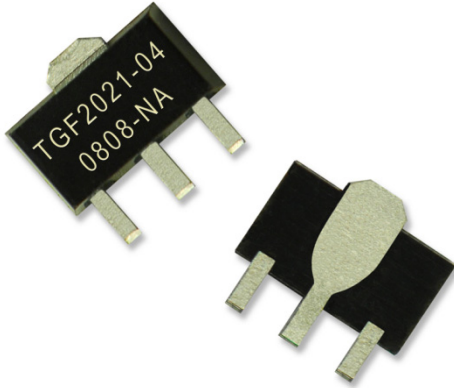
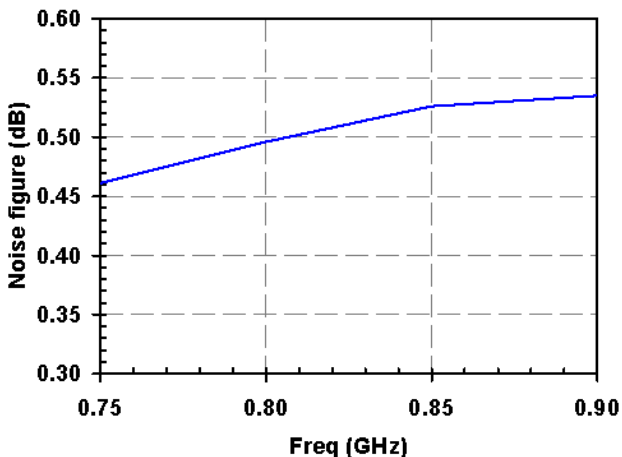
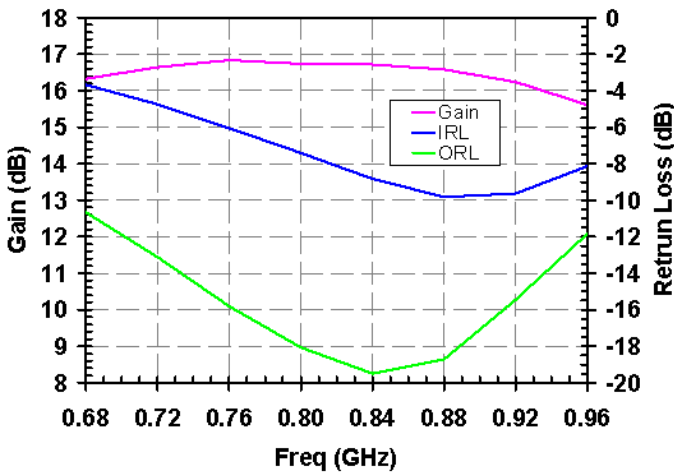


DC-4 GHz Packaged Power pHEMT



900 MHz Low Noise Application Board Performance

Bias conditions: $V_d = 5\text{ V}$, $I_{dq} = 150\text{ mA}$, $V_g = -0.8\text{ V}$ Typical



Key Features

- Frequency Range: DC-4 GHz
 - Package Dimensions: 4.5 x 4 x 1.5 mm
- Nominal 900 MHz Low Noise Application Board Performance:
- OTOI: 39.5 dBm
 - Noise Figure: 0.6dB
 - Gain: 16dB
 - P1dB: 26.5dBm
 - Input Return Loss: -8 dB
 - Output Return Loss: -18 dB
 - Bias: $V_d = 5\text{ V}$, $I_d = 150\text{ mA}$, $V_g = -0.8\text{ V}$ (Typical)

Primary Applications

- Cellular Base Stations
- WiMAX
- Wireless Infrastructure
- Low Noise Amplifiers

Product Description

The TGF2021-04-SD is a high performance pseudomorphic High Electron Mobility GaAs Transistor (pHEMT) housed in a low cost SOT89 surface mount package.

The device's ideal operating point for low noise operation is at a drain bias of 5 V and 150 mA. At this bias at 900 MHz when matched into 50 ohms using external components, this device is capable of 16 dB gain, 0.6dB noise figure, and 39.5 dBm output IP3.

The combination of high gain, low noise, and excellent linearity makes this an ideal component for use in a 3G or 4G receive chain.

Evaluation boards at 900 MHz are available.

RoHS and Lead-Free compliant

Table I
Absolute Maximum Ratings 1/

| Symbol | Parameter | Value | Notes |
|--------|-----------------------------|-----------|-------|
| Vd-Vg | Drain to Gate Voltage | 15.0 V | |
| Vd | Drain Voltage | 12.0 V | 2/ |
| Vg | Gate Voltage Range | -5 to 0 V | |
| Id | Drain Current | 1800 mA | 2/ |
| Ig | Gate Current Range | 28 mA | |
| Tch | Channel Temperature | 200 °C | 1/ |
| Pin | Input Continuous Wave Power | 31 dBm | 2/ |

- 1/ These ratings represent the maximum operable values for this device. Stresses beyond those listed under “Absolute Maximum Ratings” may cause permanent damage to the device and / or affect device lifetime. These are stress ratings only, and functional operation of the device at these conditions is not implied.
- 2/ Combinations of supply voltage, supply current, input power, and output power shall not exceed the maximum power dissipation listed in Table IV.

Table II
Recommended Low Noise Operating Conditions

| Symbol | Parameter 1/ | Typical Value |
|--------|---------------|---------------|
| Vd | Drain Voltage | 5 V |
| Idq | Drain Current | 150 mA |
| Vg | Gate Voltage | -0.8 V |

- 1/ See assembly diagram for bias instructions.

Table III
RF Characterization Table

Bias: Vd = 5 V, Idq = 150 mA, Vg = -0.8 V, typical

| Symbol | Parameter | Test Conditions | Minimum | Nominal | Maximum | Units | Notes |
|--------|-------------------------------|-----------------|---------|---------|---------|-------|-------|
| Gain | Small Signal Gain | 900 MHz | 14.0 | 16.0 | 17.0 | dB | 1/ |
| IRL | Input Return Loss | 900 MHz | | -8 | | dB | 1/ |
| ORL | Output Return Loss | 900 MHz | | -18 | | dB | 1/ |
| Psat | Saturated Output Power | 900 MHz | | 27.5 | | dBm | 1/ |
| P1dB | Output Power @1dB compression | 900 MHz | 25.5 | 26.5 | | dBm | 1/ |
| TOI | Output TOI | 900 MHz | 38.0 | 39.5 | | dBm | 1/ 2/ |
| NF | Noise Figure | 900 MHz | | 0.6 | 1.2 | dB | 1/ |

1/ Using 900 MHz Application Board.

