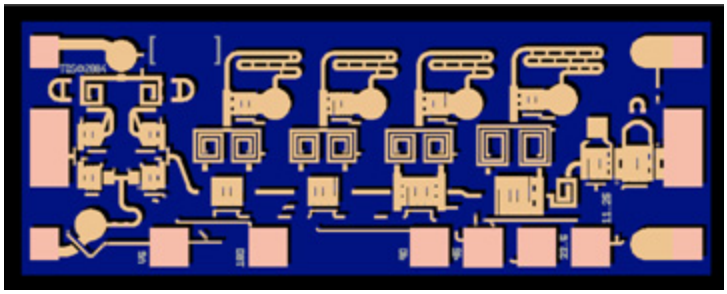
TriQuint SEMICONDUCTOR

**Product Data Sheet**
**August 5, 2008**

# 35 GHz 5-Bit Phase Shifter

# TGP2102



## Key Features and Performance

- Frequency Range: 32 - 37 GHz
- 7dB Nominal Insertion Loss
- 3.5deg RMS Phase Error @ 35GHz
- 0.4dB RMS Amp. Error @ 35GHz
- Negative Control Voltage
- Single-Ended Logic
- 0.25µm pHEMT 3MI Technology
- Chip dimensions:
  1.88 x 0.75 x 0.1 mm
  (0.074 x 0.030 x 0.004 inches)

## Primary Applications

- Military Radar
- Transmit / Receive

## Description

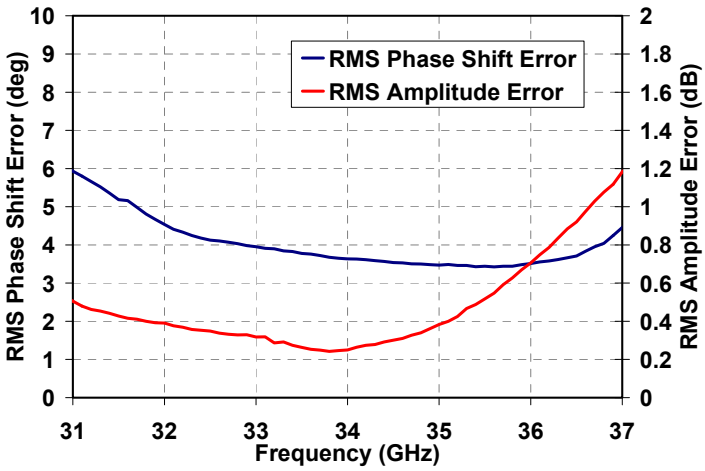
The TriQuint TGP2102 is a 5-bit digital phase shifter MMIC design using TriQuint's proven 0.25µm power pHEMT process to support a variety of Ka-Band phased array applications including military radar.

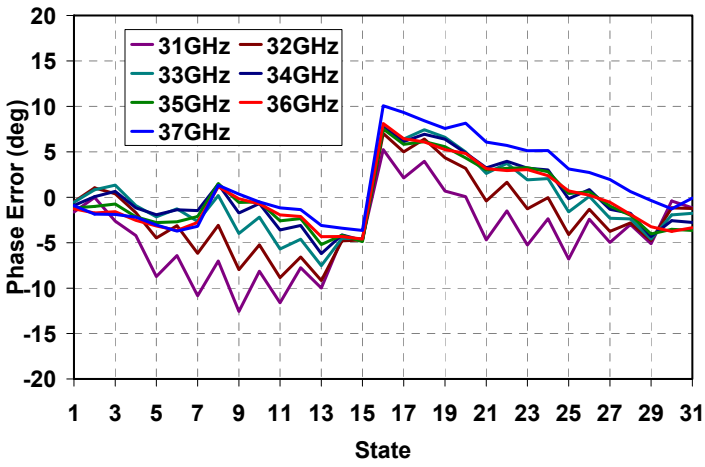
The 5-bit design utilizes a compact topology that achieves a 1.41mm$^2$ die area and high performance.

The TGP2102 provides a 5-bit digital phase shift function with a nominal 7dB insertion loss and 5° RMS phase shift error over a bandwidth of 32-37GHz.

The TGP2102 requires a minimum of off-chip components and operates with a -5V control voltage. Each device is RF tested on-wafer to ensure performance compliance. The device is available in chip form.

