

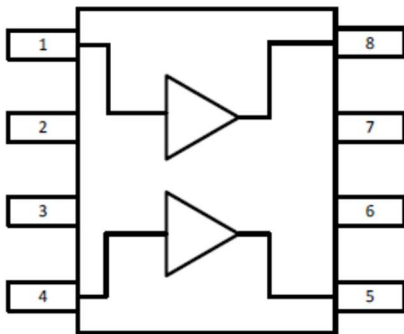
### Product Overview

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 |



# QPB8896

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

### Absolute Maximum Ratings

| Parameter                                 | Rating         |
|---|----------------|
| Supply Voltage ( $V_{DD}$ )               | +8 V           |
| Supply Current ( $I_{DD}$ )               | 360 mA         |
| Maximum CW Input Power for $V_{DD} = 5$ 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 ( $V_{DD}$ ) |  |     | 5    |     | V    |
| Supply Current ( $I_{DD}$ ) |  |     | 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                        | $P_{out} = 62$ dBmV, 5 – 195 MHz OFDM w/ 9.6 MHz exclusion band.   |     | 59.7 |     | dB   |
| DTO                         | $f_1 = 13$ MHz, $f_2 = 19$ MHz 58.75 dBmV/tone                     |     | -62  |     | dBc  |
| DSO                         | $f_1 = 13$ MHz, $f_2 = 19$ 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          | $\Theta_{JC}$  |     | 23   |     | °C/W |

Notes:

1. Typical performance at these conditions: Temp = +25 °C,  $V_{DD} = +5$  V, 75  $\Omega$  system





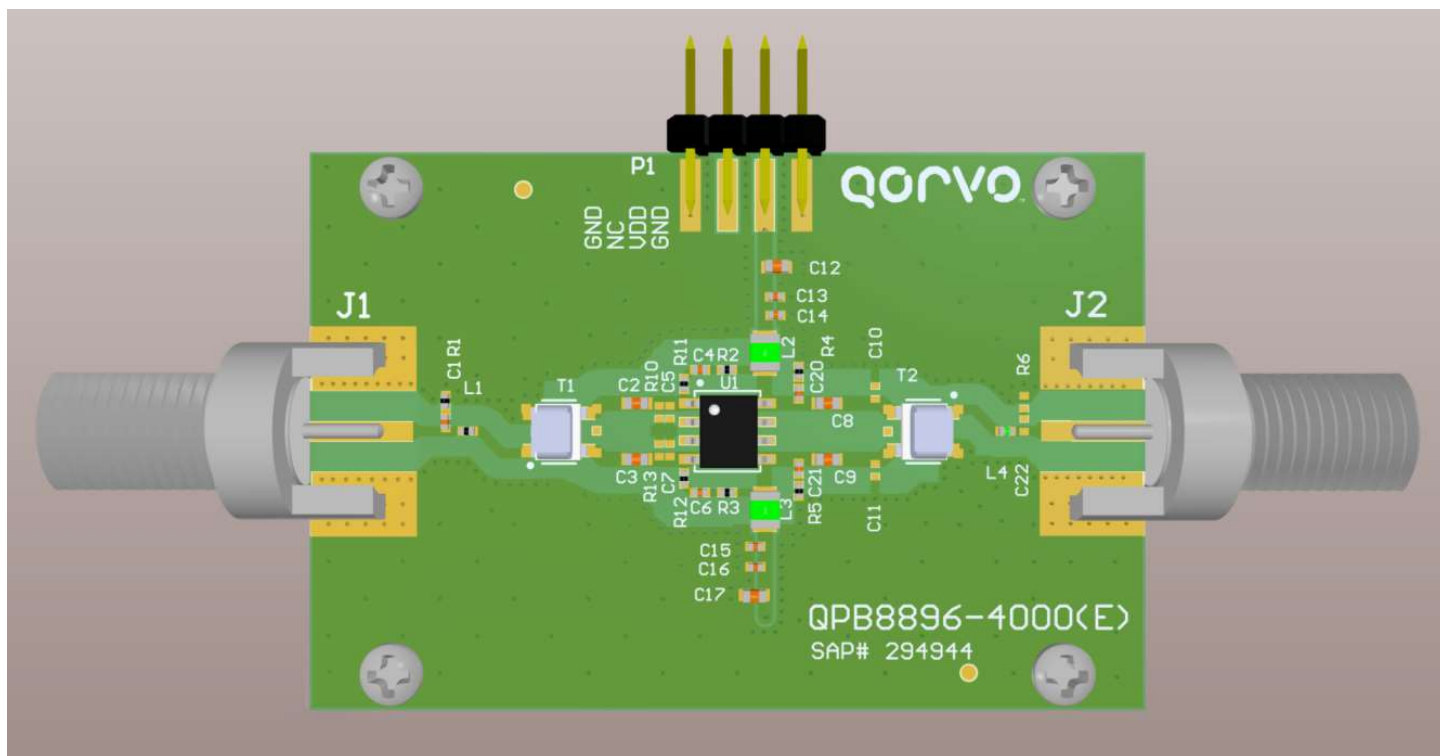
# QPB8896

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

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

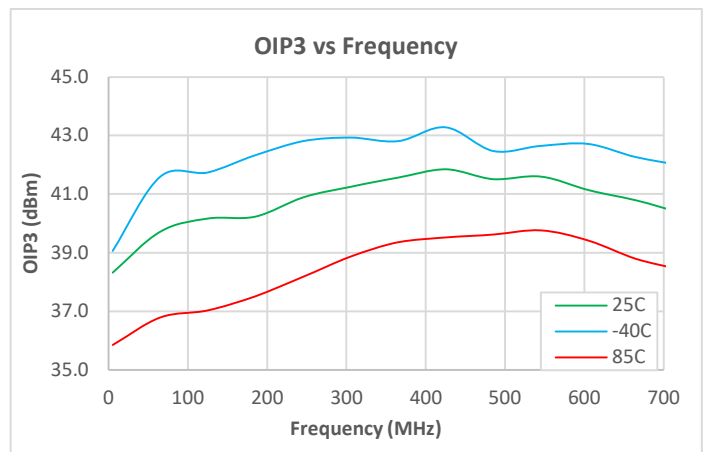
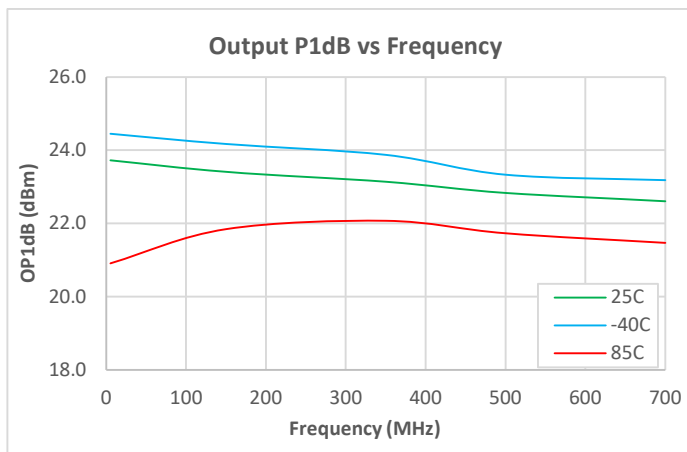
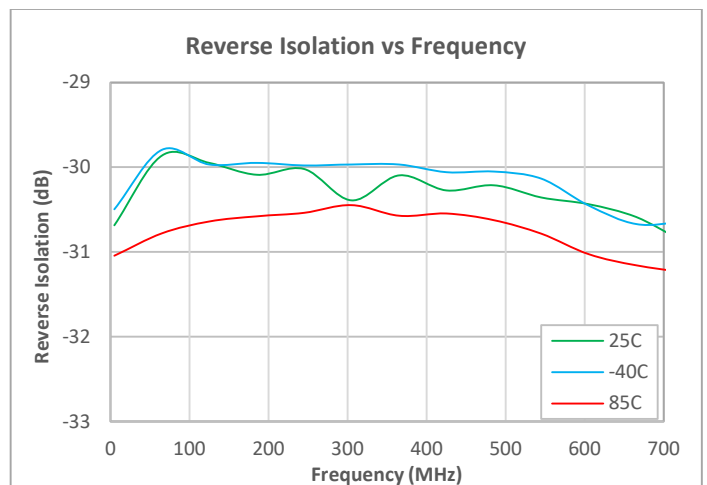
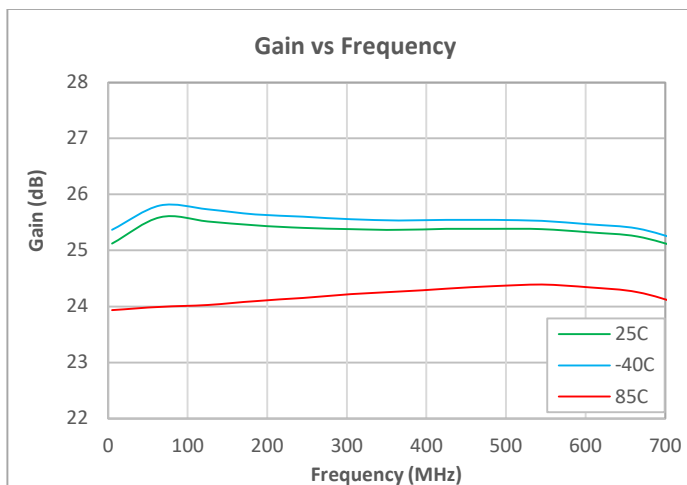
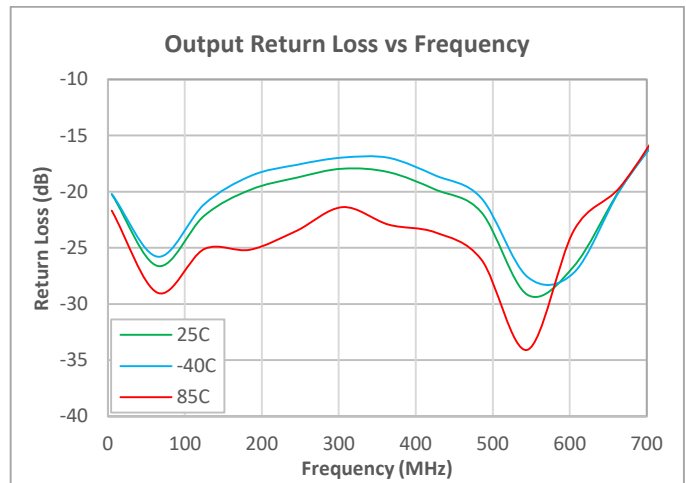
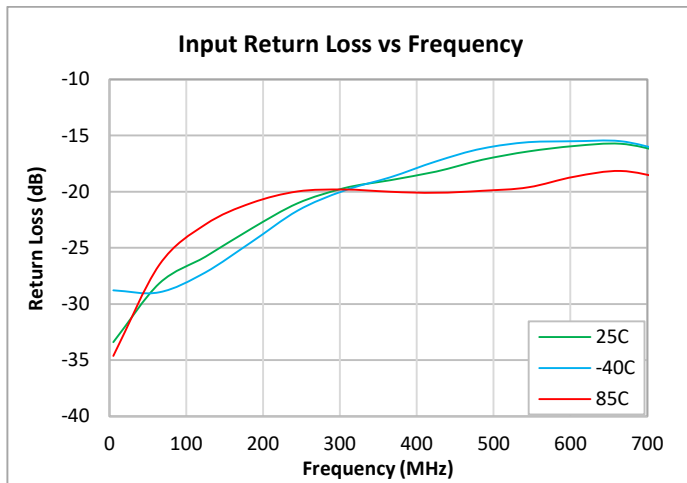
| Reference Designator                | Description                                  | Manufacturer                  | Part Number        |
|-------------------------------------|--|-------------------------------|--------------------|
| PCB                                 | QPB8896-4000                                 | 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)