2/ IP3 measured at 900MHz, 8MHz spacing, RFout=3dBm/tone

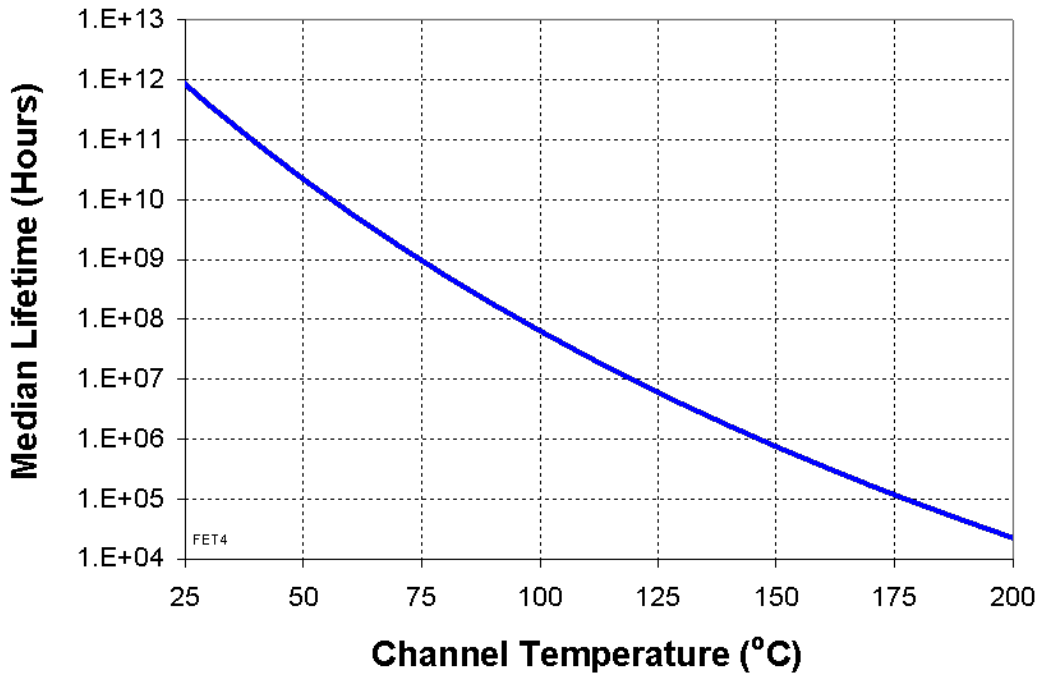
Table IV
Power Dissipation and Thermal Properties

THERMAL INFORMATION

| Parameter | Test Conditions | T _{CH} (°C) | θ _{JC} (°C/W) | T _m (hrs) |
|---|---|-------------------------|---------------------------|-------------------------|
| θ _{JC} Thermal Resistance (Channel to Backside of Package) | V _D = 4.5 V I _D = 150 mA P _{DISS} = 0.675 W T _{BASE} = 85 °C | 98 | 19 | 8E+07 |

Note: Heat transfer is conducted through the bottom of the TGF2021-04-SD package into the printed circuit board. Thermal resistance of board is application dependent and is not included above.

Median Lifetime (T_m) vs. Channel Temperature



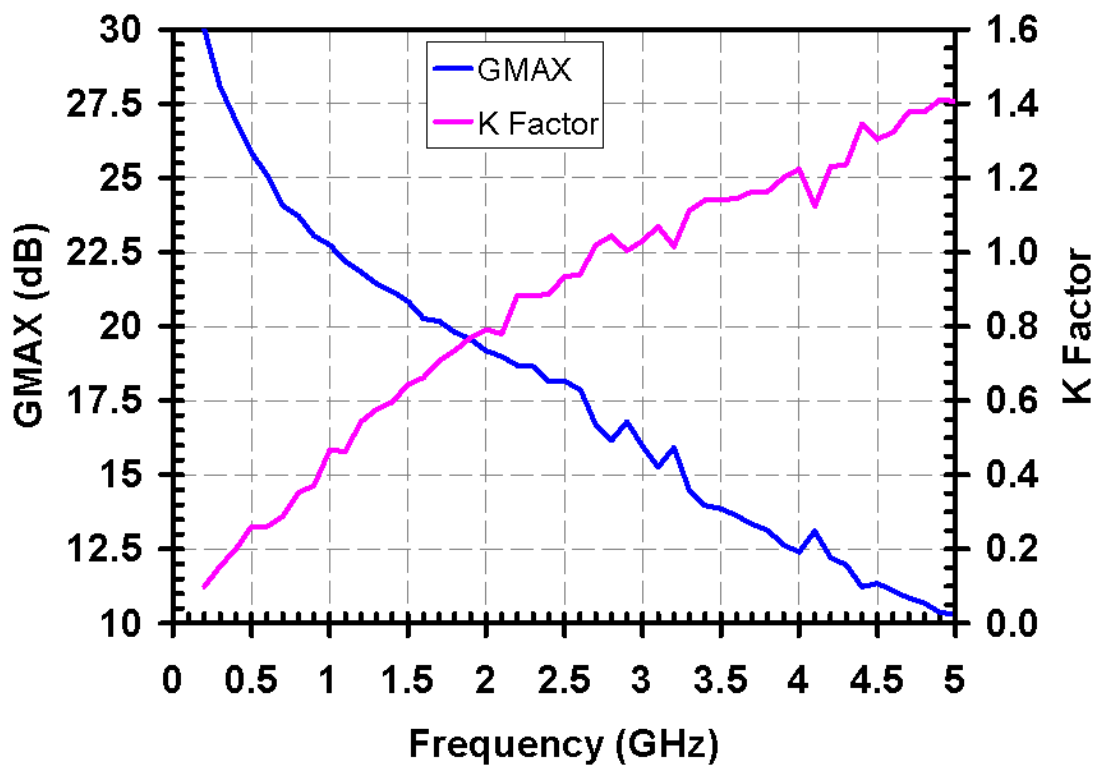
**Device S-Parameters (device mounted as shown on Page 15)
Bias conditions Vd=5V, Ids=150mA, Vg=-0.8V typical**

