

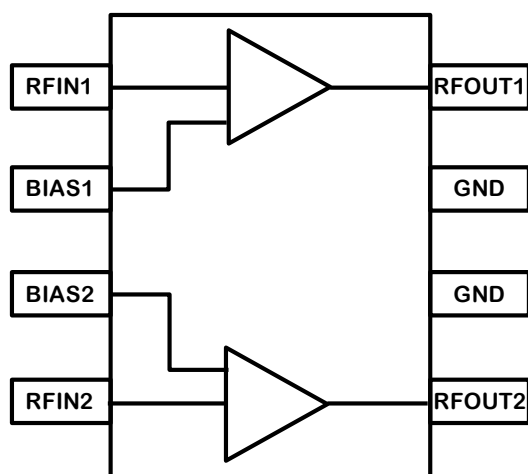
### Product Overview

The QPB2328 is an HBT RF balanced amplifier IC operating as a return path amplifier capable of supporting DOCSIS 3.1 applications. This IC is designed to provide a low noise, high gain option for 5-210MHz interface using an 8V power supply to provide lower overall power dissipation. The QPB2328 can also be used in 5V and single ended applications with reduced linearity requirements. The QPB2328 is packaged in a convenient SOIC8 package and features an externally adjustable bias control.



Package: SOIC-8 with Exposed Pad

### Functional Block Diagram



Top View

### Key Features

- 5MHz to 210MHz Operation
- 8V and 5V Operation
- Gain; 17.5dB Typical
- Noise Figure 3.5dB Typical
- Adjustable Bias Using External Resistors
- SOIC-8 Exposed Pad

### Applications

- Head End CMTS Equipment
- Post Amp for Return Path Optical Receivers
- DOCSIS 3.1 Optical Nodes
- Residential Amplifiers and Splitters

### Ordering Information

| Part No.    | Description                           |
|-------------|---------------------------------------|
| QPB2328SQ   | Sample bag with 25 pieces             |
| QPB2328SR   | 7" Reel with 100 pieces               |
| QPB2328TR13 | 13" Reel with 2500 pieces             |
| QPB2328PCK  | 5 – 210 MHz PCBA with 5 pc sample bag |

### Absolute Maximum Ratings

| Parameter                              | Rating         |
|----------------------------------------|----------------|
| Supply Voltage ( $V_{DD}$ )            | +10V           |
| Supply Current ( $I_{DD}$ )            | 350mA          |
| Maximum CW Input Power for $V_{DD}=8V$ | +16dBm         |
| Operating Temperature Range            | -40 to +85 °C  |
| Storage Temperature Range              | -65 to +150 °C |
| Maximum Junction Temperature           | +150 °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 – Push-Pull Configuration, 8V

| Parameter                   | Condition <sup>(1)</sup>                               | Min | Typ  | Max | Unit |
|-----------------------------|--------------------------------------------------------|-----|------|-----|------|
| Supply Voltage ( $V_{DD}$ ) |                                                        |     | 8    |     | V    |
| Supply Current ( $I_{DD}$ ) |                                                        |     | 235  |     | mA   |
| Frequency Range             |                                                        | 5   |      | 210 | MHz  |
| Gain                        | Full Band                                              |     | 17.8 |     | dB   |
| Gain Flatness               |                                                        |     | ±0.2 |     | dB   |
| Gain Tilt                   | Gain(210MHz) - Gain(5MHz)                              |     | 0.15 |     | dB   |
| Input Return Loss           | Full Band                                              |     | 19   |     | dB   |
| Output Return Loss          | Full Band                                              |     | 25   |     | dB   |
| Reverse Isolation           | Full Band                                              |     | 22   |     | dB   |
| Noise Figure                | Includes balun loss                                    |     | 3.5  |     | dB   |
| DTO                         | f1=13MHz, f2=19MHz 61dBmV per tone                     |     | 70   |     | -dBc |
| DSO                         | f1=13MHz, f2=19MHz 61dBmV per tone                     |     | 82   |     | -dBc |
| ACLR                        | Pout = 64dBmV, 5-195MHz OFDM w/ 9.6MHz exclusion band. |     | 63   |     | dB   |
| OIP2                        | 12dBm/tone, F1 = 113MHz, F2 = 119MHz                   |     | 93   |     | dBm  |
| OIP3                        | 12dBm/tone, F1 = 113MHz, F2 = 119MHz                   |     | 46   |     | dBm  |
| Output P1dB                 | Full Band                                              |     | 27   |     | dBm  |
| Thermal Resistance          | $\Theta_{JC}$                                          |     | 12   |     | °C/W |
|                             |                                                        |     |      |     |      |

#### Notes:

1. Typical performance at these conditions: Temp = +25°C,  $V_{DD}$  = +8V, 75Ω system

### Electrical Specifications – Single Ended, 8V (50Ω)

| Parameter                   | Condition <sup>(1)</sup>            | Min | Typ   | Max | Unit |
|-----------------------------|-------------------------------------|-----|-------|-----|------|
| Supply Current ( $I_{DD}$ ) |                                     |     | 114   |     | mA   |
| Gain                        |                                     |     | 17.75 |     | dB   |
| OIP2L                       | 9dBm/tone, F1 = 113MHz, F2 = 123MHz |     | 57.7  |     | dBm  |
| OIP2H                       | 9dBm/tone, F1 = 113MHz, F2 = 123MHz |     | 58.8  |     | dBm  |
| OIP3                        | 9dBm/tone, F1 = 113MHz, F2 = 123MHz |     | 43.9  |     | dBm  |
|                             |                                     |     |       |     |      |

Notes:

1. Typical performance at these conditions: Singled ended configuration, Temp = +25°C,  $V_{DD}$  = +8V, **50Ω system**
2. 50ohm data represents factory test conditions

### Electrical Specifications – Push-Pull Configuration, 5V

| Parameter                   | Condition <sup>(1)</sup>                               | Min | Typ  | Max | Unit |
|-----------------------------|--------------------------------------------------------|-----|------|-----|------|
| Supply Voltage ( $V_{DD}$ ) |                                                        |     | 5    |     | V    |
| Supply Current ( $I_{DD}$ ) |                                                        |     | 100  |     | mA   |
| Frequency Range             |                                                        | 5   |      | 210 | MHz  |
| Gain                        | Full Band                                              |     | 17.5 |     | dB   |
| Gain Flatness               |                                                        |     | ±0.2 |     | dB   |
| Gain Tilt                   | Gain(210MHz) - Gain(5MHz)                              |     | 0.15 |     | dB   |
| Input Return Loss           | Full Band                                              |     | 19   |     | dB   |
| Output Return Loss          | Full Band                                              |     | 24   |     | dB   |
| Reverse Isolation           | Full bandwidth                                         |     | 22   |     | dB   |
| Noise Figure                | Includes balun loss                                    |     | 3.5  |     | dB   |
| DTO                         | f1=13MHz, f2=19MHz 53dBmV per tone                     |     | 64   |     | -dBc |
| DSO                         | f1=13MHz, f2=19MHz 53dBmV per tone                     |     | 76   |     | -dBc |
| ACLR                        | Pout = 56dBmV, 5-195MHz OFDM w/ 9.6MHz exclusion band. |     | 62   |     | dB   |
| OIP2                        | 4dBm/tone, F1 = 113MHz, F2 = 119MHz                    |     | 82   |     | dBm  |
| OIP3                        | 4dBm/tone, F1 = 113MHz, F2 = 119MHz                    |     | 36.5 |     | dBm  |
| Output P1dB                 | Full Band                                              |     | 22   |     | dBm  |

Notes:

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

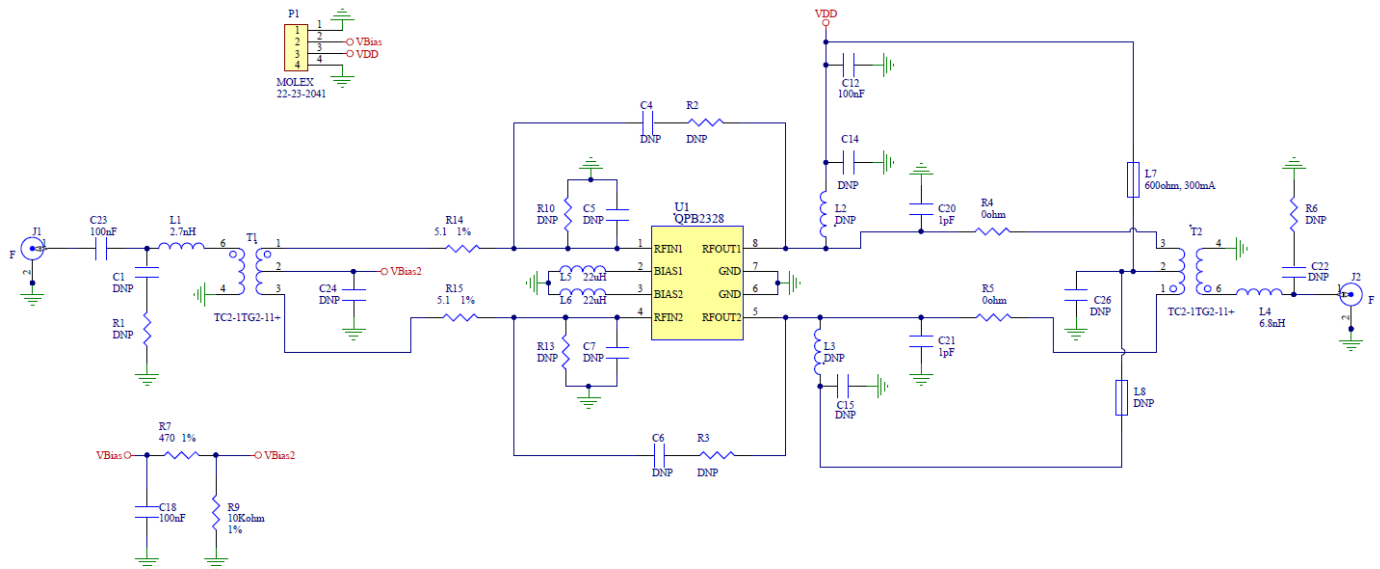
### Electrical Specifications – Single Ended Configuration, 5V

