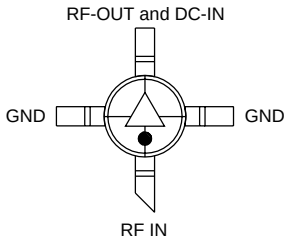
- Cellular/ PCS/ 3G Base Station
- CATV, Cable Modem & DBS
- Fixed Wireless & WLAN
- Microwave Radio & Test Equipment

### General Description

ERA-5SM+ (RoHS compliant) and ERA-5SM (non-RoHS compliant) are wideband amplifiers offering high dynamic range. They have repeatable performance from lot to lot. They are enclosed in an Micro-X package. They use Darlington configuration and are fabricated using InGaP HBT technology. Expected MTBF is 700 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. |

## Electrical Specifications at 25°C and 65mA, unless noted

| Parameter | | Min. | Typ. | Max. | Units | Cpk |
|---|---|---|---|---|---|---|
| Frequency Range | | DC | | 4 | GHz | |
| Gain | f=0.1GHz<br>f=1 GHz<br>f=2 GHz<br>f=3 GHz<br>f=4 GHz | 19<br><br>16<br><br>12 | 20.2<br>19.5<br>17.6<br>15.6<br>14 | 22<br><br>19<br><br>16 | dB | ≥1.5 |
| Magnitude of Gain Variation versus Temperature (values are negative) | f=0.1GHz<br>f=1 GHz<br>f=2 GHz<br>f=3 GHz<br>f=4 GHz | | .0025<br>.0034<br>.0043<br>.0052<br>.0065 | .005<br>.007<br>.0085<br>.0105<br>.013 | dB/°C | |
| Input Return Loss | f=0.1 GHz<br>f=2 GHz<br>f=4 GHz | | 21<br>23<br>21 | | dB | |
| Output Return Loss | f=0.1 GHz<br>f=2 GHz<br>f=4 GHz | | 30<br>26<br>17 | | dB | |
| Reverse Isolation | f=2 GHz | 19 | 22 | | dB | |
| Output Power @1 dB compression | f=0.1 GHz<br>f=1 GHz<br>f=2 GHz<br>f=4 GHz | 16.5<br>16.5<br>15.5 | 18.4<br>18.4<br>17<br>12.5 | | dBm | ≥1.5 |
| Saturated Output Power (at 3dB compression) | f=0.1 GHz<br>f=1 GHz<br>f=2 GHz | | 19.5<br>18.5<br>18 | | dBm | |
| Output IP3 | f=0.1 GHz<br>f=1 GHz<br>f=2 GHz<br>f=4 GHz | 30<br>30<br>26 | 33<br>33<br>30<br>26 | | dBm | ≥1.5 |
| Noise Figure | f=0.1GHz<br>f=2 GHz<br>f=4 GHz | | 3.5<br>3.5<br>3.5 | 4.5<br>4.5<br>4.5 | dB | ≥1.5 |
| Group Delay | f=2 GHz | | 90 | | psec | |
| Recommended Device Operating Current | | | 65 | | mA | |
| Device Operating Voltage | | 4.5 | 4.9 | 5.3 | V | ≥1.5 |
| Device Voltage Variation vs. Temperature at 65mA | | | -3.2 | | mV/°C | |
| Device Voltage Variation vs. Current at 25°C | | | 6.9 | | mV/mA | |
| Thermal Resistance, junction-to-case[1] | | | 133 | | °C/W | |

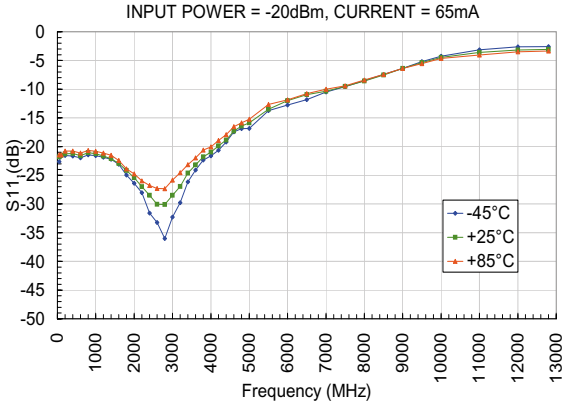
### Absolute Maximum Ratings

| Parameter | Ratings |
|---|---|
| Operating Temperature* | -45°C to 85°C |
| Storage Temperature | -65°C to 150°C |
| Operating Current | 120mA |
| Power Dissipation | 650mW |
| Input Power | 13 dBm |