| FREQ GHZ | MAG[S11] | ANG[S11] | MAG[S21] | ANG[S21] | MAG[S12] | ANG[S12] | MAG[S22] | ANG[S22] |
|----------|----------|----------|----------|----------|----------|----------|----------|----------|
| 0.2 | 0.932 | -123.072 | 21.427 | 115.942 | 0.021 | 28.395 | 0.646 | -162.037 |
| 0.3 | 0.923 | -144 | 15.412 | 103.793 | 0.024 | 20.995 | 0.687 | -168.797 |
| 0.4 | 0.925 | -156.561 | 11.895 | 96.265 | 0.024 | 17.704 | 0.712 | -173.53 |
| 0.5 | 0.919 | -165.822 | 9.652 | 90.224 | 0.025 | 14.82 | 0.714 | -177.448 |
| 0.6 | 0.921 | -173.012 | 8.124 | 85.625 | 0.025 | 9.321 | 0.722 | 179.593 |
| 0.7 | 0.919 | -178.888 | 6.922 | 81.155 | 0.027 | 7.333 | 0.724 | 177.605 |
| 0.8 | 0.917 | 176.252 | 6.152 | 76.901 | 0.026 | 7.538 | 0.723 | 175.297 |
| 0.9 | 0.917 | 171.831 | 5.473 | 74.167 | 0.027 | 5.507 | 0.729 | 173.971 |
| 1 | 0.91 | 167.67 | 4.914 | 71.157 | 0.026 | 5.744 | 0.728 | 171.727 |
| 1.1 | 0.913 | 164.057 | 4.492 | 67.99 | 0.027 | 2.806 | 0.729 | 169.556 |
| 1.2 | 0.91 | 159.687 | 4.141 | 64.777 | 0.027 | 3.81 | 0.731 | 167.568 |
| 1.3 | 0.911 | 156.568 | 3.772 | 61.779 | 0.027 | 2.984 | 0.729 | 166.375 |
| 1.4 | 0.911 | 153.572 | 3.559 | 58.565 | 0.027 | 1.561 | 0.728 | 164.845 |
| 1.5 | 0.909 | 150.565 | 3.298 | 55.316 | 0.027 | 1.23 | 0.731 | 163.193 |
| 1.6 | 0.909 | 147.435 | 3.09 | 52.976 | 0.029 | 1.256 | 0.73 | 162.211 |
| 1.7 | 0.908 | 144.315 | 2.925 | 50.204 | 0.028 | -0.611 | 0.729 | 160.552 |
| 1.8 | 0.91 | 140.46 | 2.782 | 47.128 | 0.029 | -0.344 | 0.726 | 159.282 |
| 1.9 | 0.909 | 138.172 | 2.636 | 44.653 | 0.029 | -1.169 | 0.73 | 157.476 |
| 2 | 0.909 | 135.405 | 2.493 | 41.763 | 0.03 | -2.66 | 0.724 | 155.587 |
| 2.1 | 0.914 | 132.151 | 2.382 | 39.061 | 0.03 | -4.208 | 0.732 | 154.236 |
| 2.2 | 0.901 | 129.373 | 2.296 | 36.38 | 0.031 | -4.136 | 0.728 | 152.488 |
| 2.3 | 0.907 | 126.779 | 2.208 | 34.013 | 0.03 | -5.268 | 0.734 | 151.519 |
| 2.4 | 0.908 | 123.836 | 2.1 | 31.669 | 0.032 | -6.796 | 0.729 | 149.732 |
| 2.5 | 0.904 | 120.979 | 2.031 | 27.603 | 0.031 | -8.985 | 0.728 | 148.29 |
| 2.6 | 0.908 | 118.128 | 1.97 | 25.477 | 0.032 | -8.646 | 0.724 | 146.869 |
| 2.7 | 0.902 | 115.242 | 1.878 | 23.232 | 0.033 | -8.753 | 0.717 | 145.427 |
| 2.8 | 0.899 | 111.949 | 1.84 | 20.16 | 0.033 | -10.664 | 0.718 | 144.608 |
| 2.9 | 0.905 | 109.87 | 1.772 | 17.535 | 0.034 | -12.762 | 0.719 | 142.216 |
| 3 | 0.904 | 106.959 | 1.72 | 14.591 | 0.034 | -13.733 | 0.724 | 140.595 |
| 3.1 | 0.903 | 104.385 | 1.657 | 11.908 | 0.034 | -15.628 | 0.719 | 139.267 |
| 3.2 | 0.908 | 101.359 | 1.631 | 9.029 | 0.035 | -16.881 | 0.727 | 137.618 |
| 3.3 | 0.903 | 98.561 | 1.567 | 6.636 | 0.035 | -17.376 | 0.72 | 135.872 |
| 3.4 | 0.898 | 95.964 | 1.516 | 4.466 | 0.036 | -19.167 | 0.723 | 134.591 |
| 3.5 | 0.901 | 93.255 | 1.48 | 1.046 | 0.036 | -20.739 | 0.72 | 132.781 |
| 3.6 | 0.902 | 90.562 | 1.452 | -0.991 | 0.037 | -20.869 | 0.721 | 131.451 |
| 3.7 | 0.906 | 87.974 | 1.403 | -3.95 | 0.037 | -21.813 | 0.709 | 130.368 |
| 3.8 | 0.905 | 84.898 | 1.378 | -6.245 | 0.038 | -23.159 | 0.716 | 128.457 |
| 3.9 | 0.9 | 82.083 | 1.336 | -9.121 | 0.039 | -24.762 | 0.719 | 127.044 |
| 4 | 0.897 | 79.696 | 1.311 | -11.46 | 0.039 | -27.234 | 0.722 | 125.654 |
| 4.1 | 0.908 | 77.169 | 1.305 | -14.814 | 0.039 | -28.915 | 0.725 | 123.914 |
| 4.2 | 0.904 | 74.425 | 1.265 | -16.441 | 0.039 | -29.261 | 0.717 | 121.907 |
| 4.3 | 0.901 | 71.483 | 1.238 | -20.308 | 0.04 | -31.042 | 0.72 | 120.176 |
| 4.4 | 0.893 | 68.717 | 1.194 | -22.153 | 0.04 | -34.044 | 0.716 | 118.433 |
| 4.5 | 0.895 | 66.877 | 1.2 | -25.013 | 0.041 | -35.162 | 0.714 | 116.198 |
| 4.6 | 0.9 | 63.721 | 1.157 | -27.589 | 0.041 | -37.19 | 0.704 | 114.38 |
| 4.7 | 0.898 | 60.691 | 1.135 | -30.031 | 0.04 | -37.632 | 0.713 | 112.974 |
| 4.8 | 0.896 | 57.165 | 1.119 | -32.131 | 0.041 | -38.749 | 0.721 | 111.711 |
| 4.9 | 0.89 | 55.163 | 1.102 | -34.891 | 0.042 | -40.297 | 0.724 | 109.731 |
| 5 | 0.892 | 51.923 | 1.083 | -38.623 | 0.042 | -43.138 | 0.718 | 108.428 |

