

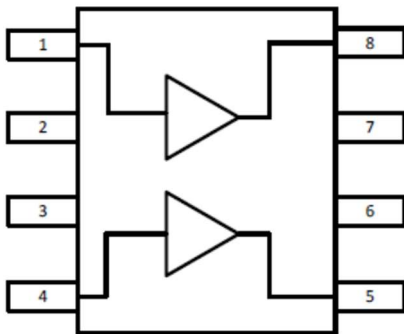
### Product Overview

The QPB8896 is a GaAs pHEMT RF balanced amplifier IC operating as return path amplifier capable of supporting DOCSIS 4.0 applications. This IC is designed to provide a low noise, high gain option for 5 – 700 MHz interface using a 5V power supply to provide lower overall power dissipation. QPB8896 is in a convenient SOIC-8 package.



SOIC-8 with Exposed Pad

### Functional Block Diagram



Functional Block Diagram

Top View

### Key Features

- 5 MHz to 700 MHz Operation
- 5 V Operation
- High Gain: 25 dB Typical
- Low Noise Figure:
  - 1.1dB for Upstream Splits Through 492MHz
  - 1.8dB for 684MHz
- SOIC-8 Exposed Pad

### Applications

- Head End CMTS Equipment
- Post Amp for Return Path Optical Receivers
- Full Duplex Upstream
- DOCSIS 4.0 Optical Nodes
- DOCSIS 4.0 Amplifiers

### Ordering Information

Part Number	Description
QPB8896SR	7" Reel with 100 pieces
QPB8896TR13	13" Reel with 2500 pieces
QPB8896PCK	5 – 700 MHz PCBA with 5 pc sample bag
QPB8896PCK-1	5 – 300 MHz PCBA with 5 pc sample bag

### Absolute Maximum Ratings

Parameter	Rating
Supply Voltage (V <sub>DD</sub> )	+8 V
Supply Current (I <sub>DD</sub> )	360 mA
Maximum CW Input Power for V <sub>DD</sub> = 5 V	+1 dBm
Operating Temperature Range	-40 to +85 °C
Storage Temperature Range	-40 to +150 °C
Maximum Junction Temperature	+160 °C

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.

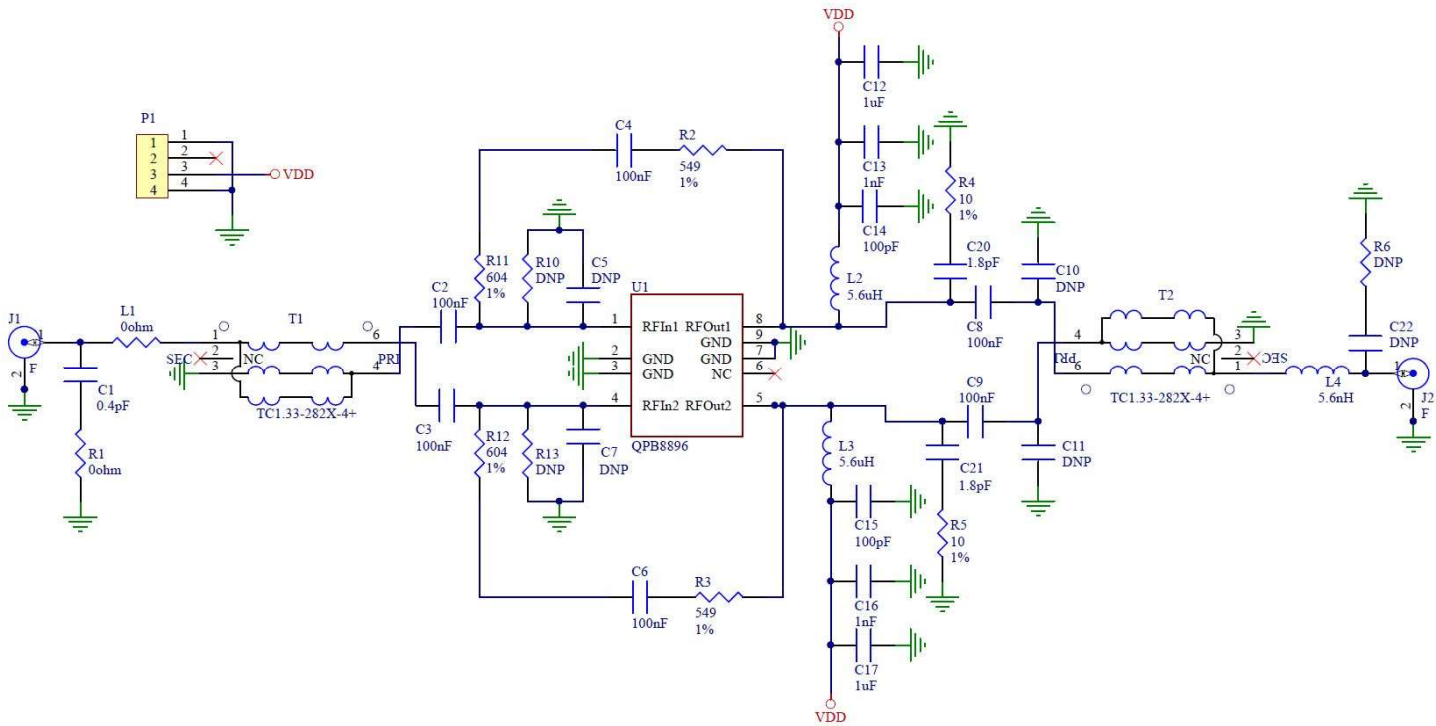
### Electrical Specifications; 5-700MHz

Parameter	Condition <sup>(1)</sup>	Min	Typ	Max	Unit
Supply Voltage (V <sub>DD</sub> )			5		V
Supply Current (I <sub>DD</sub> )			275		mA
Frequency Range		5		700	MHz
Gain	Full Bandwidth		25.0		dB
Gain Flatness	Max. deviation from line using least squares fit from 5 to 700 MHz		±0.5		dB
Gain Tilt	Gain (700 MHz) – Gain (5 MHz)		-0.1		dB
Input Return Loss	5 MHz		33		dB
	125 MHz		26		dB
	300 MHz		20		dB
	700 MHz		16		dB
Output Return Loss	5 MHz		20		dB
	125 MHz		22		dB
	300 MHz		18		dB
	700 MHz		16.5		dB
Reverse Isolation			30		dB
Noise Figure	(includes balun loss)		1.8		dB
ACLR	P <sub>out</sub> = 62 dBmV, 5 – 195 MHz OFDM w/ 9.6 MHz exclusion band.		59.7		dB
DTO	f <sub>1</sub> =13 MHz, f <sub>2</sub> =19 MHz 58.75 dBmV/tone		-62		dBc
DSO	f <sub>1</sub> =13 MHz, f <sub>2</sub> =19 MHz 58.75 dBmV/tone		-60		dBc
OIP2	5 – 700 MHz 2-Tone, 6 MHz spacing 3 dBm/tone		70		dBm
OIP3	5 – 700 MHz 2-Tone, 6 MHz spacing 5 dBm/tone		38		dBm
Output P1dB	Full Band		22.6		dBm
Thermal Resistance	Θ <sub>JC</sub>		23		°C/W

Notes:

1. Typical performance at these conditions: Temp = +25 °C, V<sub>DD</sub> = +5 V, 75 Ω system

### Evaluation Board Schematic; QPB8896-4000 EVB (5 – 700 MHz)





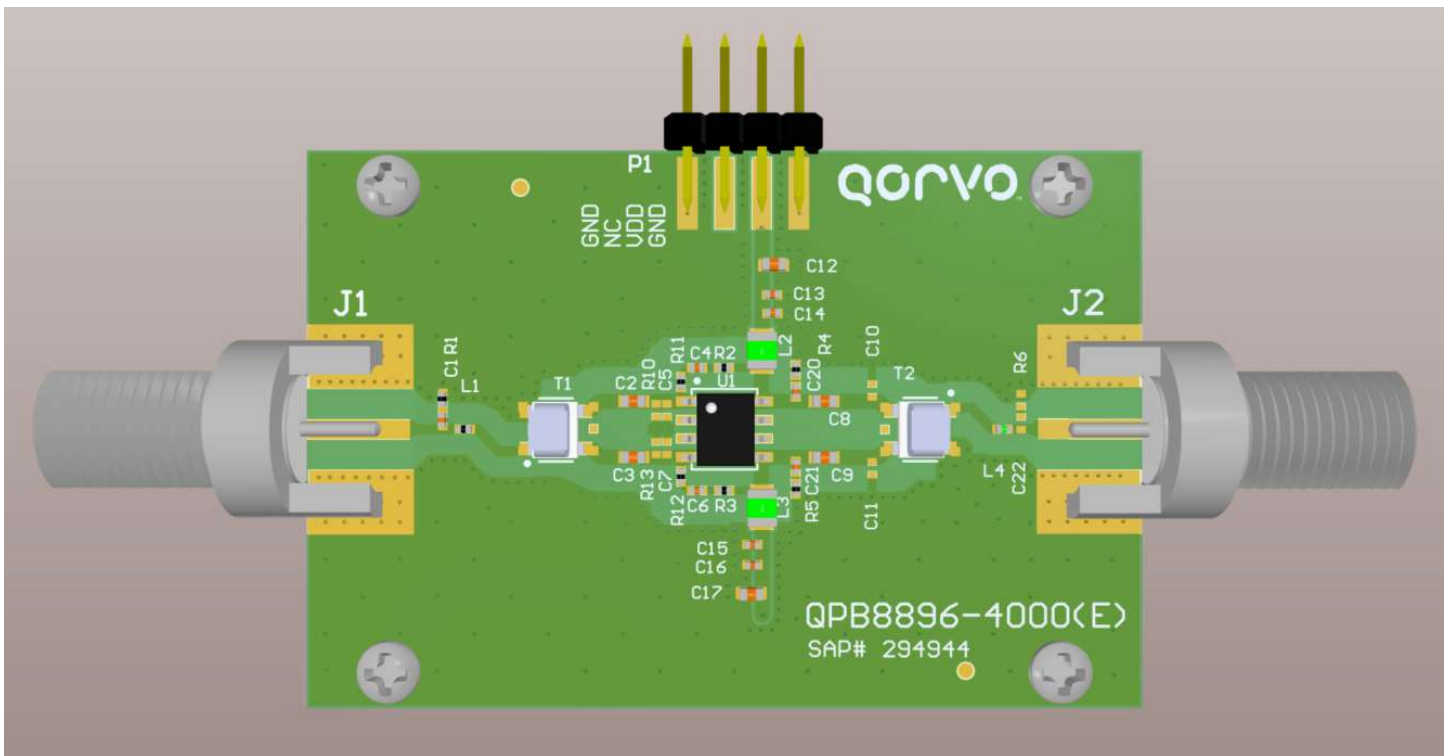
# QPB8896

## 25 dB Balanced Return Path Amplifier (5 – 700 MHz)

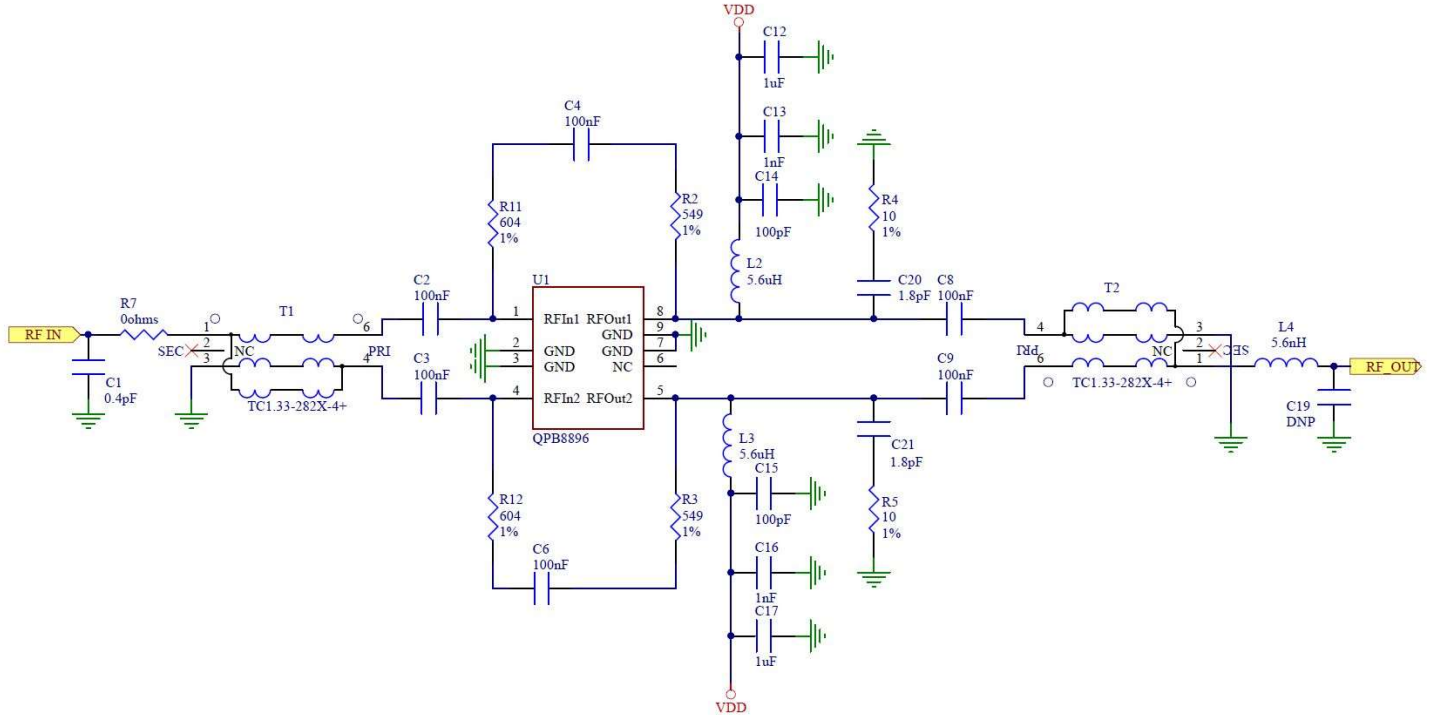
### Evaluation Board Bill of Materials; QPB8896-4000 (5 – 700 MHz)

Reference Designator	Description	Manufacturer	Part Number
PCB	QPB8896-4000	Viasystems	QPB8896-4000
U1	Balanced Return Path Amplifier, 5-700 MHz	Qorvo	QPB8896
C1	CAP, 0.4 pF, +/-0.05 pF, 50 V, C0G, 0402	Murata Electronics	GRM1555C1HR40WA01D
C13, C16	CAP, 1000 pF, 10 %, 50 V, X7R, 0402	Taiyo Yuden	RM UMK105BJ102KV-F
C4, C6	CAP, 0.1 uF, 10 %, 16 V, X7R, 0402	Murata Electronics	GRM155R71C104KA88D
C2, C3, C8, C9	CAP, 0.1 uF, 10 %, 16 V, X7R, 0603	Murata Electronics	GRM188R71C104KA01D
C20, C21	CAP, 1.8 pF, +/-0.1 pF, 50 V, C0G, 0402	Murata Electronics	GRM1555C1H1R8BA01E
C12, C17	CAP, 1 uF, 10 %, 16 V, X7R, 0603	Murata Electronics	GRM188R71C105KA12D
C14, C15	CAP, 100 pF, 5 %, 50 V, C0G, 0402	Taiyo Yuden	RM UMK105CG101JV-F
L2, L3	IND, 5.6 uH, 5 %, W/W, 1008	Coilcraft, Inc.	1008LS-562XJLC
R2, R3	RES, 549 $\Omega$ , 1 %, 1/10 W, 0402	Kamaya, Inc	RMC1/16SK5490FTH
R11, R12	RES, 604 $\Omega$ , 1 %, 1/10 W, 0402	Kamaya, Inc	RMC1/16SK6040FTH
R4, R5	RES, 10 $\Omega$ , 1 %, 1/16 W, 0402	Panasonic Industrial Devices	ERJ-2RKF10R0X
R1, L1	RES, 0 $\Omega$ , 0402	Kamaya, Inc	RMC1/16SJPTH
L4	IND, 5.6 nH, +/-0.1 nH, M/L, 0402	Murata Electronics	LQG15HS5N6B02D
T1, T2	XFMR, 5-2800 MHz, 100-75 $\Omega$	MiniCircuits	TC1.33-282X-4+
P1	CONN, HDR, ST, FRCTN LOCK, 4-PIN	Molex	22-23-2041
J1, J2	CONN, F FEM EDGE MOUNT, 75 $\Omega$ , 0.068"	Millimeter Wave, LLC	MW-846-C-DD-75
M1	HEATSINK BLOCK, 1.5 X 2.0 IN	Shenzhen Minxingda Automation	EEF-105441
S1-S4	SCREW, 2-56X3/16", SOCKET HEAD	McMaster-Carr Supply Co.	92196A076
C5, C7, C10, C11, C22, R6, R10, R13	Not Populated		

