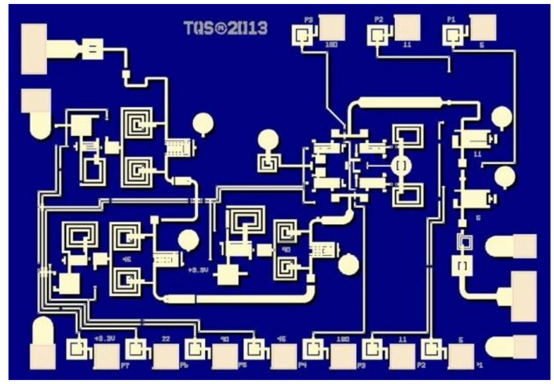
Applications

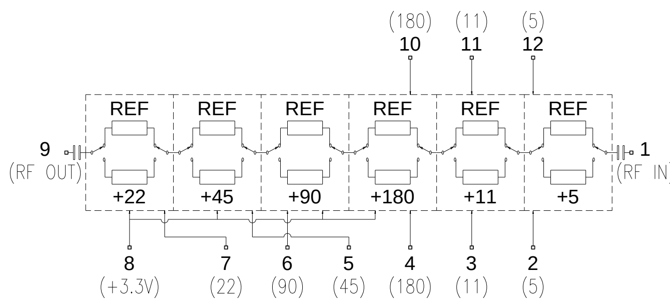
- Phased-Array Radar
- Satellite Communications



Product Features

- 6-Bit Digital Phase Shifter
- Frequency Range: 15 to 19 GHz
- 360° Coverage, LSB = 5.625°
- RMS Phase Error: 4°
- RMS Amplitude Error: 1 dB
- Insertion Loss: 7 dB
- Input Return Loss: >10 dB
- Output Return Loss: >9 dB
- Input IP3: >34 dBm
- Input P1dB: >24 dBm
- Positive Control Logic: 0/+3.3 V
- Chip Dimensions: 2.11 x 1.47 x 0.10 mm

Functional Block Diagram



General Description

TriQuint's TGP2615 is a 6-bit digital phase shifter fabricated on TriQuint's high-performance 0.15-μm GaAs pHEMT process. It operates over 15 to 19 GHz, and provides 360° of phase coverage with a LSB of 5.625°. It also achieves a low RMS phase error of 4°, with 7-dB average insertion loss over all states.

The TGP2615 uses positive single-control-line switch logic, eliminating the need for a negative voltage rail or complimentary logic. This, combined with low insertion loss and a high degree of resolution makes the TGP2615 ideally suited for applications in phased-array radar and satellite communications.

The device is lead-free and RoHS compliant.

Pad Configuration

Pad No.	Symbol
1	RF IN
2	5°
3	11°
4	180°
5	45°
6	90°
7	22°
8	V_{REF}
9	RF OUT
10	180°
11	11°
12	5°

Ordering Information

Part	ECCN	Description
TGP2615	EAR99	6-Bit Digital Phase Shifter ($+V_c$)

Absolute Maximum Ratings

Parameter	Value
Control and Reference Voltage	6 V
Power Dissipation	0.8 W
Input Power, CW, 50 Ω, 85°C	30 dBm
Channel Temperature	200°C
Mounting Temperature (30 Seconds)	320°C
Storage Temperature	−55 to 150°C

Operation of this device outside the parameter ranges given above may cause permanent damage. These are stress ratings only, and functional operation of the device at these conditions is not implied.

Recommended Operating Conditions

Parameter	Value
Control Voltage (5°, 11°, 22°, 45°, 90°, 180°)	0/+3.3 V
Reference Voltage (V_{REF})	+3.3 V

Electrical specifications are measured at specified test conditions. Specifications are not guaranteed over all recommended operating conditions.

Electrical Specifications

Test conditions unless otherwise noted: 25°C. Control Voltage (REF, 5°, 11°, 22°, 45°, 90°, 180°) = 0/+3.3 V; See Bias Truth Table.