Gmax and K factor

Device mounted as shown on Page 15

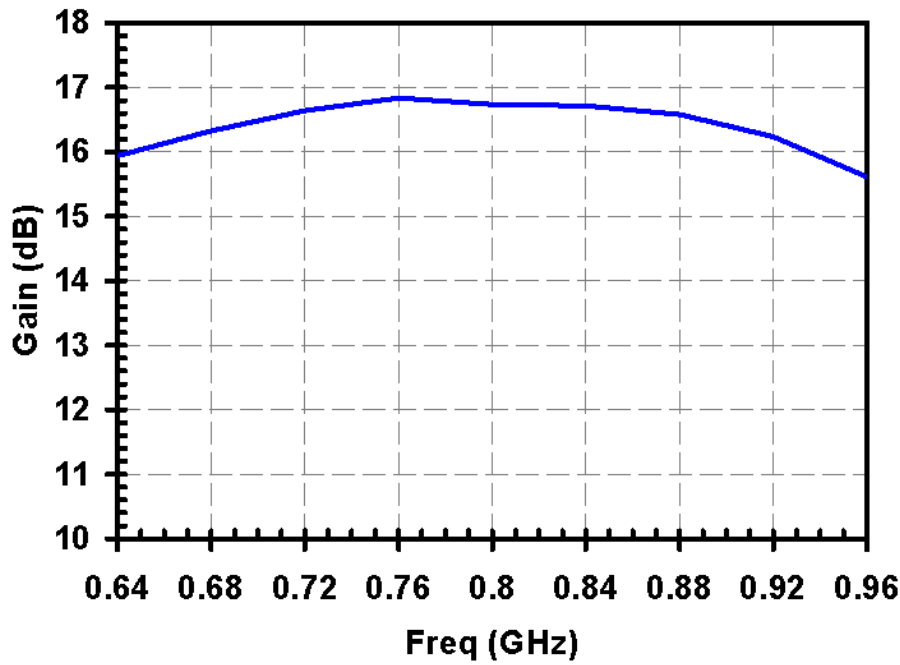
Bias conditions: $V_d = 5\text{ V}$, $I_{dq} = 150\text{ mA}$, $V_g = -0.8\text{ V}$ Typical



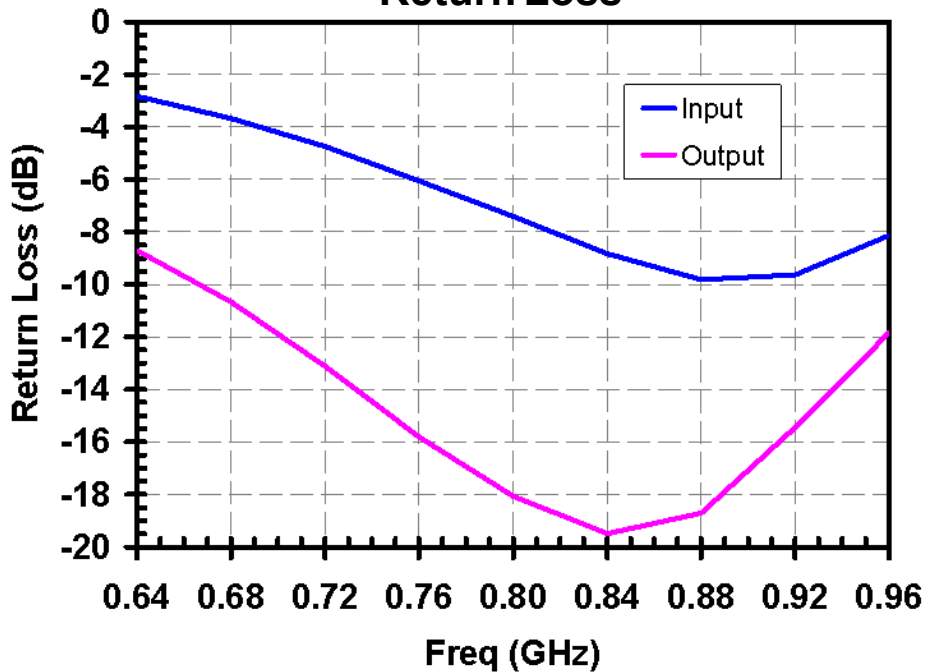
Measured Data 900 MHz Application Board

Bias conditions: $V_d = 5\text{ V}$, $I_d = 150\text{ mA}$, $V_g = -0.8\text{ V}$ Typical

