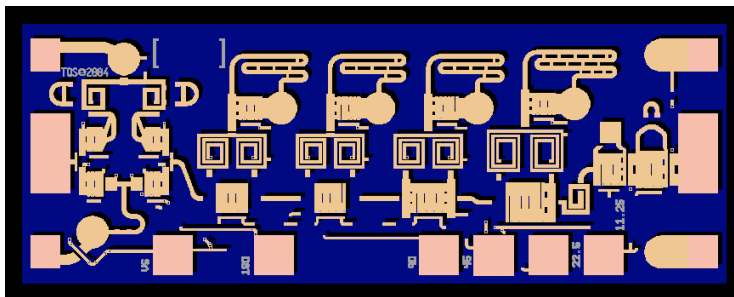


## 35 GHz 5-Bit Phase Shifter

## TGP2102-EPU



### 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

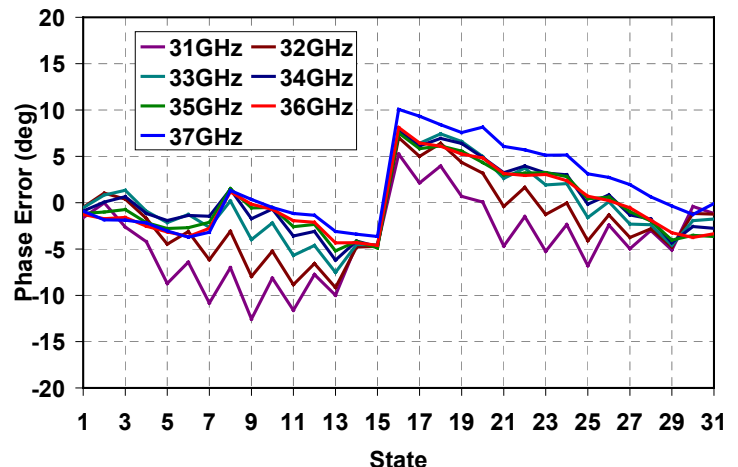
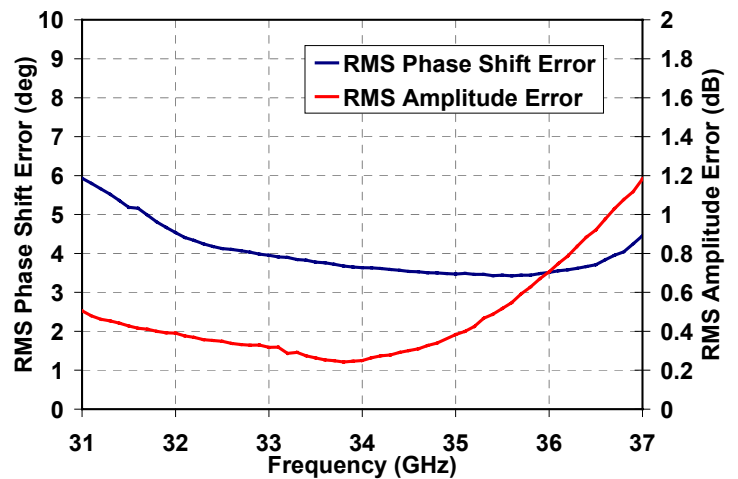
The TriQuint TGP2102-EPU is a 5-bit digital phase shifter MMIC design using TriQuint's proven 0.25µm power pHEMT process to support a variety of Ka-Band phased array applications including military radar.

The 5-bit design utilizes a compact topology that achieves a 1.41mm<sup>2</sup> die area and high performance.

