QPF4657

Wi-Fi 7 Front End Module

24 Pad 5 x 3 mm Laminate Package

Product Overview

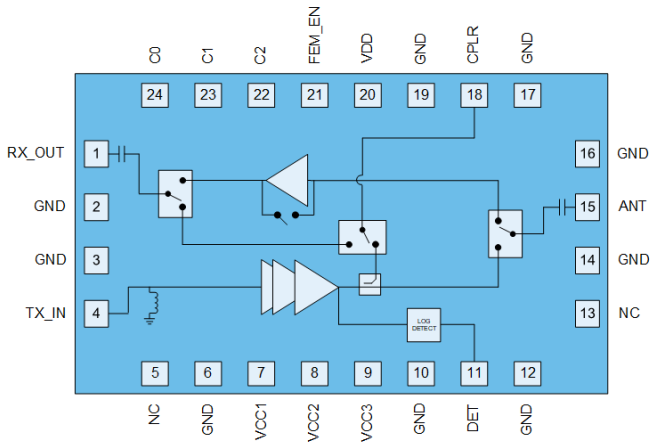
The Qorvo® QPF4657 is an integrated front end module (FEM) designed for Wi-Fi 7 (802.11be) systems. The compact form factor and integrated matching minimizes layout area in the application.

Performance is focused on optimizing the PA for a 5V supply voltage that conserves power consumption while maintaining the highest linear output power and leading edge throughput. This is done across a wide bandwidth enabling operation in all channels from UNII5-8 (5.9 to 7.1GHz)

Integrated die level filtering for 2nd and 3rd harmonics as well as 2.4 GHz rejection for DBDC operation are included. A coupler with RF output as well as a broadrange, constant slope voltage logarithmic power detector is provided for application feedback

The QPF4657 integrates a 6-7 GHz power amplifier (PA), single pole two throw switch (SP2T) and bypassable low noise amplifier (LNA) into a single device.

Functional Block Diagram



Top View

Key Features

- 5925 – 7125 MHz
- P_{OUT} = +18 dBm MCS13 320 MHz -43 dB Dynamic EVM
- P_{OUT} = +21 dBm MCS11 160 MHz -38 dB Dynamic EVM
- P_{OUT} = +24 dBm MCS9 80 MHz -35 dB Dynamic EVM
- P_{OUT} = +27 dBm MCS0 20 MHz Spectral Mask Compliance
- Optimized for +5 V Operation
- 31 dB Tx Gain
- 1.9 dB Noise Figure
- 13.5/3 dB Rx Gain & 7 dB Bypass Loss
- 25 dB 2.4 GHz Rejection on Rx Path
- Integrated RF & DC Logarithmic Power Detector

Applications

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

Ordering Information

Part Number	Description
QPF4657SB	Sample bag with 5 pieces
QPF4657SR	7” reel with 100 pieces
QPF4657TR13	13” reel with 5,000 pieces
QPF4657EVB	Assembled Evaluation Board

Absolute Maximum Ratings

Parameter	Conditions	Rating
DC Supply Voltage		-0.5 to +6 V
Control Voltage	C0, C1, C2 & FEM_EN	-0.5 to +6 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	Into 50 Ω Load for 802.11a-ax (No Damage), Transmit Mode	+10 dBm
RF Input Power at TX	Into 10:1 VSWR for 802.11a-ax (No Damage), Transmit Mode;	TBD dBm
RF Input Power at ANT	(No Damage), Receive LNA On 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	5945	-	7125	MHz
Operating Frequency^	5925	-	7125	MHz
Device Voltage (V_{CC} & V_{DD})	+4.5	+5	+5.25	V
Extended Device Voltage (V_{CC} & V_{DD}) ^	+3.8	-	+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_IN-ANT) Mode	**Unless otherwise noted: $V_{CC/DD}$=5V, T=+25ºC, C0=Low, C1=High, C2=High, FEM_EN=High**				
Wi-Fi 7 320 MHz(1) Output Power		14	18	-	dBm
Dynamic EVM	MCS13 4096QAM	-	-	-43	dB
Wi-Fi 7 160 MHz(1) Output Power		19	21	-	dBm
Dynamic EVM	MCS11 1024QAM	-	-	-38	dB
Wi-Fi 7 80 MHz Output Power		21	22.5	-	dBm
Dynamic EVM	MCS9 256QAM	-	-	-35	dB
Wi-Fi 7 20 MHz Output Power		22.5	25	-	dBm
Dynamic EVM	MCS7 64QAM	-	-	-30	dB
Margin to 20 MHz Spectral Mask	P_{OUT} = +27 dBm, MCS0	0	3	-	dBc