Gain



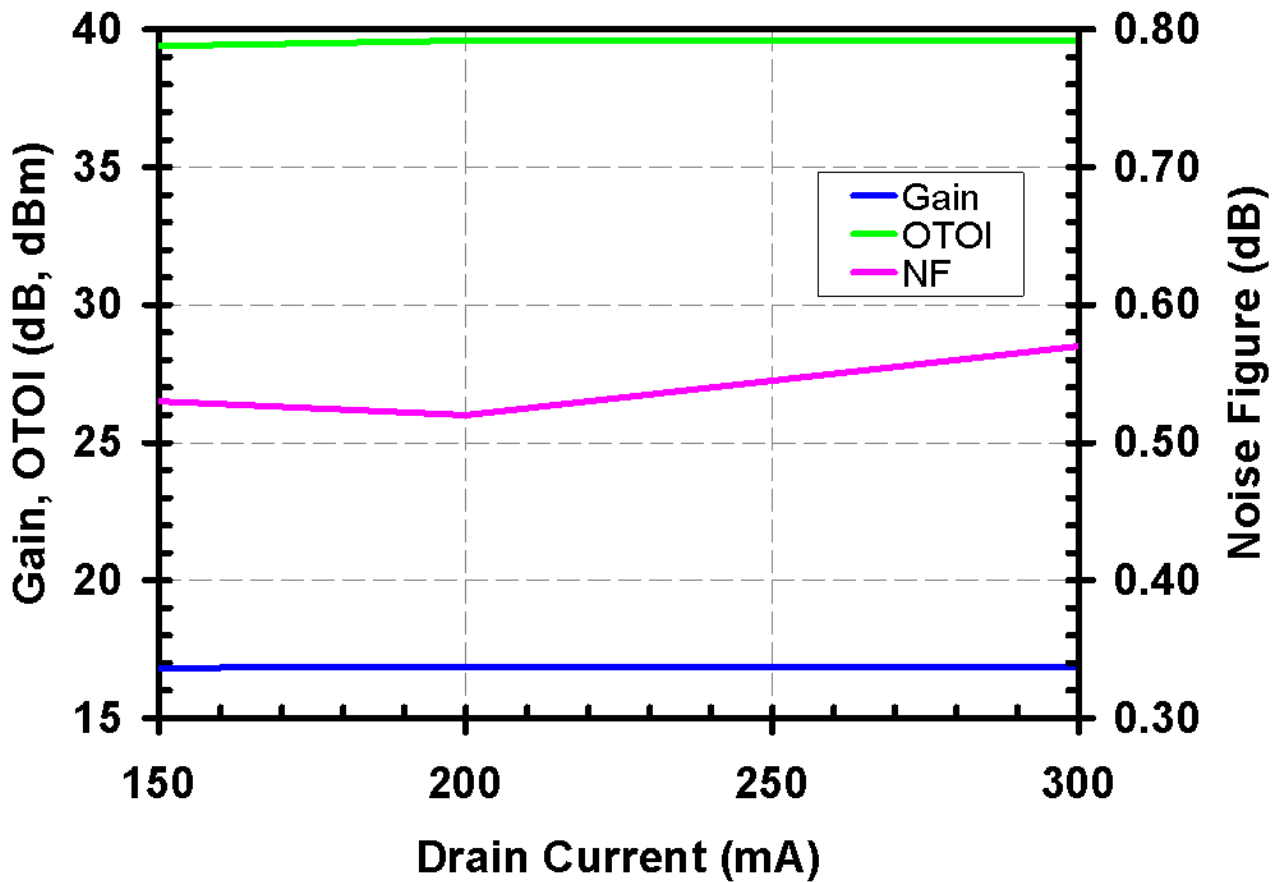
Return Loss



Measured Data, 900 MHz Application Board (at 850MHz)

Bias Conditions: $V_{dd} = 5V$

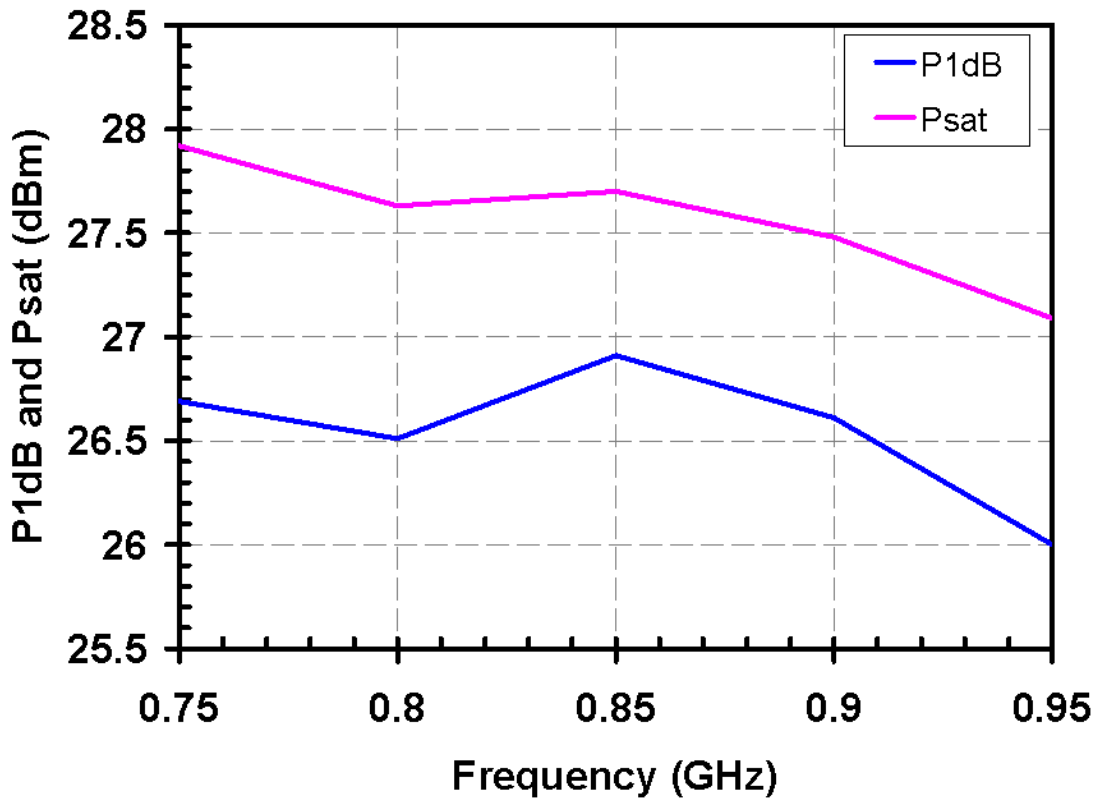
Gain, Noise Figure and OTOI vs. I_{ds}



Measured Data 900 MHz Application Board

Bias conditions: $V_d = 5\text{ V}$, $I_{dq} = 150\text{ mA}$, $V_g = -0.8\text{ V}$ Typical