## Preliminary Measured Performance




*Note: Datasheet is subject to change without notice.*

**TABLE I**
**MAXIMUM RATINGS**

| Symbol | Parameter | Value | Notes |
|---|---|---|---|
| $V_C$ | Control Voltage Range | -8V to 0V | 1/ 2/ |
| $I_D$ | Control Supply Current | 1 mA | 1/ 2/ |
| $P_{IN}$ | Input Continuous Wave Power | 20 dBm | 1/ 2/ |
| $P_D$ | Power Dissipation | 0.1 W | 1/ 2/ |
| $T_{CH}$ | Operating Channel Temperature | 150 $^0$C | 3/ |
| $T_M$ | Mounting Temperature (30 Seconds) | 320 $^0$C | |
| $T_{STG}$ | Storage Temperature | -65 to 150 $^0$C | |

**1/** These ratings represent the maximum operable values for this device

**2/** Combinations of supply voltage, supply current, input power, and output power shall not exceed $P_D$ at a package base temperature of 70°C

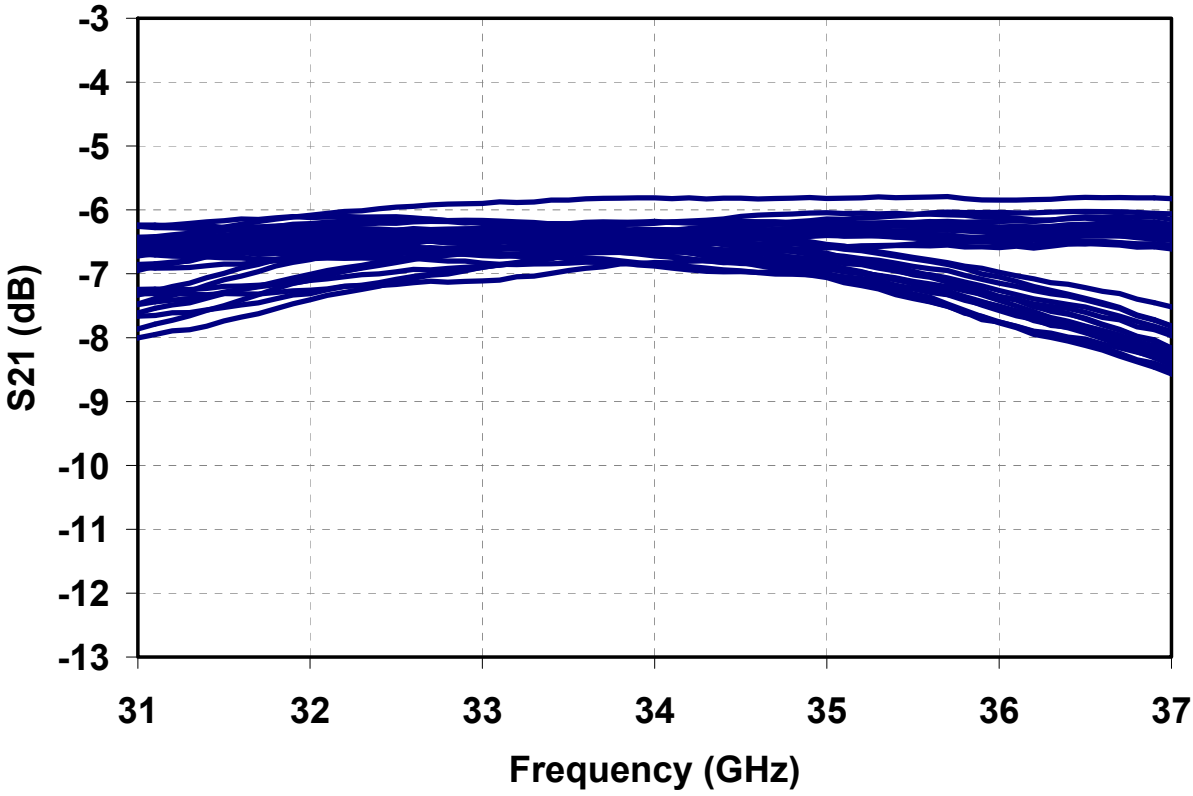
**3/** Junction operating temperature will directly affect the device median time to failure (MTTF). For maximum life, it is recommended that junction temperatures be maintained at the lowest possible levels.