| Parameter                   | Condition <sup>(1)</sup>                               | Min | Typ       | Max | Unit |
|-----------------------------|--------------------------------------------------------|-----|-----------|-----|------|
| Supply Voltage ( $V_{DD}$ ) |                                                        |     | 5         |     | V    |
| Supply Current ( $I_{DD}$ ) |                                                        |     | 55        |     | mA   |
| Frequency Range             |                                                        | 5   |           | 210 | MHz  |
| Gain                        | Full Band                                              |     | 18.7      |     | dB   |
| Gain Flatness               |                                                        |     | $\pm 0.2$ |     | dB   |
| Gain Tilt                   | Gain(210MHz) - Gain(5MHz)                              |     | 0.2       |     | dB   |
| Input Return Loss           | Full Band                                              |     | 22        |     | dB   |
| Output Return Loss          | Full Band                                              |     | 21        |     | dB   |
| Reverse Isolation           | Full bandwidth                                         |     | 21        |     | dB   |
| Noise Figure                | Full bandwidth                                         |     | 3         |     | dB   |
| DTO                         | f1=13MHz, f2=19MHz 46dBmV per tone                     |     | 74        |     | -dBc |
| DSO                         | f1=13MHz, f2=19MHz 46dBmV per tone                     |     | 49        |     | -dBc |
| ACLR                        | Pout = 48dBmV, 5-195MHz OFDM w/ 9.6MHz exclusion band. |     | 61        |     | dB   |
| OIP2                        | -3dBm/tone, F1 = 113MHz, F2 = 119MHz                   |     | 47        |     | dBm  |
| OIP3                        | -3dBm/tone, F1 = 113MHz, F2 = 119MHz                   |     | 36        |     | dBm  |
| Output P1dB                 | Full Band                                              |     | 19.5      |     | dBm  |

Notes:

1. Typical performance at these conditions: Temp = +25°C,  $V_{DD}$  = +5V applied to single ended amplifier path, 75Ω system

