

# MGA-30789

2 - 6GHz

High Linearity Gain Block



## Data Sheet

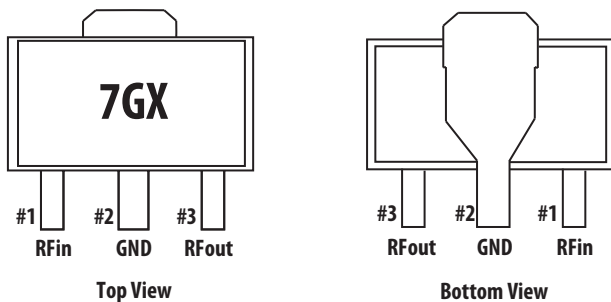
### Description

Avago Technologies' MGA-30789 is a broadband, high linearity gain block MMIC amplifier achieved through the use of Avago Technologies' proprietary 0.25um GaAs Enhancement-mode pHEMT process.

The device required simple dc biasing components to achieve wide bandwidth performance. The temperature compensated internal bias circuit provides stable current over temperature and process threshold voltage variation.

The MGA-30789 is housed inside a low cost RoHS compliant SOT89 industry standard SMT package (4.5 x 4.1 x 1.5 mm).

### Component Image




Notes:

Package marking provides orientation and identification

"7G" = Device Code

"X" = Month of Manufacture



**Attention: Observe precautions for handling electrostatic sensitive devices.**  
ESD Machine Model = 110 V  
ESD Human Body Model = 2000 V  
Refer to Avago Application Note A004R:  
Electrostatic Discharge, Damage and Control.

### Features

- High linearity
- Built in temperature compensated internal bias circuitry
- No RF matching components required
- GaAs E-pHEMT Technology<sup>[1]</sup>
- Standard SOT89 package
- Single, Fixed 5V supply
- Excellent uniformity in product specifications
- MSL-2 and Lead-free halogen free
- High MTTF for base station application

### Specifications

#### 3.5GHz; 5V, 100mA (typical)

- 11.7 dB Gain
- 41.8 dBm Output IP3
- 3.3 dB Noise Figure
- 25 dBm Output Power at 1dB gain compression

#### 5GHz; 5V, 100mA (typical)

- 8.8 dB Gain
- 40 dBm Output IP3
- 2.7 dB Noise Figure
- 25.7 dBm Output Power at 1dB gain compression

### Applications

- RF driver amplifier
- General purpose gain block

Note:

1. Enhancement mode technology employs positive gate voltage, thereby eliminating the need of negative gate voltage associated with conventional depletion mode devices.

### Absolute Maximum Rating<sup>[1]</sup> T<sub>A</sub>=25°C

| Symbol              | Parameter                              | Units | Absolute Max. |
|---------------------|--|-------|---------------|
| V <sub>dd,max</sub> | Device Voltage, RF output to ground    | V     | 5.5           |
| P <sub>in,max</sub> | CW RF Input Power                      | dBm   | 24            |
| P <sub>diss</sub>   | Total Power Dissipation <sup>[3]</sup> | W     | 0.75          |
| T <sub>j,MAX</sub>  | Junction Temperature                   | °C    | 150           |
| T <sub>STG</sub>    | Storage Temperature                    | °C    | -65 to 150    |

### Thermal Resistance

Thermal Resistance<sup>[3]</sup>  $\theta_{JC} = 52^{\circ}\text{C}/\text{W}$   
(V<sub>dd</sub> = 5, I<sub>ds</sub> = 88 mA, T<sub>c</sub> = 85°C)

Notes:

1. Operation of this device in excess of any of these limits may cause permanent damage.
2. Thermal resistance measured using Infrared measurement technique.
3. This is limited by maximum V<sub>dd</sub> and I<sub>ds</sub>. Derate 19.2 mW/°C for T<sub>c</sub> > 111°C.

### Product Consistency Distribution Charts<sup>[1, 2]</sup>

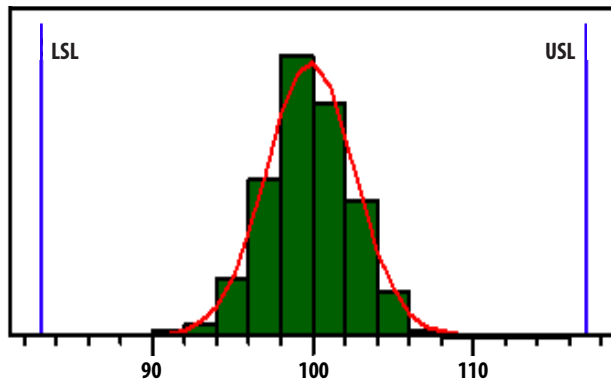


Figure 1. I<sub>ds</sub>, LSL=83mA, nominal=100mA, USL=117mA

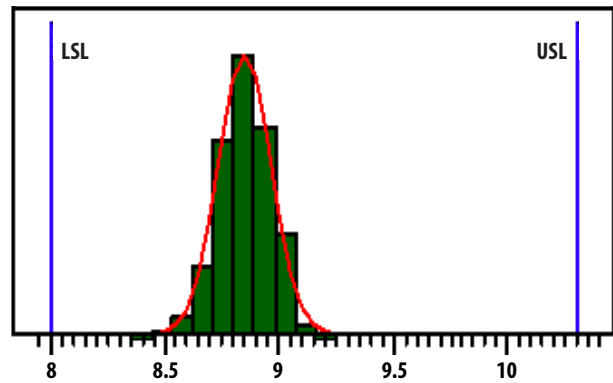


Figure 2. Gain, LSL=8dB, nominal=8.8dB, USL=10.3dB

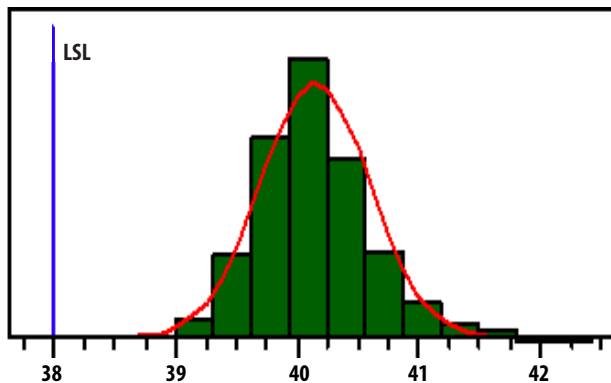


Figure 3. OIP3, LSL=38dBm, nominal=41dBm

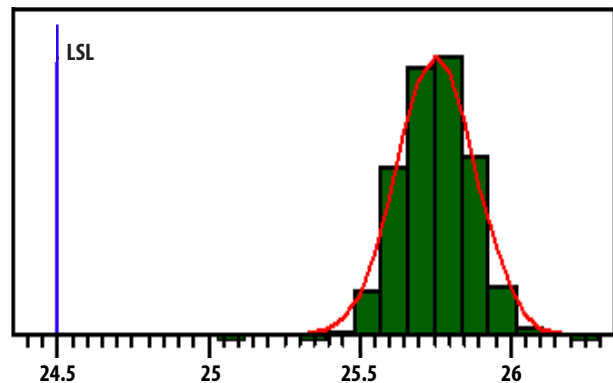


Figure 4. P1dB, LSL=24.5dBm, nominal=25.7dBm

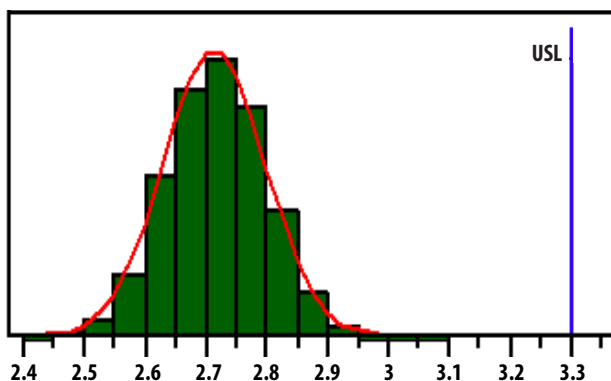


Figure 5. NF, nominal=2.7dB, USL=3.3dB

Notes:

1. Distribution data sample size is 2000 samples taken from 3 different wafer lots. Future wafers allocated to this product may have nominal values anywhere between the upper and lower limits.
2. Measurements were made on a characterization test board, which represents a trade-off between optimal OIP3, gain and P1dB. Circuit trace losses have not been de-embedded from measurements above.