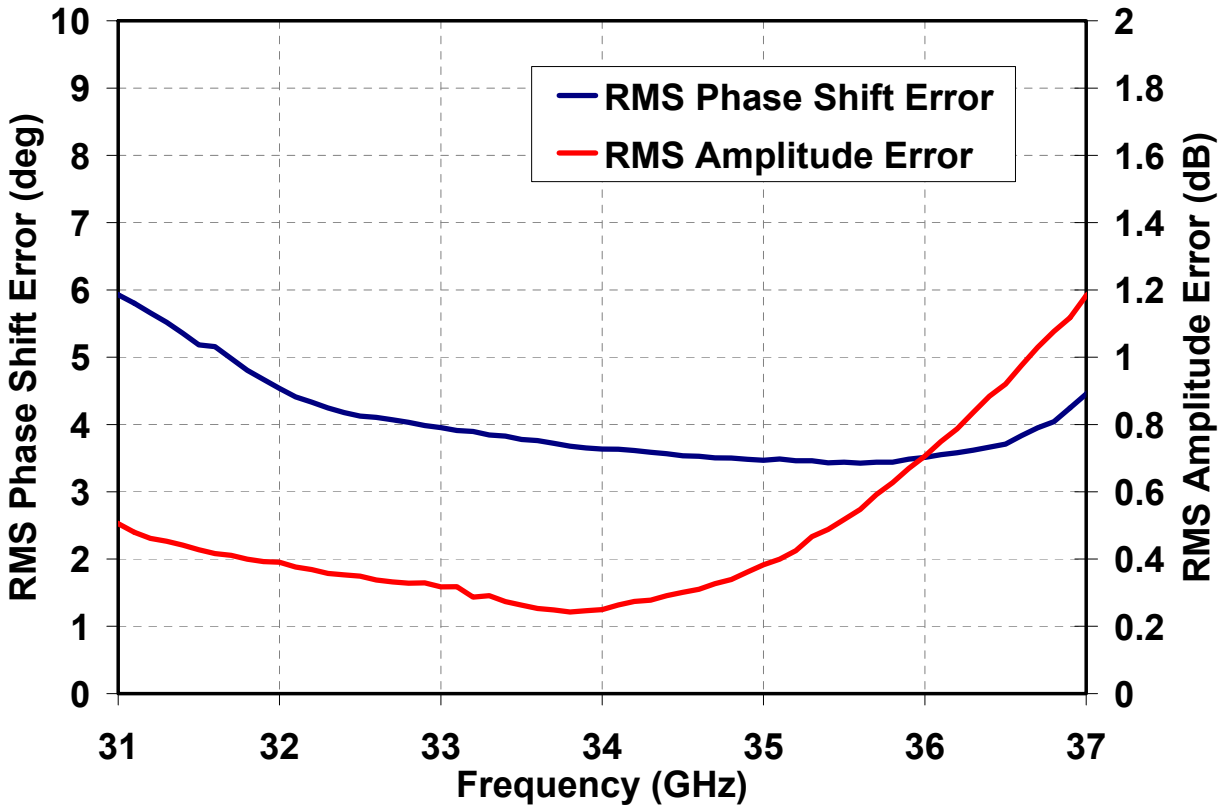
**TABLE II**
**RF CHARACTERIZATION TABLE**
**($T_A$ = 25°C, Nominal)**
**($V_C$ = -5V)**

| Parameter | Test Conditions | Typ | Units | Notes |
|---|---|---|---|---|
| Insertion Loss | 32 – 37GHz | 7 | dB | |
| Peak Amplitude Error | 32 – 37GHz | 1 | dB | |
| RMS Amplitude Error | 32 – 37GHz | 0.7 | dB | |
| Peak Phase Shift Error | 32 – 37GHz | 5 | deg | |
| RMS Phase Shift Error | 32 – 37GHz | 4 | deg | |
| Input Return Loss | 32 – 37GHz | 14 | dB | |
| Output Return Loss | 32 – 37GHz | 7 | dB | |