P1dB and Psat vs. Frequency



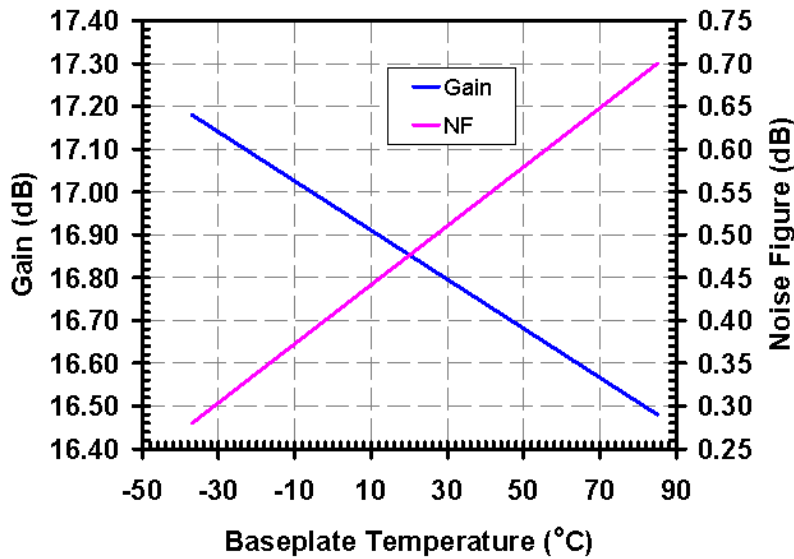
Measured Data 900 MHz Application Board

Bias conditions: $V_d = 5\text{ V}$, $I_{dq} = 150\text{ mA}$

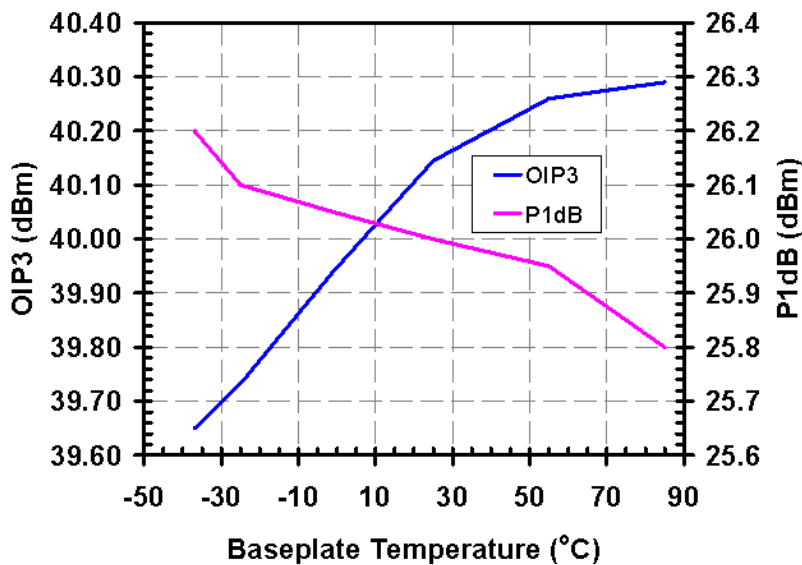
(measured at constant drain current using active bias circuit)

Device case temperature = 30°C above baseplate

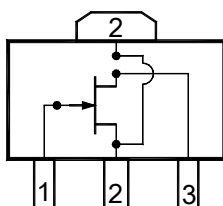
Gain and noise figure vs. temperature (at 850MHz)



OIP3 and P1dB vs. temperature (at 850MHz)



Electrical Schematic



| Pin | Signal |
|-----|----------------|
| 1 | RF In (Gate) |
| 2 | Gnd (Source) |
| 3 | RF Out (Drain) |

