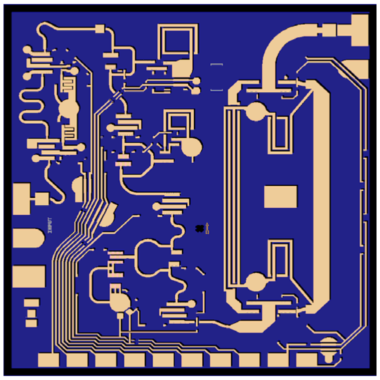
8.5 - 11 GHz 6-bit Phase Shifter



Primary Applications

- Military Radar
- Transmit / Receive

Description

The TriQuint TGP2103 is a 6-bit digital phase shifter MMIC design using TriQuint's proven 0.5μm MESFET process. The TGP2103 will support a variety of X-Band phased array applications including military radar.

The 6-bit design utilizes a compact topology that achieves a 11.31mm^2 die area and high performance.

The TGP2103 provides a 6-bit digital phase shift function with a nominal 5dB insertion loss and 2° RMS phase shift error over a bandwidth of 8.5-11GHz.

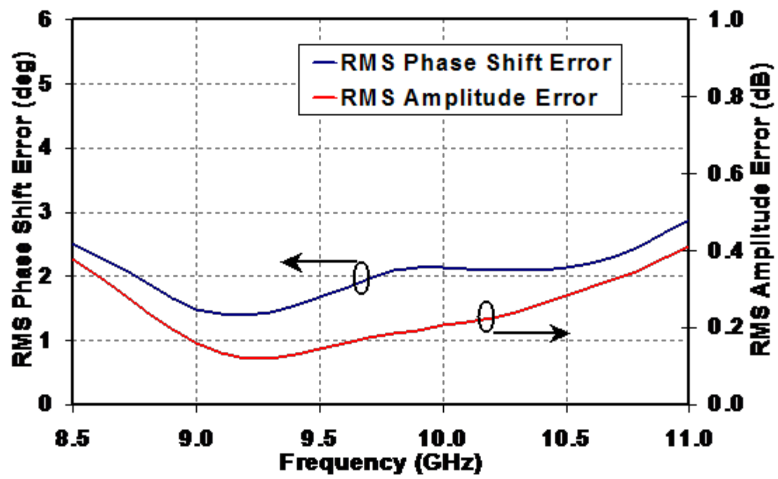
The TGP2103 requires a minimum of off-chip components and operates with a -5V control voltage. Each device is RF tested on-wafer to ensure performance compliance. The device is available in chip form.

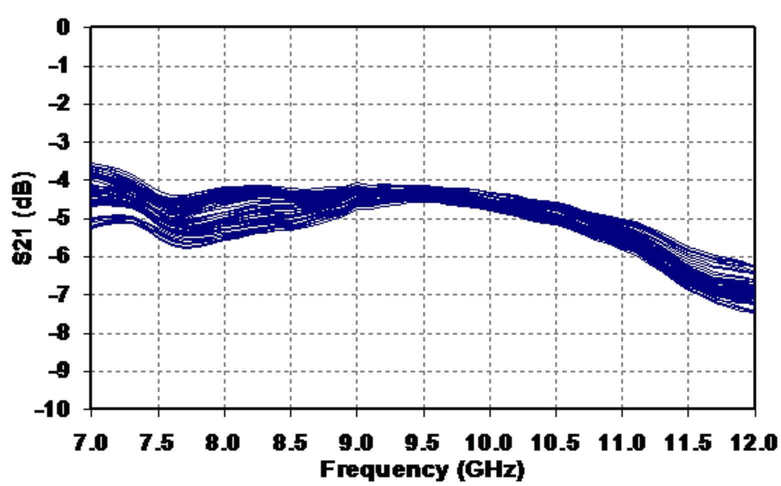
Lead-Free and RoHS compliant

Key Features and Performance

- Frequency Range: 8.5 - 11 GHz
- 5dB Nominal Insertion Loss
- 2deg RMS Phase Error @ 9.5GHz
- 0.2dB RMS Amp. Error @ 9.5GHz
- Negative Control Voltage
- 0.5μm MESFET Technology
- Chip dimensions:
  3.25 x 3.48 x 0.15 mm
  (0.128 x 0.137 x 0.006 inches)

Measured Performance





Datasheet subject to change without notice

TABLE I
MAXIMUM RATINGS

Symbol	Parameter	Value	Notes
V_C	Control Voltage Range	-8V to 0V	1/ 2/
I_C	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	200 °C	3/
	Mounting Temperature (30 Seconds)	320 °C	
T_{STG}	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_D