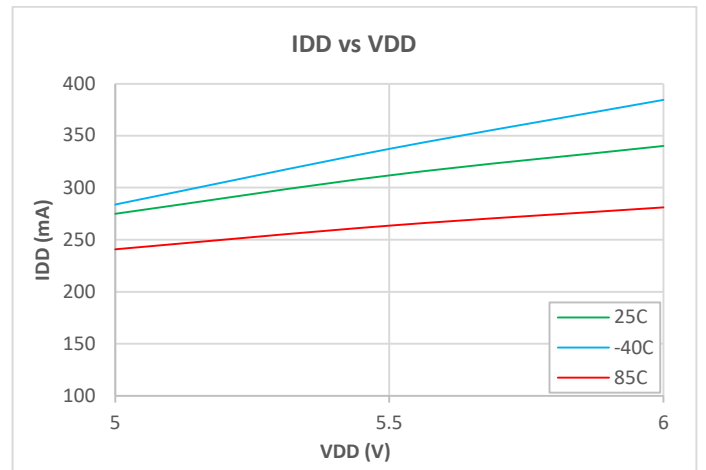
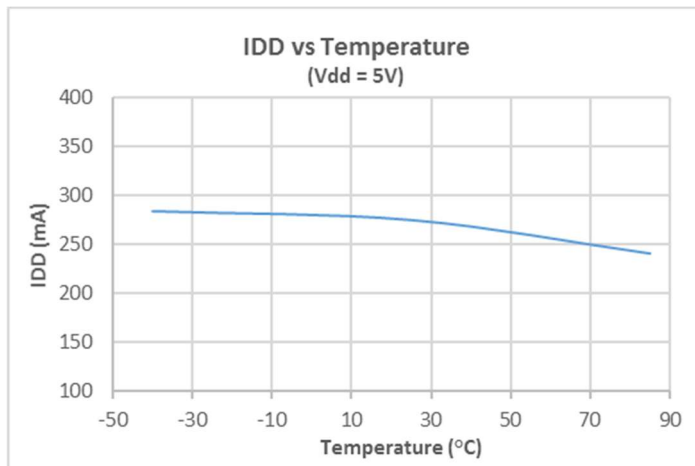
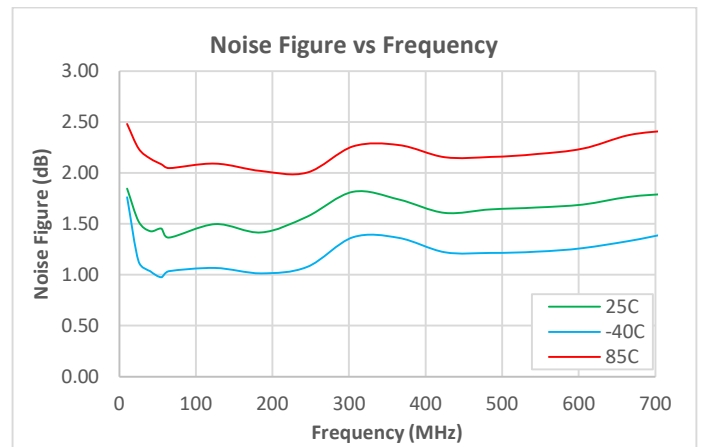
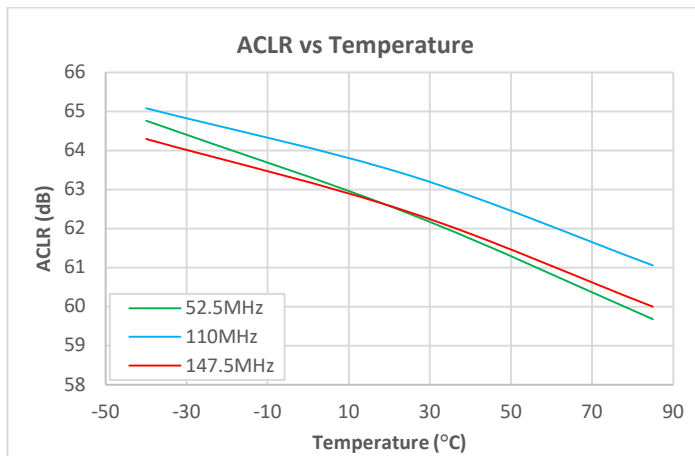
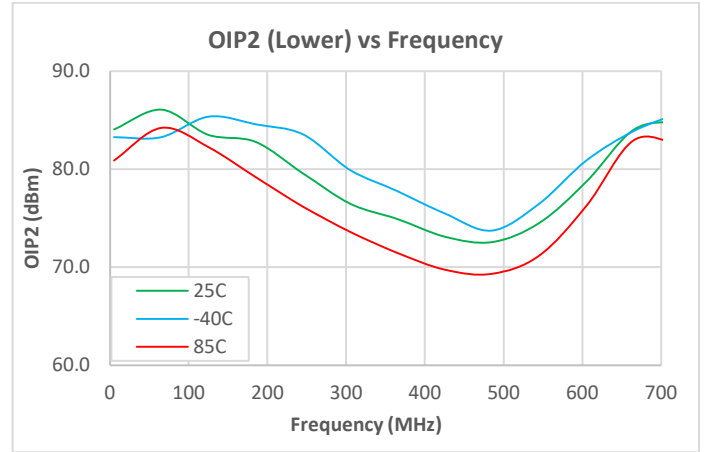
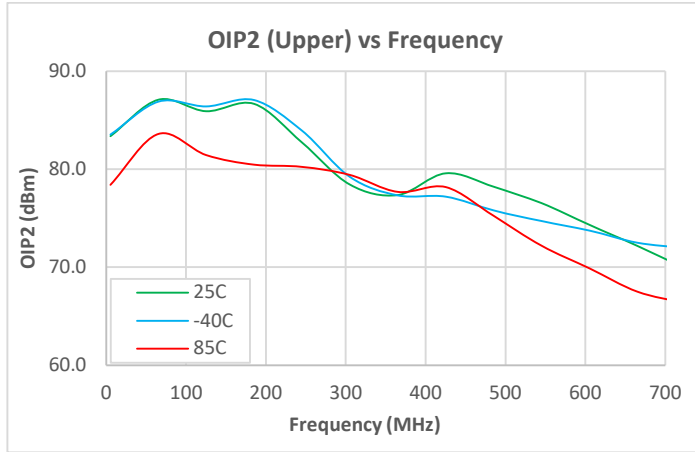
### Performance Data (5 – 700 MHz)