**Evaluation Board Assembly Drawing; QPB8896-4000 (5 – 700 MHz)**



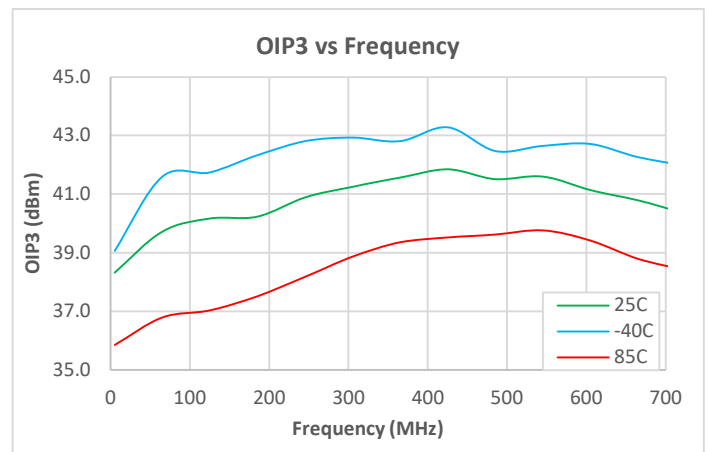
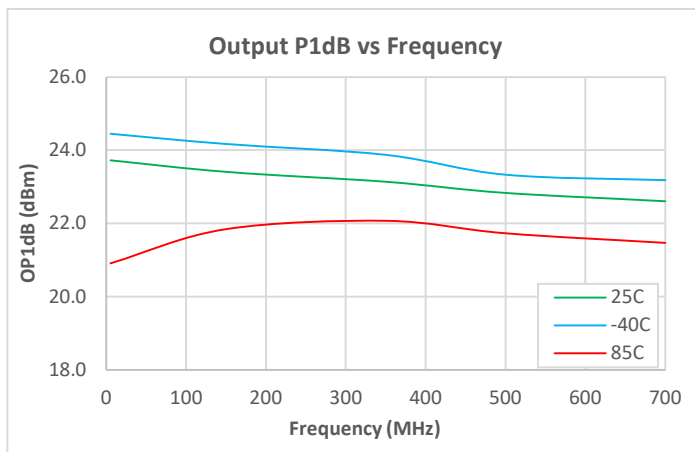
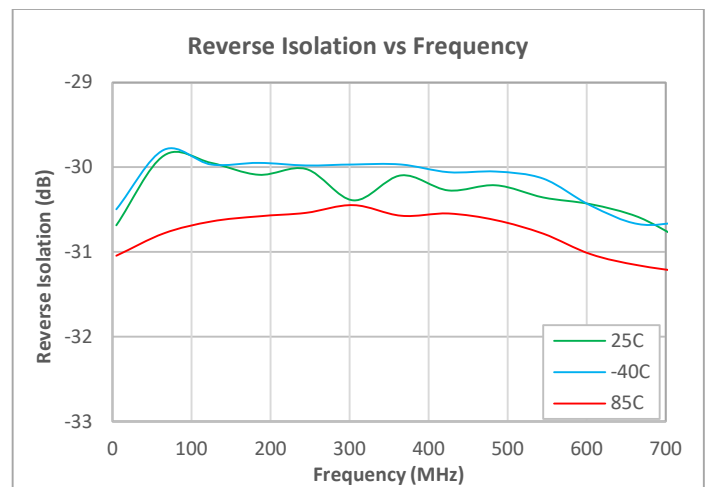
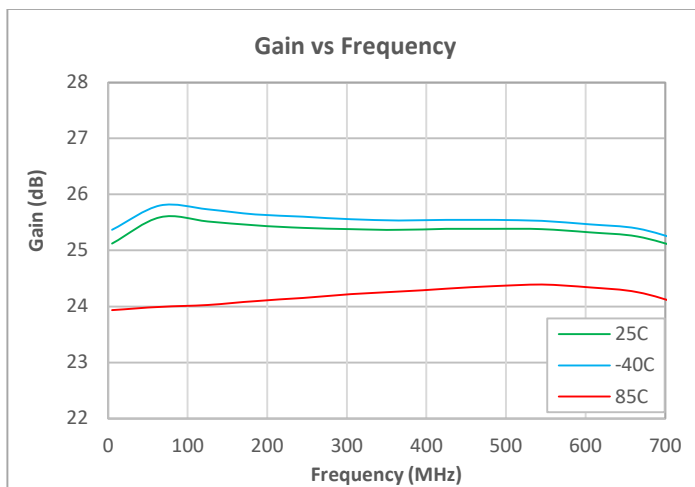
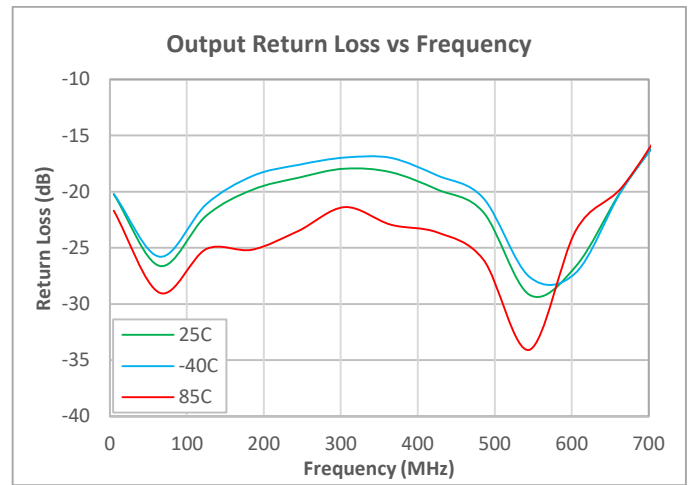
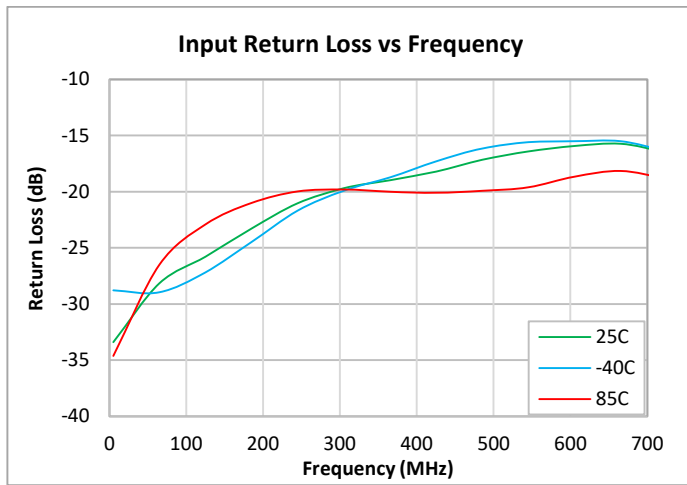
### Typical Applications Schematic (5 – 700 MHz)



**Notes:**

1. C1-R7 tune to optimize input return loss.
2. L4-C19 tune to optimize output return loss.
3. Feedback R11/R2/C4 and R12/R3/C6 can be adjusted to balance gain flatness versus return loss and IMD performance.

