

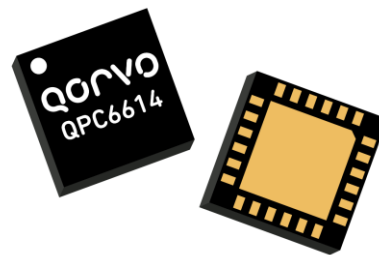


QPC6614

5 MHz to 6000 MHz Digital Step Attenuator

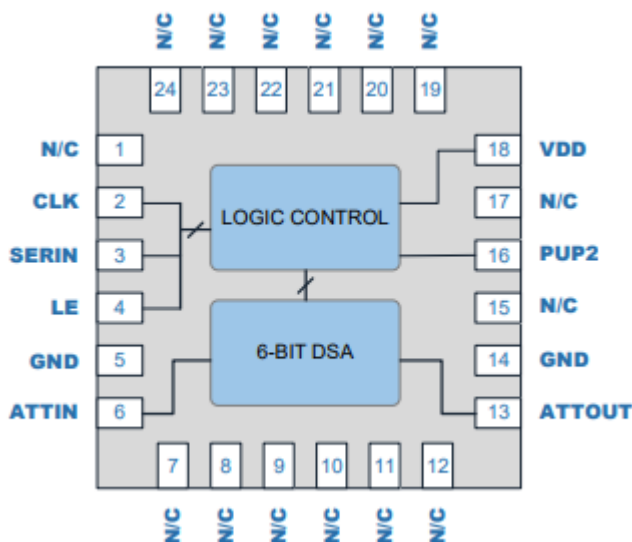
Product Description

The QPC6614 is a 6-bit digital step attenuator (DSA) that features high linearity over the entire 31.5 dB gain control range with 0.5 dB steps. The QPC6614 uses serial control interface. The QPC6614 has a low insertion loss of 1.4 dB at 2 GHz. Patented circuit architecture provides overshoot-free transient switching performance.



24-pin 4.2 mm x 4.2 mm x 0.975 mm

Functional Block Diagram



Top View

Key Features

- 6-Bit, 31.5 dB, 0.5dB Step
- Patented Circuit Architecture
- Overshoot-free During Attenuation State Transitions
- Frequency Range 5 MHz to 6000 MHz
- High Linearity, IIP3 +55 dBm Typical
- Serial Control Interface
- Fast Switching, 120 ns Typical
- Single Supply 3 V to 5 V Operation
- No DC Voltage on RF Pins, DC Grounding Allowed Externally
- Power-up Attenuation State Programmable

Applications

- 2G through 4G Base Stations
- Point-to-Point
- Wi-Fi
- Test Equipment

Ordering Information

Part No.	Description
QPC6614TR13	2500 pcs on 13" reel
QPC6614PCK401	5-600MHz PCBA w/5pcs sample bag

Absolute Maximum Ratings

Parameter	Rating
Storage Temperature	-40 to +150 °C
DC Supply Voltage (V_{DD})	-0.5 to +6.0 V
Signal Level (CLK, SERIN, LE and PUP2), when V_{DD} is applied	-0.5 to V_{DD}
Signal Level (CLK, SERIN, LE and PUP2), when V_{DD} is not applied	-0.5 to +4.0 V
RF Input Power (RFIN), +85°C Case Temp	+30 dBm
RF Input Power (RFOUT), +85°C Case Temp	+27 dBm

Notes:

- Exceeding any one or a combination of the Absolute Maximum Rating conditions may cause permanent damage to the device. Extended application of Absolute Maximum Rating conditions to the device may reduce device reliability.

Recommended Operating Conditions

Parameter	Min	Typ	Max	Units
DC Supply Voltage (V_{DD}) ⁽²⁾	+2.7	+5	+5.5	V
Case Temperature, T_C	-40		+105	°C
Operating Junction Temp. T_J			+125	°C

Notes:

- Electrical specifications are measured at specified test conditions. Specifications are not guaranteed over all recommended operating conditions.
- It is recommended to apply V_{DD} before applying any signal to logic pins.

Electrical Specifications

Parameter	Conditions	Min	Typ	Max	Units
Frequency Range		5		6000	MHz
Insertion Loss	0 dB Attenuation Setting		1.4	2.4	dB
Attenuation Range			31.5		dB
Attenuation Step			0.5		dB
Attenuation Accuracy		$\pm (0.3 + 3\% \text{ of Atten. Setting})$			dB
Input IP3			+55		dBm
Input P0.1dB			+30		dBm
RF Input Power to RFIN				+27	dBm
RF Input Power to RFOUT				+20	dBm
Return Loss			15		dB
Switching Time	50% LE Rising Edge to 10%/90% RF Output		120		ns
Successive Step Phase Delta	2000 MHz		2		Deg.
Supply Current, I_{DD}	Steady state operation ⁽²⁾		180		μ A
Thermal Resistance	At maximum attenuation state with RF power applied to the ATTIN		60		°C/W

Notes:

- Test conditions unless otherwise noted: V_{DD} =+5 V, Temp= +25 °C, Freq = 2GHz, 50 Ω system.
- Current draw during attenuation state transitions is higher.

