



QPF4609

Wi-Fi 7 Front End Module

Product Overview

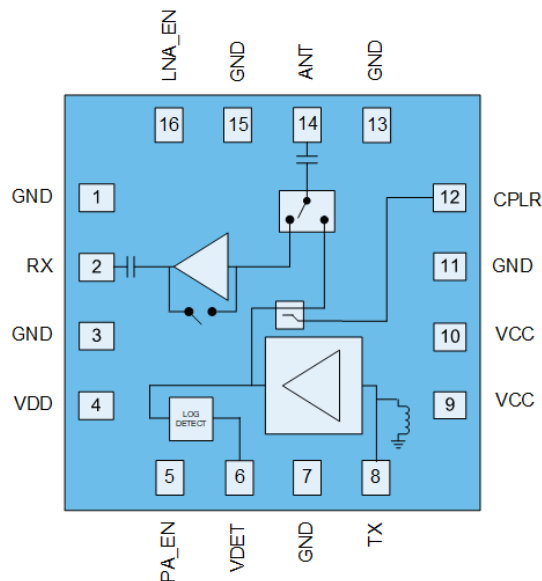
The Qorvo® QPF4609 is an integrated front end module (FEM) designed for Wi-Fi 7 (802.11be) systems. The small form factor and integrated matching minimizes layout area in the application.

Performance is focused on optimizing the PA for a 5V supply voltage that minimizes power consumption to allow for systems that use digital pre-distortion to achieve the highest linear output power and leading edge throughput for the RF chain. This is done across a wide bandwidth enabling operation in all channels from UNII5-8 (5.925 to 7.125 GHz).

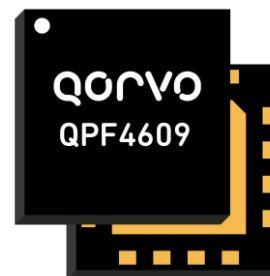
A coupler with RF output is integrated for DPD feedback training. For power control a broadrange, constant slope voltage logarithmic power detector is provided for application feedback.

The QPF4609 integrates a 6 GHz power amplifier (PA), single pole two throw switch (SP2T), coupler structure and bypassable low noise amplifier (LNA) into a single device.

Functional Block Diagram



Top View



16 Pad 3 x 3 mm Laminate Package

Key Features

- 5925 – 7125 MHz
- $P_{SAT} = +32$ dBm
- Corrected DEVM¹
 - $P_{OUT} = +15.5$ dBm MCS13 EHT320 -43dB Dynamic EVM
 - $P_{OUT} = +21$ dBm MCS11 EHT160 -43dB Dynamic EVM
 - $P_{OUT} = +23$ dBm MCS9 VHT80 -35dB Dynamic EVM
 - $P_{OUT} = +26$ dBm MCS0 HT20 Spectral Mask Compliance
- Optimized for +5 V Operation
- DC Power = 1.9 W at +27dBm
- 32 dB Tx Gain
- 1.8 dB Noise Figure
- 16 dB Rx Gain & 6.5 dB Bypass Loss
- 25 dB 2.5 GHz Rejection on Rx Path
- Integrated RF Coupler & DC Logarithmic Power Detector

¹Memoryless LUT DPD Correction

Applications

- Access Points
- Wireless Routers
- Residential Gateways
- Customer Premise Equipment
- Internet of Things

Ordering Information

Part Number	Description
QPF4609SB	Sample bag with 5 pieces
QPF4609SR	7" reel with 100 pieces
QPF4609TR13	13" reel with 5,000 pieces
QPF4609EVB	Assembled Evaluation Board



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Absolute Maximum Ratings

Parameter	Conditions	Rating
DC Supply Voltage		-0.5 to +6 V
Control Voltage	PA_EN & LNA_EN	-0.5 to +3.3 V
External DC Voltage	ANT & RX_OUT	<3.2 V
Storage Temperature		-40 to 150 °C
Junction Temperature	MTTF > 1.0x10 ⁶ hours	200 °C
RF Input Power at TX_IN	Into 50Ω Load for 802.11b-be (No Damage), Transmit Mode	+10 dBm
RF Input Power at TX_IN	Into 10:1 VSWR for 802.11b-be (No Damage), Transmit Mode	+10 dBm
RF Input Power at ANT	(No Damage), Receive LNA High Mode	+10 dBm
RF Input Power at ANT	(No Damage), Receive Bypass Mode	+20 dBm