The TGP2102-EPU 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-EPU 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: Devices designated as EPU are typically early in their characterization process prior to finalizing all electrical and process specifications. Specifications are subject to change without notice.*

**TABLE I  
MAXIMUM RATINGS**

Symbol	Parameter	Value	Notes
V <sub>C</sub>	Control Voltage Range	-8V to 0V	<u>1/</u> <u>2/</u>
I <sub>D</sub>	Control Supply Current	1 mA	<u>1/</u> <u>2/</u>
P <sub>IN</sub>	Input Continuous Wave Power	20 dBm	<u>1/</u> <u>2/</u>
P <sub>D</sub>	Power Dissipation	0.1 W	<u>1/</u> <u>2/</u>
T <sub>CH</sub>	Operating Channel Temperature	150 °C	<u>3/</u>
T <sub>M</sub>	Mounting Temperature (30 Seconds)	320 °C	
T <sub>STG</sub>	Storage Temperature	-65 to 150 °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<sub>D</sub> 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.

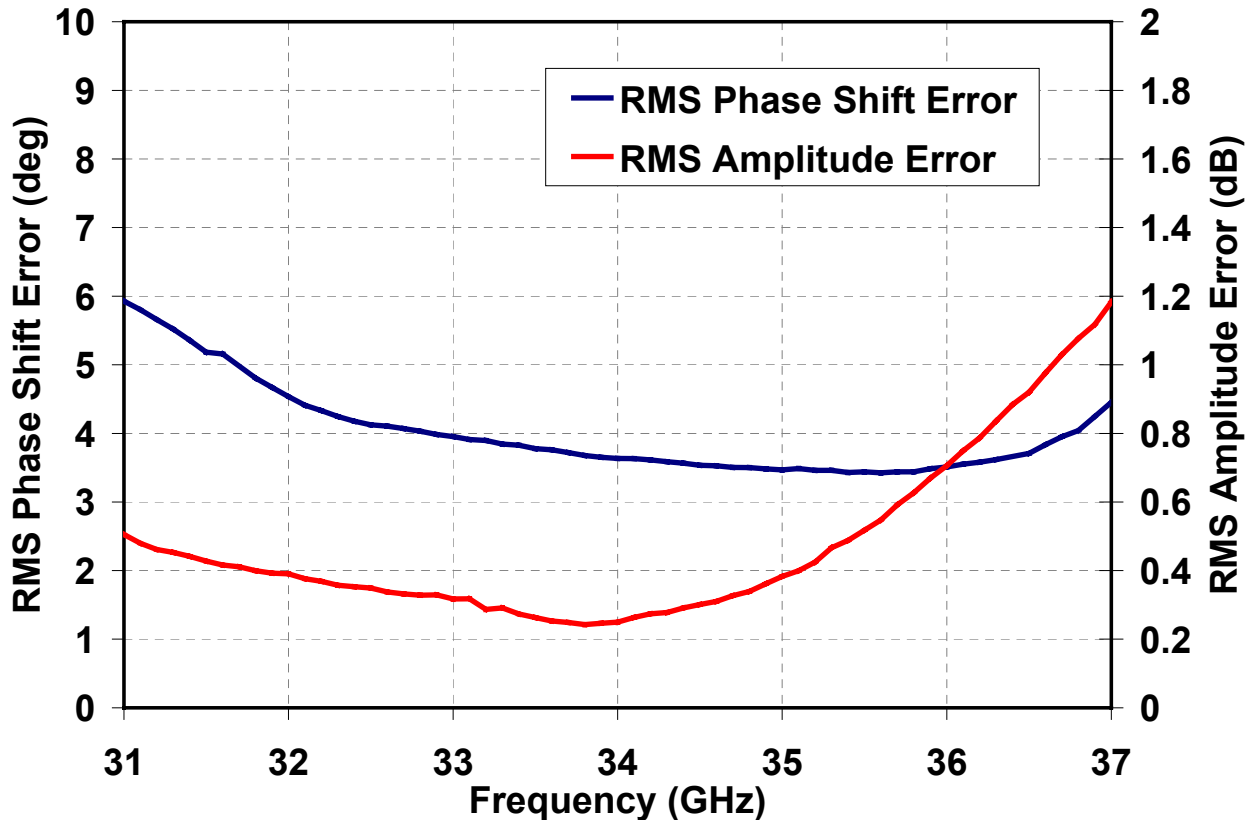
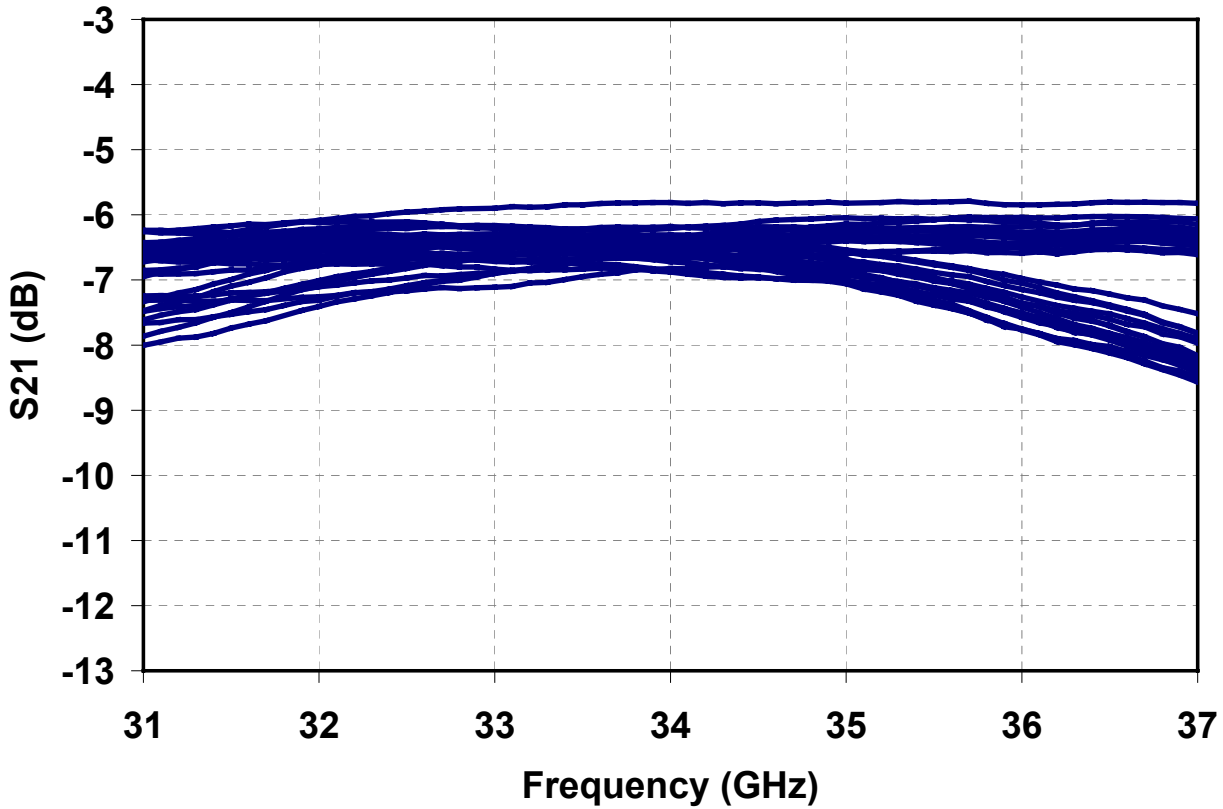
**TABLE II  
RF CHARACTERIZATION TABLE  
(T<sub>A</sub> = 25°C, Nominal)  
(V<sub>C</sub> = -5V)**

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.

