

### Product Overview

The QPA4501 is an integrated 2-stage Power Amplifier Module designed for massive MIMO applications up to 3 W RMS at the device output covering frequency range from 4.4 to 5.0 GHz.

The module is 50  $\Omega$  input and output and requires minimal external components. The module is also compact and offers a much smaller footprint than traditional discrete component solutions.

The QPA4501 incorporates a Doherty final stage delivering high power added efficiency for the entire module up to 3 W average power.

RoHS compliant.



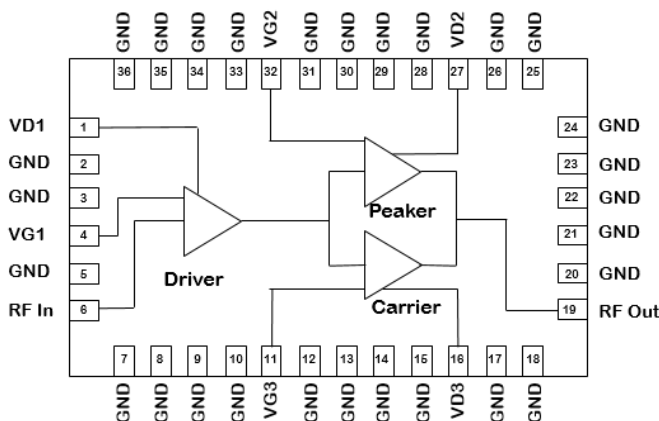
36 Pad 6 x 10 mm Plastic QFN Package

### Key Features

- Operating Frequency Range: 4.4 – 5.0 GHz
- Operating Drain Voltage: +28 V
- 50  $\Omega$  Input / Output
- Integrated Doherty Final Stage
- Gain at 1.25 W Avg.: 29.9 dB
- Power Added Efficiency at 1.25 W Avg.: 25.7%
- Power Added Efficiency at 3 W Avg.: 38%
- 6 x 10 mm Plastic Surface Mount Package

Note: T = +25°C, single-carrier, 20 MHz LTE signal with 7.8 dB PAR at 0.01% CCDF.

### Functional Block Diagram



### Applications

- 5G Massive MIMO
- W-CDMA / LTE
- Macrocell Base Station Driver
- Microcell Base Station
- Small Cell Final Stage
- Active Antenna
- General Purpose Applications

### Ordering Information

Part No.	Description
QPA4501SB	Sample Bag – 5 Pieces
QPA4501SR	Short Reel – 100 Pieces
QPA4501TR13	13" Reel – 2500 Pieces
QPA4501EVB01	Tested 4.4 – 5.0 GHz EVB

## Absolute Maximum Ratings

Parameter	Value	Units
Breakdown Voltage ( $V_{BDG}$ )	120	V
Gate Voltage ( $V_{G1,2,3}$ )	-7 to +2	V
Drain Voltage ( $V_{D1,2,3}$ )	+40	V
RF Input Power <sup>(1)</sup>	+12	dBm
VSWR Mismatch, P3dB Pulse (10% Duty Cycle, 100 $\mu$ s Pulse Width), T = +25°C	10:1	
Power Dissipation	63	W

Notes:

1. Tested at 4.7 GHz, T = +25°C, single-carrier, 20 MHz LTE signal with 7.8 dB PAR at 0.01% CCDF.
2. 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
Gate Voltage ( $V_{G1}$ )		-2.6		V
Gate Voltage ( $V_{G2}$ )		-4.2		V
Gate Voltage ( $V_{G3}$ )		-2.6		V
Drain Voltage ( $V_{D1,2,3}$ )		+28		V
Quiescent Current ( $I_{DQ1}$ )		50		mA
Quiescent Current ( $I_{DQ3}$ )		75		mA
Power Dissipation		3.8		W

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

## Electrical Specifications

Parameter	Conditions	Min	Typ	Max	Units
Frequency Range		4.4		5.0	GHz
Driver Quiescent Current ( $I_{DQ1}$ )			50		mA
Carrier Quiescent Current ( $I_{DQ3}$ )			75		mA
Gain	$P_{AVG} = 31$ dBm	26.0	29.9		dB
Saturated Power ( $P_{SAT}$ )	Pulse (10% Duty Cycle, 500 $\mu$ s Width), $P_{IN} = 19$ dBm	41.9	43.5		dBm
Power Added Efficiency (PAE)	$P_{AVG} = 31$ dBm	19.8	25.7		%
Raw ACLR	$P_{AVG} = 31$ dBm		-35.1		dBc

Test conditions unless otherwise noted:  $V_{D1,2,3} = +28$  V,  $I_{DQ1} = 50$  mA,  $I_{DQ3} = 75$  mA,  $V_{G2} = -4.2$  V, T = +25°C, using a single-carrier, 20 MHz LTE signal with 7.8 dB PAR at 0.01% CCDF on the reference design fixture.