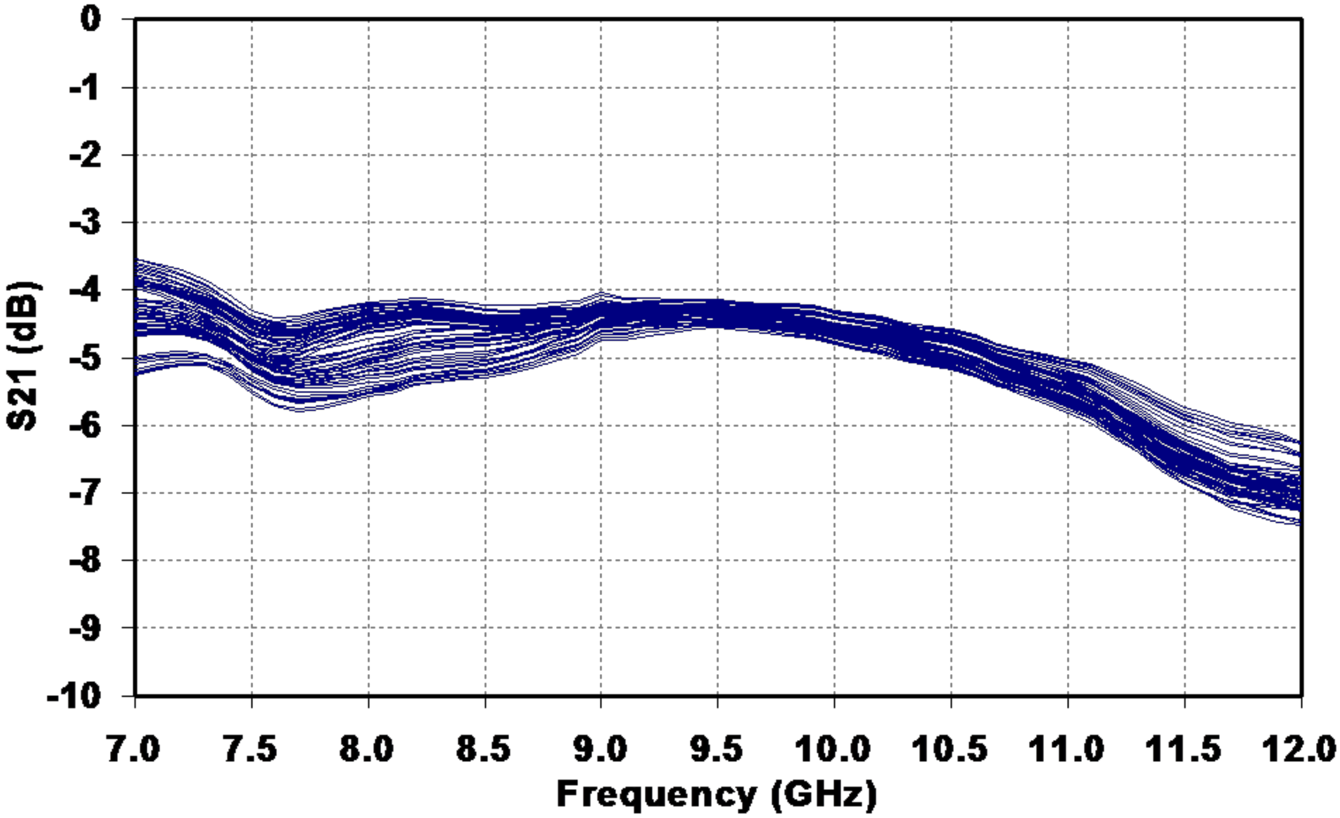
3/ Junction operating temperature will directly affect the device median time to failure (Tm). For maximum life, it is recommended that junction temperatures be maintained at the lowest possible levels.

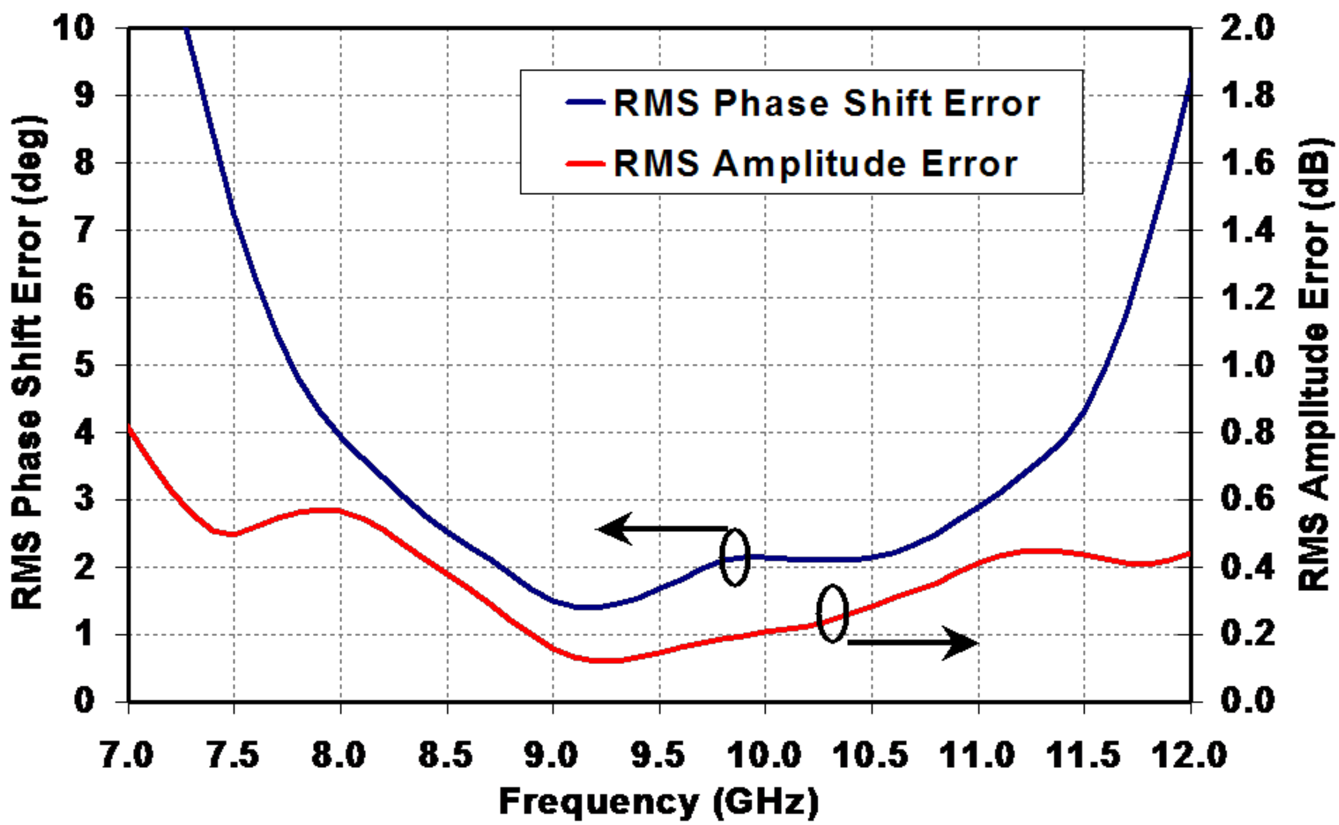
TABLE II
RF CHARACTERIZATION TABLE
(T_A = 25°C, Nominal)
(V_C = -5V)