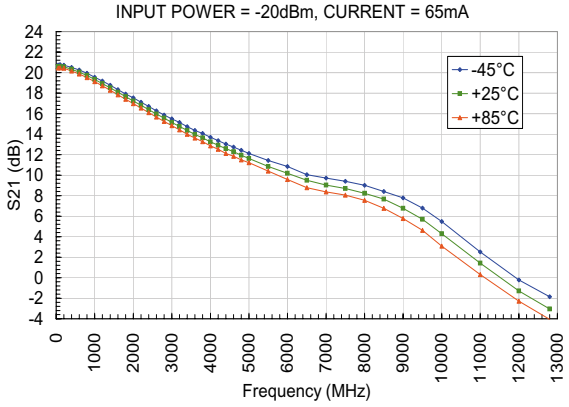
Note: Permanent damage may occur if any of these limits are exceeded.
These ratings are not intended for continuous normal operation.
[1]Case is defined as ground leads.
*Based on typical case temperature rise 10°C above ambient.

## Typical Performance Curves

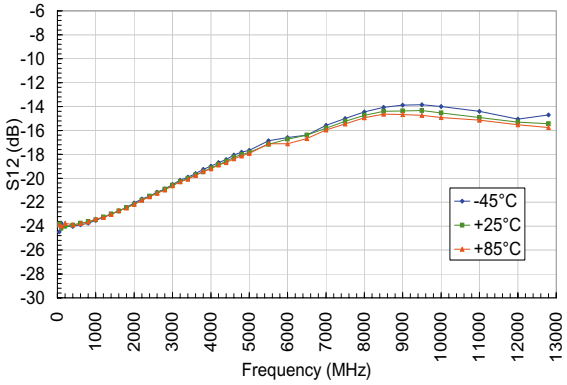
S11 vs. TEMPERATURE
INPUT POWER = -20dBm, CURRENT = 65mA



