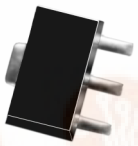
Preliminary

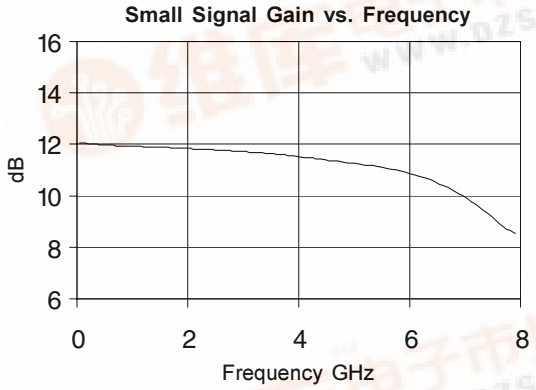
# NGA-689

## DC-5000 MHz, Cascadable GaAs HBT MMIC Amplifier



## Product Description

Stanford Microdevices' NGA-689 is a high performance Gallium Arsenide Heterojunction Bipolar Transistor MMIC Amplifier. Designed with InGaP process technology for improved reliability, a Darlington configuration is utilized for broadband performance up to 5 Ghz. The heterojunction increases breakdown voltage and minimizes leakage current between junctions. Cancellation of emitter junction non-linearities results in higher suppression of intermodulation products.




## Product Features

- 11.7dB Gain, 18.9 dBm P1dB at 1950Mhz
- Cascadable 50 ohm: 1.4:1 VSWR
- Patented GaAs HBT Technology
- Operates from Single Supply
- Low Thermal Resistance Package
- Unconditionally Stable

## Applications

- Cellular, PCS, CDPD
- Wireless Data, SONET

| Symbol | Parameters: Test Conditions: $Z_0$ = 50 Ohms, $I_D$ = 80 mA, T = 25°C | | Units | Min. | Typ. | Max. |
|---|---|---|---|---|---|---|
| $P_{1dB}$ | Output Power at 1dB Compression | f = 850 MHz<br>f = 1950 MHz<br>f = 2400 MHz | dBm<br>dBm<br>dBm | | 19.9<br>18.9<br>17.9 | |
| $IP_3$ | Third Order Intercept Point<br>Power out per tone = 0 dBm | f = 850 MHz<br>f = 1950 MHz<br>f = 2400 MHz | dBm<br>dBm<br>dBm | | 36.9<br>33.6<br>32.1 | |
| $S_{21}$ | Small Signal Gain | f = 850 MHz<br>f = 1950 MHz<br>f = 2400 MHz | dB<br>dB<br>dB | | 11.9<br>11.7<br>11.6 | |
| Bandwidth | Determined by S11 and S22 values | | MHz | | 5000 | |
| $S_{11}$ | Input VSWR | f = DC - 5000 MHz | - | | 1.4:1 | |
| $S_{22}$ | Output VSWR | f = DC - 5000 MHz | - | | 1.4:1 | |
| $S_{12}$ | Reverse Isolation | f = 850 MHz<br>f = 1950 MHz<br>f = 2400 MHz | dB<br>dB<br>dB | | 19.7<br>19.5<br>19.4 | |
| NF | Noise Figure | f = 2000 MHz | dB | | 6.0 | |
| $V_D$ | Device Voltage | | V | | 5.8 | |
| $R_{th, j-l}$ | Thermal Resistance (junction - lead) | | °C/W | | 91 | |

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**NGA-689 DC-5.0 GHz 5.8V GaAs HBT**

## Absolute Maximum Ratings

Operation of this device above any one of these parameters may cause permanent damage.

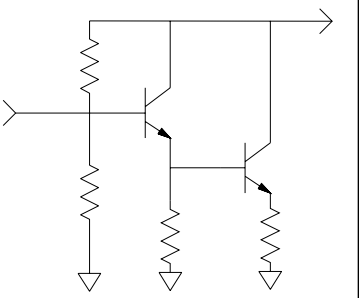
Bias Conditions should also satisfy the following expression: $I_D V_D$ (max) < $(T_J - T_{OP})/R_{th,j-l}$

| Parameter | Value | Unit |
|---|---|---|
| Supply Current | 120 | mA |
| Device Voltage | 6.7 | V |
| Operating Temperature | -40 to +85 | ºC |
| Maximum Input Power | +13 | dBm |
| Storage Temperature Range | -40 to +150 | ºC |
| Operating Junction Temperature | +150 | ºC |