Parameter	Conditions	Min	Typ	Max	Units
Operational Frequency Range		15		19	GHz
Insertion Loss	Average across all phase states		6 - 8		dB
Input Return Loss	Average across all phase states		>10		dB
Output Return Loss	Average across all phase states		>9		dB
RMS Phase Error			4		deg
RMS Amplitude Error			1		dB
Input P1dB			>24		dBm
Input IP3	Tone spacing = 10 MHz Pin/Tone = 15 dBm		>34		dBm
Insertion Loss Temperature Coefficient	Average all phase states, 19 GHz		0.002		dB/°C
Control Current			+/- 20		uA

Bias Truth Table

Logic “0” = 0 V, Logic “1” = V_{REF} = +3.3 V

Phase Shifter	5°	11°	22°	45°	90°	180°	REF
0° (Reference)	0	0	0	0	0	0	1
5°	1	0	0	0	0	0	1
11°	0	1	0	0	0	0	1
22°	0	0	1	0	0	0	1
45°	0	0	0	1	0	0	1
90°	0	0	0	0	1	0	1
180°	0	0	0	0	0	1	1
355°	1	1	1	1	1	1	1

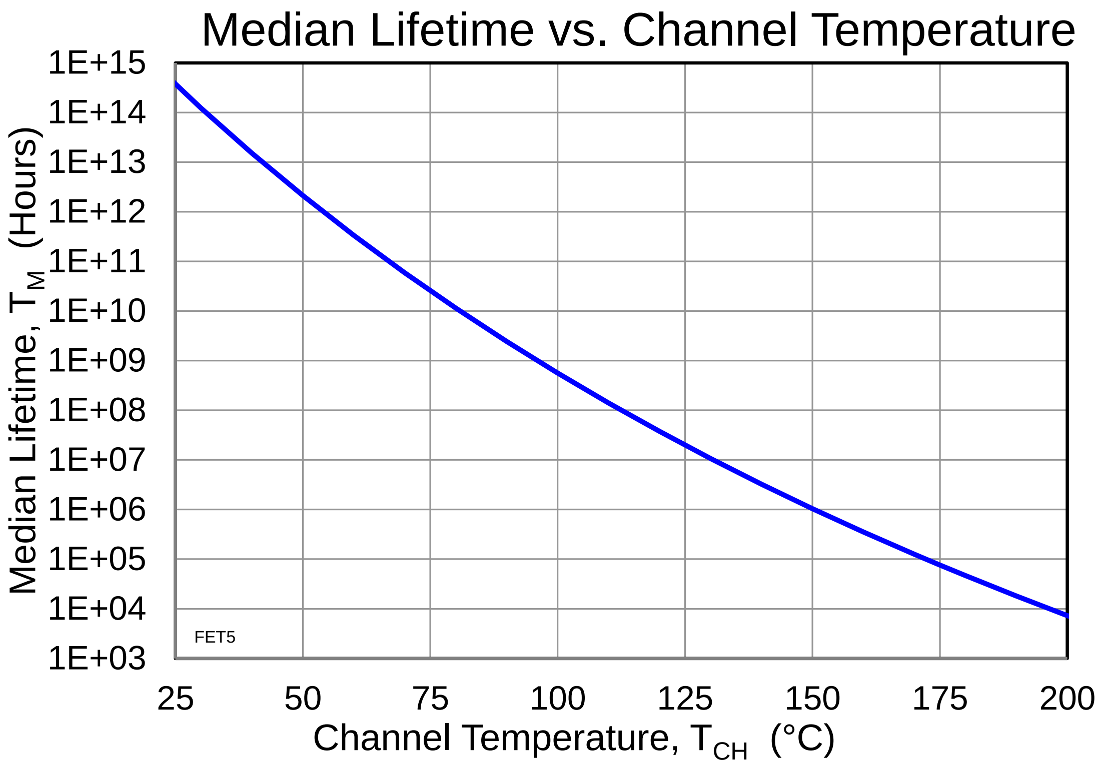
Thermal and Reliability Information

Parameter	Test Conditions	Value	Units
Channel Temperature (T_{CH})	$T_{BASEPLATE}$ = 85°C	85	°C
Median Lifetime (T_M)		5.2E+9	Hrs

Notes:

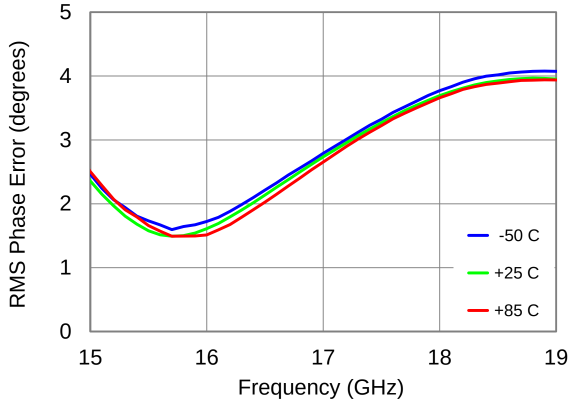
1. Under normal (lifetime) operating conditions, self-heating is not a significant contributor to channel temperature.

Median Lifetime

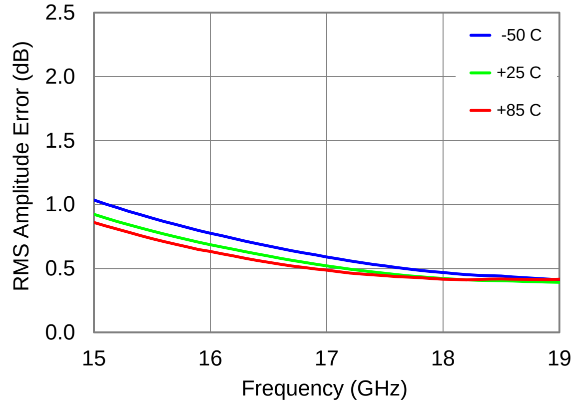


Typical Performance

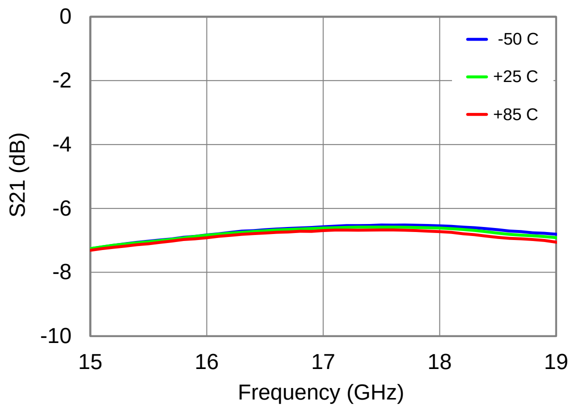
RMS Phase Error vs Frequency
All Phase States, V_{REF} = 3.3 V



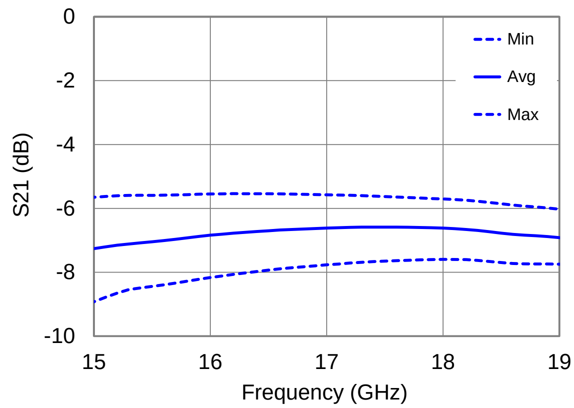
RMS Amplitude Error vs Frequency
All Phase States, V_{REF} = 3.3 V



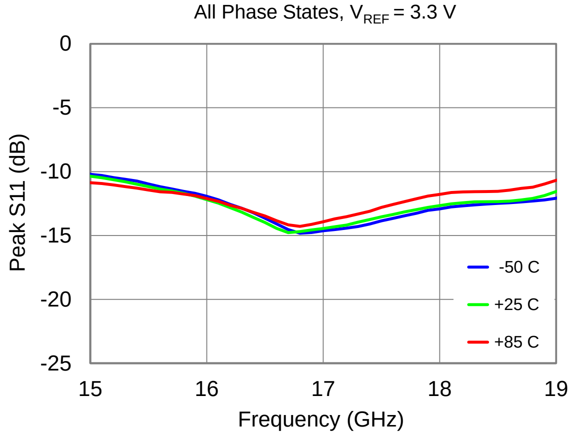
Average Insertion Loss vs Temperature
All Phase States, V_{REF} = 3.3 V