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
Operating Frequency	5925		7125	MHz
Device Voltage (V _{CC} & V _{DD})	+4.5	+5	+5.25	V
Extended Device Voltage (V _{CC} & V _{DD}) [^]	+3.15		+5.25	V
Control Voltage – High	+1.6	+1.8	3.6	V
Control Voltage - Low	0		+0.4	V
T _{OPERATING} [*]	-40		+85	°C

Electrical specifications are measured at specified test conditions. Specifications are not guaranteed over all recommended operating conditions. [^]Extended operating conditions may have degraded performance for some specifications. ^{*} T_{OPERATING} is temperature at package ground.

Electrical Specifications

Parameter	Conditions	Min.	Typ.	Max.	Units
Transmit (TX-ANT) Mode	Unless otherwise noted: V_{CC/DD}=5V, T=+25°C, PA_EN=High, LNA_EN=Low				
Saturated Output Power			+32		dBm
Wi-Fi 7 EHT320 ⁽¹⁾ Output Power	Corrected w/ memoryless/LUT DPD		15.5		dBm
Dynamic EVM	MCS13 4096QAM 11be			-43	dB
Wi-Fi 6 HE160 ⁽¹⁾ Output Power	Corrected w/ memoryless/LUT DPD		21		dBm
Dynamic EVM	MCS11 1024QAM 11ax			-43	dB
Wi-Fi 5 VHT80 ⁽¹⁾ Output Power	Corrected w/ memoryless/LUT DPD		23		dBm
Dynamic EVM	MCS9 256QAM 11ac			-35	dB
Wi-Fi 7 EHT80 Output Power	Uncorrected		10		dBm
Dynamic EVM	MCS9 256QAM 11be		-33.5	-31.5	dB



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Parameter	Conditions	Min.	Typ.	Max.	Units
Wi-Fi 7 EHT80 Output Power	Uncorrected		15		dBm
Dynamic EVM	MCS9 256QAM 11be		-33	-30.5	dB
Wi-Fi 7 EHT80 Output Power	Uncorrected		22		dBm
Dynamic EVM	MCS9 256QAM 11be		-33.5	-28.5	dB
Wi-Fi 7 EHT20/40 Output Power	Uncorrected		26		dBm
Dynamic EVM	MCS9 256QAM 11be		-22	-19	dB
Margin to HT20 Spectral Mask	P _{OUT} = +24.5 dBm, 11n MCS0, uncorrected	0	3		dB
Gain		28	32		dB
Gain Flatness	Across any 320 MHz Channel	-0.8		+0.8	dB
Out of Band Gain	f = 1600-1950 MHz			-50	dB
	f = 3.3 – 3.8 GHz			-25	dB
	f = 8 - 15 GHz			21	dB
AM/AM Distortion			3		dB
AM/PM Distortion			5		degrees
TX_IN Port Return Loss		7	15		dB
ANT Port Return Loss		9	13		dB
Quiescent Current	RF Off	115	120	125	mA
Operating Current	P _{OUT} = +16 dBm		161	185	mA
	P _{OUT} = +20 dBm		201	225	mA
	P _{OUT} = +27 dBm		382	425	mA
2 nd Harmonics	P _{OUT} = +27 dBm 802.11a MCS0, no DPD		-46	-20	dBm/MHz
3 rd Harmonics	P _{OUT} = +27 dBm 802.11a MCS0, no DPD		-55	-25	dBm/MHz
ANT-RX Isolation			-55	-45	dB
Coupling Factor (CF)		18.5	20	21.5	dB
DC Power Detect Voltage	No RF		0.184		V
	P _{OUT} = -5 dBm		0.195		V
	P _{OUT} = 0 dBm		0.217		V
	P _{OUT} = +27 dBm		0.862		V
Power Detector Slope	P _{OUT} = +10-28 dBm		23		mV/dB
RECEIVE (ANT-LNA_OUT) LNA ON MODE	Unless otherwise noted: V_{CC/DD}=5V, T=+25°C, PA_EN=Low LNA_EN=High				
Gain		13	16		dB
Gain Flatness	Across any 320 MHz Channel	-1		+1	dB
Out of Band Gain	f = 2400-2500 MHz		-25	-20	dB
Noise Figure			1.8	2.2	dB
RX Port Return Loss		7	15		dB
ANT Port Return Loss		6	7		dB
Input P _{1dB}		-7	-5		dBm
Input IP3	2-tone CW, 1MHz spacing	+7	+8		dBm
Rx Operating Current			20	32	mA
RECEIVE (ANT-LNA_OUT) BYPASS MODE	Unless otherwise noted: V_{CC/DD}=5V, T=+25°C, PA_EN=Low, LNA_EN=Low				
Bypass Loss		5.5	6.5	7.7	dB