## Key parameters, at typical operating frequencies:

| Parameter | Typical 25ºC | Unit | Test Condition ($I_D$ = 80mA, unless otherwise noted) |
|---|---|---|---|
| **500 MHz** | | | |
| Gain | 12.0 | dB | Tone spacing = 1 MHz, Pout per tone = 0dBm |
| Output IP3 | 37.2 | dBm | |
| Output P1dB | 19.9 | dBm | |
| Input Return Loss | 19.6 | dB | |
| Reverse Isolation | 19.7 | dB | |
| **850 MHz** | | | |
| Gain | 11.9 | dB | Tone spacing = 1 MHz, Pout per tone = 0dBm |
| Output IP3 | 36.9 | dBm | |
| Output P1dB | 19.9 | dBm | |
| Input Return Loss | 18.5 | dB | |
| Reverse Isolation | 19.7 | dB | |
| **1950 MHz** | | | |
| Gain | 11.7 | dB | Tone spacing = 1 MHz, Pout per tone = 0dBm |
| Output IP3 | 33.6 | dBm | |
| Output P1dB | 18.9 | dBm | |
| Input Return Loss | 16.0 | dB | |
| Reverse Isolation | 19.5 | dB | |
| **2400 MHz** | | | |
| Gain | 11.6 | dB | Tone spacing = 1 MHz, Pout per tone = 0dBm |
| Output IP3 | 32.1 | dBm | |
| Output P1dB | 17.9 | dBm | |
| Input Return Loss | 15.9 | dB | |
| Reverse Isolation | 19.4 | dB | |

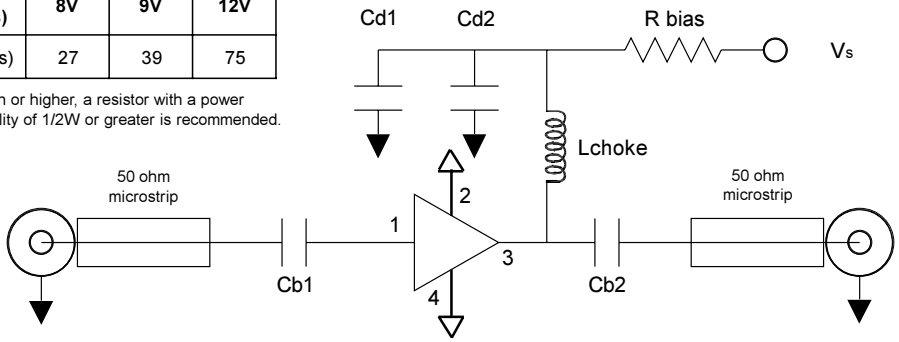
# NGA-689 DC-5.0 GHz 5.8V GaAs HBT

| Pin # | Function | Description | Device Schematic |
|---|---|---|---|
| 1 | RF IN | RF input pin. This pin requires the use of an external DC blocking capacitor chosen for the frequency of operation. |  |
| 2 | GND | Connection to ground. For best performance use via holes (as close to ground leads as possible) to reduce lead inductance. | |
| 3 | RF OUT/ BIAS | RF output and bias pin. Bias should be supplied to this pin through an external series resistor and RF choke inductor. Because DC biasing is present on this pin, a DC blocking capacitor should be used in most applications (see application schematic). The supply side of the bias network should be well bypassed. | |
| 4 | GND | Same as Pin 2. | |

## Application Schematic

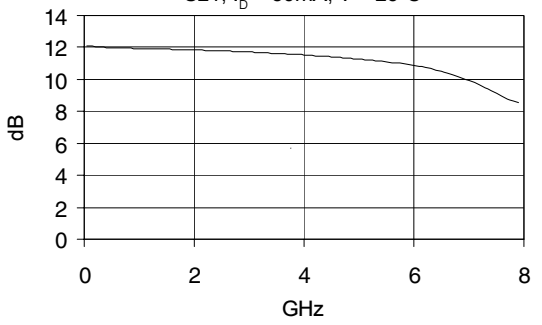
| Recommended Bias Resistor Values | | | |
|---|---|---|---|
| Supply Voltage(Vs) | 8V | 9V | 12V |
| Rbias (Ohms) | 27 | 39 | 75 |

For 8V operation or higher, a resistor with a power handling capability of 1/2W or greater is recommended.