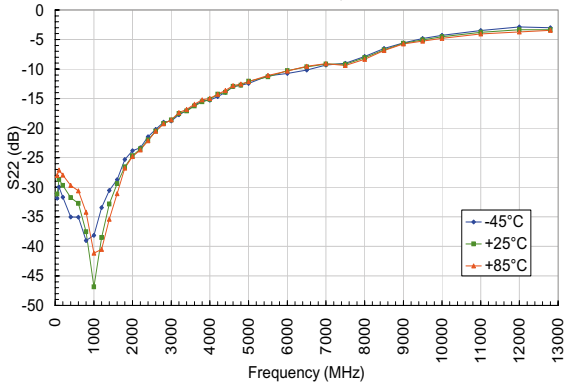

S21 vs. TEMPERATURE
INPUT POWER = -20dBm, CURRENT = 65mA



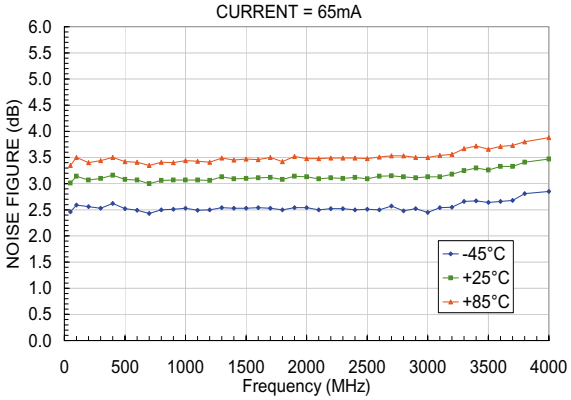

S12 vs. TEMPERATURE
INPUT POWER = -20dBm, CURRENT = 65mA



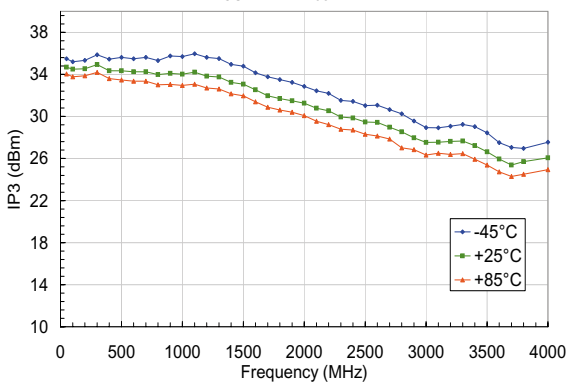

S22 vs. TEMPERATURE
INPUT POWER = -20dBm, CURRENT = 65mA




NOISE FIGURE vs. TEMPERATURE
CURRENT = 65mA

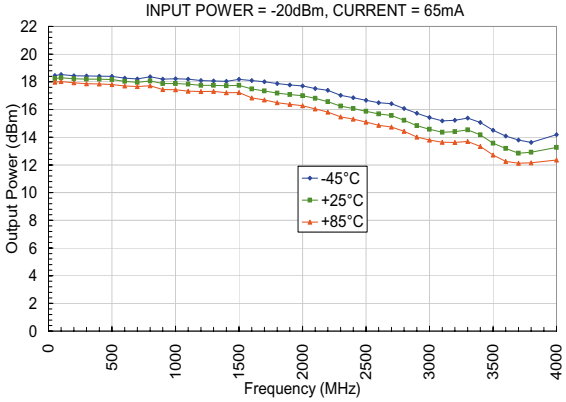



OUTPUT IP3 vs. TEMPERATURE
CURRENT = 65mA

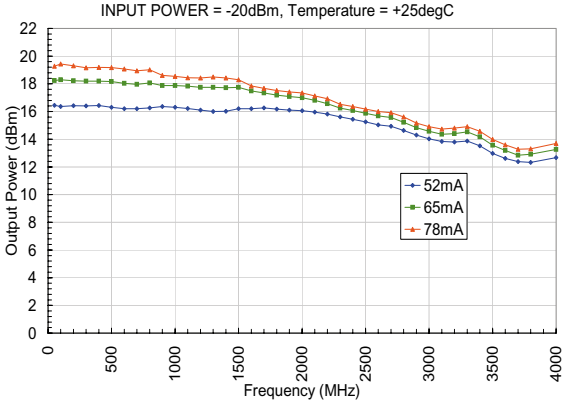


## Typical Performance Curves

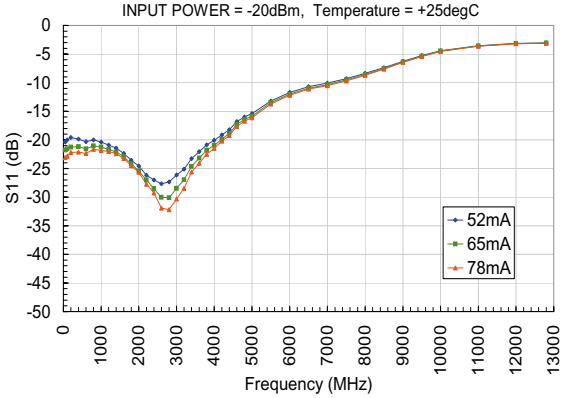
OUTPUT POWER at 1dB COMPRESSION vs. TEMPERATURE
INPUT POWER = -20dBm, CURRENT = 65mA



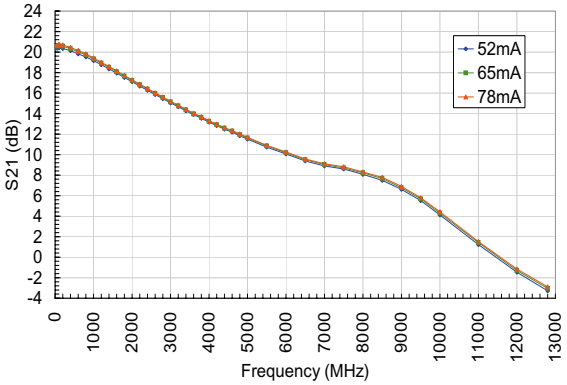

OUTPUT POWER at 1dB COMPRESSION vs. CURRENT
INPUT POWER = -20dBm, Temperature = +25degC