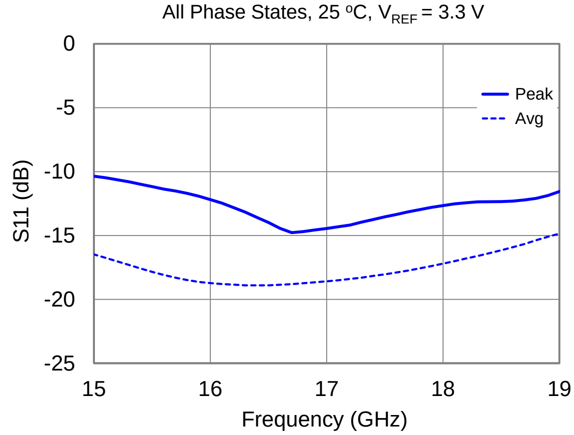
Peak Insertion Loss vs Frequency
All Phase States, 25 ºC, V_{REF} = 3.3 V



Input Return Loss vs Temperature
All Phase States, V_{REF} = 3.3 V

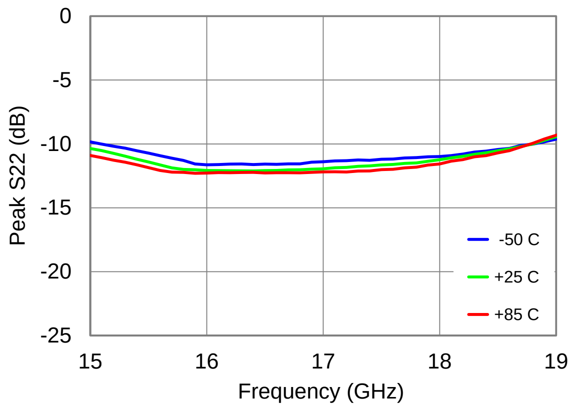


Input Return Loss vs Frequency
All Phase States, 25 ºC, V_{REF} = 3.3 V

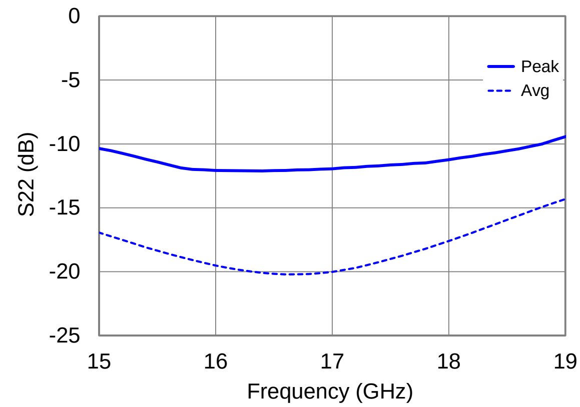


Typical Performance

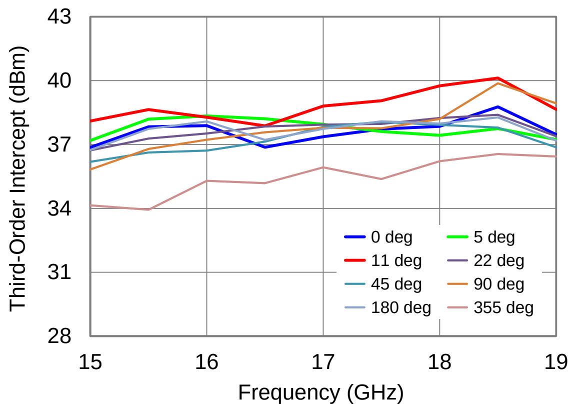
Output Return Loss vs Temperature
All Phase States, V_{REF} = 3.3 V



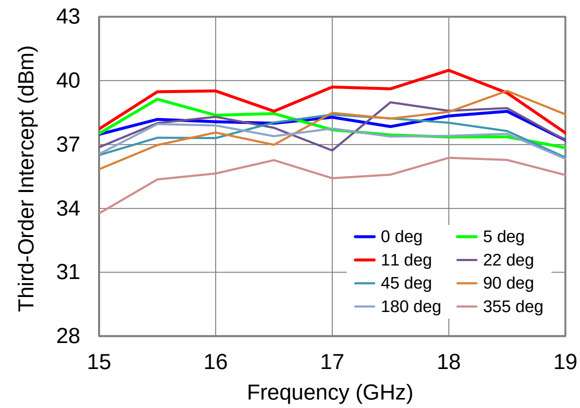
Output Return Loss vs Frequency
All Phase States, 25 ºC, V_{REF} = 3.3 V