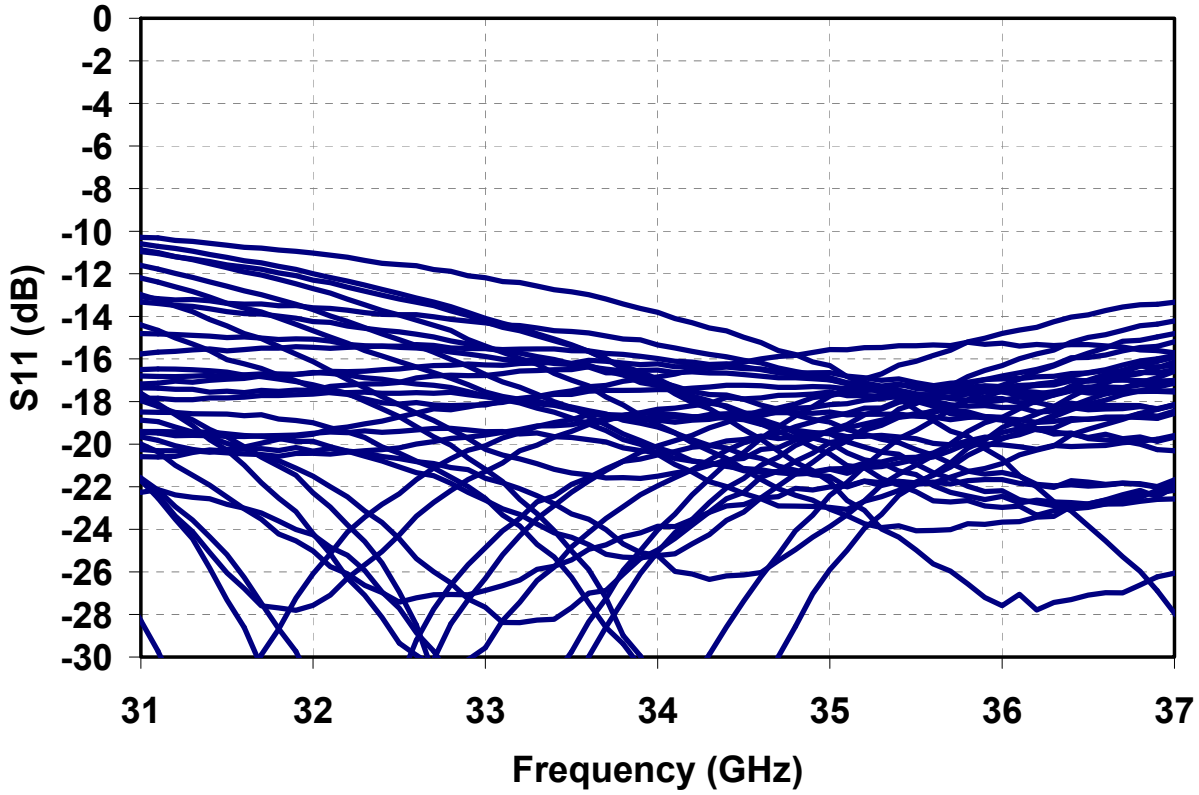
Note: Table II Lists the RF Characteristics of typical devices as determined by fixtured measurements.