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Parameter	Conditions	Min.	Typ.	Max.	Units
Loss Flatness	Across any 320 MHz Channel	-1		+1	dB
Out of Band Gain	$f = 2400\text{-}2500\text{ MHz}$		-25	-20	dB
RX Port Return Loss		13	15		dB
ANT Port Return Loss		10	11		dB
Input P_{1dB}			+30		dBm
Input IP3	2-tone CW, 1MHz spacing		+42		dBm
GENERAL SPECIFICATIONS	Unless otherwise noted: $V_{CC/DD}=5V$, $T=+25^{\circ}C$, Switching Time Power Accuracy +/- 1dB				
Control Current - High			40		μA
Control Current - Low			1		μA
TX Output P_{1dB}	CW	+29	+30		dBm
Switching Time	Transmit to LNA On or Bypass Mode			400	nS
	LNA On to Bypass Mode			200	nS
	Bypass to LNA On Mode			200	nS
	LNA On or Bypass to Transmit Mode			400	nS
PA Stability - Output VSWR	CW No Spurious above -41.25 dBm/MHz, $P_{OUT} = 0\text{-}27\text{ dBm}$		4:1		
Thermal Resistance, θ_{jc}	Junction to case		25		$^{\circ}C/W$

Notes:

1. Normalized to -55dB source

Logic Truth Table

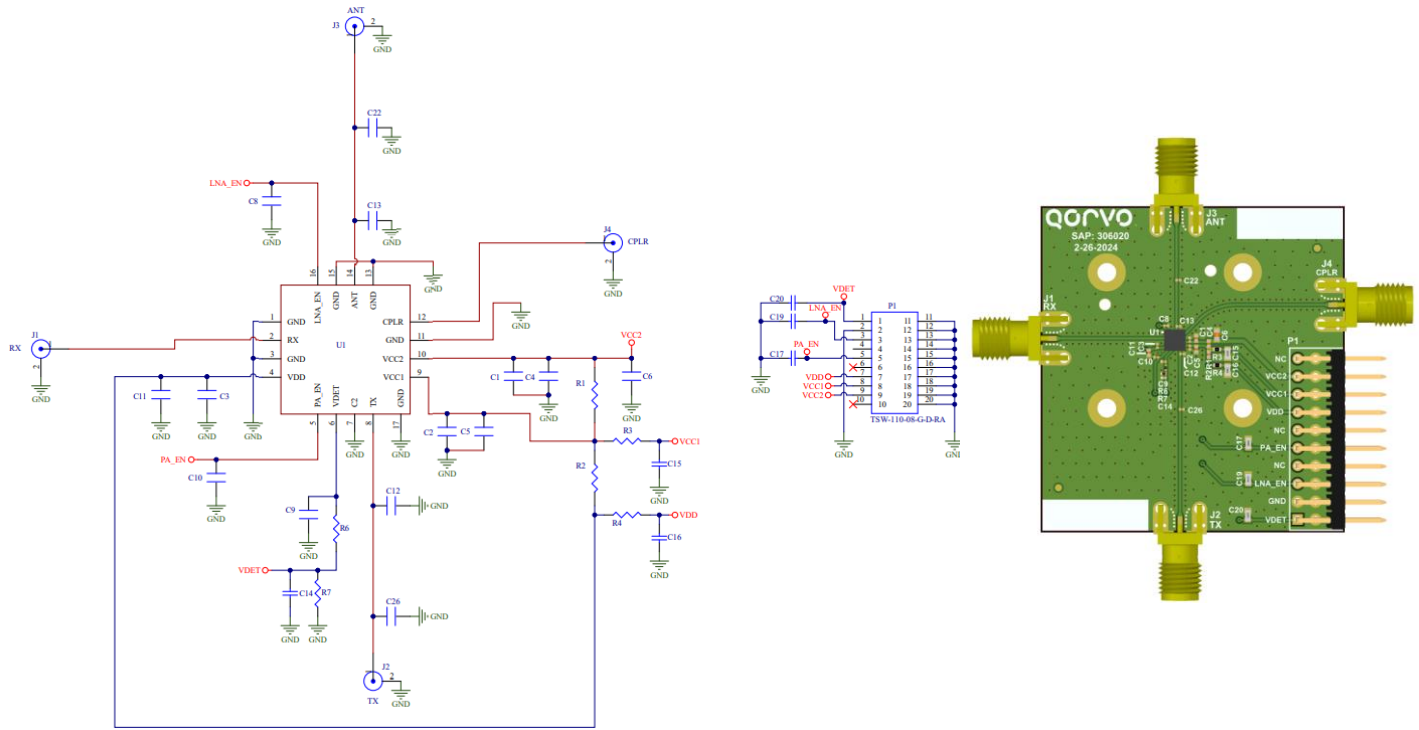
