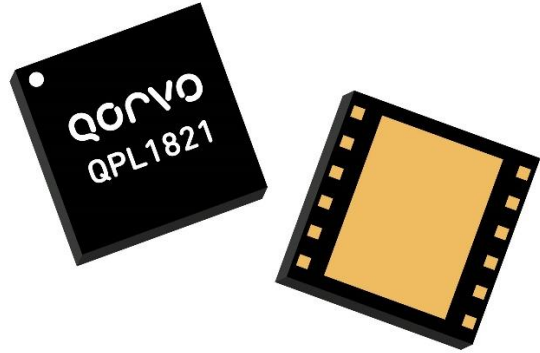


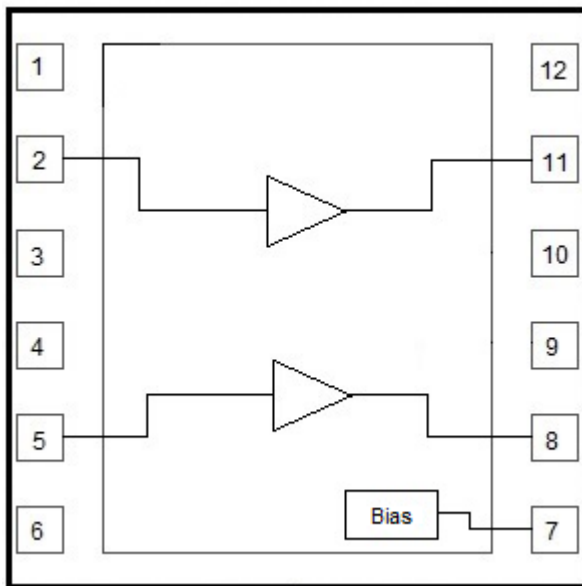
### Product Overview

The QPL1821 is an ultra-linear, GaAs pHEMT, differential RF amplifier. The device features a cascode design which provides 19dB of flat gain along with very low distortion from 5MHz to 1.8GHz. This ultra-linear IC is designed to support Broadband CATV DOCSIS 4.0 applications, such as Nodes, Amplifiers, and Remote PHY Devices, as well as Fiber to The Home (FTTH), Home Gateways, and Cable Modems. The device is powered by a single supply that can operate from 5V to 8V and current can be set from 260 mA to 350 mA. At 5V and 260 mA the QPL1821 provides an output of 63dBmV TCP with a MER of 45dB. When driven with 8V and 350mA the output is 67 dBmV TCP with a MER of 45dB. The QPL1821 is packaged in a 12-pin 5x5 mm<sup>2</sup> Laminate Module



5 x 5 12-pin Laminate MCM Package

### Functional Block Diagram



### Key Features

- 5 MHz to 1800 MHz Operation
- 5V & 8V Operation
- Gain: 19dB Typical
- TCP: 63dBmV @ 5V
- TCP: 67dBmV @ 8V
- Noise Figure: 1.6/3.2dB @ 50/1800MHz
- Adjustable Bias Using External Resistors
- RoHS Compliant

### Applications

- DOCSIS 4.0 Amplifiers
- DOCSIS 4.0 Optical Nodes
- DOCSIS 4.0 Remote PHY Devices
- FTTH GPON and GEPON
- DOCSIS 4.0 Cable Modem and Home Gateways

### Ordering Information

| Part Number   | Description                    | Part Number | Description               |
|---------------|--------------------------------|-------------|---------------------------|
| QPL1821EVB-01 | 5V Downstream Evaluation Board | QPL1821SB   | Sample bag with 5 pieces  |
| QPL1821EVB-02 | 5V Upstream Evaluation Board   | QPL1821SR   | 7" Reel with 100 pieces   |
| QPL1821EVB-03 | 8V Downstream Evaluation Board | QPL1821TR13 | 13" Reel with 2500 pieces |
| QPL1821EVB-04 | 8V Upstream Evaluation Board   |             |                           |