## Electrical Specifications <sup>[1]</sup>

T<sub>A</sub> = 25°C, V<sub>dd</sub> = 5V

| Symbol              | Parameter and Test Condition         | Frequency        | Units | Min. | Typ.          | Max. |
|---------------------|--------------------------------------|------------------|-------|------|---------------|------|
| I <sub>ds</sub>     | Quiescent current                    | N/A              | mA    | 83   | 100           | 117  |
| Gain                | Gain                                 | 3.5 GHz<br>5 GHz | dB    | 8    | 11.8<br>8.8   | 10.3 |
| OIP3 <sup>[2]</sup> | Output Third Order Intercept Point   | 3.5 GHz<br>5 GHz | dBm   | 38   | 41.8<br>40    | –    |
| NF                  | Noise Figure                         | 3.5 GHz<br>5 GHz | dB    | –    | 3.3<br>2.7    | 3.3  |
| S11                 | Input Return Loss, 50Ω source        | 3.5 GHz<br>5 GHz | dB    |      | -12<br>-8.5   |      |
| S22                 | Output Return Loss, 50Ω load         | 3.5 GHz<br>5 GHz | dB    |      | -10.5<br>-9.5 |      |
| S12                 | Reverse Isolation                    | 3.5 GHz<br>5 GHz | dB    |      | -25<br>-22    |      |
| OP1dB               | Output Power at 1dB Gain Compression | 3.5 GHz<br>5 GHz | dBm   | 24.5 | 24.5<br>25.7  | –    |

### Notes:

1. Measurements obtained using demo board described in Figure 30 and 31. 3.5GHz data was taken with 3GHz - 4GHz Application Test Circuit and 5GHz data with 4GHz - 6GHz Application Test Circuit respectively.
2. OIP3 test condition: F<sub>RF1</sub> - F<sub>RF2</sub> = 10MHz with input power of -10dBm per tone measured at worse side band
3. Use proper bias, heat sink and de-rating to ensure maximum channel temperature is not exceeded. See absolute maximum ratings and application note (if applicable) for more details.

## Typical Performance (2GHz - 3GHz)

$T_A = 25^\circ\text{C}$ ,  $V_{dd} = 5\text{V}$ , Input Signal = CW unless stated otherwise. Application Test Circuit is shown in Figure 30 and Table 1.

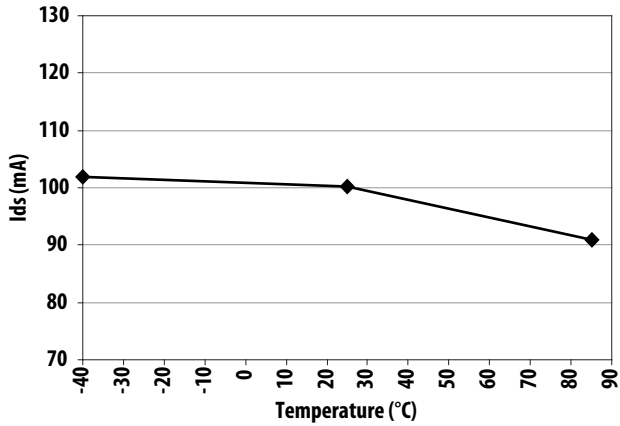


Figure 6. Ids over Temperature

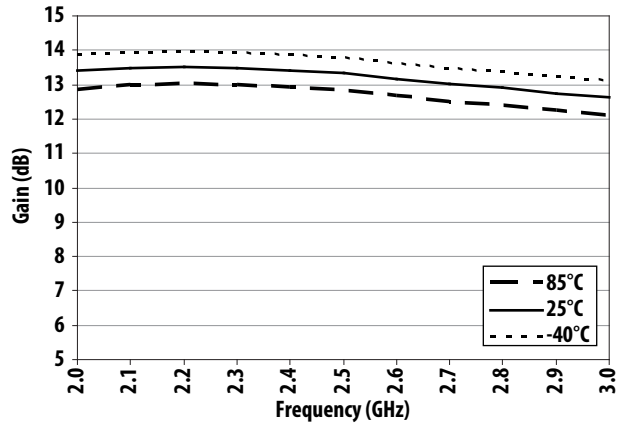


Figure 7. Gain over Frequency and Temperature

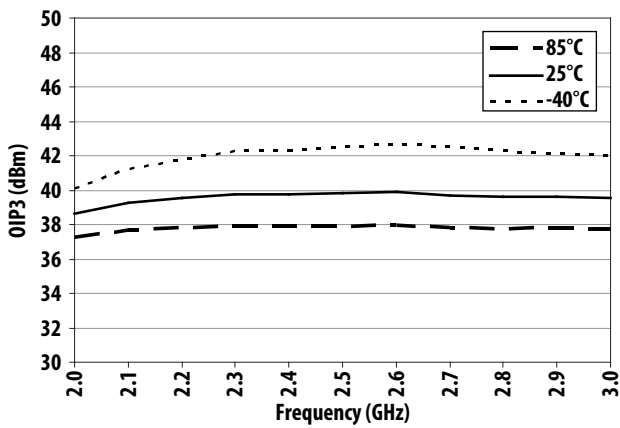


Figure 8. OIP3 over Frequency and Temperature

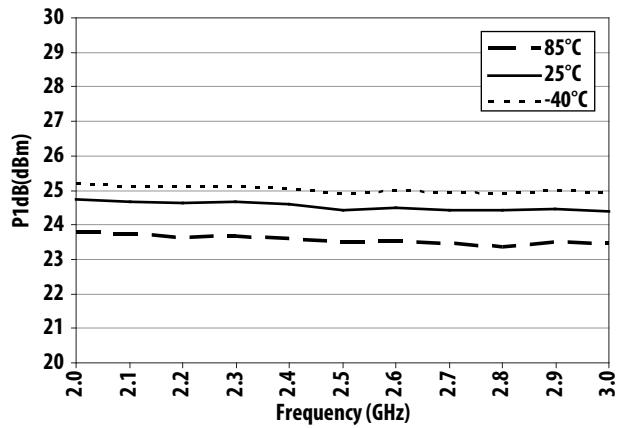


Figure 9. P1dB over Frequency and Temperature

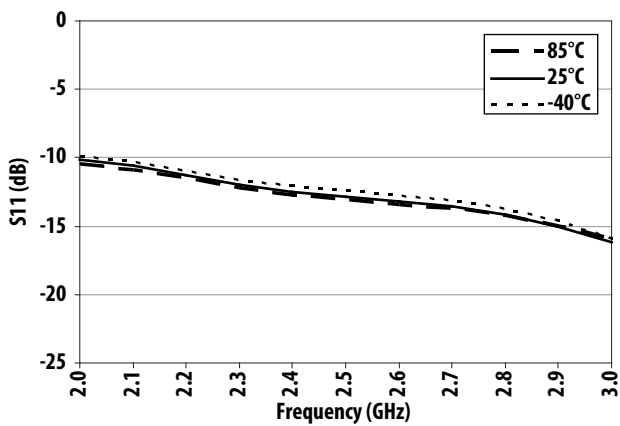


Figure 10. S11 over Frequency and Temperature

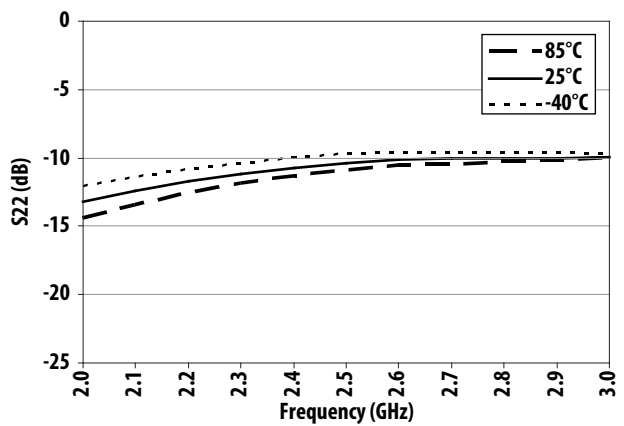


Figure 11. S22 over Frequency and Temperature

### Typical Performance (2GHz - 3GHz)

T<sub>A</sub> = 25°C, V<sub>dd</sub> = 5V, Input Signal = CW unless stated otherwise. Application Test Circuit is shown in Figure 30 and Table 1.