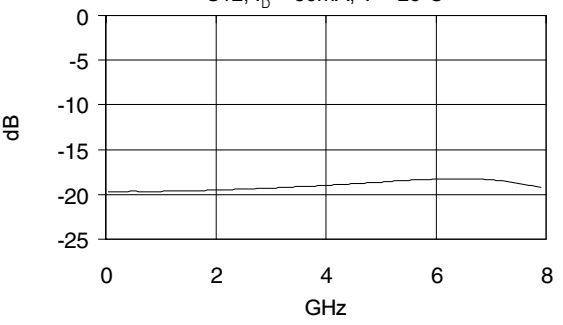



| Reference Designator | Function | 500 MHz | 850 MHz | 1950 MHz | 2400 MHz |
|---|---|---|---|---|---|
| Cb1 | DC Blocking | 220 pF | 100 pF | 68 pF | 56 pF |
| Cb2 | DC Blocking | 220 pF | 100 pF | 68 pF | 56 pF |
| Cd1 | Decoupling | 1 uF | 1 uF | 1 uF | 1 uF |
| Cd2 | Decoupling | 100 pF | 68 pF | 22 pF | 22 pF |
| Lchoke | AC Blocking | 68 nH | 33 nH | 22 nH | 18 nH |

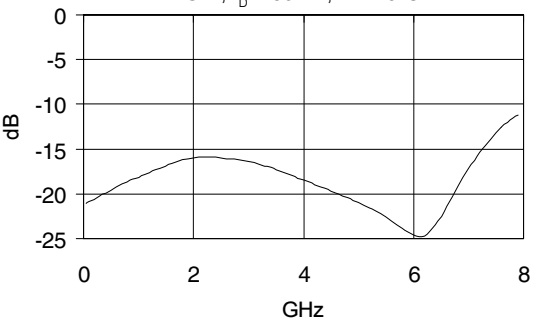
S21, $I_D$ = 80mA, T = 25ºC



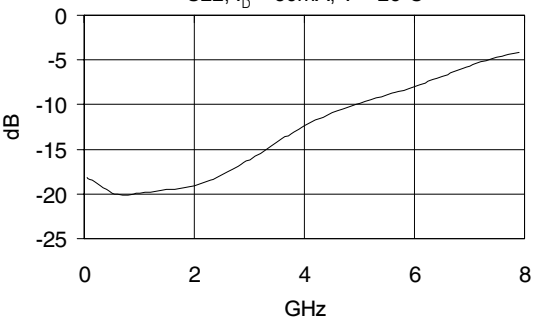

S12, $I_D$ = 80mA, T = 25ºC



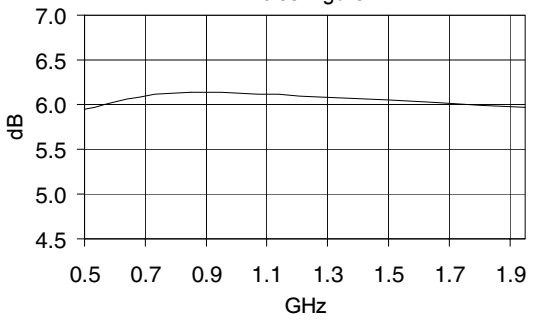

S11, $I_D$ = 80mA, T = 25ºC



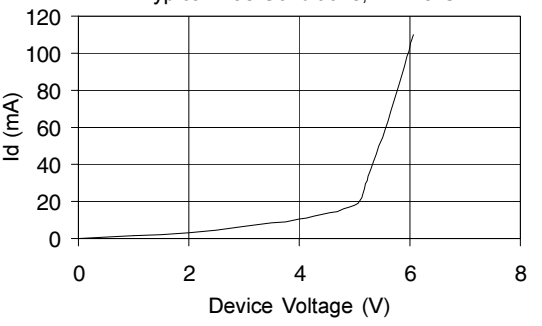

S22, $I_D$ = 80mA, T = 25ºC



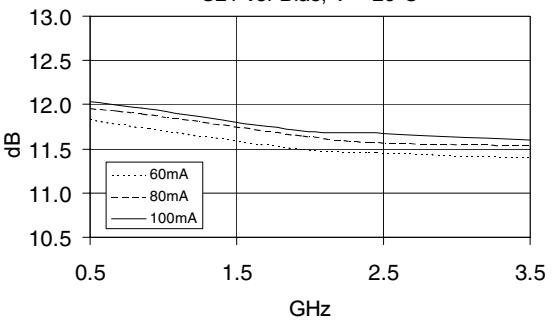

Noise Figure



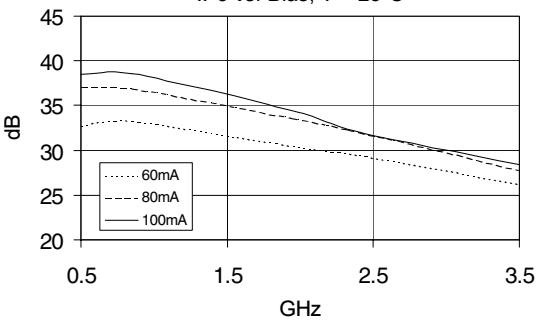

Typical Bias Conditions, T = 25ºC



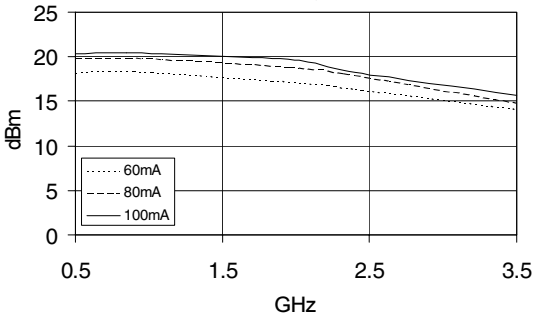
S21 vs. Bias, T = 25ºC



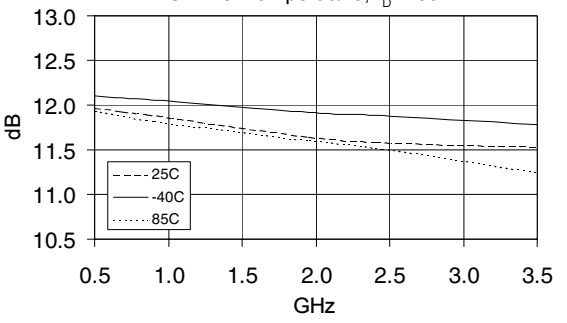

IP3 vs. Bias, T = 25ºC



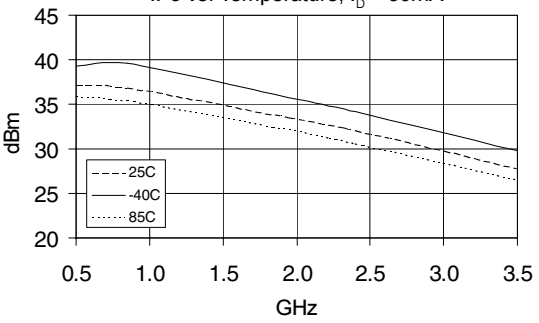

P1dB vs. Bias, T = 25ºC



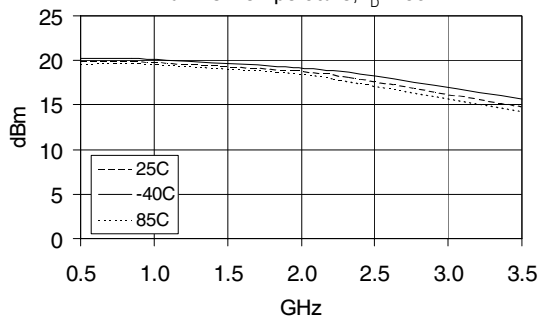

S21 vs. Temperature, $I_D$ = 80mA




IP3 vs. Temperature, $I_D$ = 80mA




P1dB vs. Temperature, $I_D$ = 80mA



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*Preliminary*

**NGA-689 DC-5.0 GHz 5.8V GaAs HBT**

## *Typical S-Parameters, $I_D$ = 80mA ( No external matching, de-embedded to device leads)*

| | S11 | | S21 | | | S12 | | | S22 | |
|---|---|---|---|---|---|---|---|---|---|---|
| Freq GHz | mag | Ang | dB | mag | Ang | dB | mag | Ang | mag | Ang |
| **0.05** | 0.089 | 2 | 12.1 | 4.014 | 175 | -19.7 | 0.103 | 0 | 0.124 | -180 |
| **0.10** | 0.090 | 1 | 12.1 | 4.009 | 174 | -19.7 | 0.103 | 0 | 0.121 | -179 |
| **0.20** | 0.093 | -1 | 12.0 | 3.997 | 173 | -19.7 | 0.104 | -2 | 0.116 | -178 |