## Absolute Maximum Ratings

| Parameter  | Rating         |
|--|----------------|
| Supply Voltage (V <sub>DD</sub> )                                    | +10 V          |
| Supply Current (I <sub>DD</sub> )                                    | 400 mA         |
| Maximum Input Level  | +65 dBmV       |
| Operating Temperature Range (Operating Device Heat Slug Temperature) | -40 to +100 °C |
| Storage Temperature Range  | -65 to +150 °C |
| Maximum Junction Temperature   | +150 °C        |

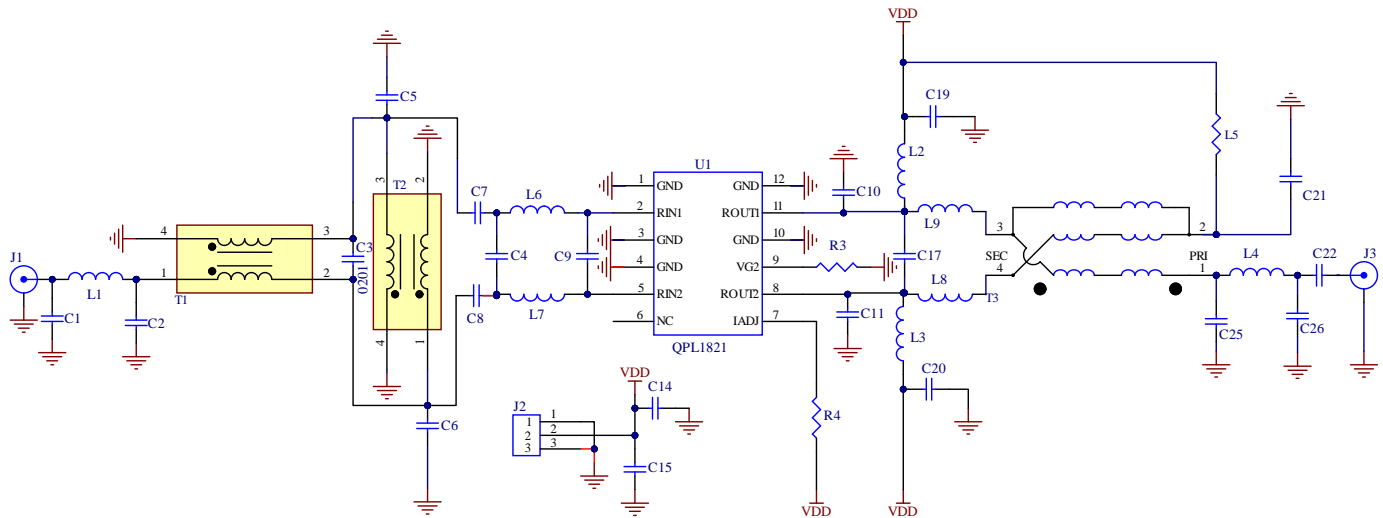
Exceeding any one or a combination of the Absolute Maximum Rating conditions may cause permanent damage to the device. Extended application of Absolute Maximum Rating conditions to the device may reduce device reliability.