#### Notes:

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

### Performance Data (5 – 700 MHz)

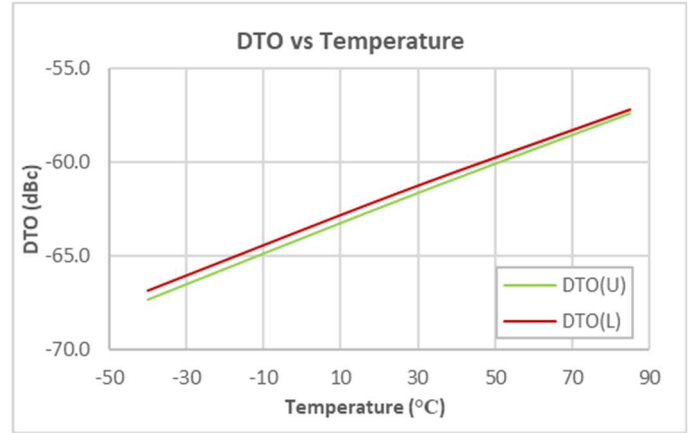
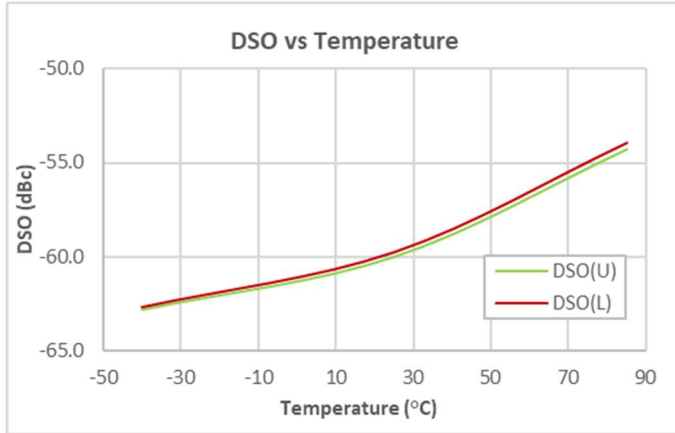


#### Notes:

- (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.



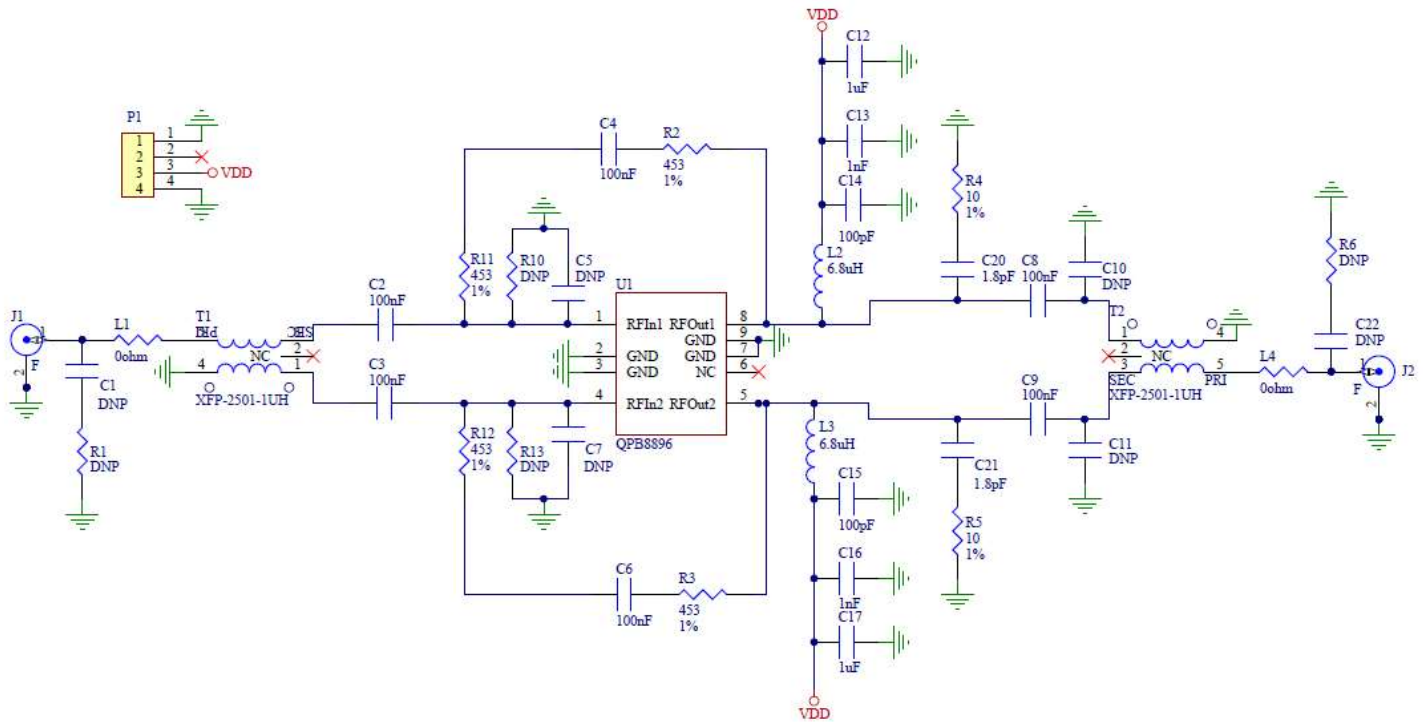
### Performance Data (5 – 700 MHz)



Notes:

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

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





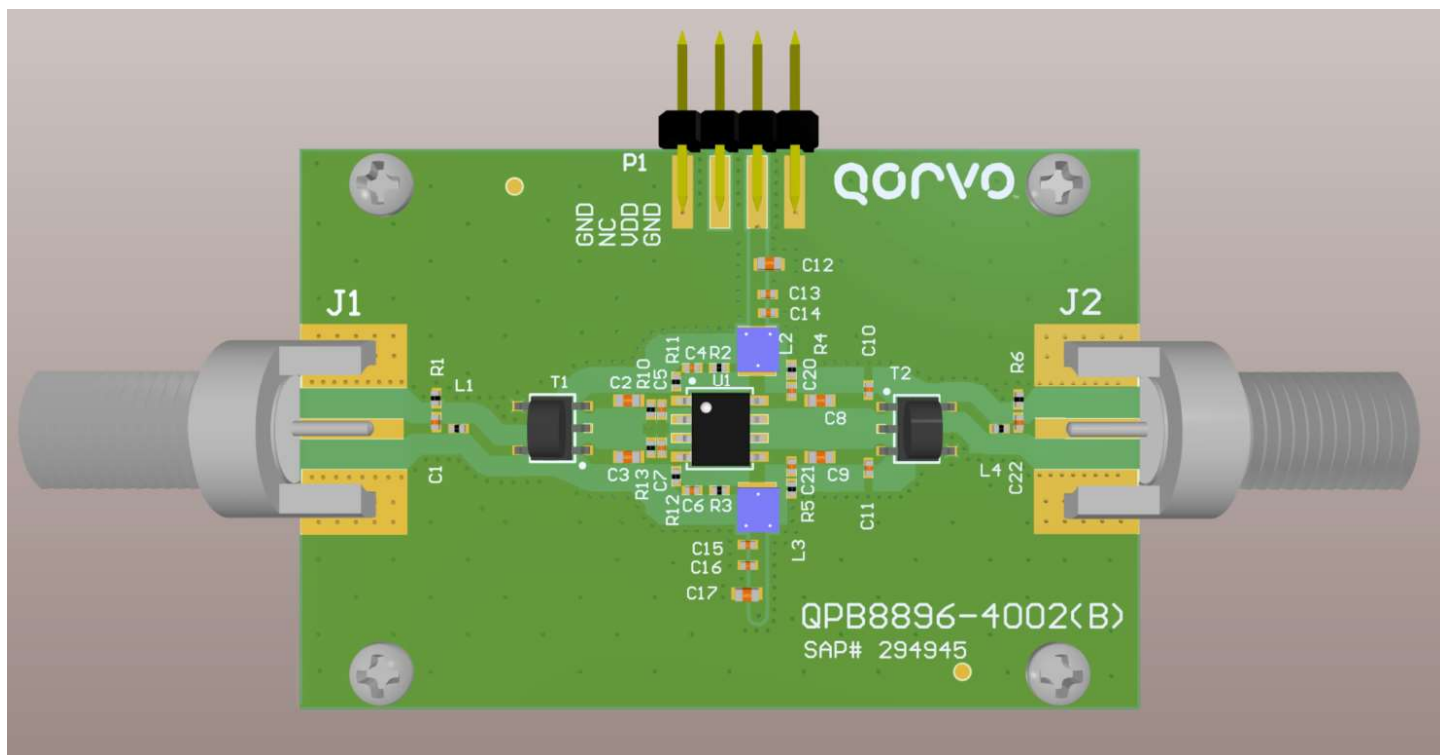
# QPB8896

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

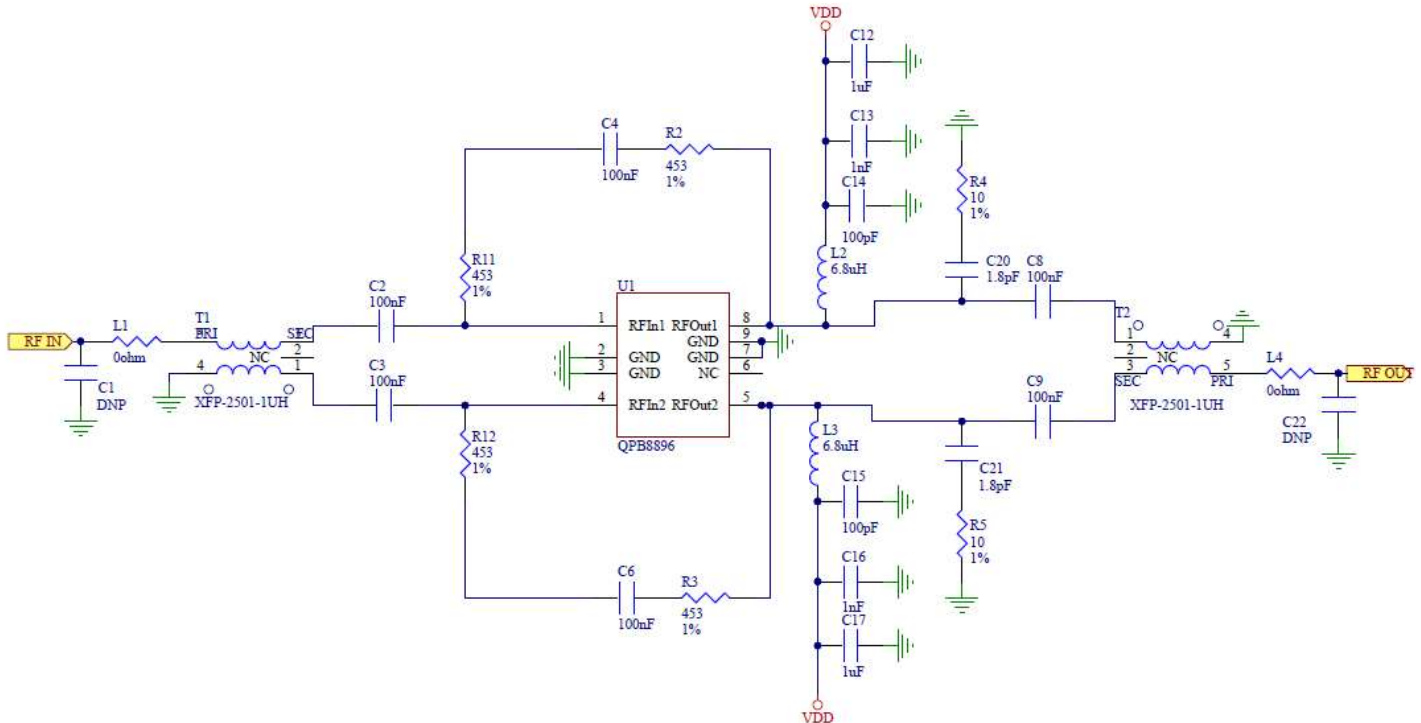
### Evaluation Board Bill of Materials for QPB8896-4002 (5 – 300 MHz)

| 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)