Control Logic Specifications

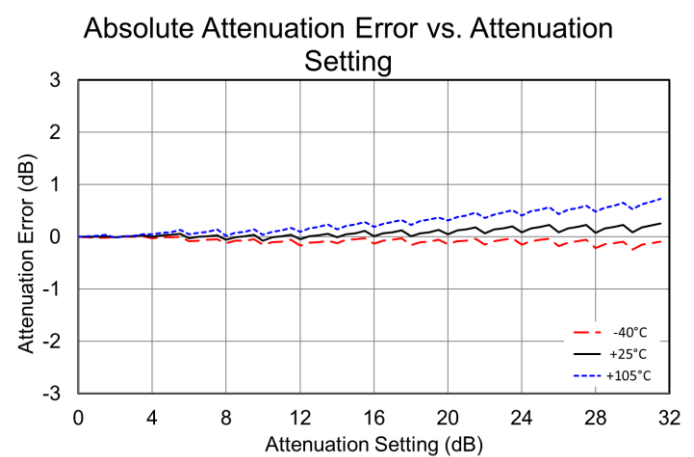
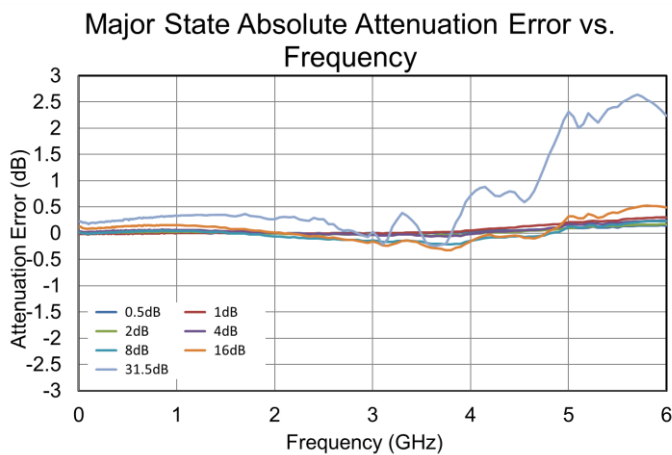
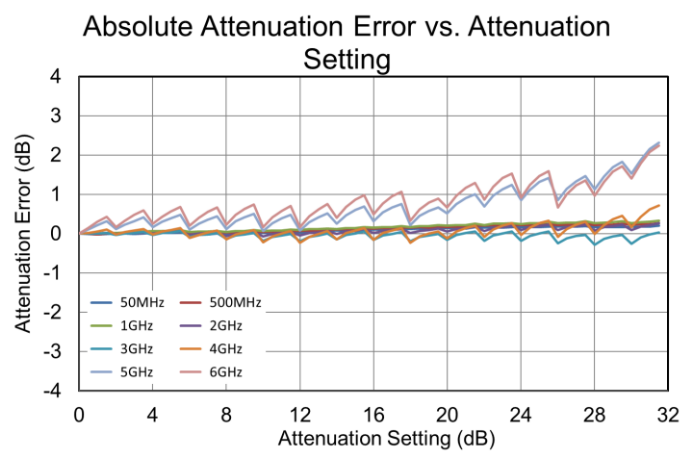
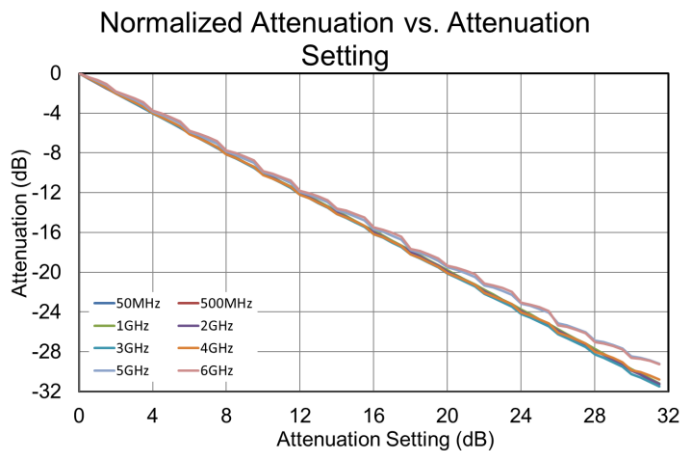
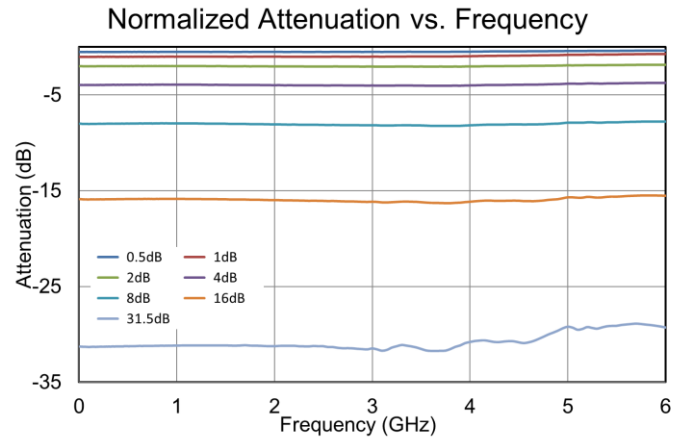
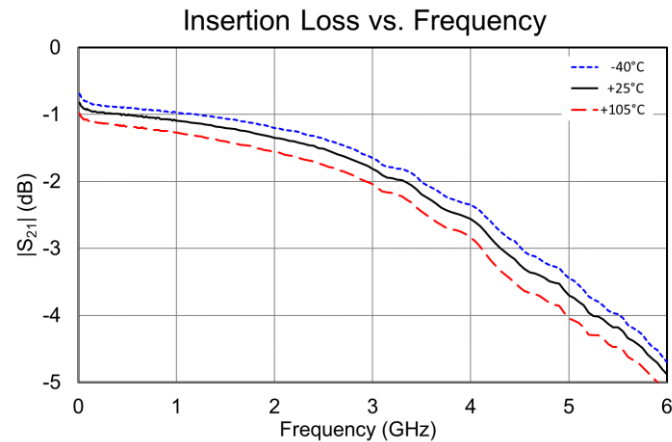
Parameter	Conditions	Min	Typ	Max	Units
Logic Low Input Voltage		0		+0.63	V
Logic High Input Voltage		+1.17		V_{DD}	V

Notes:

- Test conditions unless otherwise noted: V_{DD} =+5 V, Temp= +25 °C; Apply to CLK, SERIN, LE and PUP2

Performance Plots – QPC6614

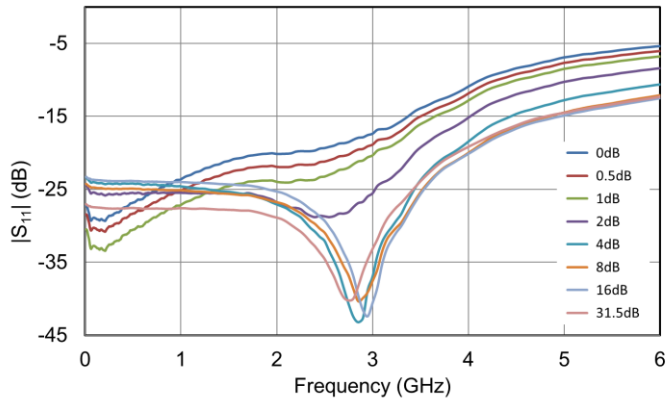
Test conditions unless otherwise noted: $V_{DD} = +5.0\text{ V}$, $50\ \Omega$ system, Temp = 25°C



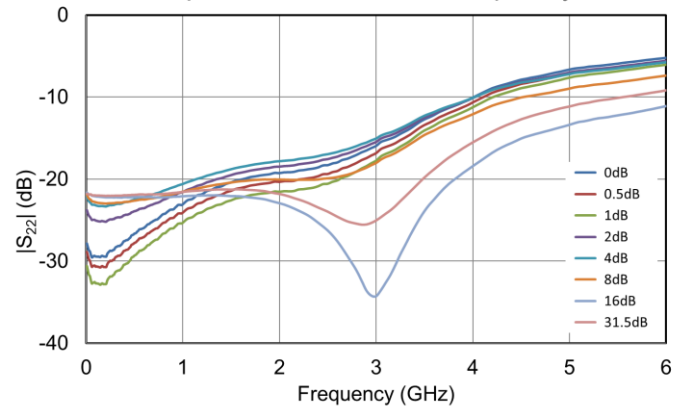
Performance Plots – QPC6614 (Continued 1)

Test conditions unless otherwise noted: $V_{DD} = +5.0\text{ V}$, $50\ \Omega$ system, Temp = 25°C