| **0.30** | 0.097 | -4 | 12.0 | 3.985 | 170 | -19.7 | 0.104 | -3 | 0.111 | -177 |
| **0.40** | 0.101 | -7 | 12.0 | 3.976 | 168 | -19.7 | 0.104 | -4 | 0.106 | -175 |
| **0.50** | 0.105 | -10 | 12.0 | 3.968 | 165 | -19.7 | 0.104 | -6 | 0.101 | -173 |
| **0.60** | 0.109 | -12 | 12.0 | 3.964 | 162 | -19.7 | 0.104 | -7 | 0.099 | -171 |
| **0.70** | 0.114 | -14 | 12.0 | 3.959 | 159 | -19.7 | 0.104 | -8 | 0.098 | -168 |
| **0.80** | 0.117 | -16 | 11.9 | 3.955 | 156 | -19.7 | 0.104 | -9 | 0.099 | -167 |
| **0.90** | 0.120 | -18 | 11.9 | 3.950 | 153 | -19.7 | 0.104 | -10 | 0.100 | -165 |
| **1.00** | 0.124 | -20 | 11.9 | 3.948 | 150 | -19.7 | 0.104 | -11 | 0.100 | -164 |
| **1.10** | 0.128 | -22 | 11.9 | 3.944 | 147 | -19.7 | 0.104 | -12 | 0.102 | -163 |
| **1.20** | 0.131 | -24 | 11.9 | 3.940 | 144 | -19.7 | 0.104 | -13 | 0.103 | -162 |
| **1.30** | 0.135 | -26 | 11.9 | 3.936 | 141 | -19.6 | 0.104 | -14 | 0.104 | -161 |
| **1.40** | 0.140 | -28 | 11.9 | 3.931 | 138 | -19.6 | 0.104 | -16 | 0.105 | -161 |
| **1.50** | 0.144 | -29 | 11.9 | 3.928 | 135 | -19.6 | 0.104 | -17 | 0.106 | -161 |
| **1.60** | 0.148 | -31 | 11.9 | 3.923 | 132 | -19.6 | 0.105 | -18 | 0.106 | -161 |
| **1.70** | 0.152 | -32 | 11.9 | 3.920 | 129 | -19.6 | 0.105 | -19 | 0.107 | -161 |
| **1.80** | 0.156 | -34 | 11.9 | 3.916 | 126 | -19.6 | 0.105 | -20 | 0.108 | -162 |
| **1.90** | 0.158 | -36 | 11.8 | 3.911 | 123 | -19.5 | 0.105 | -21 | 0.110 | -164 |
| **2.00** | 0.159 | -38 | 11.8 | 3.907 | 120 | -19.5 | 0.106 | -22 | 0.111 | -166 |
| **2.20** | 0.161 | -43 | 11.8 | 3.898 | 113 | -19.5 | 0.106 | -25 | 0.116 | -172 |
| **2.40** | 0.160 | -47 | 11.8 | 3.889 | 107 | -19.4 | 0.107 | -27 | 0.123 | -179 |
| **2.60** | 0.158 | -53 | 11.8 | 3.878 | 101 | -19.4 | 0.107 | -30 | 0.133 | 174 |