## Thermal Information

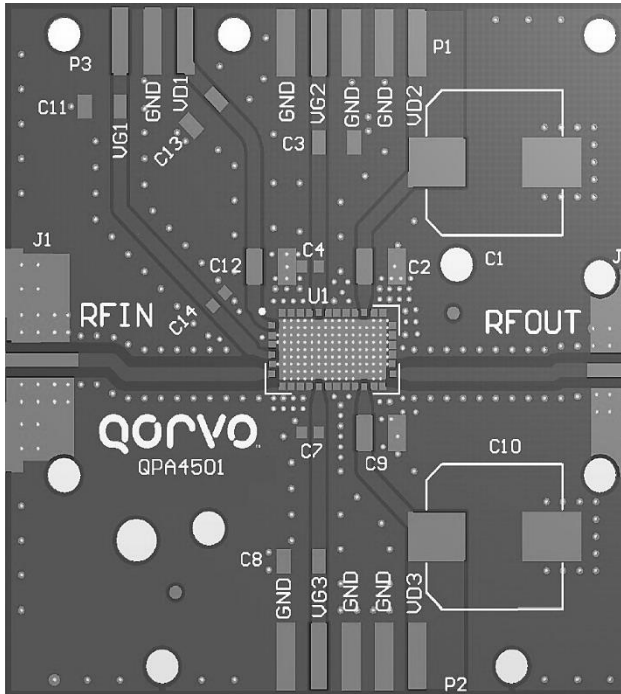
Parameter	Conditions	Values	Units
Peak IR Surface Thermal Resistance at Average Power ( $\theta_{JC}$ )	$T_{CASE} = +85^\circ\text{C}$ , $T_{CH} = 91^\circ\text{C}$ CW: $P_{DISS} = 4$ W, $P_{OUT} = 1.25$ W	1.5	°C/W

Notes:

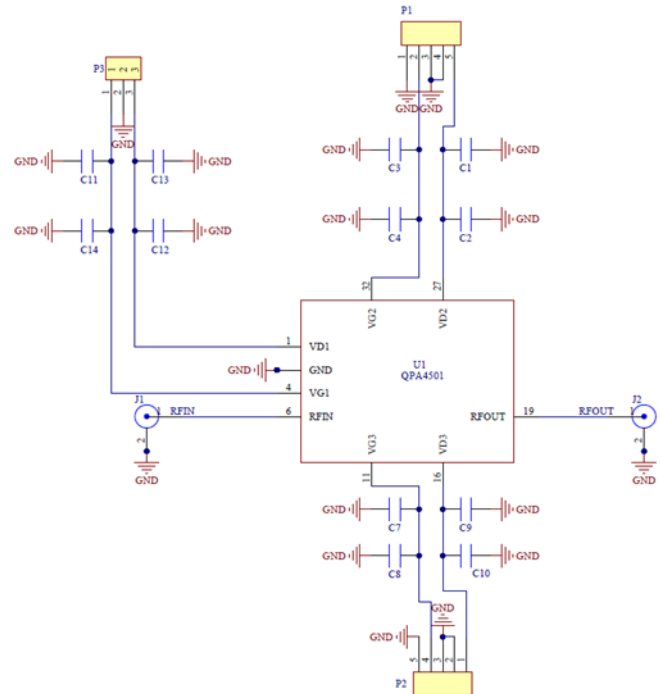
1. Based on expected carrier amplifier efficiency of Doherty.
2.  $P_{OUT}$  assumes 10% peaking amplifier contribution of total average Doherty rated power.
3. Thermal resistance is measured to package backside.
4. Refer to the following document: [GaN Device Channel Temperature, Thermal Resistance, and Reliability Estimates](#)