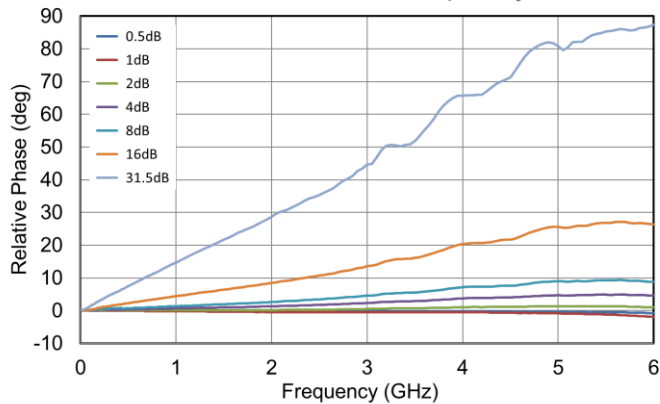
Input Return Loss vs. Frequency



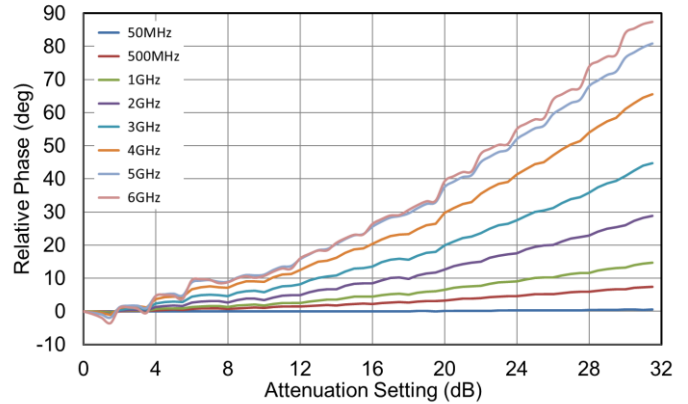
Output Return Loss vs. Frequency



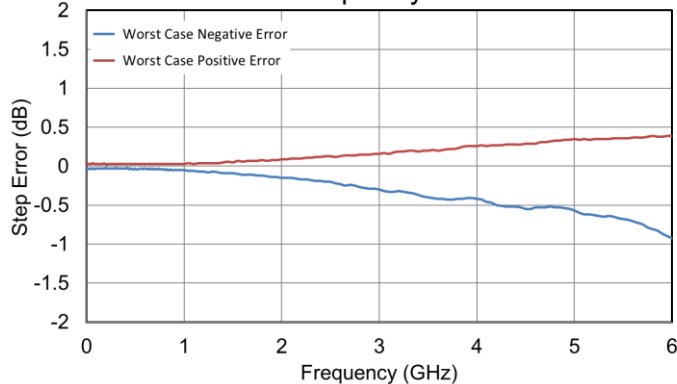
Relative Phase vs. Frequency



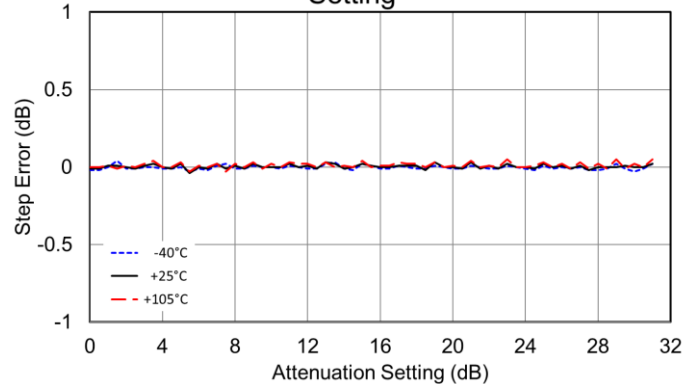
Relative Phase vs. Attenuation Setting



Worst Case Successive Step Error vs. Frequency

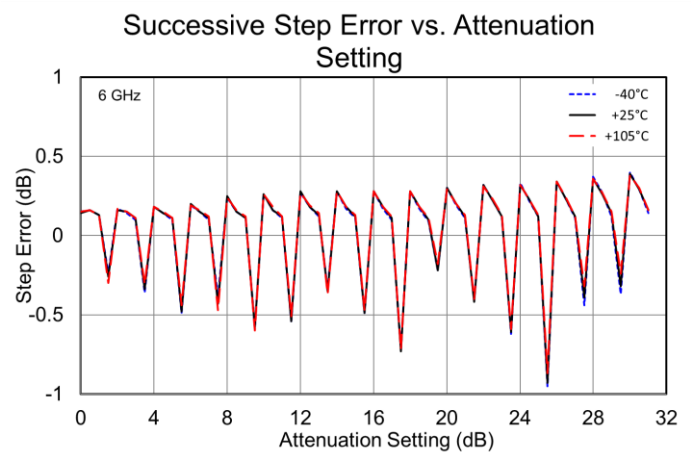
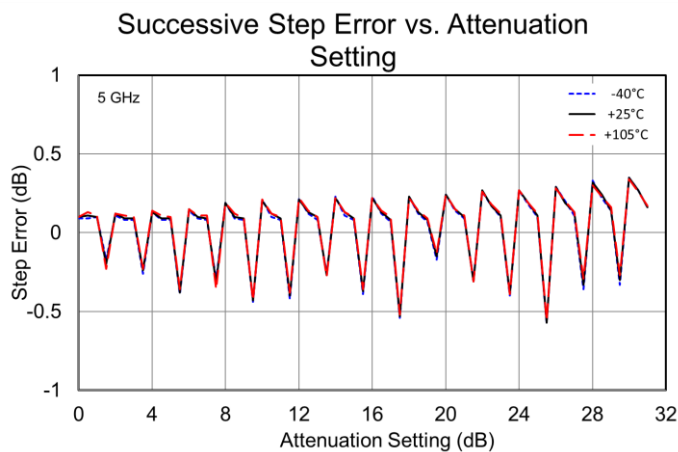
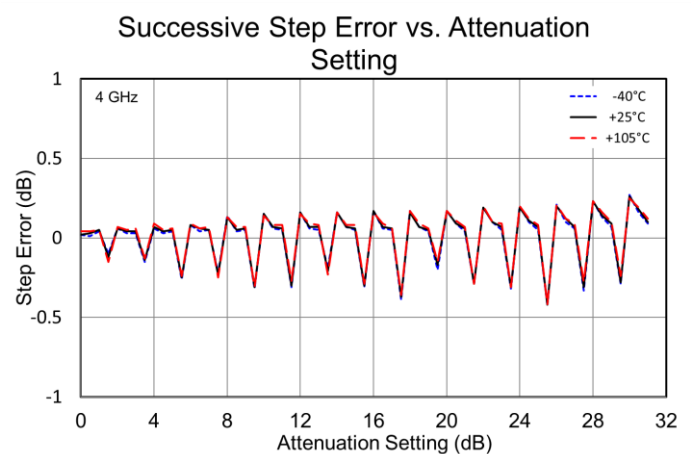
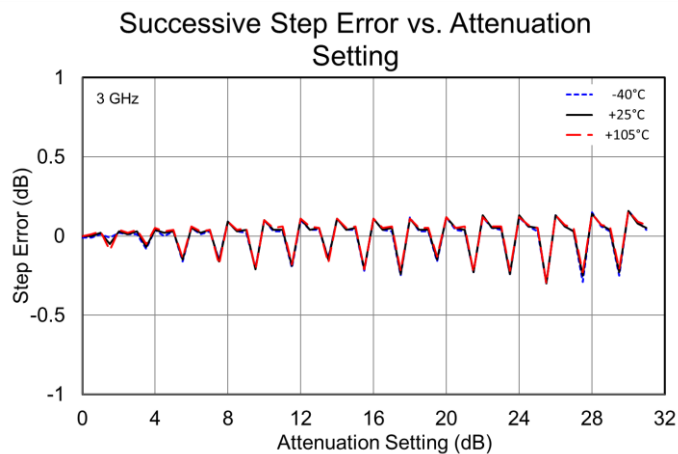
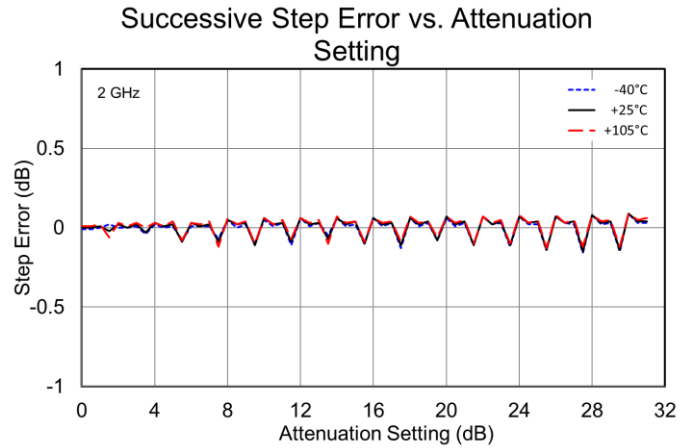
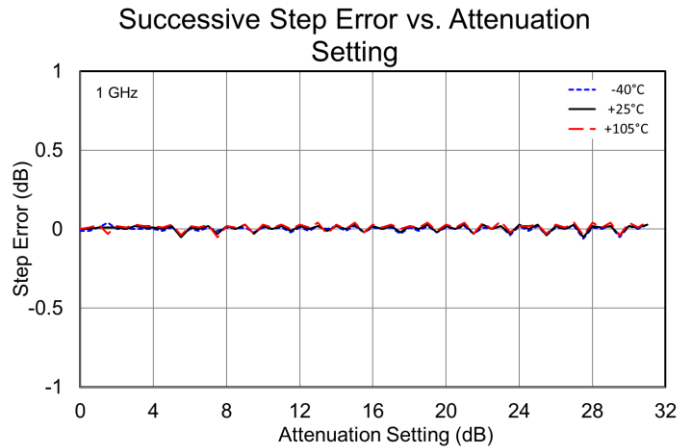