MODE	STATE	PA_EN	LNA_EN
Transmit On	1	High	Low
LNA On	2	Low	High
LNA Bypass	3	Low	Low
Not Used	4	High	High



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Evaluation Board Schematic



Bill of Material

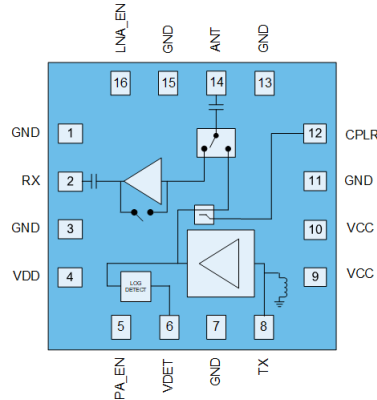
REF. DES.	VALUE	DESCRIPTION	MANUF.	PART NUMBER
-	-	Printed Circuit Board	-	-
U1	-	6GHz Wi-Fi 7 Front End Module	Qorvo®	QPF4609
C10	150 pF	Capacitor, Chip, 10%, 16V, X7R, 0201	Murata	GRM033R71C151KA01D
C4, C5, C11	2.2 μ F	Capacitor, Chip, 10%, 16V, X5R, 0402	Murata	GRM155R61C225KE11D
C6, C15, C16	4.7 μ F	Capacitor, Chip, 20%, 16V, X7R, 0603	Murata	GRM188Z71C475ME21D
C8	22 pF	Capacitor, Chip, 5%, 25V, C0G, 0201		
C1, C2	2.2 uF	Capacitor, Chip, 20%, 10V, X5R, 0201		
C3	10,000 pF	Capacitor, Chip, 10%, 10V, X7R, 0201	Kamaya	0201B103K100CT
R6	0 Ω	Resistor, Chip, 5%, 1/20W, 0201	Kamaya	RMC1/20JPPA
R1, R2	0 Ω	Resistor, Chip, 5%, 1/10W, 0402	Kamaya	RMC1/16SJPTH
C9, C12, C13, C14, C17, C19, C20, R3, R4, R7	-	Not Populated Item	-	-