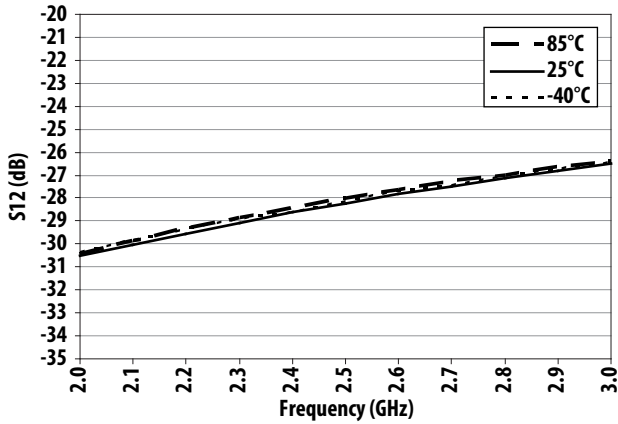


Figure 12. S12 over Frequency and Temperature

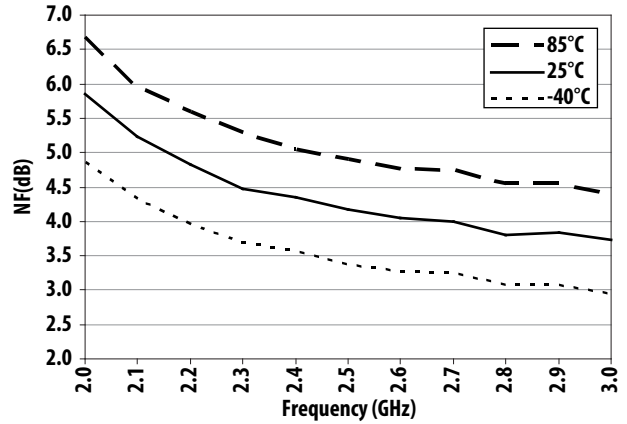


Figure 13. Noise Figure over Frequency and Temperature

### Typical Performance (3GHz - 4GHz)

T<sub>A</sub> = 25°C, V<sub>dd</sub> = 5V, Input Signal=CW. Application Test Circuit is shown in Figure 30 and Table 2.

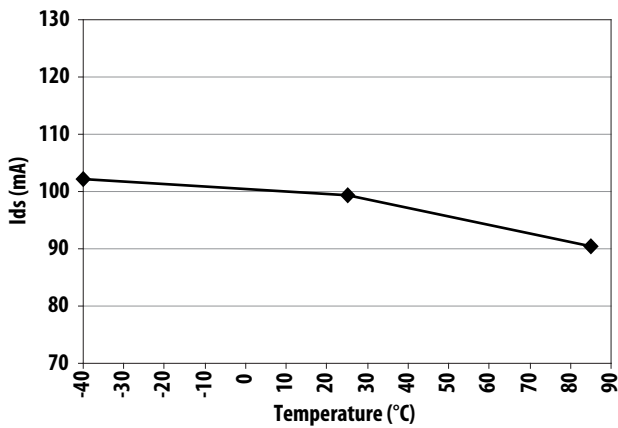


Figure 14. Ids over Temperature

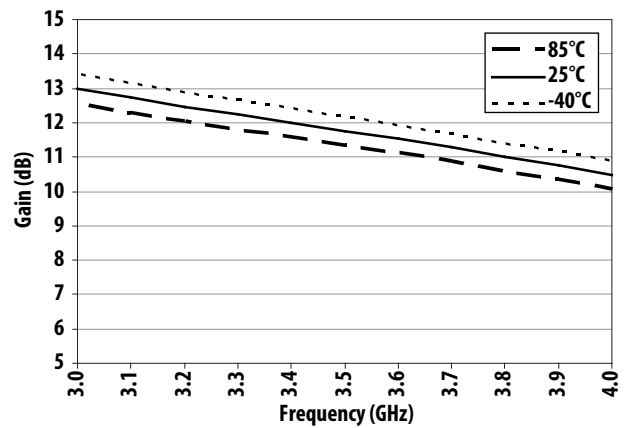


Figure 15. Gain over Frequency and Temperature

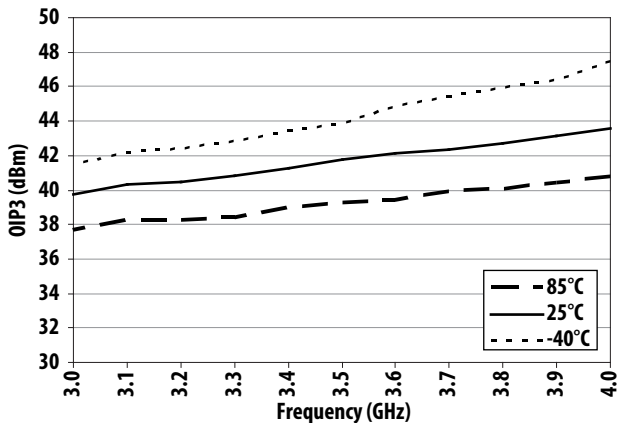


Figure 16. OIP3 over Frequency and Temperature

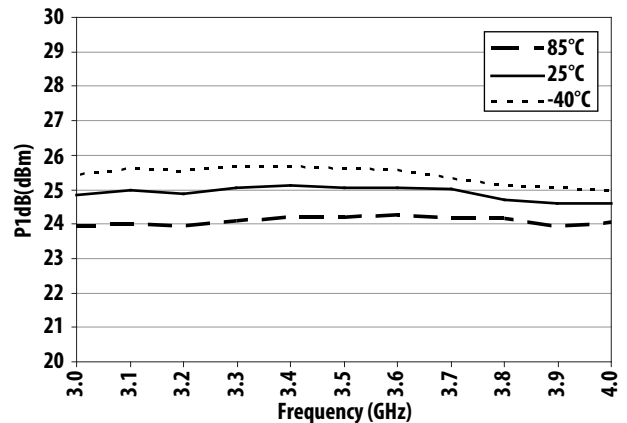


Figure 17. P1dB over Frequency and Temperature

### Typical Performance (3GHz - 4GHz)

T<sub>A</sub> = 25°C, V<sub>dd</sub> = 5V, Input Signal=CW. Application Test Circuit is shown in Figure 30 and Table 2.