## Electrical Specifications (Downstream)

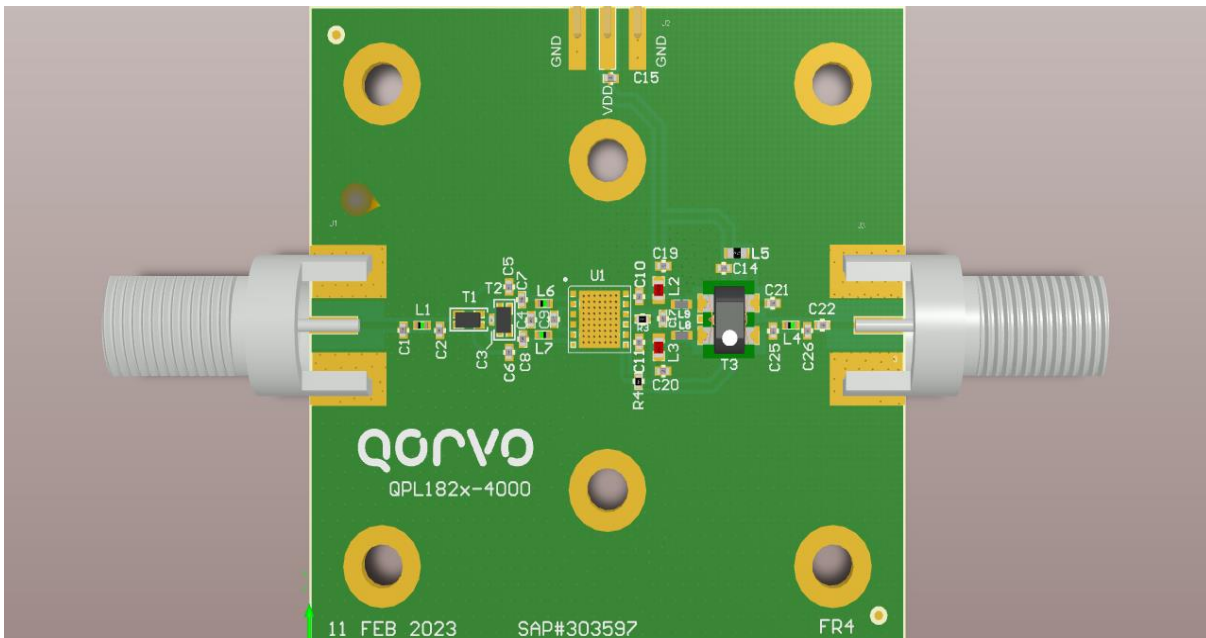
| Parameter                         | Test Condition  | Min | Typ     | Max  | Unit |
|-----------------------------------|---|-----|---------|------|------|
| Supply Voltage (V <sub>DD</sub> ) |   |     | 5/8     |      | V    |
| Supply Current (I <sub>DD</sub> ) |   |     | 260/350 |      | mA   |
| Frequency Range                   |   | 50  |         | 1800 | MHz  |
| Gain at 50 MHz                    |   |     | 18      |      | dB   |
| Gain at 1800 MHz                  |   |     | 19      |      | dB   |
| Gain Slope                        |   |     | 1       |      | dB   |
| Reverse Isolation                 |   |     | 23      |      | dB   |
| Input Return Loss                 | 50 – 1200 MHz   |     | -22     |      | dB   |
|                                   | 1200 – 1800 MHz   |     | -20     |      | dB   |
| Output Return Loss                | 50 – 1200 MHz   |     | -22     |      | dB   |
|                                   | 1200 – 1800 MHz   |     | -20     |      | dB   |
| MER                               | At +63dBmV @ 5V and +67dBmV @ 8V Total Composite Output power. 108 to 1791MHz, 280 Ch, SC-QAM, 10dB tilt, 0dB Offset (Source corrected) |     | 45      |      | dB   |
| Noise Figure                      | 50MHz   |     | 1.6     |      | dB   |
|                                   | 1800MHz   |     | 3.2     |      |      |
| OIP2L                             | +12 dBm / tone output, Δf=53MHz, Full Band  |     | 85      |      | dBm  |
| OIP2U                             | +12 dBm / tone output, Δf=53MHz, Full Band  |     | 70      |      | dBm  |
| OIP3                              | +12 dBm / tone output, Δf=6MHz, Full Band   |     | 42/45   |      | dBm  |
| OP1dB                             | 50-1800MHz  |     | 27/30   |      | dBm  |
| Thermal Resistance                | ΘJC (Junction to Device Heat Slug)  |     | 12      |      | °C/W |

Note: Typical performance at these conditions: Temp = +25 °C, V<sub>DD</sub> = +5 V, 75 Ω system, Full band unless otherwise noted