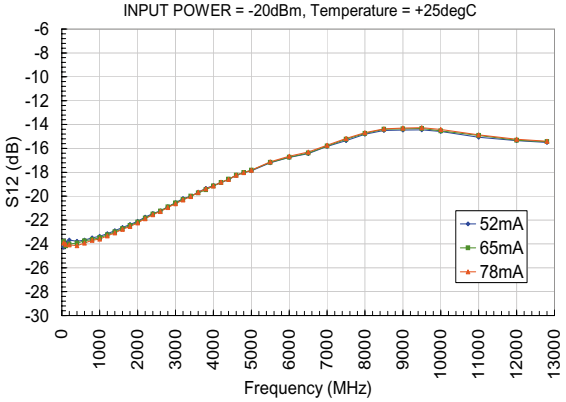

S11 vs. CURRENT
INPUT POWER = -20dBm, Temperature = +25degC



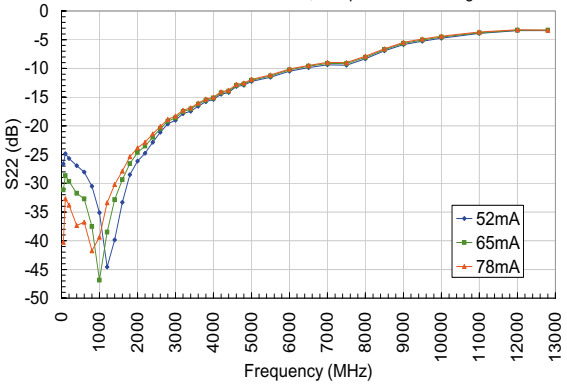

S21 vs. CURRENT
INPUT POWER = -20dBm, Temperature = +25degC



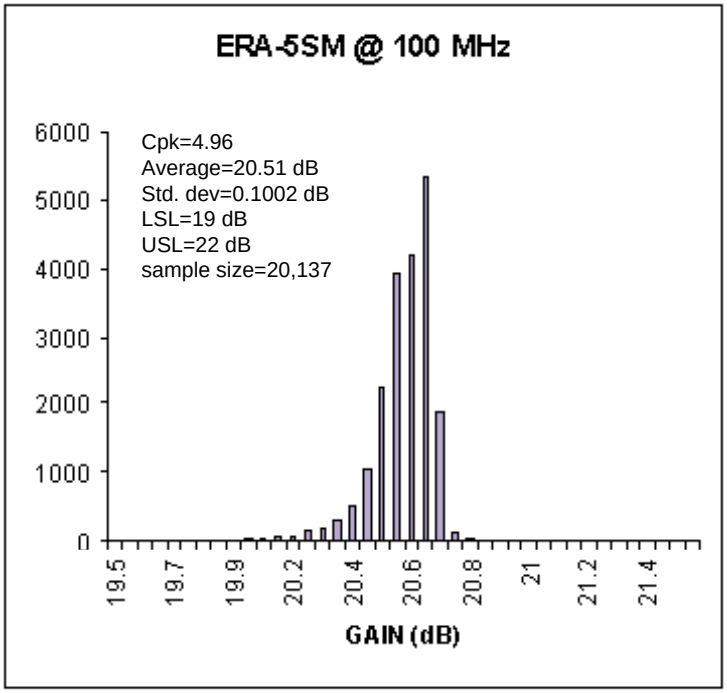

S12 vs. CURRENT
INPUT POWER = -20dBm, Temperature = +25degC

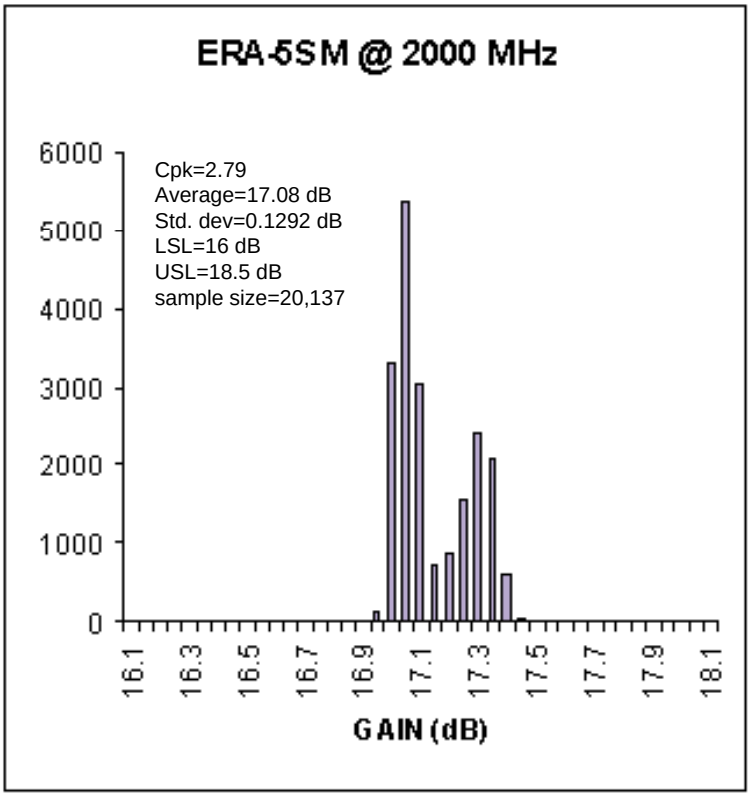



S22 vs. CURRENT
INPUT POWER = -20dBm, Temperature = +25degC



## Product Consistency Distribution Charts



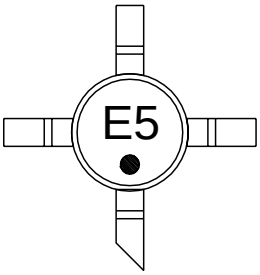



## S-Parameters

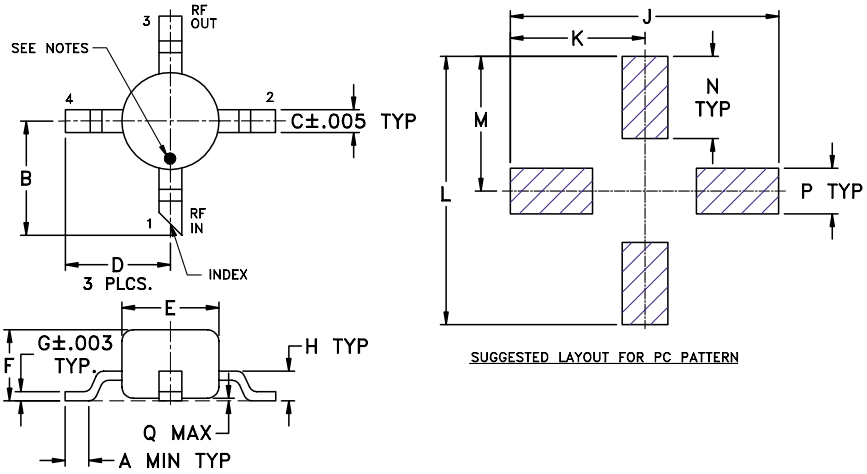
| Freq. | S11 | | | S21 | | | S12 | | | S22 | | | K |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| MHz | dB | Mag | Angle | dB | Mag | Angle | dB | Mag | Angle | dB | Mag | Angle | |
| 50.00 | -21.78 | 0.08 | -7.26 | 20.59 | 10.70 | 173.73 | -23.82 | 0.06 | -1.80 | -31.15 | 0.03 | 12.78 | 1.07 |
| 100.00 | -21.56 | 0.08 | -3.49 | 20.61 | 10.73 | 168.05 | -24.17 | 0.06 | -5.28 | -28.67 | 0.04 | -6.95 | 1.08 |
| 200.00 | -21.26 | 0.09 | -11.36 | 20.57 | 10.68 | 156.37 | -24.01 | 0.06 | -10.57 | -29.69 | 0.03 | -10.12 | 1.08 |
| 400.00 | -21.19 | 0.09 | -18.58 | 20.34 | 10.40 | 133.56 | -23.93 | 0.06 | -21.76 | -31.74 | 0.03 | -30.73 | 1.08 |
| 600.00 | -21.58 | 0.08 | -30.61 | 20.03 | 10.03 | 111.04 | -23.75 | 0.07 | -33.17 | -32.73 | 0.02 | -33.56 | 1.09 |
| 800.00 | -21.05 | 0.09 | -43.40 | 19.72 | 9.68 | 88.97 | -23.63 | 0.07 | -44.24 | -37.52 | 0.01 | -48.14 | 1.10 |
| 1000.00 | -21.24 | 0.09 | -56.66 | 19.33 | 9.26 | 67.32 | -23.48 | 0.07 | -55.79 | -46.85 | 0.00 | -16.81 | 1.11 |
| 1200.00 | -21.66 | 0.08 | -69.62 | 18.92 | 8.83 | 46.10 | -23.24 | 0.07 | -67.12 | -38.51 | 0.01 | 71.65 | 1.12 |
| 1400.00 | -22.10 | 0.08 | -85.98 | 18.51 | 8.42 | 25.31 | -22.99 | 0.07 | -79.08 | -32.84 | 0.02 | 56.89 | 1.13 |
| 1600.00 | -22.94 | 0.07 | -101.92 | 18.08 | 8.02 | 4.84 | -22.73 | 0.07 | -91.03 | -29.38 | 0.03 | 46.32 | 1.14 |
| 1800.00 | -24.18 | 0.06 | -121.65 | 17.65 | 7.63 | -15.31 | -22.45 | 0.08 | -103.03 | -26.57 | 0.05 | 37.37 | 1.15 |
| 2000.00 | -25.42 | 0.05 | -143.33 | 17.22 | 7.26 | -35.03 | -22.18 | 0.08 | -115.80 | -24.65 | 0.06 | 18.00 | 1.16 |
| 2200.00 | -26.99 | 0.04 | -168.99 | 16.81 | 6.93 | -54.63 | -21.84 | 0.08 | -128.01 | -23.52 | 0.07 | 1.49 | 1.16 |
| 2400.00 | -28.50 | 0.04 | 164.00 | 16.39 | 6.60 | -73.95 | -21.50 | 0.08 | -140.98 | -22.00 | 0.08 | -12.28 | 1.17 |