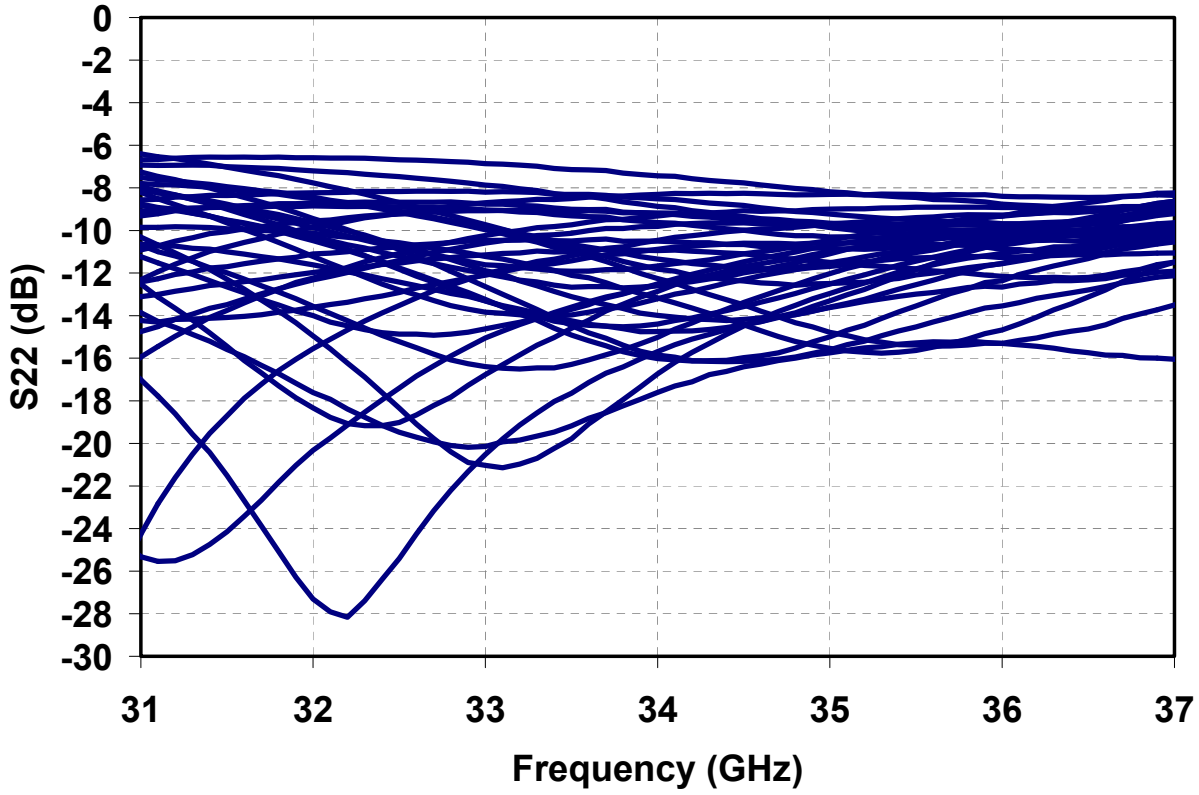
## Preliminary Measured Data



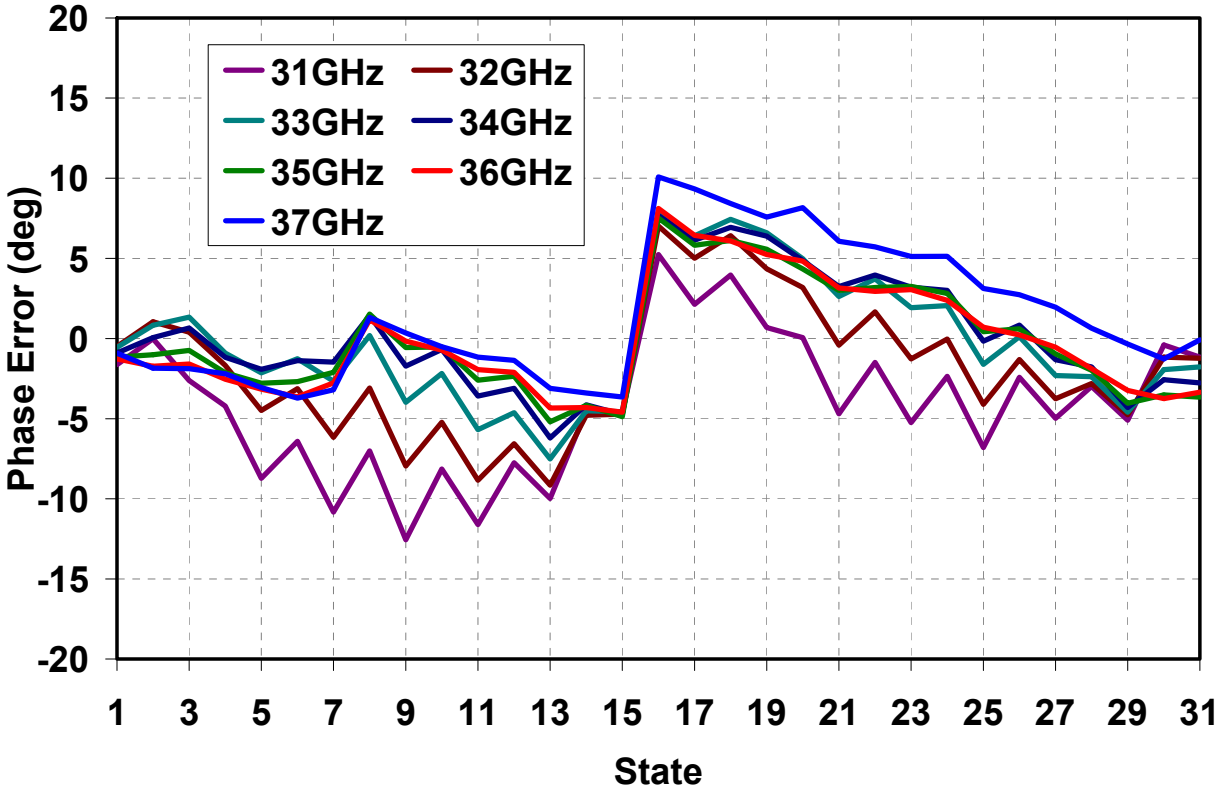



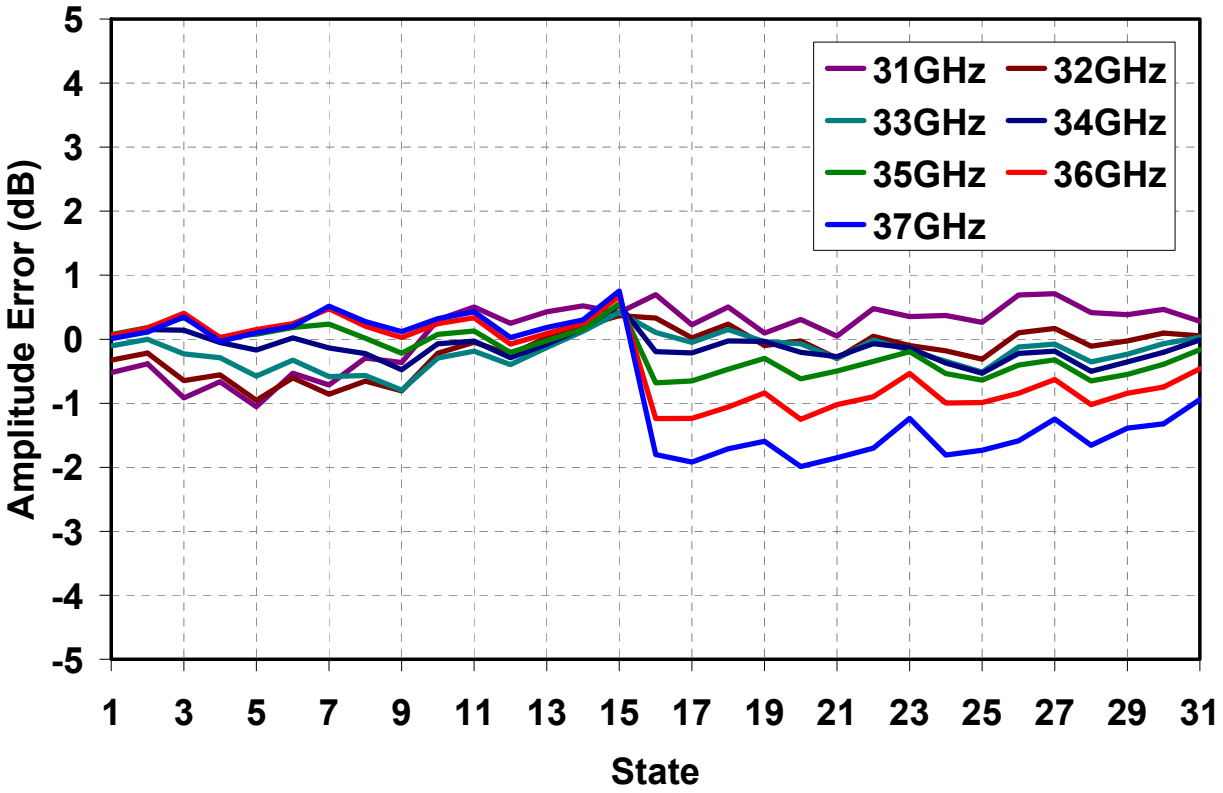
## Preliminary Measured Data



## Preliminary Measured Data

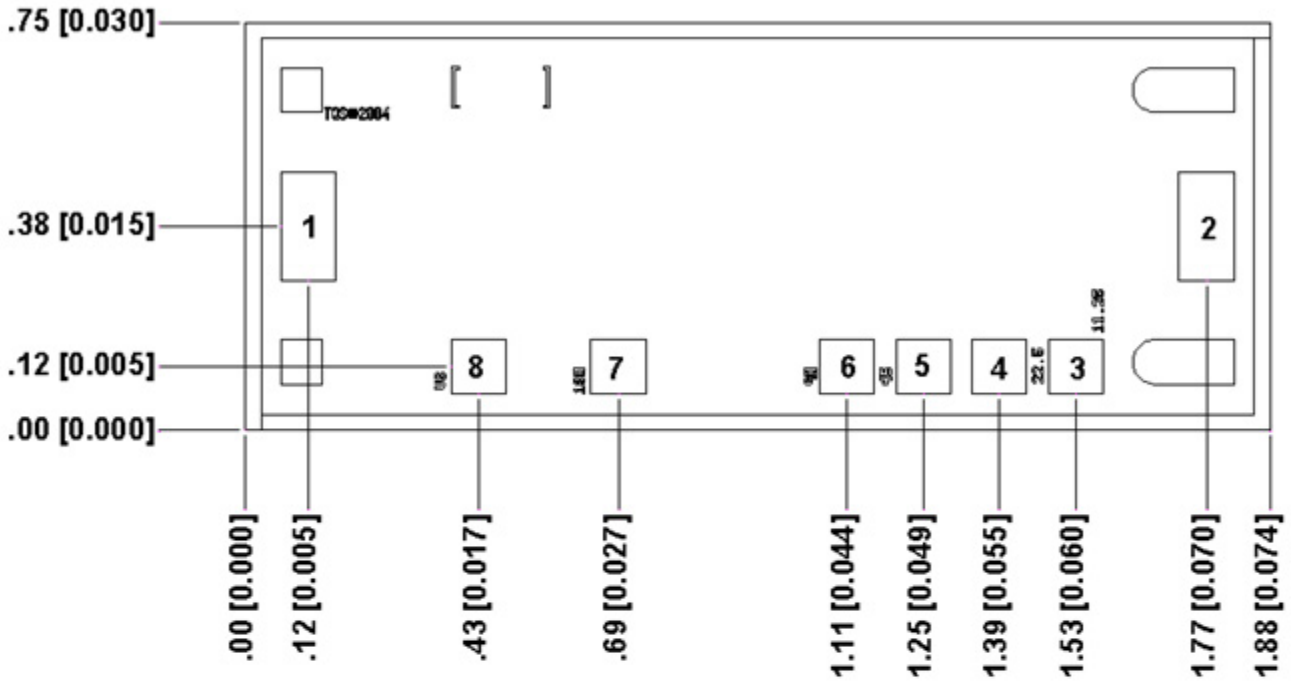


# State Table

| State | V-Supply | V-11.25 | V-22.5 | V-45 | V-90 | V-180 | Phase Shift |
|---|---|---|---|---|---|---|---|
| 0 | -5V | 0V | 0V | 0V | 0V | 0V | Reference |
| 1 | -5V | -5V | 0V | 0V | 0V | 0V | 11.25° |
| 2 | -5V | 0V | -5V | 0V | 0V | 0V | 22.5° |
| 3 | -5V | -5V | -5V | 0V | 0V | 0V | 33.75° |
| 4 | -5V | 0V | 0V | -5V | 0V | 0V | 45° |
| 5 | -5V | -5V | 0V | -5V | 0V | 0V | 56.25° |