Bias Procedures

Bias-up Procedure

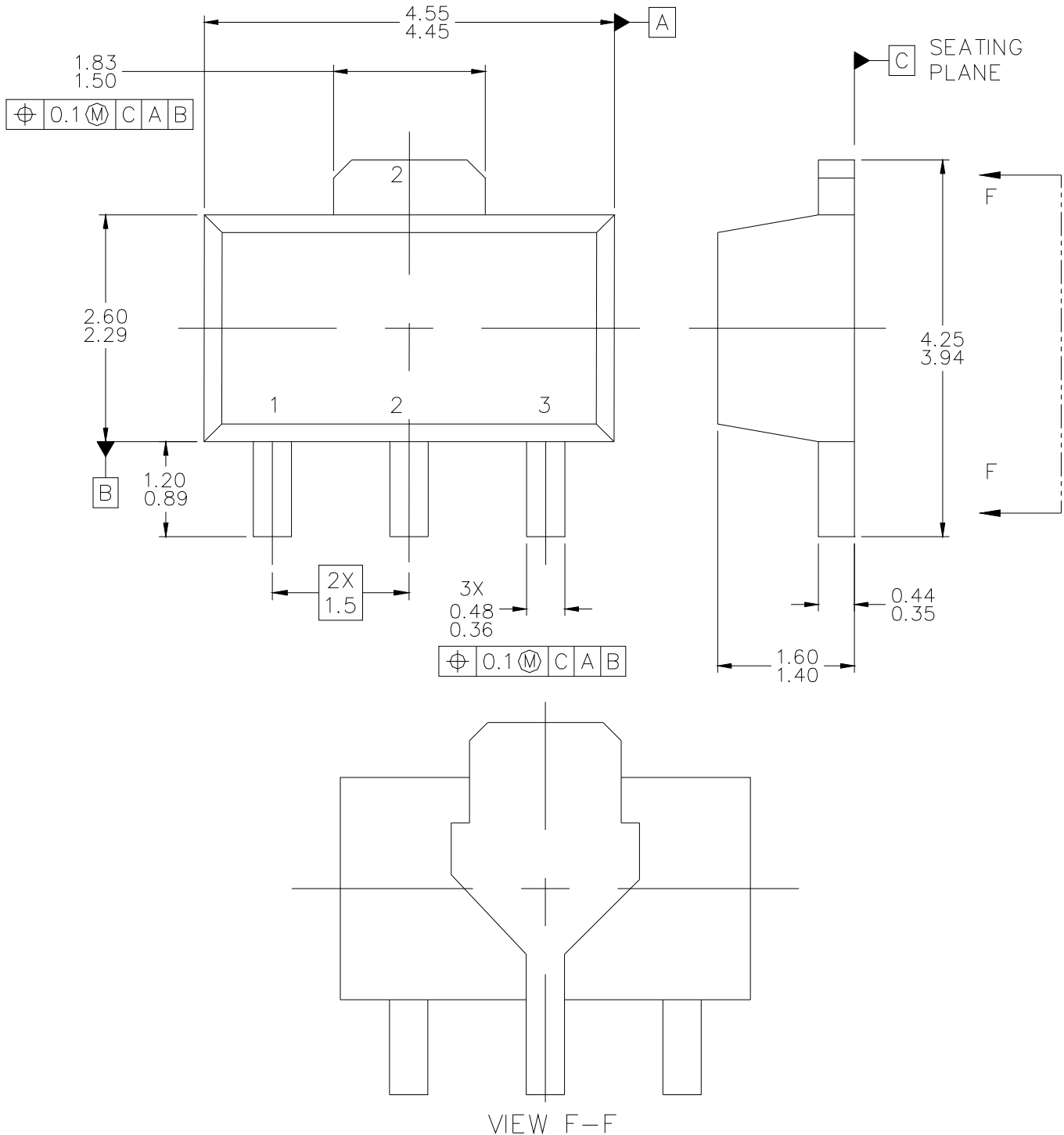
- Vg set to -2.5 V
- Vd set to +5 V
- Adjust Vg more positive until Idq is 150 mA. This will be at approximately Vg = -0.8 V
- Apply RF signal to input

Bias-down Procedure

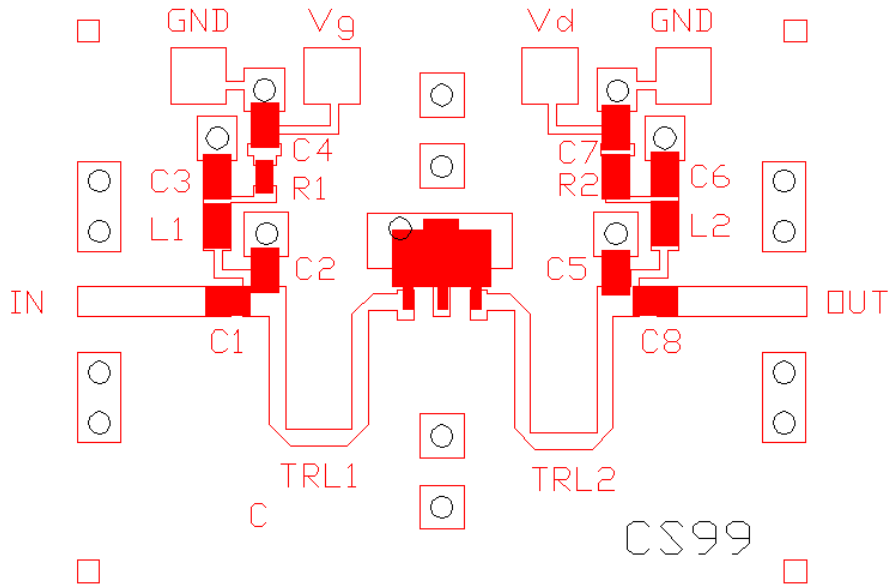
- Turn off RF signal at input
- Reduce Vg to -2.5V. Ensure Id ~ 0 mA
- Turn Vd to 0 V
- Turn Vg to 0 V