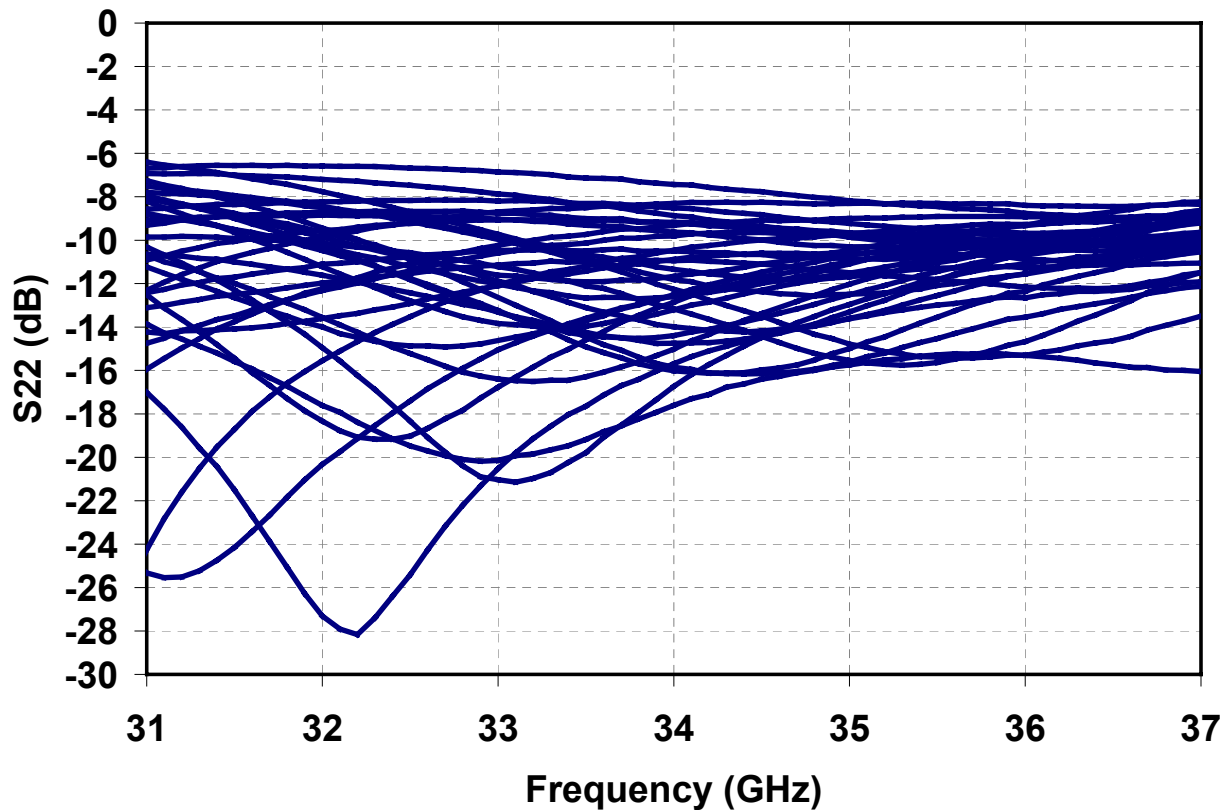
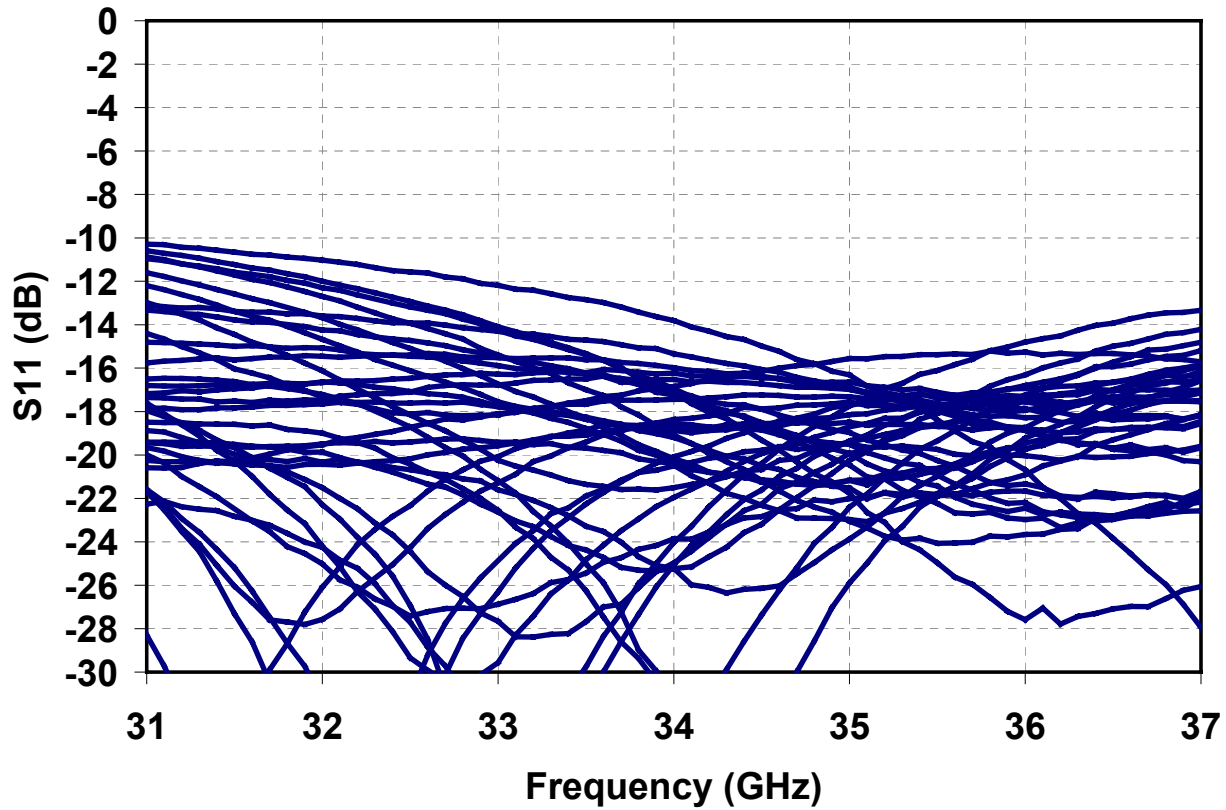
Note: Devices designated as EPU are typically early in their characterization process prior to finalizing all electrical and process specifications. Specifications are subject to change without notice.