Parameter	Conditions	Min.	Typ.	Max.	Units
Gain		-	31	-	dB
Gain Flatness	Across any 320 MHz Channel	-0.5	-	+0.5	dB
Out of Band Gain	*f* < 4755 MHz	15	-	-	dB
	f > 7960 MHz	15	-	-	dB
TX Port Return Loss		-	20	-	dB
ANT Port Return Loss		-	14	-	dB
Quiescent Current	RF Off	-	150	-	mA
Operating Current	P_{OUT} = +18 dBm	-	230	-	mA
	P_{OUT} = +21 dBm	-	275	-	mA
	P_{OUT} = +24 dBm	-	340	-	mA
	P_{OUT} = +27 dBm	-	450	-	mA
2nd Harmonics	P_{OUT} = +27 dBm 802.11ax MCS0	-	-42	-	dBm/MHz
3rd Harmonics	P_{OUT} = +27 dBm 802.11ax MCS0	-	-44	-	dBm/MHz
ANT-RX Isolation		-	40	-	dB
CLPR Directivity	Relative to a 4 Port Coupled Line Internal Isolation Port	-	20	-	dB
CPLR-TX Isolation		-	50	-	
CPLR-RX_OUT Isolation		-	30	-	
DC Power Detect Voltage	P_{OUT} = 0 dBm	-	0.15	-	V
	P_{OUT} = +5 dBm	-	0.5	-	V
	P_{OUT} = +27 dBm	-	1.0	-	V
Power Detector Slope	P_{OUT} = +5-28 dBm	-	32	-	mV/dB
RECEIVE (ANT-LNA_OUT) LNA ON HIGH MODE	**Unless otherwise noted: $V_{CC/DD}$=5V, T=+25ºC, C0=High, C1=Low, C2=Low, FEM_EN=High**				
Gain		-	13.5	-	dB
Gain Flatness	Across any 320 MHz Channel	-0.5	-	+0.5	dB
Out of Band Gain	*f* = 2400-2500 MHz	-	-25	-	dB
Noise Figure		-	1.9	-	dB
RX Port Return Loss		-	15	-	dB
ANT Port Return Loss		-	10	-	dB
Input P_{1dB}		-	-3	-	dBm
Input IP3	2-tone CW, 1MHz spacing	-	+8	-	dBm
Rx Operating Current		-	20	-	mA
RECEIVE (ANT-LNA_OUT) LNA ON MID MODE	**Unless otherwise noted: $V_{CC/DD}$=5V, T=+25ºC, C0=Low, C1=Low, C2=High, FEM_EN=High**				
Gain		-	4	-	dB
Gain Flatness	Across any 320 MHz Channel	-0.5	-	+0.5	dB
Out of Band Gain	*f* = 2400-2500 MHz	-	-30	-	dB
Noise Figure		-	4	-	dB
RX Port Return Loss		-	20	-	dB
ANT Port Return Loss		-	15	-	dB
Input P_{1dB}		-	-1	-	dBm
Input IP3	2-tone CW, 1MHz spacing	-	+9	-	dBm
Rx Operating Current		-	20	-	mA