| 6 | -5V | 0V | -5V | -5V | 0V | 0V | 67.5° |
| 7 | -5V | -5V | -5V | -5V | 0V | 0V | 78.75° |
| 8 | -5V | 0V | 0V | 0V | -5V | 0V | 90° |
| 9 | -5V | -5V | 0V | 0V | -5V | 0V | 101.25° |
| 10 | -5V | 0V | -5V | 0V | -5V | 0V | 112.5° |
| 11 | -5V | -5V | -5V | 0V | -5V | 0V | 123.75° |
| 12 | -5V | 0V | 0V | -5V | -5V | 0V | 135° |
| 13 | -5V | -5V | 0V | -5V | -5V | 0V | 146.25° |
| 14 | -5V | 0V | -5V | -5V | -5V | 0V | 157.5° |
| 15 | -5V | -5V | -5V | -5V | -5V | 0V | 168.75° |
| 16 | -5V | 0V | 0V | 0V | 0V | -5V | 180° |
| 17 | -5V | -5V | 0V | 0V | 0V | -5V | 191.25° |
| 18 | -5V | 0V | -5V | 0V | 0V | -5V | 202.5° |
| 19 | -5V | -5V | -5V | 0V | 0V | -5V | 213.75° |
| 20 | -5V | 0V | 0V | -5V | 0V | -5V | 225° |
| 21 | -5V | -5V | 0V | -5V | 0V | -5V | 236.25° |
| 22 | -5V | 0V | -5V | -5V | 0V | -5V | 247.5° |
| 23 | -5V | -5V | -5V | -5V | 0V | -5V | 258.75° |
| 24 | -5V | 0V | 0V | 0V | -5V | -5V | 270° |
| 25 | -5V | -5V | 0V | 0V | -5V | -5V | 281.25° |
| 26 | -5V | 0V | -5V | 0V | -5V | -5V | 292.5° |
| 27 | -5V | -5V | -5V | 0V | -5V | -5V | 303.75° |
| 28 | -5V | 0V | 0V | -5V | -5V | -5V | 315° |
| 29 | -5V | -5V | 0V | -5V | -5V | -5V | 326.25° |
| 30 | -5V | 0V | -5V | -5V | -5V | -5V | 337.5° |
| 31 | -5V | -5V | -5V | -5V | -5V | -5V | 348.75° |