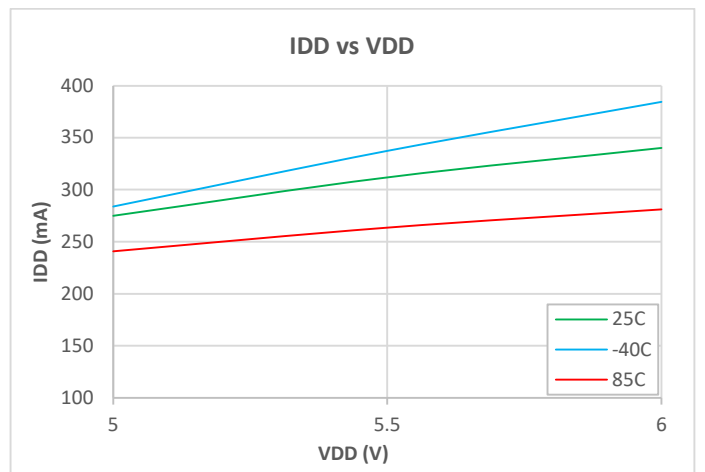
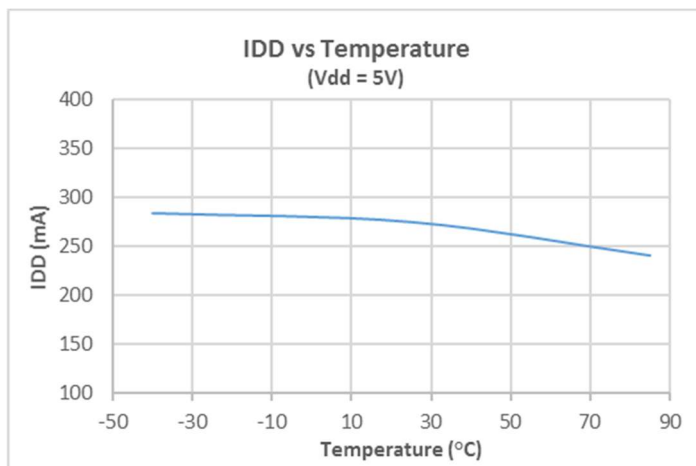
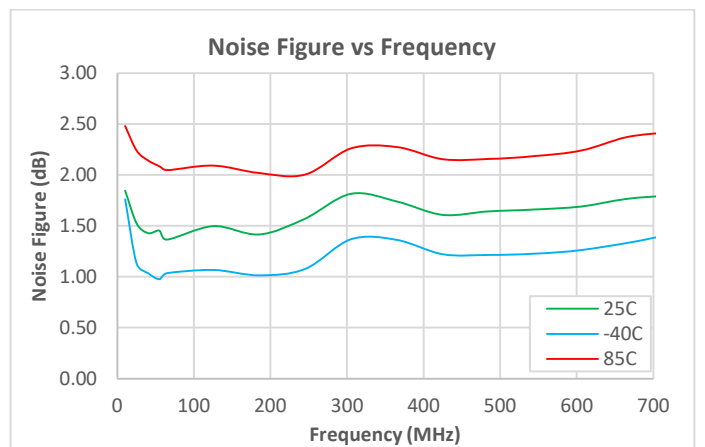
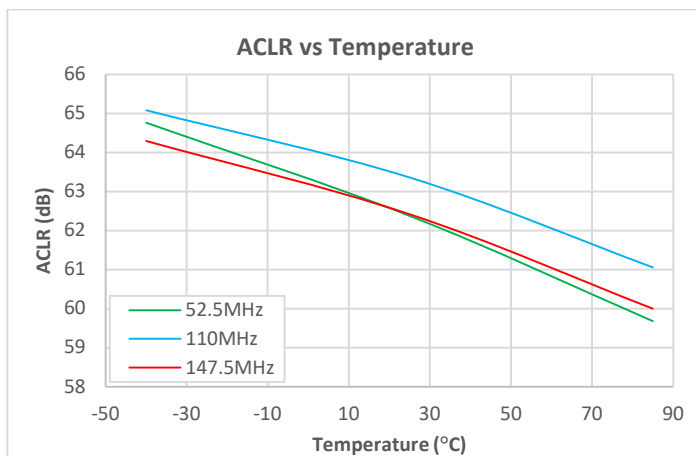
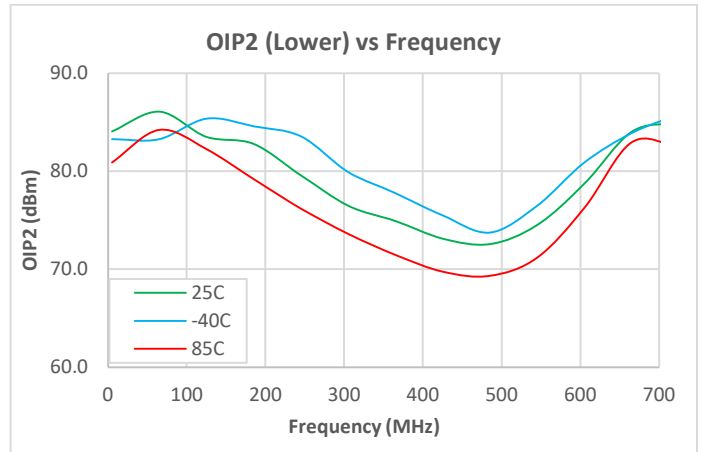
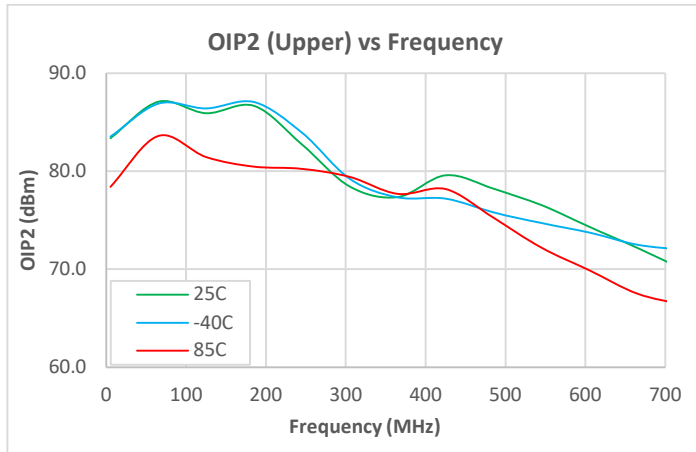
### Performance Data (5 – 700 MHz)



**Notes:**

- (1) OIP3: +5 dBm/tone, 6 MHz spacing

### Performance Data (5 – 700 MHz)

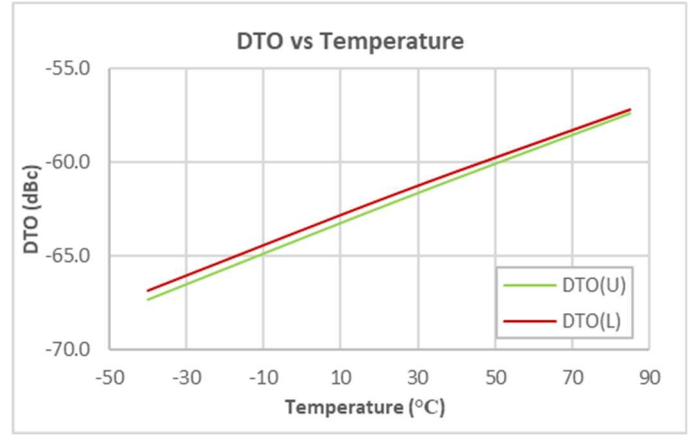
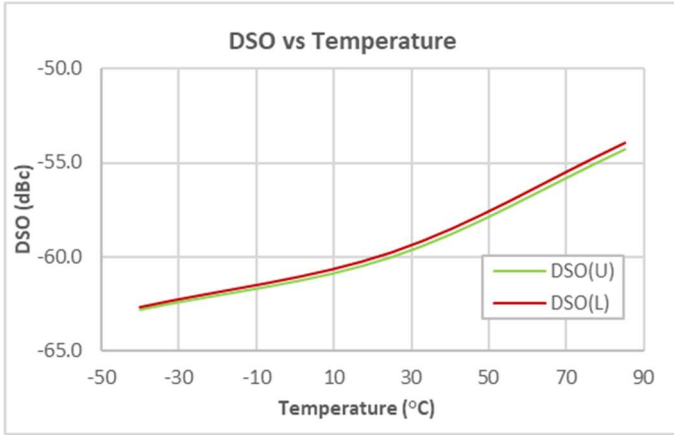


**Notes:**

- (1) OIP2: 3 dBm/tone, 6 MHz spacing
- (2) ACLR: Pout = 62 dBmV, 5-195 MHz OFDM w/ 9.6 MHz exclusion band.
- (3) IDD vs VDD, -10 dBm input power at 125 MHz
- (4) IDD vs Temperature, -10 dBm input power at 125 MHz, VDD = 5 V.