Parameter	Test Conditions	Typ	Units	Notes
Insertion Loss	8.5 – 11GHz	5	dB	
Peak Amplitude Error	8.5 – 11GHz	0.5	dB	
RMS Amplitude Error	8.5 – 11GHz	0.2	dB	
Peak Phase Shift Error	8.5 – 11GHz	3	deg	
RMS Phase Shift Error	8.5 – 11GHz	2	deg	
Input Return Loss	8.5 – 11GHz	15	dB	
Output Return Loss	8.5 – 11GHz	12	dB	

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

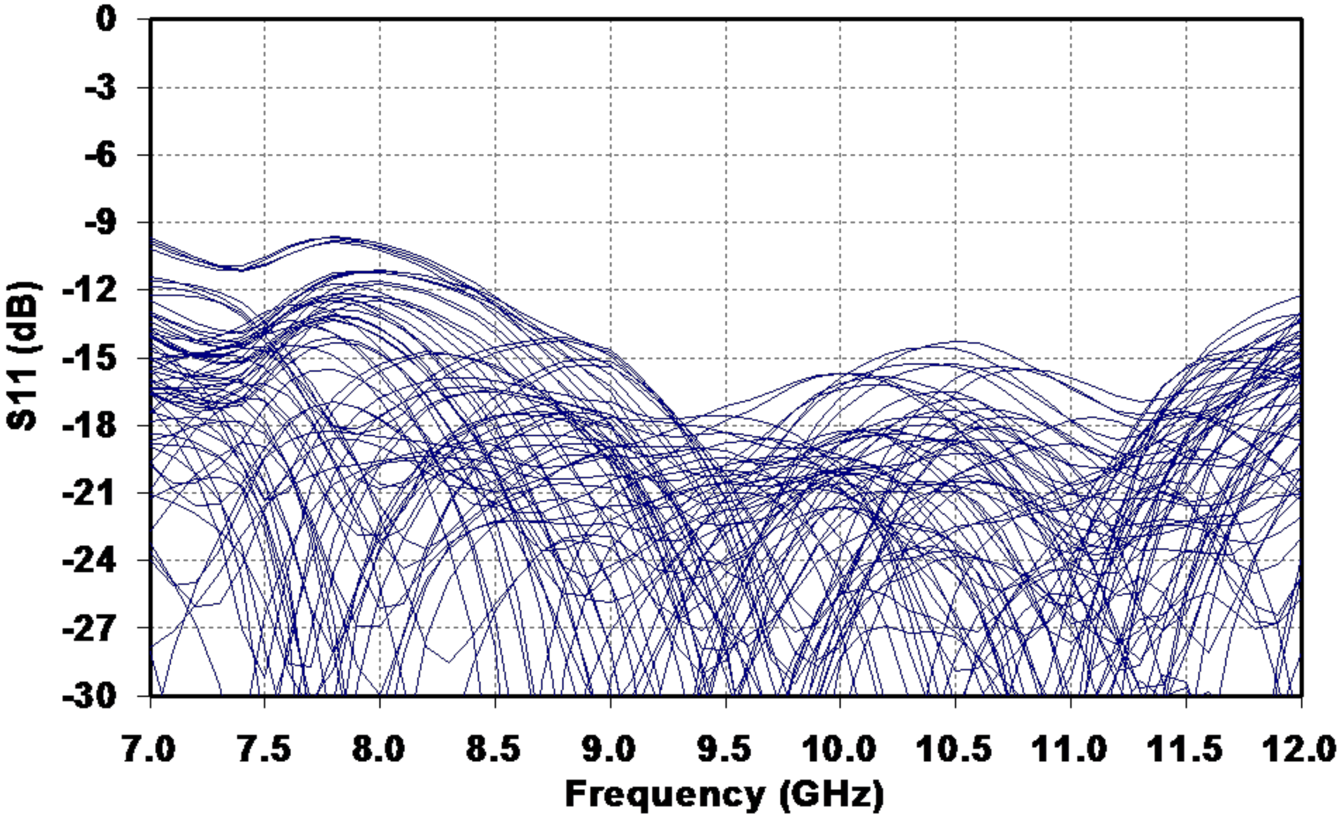
Preliminary Measured Data

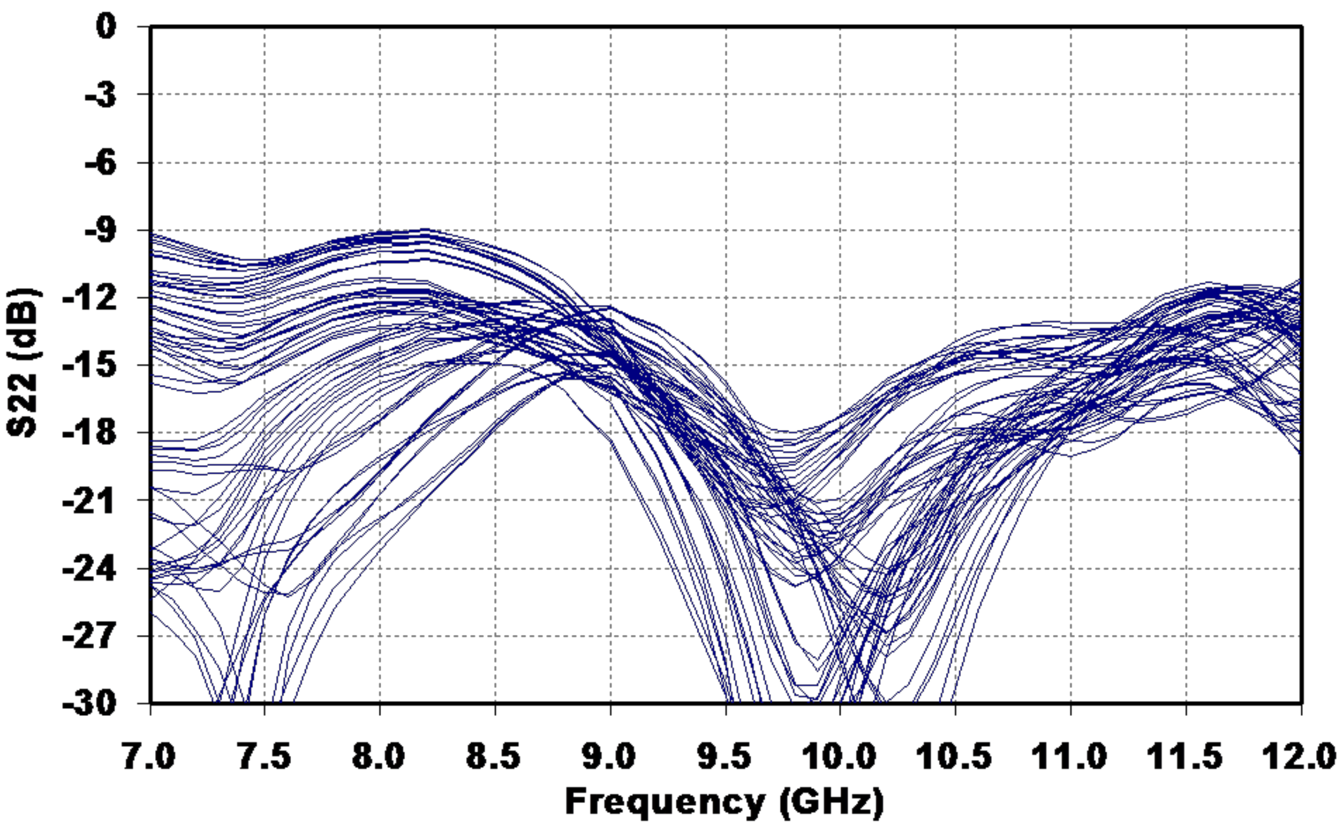




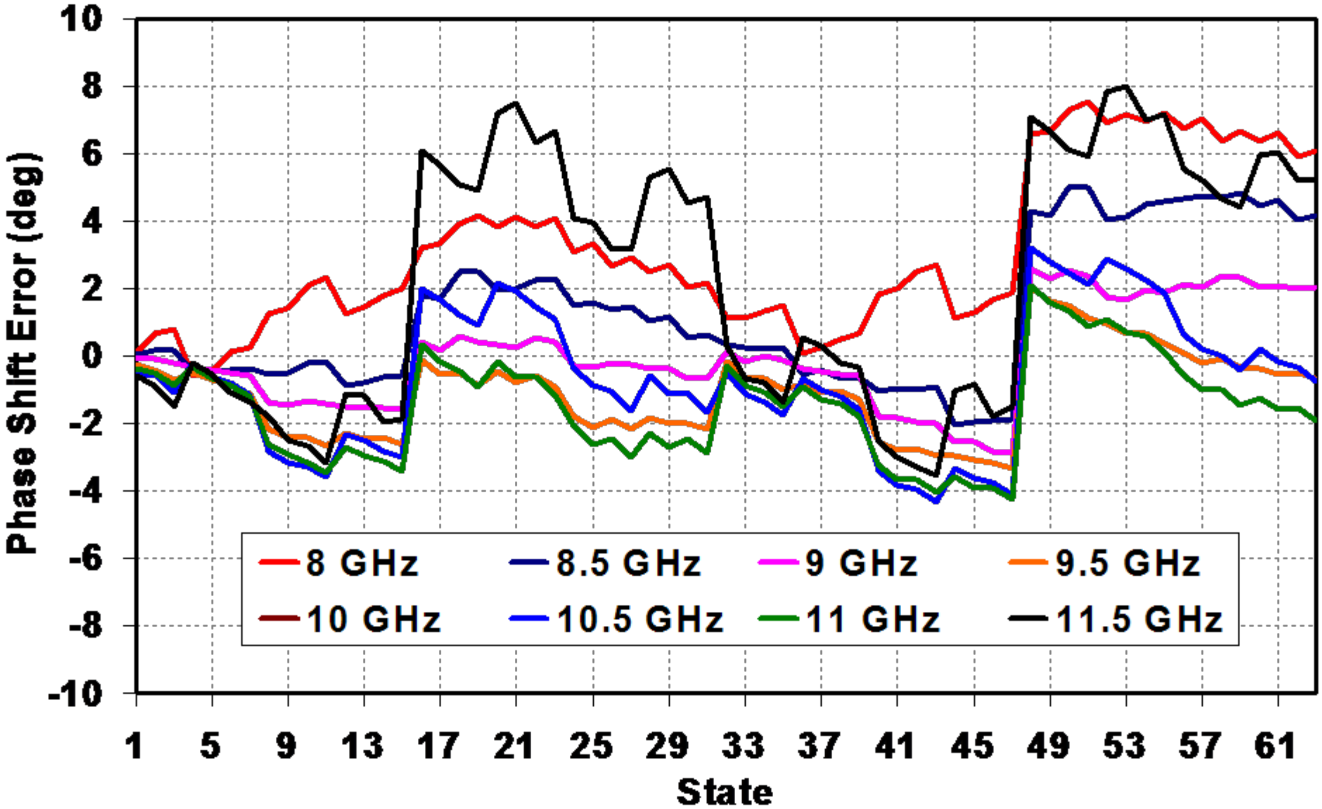
TriQuint Semiconductor: www. triquint.com (972)994-8465 Fax (972)994-8504 Info-mmw@tqs.com

