QPC1000

29 – 31GHz Phase Shifter with Integrated SPDT

Product Description

Qorvo's QPC1000 integrates a 5-bit digital phase shifter and a SPDT switch inside a small 6x5mm surface mount package. Individually, the Qorvo products include the TGP2100 phase shifter and the TGS4302 SPDT switch. Together, they support 360° of phase coverage over 29-31GHz, with a RMS phase error of 5° and 9dB of insertion loss.

With a small footprint, good phase resolution and ability to switch between transmit and receive paths, the QPC1000 gives the system designer a small, highly functional block that is easily integrated into a higher level assembly.

The QPC1000 is matched to 50Ω with DC blocking capacitors on all RF ports. Its functionality makes it an ideal choice for ka-band, phased-array communication systems.

Lead-free and RoHS compliant.

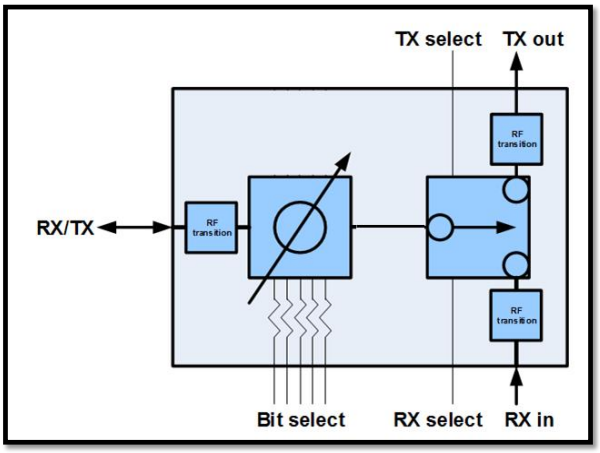
Evaluation boards are available upon request.

Product Features

- Frequency Range: 29 – 31 GHz
- 5-Bit Digital Phase Shifter and SPDT Switch
- 360° Coverage, LSB = 11.25°, MSB = 180°
- RMS Phase Error, cardinal states: 5°
- RMS Amplitude Error, cardinal states: 0.7 dB
- Insertion Loss: 9 dB
- Isolation: 30 dB
- Input Return Loss: 10 dB
- Output Return Loss: 15 dB
- Input Power handling: 20 dBm
- Voltages: V_S = 5 V, V_{BIT} = 0/+5 V, V_{CTRL} = ± 5 V
- Package Dimensions: 6 x 5 x 1.72 mm

Performance is typical across frequency. Please reference electrical specification table and data plots for more details.

Block Diagram



Applications

- Ka-band Satellite Communications

Ordering Information

Part No.	ECCN	Description
QPC1000	EAR99	29 – 31 GHz Phase Array

Electrical Specifications

Test conditions unless otherwise noted: 25 °C, V_S = 5 V, V_{BIT} = 0/+5 V, V_{CTRL} = ± 5 V

Parameter		Min	Typ	Max	Units
Operational Frequency Range		29	–	31	GHz
RMS Phase Error	Cardinal states		5		degree
	All phase states		10		
RMS Amplitude Error	Cardinal states		0.6		dB
	All phase states		1.1		
Insertion Loss, S21			9		dB
Isolation, S31			30		dB
Input Return Loss – Common Port RL, S11			10		dB
Output Return Loss – Switched Port RL, S22			15		dB
Output Return Loss – Isolated Port RL, S33			3		dB
Input Power Handling, P_{IN}			20		dBm
MTBF (T_{CH} ≤ 150 ^{0}C, P_{IN} ≤ 20 dBm)		20,000			hours

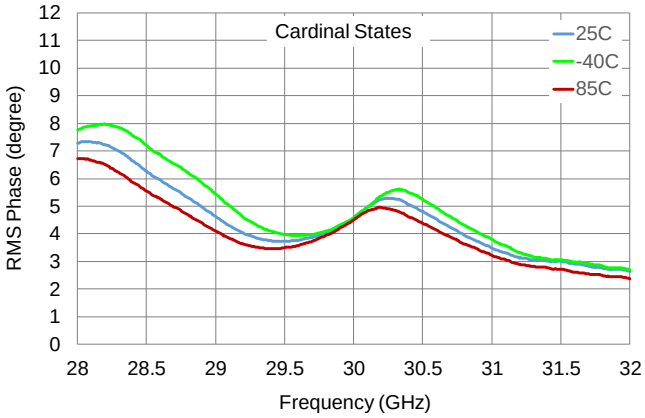
Recommended Operating Conditions

Parameter	Value / Range
Supply Voltage (V_S)	+5 V
Phase Bit Voltage (V_{BIT})	0/+5 V
Switch Control Voltage (V_{CTRL})	± 5 V
Supply Current (I_S)	100 uA typical
Phase Bit Current (I_S, I_{BIT})	± 100 uA typical
Switch Control Current (I_{CTRL})	-20 mA / +100 uA typical
Temperature (T_{BASE})	−40 °C to 85 °C

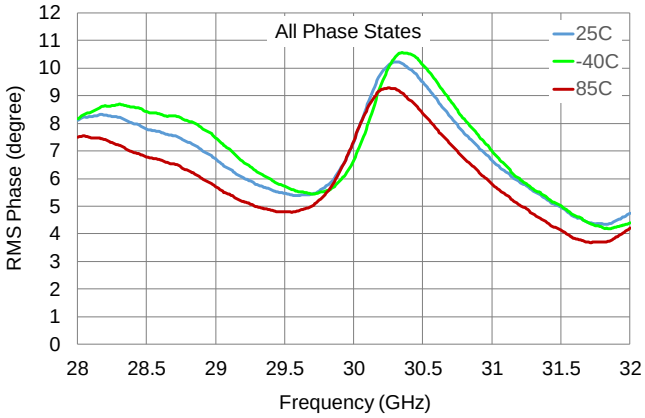
Electrical specifications are measured at specified test conditions.
Specifications are not guaranteed over all recommended operating conditions.