### Evaluation Board Schematic 5-210MHz





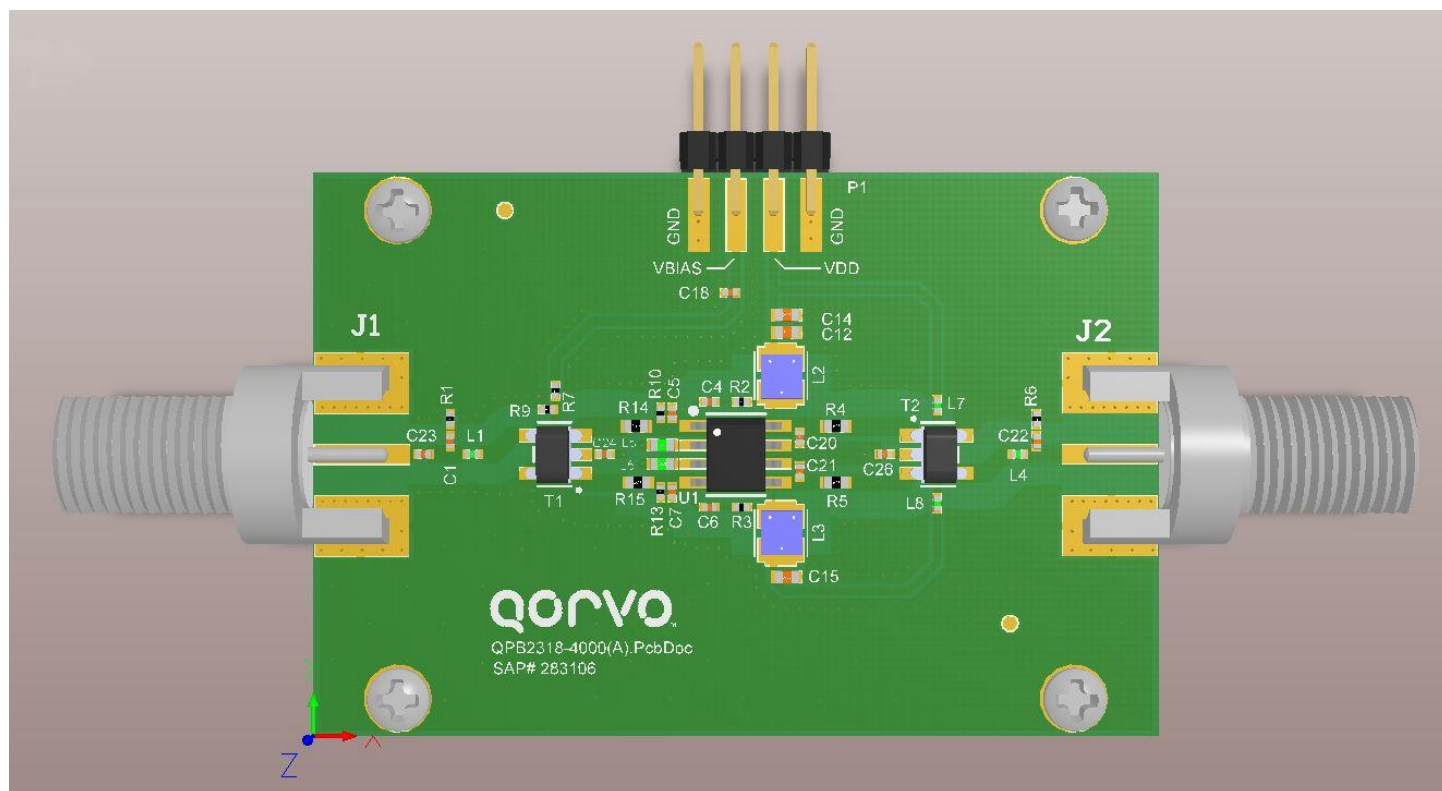
# QPB2328

## 17.5 dB Balanced Return Path Amplifier 5 – 210 MHz

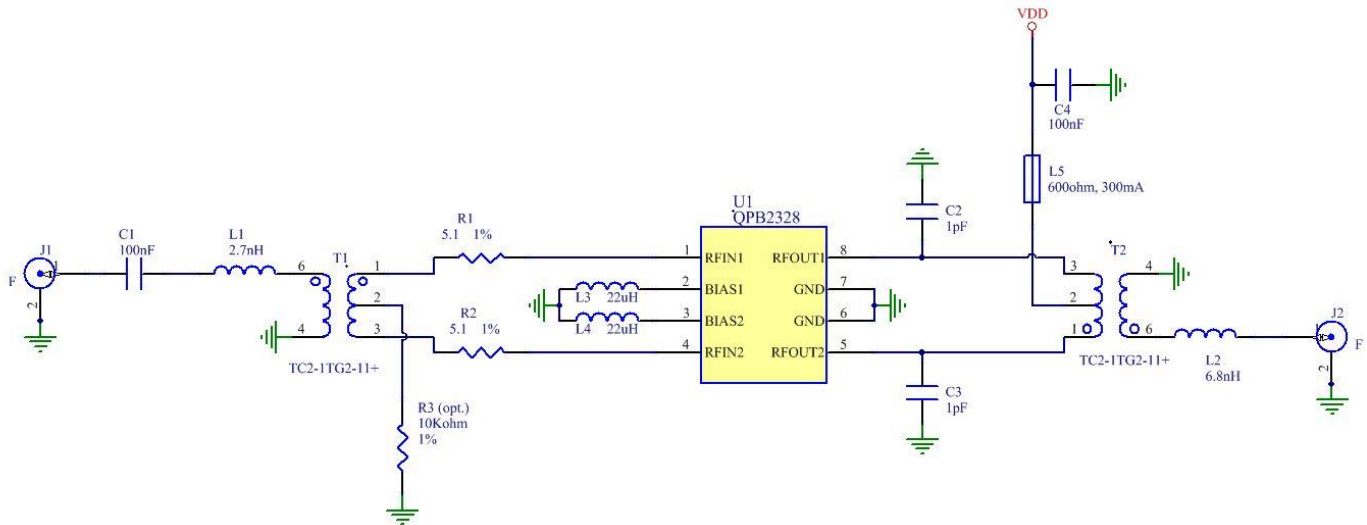
### Evaluation Board Bill of Materials

| Designator                                                                        | Description                              | Manufacturer                        | Part Number        |
|-----------------------------------------------------------------------------------|------------------------------------------|-------------------------------------|--------------------|
| PCB                                                                               | QPB2318-4000                             | DDI                                 | QPB2318-4000(A)    |
| C12, C18, C23                                                                     | CAP, 0.1uF, 10%, 16V, X7R, 0402          | Murata Electronics                  | GRM155R71C104KA88D |
| C20, C21                                                                          | 1.0PF, .1PF, 50, NPO, 0402, LF LEAD FREE | Murata Electronics                  | GRM1555C1H1R0BZ01D |
| J1, J2                                                                            | CONN, F FEM EDGE MOUNT, 75 OHMS, 0.068"  | Millimeter Wave Technologies, LLC   | MW-846-C-DD-75     |
| L1                                                                                | IND, 2.7nH, +/-0.3nH, M/L, 0402          | Murata Electronics                  | LQG15HS2N7S02D     |
| L4                                                                                | IND, 6.8nH, 5%, M/L, 0402                | Murata Electronics                  | LQG15HN6N8J02D     |
| L5, L6                                                                            | IND, 22uH, 20%, 190mA, M/L, 0603         | TDK                                 | MLZ1608N220LT000   |
| L7                                                                                | FER, BEAD, 600 OHM, 300mA, 0402          | Murata                              | BLM15HG601SN       |
| P1                                                                                | CONN, HDR, ST, FRCTN LOCK, 4-PIN         | MOLEX                               | 22-23-2041         |
| R14, R15                                                                          | RES, 5.1 OHM, 1%, 1/10W, 0402            | Kamaya, Inc                         | RMC1/16SK5R10FTH   |
| R4, R5                                                                            | JMPR, 0 OHM, 0402                        | Panasonic Industrial Devices Sales  | ERJ-2GE0R00        |
| R7                                                                                | Res, 470R /1%/0402/TK100/Chip            | Kamaya, Inc                         | RMC1/16SK4700FTH   |
| R9                                                                                | RES, 10K, 1%, 1/16W, 0402                | Panasonic Industrial Devices Sales  | ERJ-2RKF1002X      |
| T1, T2                                                                            | XFMR, 3-300MHz, 50 OHM, 250mW, AT224-3   | Minicircuits                        | TC2-1TG2-11+       |
| U1                                                                                | 17.5dB High-Linearity Push-Pull MMIC     | Qorvo                               | QPB2328            |
| C1, C4, C5, C6, C7, C14, C15, C22, C24, C26, L2, L3, L8, R1, R2, R3, R6, R10, R13 | DNP                                      | N/A                                 | N/A                |
| HS1                                                                               | Heat Sink 1.5 x 2                        | Shenzhen Minxingda Automation Equip | 211086             |
| S1, S2, S3, S4                                                                    | Screw, 2-56x3/16:, Socket Head           | McMaster-Carr Supply Co.            | 92196A076          |
|                                                                                   |                                          |                                     |                    |

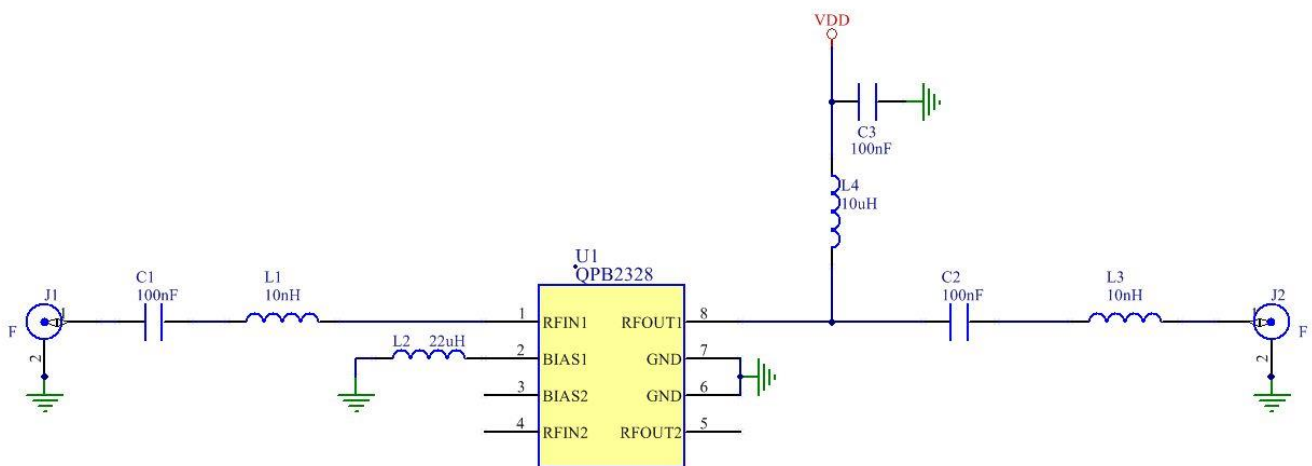
## Evaluation Board Assembly Drawing



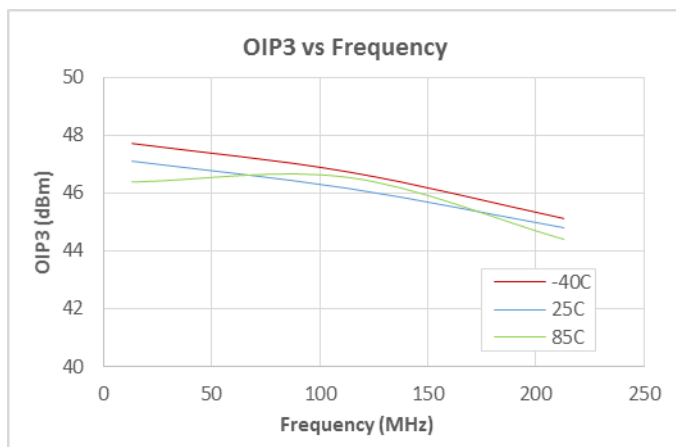
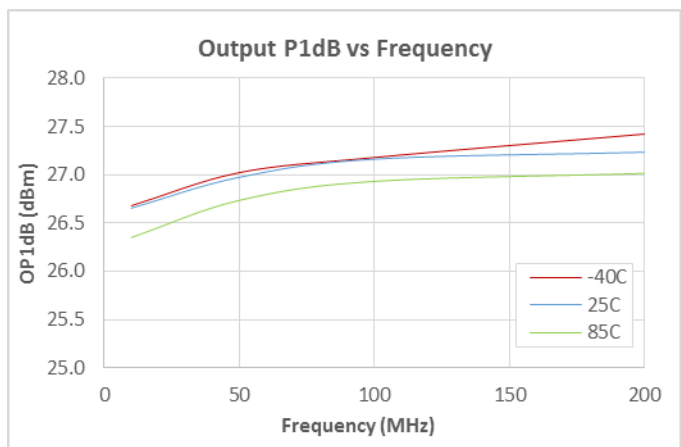
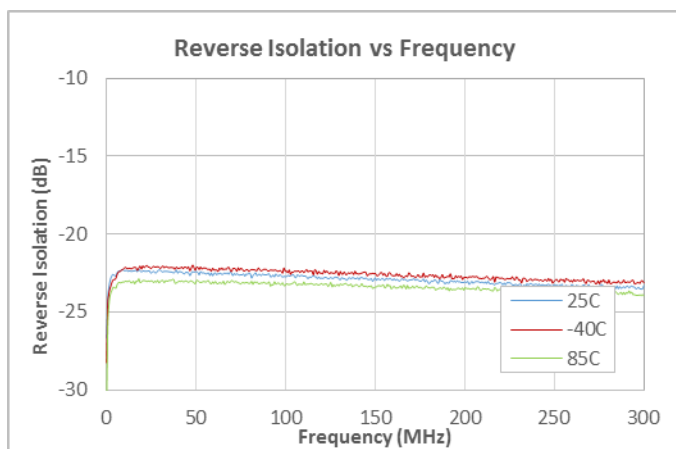
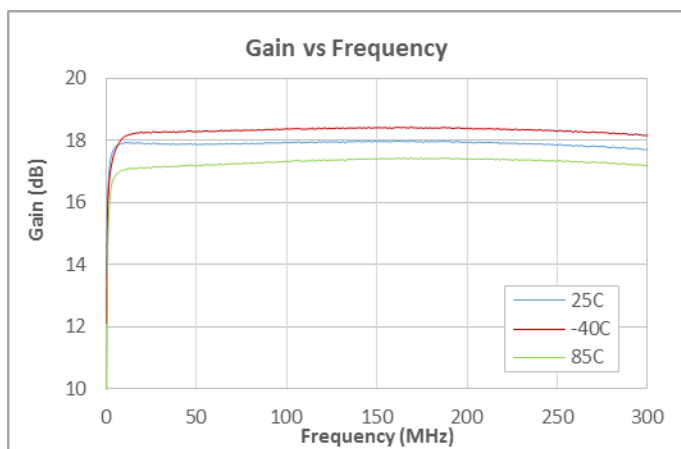
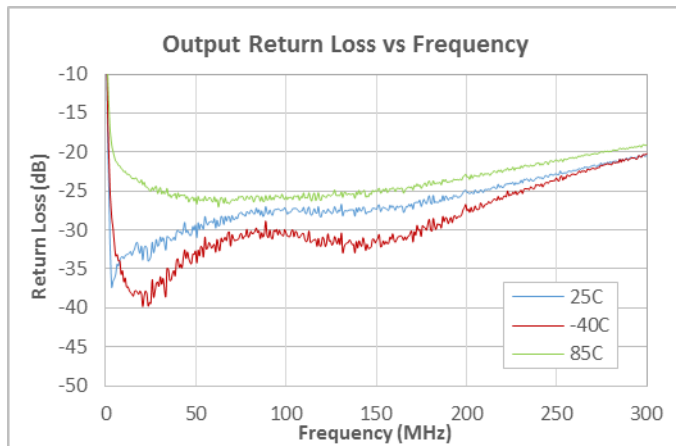
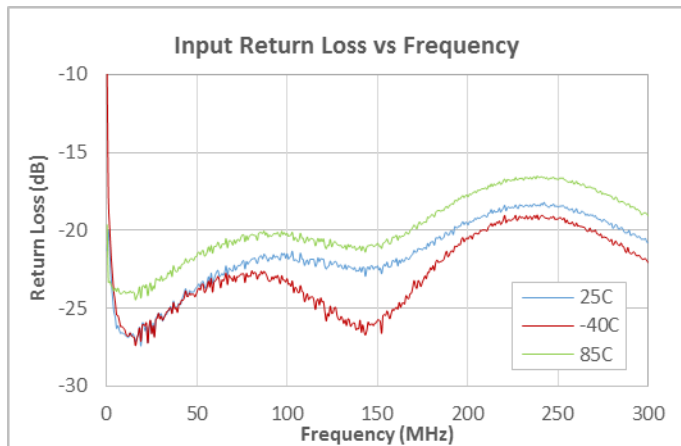
## Typical Application Schematic – Push-Pull Configuration