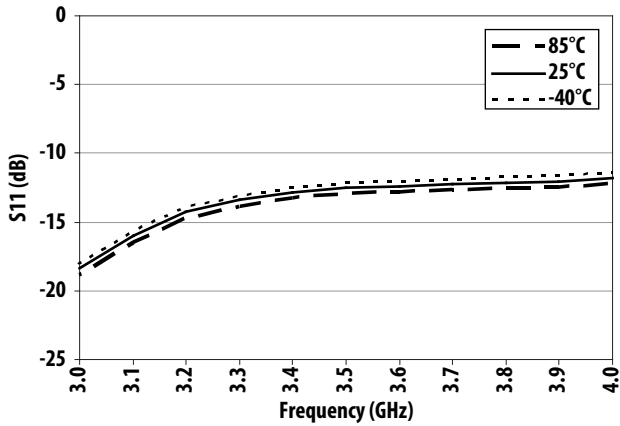


Figure 18. S11 over Frequency and Temperature

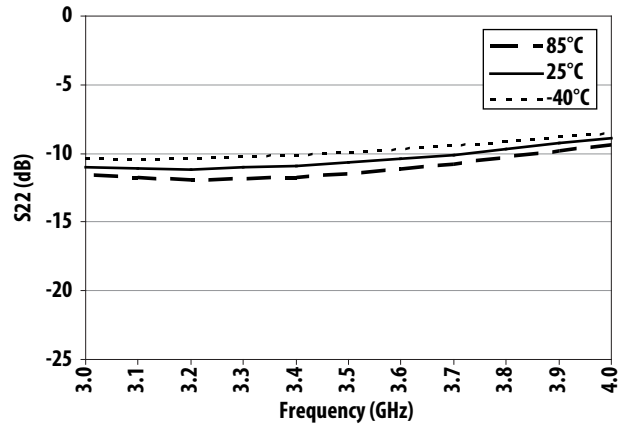


Figure 19. S22 over Frequency and Temperature

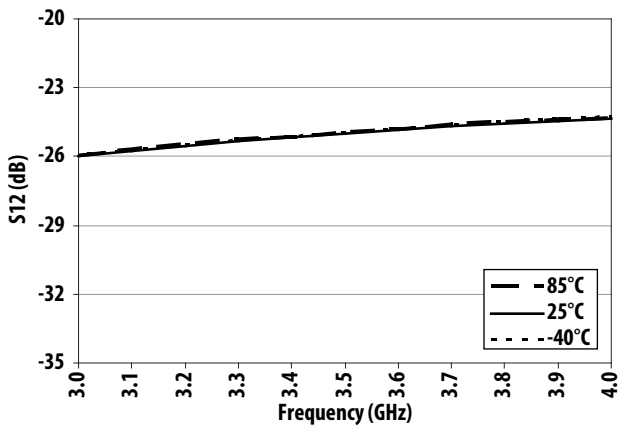


Figure 20. S12 over Frequency and Temperature

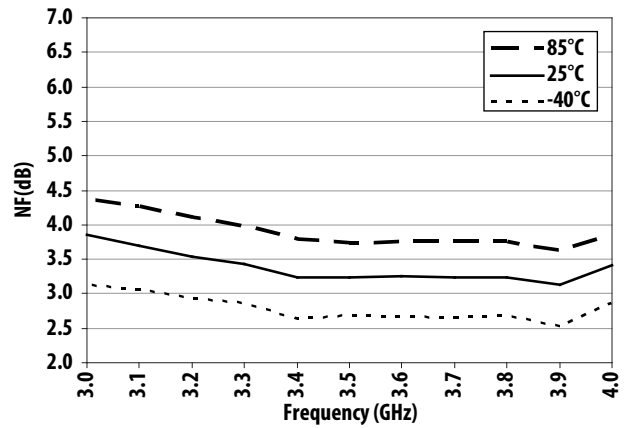


Figure 21. Noise Figure over Frequency and Temperature

### Typical Performance (4GHz - 6GHz)

T<sub>A</sub> = 25°C, V<sub>dd</sub> = 5V, Input Signal=CW. Application Test Circuit is shown in Figure 30 and Table 3.

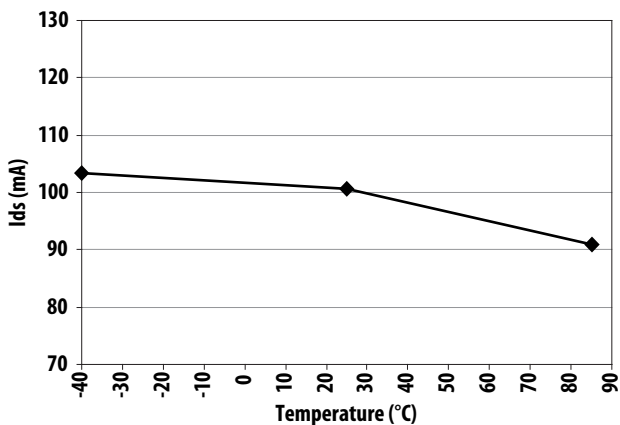


Figure 22. Ids over Temperature

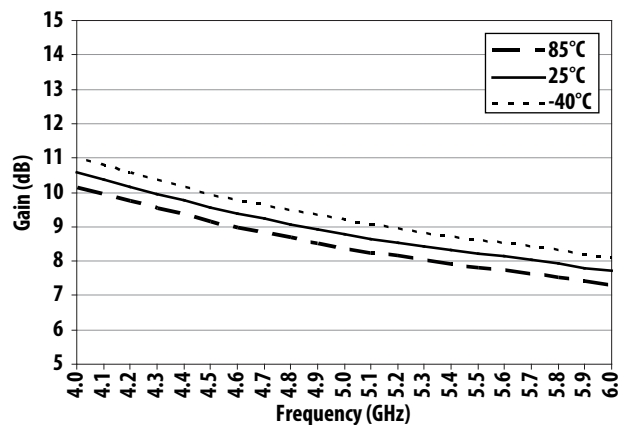


Figure 23. Gain over Frequency and Temperature

## Typical Performance (4GHz - 6GHz)

T<sub>A</sub> = 25°C, V<sub>dd</sub> = 5V, Input Signal=CW. Application Test Circuit is shown in Figure 30 and Table 3.