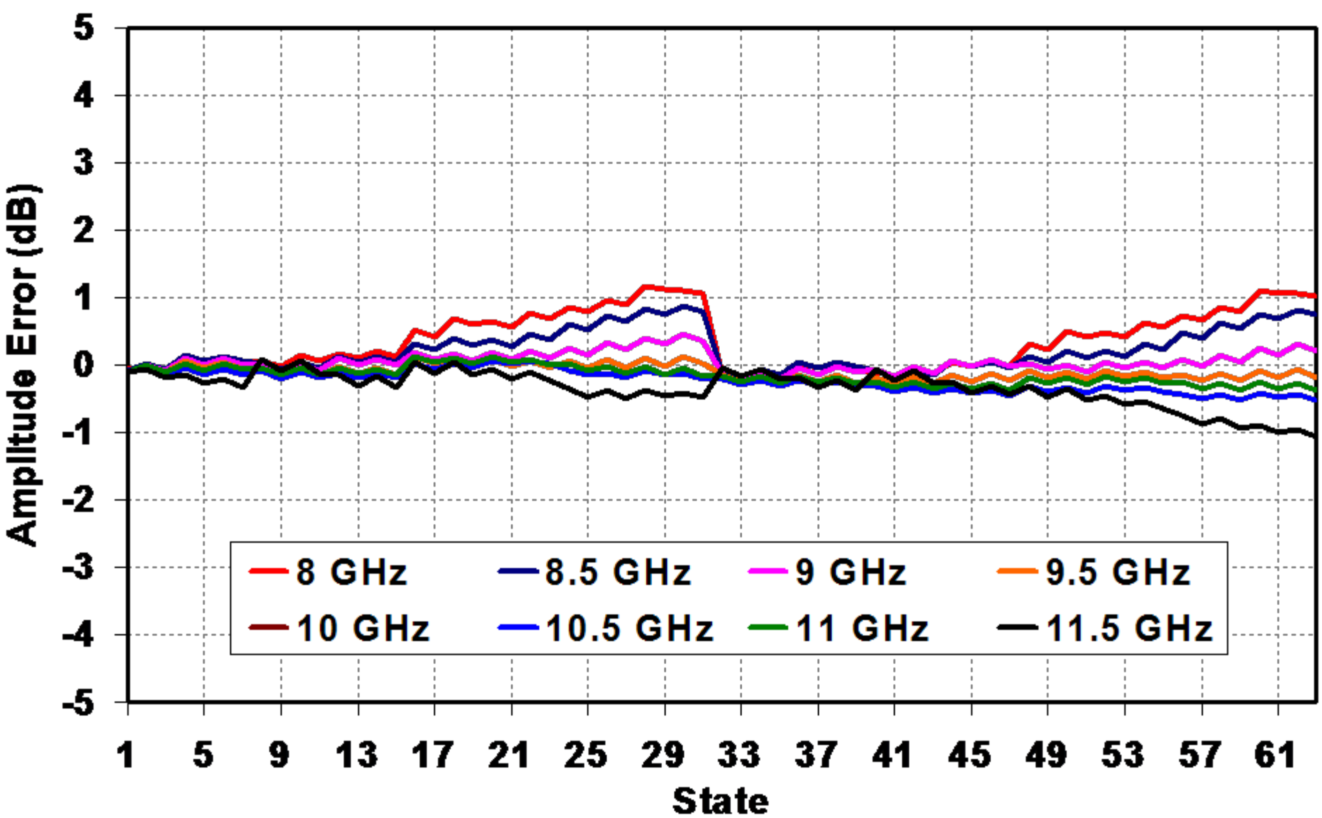
Preliminary Measured Data





Preliminary Measured Data

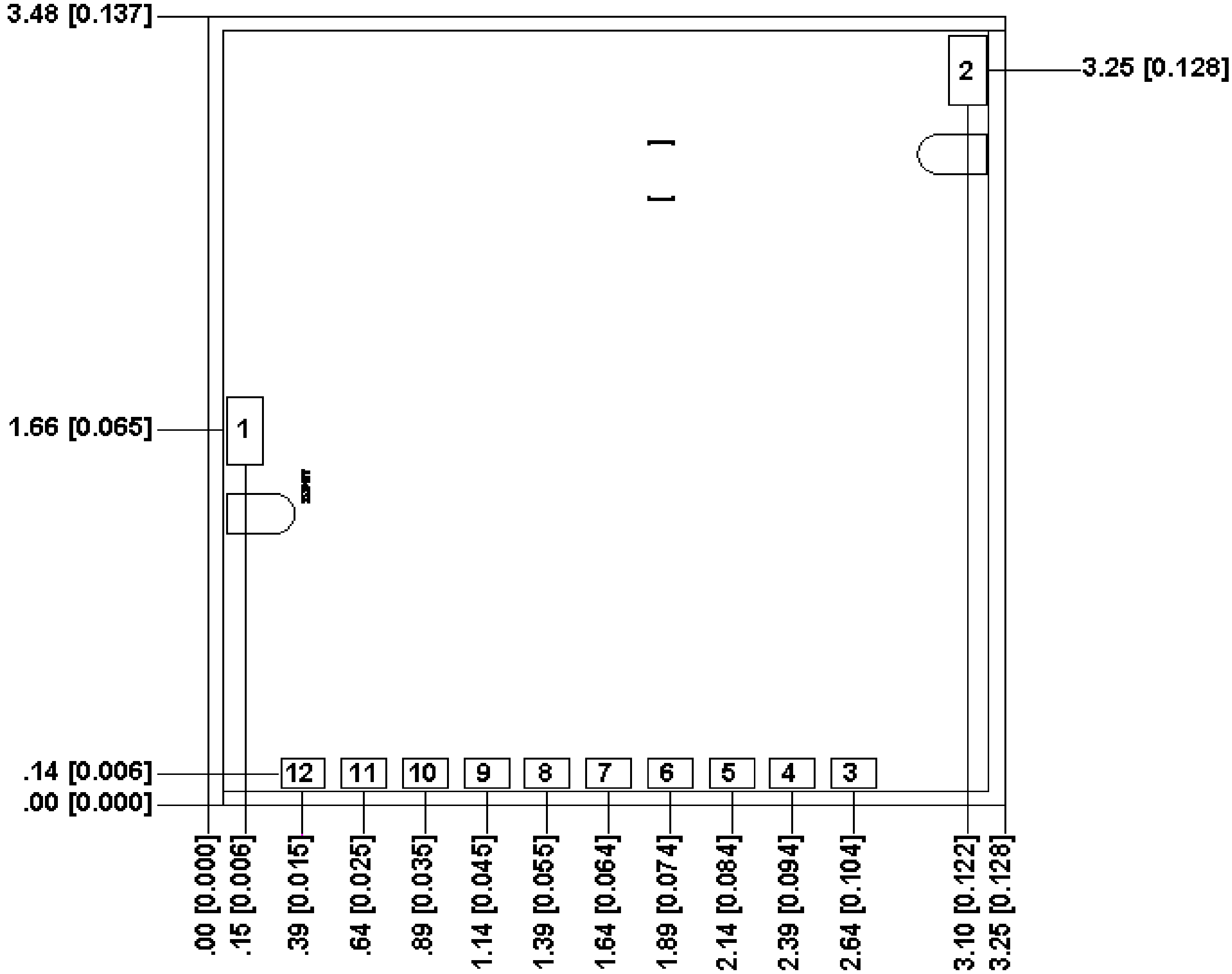




State Table

State	V-5.625	V-11.25	V-22.5A	V-22.5B	V-45A	V-45B	V-90A	V-90B	V-180A	V-180B	Phase Shift
0	0V	0V	0V	-5V	-5V	0V	-5V	0V	-5V	0V	Reference
1	-5V	0V	0V	-5V	-5V	0V	-5V	0V	-5V	0V	5.625°
2	0V	-5V	0V	-5V	-5V	0V	-5V	0V	-5V	0V	11.25°
3	-5V	-5V	0V	-5V	-5V	0V	-5V	0V	-5V	0V	16.875°
4	0V	0V	-5V	0V	-5V	0V	-5V	0V	-5V	0V	22.5°
5	-5V	0V	-5V	0V	-5V	0V	-5V	0V	-5V	0V	28.125°
6	0V	-5V	-5V	0V	-5V	0V	-5V	0V	-5V	0V	33.75°
7	-5V	-5V	-5V	0V	-5V	0V	-5V	0V	-5V	0V	39.375°
8	0V	0V	0V	-5V	0V	-5V	-5V	0V	-5V	0V	45°
9	-5V	0V	0V	-5V	0V	-5V	-5V	0V	-5V	0V	50.625°
10	0V	-5V	0V	-5V	0V	-5V	-5V	0V	-5V	0V	56.25°
11	-5V	-5V	0V	-5V	0V	-5V	-5V	0V	-5V	0V	61.875°
12	0V	0V	-5V	0V	0V	-5V	-5V	0V	-5V	0V	67.5°
13	-5V	0V	-5V	0V	0V	-5V	-5V	0V	-5V	0V	73.125°
14	0V	-5V	-5V	0V	0V	-5V	-5V	0V	-5V	0V	78.75°
15	-5V	-5V	-5V	0V	0V	-5V	-5V	0V	-5V	0V	84.375°
16	0V	0V	0V	-5V	-5V	0V	0V	-5V	-5V	0V	90°
17	-5V	0V	0V	-5V	-5V	0V	0V	-5V	-5V	0V	95.625°