## QPA4501 4.4 – 5.0 GHz Reference Design

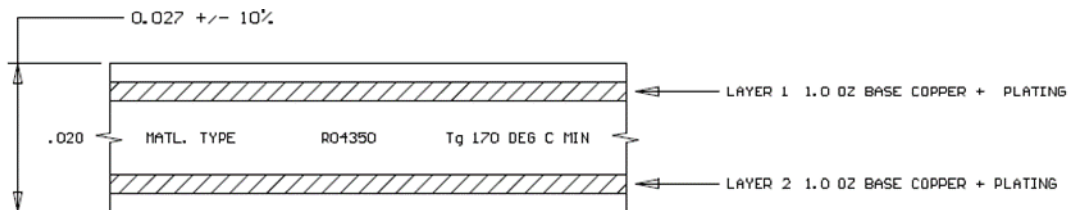
EVB Layout



EVB Schematic



PCB Stackup and Material



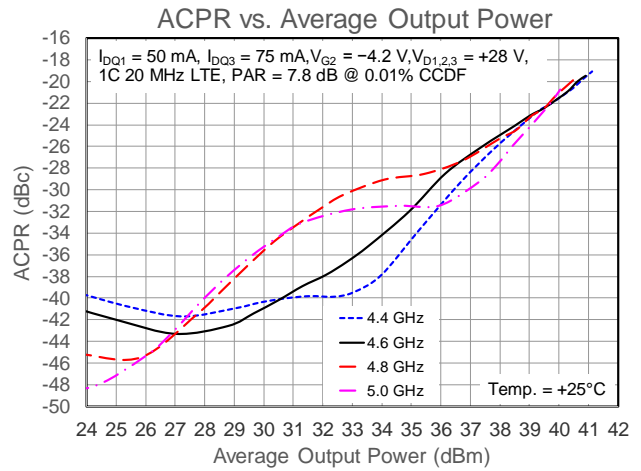
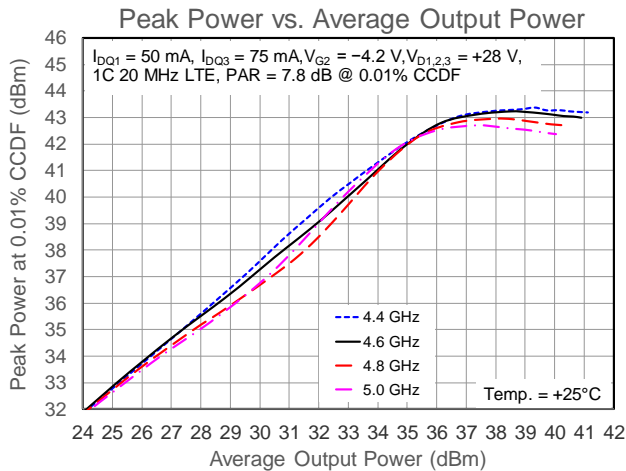
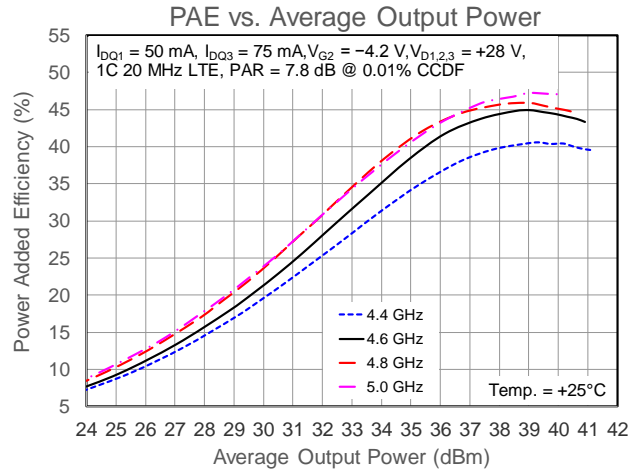
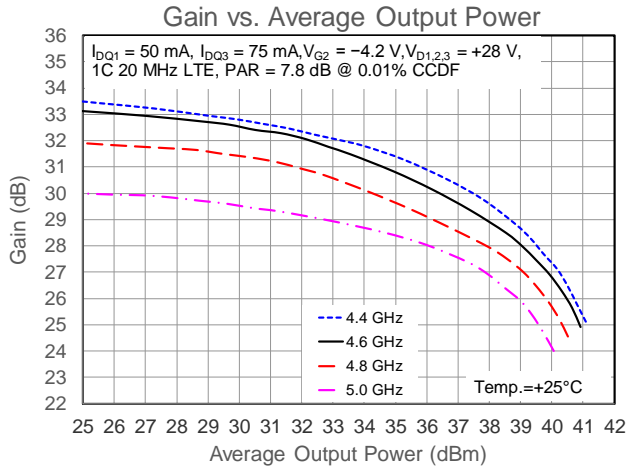
**Notes:**