| **2.80** | 0.155 | -57 | 11.7 | 3.866 | 95 | -19.3 | 0.108 | -32 | 0.143 | 167 |
| **3.00** | 0.151 | -60 | 11.7 | 3.854 | 89 | -19.3 | 0.109 | -35 | 0.156 | 160 |
| **3.20** | 0.146 | -63 | 11.7 | 3.838 | 83 | -19.2 | 0.109 | -37 | 0.170 | 154 |
| **3.40** | 0.140 | -66 | 11.6 | 3.823 | 76 | -19.2 | 0.110 | -40 | 0.186 | 147 |
| **3.60** | 0.133 | -69 | 11.6 | 3.805 | 70 | -19.1 | 0.111 | -43 | 0.204 | 142 |
| **3.80** | 0.126 | -71 | 11.6 | 3.785 | 64 | -19.0 | 0.112 | -45 | 0.222 | 136 |
| **4.00** | 0.120 | -74 | 11.5 | 3.766 | 58 | -19.0 | 0.112 | -48 | 0.240 | 131 |
| **4.20** | 0.113 | -76 | 11.5 | 3.745 | 51 | -18.9 | 0.113 | -51 | 0.258 | 126 |
| **4.40** | 0.107 | -78 | 11.4 | 3.723 | 45 | -18.9 | 0.114 | -54 | 0.276 | 121 |
| **4.60** | 0.101 | -80 | 11.4 | 3.702 | 38 | -18.8 | 0.115 | -57 | 0.292 | 116 |
| **4.80** | 0.095 | -82 | 11.3 | 3.679 | 32 | -18.7 | 0.116 | -60 | 0.308 | 111 |
| **5.00** | 0.089 | -83 | 11.3 | 3.655 | 26 | -18.6 | 0.117 | -63 | 0.323 | 106 |
| **5.20** | 0.084 | -84 | 11.2 | 3.630 | 19 | -18.5 | 0.118 | -67 | 0.337 | 101 |
| **5.40** | 0.078 | -84 | 11.1 | 3.602 | 13 | -18.5 | 0.119 | -70 | 0.351 | 95 |
| **5.60** | 0.071 | -81 | 11.1 | 3.574 | 6 | -18.4 | 0.120 | -74 | 0.365 | 89 |
| **5.80** | 0.064 | -75 | 11.0 | 3.538 | -1 | -18.3 | 0.121 | -77 | 0.382 | 82 |
| **6.00** | 0.059 | -65 | 10.9 | 3.496 | -7 | -18.3 | 0.122 | -81 | 0.399 | 76 |
| **6.50** | 0.075 | -26 | 10.5 | 3.349 | -25 | -18.3 | 0.122 | -91 | 0.455 | 58 |
| **7.00** | 0.138 | -11 | 9.9 | 3.138 | -42 | -18.4 | 0.120 | -102 | 0.521 | 41 |
| **7.50** | 0.220 | -11 | 9.1 | 2.863 | -59 | -18.8 | 0.115 | -112 | 0.583 | 25 |
| **7.90** | 0.276 | -15 | 8.5 | 2.672 | -70 | -19.1 | 0.110 | -119 | 0.621 | 16 |