## Typical Application Schematic – Single Ended Configuration



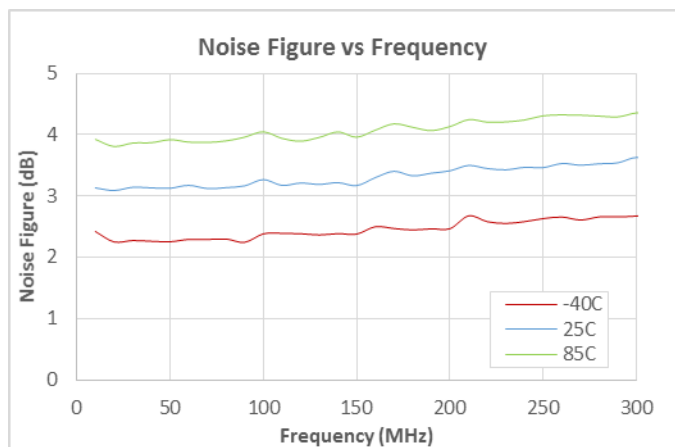
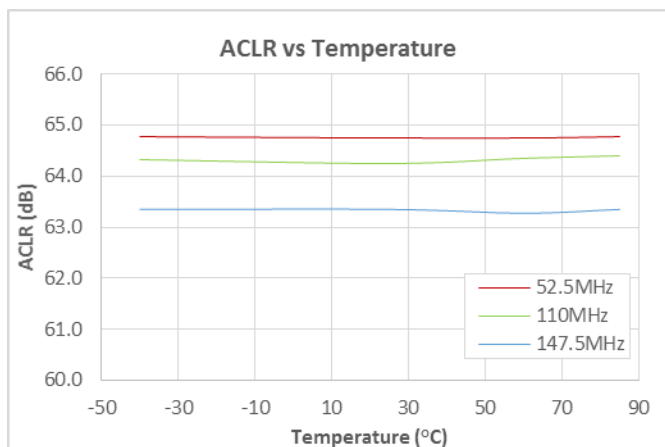
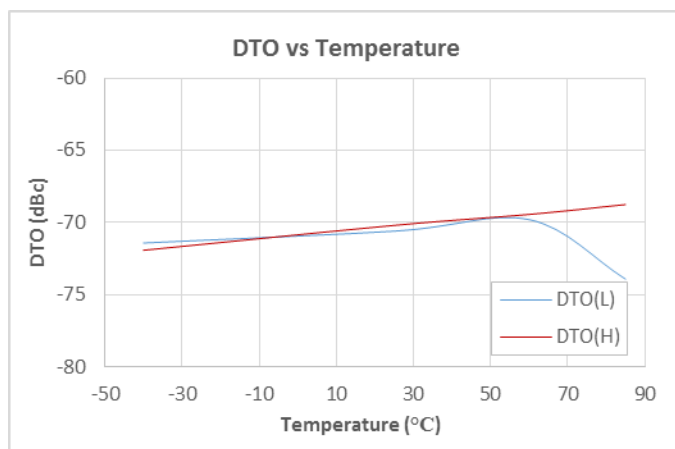
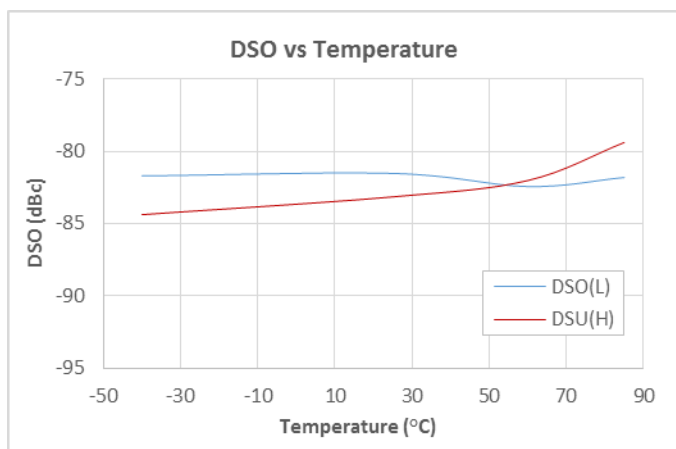
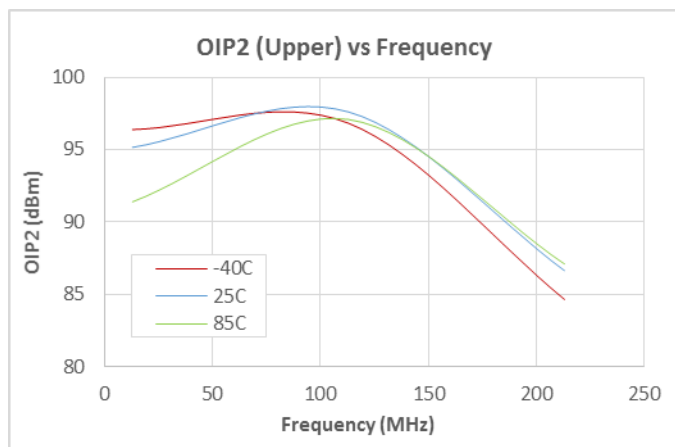
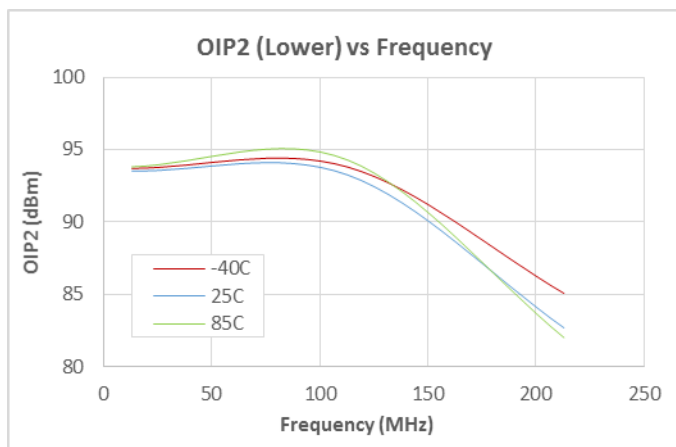
### Performance Data – Push-Pull Configuration, 8V



**Notes:**

- (1) OIP3: 12dBm/tone, F1 = 113MHz, F2 = 119MHz

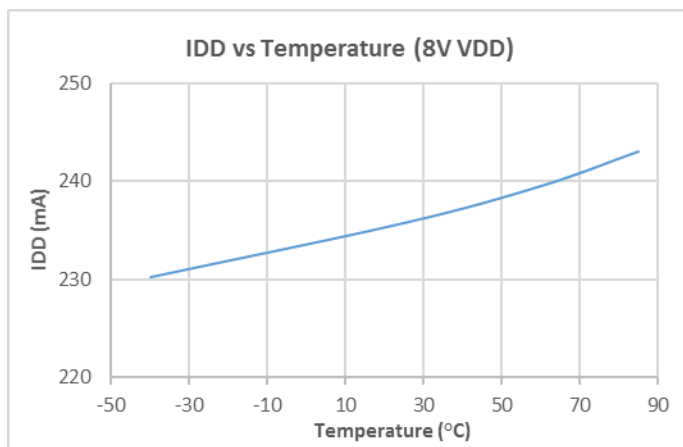
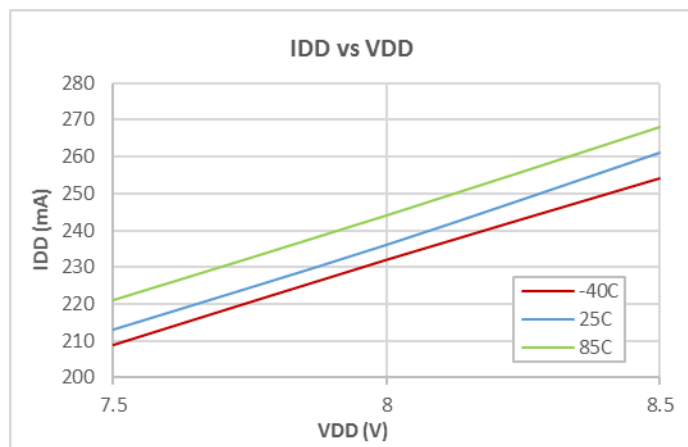
### Performance Data – Push-Pull Configuration, 8V