1. All dimensions are in inches.
2. PCB is soldered on a 2 in. x 2 in. copper base plate with 0.25 in. thickness.

## Bill of Materials – QPA4501 4.4 – 5.0 GHz Evaluation Board

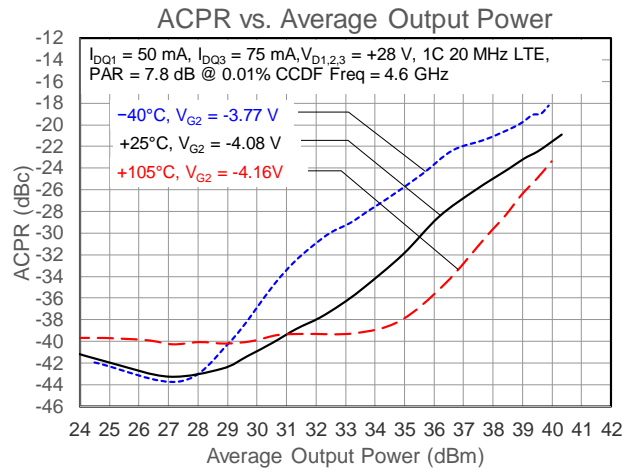
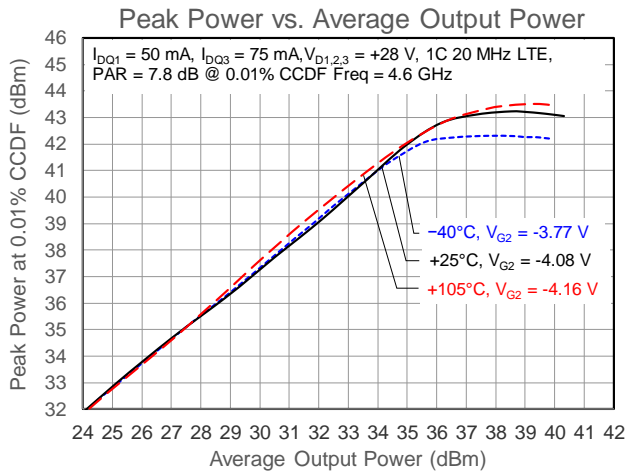
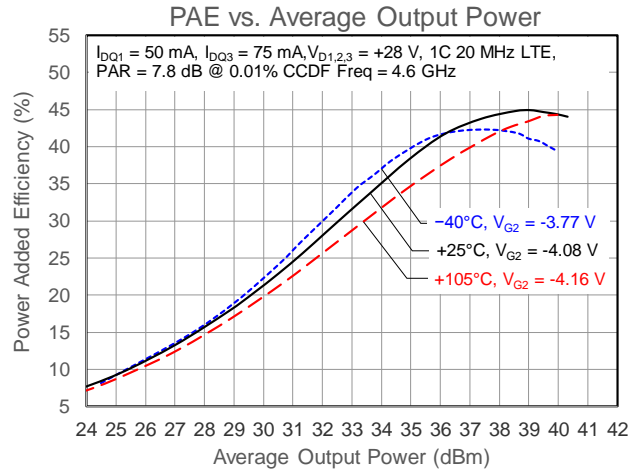
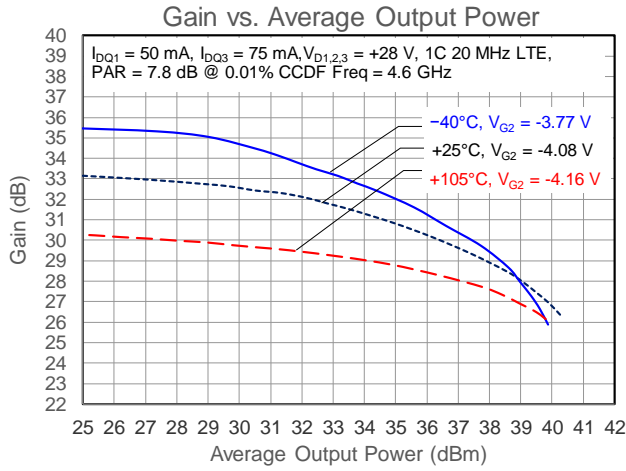
Reference Des.	Value	Description	Manufacturer	Part Number
C1, C10	220 $\mu$ F	Capacitor, 220 $\mu$ F, electrolytic, 50 V	Panasonic	EEEFK1H221P
C4, C7, C14	22,000 pF	Capacitor, 22,000 pF, 10%, 50 V, X7R, 0603	Murata	GRM188R71H223KA01D
C3, C8, C11, C13	4.7 $\mu$ F	Capacitor, 4.7 $\mu$ F, 10%, 50 V, X7R, 1206	Murata	GRM31CR71H475KA12L