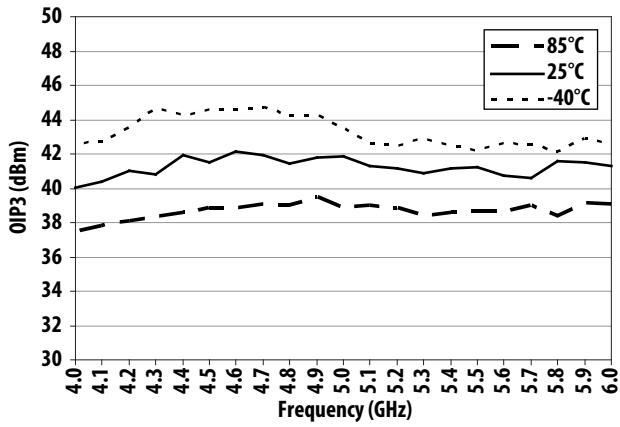


Figure 24. OIP3 over Frequency and Temperature

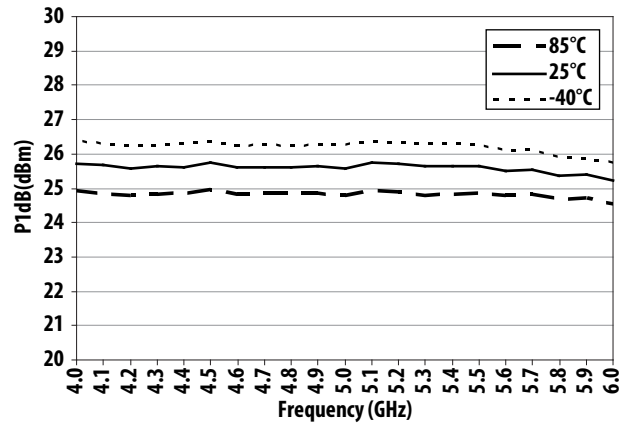


Figure 25. P1dB over Frequency and Temperature

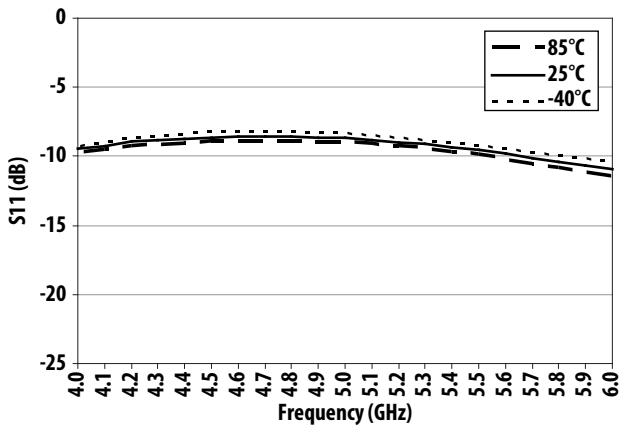


Figure 26. S11 over Frequency and Temperature

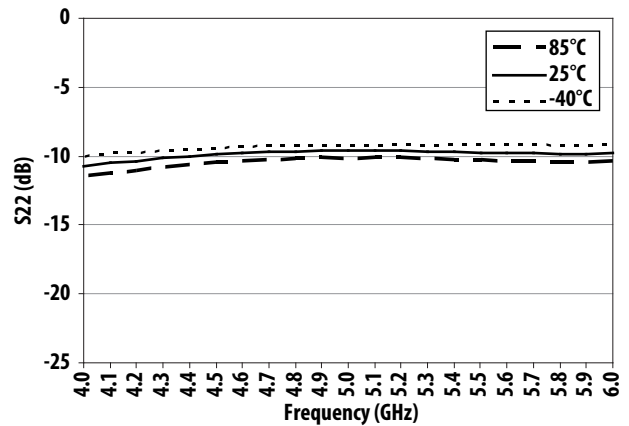


Figure 27. S22 over Frequency and Temperature

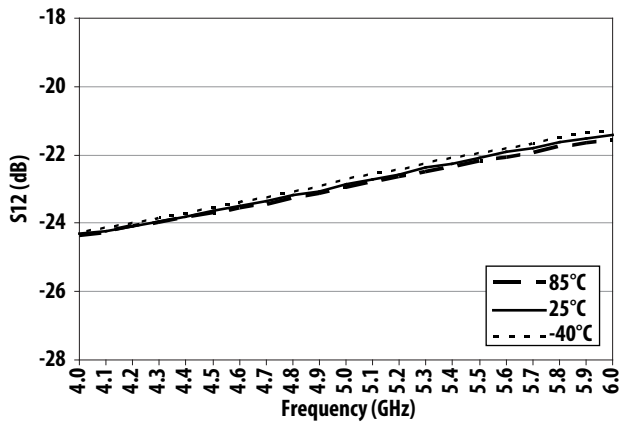


Figure 28. S12 over Frequency and Temperature

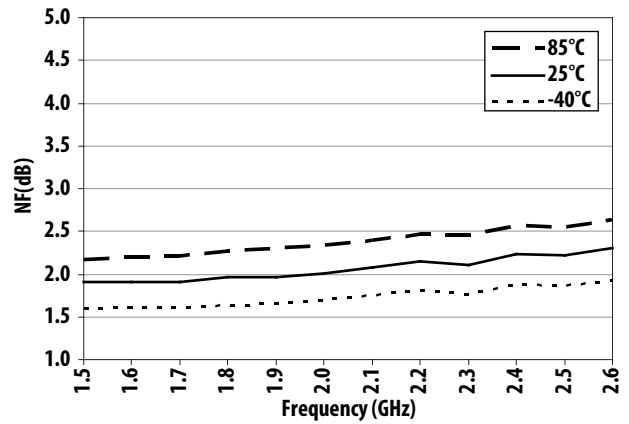


Figure 29. Noise Figure over Frequency and Temperature

## Application Schematic Components Table and Demo Board

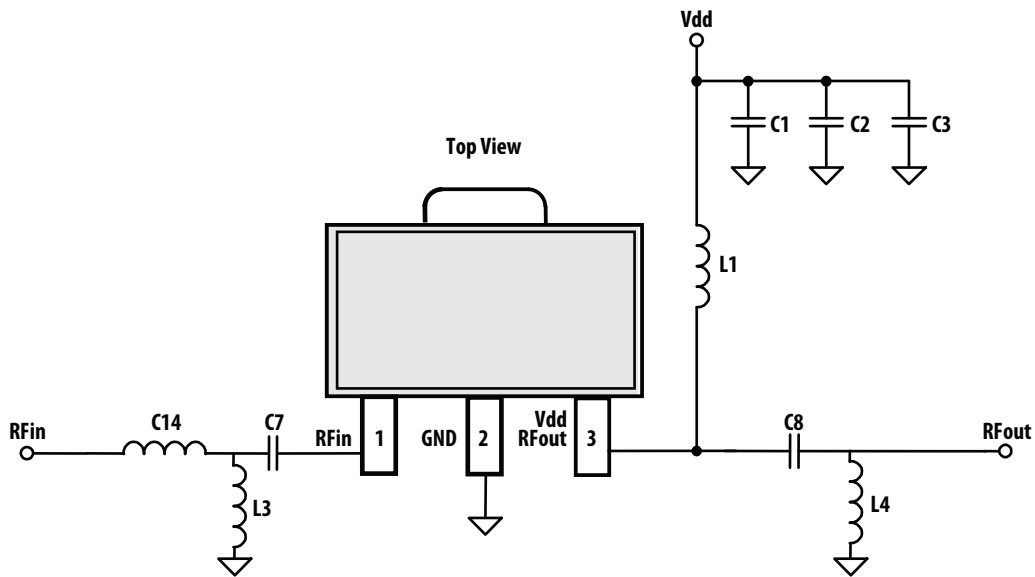


Figure 30. Application Schematic

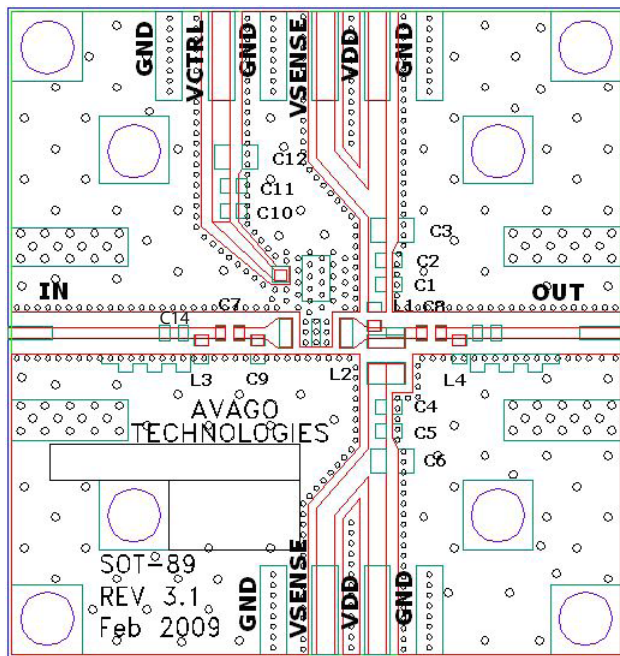


Figure 31. Demo board Layout

- Recommended PCB material is 10 mils Rogers RO4350, with FR4 backing for mechanical strength.
- Suggested component values may vary according to layout and PCB material.



## Demo board Part List

**Table 1. 2GHz - 3GHz Application Schematic Components**

| Circuit Symbol | Size   | Value | Part Number                 | Description              |
|----------------|--------|-------|-----------------------------|--------------------------|
| L1             | 0402CS | 19nH  | 0402CS-19NX (CoilCraft)     | Wire Wound Chip Inductor |
| L3             |        |       | NA                          |                          |
| L4             | 0402   | 4.3nH | 0402CS-4N3X (CoilCraft)     | Wire Wound Chip Inductor |
| C1             | 0402   | 100pF | GRM1555C1H101JZ01 (Murata)  | Ceramic Chip Capacitor   |
| C2             | 0402   | 0.1uF | GRM155R71C104KA88D (Murata) | Ceramic Chip Capacitor   |
| C3             | 0805   | 2.2uF | GRM21BR61E225KA12L (Murata) | Ceramic Chip Capacitor   |
| C7             | 0402   | 10pF  | GRM1555C1H100JZ01 (Murata)  | Ceramic Chip Capacitor   |
| C8             | 0402   | 2.2pF | GRM1555C1H2R2CA01 (Murata)  | Ceramic Chip Capacitor   |
| C14            | 0402   | 1.2nH | LL1005-FHL1N2 (Toko)        | MLC Inductor             |