18	0V	-5V	0V	-5V	-5V	0V	0V	-5V	-5V	0V	101.25°
19	-5V	-5V	0V	-5V	-5V	0V	0V	-5V	-5V	0V	106.875°
20	0V	0V	-5V	0V	-5V	0V	0V	-5V	-5V	0V	112.5°
21	-5V	0V	-5V	0V	-5V	0V	0V	-5V	-5V	0V	118.125°
22	0V	-5V	-5V	0V	-5V	0V	0V	-5V	-5V	0V	123.75°
23	-5V	-5V	-5V	0V	-5V	0V	0V	-5V	-5V	0V	129.375°
24	0V	0V	0V	-5V	0V	-5V	0V	-5V	-5V	0V	135°
25	-5V	0V	0V	-5V	0V	-5V	0V	-5V	-5V	0V	140.625°
26	0V	-5V	0V	-5V	0V	-5V	0V	-5V	-5V	0V	146.25°
27	-5V	-5V	0V	-5V	0V	-5V	0V	-5V	-5V	0V	151.875°
28	0V	0V	-5V	0V	0V	-5V	0V	-5V	-5V	0V	157.5°
29	-5V	0V	-5V	0V	0V	-5V	0V	-5V	-5V	0V	163.125°
30	0V	-5V	-5V	0V	0V	-5V	0V	-5V	-5V	0V	168.75°
31	-5V	-5V	-5V	0V	0V	-5V	0V	-5V	-5V	0V	174.375°
32	0V	0V	0V	-5V	-5V	0V	-5V	0V	0V	-5V	180°
33	-5V	0V	0V	-5V	-5V	0V	-5V	0V	0V	-5V	185.625°
34	0V	-5V	0V	-5V	-5V	0V	-5V	0V	0V	-5V	191.25°
35	-5V	-5V	0V	-5V	-5V	0V	-5V	0V	0V	-5V	196.875°
36	0V	0V	-5V	0V	-5V	0V	-5V	0V	0V	-5V	202.5°
37	-5V	0V	-5V	0V	-5V	0V	-5V	0V	0V	-5V	208.125°
38	0V	-5V	-5V	0V	-5V	0V	-5V	0V	0V	-5V	213.75°
39	-5V	-5V	-5V	0V	-5V	0V	-5V	0V	0V	-5V	219.375°
40	0V	0V	0V	-5V	0V	-5V	-5V	0V	0V	-5V	225°