| 2600.00 | -30.04 | 0.03 | 125.13 | 15.96 | 6.28 | -92.95 | -21.25 | 0.09 | -153.46 | -20.49 | 0.09 | -24.89 | 1.18 |
| 2800.00 | -30.09 | 0.03 | 78.39 | 15.57 | 6.00 | -111.87 | -20.91 | 0.09 | -167.13 | -19.21 | 0.11 | -38.61 | 1.18 |
| 3000.00 | -28.48 | 0.04 | 45.01 | 15.14 | 5.71 | -131.03 | -20.57 | 0.09 | 179.32 | -18.61 | 0.12 | -53.52 | 1.19 |
| 3200.00 | -26.97 | 0.04 | 9.53 | 14.75 | 5.46 | -149.47 | -20.28 | 0.10 | 165.90 | -17.54 | 0.13 | -67.62 | 1.19 |
| 3400.00 | -24.62 | 0.06 | -17.05 | 14.36 | 5.22 | -168.00 | -20.00 | 0.10 | 152.10 | -17.09 | 0.14 | -85.38 | 1.20 |
| 3600.00 | -23.17 | 0.07 | -39.17 | 13.98 | 5.00 | 173.58 | -19.73 | 0.10 | 138.05 | -16.24 | 0.15 | -99.63 | 1.20 |
| 3800.00 | -21.80 | 0.08 | -61.61 | 13.63 | 4.80 | 155.15 | -19.47 | 0.11 | 123.88 | -15.54 | 0.17 | -115.18 | 1.20 |
| 4000.00 | -20.94 | 0.09 | -82.84 | 13.25 | 4.60 | 137.27 | -19.14 | 0.11 | 109.98 | -15.15 | 0.17 | -131.03 | 1.20 |
| 4200.00 | -19.88 | 0.10 | -106.70 | 12.92 | 4.43 | 119.19 | -18.86 | 0.11 | 95.43 | -14.26 | 0.19 | -145.08 | 1.20 |
| 4400.00 | -18.85 | 0.11 | -123.53 | 12.58 | 4.26 | 101.19 | -18.58 | 0.12 | 81.30 | -13.96 | 0.20 | -162.55 | 1.20 |
| 4600.00 | -17.30 | 0.14 | -144.85 | 12.30 | 4.12 | 83.02 | -18.24 | 0.12 | 66.49 | -12.95 | 0.23 | -176.70 | 1.19 |
| 4800.00 | -16.42 | 0.15 | -164.22 | 11.94 | 3.95 | 65.07 | -18.02 | 0.13 | 51.54 | -12.73 | 0.23 | 166.15 | 1.19 |
| 5000.00 | -15.85 | 0.16 | 175.38 | 11.62 | 3.81 | 47.64 | -17.83 | 0.13 | 37.63 | -12.07 | 0.25 | 151.92 | 1.20 |
| 5500.00 | -13.49 | 0.21 | 133.44 | 10.85 | 3.49 | 2.91 | -17.17 | 0.14 | -0.60 | -11.33 | 0.27 | 107.83 | 1.19 |
| 6000.00 | -11.98 | 0.25 | 91.11 | 10.19 | 3.23 | -40.26 | -16.73 | 0.15 | -37.47 | -10.26 | 0.31 | 71.42 | 1.17 |
| 6500.00 | -10.96 | 0.28 | 48.77 | 9.51 | 2.99 | -83.57 | -16.39 | 0.15 | -75.97 | -9.62 | 0.33 | 32.58 | 1.18 |
| 7000.00 | -10.34 | 0.30 | 8.80 | 9.03 | 2.83 | -127.14 | -15.80 | 0.16 | -114.00 | -9.14 | 0.35 | -3.26 | 1.14 |
| 7500.00 | -9.52 | 0.33 | -29.87 | 8.71 | 2.73 | -171.88 | -15.24 | 0.17 | -153.67 | -9.18 | 0.35 | -46.21 | 1.10 |
| 8000.00 | -8.57 | 0.37 | -76.53 | 8.23 | 2.58 | 142.03 | -14.74 | 0.18 | 165.07 | -8.07 | 0.40 | -89.96 | 1.06 |
| 8500.00 | -7.52 | 0.42 | -125.63 | 7.67 | 2.42 | 95.35 | -14.40 | 0.19 | 123.52 | -6.74 | 0.46 | -131.22 | 1.02 |