**Table 2. 3GHz - 4GHz Application Schematic Components**

| Circuit Symbol | Size | Value | Part Number                 | Description              |
|----------------|------|-------|-----------------------------|--------------------------|
| L1             | 0603 | 4.7nH | 0603CS-4N7X (CoilCraft)     | Wire Wound Chip Inductor |
| L3             |      |       | NA                          |                          |
| L4             | 0402 | 100nH | LL1005-FHLR10J (Toko)       | MLC Inductor             |
| C1             | 0402 | 100pF | GRM1555C1H101JZ01B (Murata) | Ceramic Chip Capacitor   |
| C2             | 0402 | 0.1uF | GRM155R71C104KA88D (Murata) | Ceramic Chip Capacitor   |
| C3             | 0805 | 2.2uF | GRM21BR61E225KA12L (Murata) | Ceramic Chip Capacitor   |
| C7             | 0402 | 10pF  | GRM1555C1H100JA01 (Murata)  | Ceramic Chip Capacitor   |
| C8             | 0402 | 5.6pF | GRM1555C1H5R6CA01 (Murata)  | Ceramic Chip Capacitor   |
| C14            |      |       | NA                          |                          |

**Table 3. 4GHz - 6GHz Application Schematic Components**

| Circuit Symbol | Size | Value | Part Number                 | Description              |
|----------------|------|-------|-----------------------------|--------------------------|
| L1             | 0603 | 5.1nH | LLQ1608-F5N1 (Toko)         | Wire Wound Chip Inductor |
| L3             | 0402 | 4.7nH | LL1005-FHL4N7 (Toko)        | MLC Inductor             |
| L4             |      |       | NA                          |                          |
| C1             | 0402 | 100pF | GRM1555C1H101JZ01 (Murata)  | Ceramic Chip Capacitor   |
| C2             | 0402 | 0.1uF | GRM155R71C104KA88D (Murata) | Ceramic Chip Capacitor   |
| C3             | 0805 | 2.2uF | GRM21BR61E225KA12L (Murata) | Ceramic Chip Capacitor   |
| C7             | 0402 | 2.2pF | CM05CH2R2C50AH (Kyocera)    | Ceramic Chip Capacitor   |
| C8             | 0402 | 2.2pF | CM05CH2R2C50AH (Kyocera)    | Ceramic Chip Capacitor   |
| C14            |      |       | NA                          |                          |

# Test Circuit for S-Parameter and Noise Parameter

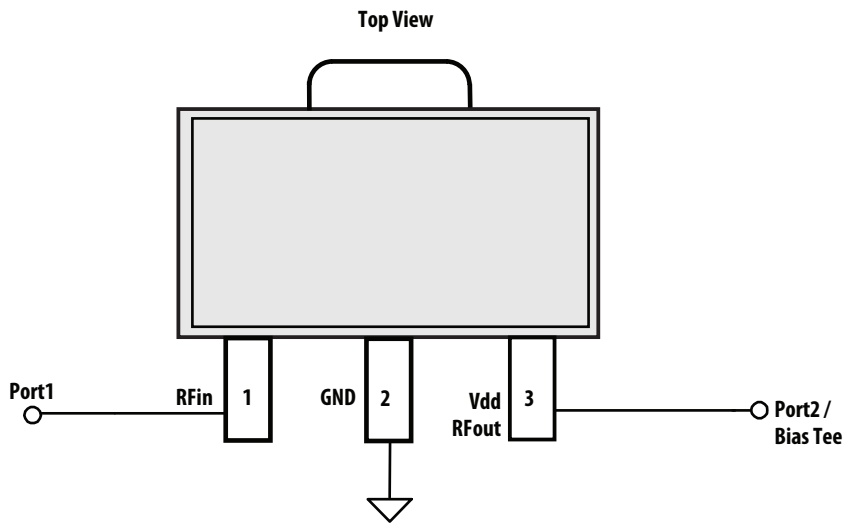


Figure 32. S-parameter and Noise parameter test circuit

**Typical S-Parameter (Vdd = 5V, TA = 25°C, 50 ohm)**

| Freq (GHz) | S11 (dB) | S11 (ang) | S21 (dB) | S21 (ang) | S12 (dB) | S12 (ang) | S22 (dB) | S22 (ang) |
|------------|----------|-----------|----------|-----------|----------|-----------|----------|-----------|
| 0.1        | -0.89    | 171.29    | -63.15   | 137.09    | -70.77   | 74.72     | -6.40    | 178.55    |
| 0.5        | -0.87    | 134.26    | -56.43   | 159.75    | -58.33   | 62.10     | -7.78    | 155.81    |
| 1          | -1.28    | 79.26     | -21.10   | 165.63    | -53.76   | 50.95     | -12.61   | 144.22    |
| 1.5        | -2.61    | 5.44      | 3.05     | 90.24     | -40.55   | 11.02     | -13.88   | -157.29   |
| 2          | -8.89    | -48.46    | 13.14    | -45.05    | -30.39   | -122.16   | -7.87    | 155.45    |
| 2.2        | -10.88   | -75.15    | 13.54    | -82.79    | -29.06   | -158.46   | -8.29    | 148.89    |
| 2.4        | -14.73   | -111.10   | 13.66    | -114.23   | -27.99   | 172.79    | -7.98    | 144.64    |
| 2.6        | -20.58   | -165.76   | 13.51    | -141.52   | -27.15   | 148.77    | -7.42    | 139.09    |
| 2.8        | -22.68   | 110.04    | 13.18    | -165.17   | -26.55   | 129.02    | -7.02    | 133.06    |
| 3          | -20.20   | 53.49     | 12.79    | 174.17    | -26.01   | 112.23    | -6.75    | 127.76    |
| 3.2        | -18.95   | 13.54     | 12.36    | 155.70    | -25.56   | 97.67     | -6.59    | 123.30    |
| 3.4        | -18.13   | -25.72    | 11.96    | 138.97    | -25.14   | 84.61     | -6.50    | 119.81    |
| 3.6        | -16.60   | -63.19    | 11.55    | 123.41    | -24.75   | 72.79     | -6.39    | 116.90    |
| 3.8        | -14.55   | -93.60    | 11.13    | 108.88    | -24.41   | 61.86     | -6.31    | 113.70    |
| 4          | -12.62   | -116.51   | 10.71    | 95.32     | -24.10   | 51.65     | -6.27    | 110.52    |
| 4.2        | -11.03   | -134.23   | 10.30    | 82.60     | -23.82   | 41.96     | -6.30    | 106.60    |
| 4.4        | -9.89    | -148.50   | 9.90     | 70.48     | -23.57   | 33.02     | -6.43    | 102.28    |
| 4.6        | -9.17    | -160.67   | 9.54     | 59.03     | -23.29   | 24.51     | -6.60    | 97.08     |
| 4.8        | -8.72    | -172.00   | 9.23     | 48.03     | -22.99   | 16.15     | -6.84    | 91.25     |
| 5          | -8.54    | 176.59    | 8.95     | 37.24     | -22.69   | 7.90      | -7.06    | 84.67     |
| 5.2        | -8.98    | 162.84    | 8.82     | 25.05     | -22.25   | -1.75     | -7.37    | 70.40     |
| 5.4        | -8.89    | 149.06    | 8.51     | 14.69     | -22.01   | -9.74     | -7.27    | 65.40     |
| 5.6        | -8.89    | 134.06    | 8.20     | 4.48      | -21.79   | -17.80    | -7.09    | 60.58     |
| 5.8        | -8.87    | 117.54    | 7.91     | -5.83     | -21.60   | -26.09    | -6.89    | 55.99     |
| 6          | -8.74    | 99.65     | 7.58     | -16.09    | -21.45   | -34.31    | -6.67    | 51.77     |
| 6.2        | -8.36    | 81.31     | 7.21     | -26.36    | -21.36   | -42.67    | -6.38    | 47.34     |
| 6.4        | -7.71    | 63.61     | 6.82     | -36.57    | -21.32   | -51.08    | -6.06    | 42.69     |
| 6.6        | -6.88    | 47.92     | 6.38     | -46.67    | -21.35   | -59.31    | -5.73    | 37.79     |
| 6.8        | -6.01    | 34.84     | 5.86     | -56.40    | -21.46   | -67.30    | -5.43    | 32.62     |
| 7          | -5.21    | 24.24     | 5.32     | -65.48    | -21.59   | -74.72    | -5.16    | 27.32     |
| 8          | -3.02    | -3.41     | 3.00     | -103.98   | -22.10   | -105.83   | -4.71    | -5.35     |
| 9          | -2.59    | -27.30    | 1.34     | -139.80   | -22.25   | -135.66   | -4.53    | -43.08    |
| 10         | -2.12    | -67.56    | -0.79    | -177.42   | -23.00   | -168.17   | -3.86    | -73.44    |
| 11         | -1.21    | -103.01   | -4.16    | 150.87    | -25.17   | 164.20    | -2.79    | -92.66    |
| 12         | -0.80    | -117.86   | -7.00    | 130.49    | -26.95   | 146.68    | -2.33    | -103.81   |
| 13         | -0.88    | -131.07   | -8.26    | 108.78    | -27.28   | 127.48    | -2.27    | -121.44   |
| 14         | -1.02    | -151.35   | -8.82    | 81.73     | -26.93   | 103.00    | -2.42    | -146.67   |
| 15         | -0.93    | -174.30   | -10.38   | 52.63     | -27.48   | 77.03     | -2.03    | -177.32   |
| 16         | -0.83    | 173.31    | -12.04   | 36.30     | -27.78   | 64.17     | -1.57    | 173.29    |
| 17         | -0.93    | 162.53    | -12.15   | 20.39     | -26.28   | 48.69     | -1.69    | 161.95    |
| 18         | -1.09    | 149.25    | -11.95   | 2.84      | -24.66   | 32.64     | -1.62    | 149.85    |
| 19         | -1.52    | 132.50    | -10.69   | -19.47    | -22.19   | 10.57     | -2.31    | 131.12    |
| 20         | -1.75    | 111.66    | -10.17   | -46.41    | -20.49   | -16.89    | -2.46    | 104.29    |