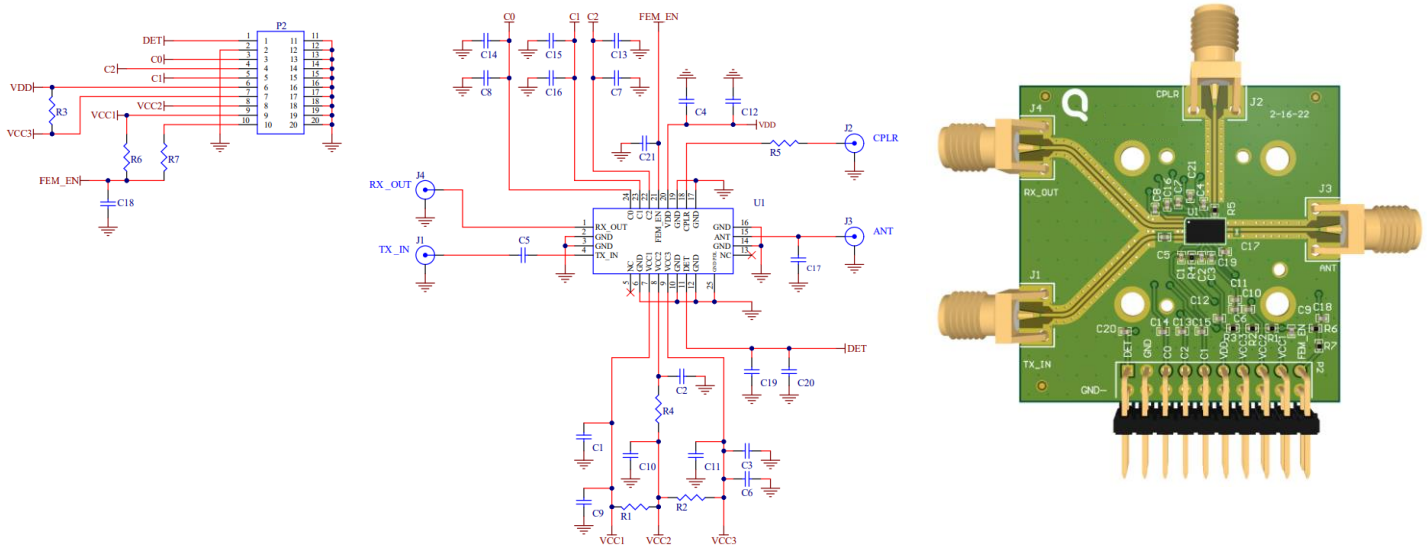
Parameter	Conditions	Min.	Typ.	Max.	Units
RECEIVE (ANT-LNA_OUT) BYPASS MODE	**Unless otherwise noted: $V_{CC/DD}$=5V, T=+25ºC, C0=High, C1=High, C2=Low, FEM_EN=High**				
Bypass Loss		-	7	-	dB
Loss Flatness	Across any 160 MHz Channel	-0.25	-	+0.25	dB
Out of Band Gain	*f* = 2400-2500 MHz	-	-35	-	dB
RX Port Return Loss		-	10	-	dB
ANT Port Return Loss		-	12	-	dB
Input P_{1dB}		-	+29	-	dBm
Input IP3	2-tone CW, 1MHz spacing	-	+45	-	dBm
GENERAL SPECIFICATIONS	**Unless otherwise noted: $V_{CC/DD}$=5V, T=+25ºC, Switching Time Power Accuracy +/- 1dB**				
FEM Leakage Current	Standby Mode	-	475	-	µA
Control Current - High		-	15	-	µA
Control Current - Low		-	1	-	µA
TX Output P_{1dB}	CW	-	+31	-	dBm
Switching Time	Transmit to LNA On or Bypass Mode	-	-	1000	nS
	LNA On to Bypass Mode	-	-	200	nS
	Bypass to LNA On Mode	-	-	200	nS
	LNA On or Bypass to Transmit Mode	-	-	1000	nS
PA Stability - Output VSWR	CW No Spurious above -41.25 dBm/MHz, P_{OUT} = 0-27 dBm	-	10:1	-	
Thermal Resistance, θ_{jc}	Junction to case	-	25	-	°C/W

Notes:
1. Normalized to -50dB source

Logic Truth Table

Mode	STATE	FEM_EN	C0	C1	C2
Transmit	1	High	Low	High	High
LNA On – High	2	High	High	Low	Low
Bypass	3	High	High	High	Low
All Off	4	High	Low	Low	Low
Transmit + Coupler	5	High	High	High	High
Coupler to RX_OUT	6	High	Low	High	Low
LNA On – Mid	7	High	Low	Low	High
Not Supported	8	High	High	Low	High
FEM Disabled	9	Low	-	-	-