Successive Step Error vs Attenuation Setting



Performance Plots – QPC6614 (Continued 2)

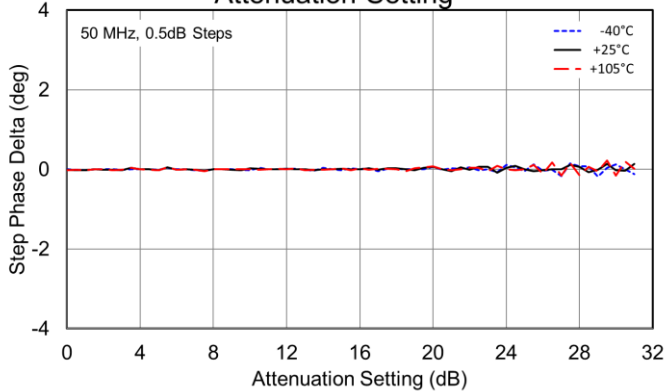
Test conditions unless otherwise noted: $V_{DD} = +5.0\text{ V}$, $50\ \Omega$ system, Temp = 25°C



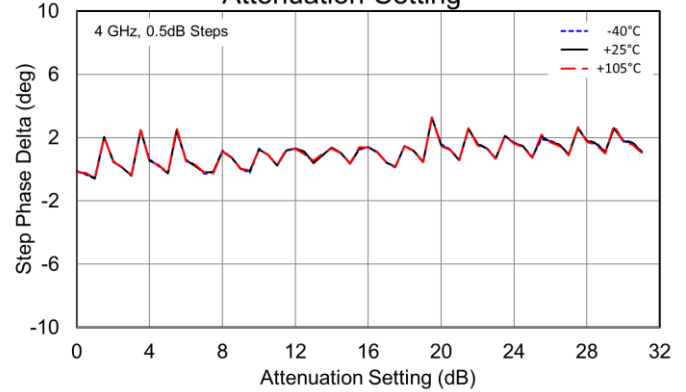
Performance Plots – QPC6614 (Continued 3)

Test conditions unless otherwise noted: $V_{DD} = +5.0\text{ V}$, $50\ \Omega$ system, Temp = 25°C

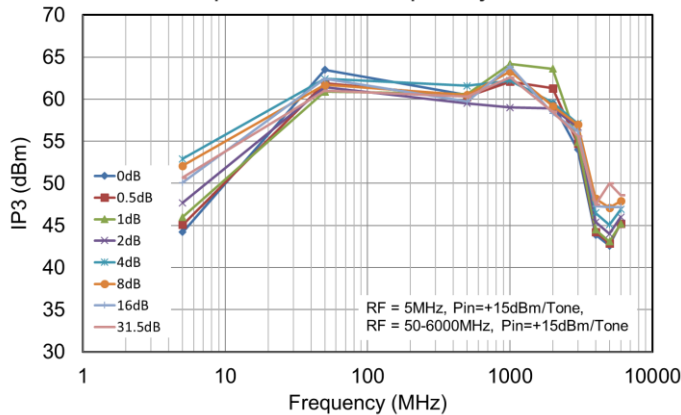
Successive Step Phase Delta vs. Attenuation Setting



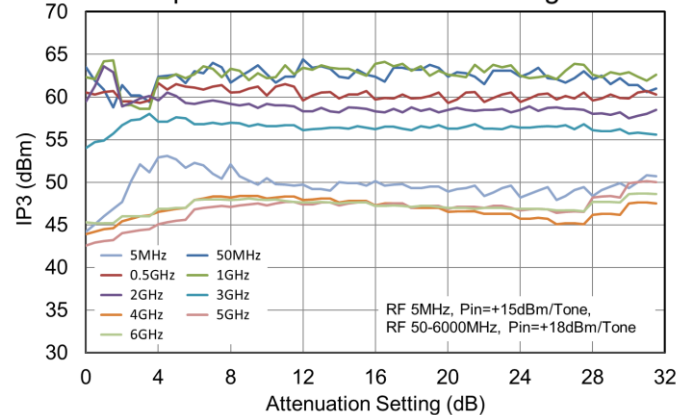
Successive Step Phase Delta vs. Attenuation Setting