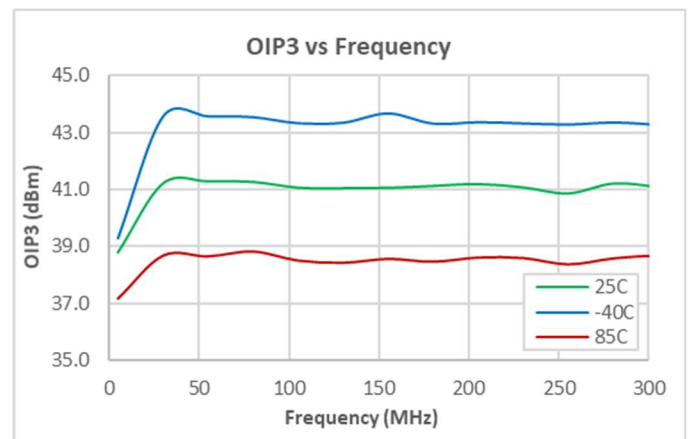
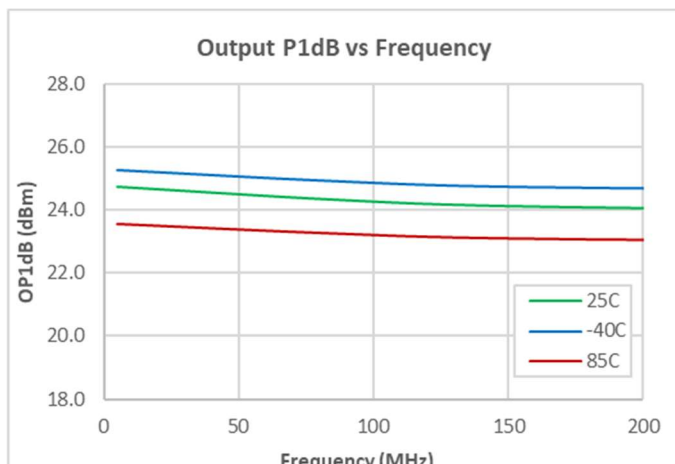
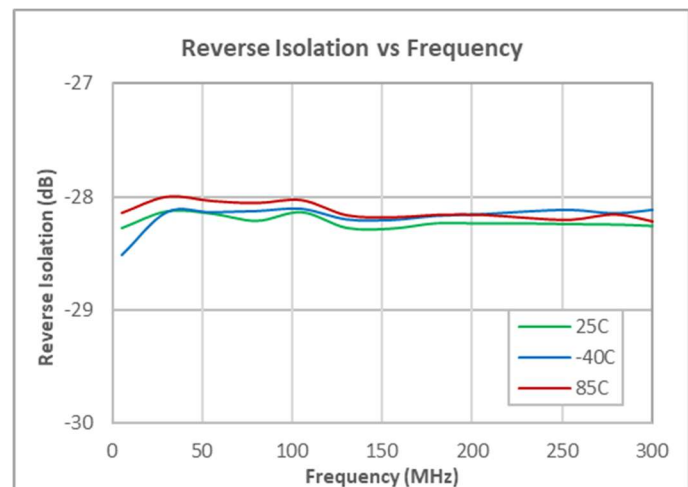
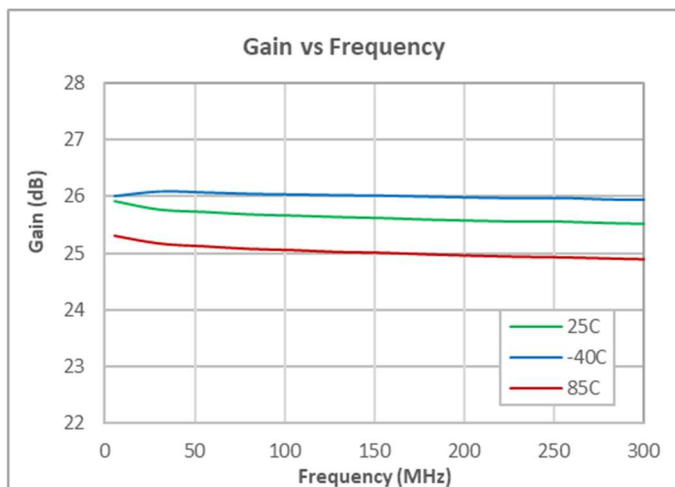
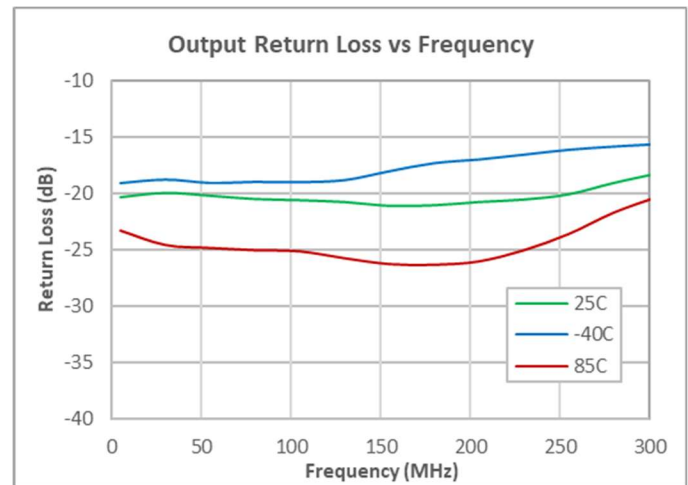
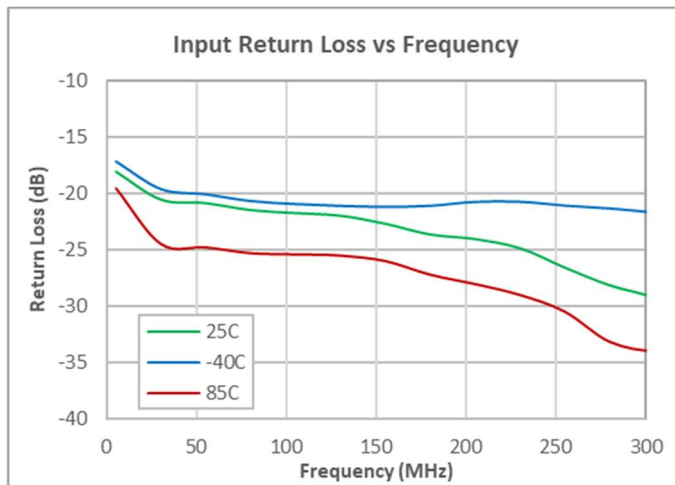
### Typical Applications Schematic (5 – 300 MHz)