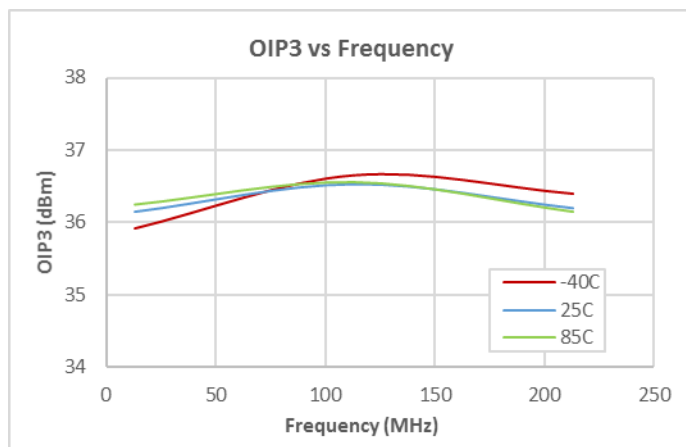
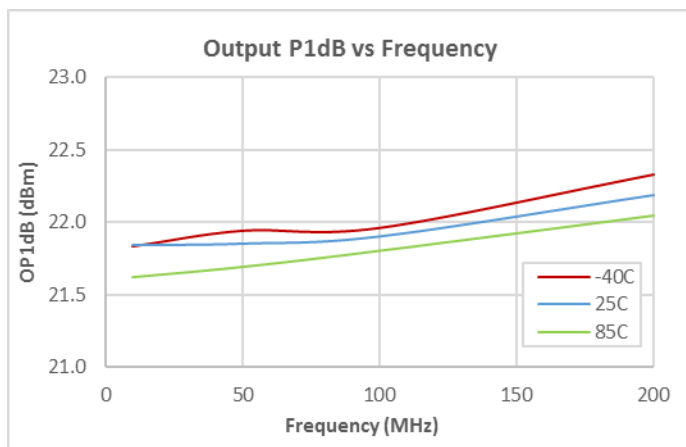
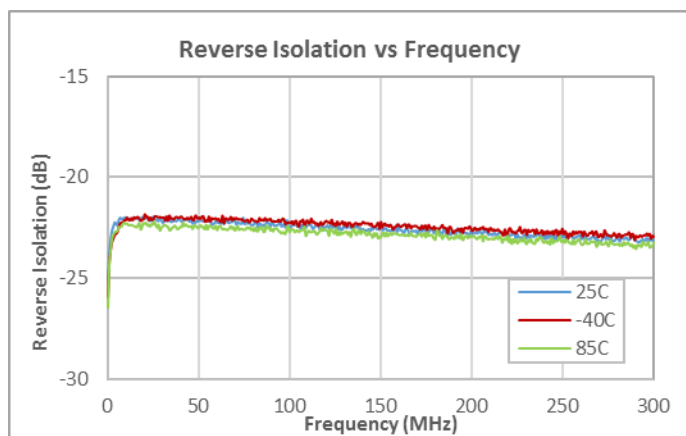
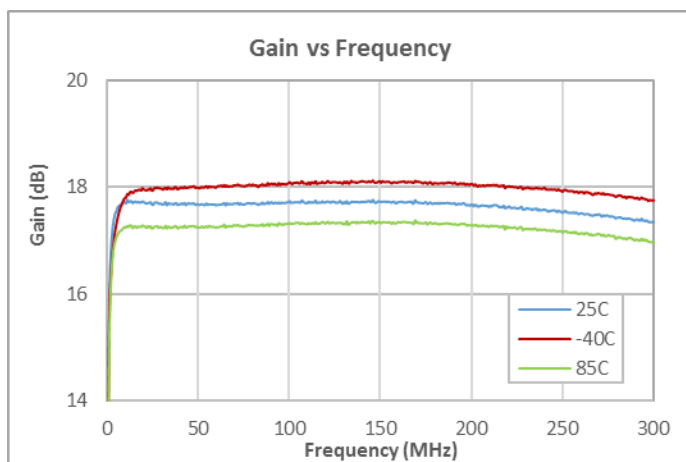
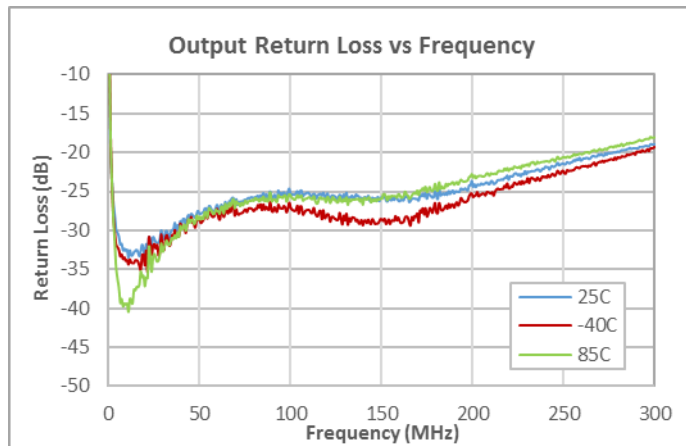
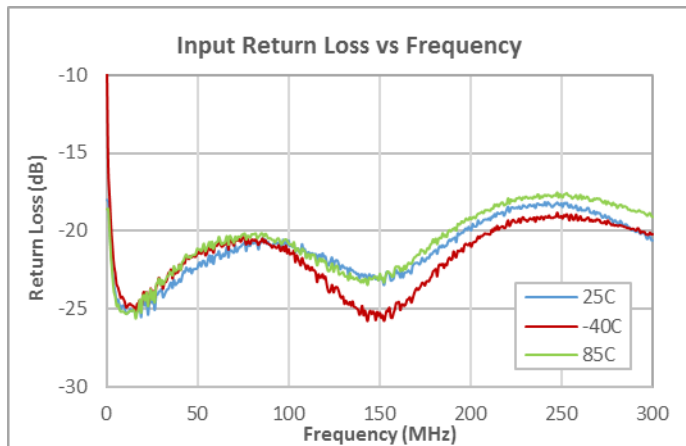
#### Notes:

- (2) OIP2: 12dBm/tone, F1 = 113MHz, F2 = 119MHz
- (3) DSO/DTO: f1=13MHz, f2=19MHz 61dBmV per tone
- (4) ACLR: Pout = 64dBmV, 5-195MHz OFDM w/ 9.6MHz exclusion band.

**Performance Data – Push-Pull Configuration, 8V**



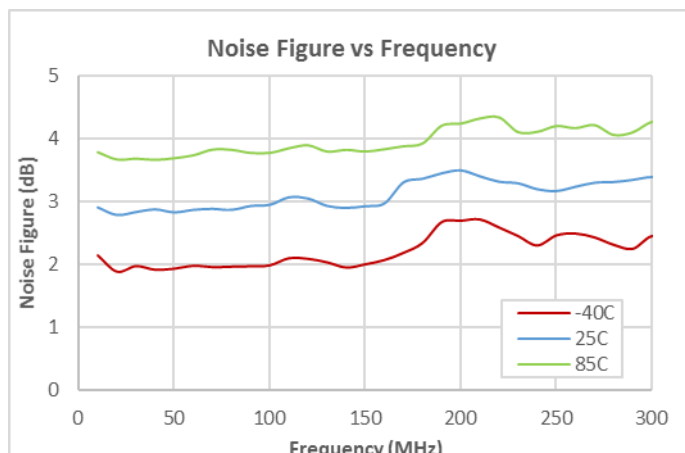
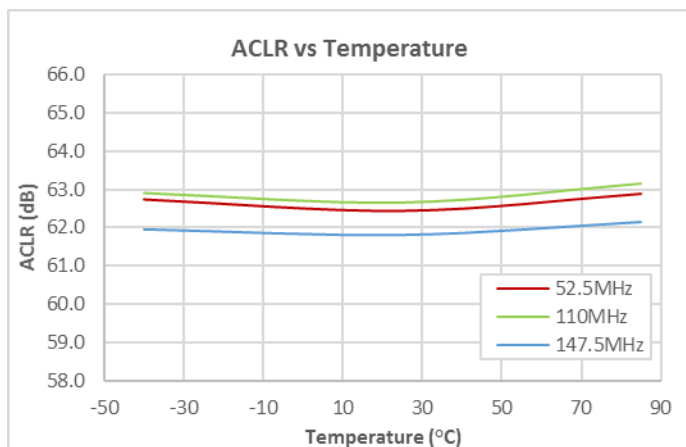
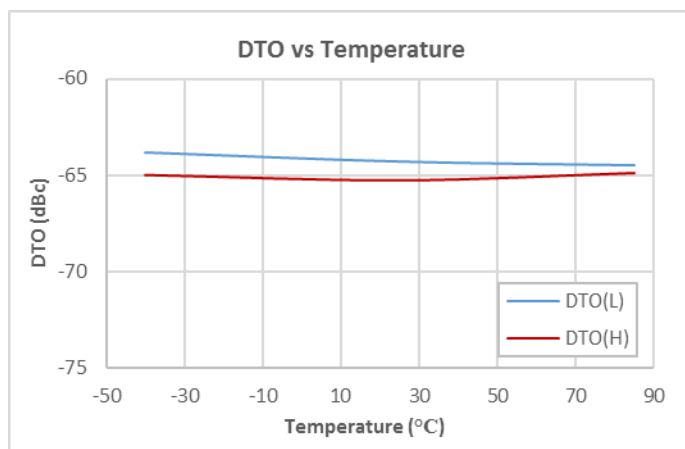
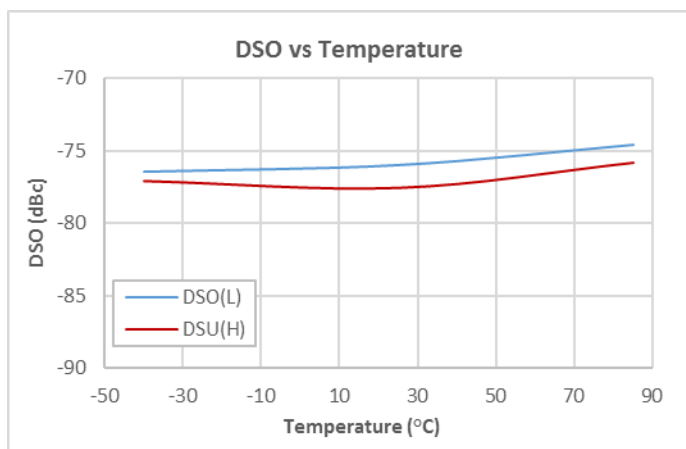
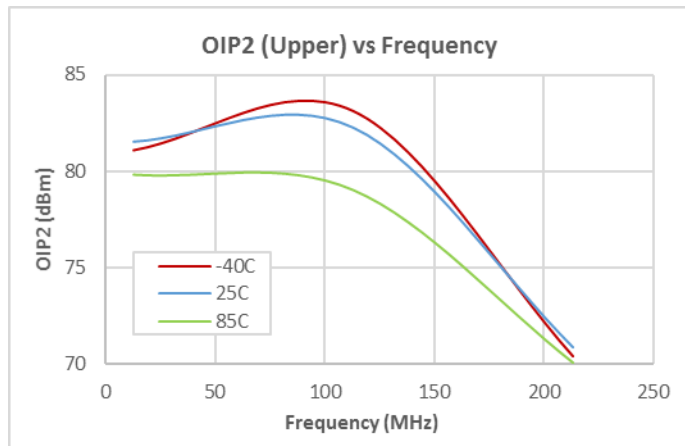
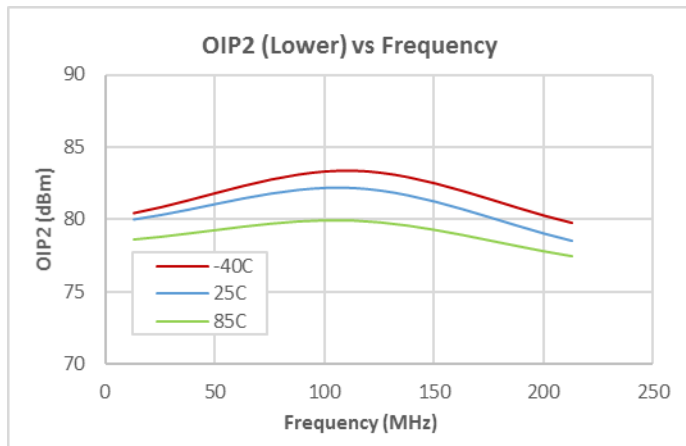
### Performance Data – Push-Pull Configuration, 5V