Performance Plots – Small Signal

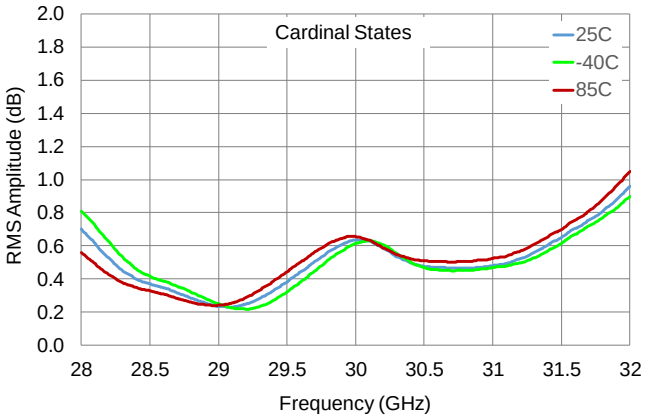
RMS Phase Error vs. Frequency vs. Temp.
Vs = 5 V



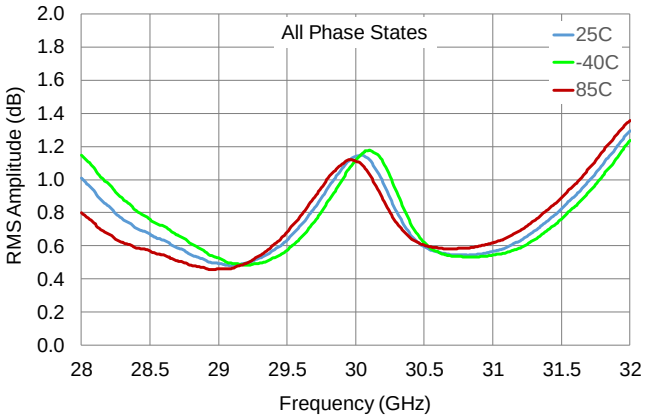
RMS Phase Error vs. Frequency vs. Temp.
Vs = 5 V



RMS Amplitude Error vs. Frequency vs. Temp.
Vs = 5 V

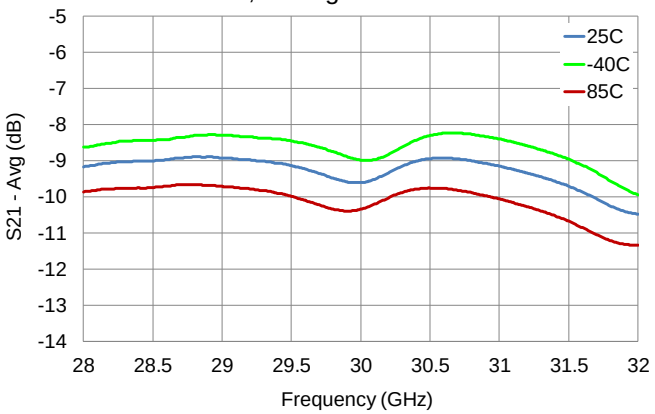


RMS Amplitude Error vs. Frequency vs. Temp.
Vs = 5 V

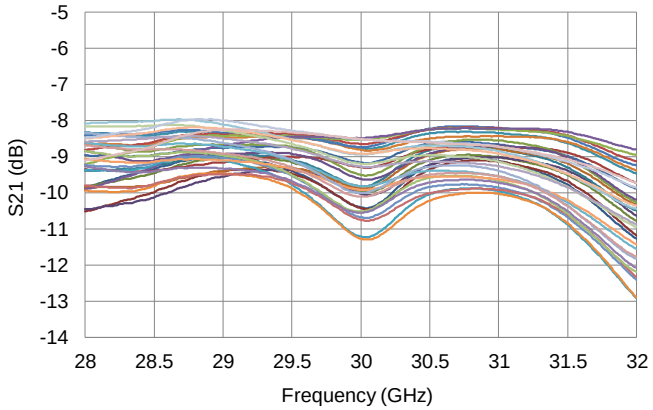


Performance Plots – Small Signal

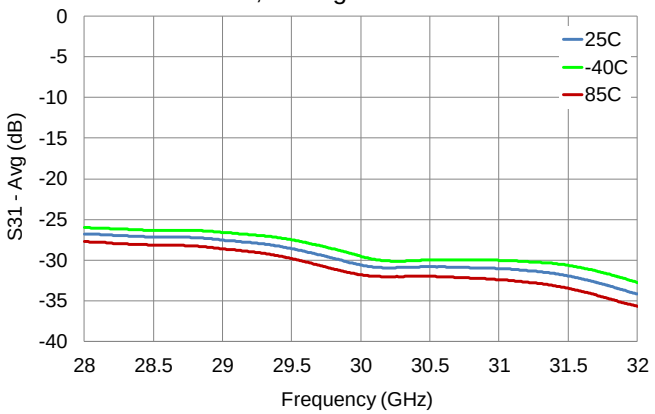
Insertion Loss vs. Frequency vs. Temp.
Vs = 5 V, Average All Phase States



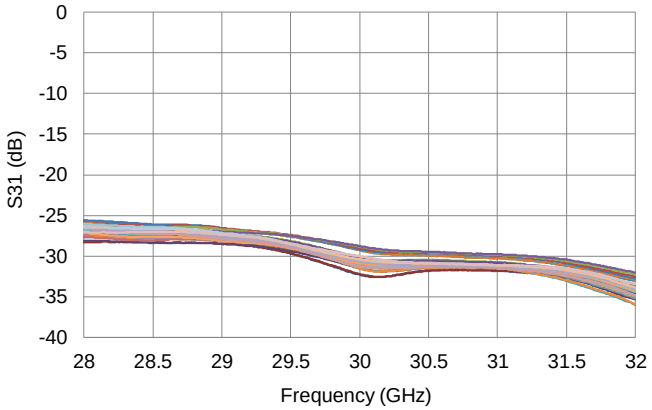
Insertion Loss vs. Frequency
Vs = 5 V, 25 ^{0}C, All Phase States