Preliminary Measured Data



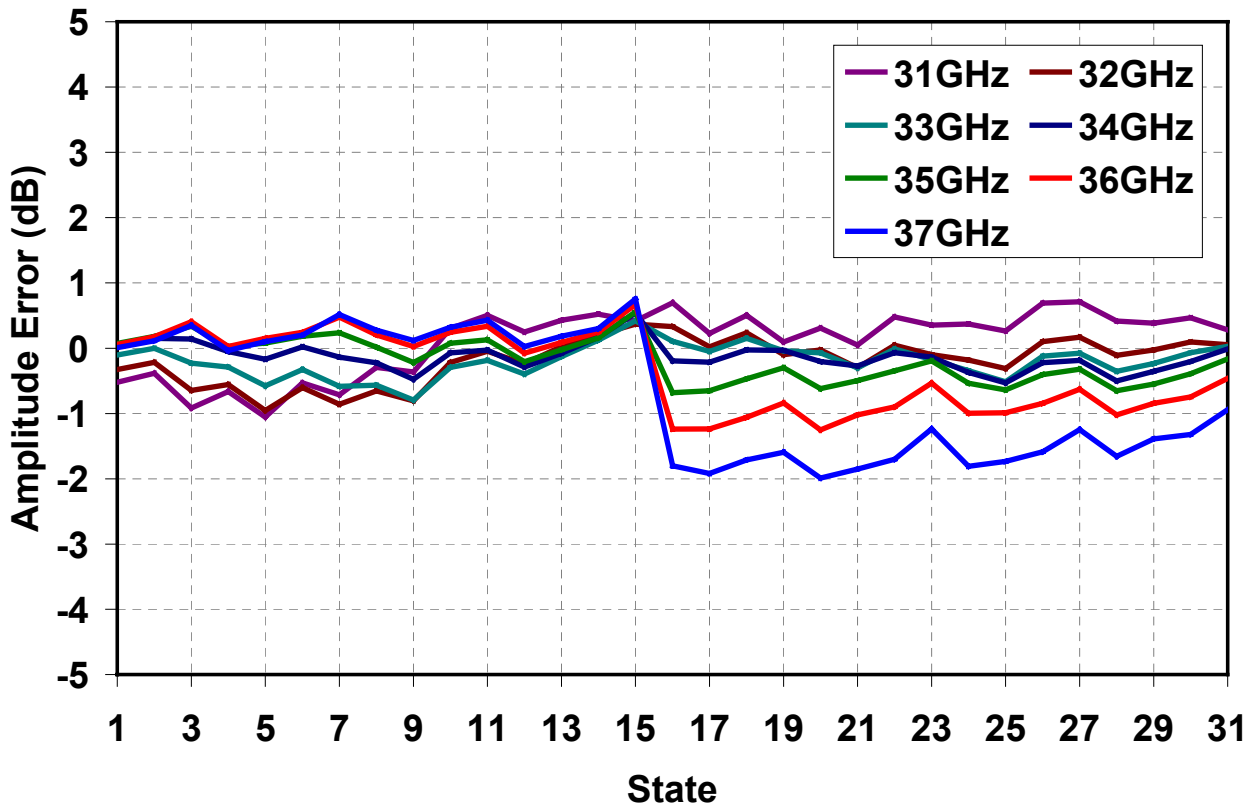
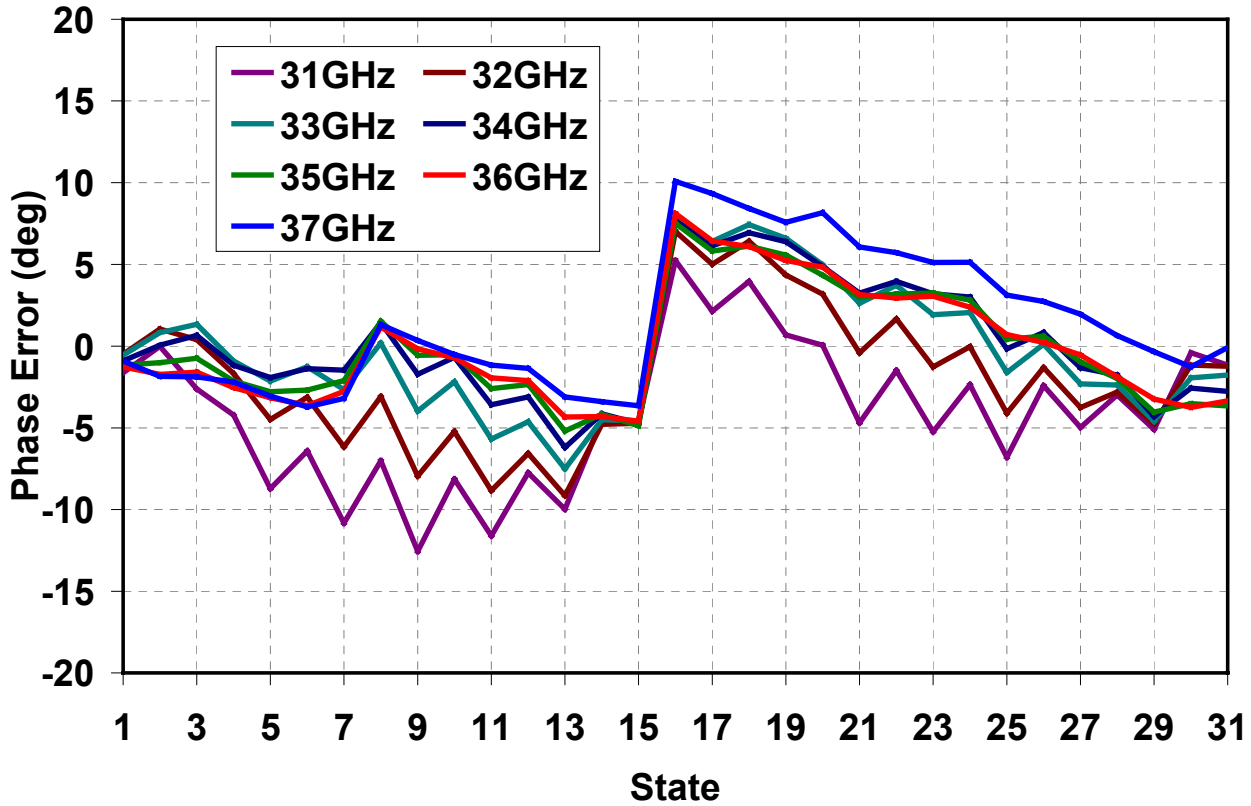
Note: Devices designated as EPU are typically early in their characterization process prior to finalizing all electrical and process specifications. Specifications are subject to change without notice.