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*Preliminary*

# NGA-689 DC-5.0 GHz 5.8V GaAs HBT

**Caution: ESD sensitive**
Appropriate precautions in handling, packaging and testing devices must be observed.

## Part Number Ordering Information

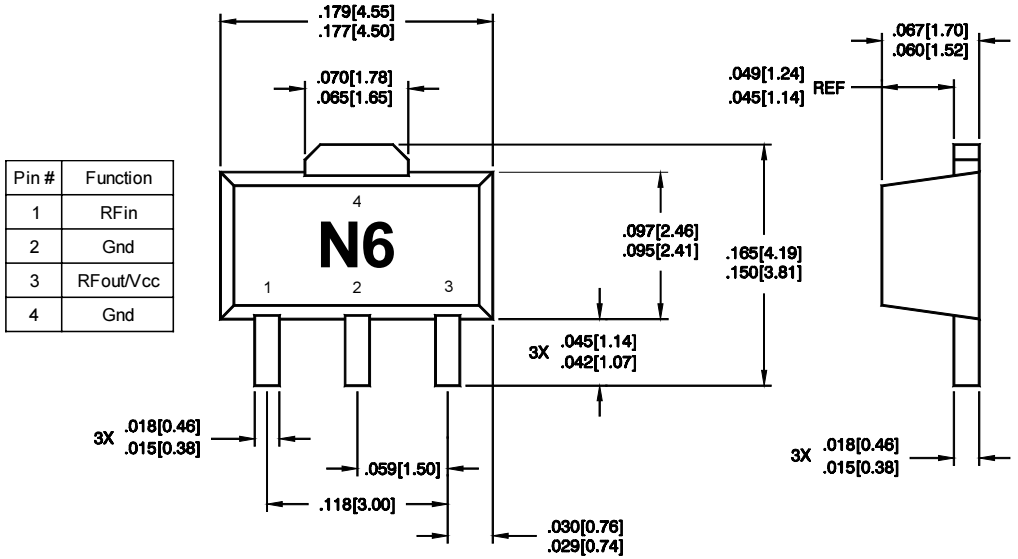
| Part Number | Reel Size | Devices/Reel |
|---|---|---|
| NGA-689 | 7" | 1000 |

## Part Symbolization

The part will be symbolized with a "N6" designator on the top surface of the package.