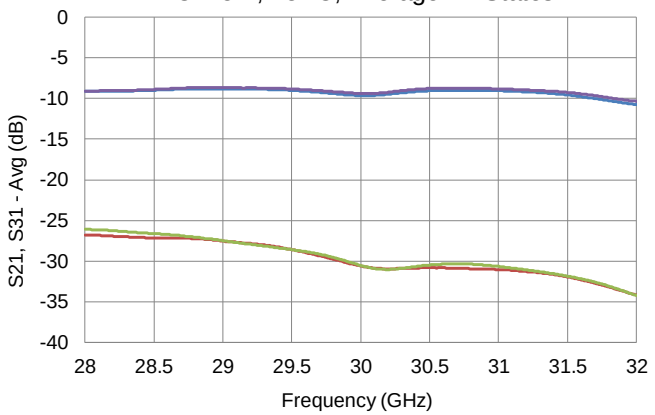
Isolation vs. Frequency vs. Temp.
Vs = 5 V, Average All Phase States



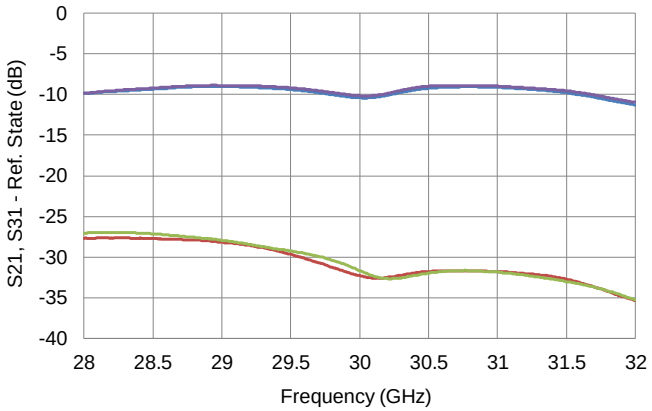
Isolation vs. Frequency
Vs = 5 V, 25 ^{0}C, All Phase States



IL and Isolation vs. Frequency vs. RF Out Path
Vs = 5 V, 25 ^{0}C, Average All States

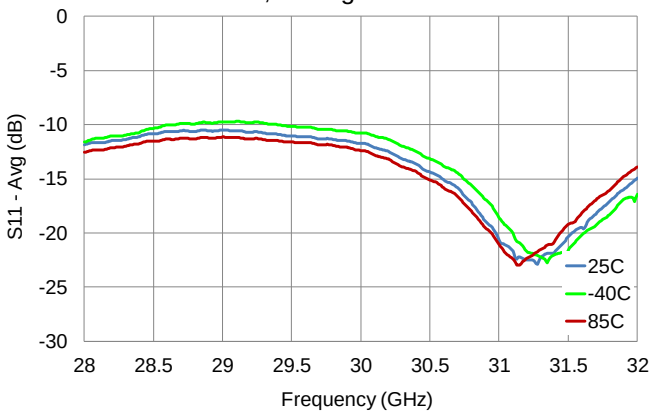


IL and Isolation vs. Frequency vs. RF Out Path
Vs = 5 V, 25 ^{0}C

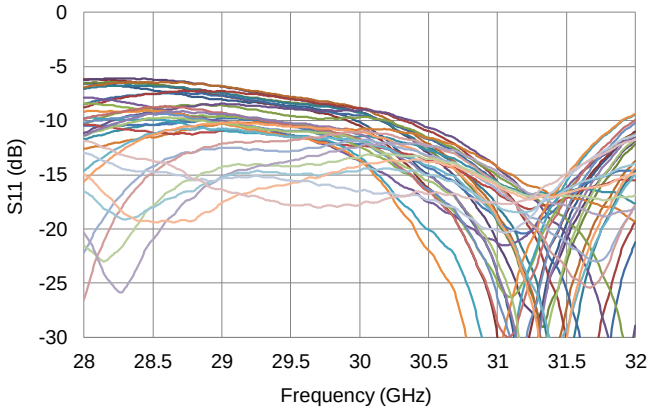


Performance Plots – Small Signal

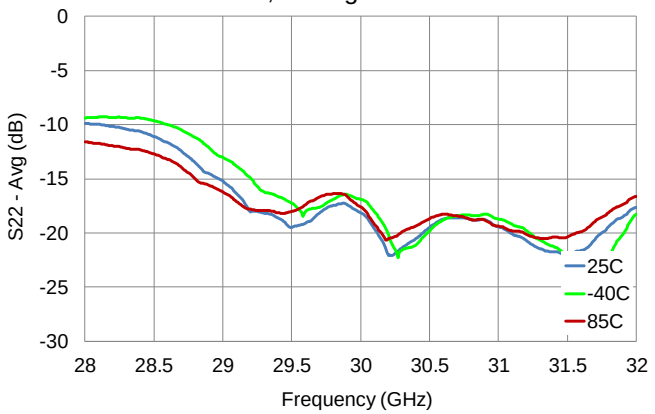
Input Return Loss vs. Frequency vs. Temp.
Vs = 5 V, Average All Phase States



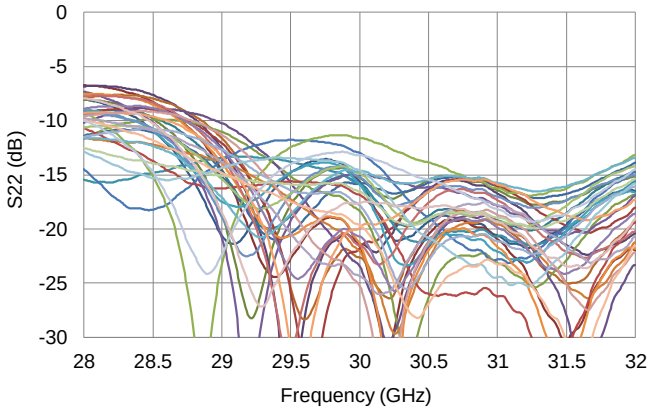
Input Return Loss vs. Frequency
Vs = 5 V, 25 ^{0}C, All Phase States