Preliminary Measured Data



Note: Devices designated as EPU are typically early in their characterization process prior to finalizing all electrical and process specifications. Specifications are subject to change without notice.

Preliminary Measured Data



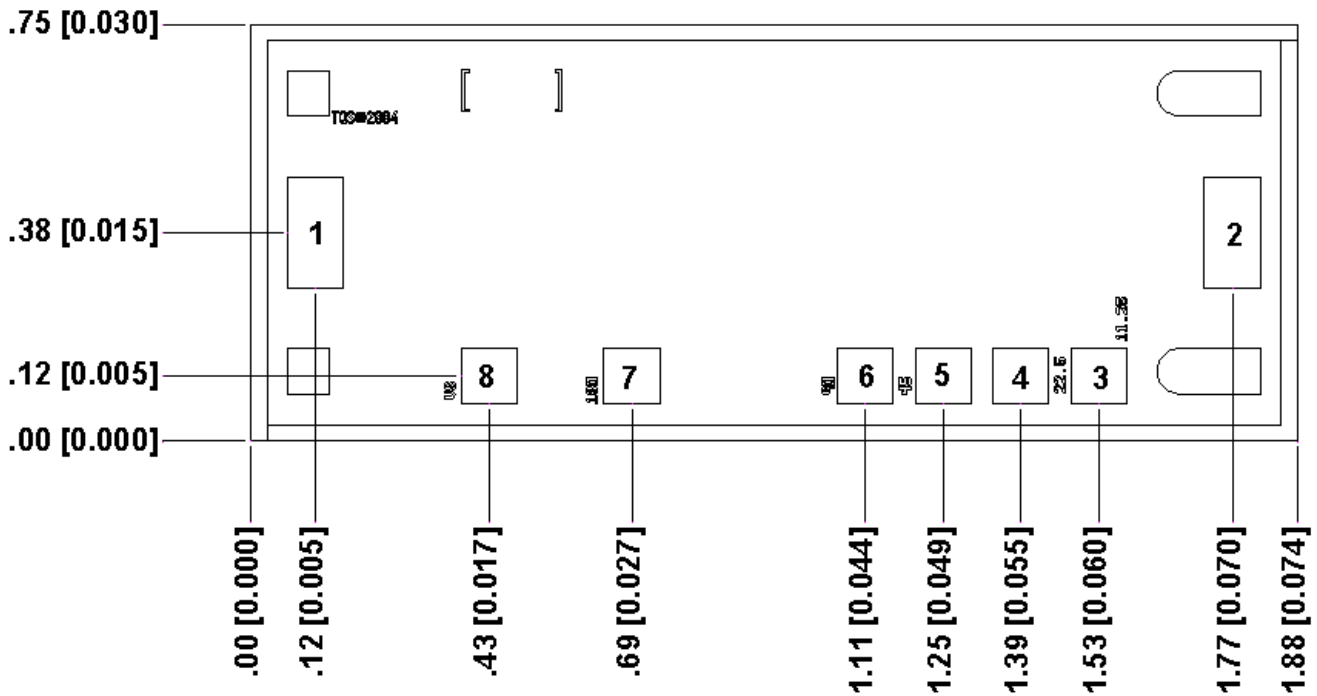
Note: Devices designated as EPU are typically early in their characterization process prior to finalizing all electrical and process specifications. Specifications are subject to change without notice.