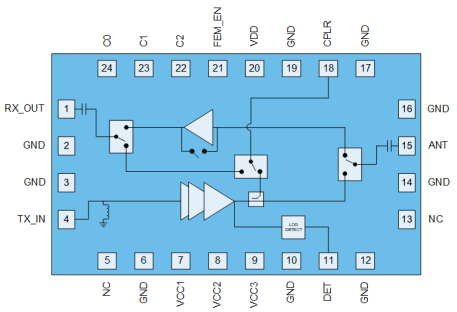
Evaluation Board Schematic



Bill of Material

Ref. Des.	Value	Description	Manuf.	Part number
-	-	Printed Circuit Board		
U1	-	6GHz Wi-Fi 7 Front End Module	Qorvo	QPF4657
C4	1000 pF	Capacitor, Chip, 5%, 50V, C0G, 0402	MuRata	GRM1555C1H102JA01D
C21	150 pF	Capacitor, Chip, 10%, 50V, C0G, 0402	Kemet	C0402C151K5RACTU
C1,C2,C3	2.2 uF	Capacitor, Chip, 10%, 16V, X5R, 0402	Murata	GRM155R61C225KE11D
C12	4.7 uF	Capacitor, Chip, 20%, 10V, X6S, 0402	Taiyo Yuden	MEASL105CC6475MFNA01
C19	10 kΩ	Resistor, Chip, 5%, 1/16W, 0402	Kamaya	RMC1/16S-103JTH
C5,R4,R5,R7	0 Ω	Resistor, Chip, 5%, 1/10W, 0402	Kamaya	RMC1/16SJPTH
R1,R2,R3,R6,C6,C7,C8, C9,C10,C11,C13,C14,C15, C16,C17,C18,C20	-	Do Not Install		