### Evaluation Board Schematic 50 MHz – 1800 MHz (Downstream)



### Evaluation Board Assembly Drawing (Downstream)



**Materials:** Isola370HR High-Tg FR4

| Layer     | Thickness | Primary Stack | Description                              | Dk / Df       |
|-----------|-----------|---------------|--|---------------|
| Layer - 1 | 0.0010    |               | Taiyo 4000-HFX DI<br>1/2oz Mix (Std Plt) | 3.50 / 0.0190 |
|           | 0.0020    |               |  |               |
| Layer - 2 | 0.0578    |               | 370H<br>1/2oz Mix (Std Plt)              | 4.34 / 0.0180 |
|           | 0.0020    |               |  |               |



### Evaluation Board Bill of Materials for Downstream 5V

| Ref Des                           | Description                           | Manufacturer    | Part Number        |
|-----------------------------------|---------------------------------------|-----------------|--------------------|
| PCB                               | PCB, QPL182X-4000                     | Qorvo           | QPL1823-4000(A)    |
| C3                                | CAP, 0.3pF, +/-0.1pF, 25V, HI-Q, 0201 | MURATA          | GJM0335C1ER30BB01D |
| C4                                | CAP, 0.7pF, +/-0.1pF, 50V, HI-Q, 0402 | MURATA          | GJM1555C1HR70BB01D |
| C10, C11                          | CAP, 0.6pF, +/-0.1pF, 50V, HI-Q, 0402 | MURATA          | GJM1555C1HR60BB01D |
| C7, C8                            | CAP, 1000pF, 5%, 50V, COG, 0402       | MURATA          | GRM1555C1H102JA01D |
| C14, C19, C20, C21                | CAP, 0.01uF, 10%, 50V, X7R, 0402      | MURATA          | GCM155R71H103KA55D |
| C22                               | CAP, 470pF, 5%, 50V, COG, 0402        | MURATA          | GRM1555C1H471JA01D |
| C15                               | CAP, 0.1uF, 10%, 25V, X7R, 0402       | MURATA          | GRM155R71E104KE14D |
| C2                                | CAP, 0.3pF, 0.1pF, 50V, COG, HI-Q     | MURATA          | GJM1555C1HR30BB01D |
| L8, L9                            | RES, 0 OHM, 5%, 1/10W, 0402           | Kamaya, Inc     | RMC1/16SJPTH       |
| R3                                | RES, 3.3K, 5%, 1/16W, 0402            | Kamaya, Inc     | RMC1/16S-332JTH    |
| R4                                | Res, 1.3K /1%/0402/TK100/Chip         | Kamaya, Inc     | RMC1/16SK1301FTH   |
| L1, L4                            | IND, 1nH, +/-0.3nH, M/L, 0402         | MURATA          | LQG15HN1N0S02D     |
| L6, L7                            | IND, 1.8nH, ±0.2nH, W/W, HI-Q, 0402   | MURATA          | LQW15AN1N8C00D     |
| U1                                | 1.8GHz 5V, Push Pull, 19dB gain       | Qorvo           | QPL1821            |
| L2, L3                            | FER, BEAD, 1500 OHM, 500mA, 0603      | MURATA          | BLM18HE152SN1D     |
| T1, T2                            | BALUN, 1GHz ~ 1.5GHz, 75 / 75 OHM     | MURATA          | DXW21BN7511SL07    |
| T3                                | Transformer - 10-1800MHz, 75 ohms     | Mini Circuits   | TRS1-182-75-7+     |
| J2, J3                            | CONN, HDR, ST, 3-PIN, 0.100"          | SAMTEC INC.     | TSW-103-07-G-S     |
| J1, J4                            | CONN, F FEM EDGE MOUNT, 75R           | Millimeter Wave | MW-846-C-DD-75     |
| HS                                | HEATSINK, 50 x 50 x10, ALUMINUM       | Alpha Nova Tech | S08EFV05-A         |
| C1 ,C5, C6, C9, C17, C25, C26, L5 | NOT POPULATED ITEMS                   |                 | DUMMY PART         |