**Definitions:**
dB values=20 log (Mag)
Input Return Loss= -(S11, dB)
Gain (Power Gain)= (S21, dB)
Reverse Isolation= -(S12, dB)
Output Return Loss= -(S22, dB)

## Product Marking



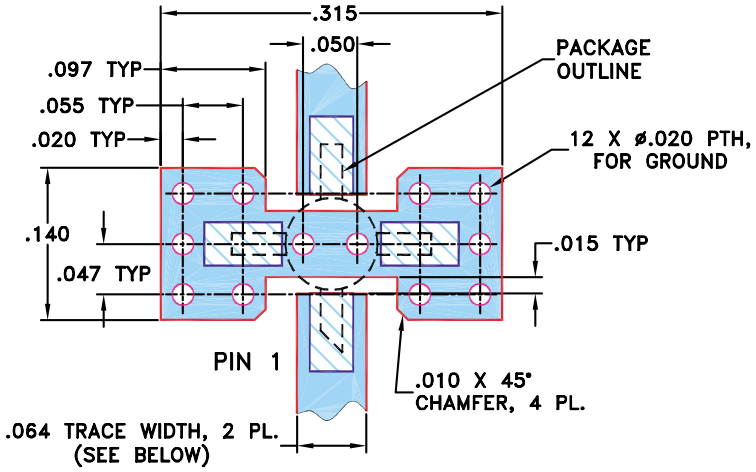

## Outline Drawing (Micro-X) WW107




## Outline Dimensions (inch / mm)

| A | B | C | D | E | F | G | H | J | K | L | M | N | P | Q | WT. GRAMS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| .012 | .10 | .020 | .092 | .085 | .060 | .007 | .026 | .235 | .118 | .235 | .118 | .072 | .040 | .020 | .015 |
| .30 | 2.54 | .51 | 2.34 | 2.16 | 1.52 | .18 | .66 | 5.97 | 3.00 | 5.97 | 3.00 | 1.83 | 1.02 | 0.51 | |