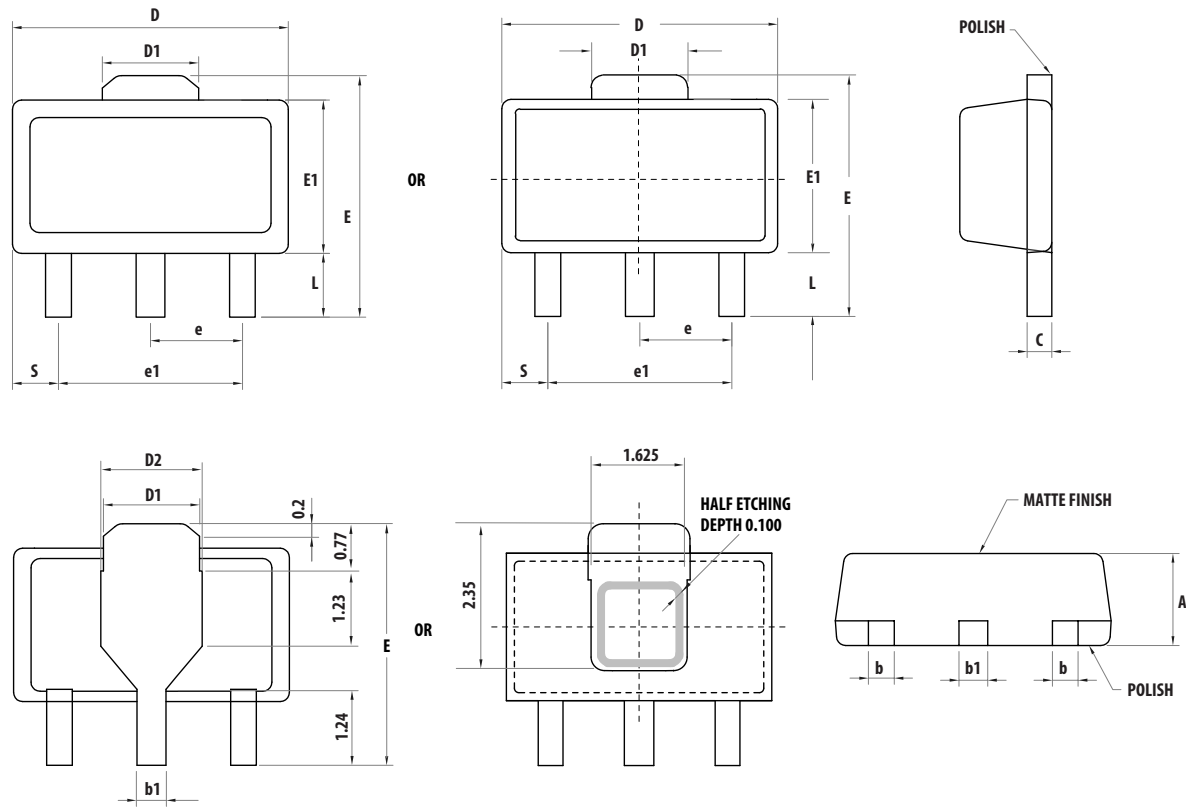
### Typical Noise Parameters (V<sub>dd</sub> = 5V, T<sub>A</sub> = 25°C, 50 ohm)

| Freq (GHz) | F <sub>min</sub> (dB) | Γ <sub>opt</sub> Mag | Γ <sub>opt</sub> Ang | R <sub>n</sub> /Z <sub>0</sub> |
|------------|-----------------------|----------------------|----------------------|--------------------------------|
| 2.0        | 5.5                   | 0.25                 | 52                   | 1.1                            |
| 2.5        | 3.81                  | 0.26                 | 77                   | 0.81                           |
| 3.0        | 3.14                  | 0.27                 | 110                  | 0.40                           |
| 3.5        | 2.36                  | 0.28                 | 159                  | 0.20                           |
| 4.0        | 2.17                  | 0.29                 | -163                 | 0.19                           |
| 4.5        | 2.28                  | 0.30                 | -125                 | 0.23                           |
| 5.0        | 2.61                  | 0.31                 | -97                  | 0.38                           |
| 5.5        | 2.68                  | 0.32                 | -59                  | 0.59                           |
| 6.0        | 2.78                  | 0.33                 | -27                  | 0.53                           |

### Part Number Ordering Information

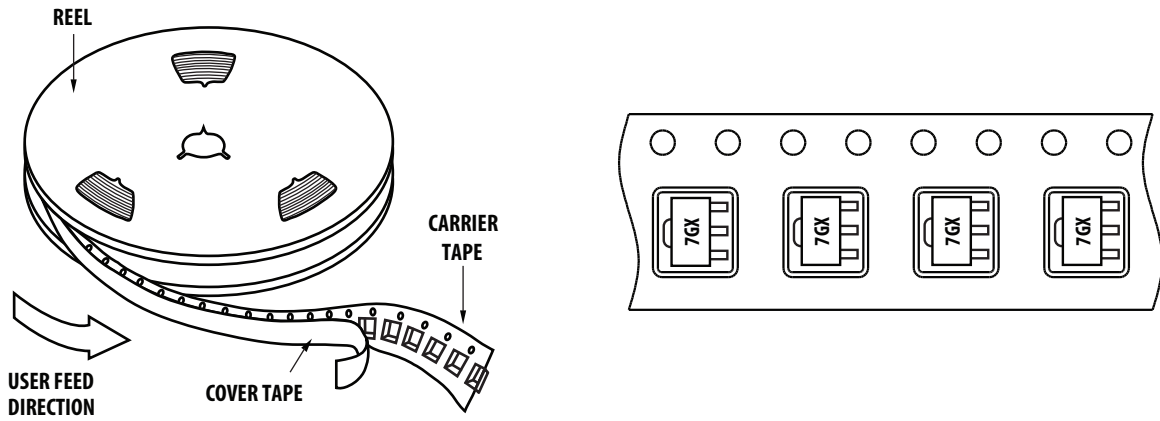
| Part Number    | No. of Devices | Container     |
|----------------|----------------|---------------|
| MGA-30789-BLKG | 100            | 7" Tape/Reel  |
| MGA-30789-TR1G | 3000           | 13" Tape/Reel |