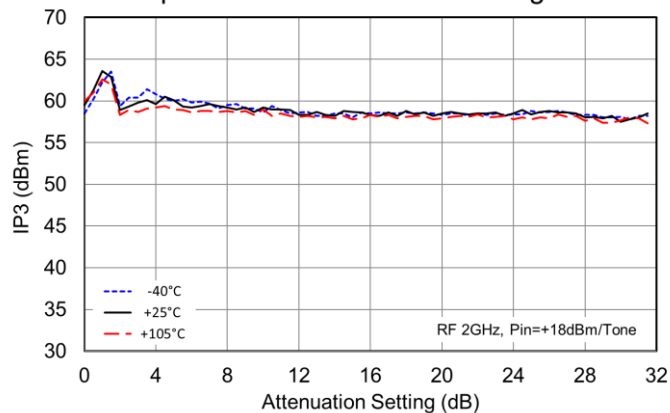
Input IP3 vs. Frequency



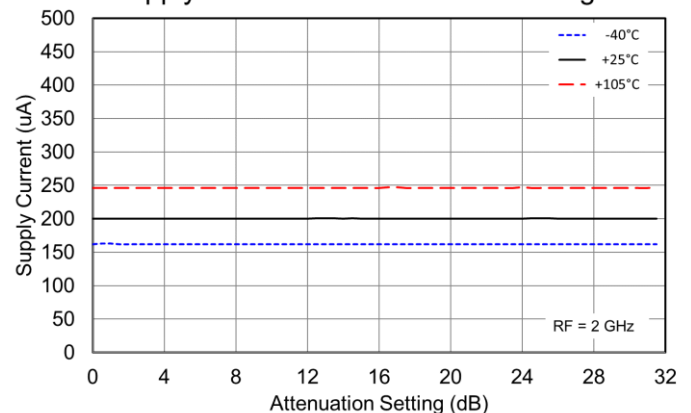
Input IP3 vs. Attenuation Setting



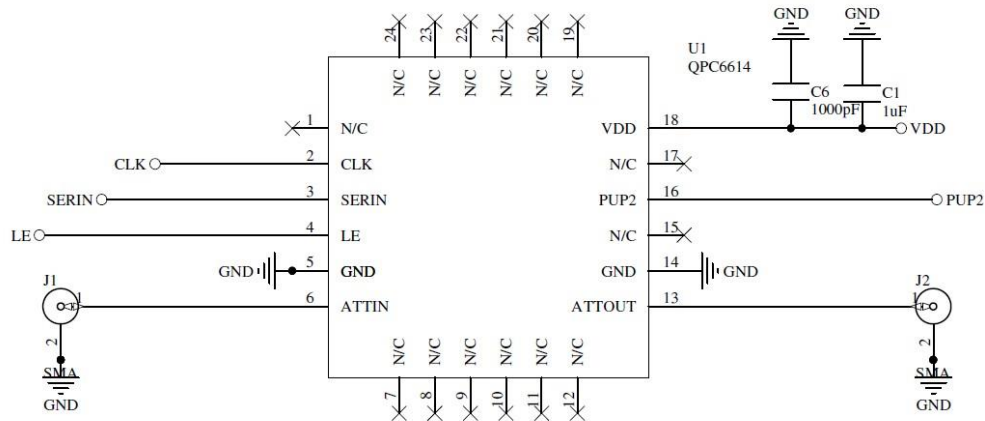
Input IP3 vs. Attenuation Setting



Supply Current vs. Attenuation Setting



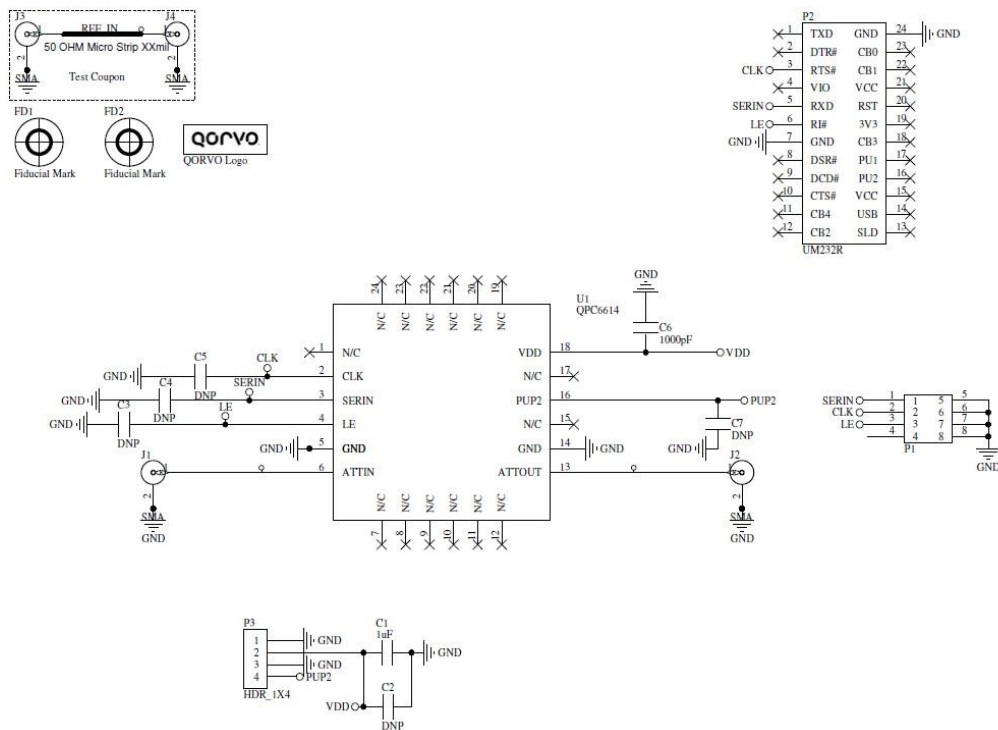
Typical Application Schematic – 5 MHz to 6000 MHz



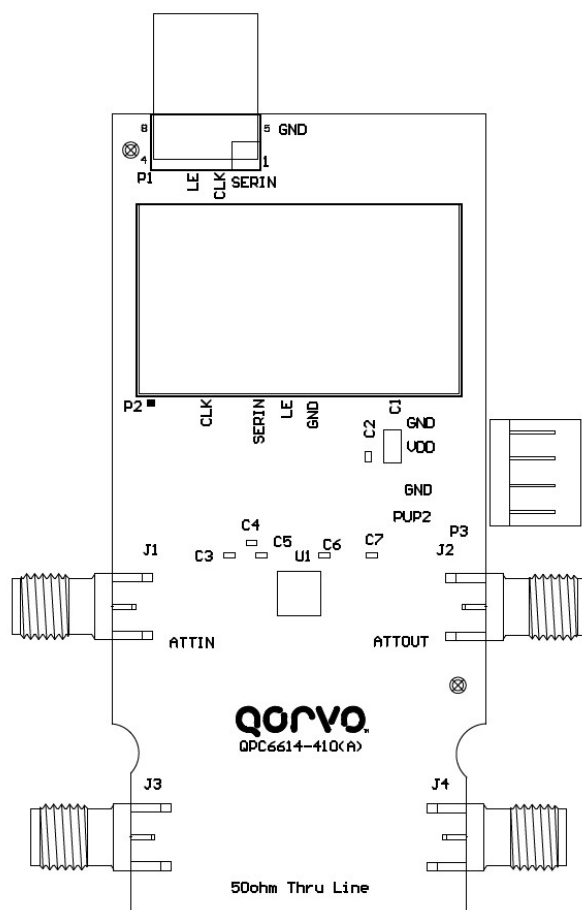
Notes:

1. If digital control signal of 4 - 5V is applied prior to V_{DD} , use series 1k Ohm resistor at the input of CLK, SERIN, LE and PUP2,

Evaluation Board Schematic – 5 MHz to 6000 MHz



Evaluation Board Assembly Drawing



Bill of Material – Evaluation Board

Reference Des.	Value	Description	Manufacturer	Part Number
	-	QPC6614-410	ViaSystems	QPC6614-410(A)
U1	-	Digital Step Attenuator 5 MHz to 6000 MHz	Qorvo	QPC6614SB
J1- J4	-	CONN, SMA, END LNCH, UNIV, HYB MNT, FLT	Molex	SD-73251-4000
C1	1 μ F	CAP, 1 μ F, 10%, 25 V, X7R, 1206	Taiyo Yuden	CE TMK316B7105KL-T
C6	1000 pF	CAP, 1000 pF, 10%, 50 V, X7R, 0402	TDK Corporation	C1005X7R1H102KT000F
P2	-	CONN, SKT, 24-PIN DIP, .600", T/H	Aries Electronics Inc.	24-6518-10
M1 ⁽¹⁾	-	MOD, USB TO SERIAL UART, SSOP-28	Future Technology	UM232R
P3	-	CONN, HDR, ST, 4-PIN, 0.100"	Samtec Inc.	TSW-104-08-S-S
P1	-	CONN, HDR, 2 X 4, RA, 0.100, T/H	Samtec Inc.	TSW-104-08-G-D-RA

Notes:

1. M1 should be mounted into P2 with respect to the Pin 1 alignment of M1 and P2.

Evaluation Board Programming Using USB Interface

Serial Addressable Mode

Refer to the Control Bit Generator (CBG) Software Reference Manual for detailed instructions on how to setup the software for use. Apply the supply voltage to P3. Select QPC6614 from the RFMD Parts List of the CBG user interface. Set the attenuation value using the CBG user interface. The attenuator is set to the desired state and measurements can be taken.