#### 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.

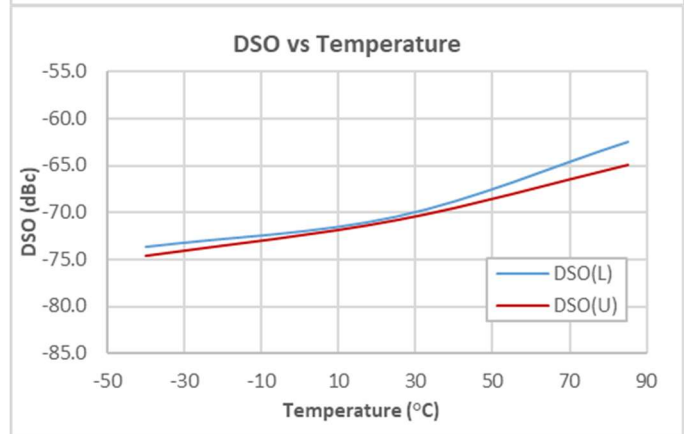
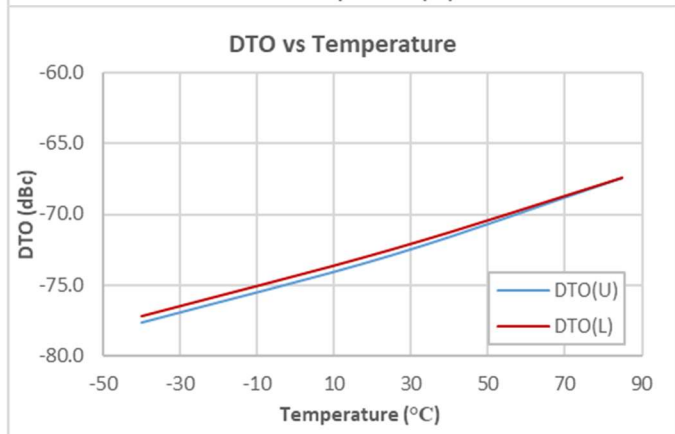
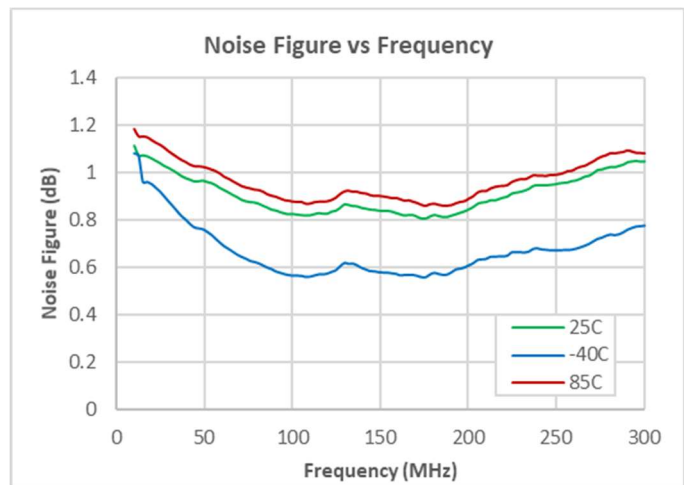
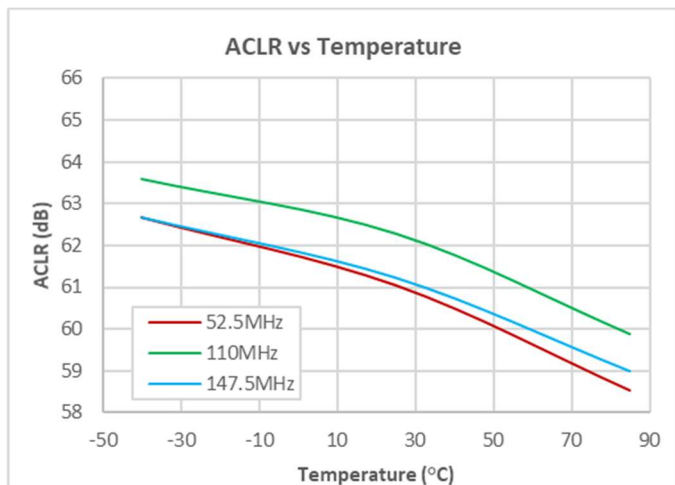
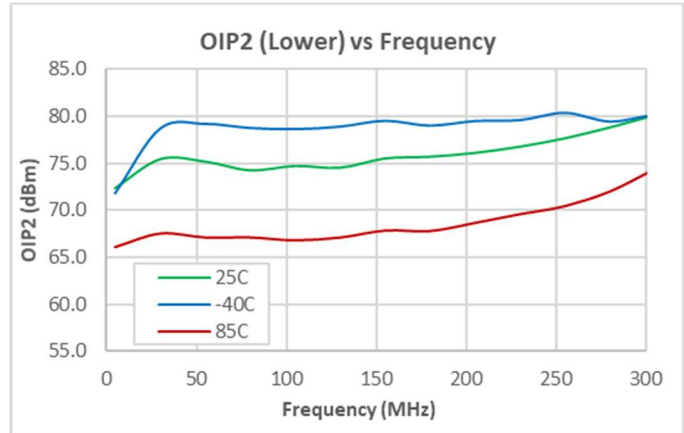
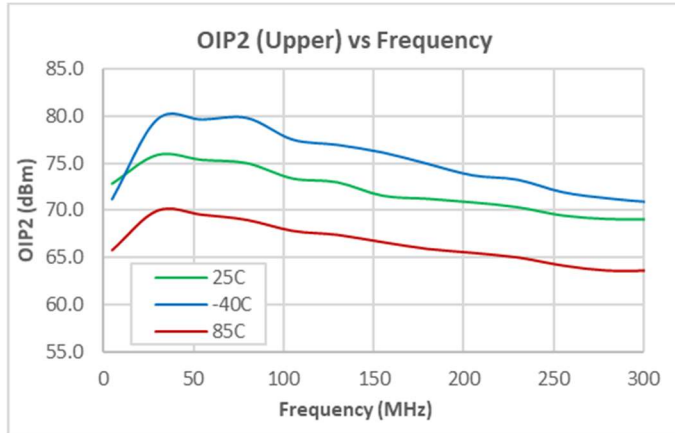
### Performance Data (5 – 300 MHz)



Notes:

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

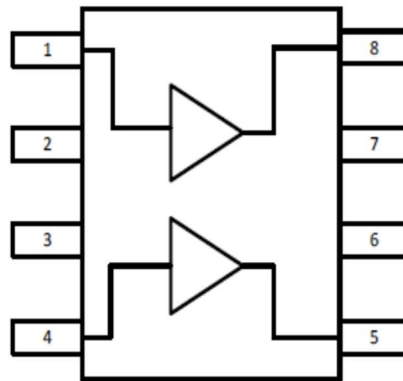
### Performance Data (5 – 300 MHz)