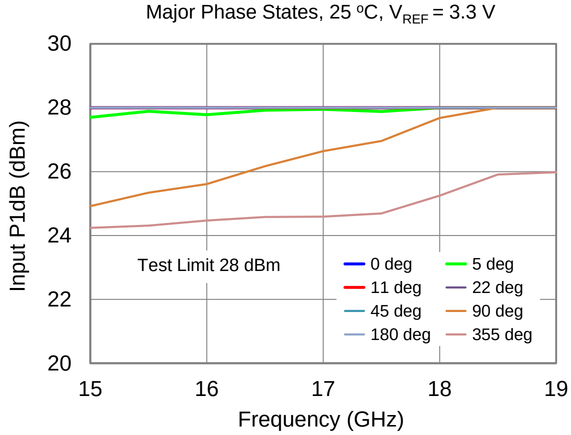
Input TOI vs Frequency
Major Phase States, 25 ºC, V_{REF} = 3.3 V



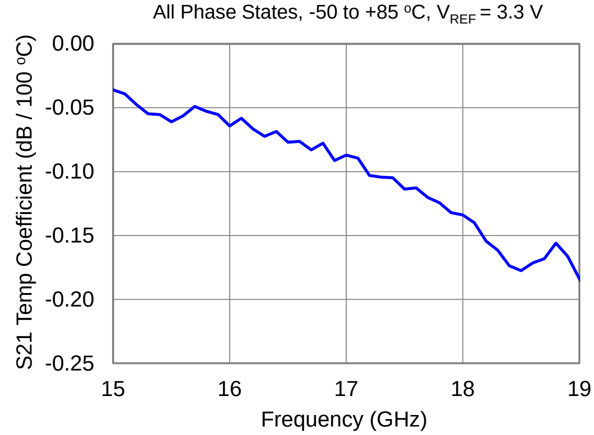
Input TOI vs Frequency
Major Phase States, 85 ºC, V_{REF} = 3.3 V



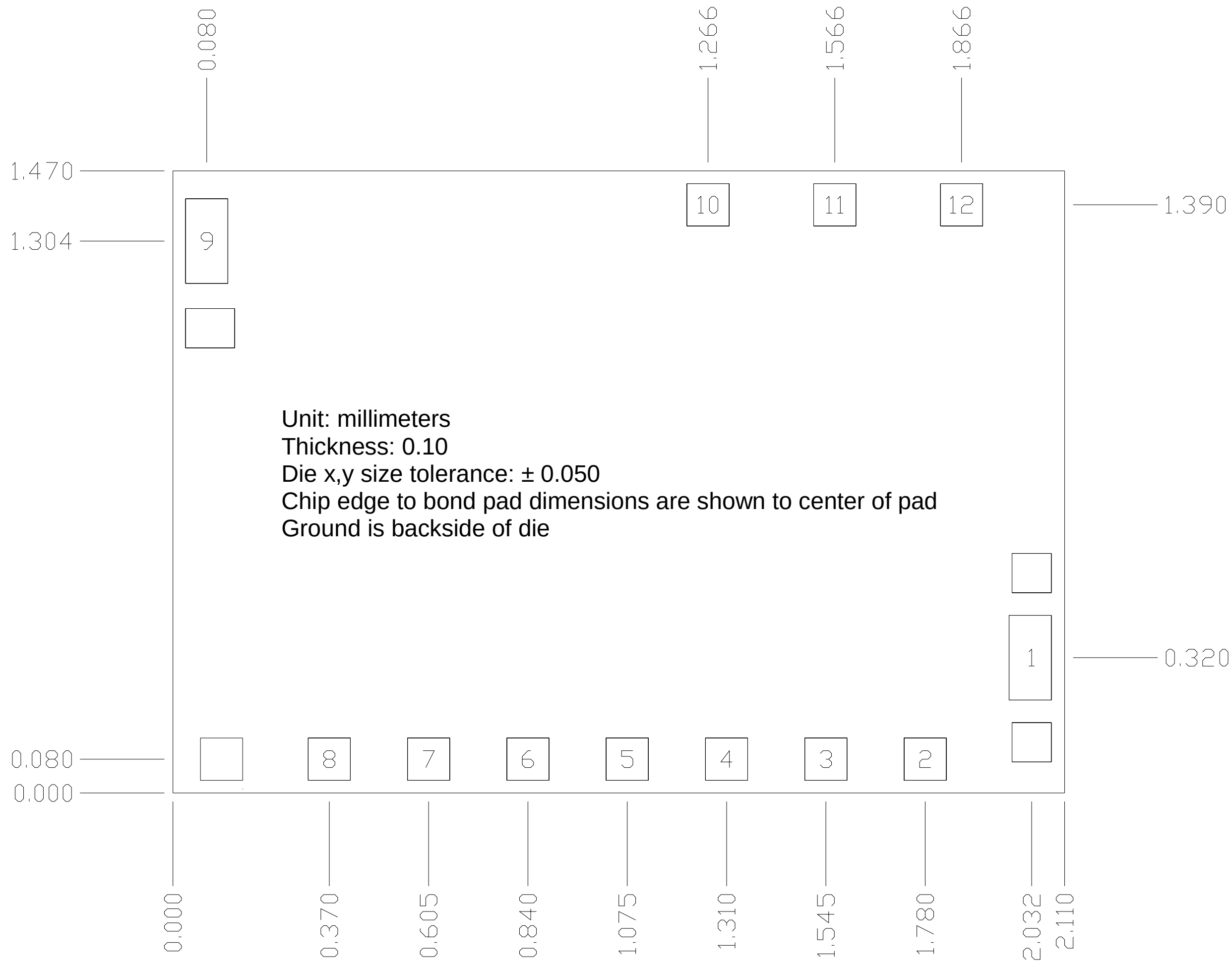
Input P1dB vs Frequency
Major Phase States, 25 ºC, V_{REF} = 3.3 V