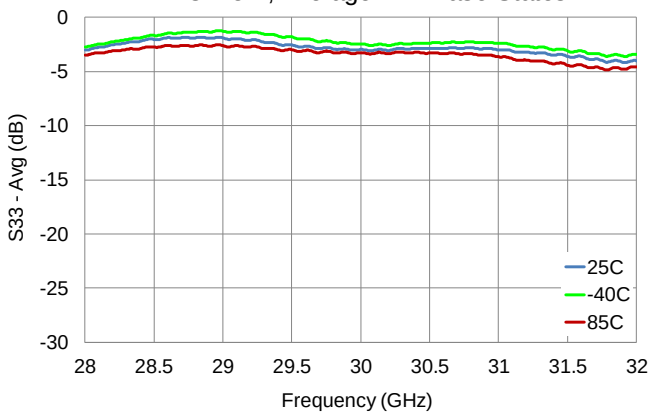
Output Return Loss vs. Frequency vs. Temp.
Vs = 5 V, Average All Phase States



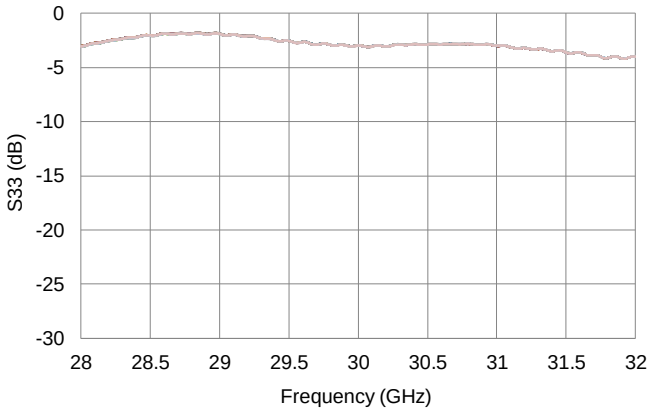
Output Return Loss vs. Frequency
Vs = 5 V, 25 ^{0}C, All Phase States



Output Return Loss vs. Frequency vs. Temp.
Vs = 5 V, Average All Phase States

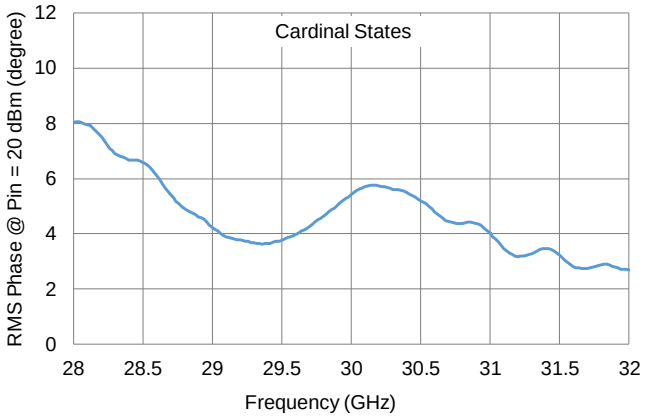


Output Return Loss vs. Frequency
Vs = 5 V, 25 ^{0}C, All Phase States

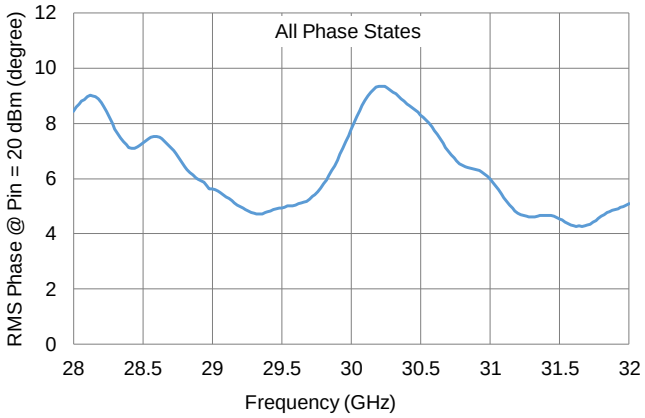


Performance Plots – Large Signal

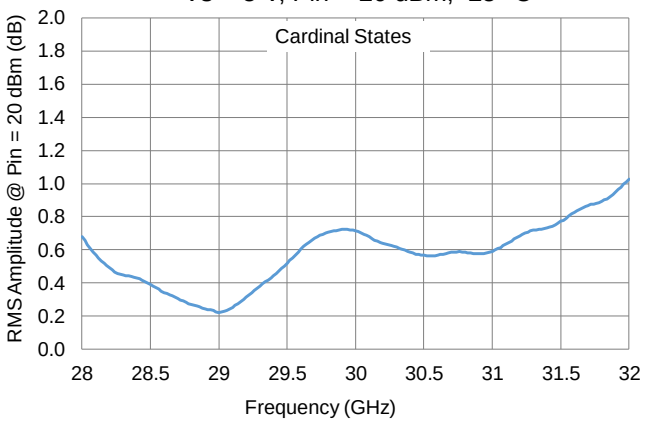
RMS Phase Error vs. Frequency
Vs = 5 V, Pin = 20 dBm, 25 ^{0}C



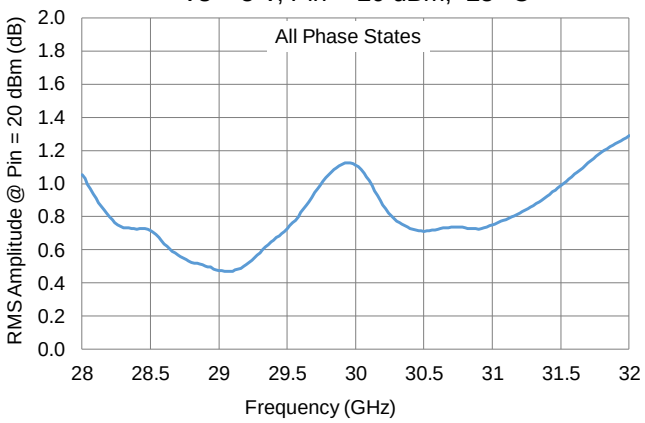
RMS Phase Error vs. Frequency
Vs = 5 V, Pin = 20 dBm, 25 ^{0}C