## Suggested Layout for PCB Design (PL-075)

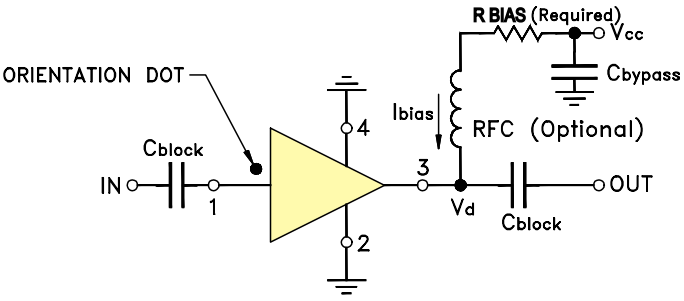



NOTES:

1. TRACE WIDTH IS SHOWN FOR ROGERS RO4350B WITH DIELECTRIC THICKNESS .030" ± .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.

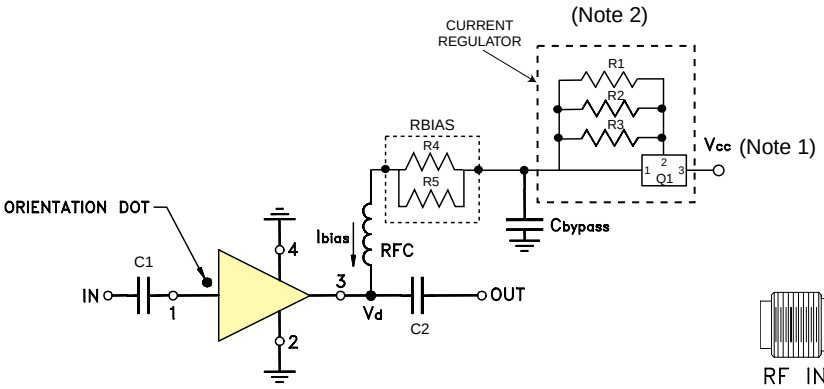
DENOTES PCB COPPER LAYOUT WITH SMOBC (SOLDER MASK OVER BARE COPPER)
DENOTES COPPER LAND PATTERN FREE OF SOLDER MASK

## Recommended Application Circuit

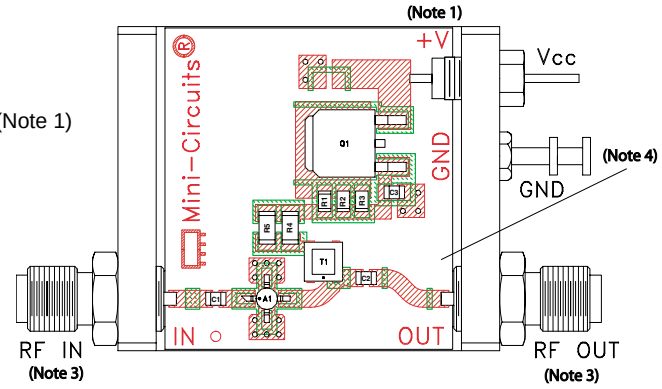



| R BIAS "1%" Resistor Values (ohms) | |
|---|---|
| Vcc | ERA-5SM+ ERA-5SM |
| 7 | 33.2 |
| 8 | 48.7 |
| 9 | 63.4 |
| 10 | 78.7 |
| 11 | 95.3 |
| 12 | 110 |
| 13 | 124 |
| 14 | 140 |
| 15 | 158 |
| 16 | 174 |
| 17 | 187 |
| 18 | 205 |
| 19 | 221 |
| 20 | 232 |

## Evaluation Board and Circuit




Schematic Diagram




ERA-05TB

## BOM of Evaluation Board

| Component | Value | Function |
|---|---|---|
| A1 | ERA-5SM | Device Under Test |
| C1 (Note 5) | 2400 pF | DC Blocking (C block) |
| C2 (Note 5) | 2400 pF | DC Blocking (C block) |
| C bypass (C3) | 0.1 µF | RF bypass |
| R1 (Note 2) | 39.2 ohms | Sets bias current Ibias |
| R2 (Note 2) | 39.2 ohms | Sets bias current Ibias |
| R3 | Not used | Sets bias current Ibias |
| R4 | 64.9 ohms | Enables low frequency performance. Sets bias current in the absence of the current regulator |
| R5 | 64.9 ohms | |
| Q1 | LM317MABDTRK | Voltage Regulator, along with R1, R2, R3 works as constant current source |
| RFC (T1) | Mini-Circuits TCCH-80 | RF choke (50 MHz to 8.2 GHz) |