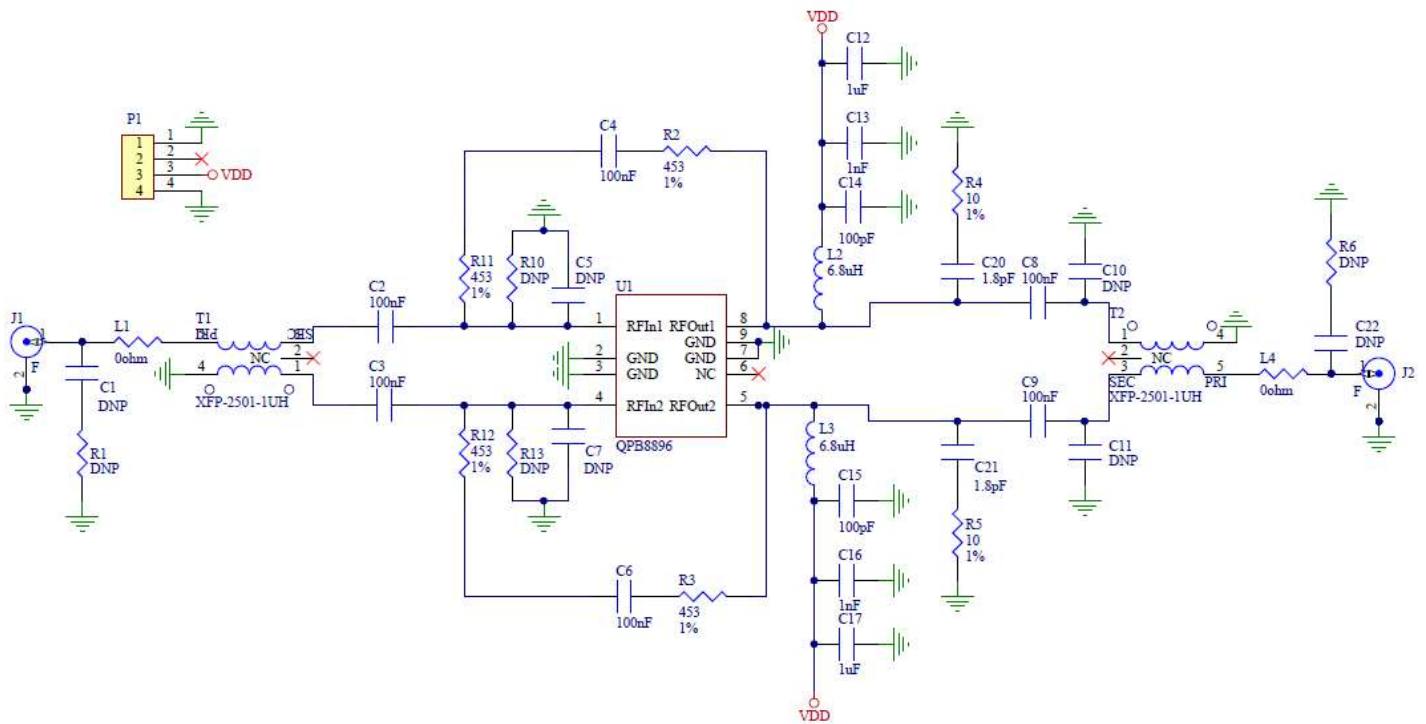
**Performance Data (5 – 700 MHz)**



Notes:

- (1) DSO/DTO: f1=13 MHz, f2=19 MHz 58.75 dBmV per tone

### Evaluation Board Schematic; QPB8896-4002 (5 – 300 MHz)





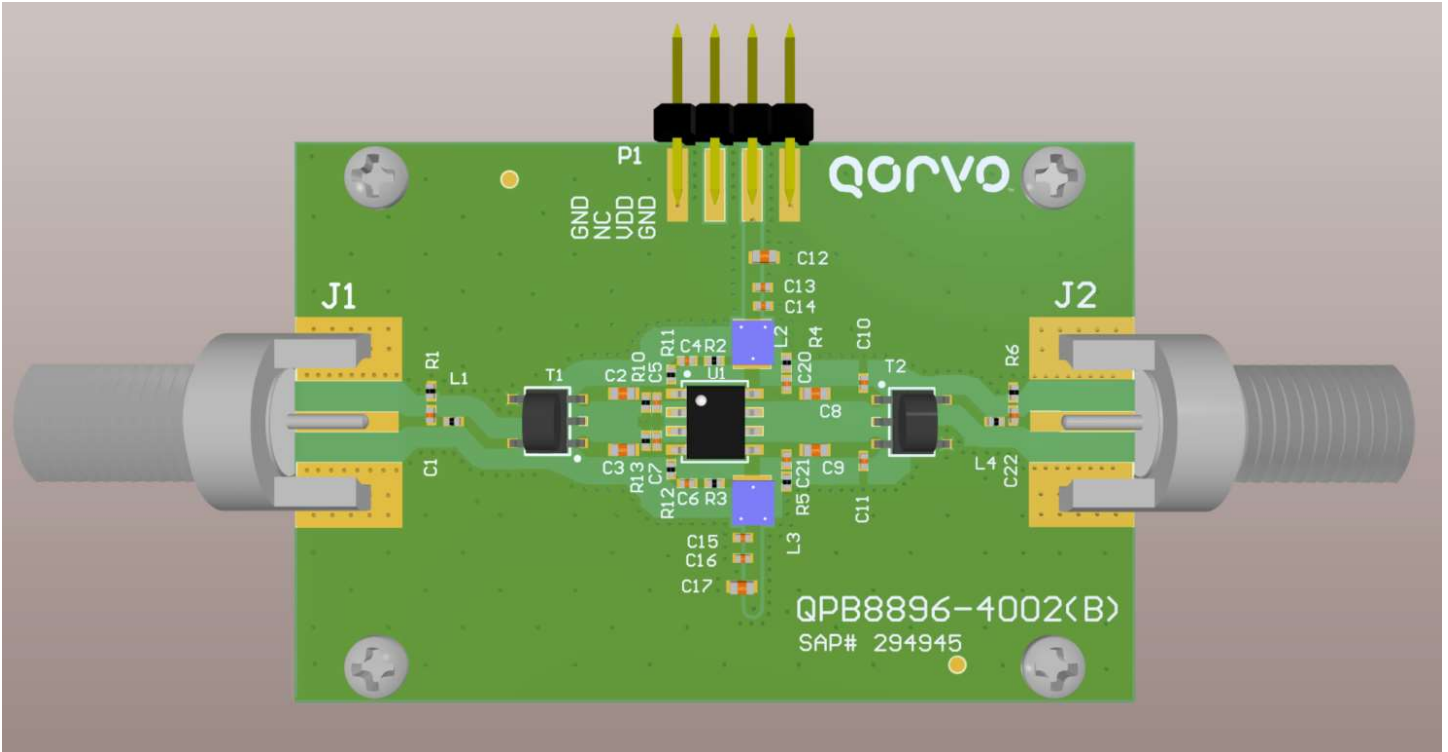
# QPB8896

## 25 dB Balanced Return Path Amplifier (5 – 700 MHz)

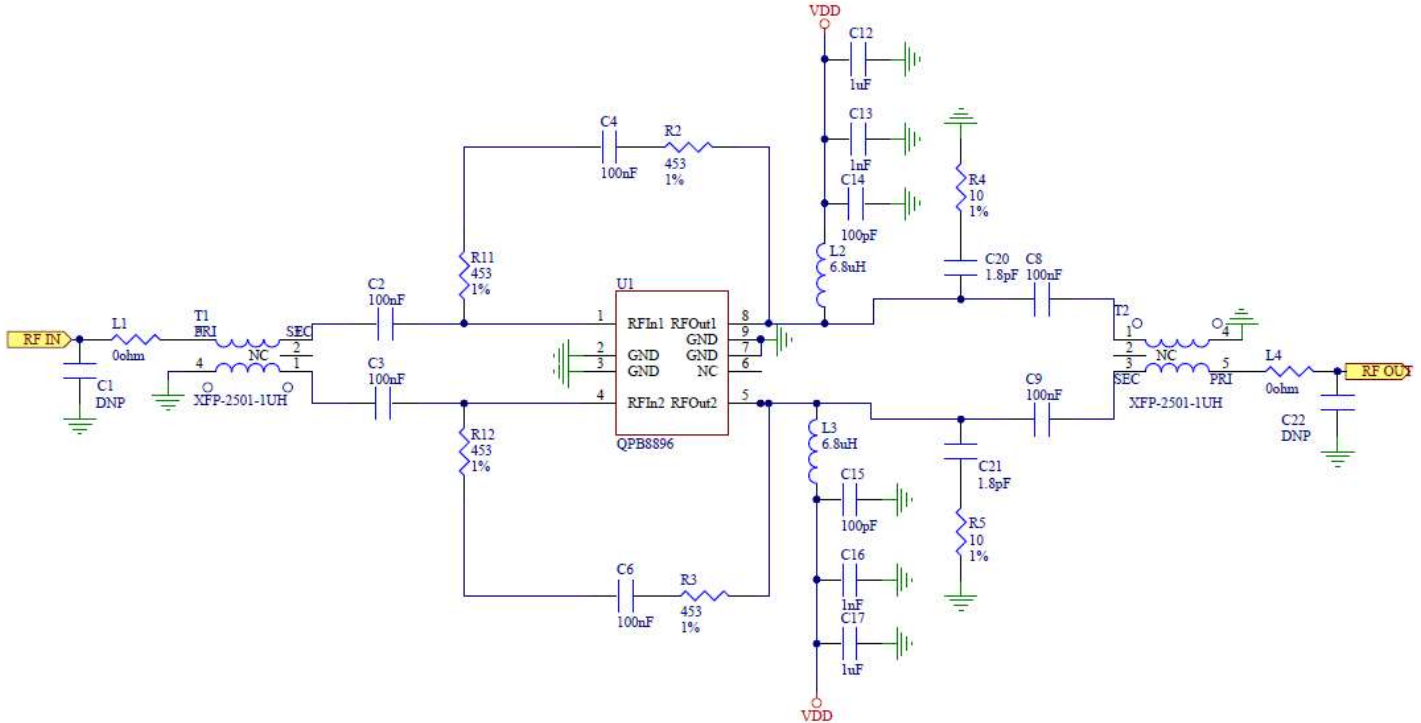
### Evaluation Board Bill of Materials for QPB8896-4002 (5 – 300 MHz)