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Pin Configuration and Description



Top View

PIN NUMBER	LABEL	DESCRIPTION
1	GND	Ground connection.
2	RX	RF output from the low noise amplifier. Internally matched to 50 Ω and DC blocked. ⁽¹⁾
3	GND	Ground connection.
4	VDD	Supply voltage.
5	PA_EN	Control pin
6	VDET	DC power detector. Provides an output voltage proportional to the RF output power level
7	GND	Not internally connected. Recommend connecting to ground or leave floating
8	TX	RF input. Internally matched to 50 Ω and DC shorted. ⁽²⁾
9	VCC	Supply voltage.
10	VCC	Supply voltage.
11	GND	Ground connection.
12	CPLR	RF power detector. Provides a coupled RF output power proportional to the RF output power level
13	GND	Ground connection.
14	ANT	RF bi-directional antenna port. Internally matched to 50 Ω .
15	GND	Ground connection.
16	LNA_EN	Control pin
Backside Paddle	GND	RF/DC ground. Use recommended via pattern to minimize inductance and thermal resistance. See PCB Mounting Pattern for suggested footprint.

Notes:

1. Pin is DC blocked internally. There is no DC present on this port. If connected to an external component with DC present, a 10pF blocking capacitor is recommended.
2. Pin is DC shorted internally. There is no DC present on this port. If connected to an external component with DC present, a 10pF blocking capacitor is recommended.