C2, C9, C12	10 $\mu$ F	Capacitor, 10 $\mu$ F, 10%, 50 V, X7R, 1210	Murata	GRM32ER71H106KA
J1, J2		Connector, SMA, 4-Hole Panel Mount Jack	Gigalane	PAF-S00-000
P1, P2		Connector, HDR, ST, PLRZD, 5-Pin, 0.100"	ITW Pancon	MPSS100-5-C
P3		Connector, HDR, ST, 3-PIN, T/H	Molex	22-28-4033
U1		3 W 4.4 – 5.0 GHz GaN PA Module	Qorvo	QPA4501

**Performance Plots**



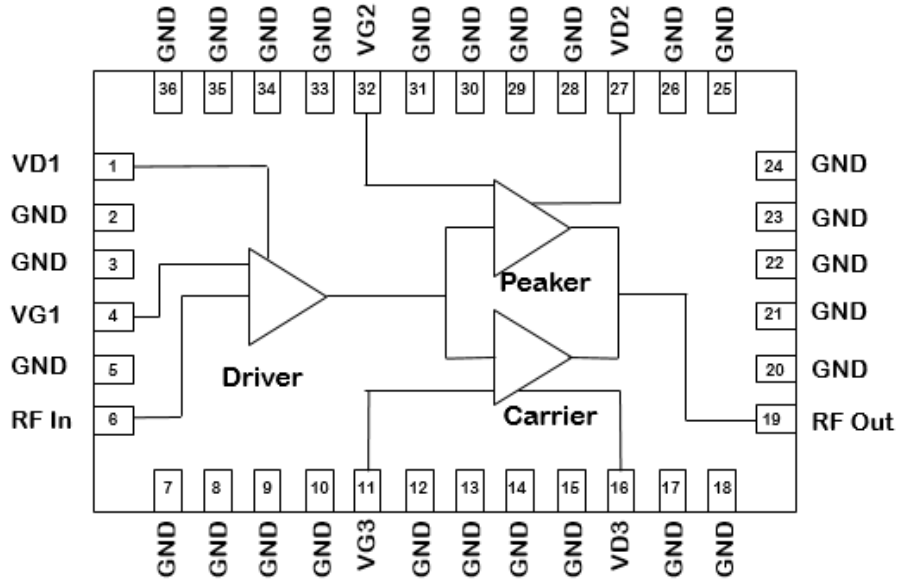
Test conditions unless otherwise noted:  $V_{D1,2,3} = +28 \text{ V}$ ,  $I_{DQ1} = 50 \text{ mA}$ ,  $I_{DQ3} = 75 \text{ mA}$ ,  $V_{G2} = -4.2 \text{ V}$ ,  $T = +25^\circ\text{C}$ , tested using a single-carrier, 20 MHz LTE signal with 7.8 dB PAR at 0.01% CCDF on a reference design fixture.