### SOT89 Package Dimensions

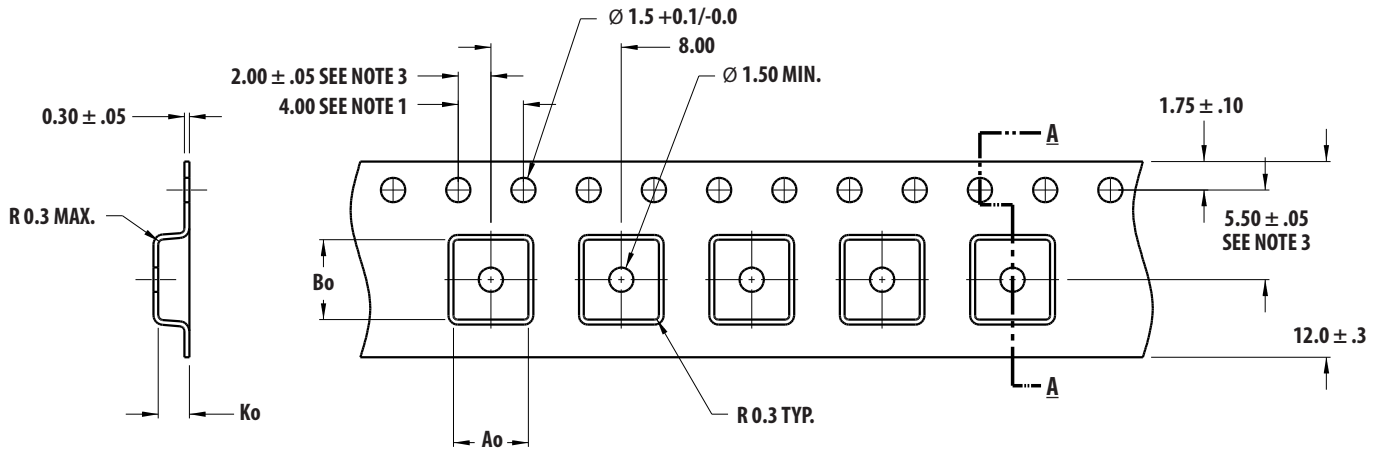


| Symbols | Dimensions in mm |         |         | Dimensions in inches |         |         |
|---------|------------------|---------|---------|----------------------|---------|---------|
|         | Minimum          | Nominal | Maximum | Minimum              | Nominal | Maximum |
| A       | 1.40             | 1.50    | 1.60    | 0.055                | 0.059   | 0.063   |
| L       | 0.89             | 1.04    | 1.20    | 0.0350               | 0.041   | 0.047   |
| b       | 0.36             | 0.42    | 0.48    | 0.014                | 0.016   | 0.018   |
| b1      | 0.41             | 0.47    | 0.53    | 0.016                | 0.018   | 0.030   |
| C       | 0.38             | 0.40    | 0.43    | 0.014                | 0.015   | 0.017   |
| D       | 4.40             | 4.50    | 4.60    | 0.173                | 0.177   | 0.181   |
| D1      | 1.40             | 1.60    | 1.75    | 0.055                | 0.062   | 0.069   |
| D2      | 1.45             | 1.65    | 1.80    | 0.055                | 0.062   | 0.069   |
| E       | 3.94             | -       | 4.25    | 0.155                | -       | 0.167   |
| E1      | 2.40             | 2.50    | 2.60    | 0.094                | 0.098   | 0.102   |
| e1      | 2.90             | 3.00    | 3.10    | 0.114                | 0.118   | 0.122   |
| S       | 0.65             | 0.75    | 0.85    | 0.026                | 0.030   | 0.034   |
| e       | 1.40             | 1.50    | 1.60    | 0.054                | 0.059   | 0.063   |

## Device Orientation



## Tape Dimensions



### SECTION A - A

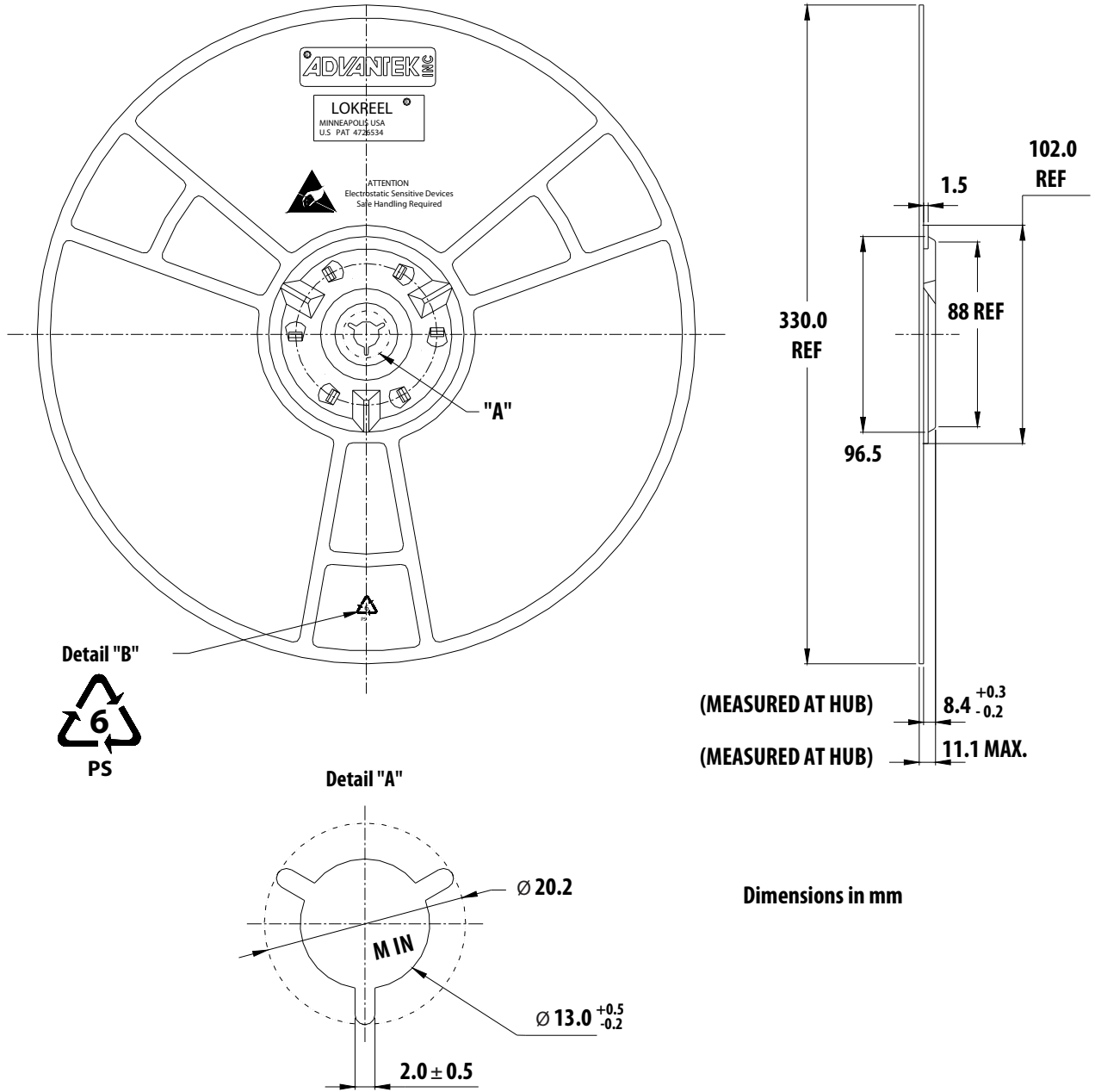
Ao = 4.60  
Bo = 4.90  
Ko = 1.90

### DIMENSIONS IN MM

#### NOTES:

1. 10 SPROCKET HOLE PITCH CUMULATIVE TOLERANCE  $\pm 0.2$
2. CAMBER IN COMPLIANCE WITH EIA 481
3. POCKET POSITION RELATIVE TO SPROCKET HOLE MEASURED AS TRUE POSITION OF POCKET, NOT POCKET HOLE

# Reel Dimensions – 13" Reel



For product information and a complete list of distributors, please go to our web site: [www.avagotech.com](http://www.avagotech.com)

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