RMS Amplitude Error vs. Frequency
Vs = 5 V, Pin = 20 dBm, 25 ^{0}C

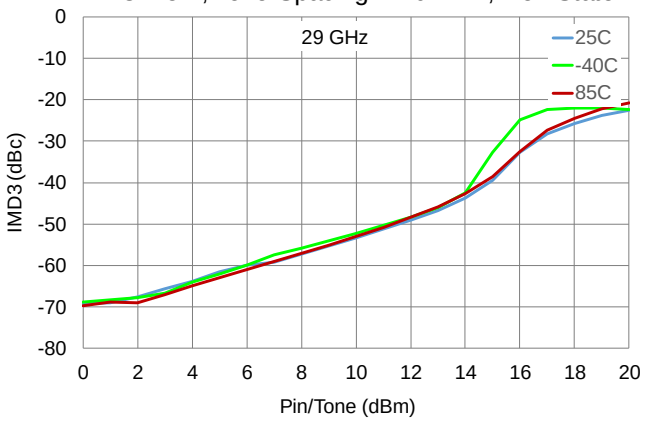


RMS Amplitude Error vs. Frequency
Vs = 5 V, Pin = 20 dBm, 25 ^{0}C

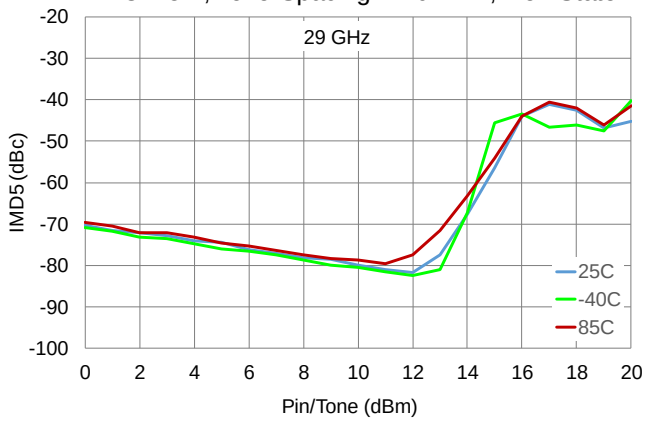


Performance Plots – Linearity

IMD3 vs. Pin/Tone vs. Temp.
Vs = 5 V, Tone Spacing = 10 MHz, Ref. State

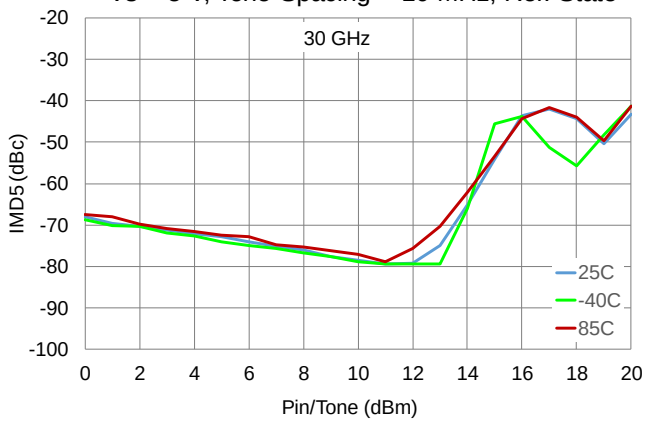


IMD5 vs. Pin/Tone vs. Temp.
Vs = 5 V, Tone Spacing = 10 MHz, Ref. State

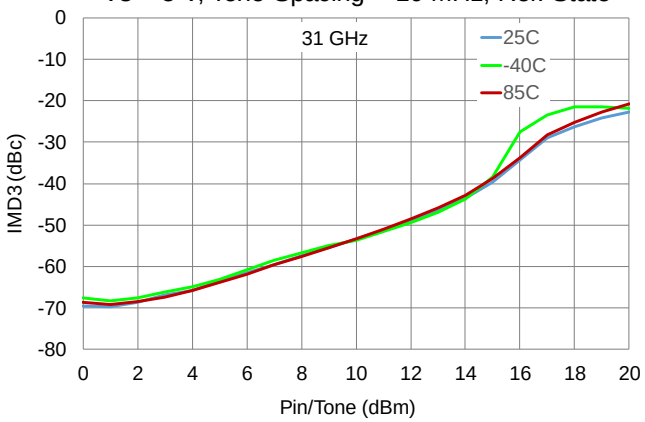


IMD3 vs. Pin/Tone vs. Temp.
Vs = 5 V, Tone Spacing = 10 MHz, Ref. State

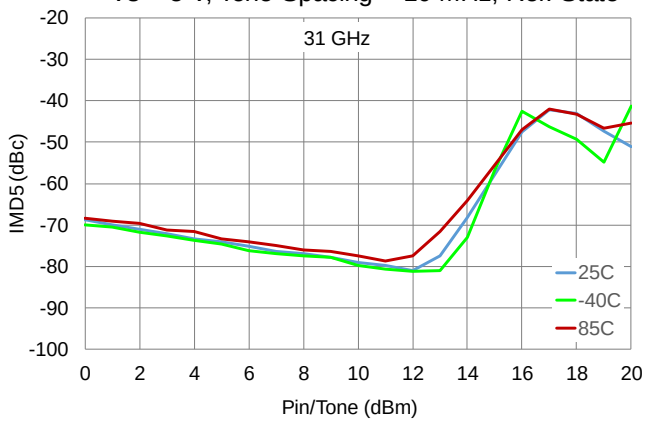
IMD5 vs. Pin/Tone vs. Temp.
Vs = 5 V, Tone Spacing = 10 MHz, Ref. State