**Performance Plots**



Test conditions unless otherwise noted:  $V_{D1,2,3} = +28 \text{ V}$ ,  $I_{DQ1} = 50 \text{ mA}$ ,  $I_{DQ3} = 75 \text{ mA}$ ,  $V_{G2} = -4.2 \text{ V}$ , tested at 4.6 GHz using a single-carrier, 20 MHz LTE signal with 7.8 dB PAR at 0.01% CCDF on a reference design fixture.

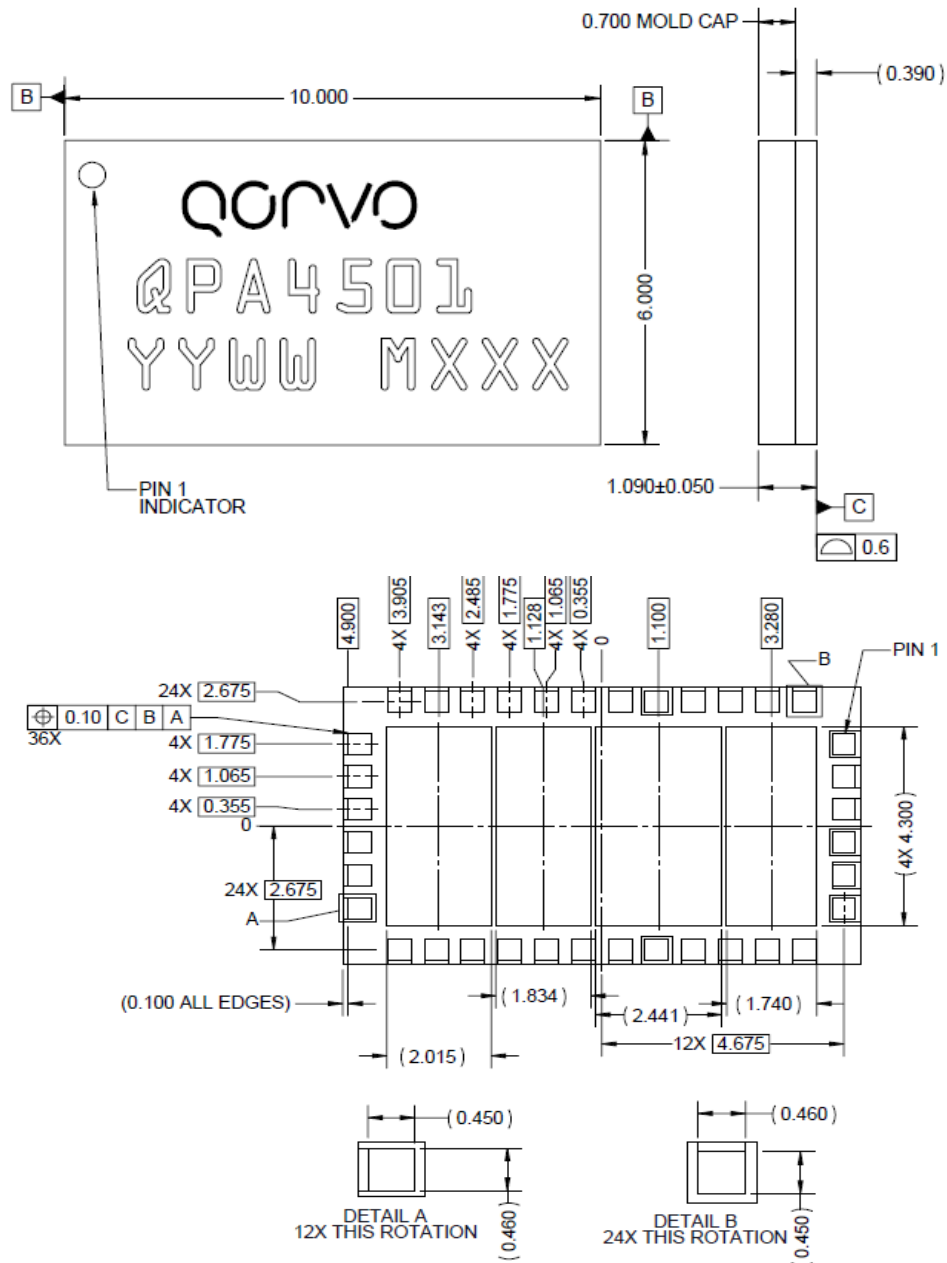
## Pad Configuration and Description



Pad No.	Label	Description
1	VD1	Driver Amplifier, Drain Bias
4	VG1	Driver Amplifier, Gate Bias
6	RF IN	RF Input
11	VG3	Carrier Amplifier, Gate Bias
16	VD3	Carrier Amplifier, Drain Bias
19	RF OUT	RF Output
27	VD2	Peaking Amplifier, Drain Bias
32	VG2	Peaking Amplifier, Gate Bias
2 – 3, 5, 7, 10, 12 – 15, 17 – 18, 20 – 26, 28 – 31, 33 – 36	GND	Internal Grounding. Recommend connecting to Epad ground.
EPAD	GND	DC/RF Ground. Must be soldered to EVB ground plane over array of vias for thermal and RF performance. Solder voids under EPAD will result in excessive junction temperatures causing permanent damage.

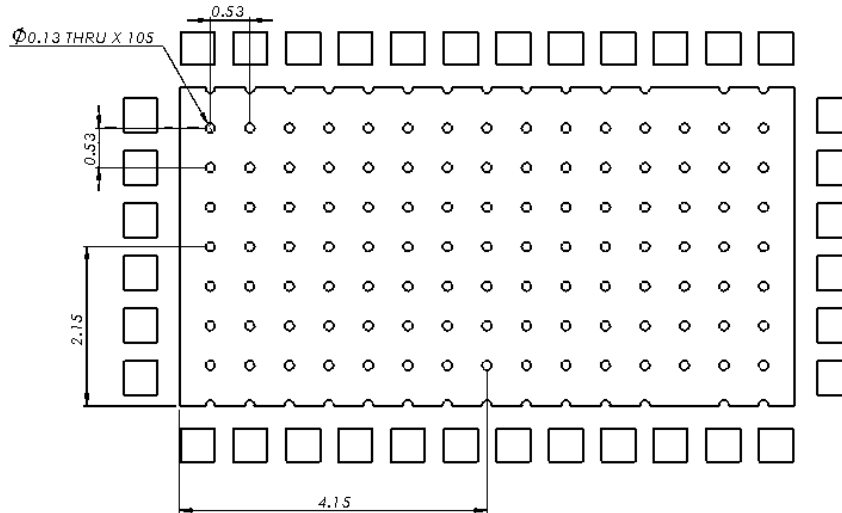
## Package Marking and Dimensions

Marking: Qorvo Logo  
 Part Number – QPA4501  
 Date Code – YYWW  
 Batch Code – MXXXX



- Notes:
1. All dimensions are in millimeters. Angles are in degrees.
  2. Exposed metallization is NiPdAu plated. Au thickness is 0.095  $\mu\text{m}$ .