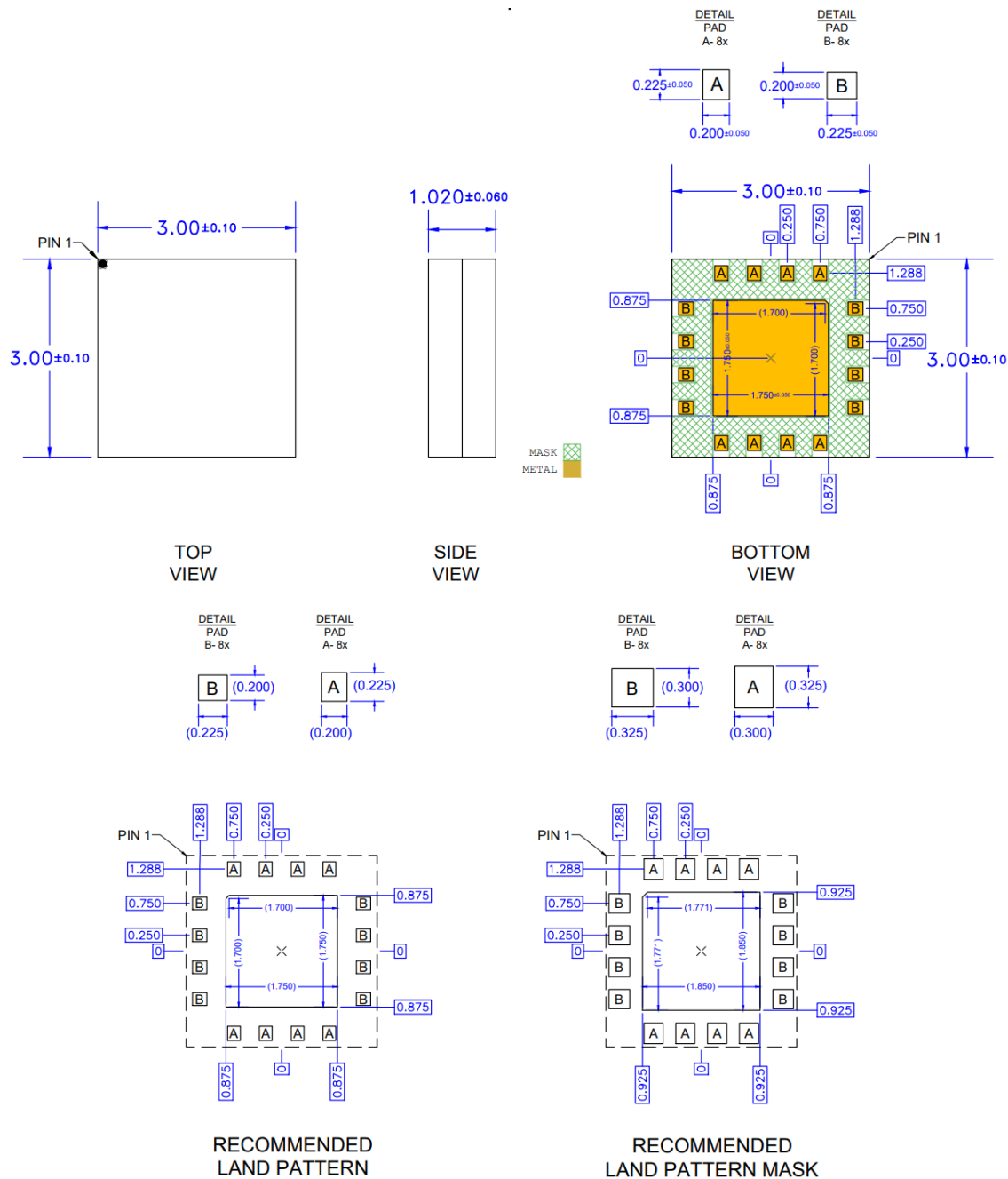


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Mechanical Information

Dimensions and PCB Mounting Pattern



Notes:

1. All dimensions are in millimeters. Angles are in degrees.
2. Dimension and tolerance formats conform to ASME Y14.4M-1994.
3. The terminal #1 identifier and terminal numbering conform to JESD 95-1SPP-012



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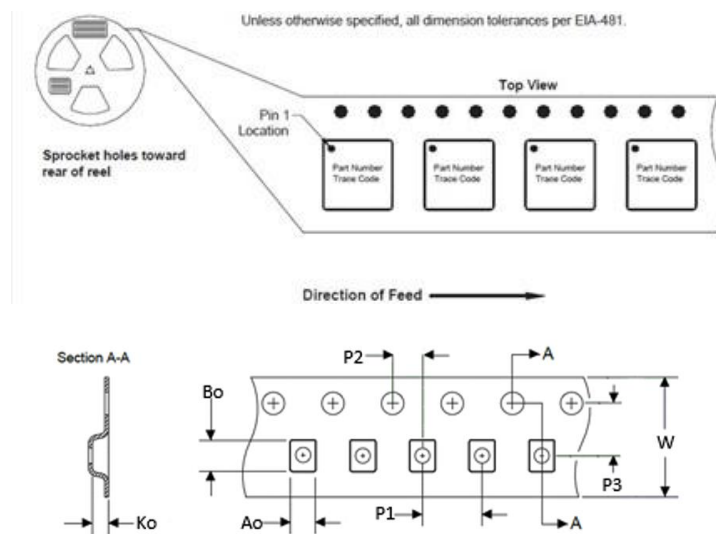
Part Marking



Tape and Reel Information – Carrier and Cover Tape Dimensions

Tape and reel specifications for this part are also available on the Qorvo website.

Standard T/R size = 5,000 pieces on a 13" reel.



FEATURE	MEASURE	SYMBOL	SIZE (IN)	SIZE (MM)
Cavity	Length	A0	0.128	3.25
	Width	B0	0.128	3.25
	Depth	K0	0.055	1.40
	Pitch	P1	0.157	4.0
Centerline Distance	Cavity to Perforation - Length Direction	P2	0.079	2.0
C2	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