### BOM Changes for Downstream 8V Operation

|    |                                |        |                |
|----|--------------------------------|--------|----------------|
| R4 | RES, 2.0K OHM, 5%, 1/16W, 0402 | Kamaya | RMC1/16-202JTH |
|----|--------------------------------|--------|----------------|

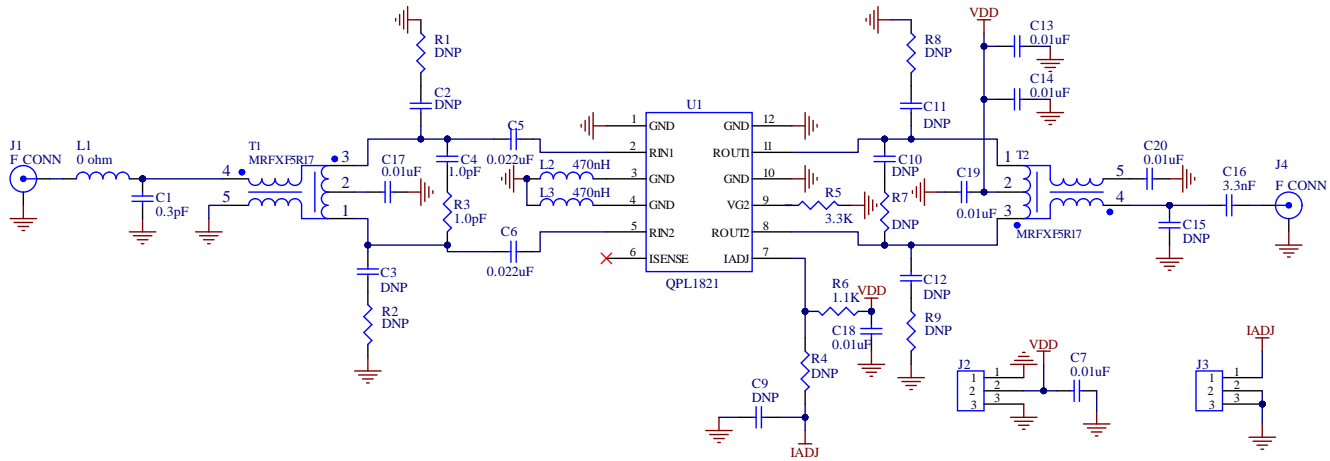
### Electrical Specifications (Upstream)