Pin Configuration and Description



Top View

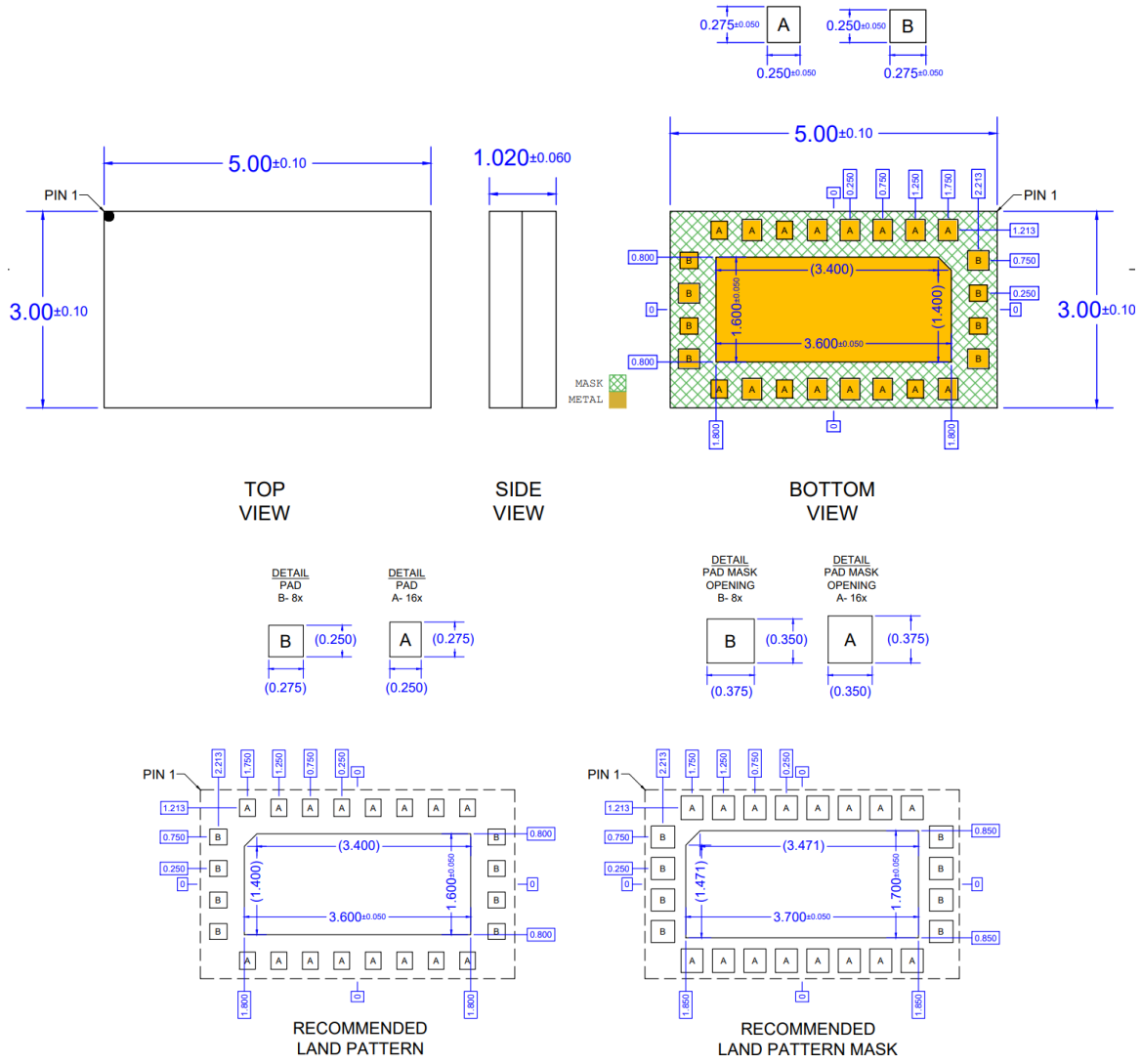
Pin Number	Label	Description
1	RX_OUT	RF output from the low noise amplifier. Internally matched to 50 Ω and DC blocked. (1)
2	GND	Ground connection.
3	GND	Ground connection.
4	TX_IN	RF input. Internally matched to 50 Ω and DC blocked. (1)
5	NC	No connection.
6	GND	Ground connection.
7	VCC1	Supply voltage.
8	VCC2	Supply voltage.
9	VCC3	Supply voltage.
10	GND	Ground connection.
11	DET	DC power detector. Provides an output voltage proportional to the RF output power level
12	GND	Ground connection.
13	NC	No connection.
14	GND	Ground connection.
15	ANT	RF bi-directional antenna port. Internally matched to 50 Ω and DC blocked. (1)
16	GND	Ground connection.
17	GND	Ground connection.
18	CPLR	RF power detector. Provides a coupled RF output power proportional to the RF output power level
19	GND	Ground connection.
20	VDD	LNA & regulator supply voltage.
21	FEM_EN	Control pin.
22	C2	Control pin.
23	C1	Control pin.
24	C0	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 these ports. If connected to an external component with DC present, a 10pF blocking capacitor is recommended.

Mechanical Information

Dimensions and PCB Mounting Pattern



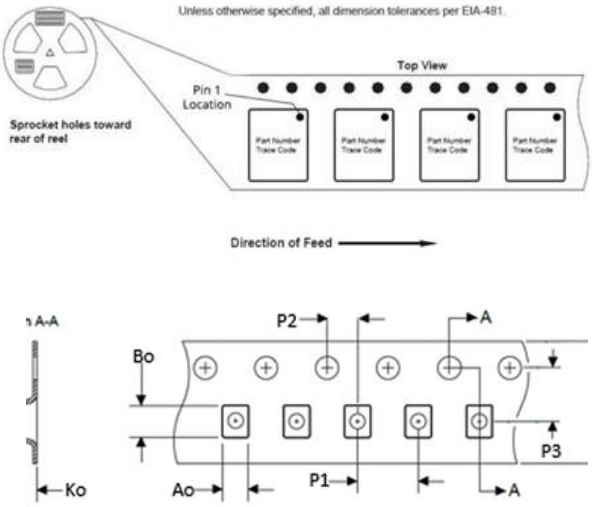
Notes:
2. All dimensions are in millimeters. Angles are in degrees.
3. Dimension and tolerance formats conform to ASME Y14.4M-1994.
4. The terminal #1 identifier and terminal numbering conform to JESD 95-1SPP-012

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.