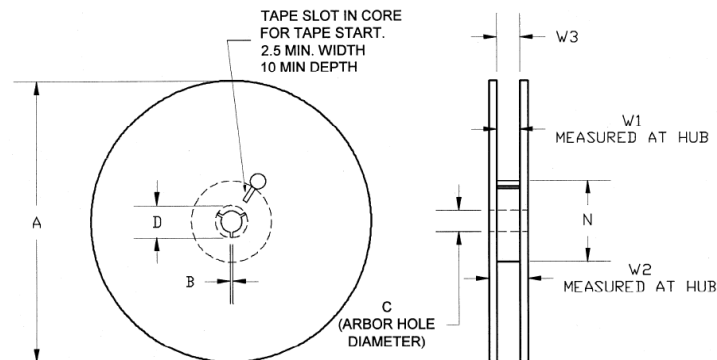


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Tape and Reel Information – Reel Dimensions

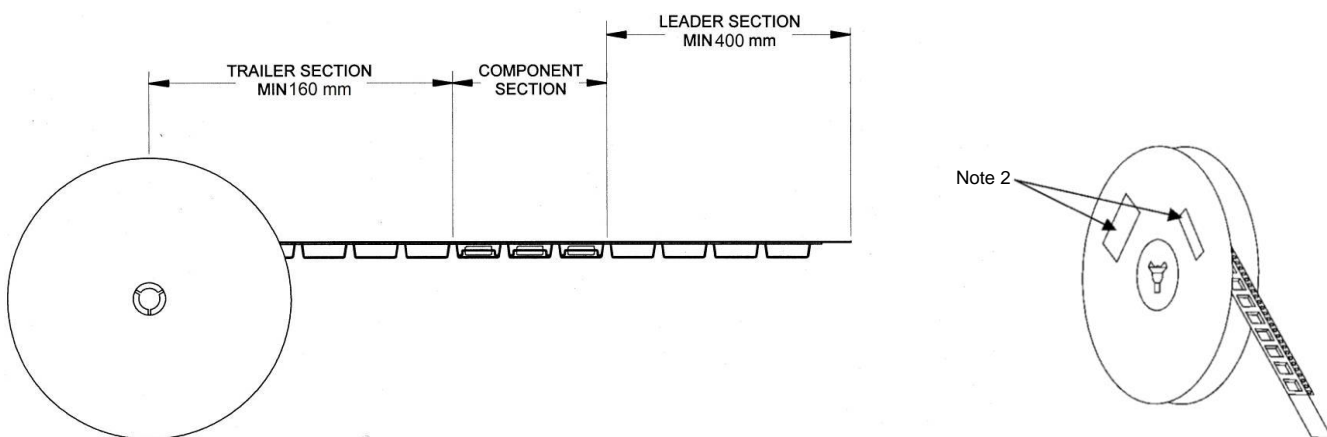
Packaging reels are used to prevent damage to devices during shipping and storage, loaded carrier tape is typically wound onto a plastic take-up reel. The reel size is 13" diameter. The reels are made from high-impact injection-molded polystyrene (HIPS), which offers mechanical and ESD protection to packaged devices.



FEATURE	MEASURE	SYMBOL	SIZE (IN)	SIZE (MM)
Flange	Diameter	A	12.992	330.0
	Thickness	W2	0.724	18.4
	Space Between Flange	W1	0.488	12.4
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 & Label Placement

Tape and reel specifications for this part are also available on the Qorvo website.



Notes:

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



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Handling Precautions

Parameter	Rating	Standard
ESD – Human Body Model (HBM)	Class 1C (1,000V)	ANSI/ESD/JEDEC JS-001
ESD – Charged Device Model (CDM)	Class C3 (1,000V)	ANSI/ESD/JEDEC JS-002
MSL – Moisture Sensitivity Level	MSL 3	IPC/JEDEC J-STD-020



Caution!

ESD sensitive device

Solderability

Compatible with both lead-free (260 °C max. reflow temperature) and tin/lead (245 °C max. reflow temperature) soldering processes.

Package lead plating: Electroless Ni/Electroless Pd/Immersion Au (ENEPIG)

RoHS Compliance

This part 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
- Halogen Free (Chlorine, Bromine)
- Antimony Free
- TBBP-A (C₁₅H₁₂Br₄O₂) Free
- SVHC Free
- PFOS Free

Contact Information

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

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Tel: 1-844-890-8163

Email: customer.support@qorvo.com

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