Mechanical Drawing

Units: Millimeters

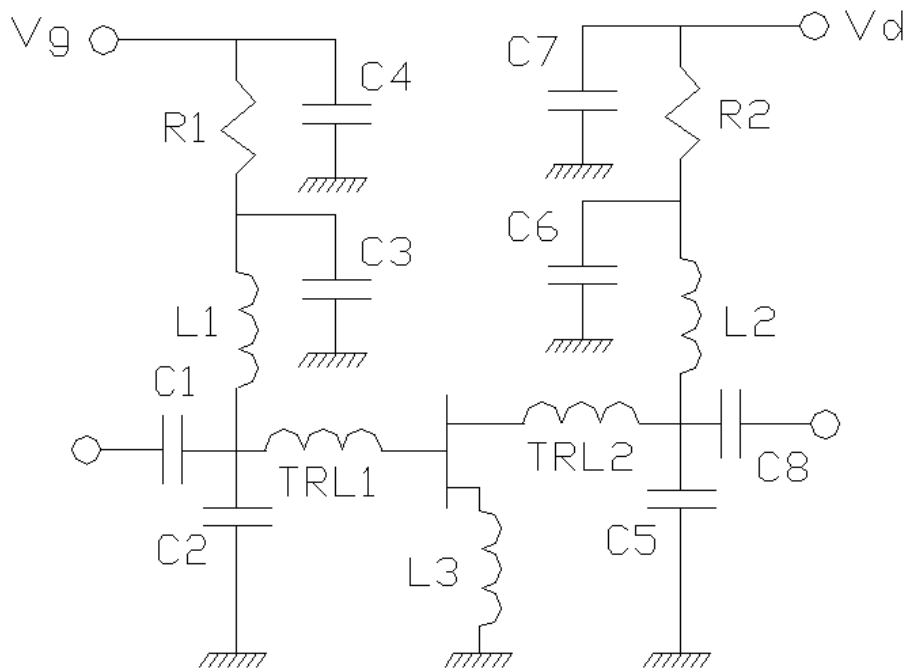


Evaluation Board Layout



Board dimensions: 33.0 x 25.4mm

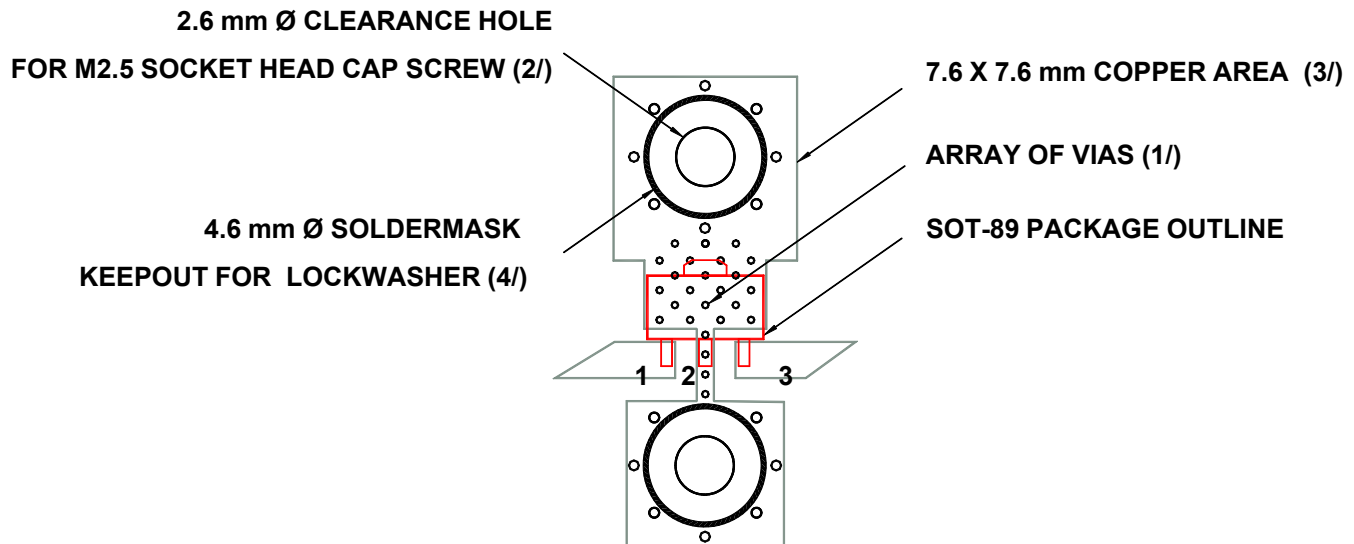
Evaluation Board Schematic – 900 MHz



Evaluation Board Bill of Materials

C1: 4.7pF 0805 AVX 08052U4R7CAT2A
C2: 2.7pF 0805 AVX 08052U2R7BAT2A
C3: 27pF 0805 AVX 08052U270GAT2A
C4: 0.47uF 0805
C5: 3.3pF 0805 AVX 08052U3R3BAT2A
C6: 27pF 0805 AVX 08052U270GAT2A
C7: 1.0uF 0805
C8: 27pF 0805 AVX 08052U270GAT2A
R1: 47R 0603
R2: 3R3 0805
L1: 22nH 0805 AVX L0805220JESTR
L2: 22nH 0805 AVX L0805220JESTR
L3: ~0.5nH, realised on board with one source via
TRL1: transmission line: w=0.75mm, l=15.8mm
TRL2: transmission line: w=0.75mm, l=16.1mm
Board material – FR4, 0.79mm thick

Recommended Assembly Diagram



Assembly Notes

1/ The lowest possible thermal and electrical resistance for Pin 2 is critical for optimal performance. The array of vias under Pin 2 should be as small and as dense as the PC board fabrication permits. 0.30 mm diameter vias on 0.60 mm center to center spacing is recommended.

2/ Mounting screws in the vicinity of the package improve heat transfer to the chassis or to a heat spreader located on the backside of the PC board. Shown are clearance holes and solder mask keepout zone for an M2.5 socket head cap screw. Use of a split lockwasher and proper torque on the screw will prevent compression damage to the PC board.

3/ Use of 1 oz copper (min) in the PC board construction is recommended.

4/ For lowest thermal resistance, solder mask must be removed where the copper traces on the PC board contact the heat spreader. In this example, this would be a) backside of the PC board and b) front of the PC board around package pin 2.

GaAs FET devices are susceptible to damage from Electrostatic Discharge. Proper precautions should be observed during handling, assembly and test.

Recommended Surface Mount Package Assembly

Proper ESD precautions must be followed while handling packages.

Clean the board and rinse with alcohol. Allow the circuit to fully dry.

TriQuint recommends using solder paste for attachment. Follow solder paste and reflow oven vendors' recommendations when developing a solder reflow profile. Typical solder reflow profiles are listed in the table below.

Solder paste can be applied using a stencil printer or dot placement. The volume of solder paste depends on PCB and component layout and should be well controlled to ensure consistent mechanical and electrical performance.

Clean the assembly with alcohol after soldering.

Typical Solder Reflow Profiles

| Reflow Profile | SnPb | Pb Free |
|--------------------------------------|-----------------------------|-----------------------------|
| Ramp-up Rate | 3 °C/sec | 3 °C/sec |
| Activation Time and Temperature | 60 – 120 sec @ 140 – 160 °C | 60 – 180 sec @ 150 – 200 °C |
| Time above Melting Point | 60 – 150 sec | 60 – 150 sec |
| Max Peak Temperature | 240 °C | 260 °C |
| Time within 5 °C of Peak Temperature | 10 – 20 sec | 10 – 20 sec |
| Ramp-down Rate | 4 – 6 °C/sec | 4 – 6 °C/sec |

Ordering Information

| Part | Package Style |
|-------------------|-----------------------|
| TGF2021-04-SD | SOT-89, BULK |
| TGF2021-04-SD-T/R | SOT-89, TAPE AND REEL |

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