#### Notes:

- (1) OIP3: 4dBm/tone, F1 = 113MHz, F2 = 119MHz

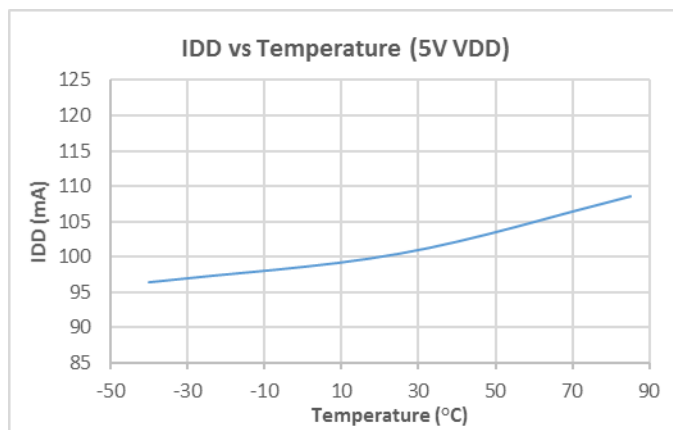
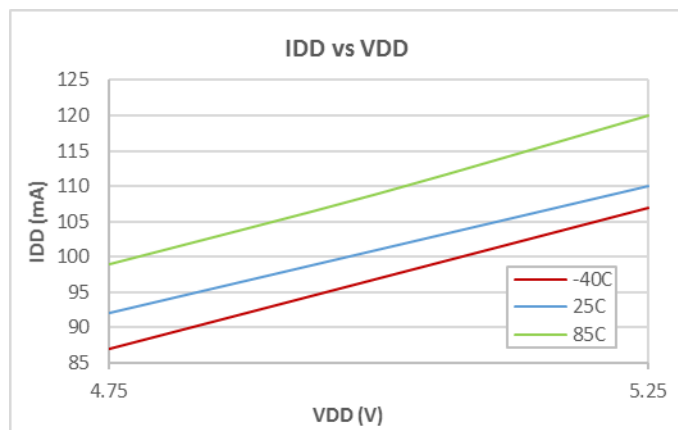
### Performance Data – Push-Pull Configuration, 5V



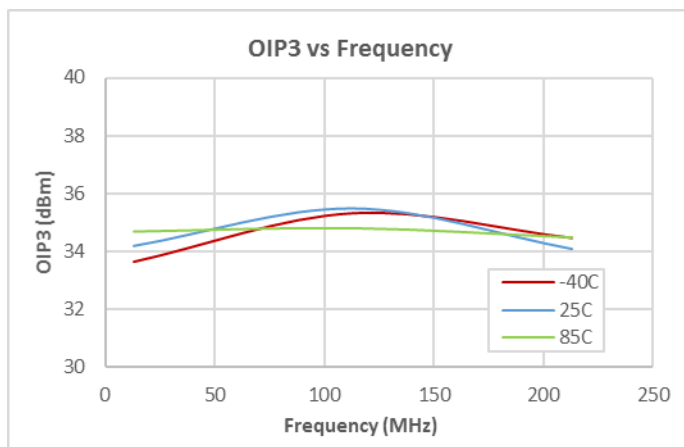
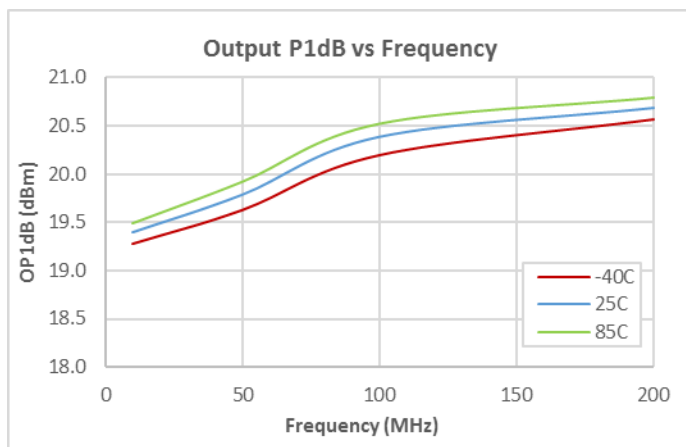
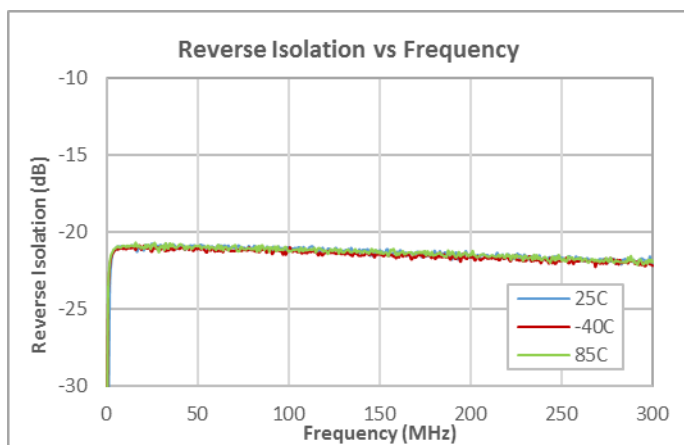
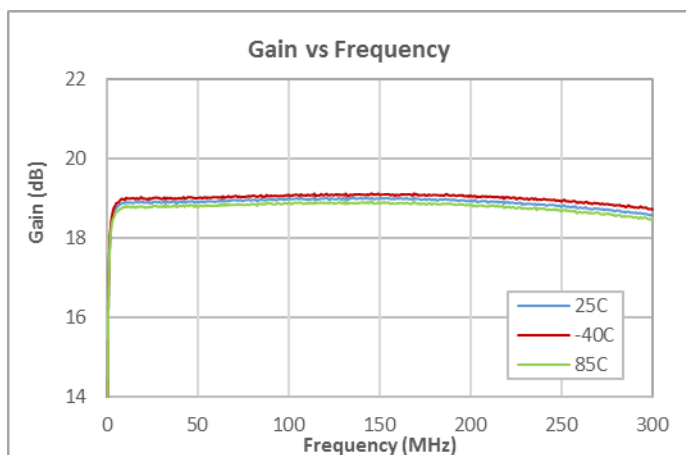
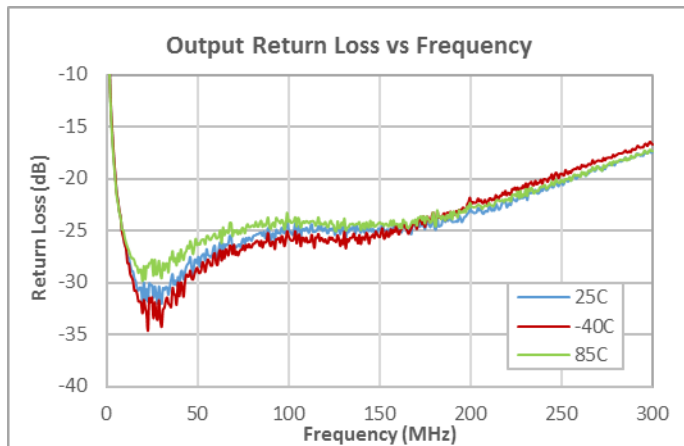
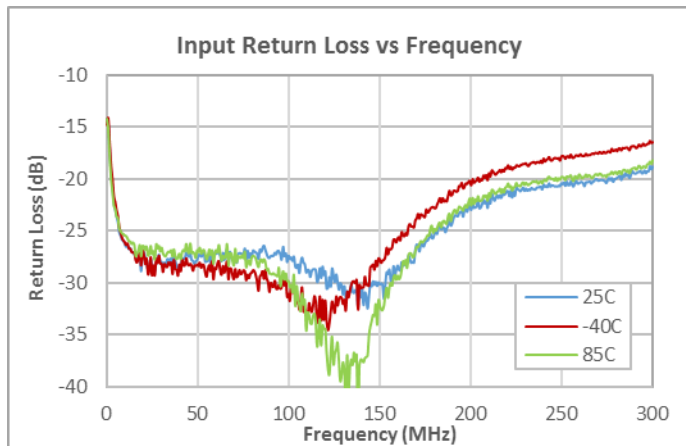
#### Notes:

- (1) OIP2: 4dBm/ton, F1 = 113MHz, F2 = 119MHz
- (2) DSO/DTO: f1=13MHz, f2=19MHz 53dBmV per tone
- (3) ACLR: Pout = 56dBmV, 5-195MHz OFDM w/ 9.6MHz exclusion band.