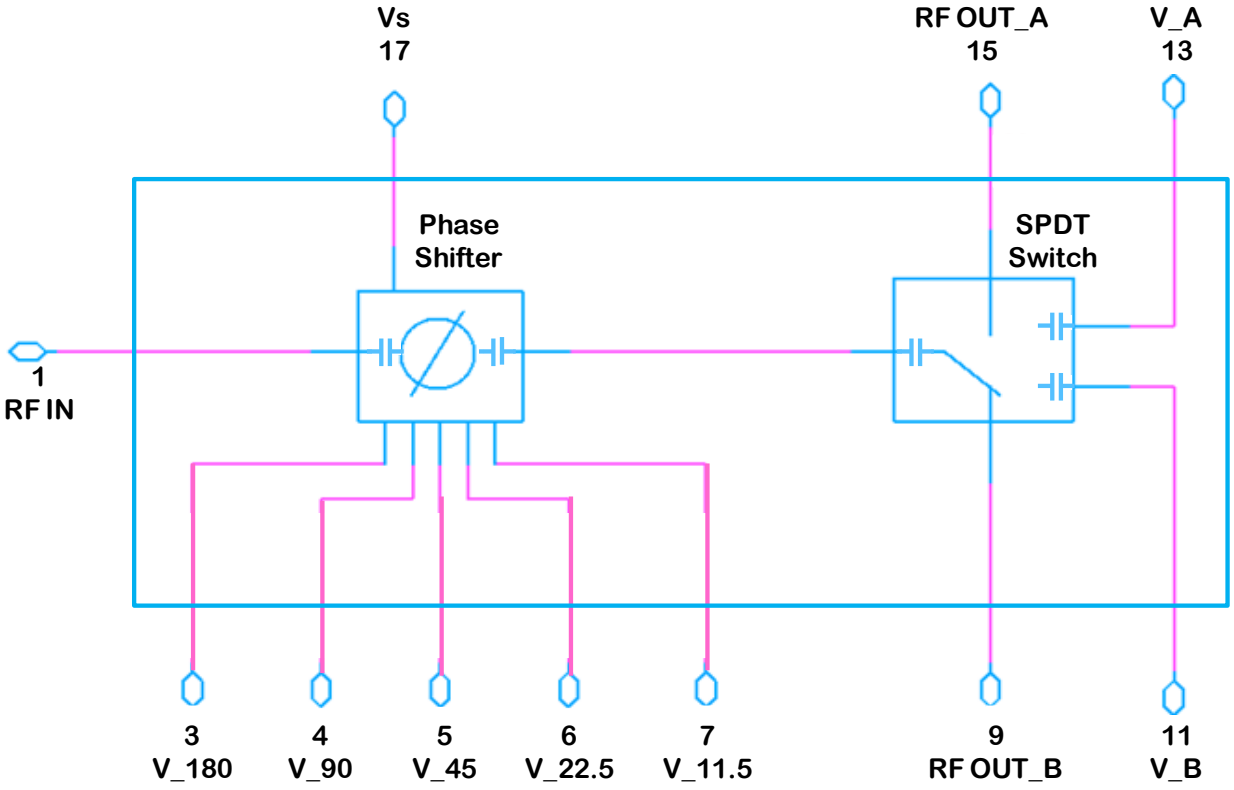
IMD3 vs. Pin/Tone vs. Temp.
Vs = 5 V, Tone Spacing = 10 MHz, Ref. State



IMD5 vs. Pin/Tone vs. Temp.
Vs = 5 V, Tone Spacing = 10 MHz, Ref. State



Applications Circuit



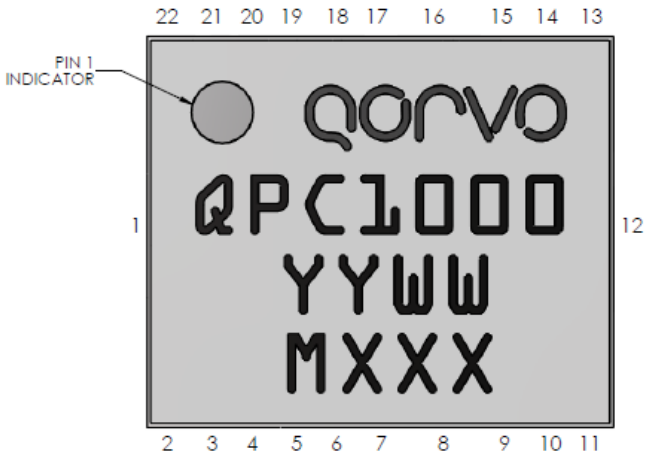
Bias Truth Table

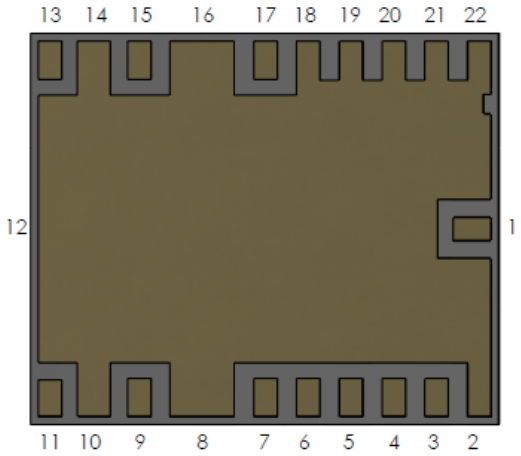
Logic “0” = 0 V, Logic “1” = +5 V, V_{CTRL} = ± 5 V

Phase Shifter / V_{BIT}	V_11.5	V_22.5	V_45	V_90	V_180	Vs	V_A	V_B
0° (Reference)	0	0	0	0	0	1	See V_{CTRL}	
11.5°	1	0	0	0	0	1		
22.5°	0	1	0	0	0	1		
45°	0	0	1	0	0	1		
90°	0	0	0	1	0	1		
180°	0	0	0	0	1	1		