Notes:
1. Vcc may be any voltage from +12 to +24V
2. Parallel combination of R1, R2, R3 (sets bias current). Each is a 0805-size chip rated at 1/8W.
3. SMA Female connectors
4. PCB material: Rogers RO4350 or equivalent, dielectric constant=3.5, dielectric thickness= .030 inch.
5. Capacitors, C1&C2 should be free of resonance up to the highest frequency specified.

## ESD Rating

Human Body Model (HBM): Class 1B (500 v to < 1,000 v) in accordance with ANSI/ESD STM 5.1 - 2001

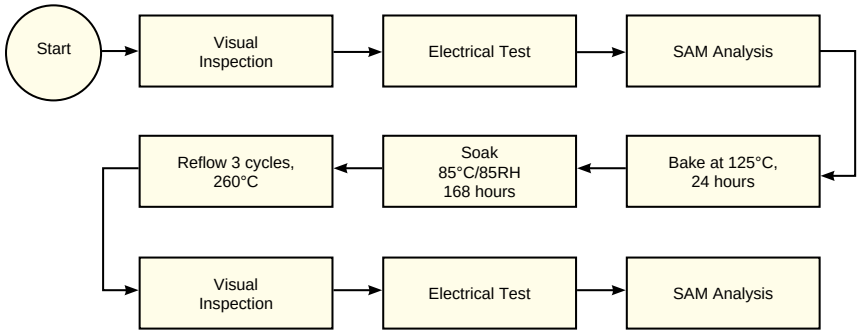
Machine Model (MM): Class M1 (< 100 v) in accordance with ANSI/ESD STM 5.2 - 1999

## MSL Rating

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

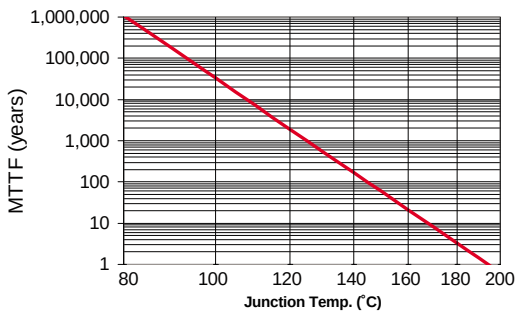
| NO. | TEST REQUIRED | CONDITION | STANDARD | QUANTITY |
|---|---|---|---|---|
| 1 | Visual Inspection | Low Power Microscope Magnification 40x | MIP-IN-0003 (MCT spec) | 45 units |
| 2 | Electrical Test | Room Temperature | SCD (MCL spec) | 45 units |
| 3 | SAM Analysis | Less than 10% growth in term of delamination | J-Std-020C (Jedec Standard) | 45 units |
| 4 | Moisture Sensitivity 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 (Jedec Standard) | 45 units |

### MSL Test Flow Chart



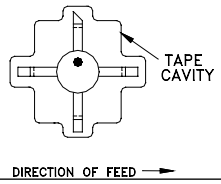

## Reliability

### MTTF vs. Junction Temperature



## Tape and Reel Packaging Information

**Table T&R**

| TR No. | No. of Devices | Designation Letter | Reel Size | Tape Width | Pitch | Unit Orientation |
|---|---|---|---|---|---|---|
| T-003 | 1000 | K | 7 inch | 12mm | 8mm |  |
| | 2000 | T | 13 inch | | | |
| | 4000 | R | 13 inch | | | |
| | multiples of 10, less than full reel of 1K | PR | 7 inch | | | |
| | multiples of 10, on tape only | E | not applicable | | | |



## Ordering Information

| Model No. | Description | Packaging Designation Letter (See Table T&R) | Quantity Min. No. of Units | Price, $ Per Unit | |
|---|---|---|---|---|---|
| | | | | Qty. (10) | Qty. (30) |
| ERA-5SM+ | RoHS Compliant | E | 10 | 4.20 | 3.90 |
| ERA-5SM | Non-RoHS Compliant | | 10 | 4.20 | 3.90 |
| ERA-05TB | Evaluation Board with unit mounted | Not Applicable | 1 | 59.95 | |

## How to Order

Example: 1000 pieces of ERA-5SM+

1K — Quantity
ERA-5SM+ — Model No.
T&R=K — T&R designation letter (see Table T&R)