#### Notes:

- (1) OIP2: 3 dBm/ton, 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



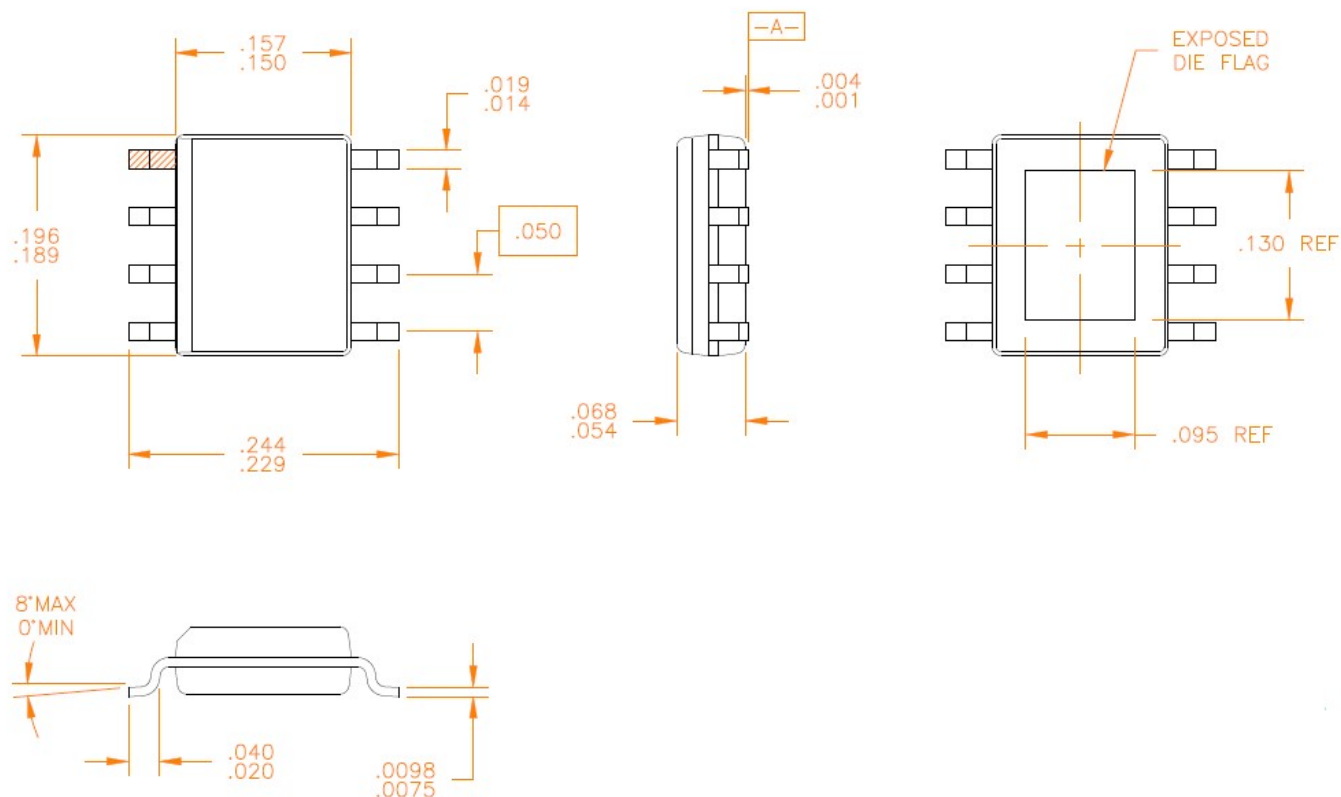
Functional Block Diagram

[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. |



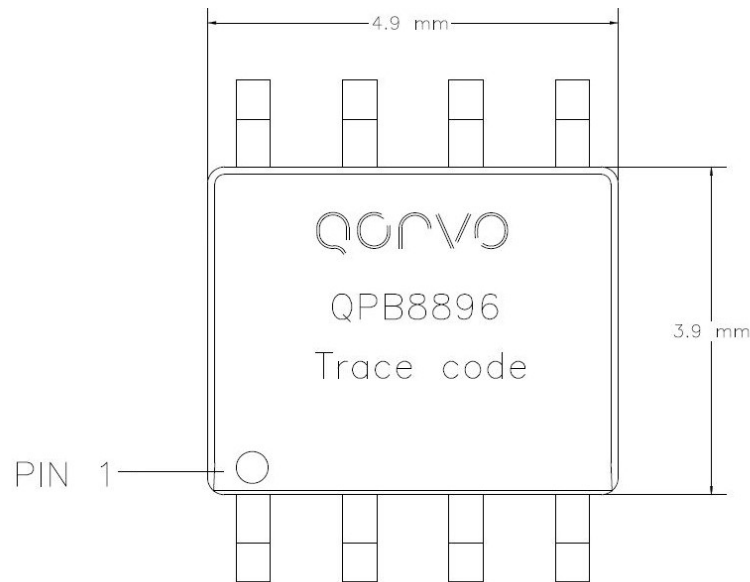
## Package Outline



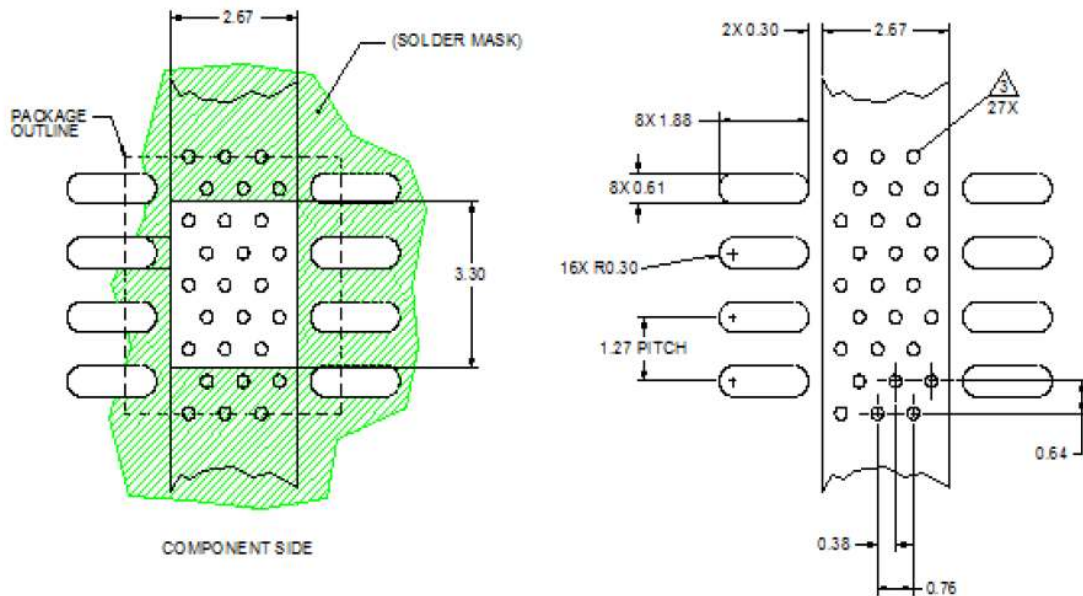
### Notes:

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.



# QPB8896

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

### 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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