Evaluation Board Programming Using External Bus

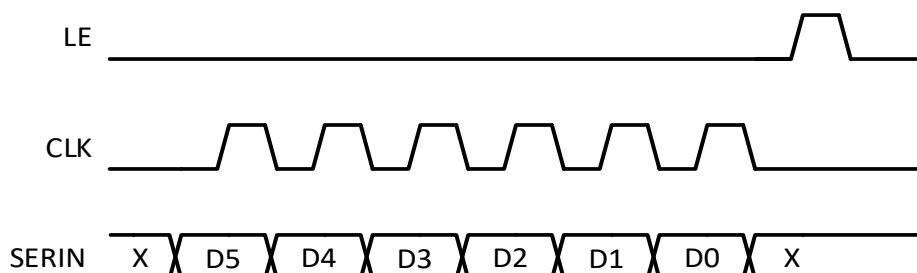
Serial Addressable Mode

This configuration allows the user to control the attenuator through the P1 connector using an external harness. Remove the USB interface board if it is currently installed on the evaluation board. Connect a user-supplied harness to the P1 connector. Note the top row of the P1 contains the serial bus signals and the bottom row is ground. Apply the supply voltage to P3. Send the appropriate signals onto the serial bus lines in accordance with the Serial Mode Timing Diagram. The attenuator is set to the desired state and measurements can be taken. If digital control signal of 4 - 5V is applied prior to V_{DD} , use series 1k Ohm resistor at the input of CLK, SERIN, LE and PUP2.

Default Power-up State

The attenuation state set during power-up can be controlled using the PUP2 pin. To power-up in the maximum attenuation state, apply a logic low to PUP2 pin prior to applying supply voltage V_{DD} . To power-up in the minimum attenuation state apply a logic high to the PUP2 pin prior to applying supply voltage V_{DD} .

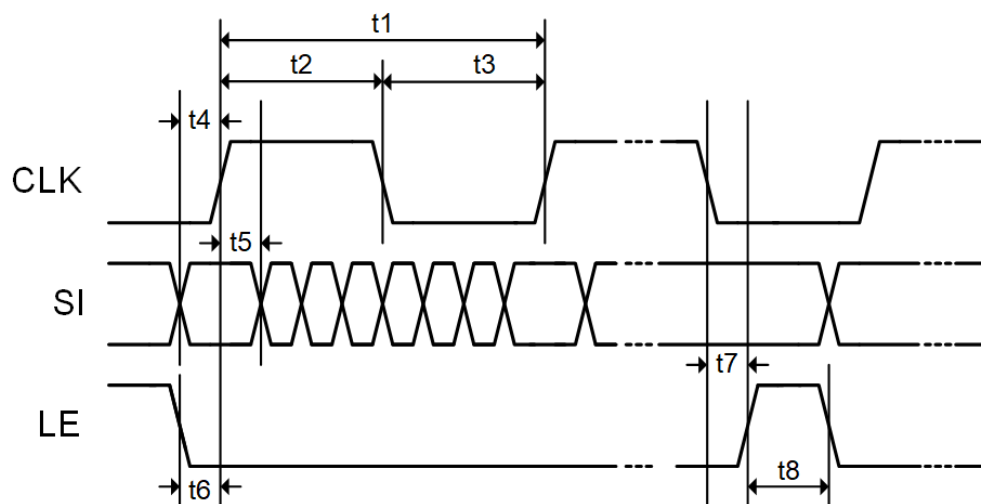
Serial Mode Timing Diagram



Serial Programmable Attenuation Word Truth Table

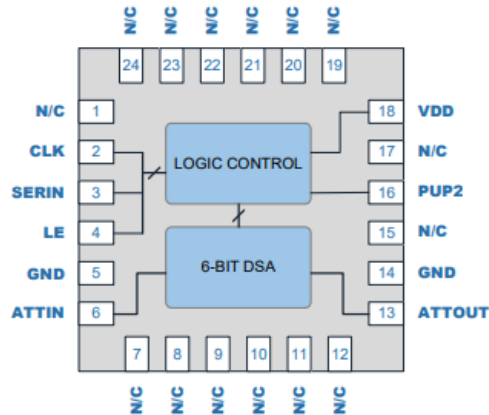
Attenuation Word						Attenuation State
D5 (MSB)	D4	D3	D2	D1	D0 (LSB)	
H	H	H	H	H	H	0dB / Reference Insertion Loss
H	H	H	H	H	L	0.5dB
H	H	H	H	L	H	1dB
H	H	H	L	H	H	2dB
H	H	L	H	H	H	4dB
H	L	H	H	H	H	8dB
L	H	H	H	H	H	16dB
L	L	L	L	L	L	31.5dB

Serial Bus Timing Specifications



Parameter	Symbol	Min.	Max.	Unit
CLK Frequency	1/t1		25	MHz
CLK High Time	t2	20		ns
CLK Low Time	t3	20		ns
SI Setup Time	t4	5		ns
SI Hold Time	t5	5		ns
LE Low Setup Time	t6	5		ns
LE High Setup Time	t7	5		ns
LE High Time	t8	10		ns