**Performance Data – Push-Pull Configuration, 5V**



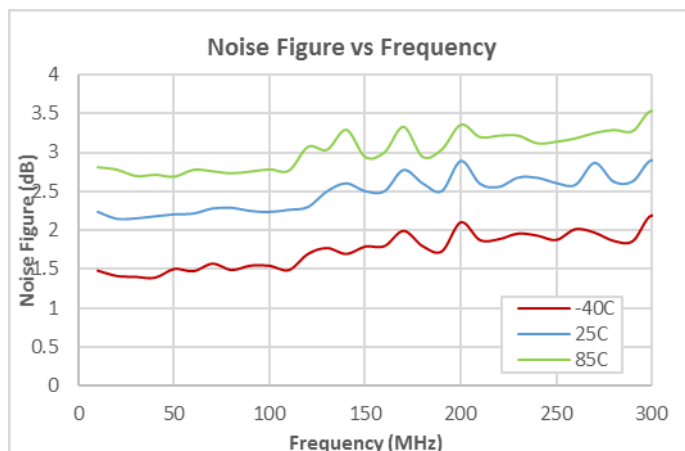
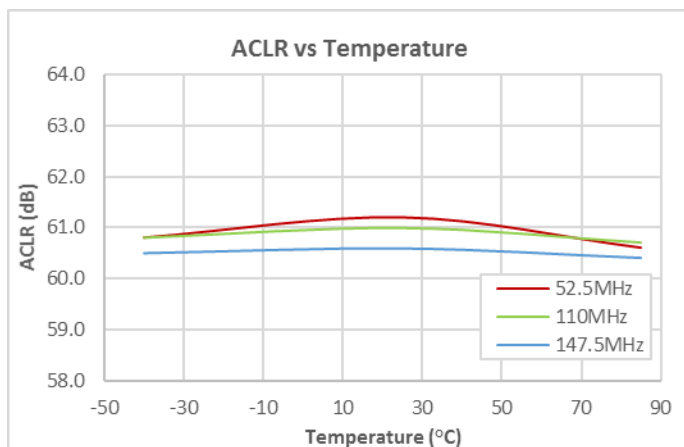
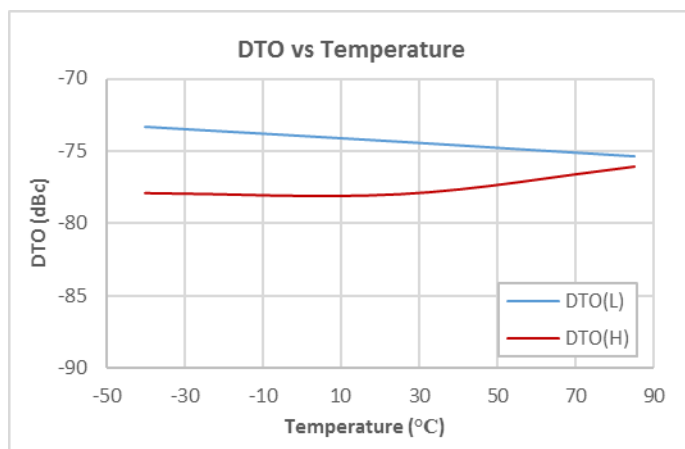
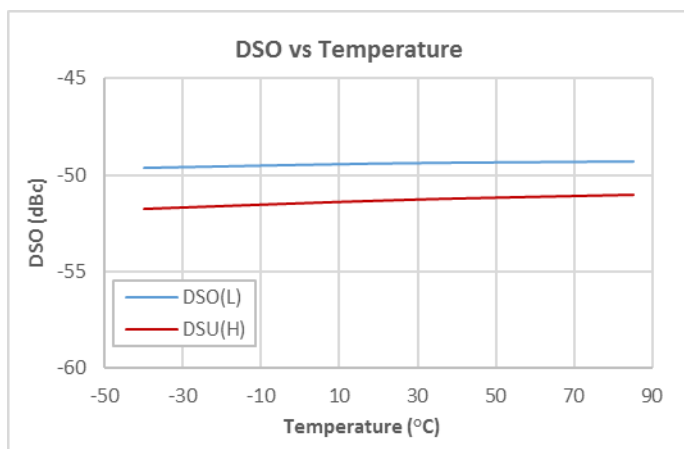
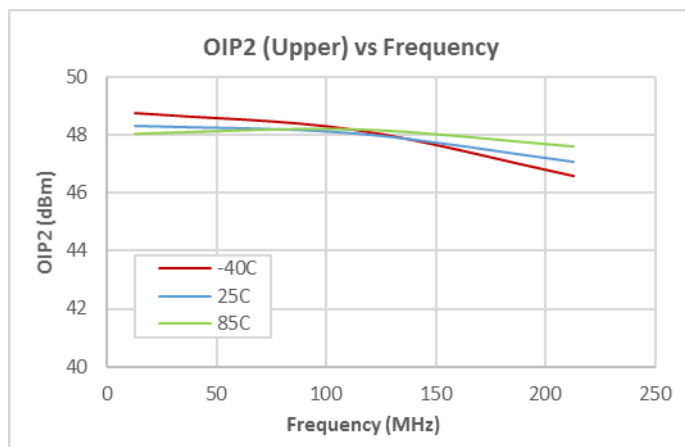
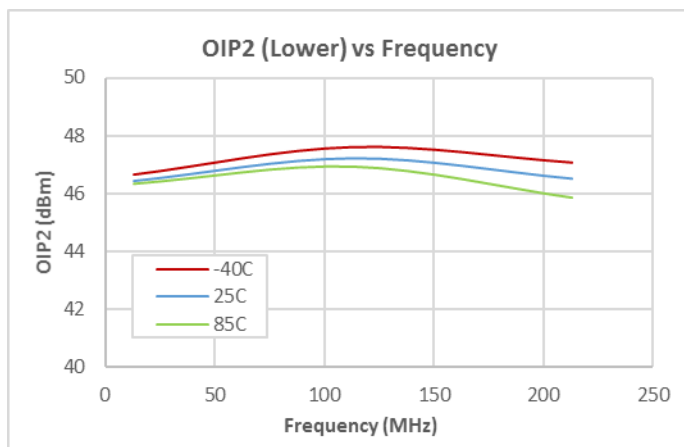
## Performance Data – Single Ended Configuration, 5V



### Notes:

- (1) OIP3: -3dBm/tone, F1 = 113MHz, F2 = 119MHz

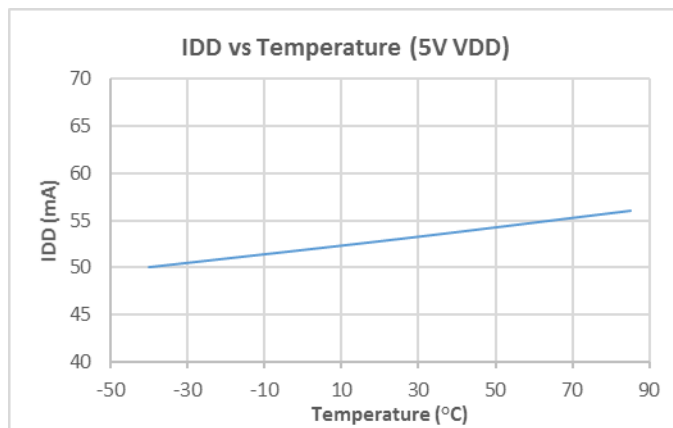
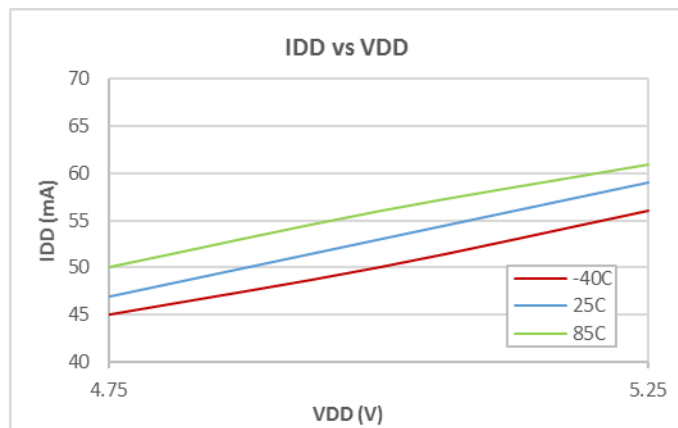
### Performance Data – Single Ended Configuration, 5V