RF Out Port / V_{CTRL}	V_A	V_B
RF OUT_A	+5V	-5V
RF OUT_B	-5V	+5V

Pin Description

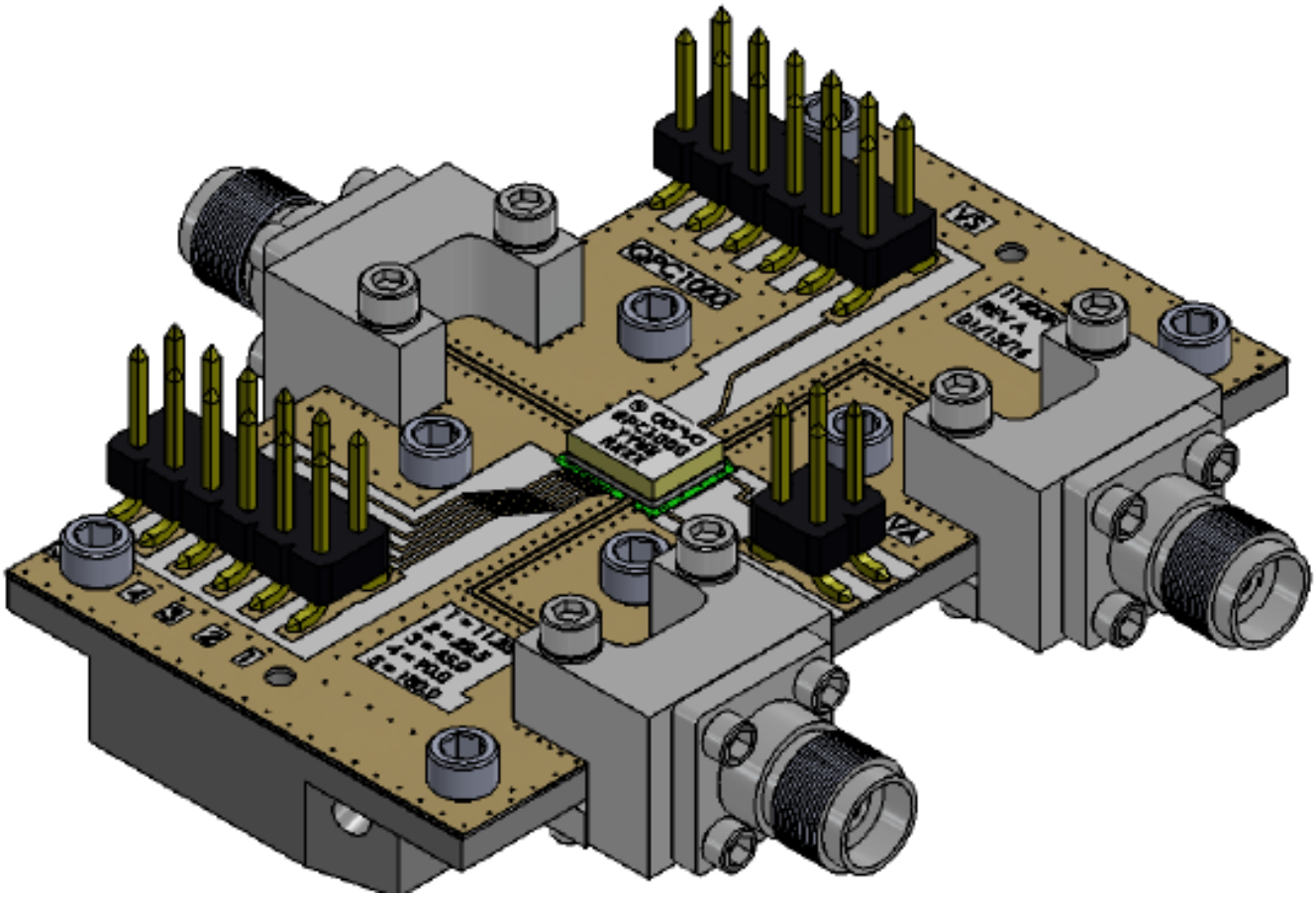




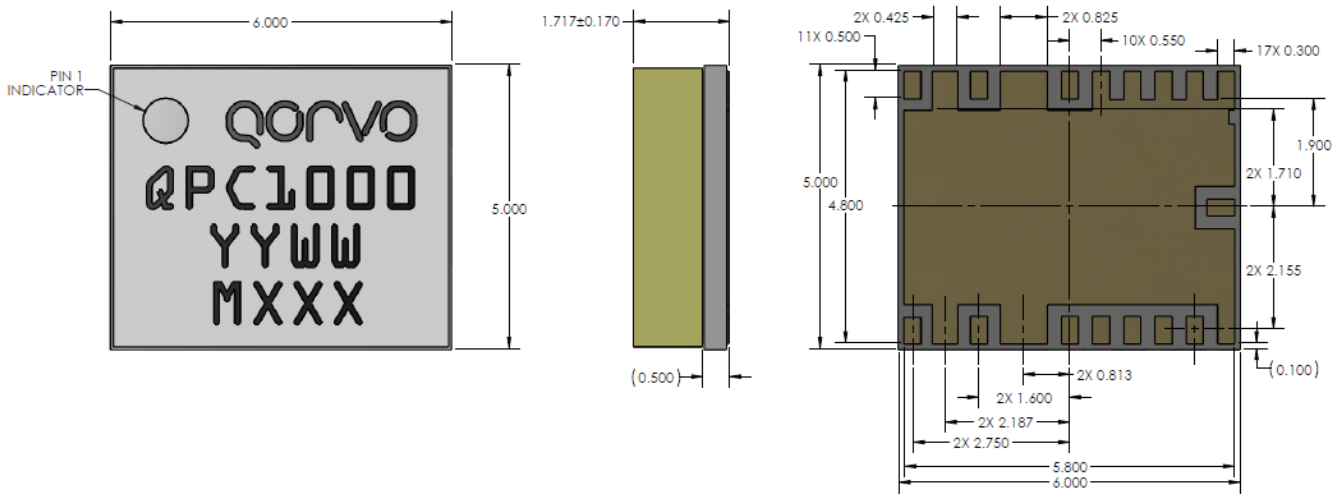
Pin Description

Pin No.	Symbol	Description
1	RF IN	RF Input, 50 Ω, DC blocked
2, 8, 10, 12, 14, 16, 18 - 22	GND	Internal grounding and shielding, must be grounded on PCB
3	V_180	180° Phase Bit Voltage
4	V_90	90° Phase Bit Voltage
5	V_45	45° Phase Bit Voltage
6	V_22.5	22.5° Phase Bit Voltage
7	V_11.5	11.5° Bit Voltage
9	RF OUT_B	RF Output_B, 50 Ω, DC blocked
11	V_B	Switch Control Voltage
13	V_A	Switch Control Voltage
15	RF OUT_A	RF Output_A, 50 Ω, DC blocked
17	V_S	Supply Voltage
23	GND	Backside Paddle; multiple vias should be used on PCB to minimize inductance and thermal resistance