Loss Temperature Coefficient vs Frequency
All Phase States, -50 to +85 ºC, V_{REF} = 3.3 V

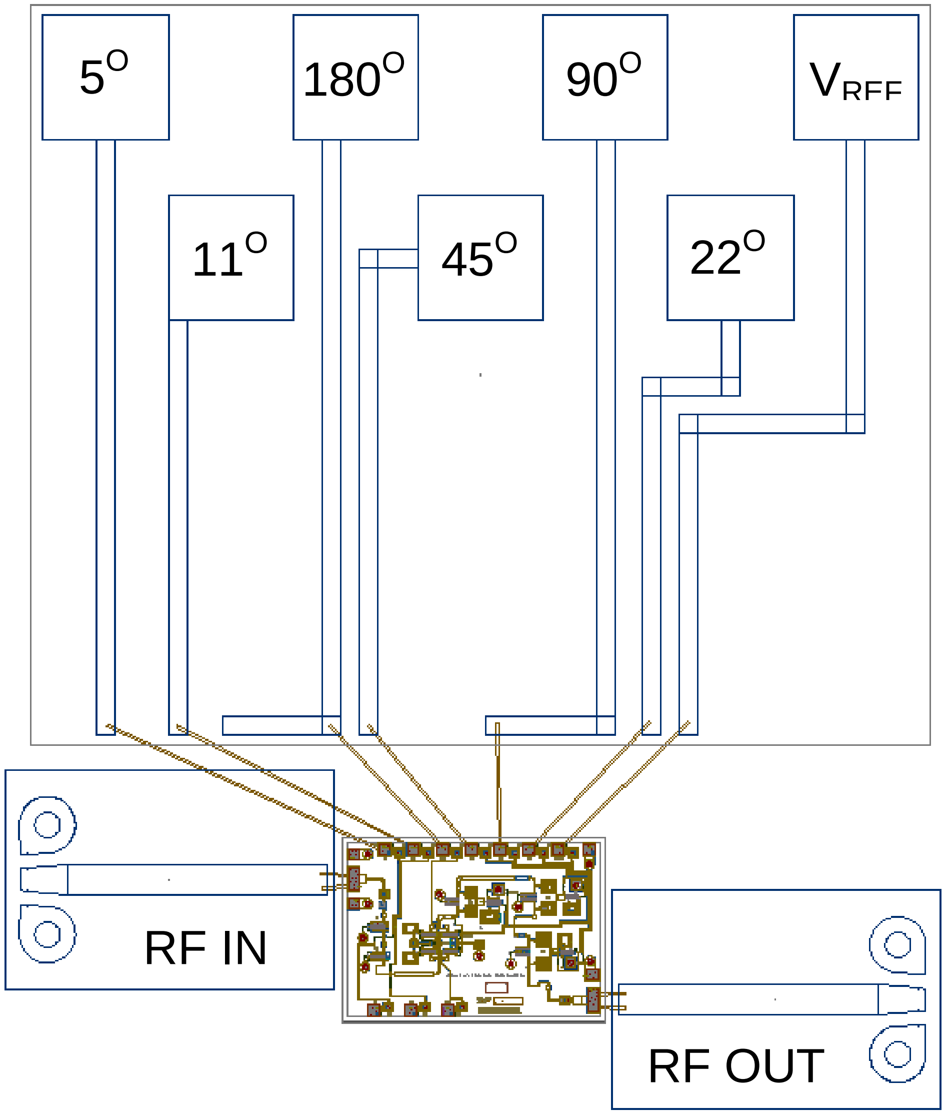


Mechanical Information and Bond Pad Description



Bond Pad	Symbol	Description	Pad Size
1	RF IN	RF Input; 50 Ω; DC-Blocked	0.100 x 0.200
2	5°	5° Bit Control	0.100 x 0.100
3	11°	11° Bit Control	0.100 x 0.100
4	180°	180° Bit Control	0.100 x 0.100
5	45°	45° Bit Control	0.100 x 0.100
6	90°	90° Bit Control	0.100 x 0.100
7	22°	22° Bit Control	0.100 x 0.100
8	V_{REF}	Reference voltage for logic “1”	0.100 x 0.100
9	RF OUT	RF Output; 50 Ω; DC-Blocked	0.100 x 0.200
10	180°	180° Bit Alternate Control	0.100 x 0.100
11	11°	11° Bit Alternate Control	0.100 x 0.100
12	5°	5° Bit Alternate Control	0.100 x 0.100

Assembly Drawing



- The spacing between MMIC and TFN (at RF In or RF Out) is < 5 mils typical.
- RF connections: Bond two 1 mil diameter, < 20 mils length, gold bond wires at RF In and RF Out for optimum RF performance.
- For fixtured testing, device was rotated 180 degrees from orientation in the page-1 chip photograph.

Assembly Notes

Component placement and adhesive attachment assembly notes:

- Vacuum pencils and/or vacuum collets are the preferred method of pick up.
- Contact with air bridges must be avoided during placement.
- The force impact is critical during auto placement.
- Solder or Organic Adhesive attachment may be used for this part.