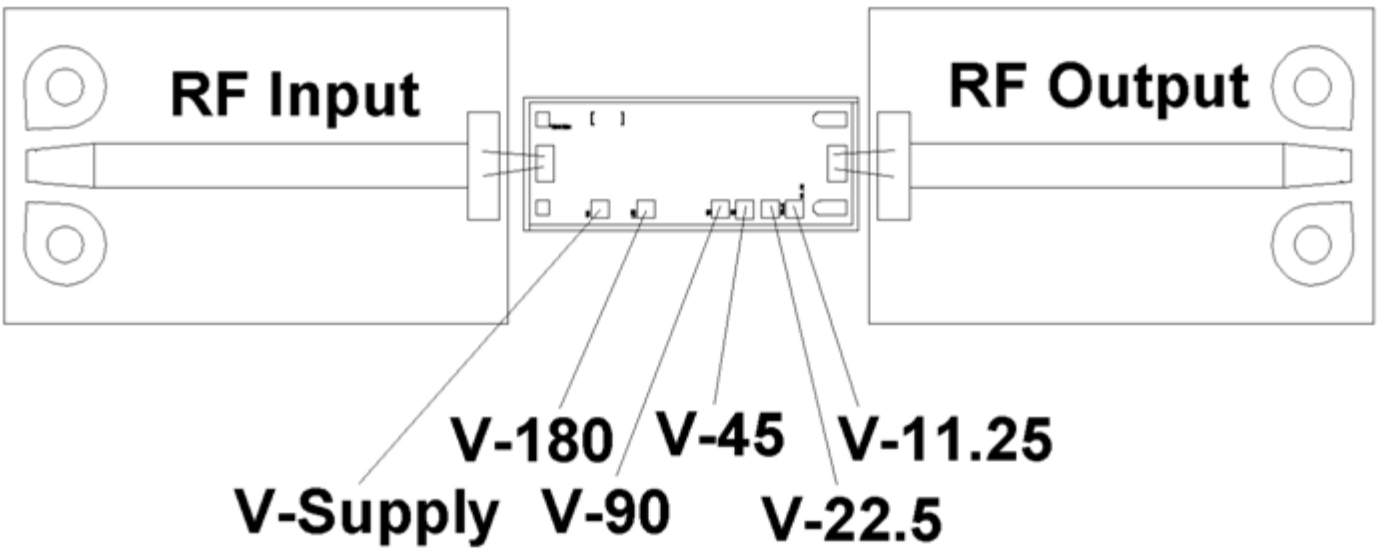
## Mechanical Drawing




Units: millimeters [inches]
Thickness: 0.10 [0.004] (reference only)
Chip edge to bond pad dimensions are shown to center of bond pads.
Chip size tolerance: ±0.05 [0.002]
RF ground through backside

| | | | |
|---|---|---|---|
| Bond Pad #1 | RF Input | 0.10 x 0.20 | [0.004 x 0.008] |
| Bond Pad #2 | RF Output | 0.10 x 0.20 | [0.004 x 0.008] |
| Bond Pad #3 | V-11.25 (ON V=-5V) | 0.10 x 0.10 | [0.004 x 0.004] |
| Bond Pad #4 | V-22.5 (ON V=-5V) | 0.10 x 0.10 | [0.004 x 0.004] |
| Bond Pad #5 | V-45 (ON V=-5V) | 0.10 x 0.10 | [0.004 x 0.004] |
| Bond Pad #6 | V-90 (ON V=-5V) | 0.10 x 0.10 | [0.004 x 0.004] |
| Bond Pad #7 | V-180 (ON V=-5V) | 0.10 x 0.10 | [0.004 x 0.004] |
| Bond Pad #8 | V-Supply (-5V) | 0.10 x 0.10 | [0.004 x 0.004] |

## Chip Assembly & Bonding Diagram




- Devices were tested with 500Ω resistors in series with control lines
- Input and output stubs are 0.007" x 0.024" on 0.010" alumina substrate

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

# Assembly Process Notes

Reflow process assembly notes:

- Use AuSn (80/20) solder with limited exposure to temperatures at or above 300°C. (30 seconds maximum)
- An alloy station or conveyor furnace with reducing atmosphere should be used.
- No fluxes should be utilized.
- Coefficient of thermal expansion matching is critical for long-term reliability.
- Devices must be stored in a dry nitrogen atmosphere.

Component placement and adhesive attachment assembly notes:

- Vacuum pencils and/or vacuum collets are the preferred method of pick up.
- Air bridges must be avoided during placement.
- The force impact is critical during auto placement.
- Organic attachment can be used in low-power applications.
- Curing should be done in a convection oven; proper exhaust is a safety concern.
- Microwave or radiant curing should not be used because of differential heating.
- Coefficient of thermal expansion matching is critical.

Interconnect process assembly notes:

- Thermosonic ball bonding is the preferred interconnect technique.
- Force, time, and ultrasonics are critical parameters.
- Aluminum wire should not be used.
- Maximum stage temperature is 200°C.

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