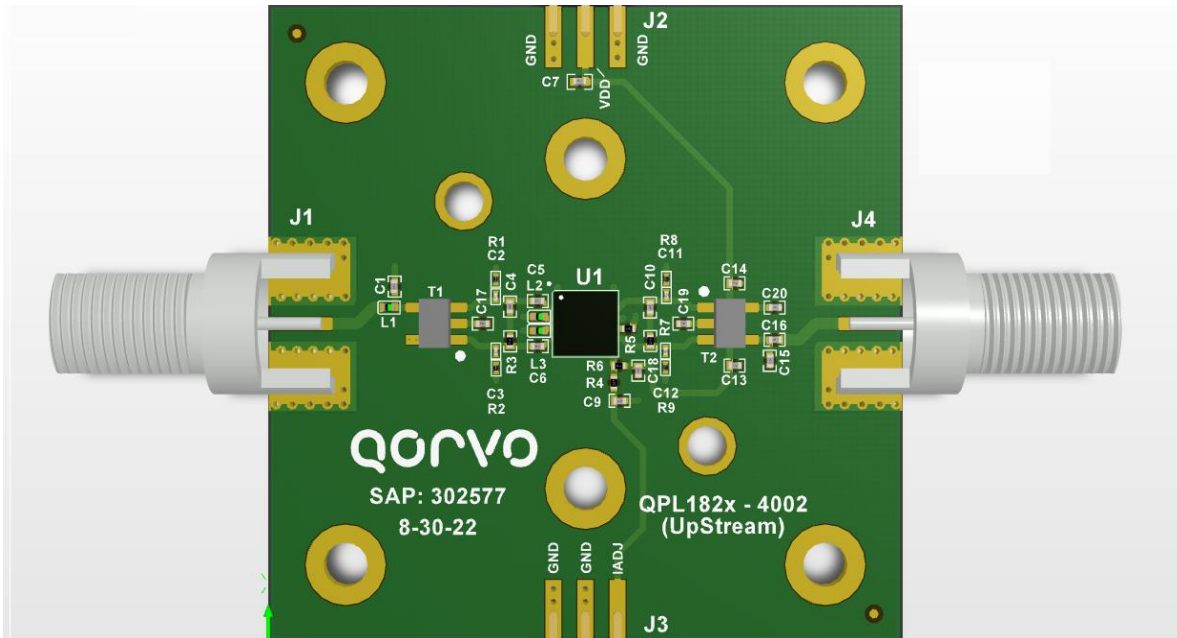
| Parameter            | Condition (1)  | Min | Typ     | Max | Unit                        |
|----------------------|--|-----|---------|-----|-----------------------------|
| Supply Voltage (VDD) |  |     | 5/8     |     | V                           |
| Supply Current (IDD) |  |     | 260/350 |     | mA                          |
| Frequency Range      |  | 5   |         | 700 | MHz                         |
| Gain at 5 MHz        |  |     | 18      |     | dB                          |
| Gain at 700 MHz      |  |     | 18      |     | dB                          |
| Gain Slope           |  |     | 0       |     | dB                          |
| Reverse Isolation    |  |     | 24      |     | dB                          |
| Input Return Loss    | 5 – 700MHz   |     | -20     |     | dB                          |
| Output Return Loss   | 5 – 700MHz   |     | -20     |     | dB                          |
| MER                  | At +66dBmV @ 5V and +69dBmV @ 8V Total Composite Output power. 5MHz to 700MHz, 112 Ch, SC-QAM, 0dB tilt, 0dB Offset (Source corrected) |     | 45      |     | dB                          |
| Noise Figure         | 5-700MHz   |     | 1.5     |     | dB                          |
| OIP2L                | +12 dBm / tone output, $\Delta f=53$ MHz, Full Band  |     | 90      |     | dBm                         |
| OIP2U                | +12 dBm / tone output, $\Delta f=53$ MHz, Full Band  |     | 80      |     | dBm                         |
| OIP3                 | +12 dBm / tone output, $\Delta f=6$ MHz, Full Band   |     | 43/46   |     | dBm                         |
| OP1dB                | 5-700MHz   |     | 27/30   |     | dBm                         |
| Thermal Resistance   | $\Theta_{JC}$ (Junction to Device Heat Slug)   |     | 12      |     | $^{\circ}\text{C}/\text{W}$ |

Note: Typical performance at these conditions: Temp = +25  $^{\circ}\text{C}$ ,  $V_{DD}$  = +5 V, 75  $\Omega$  system, Full band unless otherwise noted

### Evaluation Board Schematic 5 MHz – 700 MHz (Upstream)



### Evaluation Board Assembly Drawing (Upstream)



Materials: Isola370HR High-Tg FR4

| Layer     | Thickness        | Primary Stack | Description                              | Dk / Df                     |
|-----------|------------------|---------------|--|-----------------------------|
| Layer - 1 | 0.0010<br>0.0020 |               | Taiyo 4000-HFX DI<br>1/2oz Mix (Std Plt) | 3.50 / 0.0190               |
| Layer - 2 | 0.0578<br>0.0020 |               | 0.0590<br>(8-7628)                       | 370H<br>1/2oz Mix (Std Plt) |