Reference Designator	Description	Manufacturer	Part Number
PCB	QPB8896-4002	Viasystems	QPB8896-4002
U1	Balanced Return Path Amplifier, 5-700 MHz	Qorvo	QPB8896
C13, C16	CAP, 1000 pF, 10 %, 50 V, X7R, 0402	Taiyo Yuden	RM UMK105BJ102KV-F
C4, C6	CAP, 0.1 uF, 10 %, 16 V, X7R, 0402	Murata Electronics	GRM155R71C104KA88D
C2, C3, C8, C9	CAP, 0.1 uF, 10 %, 16 V, X7R, 0603	Murata Electronics	GRM188R71C104KA01D
C20, C21	CAP, 1.8 pF, +/-0.1 pF, 50 V, C0G, 0402	Murata Electronics	GRM1555C1H1R8BA01E
C12, C17	CAP, 1 uF, 10 %, 16 V, X7R, 0603	Murata Electronics	GRM188R71C105KA12D
C14, C15	CAP, 100 pF, 5 %, 50 V, C0G, 0402	Taiyo Yuden	RM UMK105CG101JV-F
L2, L3	IND, 6.8 uH, 5 %, W/W, 1008	Coilcraft, Inc.	1008LS-682XJLC
R2, R3, R11, R12	RES, 453 $\Omega$ , 1 %, 1/10 W, 0402	Panasonic	ERJ-2RKF4530X
R4, R5	RES, 10 $\Omega$ , 1 %, 1/16 W, 0402	Panasonic Industrial Devices	ERJ-2RKF10R0X
L1, L4	RES, 0 $\Omega$ , 0402	Kamaya, Inc	RMC1/16SJPTH
T1, T2	BALUN, 1:1, 1-2500 MHz, 75 $\Omega$ , SMD	MiniRF	XFP-2501-1UH
P1	CONN, HDR, ST, FRCTN LOCK, 4-PIN	Molex	22-23-2041
J1, J2	CONN, F FEM EDGE MOUNT, 75 $\Omega$ , 0.068"	Millimeter Wave , LLC	MW-846-C-DD-75
M1	HEATSINK BLOCK, 1.5 X 2.0 IN	Shenzhen Minxingda Automation	EEF-105441
S1-S4	SCREW, 2-56 X 3/16", SOCKET HEAD	McMaster-Carr Supply Co.	92196A076
C1, C5, C7, C10, C11, C22, R1, R6, R10, R13	Not Populated		

**Evaluation Board Assembly Drawing for QPB8896-4002 (5 – 300 MHz)**



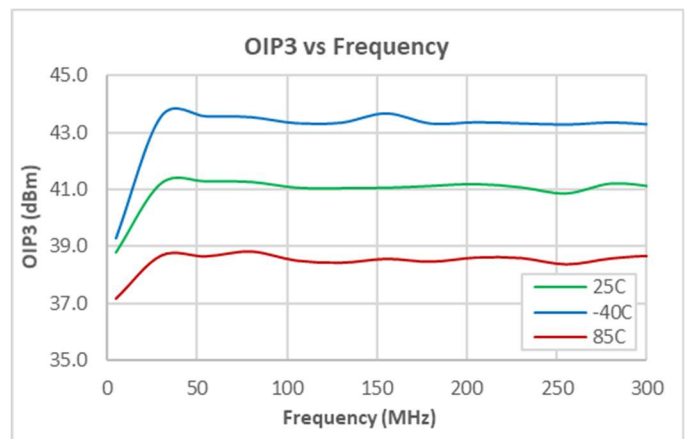
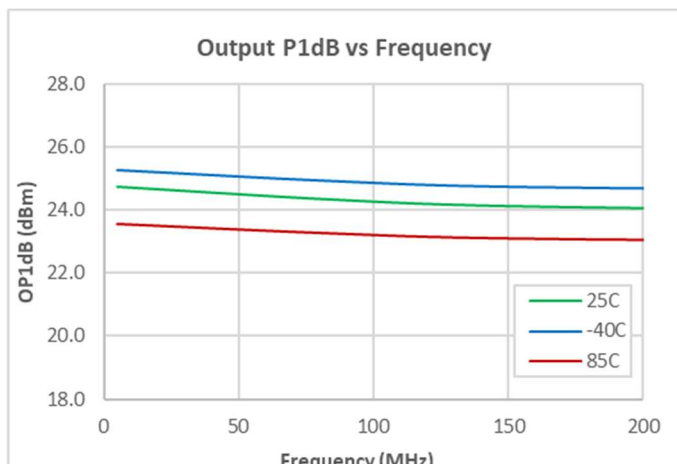
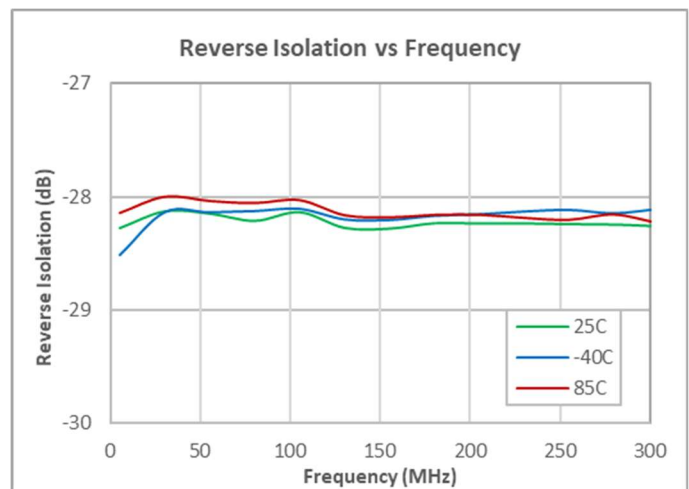
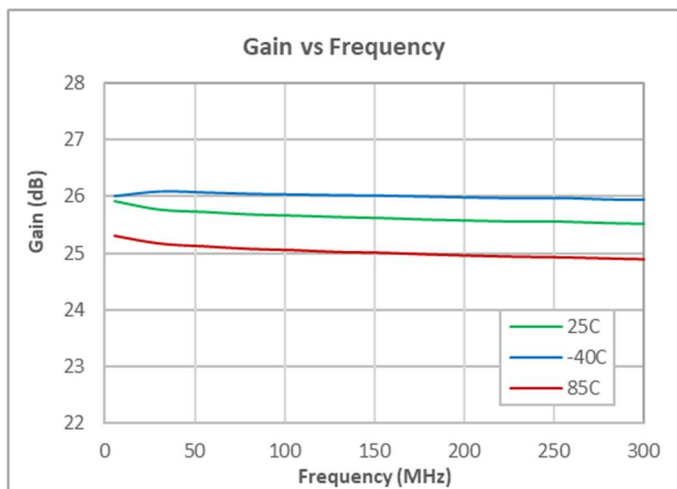
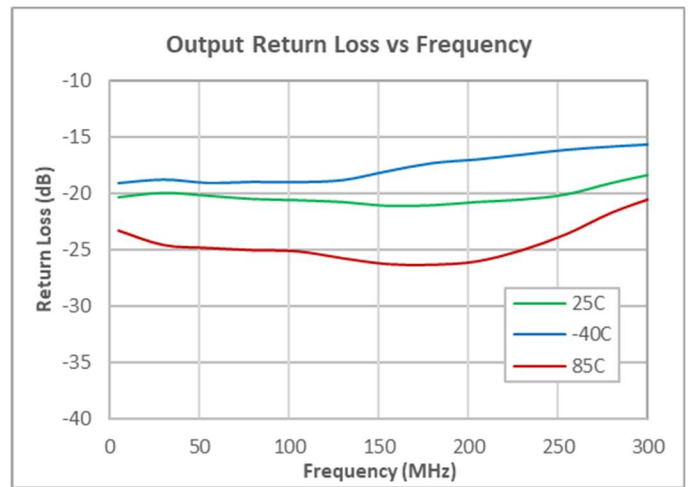
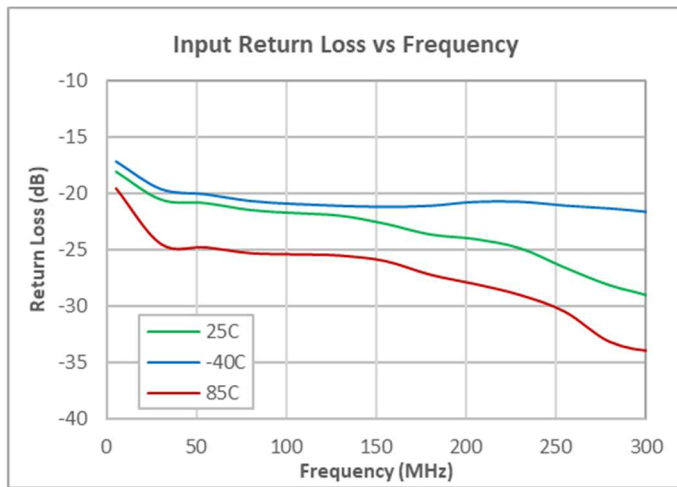
### Typical Applications Schematic (5 – 300 MHz)