41	-5V	0V	0V	-5V	0V	-5V	-5V	0V	0V	-5V	230.625°
42	0V	-5V	0V	-5V	0V	-5V	-5V	0V	0V	-5V	236.25°
43	-5V	-5V	0V	-5V	0V	-5V	-5V	0V	0V	-5V	241.875°
44	0V	0V	-5V	0V	0V	-5V	-5V	0V	0V	-5V	247.5°
45	-5V	0V	-5V	0V	0V	-5V	-5V	0V	0V	-5V	253.125°
46	0V	-5V	-5V	0V	0V	-5V	-5V	0V	0V	-5V	258.75°
47	-5V	-5V	-5V	0V	0V	-5V	-5V	0V	0V	-5V	264.375°
48	0V	0V	0V	-5V	-5V	0V	0V	-5V	0V	-5V	270°
49	-5V	0V	0V	-5V	-5V	0V	0V	-5V	0V	-5V	275.625°
50	0V	-5V	0V	-5V	-5V	0V	0V	-5V	0V	-5V	281.25°
51	-5V	-5V	0V	-5V	-5V	0V	0V	-5V	0V	-5V	286.875°
52	0V	0V	-5V	0V	-5V	0V	0V	-5V	0V	-5V	292.5°
53	-5V	0V	-5V	0V	-5V	0V	0V	-5V	0V	-5V	298.125°
54	0V	-5V	-5V	0V	-5V	0V	0V	-5V	0V	-5V	303.75°
55	-5V	-5V	-5V	0V	-5V	0V	0V	-5V	0V	-5V	309.375°
56	0V	0V	0V	-5V	0V	-5V	0V	-5V	0V	-5V	315°
57	-5V	0V	0V	-5V	0V	-5V	0V	-5V	0V	-5V	320.625°
58	0V	-5V	0V	-5V	0V	-5V	0V	-5V	0V	-5V	326.25°
59	-5V	-5V	0V	-5V	0V	-5V	0V	-5V	0V	-5V	331.875°
60	0V	0V	-5V	0V	0V	-5V	0V	-5V	0V	-5V	337.5°
61	-5V	0V	-5V	0V	0V	-5V	0V	-5V	0V	-5V	343.125°
62	0V	-5V	-5V	0V	0V	-5V	0V	-5V	0V	-5V	348.75°
63	-5V	-5V	-5V	0V	0V	-5V	0V	-5V	0V	-5V	354.375°