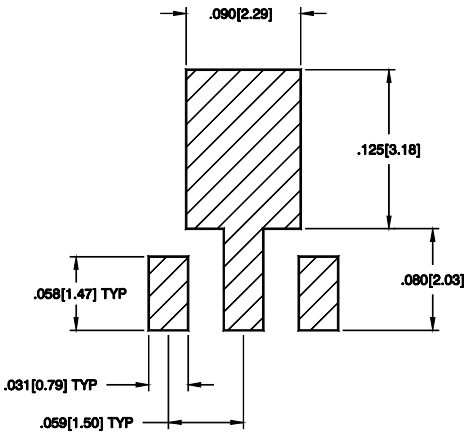
## Package Dimensions

| Pin # | Function |
|---|---|
| 1 | RFin |
| 2 | Gnd |
| 3 | RFout/Vcc |
| 4 | Gnd |




Pin assignments shown for reference only, not marked on part

## PCB Pad Layout

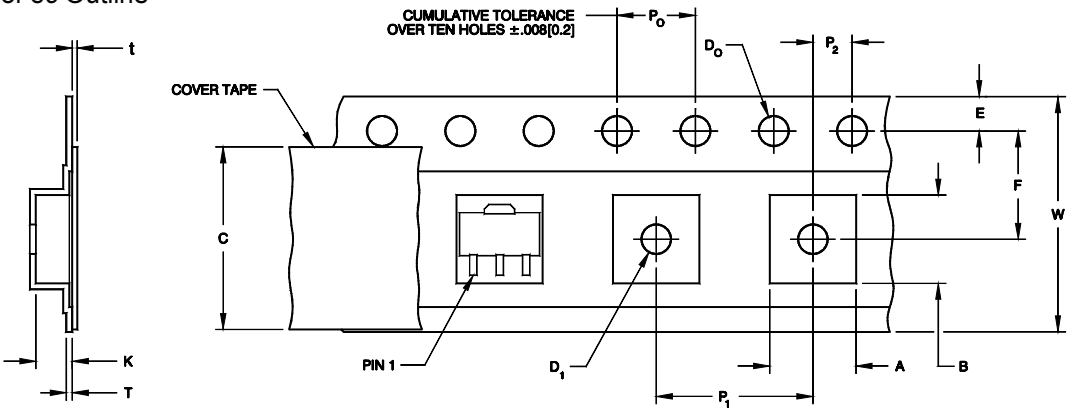



DIMENSIONS ARE IN INCHES [MM]

# Component Tape and Reel Packaging

## Tape Dimensions

For 89 Outline




| Description | | Symbol | Size | |
|---|---|---|---|---|
| | | | Millimeters | Inches |
| Cavity | Length | A | 4.91 +/- 0.01 | 0.19 +/- 0.0004 |
| | Width | B | 4.52 +/- 0.01 | 0.18 +/- 0.0004 |
| | Depth | K | 1.90 +/- 0.01 | 0.07 +/- 0.0004 |
| | Pitch | $P_1$ | 8.00 +/- 0.01 | 0.31 +/- 0.0004 |
| | Bottom Hole Diameter | $D_1$ | 1.60 +/- 0.10 | 0.06 +/- 0.004 |
| Perforation | Diameter | $D_0$ | 1.55 +/- 0.05 | 0.06 +/- 0.002 |
| | Pitch | $P_0$ | 4.00 +/- 0.01 | 0.16 +/- 0.0004 |
| | Position | E | 1.75 +/- 0.01 | 0.07 +/- 0.0004 |
| Cover Tape | Width | C | 9.10 +/- 0.25 | 0.36 +/- 0.01 |
| | Tape Thickness | t | 0.05 +/- 0.01 | 0.002 +/- 0.0004 |
| Carrier Tape | Width | W | 12.0 +/- 0.03 | 0.47 +/- 0.001 |
| | Thickness | T | 0.30 +/- 0.05 | 0.01 +/- 0.002 |
| Distance | Cavity to Perforation (Width Direction) | F | 5.50 +/- 0.10 | 0.22 +/- 0.0004 |
| | Cavity to Perforation (Length Direction) | $P_2$ | 2.00 +/- 0.10 | 0.08 +/- 0.0004 |

Note: Drawing not to scale