#### Notes:

1. Low insertion loss 1:1 baluns help reduce noise figure  $\leq 1.1$  dB
2. Optimal bandwidth with 1:1 baluns is 5 to 500MHz. 1.33:1 ratio baluns provide an easier path to matching for bandwidths beyond 500MHz.
3. C1-L1 tune to optimize input return loss.
4. L4-C22 tune to optimize output return loss.
5. Feedback R11/R2/C4 and R12/R3/C6 can be adjusted to balance gain flatness versus return loss and IMD performance.

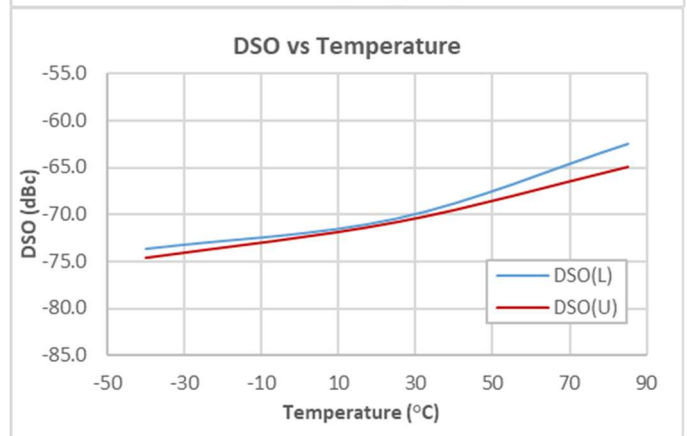
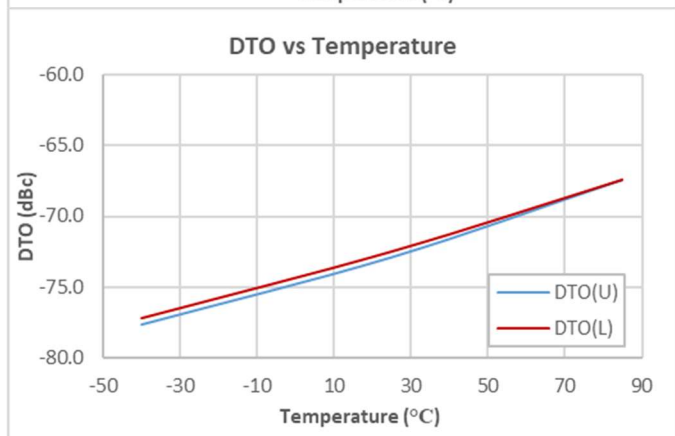
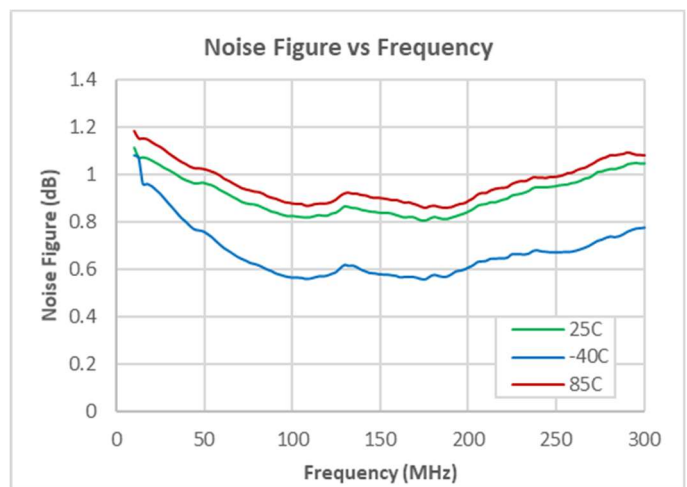
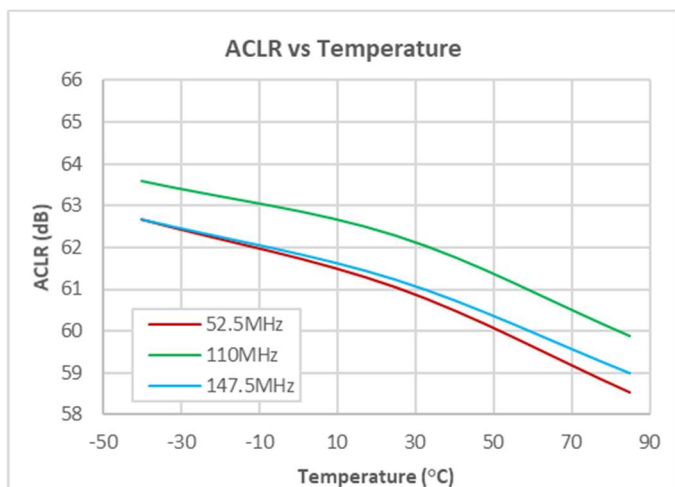
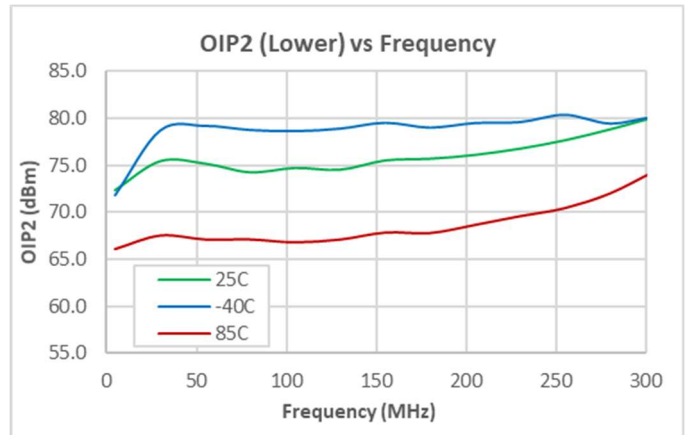
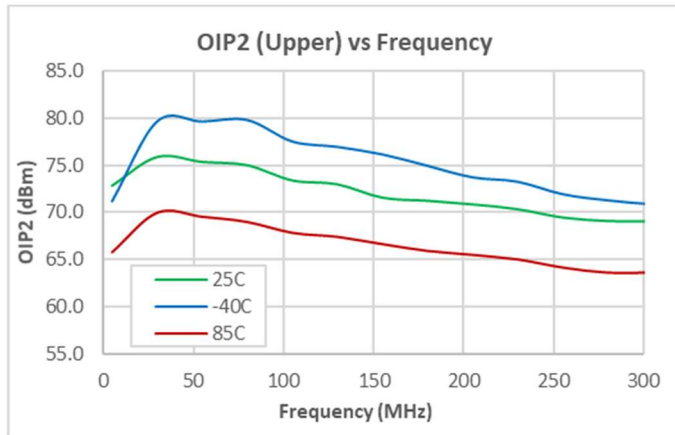
### Performance Data (5 – 300 MHz)



Notes:

- (1) OIP3: +5 dBm/tone, 6 MHz spacing

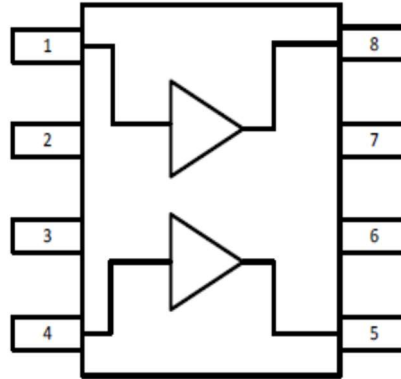
### Performance Data (5 – 300 MHz)



**Notes:**

- (1) OIP2: 3 dBm/tone, 6 MHz spacing
- (2) ACLR: Pout = 62 dBmV, 5-195 MHz OFDM w/ 9.6 MHz exclusion band.
- (3) DSO/DTO: f1=13 MHz, f2=19 MHz 58.75 dBmV per tone.