Evaluation Board (EVB) Layout Assembly



Mechanical Information



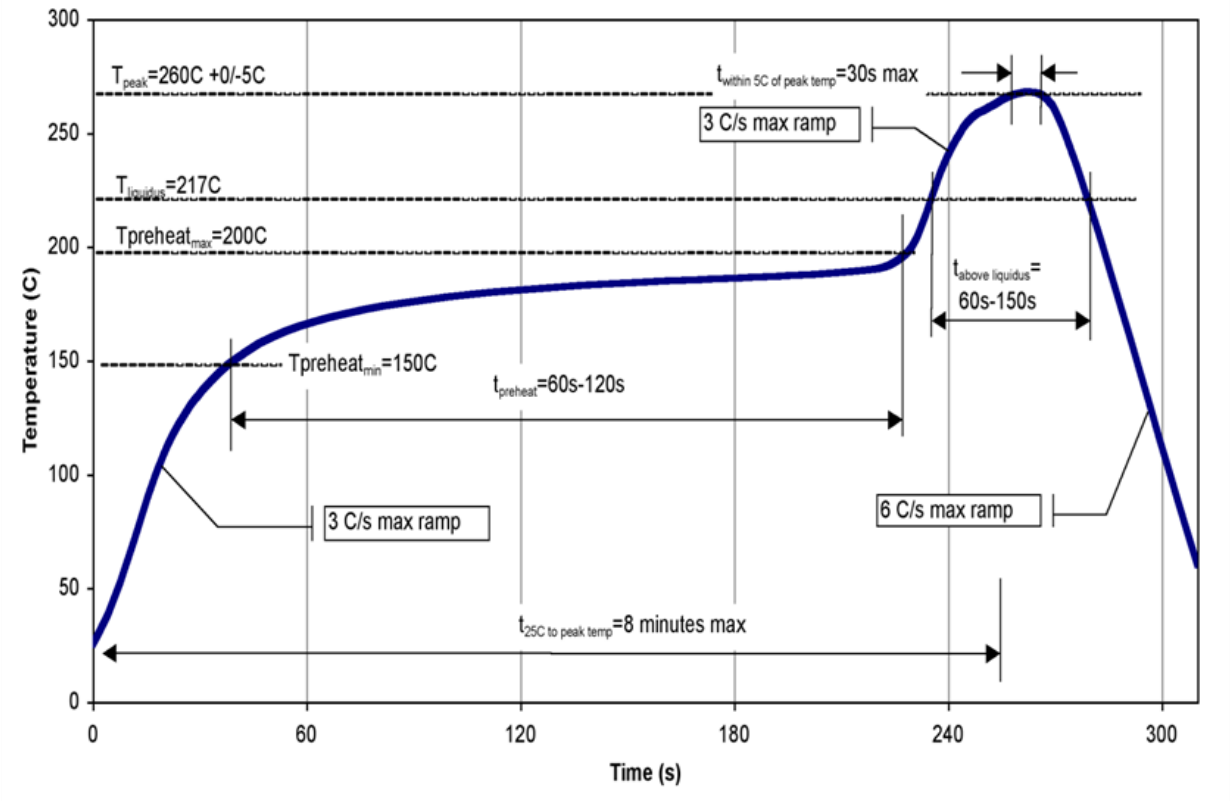
Units: Millimeter (mm)
Tolerances: unless specified
x.xx = ± 0.25
x.xxx = ± 0.100
Materials:
Base: EHS Laminate
Lid: Laminate
All metalized features are gold plated
Part is epoxy sealed
Marking:
QPC1000: Part number
YY: Part Assembly year
WW: Part Assembly week
MXXX: Lot Number

Absolute Maximum Ratings

Parameter	Value / Range
Supply Voltage (V_S)	+8 V
Phase Bit Voltage (V_{BIT})	0 / +8 V
Switch Control Voltage (V_{CTRL})	± 5 V
Phase Bit Current (I_S, I_{BIT})	5 mA
Switch Control Current (I_{CTRL})	30 mA
Input Power, CW, 50 Ω, 85°C (P_{IN})	20 dBm
Channel Temperature (T_{CH})	200 °C
Mounting Temperature (30 Seconds)	260 °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 Soldering Temperature Profile



Handling Precautions

Parameter	Rating	Standard
ESD – Human Body Model (HBM)	TBD	ESDA / JEDEC JS-001-2012
MSL – Moisture Sensitivity Level	TBD	IPC/JEDEC J-STD-020

Caution!
ESD-Sensitive Device

Solderability

Compatible with both lead-free (260°C max. reflow temp.) and tin/lead (245°C max. reflow temp.) soldering processes.
Solder profiles available upon request.

RoHS Compliance

This product is compliant with the 2011/65/EU RoHS directive (Restrictions on the Use of Certain Hazardous Substances in Electrical and Electronic Equipment), as amended by Directive 2015/863/EU. This product also has the following attributes:

- Lead Free
- Antimony Free
- TBBP-A ($C_{15}H_{12}Br_4O_2$) Free
- PFOS Free
- SVHC Free
- Qorvo Green

Contact Information

For the latest specifications, additional product information, worldwide sales and distribution locations:

Tel: **1-844-890-8163**

Web: www.qorvo.com

Email: customer.support@qorvo.com

For technical questions and application information: **Email:** appsupport@qorvo.com

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Океан Электроники
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- Поставка сложных, дефицитных, либо снятых с производства позиций;
- Оперативные сроки поставки под заказ (от 5 рабочих дней);
- Экспресс доставка в любую точку России;
- Помощь Конструкторского Отдела и консультации квалифицированных инженеров;
- Техническая поддержка проекта, помощь в подборе аналогов, поставка прототипов;
- Поставка электронных компонентов под контролем ВП;
- Система менеджмента качества сертифицирована по Международному стандарту ISO 9001;
- При необходимости вся продукция военного и аэрокосмического назначения проходит испытания и сертификацию в лаборатории (по согласованию с заказчиком);
- Поставка специализированных компонентов военного и аэрокосмического уровня качества (Xilinx, Altera, Analog Devices, Intersil, Interpoint, Microsemi, Actel, Aeroflex, Peregrine, VPT, Syfer, Eurofarad, Texas Instruments, MS Kennedy, Miteq, Cobham, E2V, MA-COM, Hittite, Mini-Circuits, General Dynamics и др.);

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AVIC JONHON

«JONHON» (основан в 1970 г.)

Разъемы специального, военного и аэрокосмического назначения:

(Применяются в военной, авиационной, аэрокосмической, морской, железнодорожной, горно- и нефтедобывающей отраслях промышленности)

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