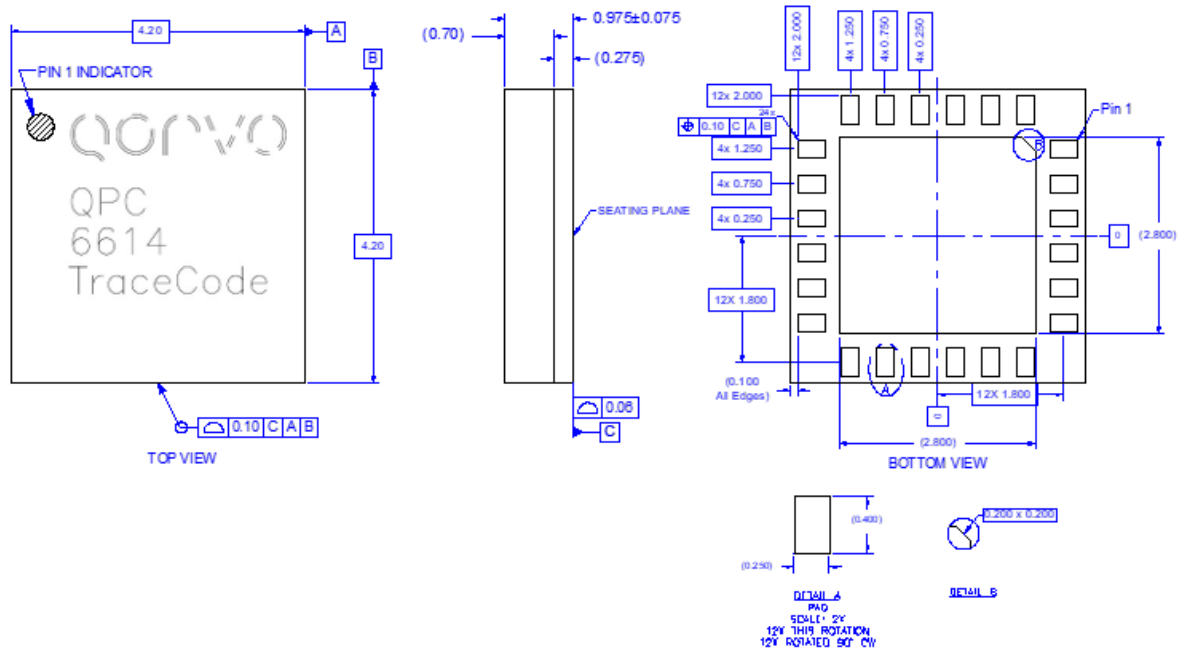
Pad Configuration and Description



Top View

Pad No.	Label	Description
1	NC	No Internal Connection
2	CLK	Serial Clock Input.
3	SERIN	Serial Data Input.
4	LE	Latch Enable.
5	GND	Connect to PCB Ground
6	ATTIN	RF Input. Incident RF power must enter this pin for rated thermal performance and reliability. Do not apply DC Voltage to this pin. It is internally with resistive ground return. External DC ground allowed.
7	NC	No Internal Connection
8	NC	No Internal Connection
9	NC	No Internal Connection
10	NC	No Internal Connection
11	NC	No Internal Connection
12	NC	No Internal Connection
13	ATTOUT	RF Output. Do not apply DC voltage to this pin. It is internally with resistive ground return. External DC ground allowed.
14	GND	Connect to PCB Ground
15	NC	No Internal Connection
16	PUP2	Power-up Programming Pin. See Default Power-up State Section for usage. If 4~5V signal presents prior to V _{DD} , 1K Ω series resistor required on this pin.
17	NC	No Internal Connection
18	VDD	DC Supply Voltage Input
19	NC	No Internal Connection
20	NC	No Internal Connection
21	NC	No Internal Connection
22	NC	No Internal Connection
23	NC	No Internal Connection
24	NC	No Internal Connection
Backside Paddle	-	RF/DC ground. See PCB Layout Pattern for suggested foot print

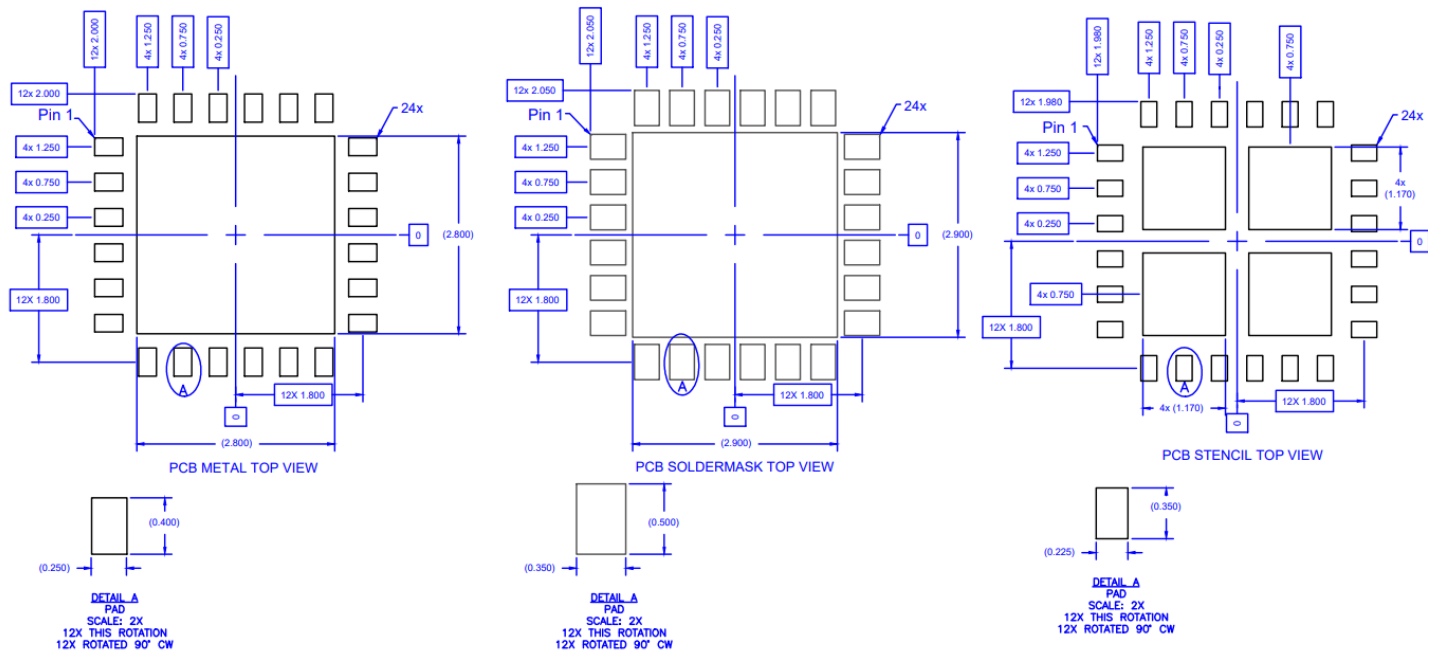
Package Marking and Dimensions



Notes:

1. All Dimensions in millimeters

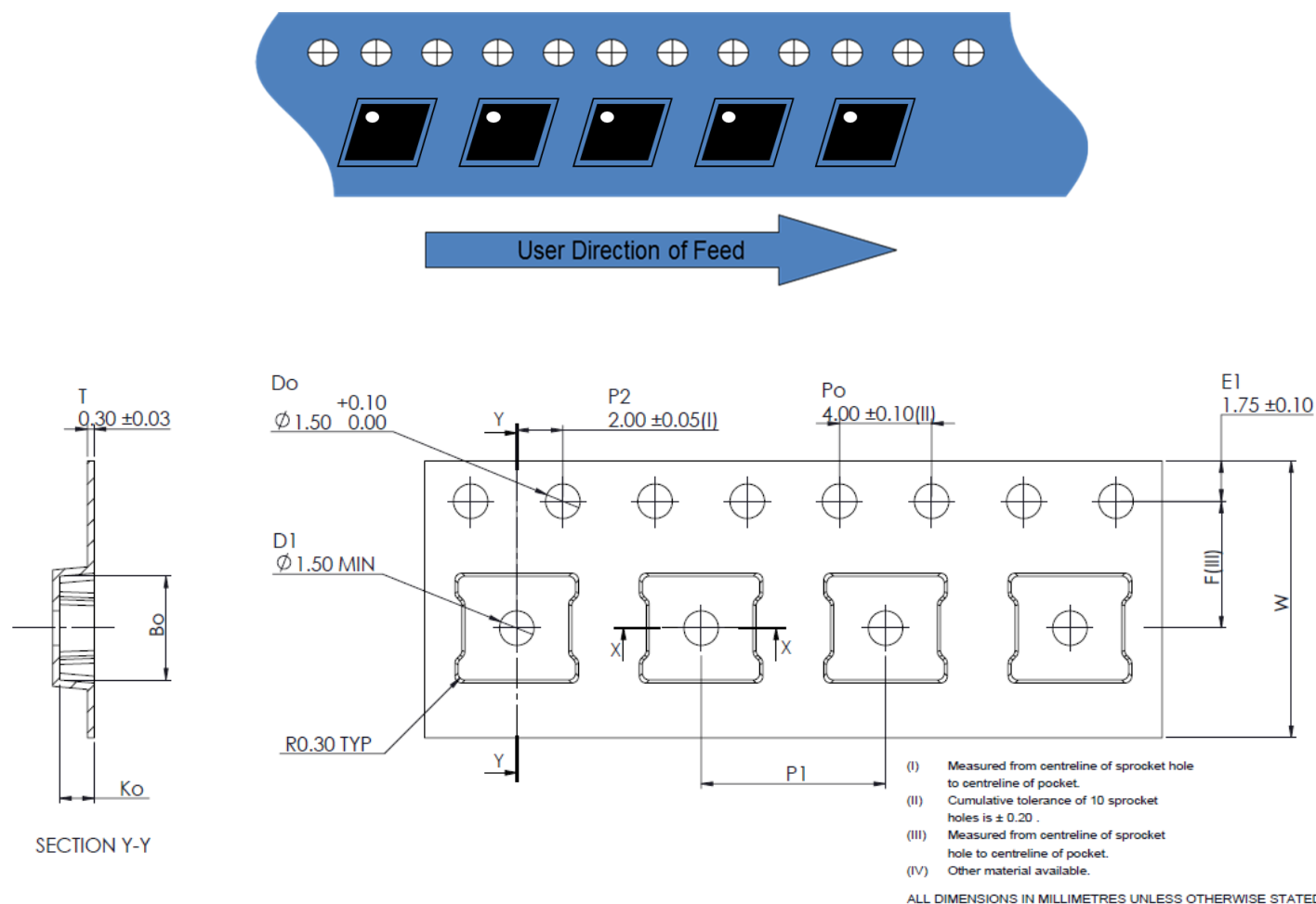
Recommended PCB Layout Pattern



Notes:

1. All Dimensions in millimeters. All angles are in degrees.

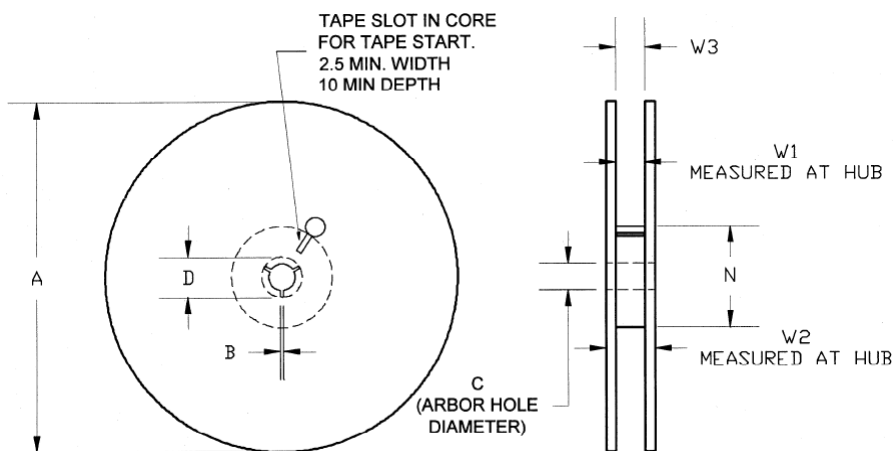
Tape and Reel Information – Carrier and Cover Tape Dimensions



Feature	Measure	Symbol	Size (in)	Size (mm)
Cavity	Length	A0	0.177	4.5
	Width	B0	0.177	4.5
	Depth	K0	0.059	1.5
	Pitch	P1	0.315	8.0
Centerline Distance	Cavity to Perforation - Length Direction	P2	0.079	2.0
	Cavity to Perforation - Width Direction	F	0.217	5.50
Cover Tape	Width	C	0.362	9.20
Carrier Tape	Width	W	0.472	12.0

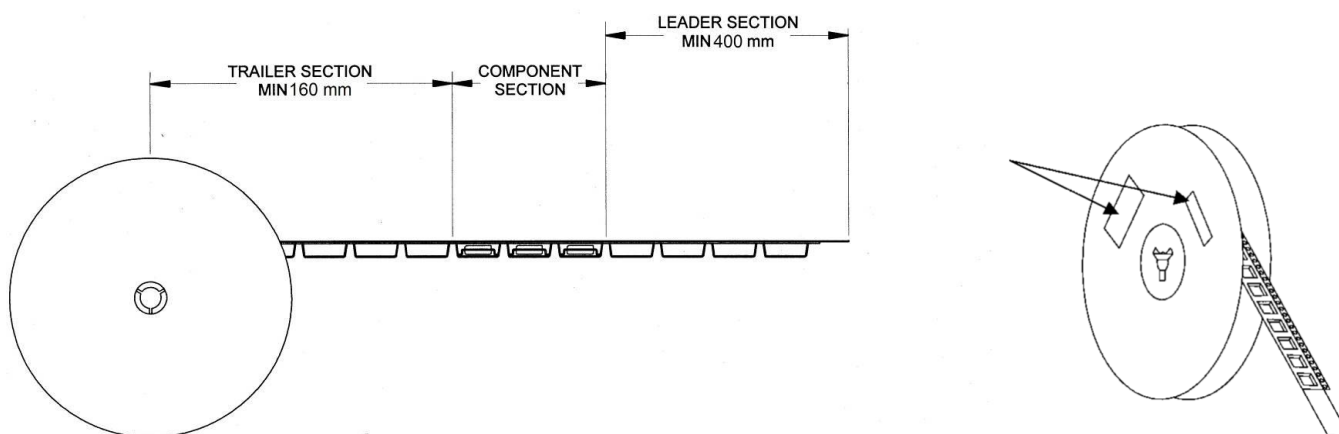
Tape and Reel Information – Reel Dimensions

Standard T/R size = 2,500 pieces on a 13" reel.



Feature	Measure	Symbol	Size (in)	Size (mm)
Flange	Diameter	A	12.992	330
	Thickness	W2	0.717	18.2
	Space Between Flange	W1	0.504	12.8
Hub	Outer Diameter	N	4.016	102.0
	Arbor Hole Diameter	C	0.512	13.0
	Key Slit Width	B	0.079	2.0
	Key Slit Diameter	D	0.795	20.2

Tape and Reel Information – Tape Length and Label Placement



Notes:

1. Empty part cavities at the trailing and leading ends are sealed with cover tape. See EIA 481-1-A.
2. Labels are placed on the flange opposite the sprockets in the carrier tape.

Handling Precautions

Parameter	Rating	Standard
ESD – Human Body Model (HBM)	Class 1C	ESDA / JEDEC JESD22-A114
ESD – Charged Device Model (CDM)	Class C3	JEDEC JESD22-C101F
MSL – Moisture Sensitivity Level	Level 2	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.

Contact plating: Ni/Pd/Au (*Electroless Ni 2-5 μm , Electroless Pd 0.11-0.18 μm , Electroless (hybrid) Au 0.07 – 0.12 μm*)

RoHS Compliance

This part is compliant with 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
- Halogen Free (Chlorine, Bromine)
- Antimony Free
- TBBP-A ($\text{C}_{15}\text{H}_{12}\text{Br}_4\text{O}_2$) Free
- PFOS Free
- SVHC Free



Contact Information

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

Web: www.qorvo.com

Tel: 1-844-890-8163

Email: customer.support@qorvo.com

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