**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°

*Note: Devices designated as EPU are typically early in their characterization process prior to finalizing all electrical and process specifications. Specifications are subject to change without notice.*

**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.**

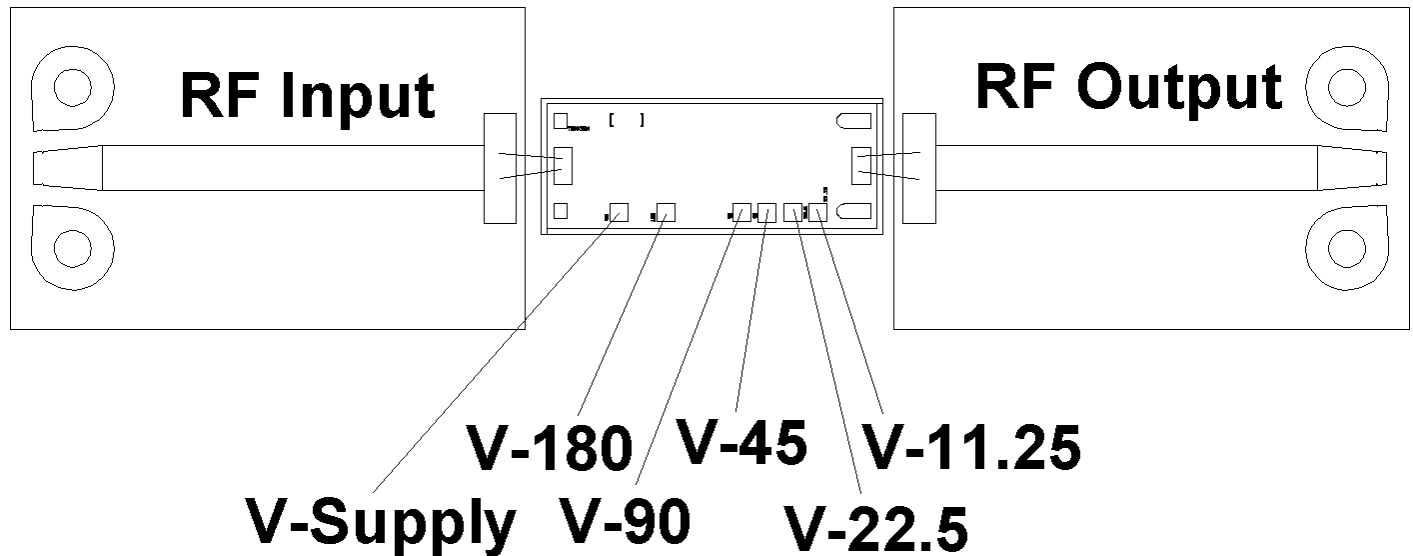
**Chip size tolerance: ±0.05 [0.002]**

**RF ground through backside**

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

*Note: Devices designated as EPU are typically early in their characterization process prior to finalizing all electrical and process specifications. Specifications are subject to change without notice.*

## Chip Assembly & Bonding Diagram



- Devices were tested with 500 $\Omega$  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.***

*Note: Devices designated as EPU are typically early in their characterization process prior to finalizing all electrical and process specifications. Specifications are subject to change without notice.*



## **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.

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

*Note: Devices designated as EPU are typically early in their characterization process prior to finalizing all electrical and process specifications. Specifications are subject to change without notice.*