Mounting Footprint Pattern

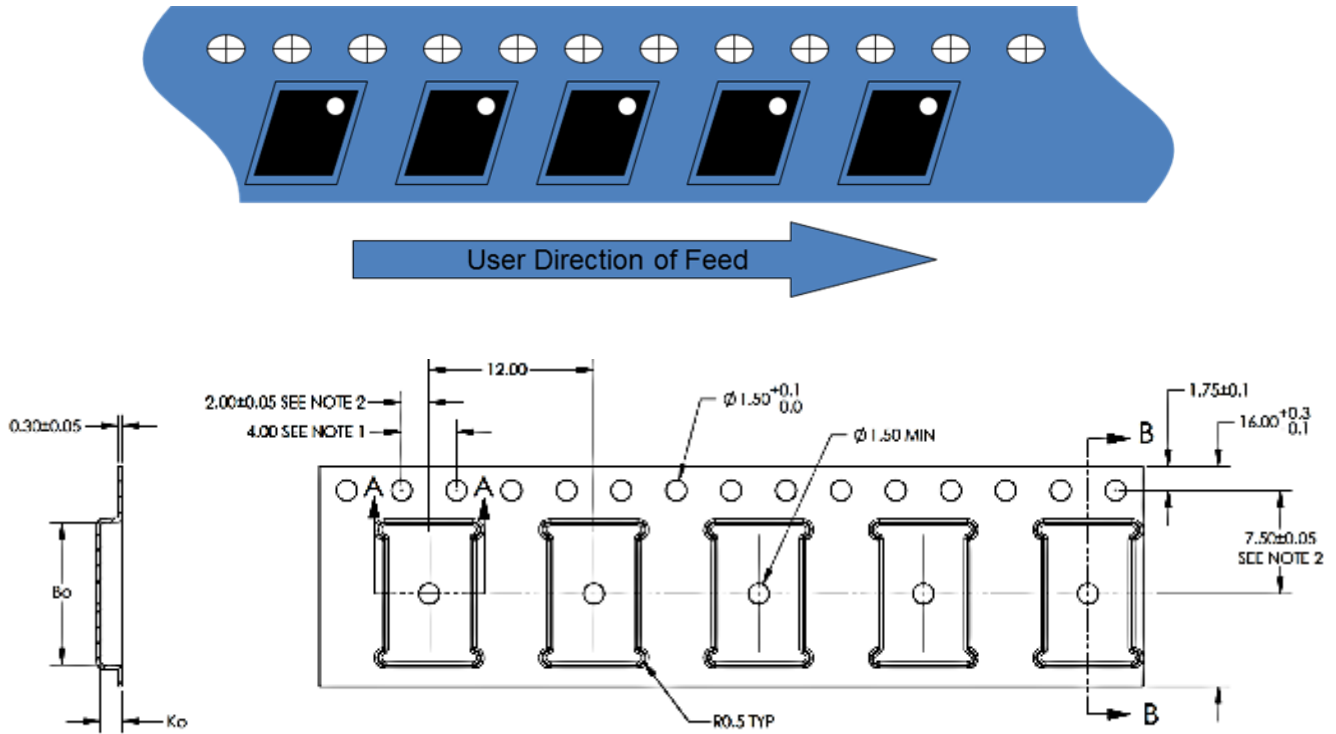


Notes:

1. All dimensions are in millimeters. Angles are in degrees.
2. Vias are required under the backside paddle of this device for proper RF/DC grounding and thermal dissipation. All vias are plated thru hole (PTH) to ground.
3. Ensure good package backside paddle solder attach for reliable operation and best electrical performance.



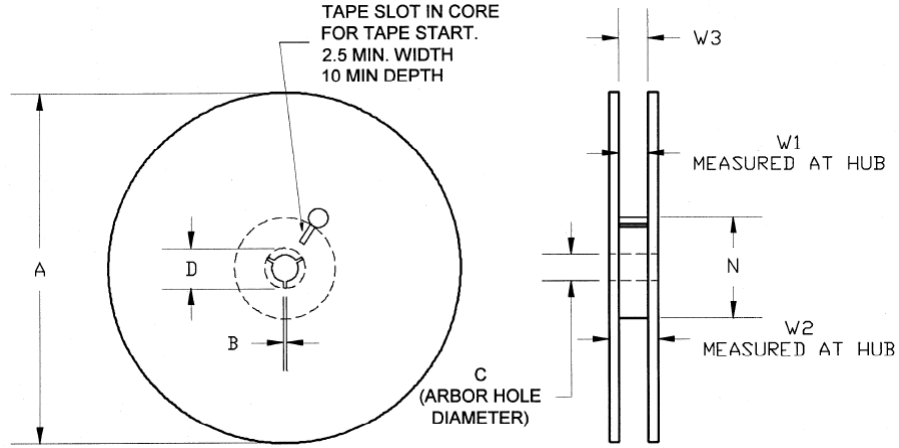
**Tape and Reel Information – Carrier and Cover Tape Dimensions**



Feature	Measure	Symbol	Size (in)	Size (mm)
Cavity	Length	A0	0.248	6.30
	Width	B0	0.406	10.3
	Depth	K0	0.061	1.55
	Pitch	P1	0.472	12.0
Centerline Distance	Cavity to Perforation - Length Direction	P2	0.079	2.00
	Cavity to Perforation - Width Direction	F	0.295	7.5
Cover Tape	Width	C	0.524	13.3
Carrier Tape	Width	W	0.630	16.0

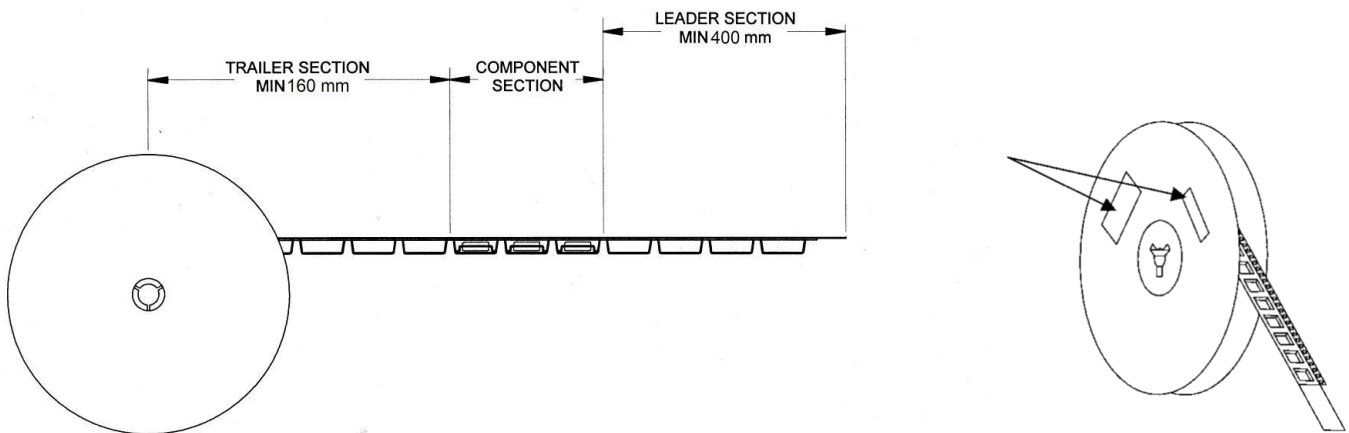
**Tape and Reel Information – Reel Dimensions**