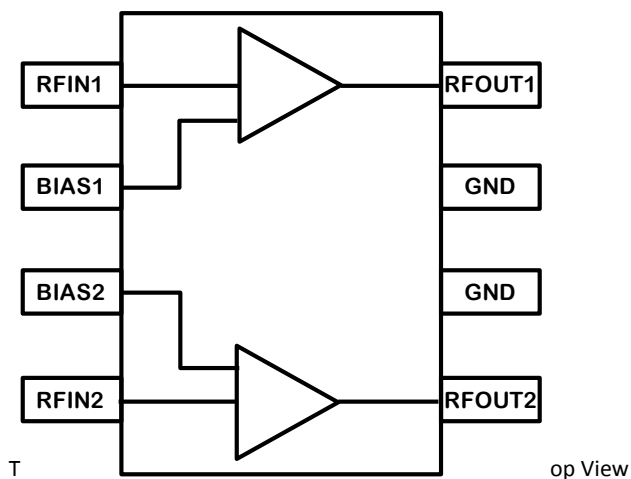
#### Notes:

- (1) OIP2: -3dBm/ton, F1 = 113MHz, F2 = 119MHz
- (2) DSO/DTO: f1=13MHz, f2=19MHz 46dBmV per tone
- (3) ACLR: Pout = 49dBmV, 5-195MHz OFDM w/ 9.6MHz exclusion band.

**Performance Data – Single Ended Configuration, 5V**

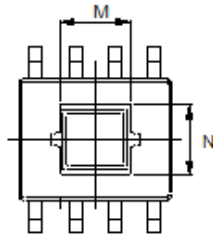
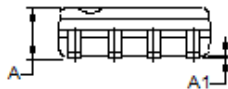
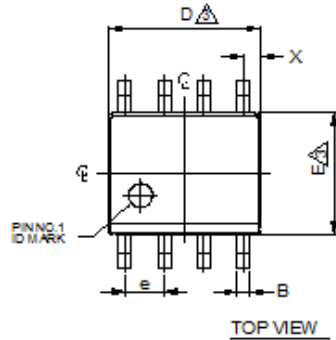


### Pad Configuration and Description

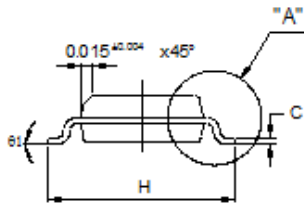
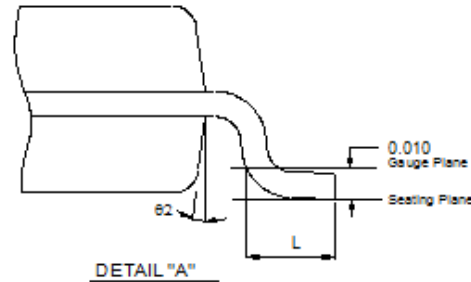


| Pad No.         | Label  | Description                                                                                                                          |
|-----------------|--------|--------------------------------------------------------------------------------------------------------------------------------------|
| 1               | RFIN1  | RF input for AMP1                                                                                                                    |
| 2               | BIAS1  | AMP1 bias, requires choke to ground                                                                                                  |
| 3               | BIAS2  | AMP2 bias, requires choke to ground                                                                                                  |
| 4               | RFIN2  | RF input for AMP2                                                                                                                    |
| 5               | RFOUT2 | RF output for AMP2                                                                                                                   |
| 6               | GND    | Internally Not Connected                                                                                                             |
| 7               | GND    | Internally Not Connected                                                                                                             |
| 8               | RFOUT1 | RF output for AMP1                                                                                                                   |
| Backside Paddle | GND    | Ground. Use recommended via pattern to minimize inductance and thermal resistance. See PCB Mounting Pattern for suggested footprint. |

## Package Outline



EXPOSED PADDLE



| SYMBOL | 8 SOIC     |        |
|--------|------------|--------|
|        | MIN        | MAX    |
| A      | 0.054      | 0.068  |
| A1     | 0.001      | 0.004  |
| B      | 0.014      | 0.019  |
| D      | 0.189      | 0.196  |
| E      | 0.150      | 0.157  |
| H      | 0.229      | 0.244  |
| M      | 0.087      | 0.097  |
| N      | 0.082      | 0.092  |
| e      | 0.050 BSC  |        |
| C      | 0.0075     | 0.0098 |
| L      | 0.020      | 0.040  |
| X      | 0.0215 REF |        |
| 61     | 0°         | 8°     |
| 62     | 7° BSC     |        |

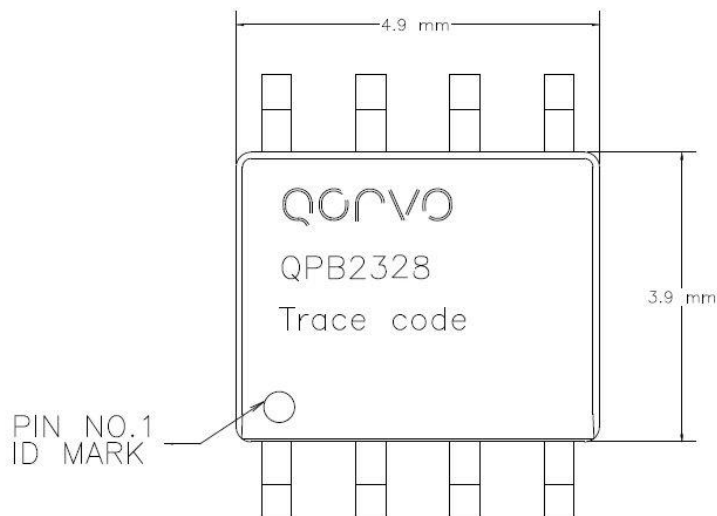
NOTE:

1. TOP PACKAGE SURFACE TO BE Ni, Pd, Au PLATING
2. BOTTOM PACKAGE SURFACE TO BE Ni, Pd, Au PLATING
3. DIMENSIONS ARE EXCLUSIVE MOLD FLASH AND GATE BURR.
4. FOOT LENGTH MEASURING IS BASED ON THE GAUGE PLANE METHOD.

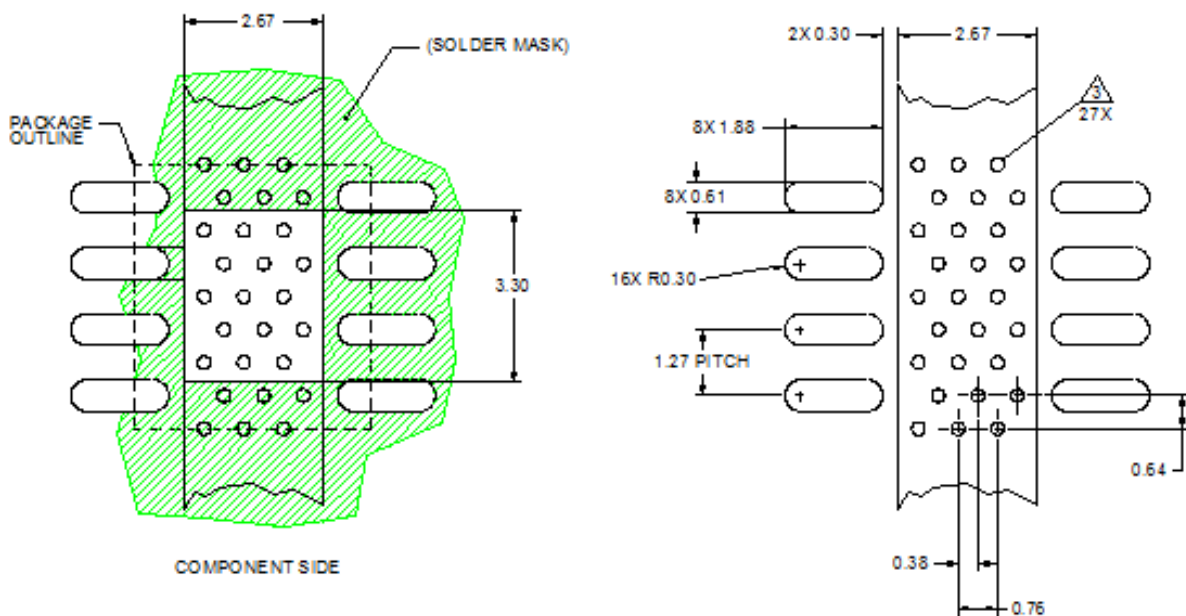
Notes:

1. Dimensions in millimeters

## Package Marking



## Recommended Mounting Pattern



### Notes:

1. All dimensions are in millimeters. Angles are in degrees.
2. Use 1oz. 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 0.35mm (#80/0.135") diameter bit for drilling via holes and a final plated through diameter of 0.25mm (0.010").
4. Ensure good backside paddle solder attach for reliable operation and best electrical performance.



# QPB2328

## 17.5 dB Balanced Return Path Amplifier 5 – 210 MHz

### Handling Precautions

| Parameter                        | Rating | Standard                 |
|----------------------------------|--------|--------------------------|
| ESD – Human Body Model (HBM)     | 1B     | ESDA / JEDEC JS-001-2012 |
| ESD – Charged Device Model (CDM) | C3     | JEDEC JESD22-C101F       |
| MSL – Moisture Sensitivity Level | MSL3   | 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: NiPdAu

### 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.

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:

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

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

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Система менеджмента качества компании отвечает требованиям в соответствии с ГОСТ Р ИСО 9001, ГОСТ РВ 0015-002 и ЭС РД 009

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