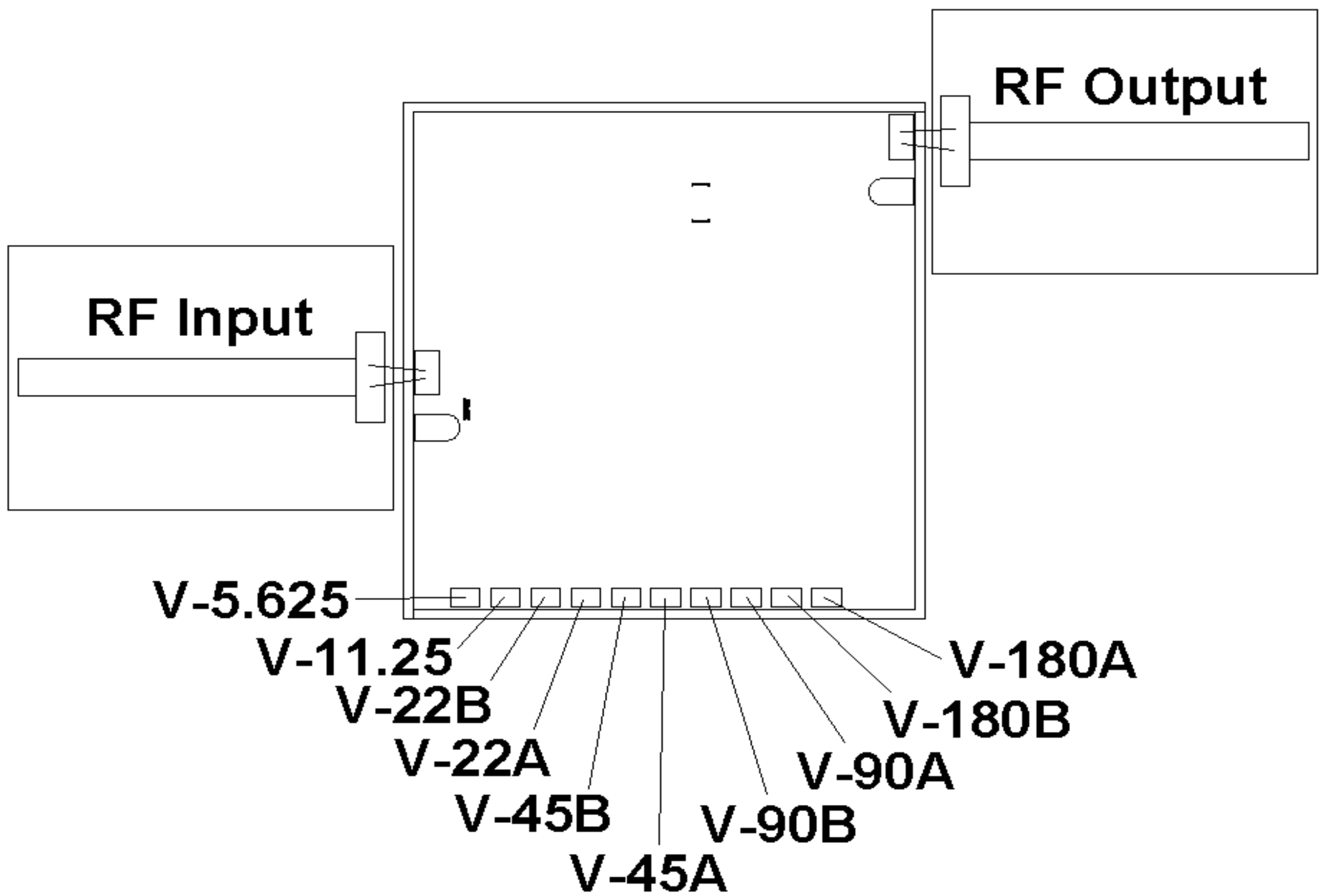
Mechanical Drawing



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	0.15 x 0.30	[0.006 x 0.012]
Bond Pad #2	RF Output	0.15 x 0.30	[0.006 x 0.012]
Bond Pad #3	V-180A (ON V=0V)	0.18 x 0.13	[0.007 x 0.005]
Bond Pad #4	V-180B (ON V=-5V)	0.18 x 0.13	[0.007 x 0.005]
Bond Pad #5	V-90A (ON V=0V)	0.18 x 0.13	[0.007 x 0.005]
Bond Pad #6	V-90B (ON V=-5V)	0.18 x 0.13	[0.007 x 0.005]
Bond Pad #7	V-45A (ON V=0V)	0.18 x 0.13	[0.007 x 0.005]
Bond Pad #8	V-45B (ON V=-5V)	0.18 x 0.13	[0.007 x 0.005]
Bond Pad #9	V-22A (ON V=-5V)	0.18 x 0.13	[0.007 x 0.005]
Bond Pad #10	V-22B (ON V=0V)	0.18 x 0.13	[0.007 x 0.005]
Bond Pad #11	V-11.25 (ON V=-5V)	0.18 x 0.13	[0.007 x 0.005]
Bond Pad #12	V-5.625 (ON V=-5V)	0.18 x 0.13	[0.007 x 0.005]

Chip Assembly & Bonding Diagram



- Devices were tested with 500Ω resistors in series with control lines
- Input and output stubs are 0.010" x 0.025" 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.

TGP2103

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.