## Pin Configuration and Description



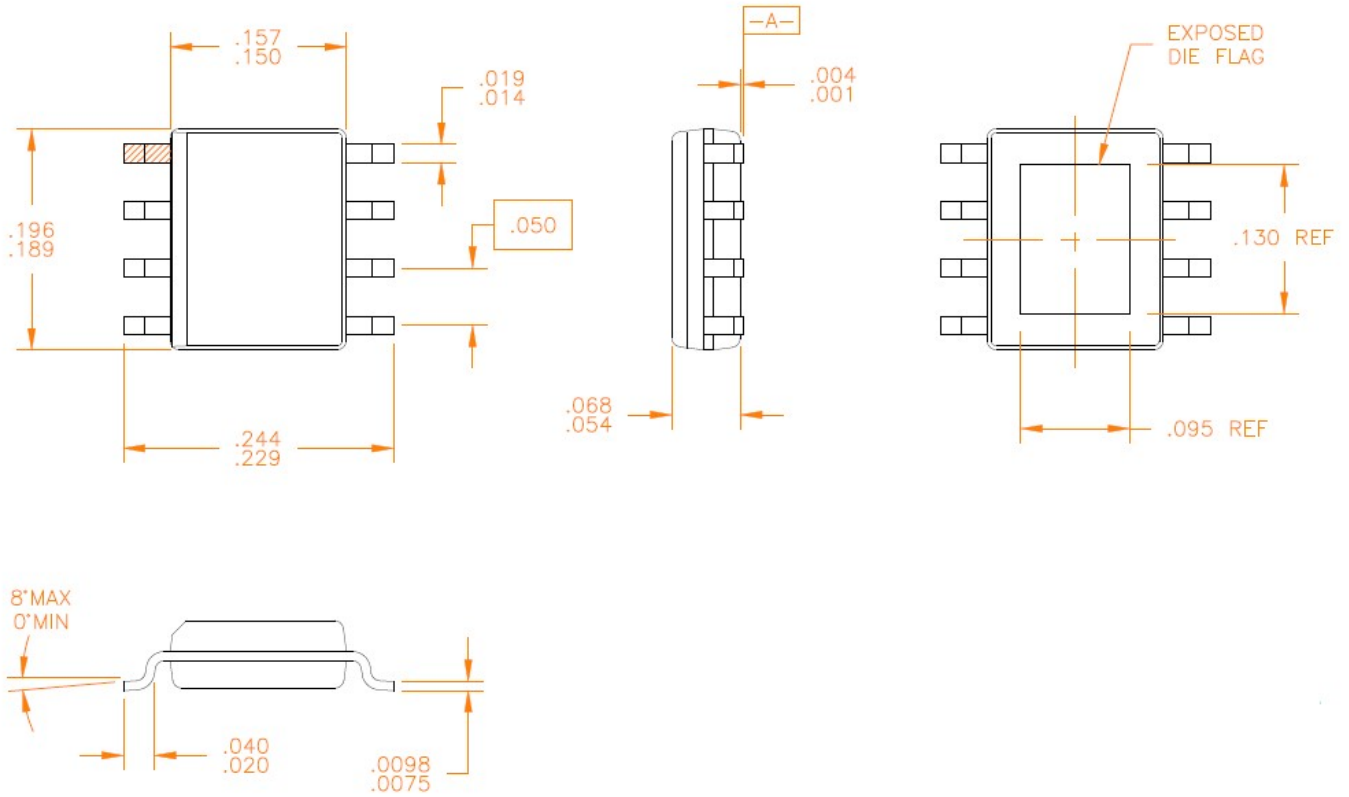
Functional Block Diagram

[Top View](#)

Pin Number	Label	Description
1	RFIN1	RF Input for plus side of amplifier
2	GND	Internally Not Connected
3	GND	Internally Not Connected
4	RFIN2	RF Input for minus side of amplifier
5	RFOUT2	RF Output for minus side of amplifier
6	NC	Internally Not Connected; Can be left open or grounded.
7	GND	Internally Not Connected
8	RFOUT1	RF Output for plus side of amplifier
Backside Paddle	GND	Ground. Use recommended via pattern to minimize inductance and thermal resistance. See PCB Mounting Pattern for suggested footprint.



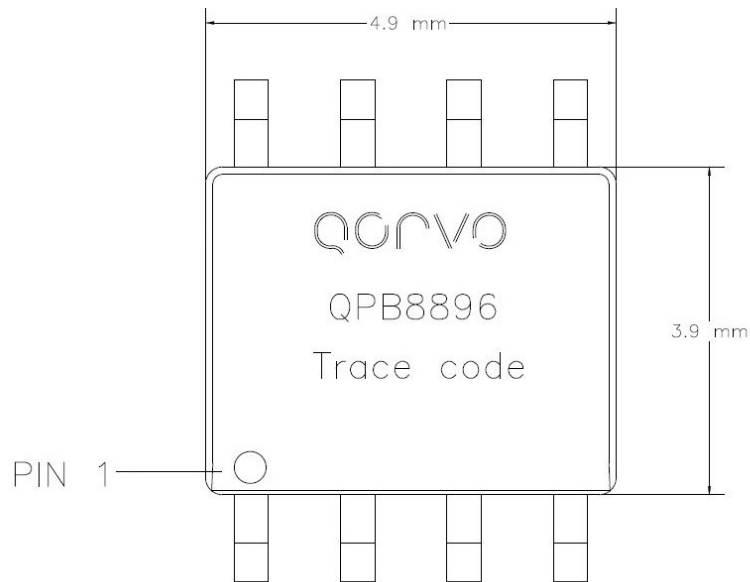
**Package Outline**



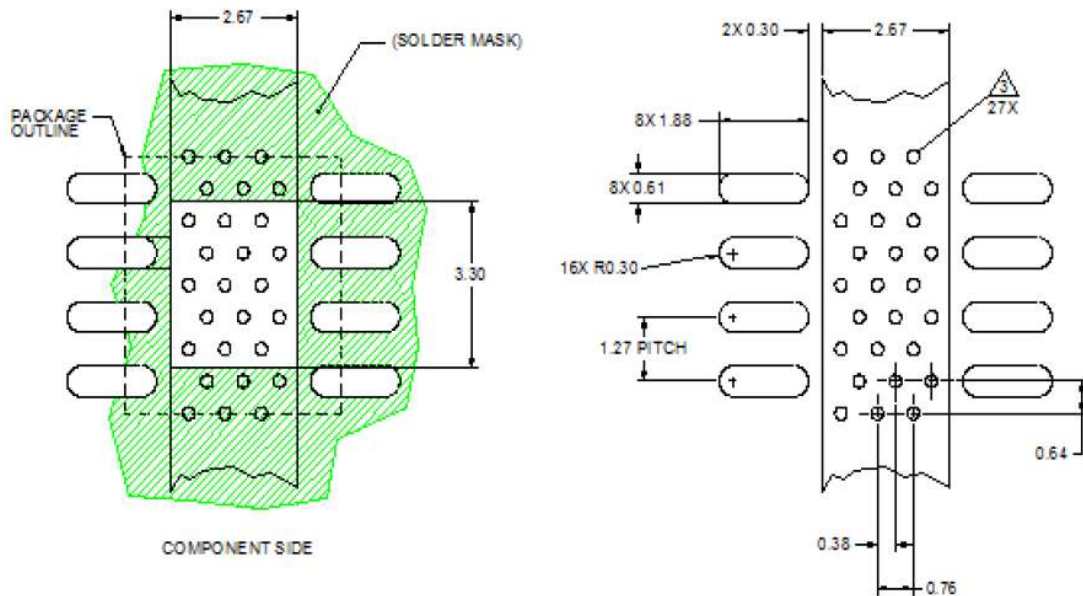
**Notes:**

1. Dimensions in millimeters

## Package Marking



## Recommended Mounting Pattern



### Notes:

1. All dimensions are in millimeters. Angles are in degrees.
2. Use 1 oz. copper minimum for top and bottom layers
3. Vias are required under the backside paddle for proper RF/DC grounding and thermal dissipation. We recommend a 0.35 mm (# 80/0.135") diameter bit for drilling via holes and a final plated through diameter of 0.25 mm (0.010").
4. Ensure good backside paddle solder attach for reliable operation and best electrical performance.

## Handling Precautions

Parameter	Rating	Standard
ESD – Human Body Model (HBM)	1A (250V)	ESDA / JEDEC JS-001-2012
ESD – Charged Device Model (CDM)	C3 (1000V)	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: Matte Sn

## 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 (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:

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

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

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

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