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



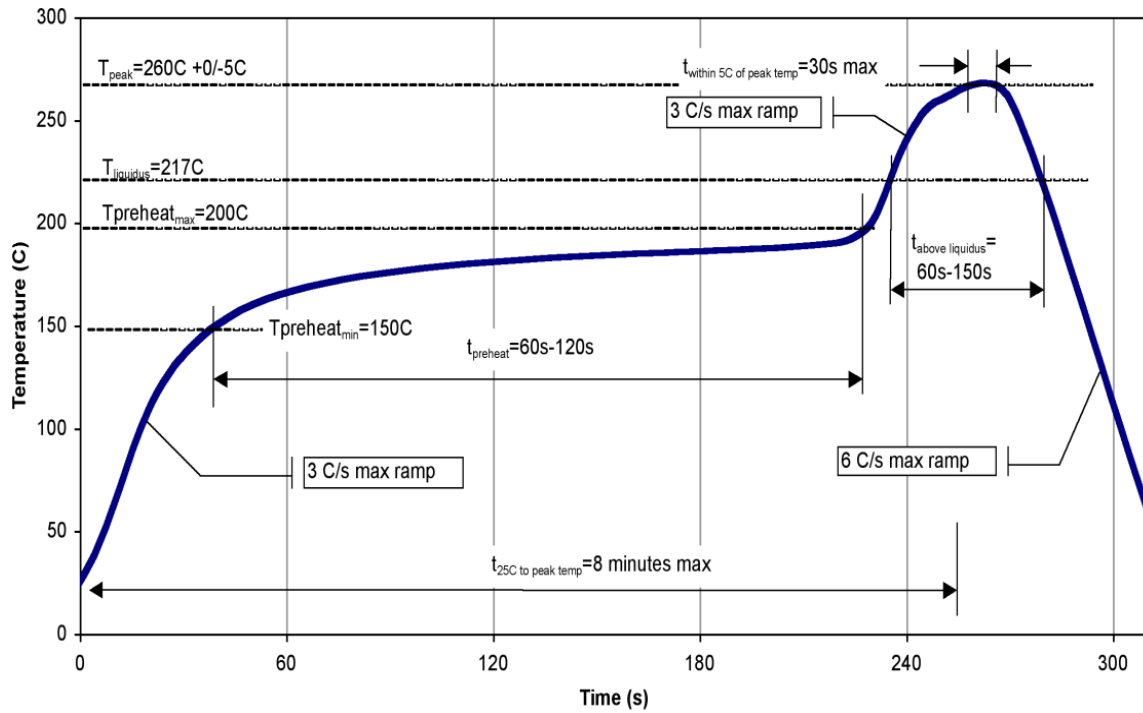
Feature	Measure	Symbol	Size (in)	Size (mm)
Flange	Diameter	A	12.992	330.0
	Thickness	W2	0.874	22.2
	Space Between Flange	W1	0.661	16.8
Hub	Outer Diameter	N	4.016	102.0
	Arbor Hole Diameter	C	0.512	13.0
	Key Slit Width	B	0.079	2.0
	Key Slit Diameter	D	0.787	20.0

**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.

Recommended Solder Temperature Profile



## Handling Precautions

Parameter	Rating	Standard
ESD – Human Body Model (HBM)	Class 1B (500 V)	ANSI/ESDA/JEDEC Standard JS-001
ESD – Charged Device Model (CDM)	Class C3 (1000 V)	ANSI/ESDA/JEDEC Standard JS-002
MSL – 260°C Convection Reflow	Level 3	IPC/JEDEC Standard J-STD-020



## Solderability

Compatible with lead-free (260°C max. reflow temp.) soldering processes.

Package lead plating is NiPdAu. Au thickness is 0.095 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:

- Halogen Free (Chlorine, Bromine)
- Antimony Free
- TBBP-A (C<sub>15</sub>H<sub>12</sub>Br<sub>4</sub>O<sub>2</sub>) Free
- PFOS Free
- SVHC Free

## Contact Information

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

**Web:** [www.qorvo.com](http://www.qorvo.com)

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

**Email:** [customer.support@qorvo.com](mailto:customer.support@qorvo.com)

For technical questions and application information:

**Email:** [BTSApplcations@qorvo.com](mailto:BTSApplcations@qorvo.com)

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