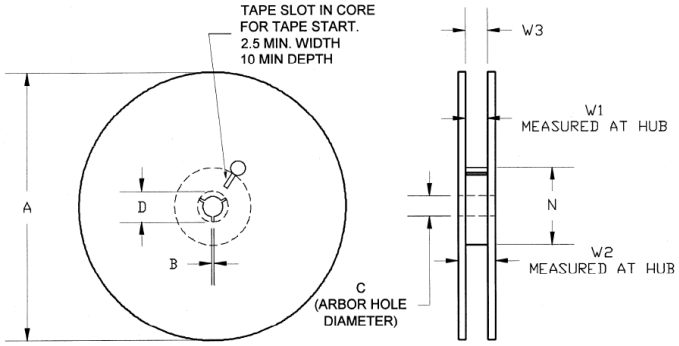
Standard T/R size = 5,000 pieces on a 13” reel.



FEATURE	MEASURE	SYMBOL	SIZE (IN)	SIZE (MM)
Cavity	Length	A0	0.128	3.20
	Width	B0	0.206	5.25
	Depth	K0	0.047	1.20
	Pitch	P1	0.315	8.00
Centerline Distance	Cavity to Perforation - Length Direction	P2	0.079	2.00
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	12.00

Tape and Reel Information – Reel Dimensions

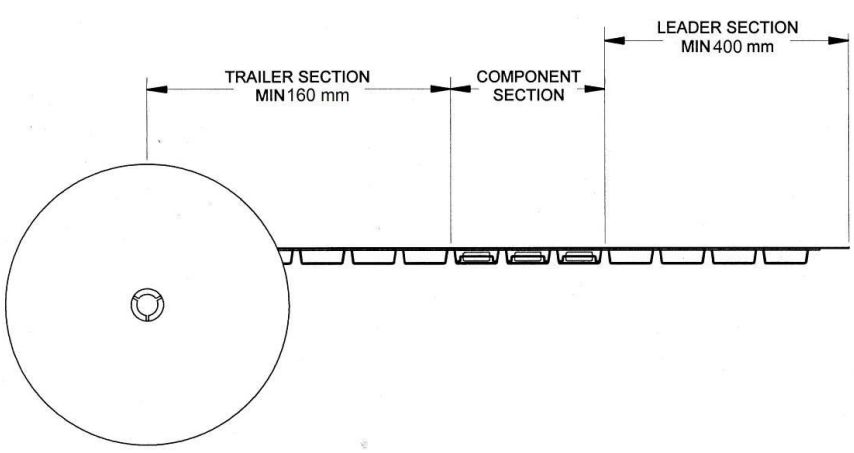
Packaging reels are used to prevent damage to devices during shipping and storage, loaded carrier tape is typically wound onto a plastic take-up reel. The reel size is 13" diameter. The reels are made from high-impact injection-molded polystyrene (HIPS), which offers mechanical and ESD protection to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



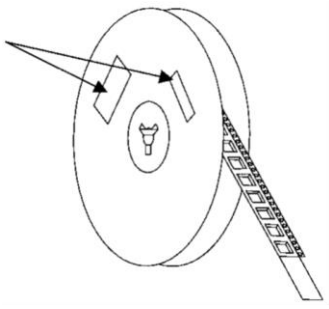
FEATURE	MEASURE	SYMBOL	SIZE (IN)	SIZE (MM)
Flange	Diameter	A	12.992	330.0
	Thickness	W2	0.724	18.4
	Space Between Flange	W1	0.488	12.4
Hub	Outer Diameter	N	4.016	102.0
	Arbor Hole Diameter	C	0.512	13.0
	Key Slit Width	B	0.079	2.0
	Key Slit Diameter	D	0.795	20.2

Tape and Reel Information – Tape Length & Label Placement

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



Note 2



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..

Handling Precautions

Parameter	Rating	Standard
ESD – Human Body Model (HBM)	Class 1C 1500 V	ANSI/ESD/JEDEC JS-001
ESD – Charged Device Model (CDM)	Class C3 1000 V	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 ($C_{15}H_{12}Br_4O_2$) Free
- SVHC Free
- PFOS Free

Contact Information

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

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