- Devices must be stored in a dry nitrogen atmosphere.

Solder attachment reflow process assembly notes:

- Use AuSn (80/20) solder and limit exposure to temperatures above 300°C to 3 to 4 minutes, maximum.
- An alloy station or conveyor furnace with reducing atmosphere should be used.
- Do not use any kind of flux.
- Coefficient of thermal expansion matching is critical for long-term reliability.

Organic adhesive attachment assembly notes:

- The organics such as epoxy or polyimide can be used.
- Epoxies cure at temperatures of 100 to 200°C.
- Curing should be done in a convection oven; proper exhaust is a safety concern.

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.
- Devices with small pad sizes should be bonded with 0.0007-inch wire.

Product Compliance Information

ESD Sensitivity Ratings

Caution! ESD-Sensitive Device

ESD Rating: TBD
Value: TBD
Test: Human Body Model (HBM)
Standard: JEDEC Standard JESD22-A114

Solderability

This part is compliant with EU 2002/95/EC RoHS directive (Restrictions on the Use of Certain Hazardous Substances in Electrical and Electronic Equipment).

This product also has the following attributes:

- Lead Free
- Halogen Free (Chlorine, Bromine)
- Antimony Free
- TBBP-A ($C_{15}H_{12}Br_40_2$) Free
- PFOS Free
- SVHC Free

ECCN

US Department of Commerce: EAR99

Contact Information

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