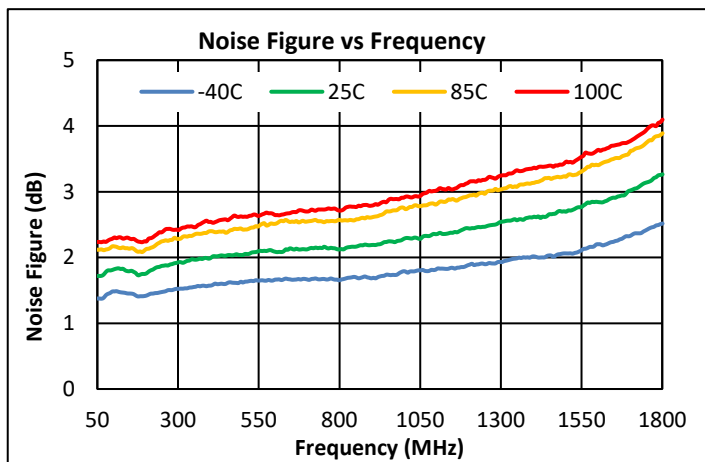
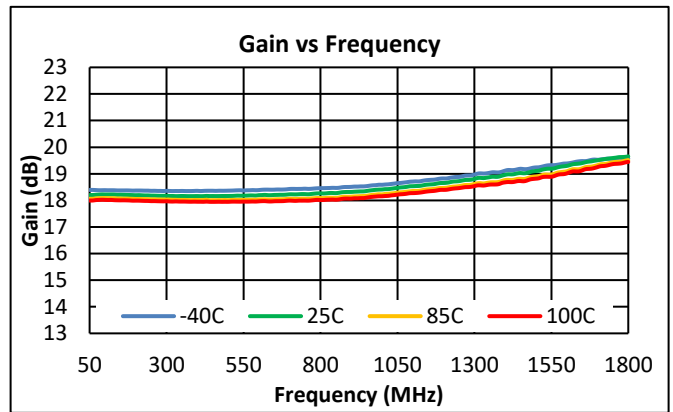
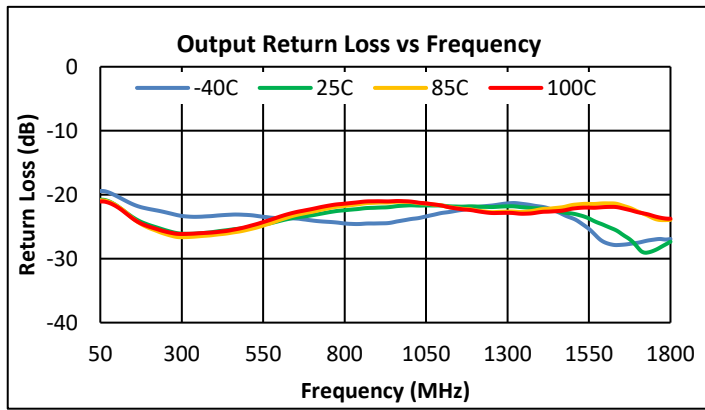
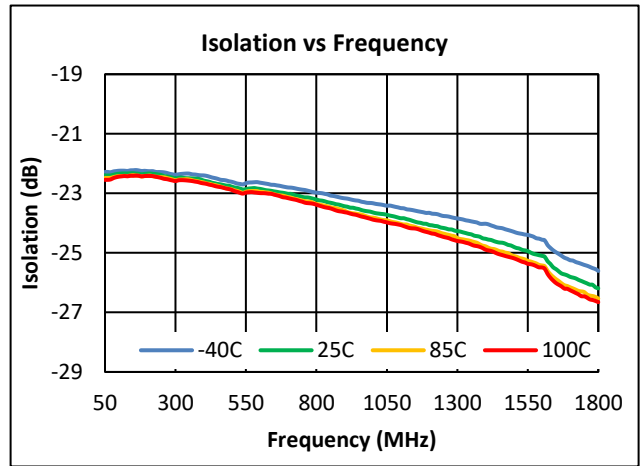
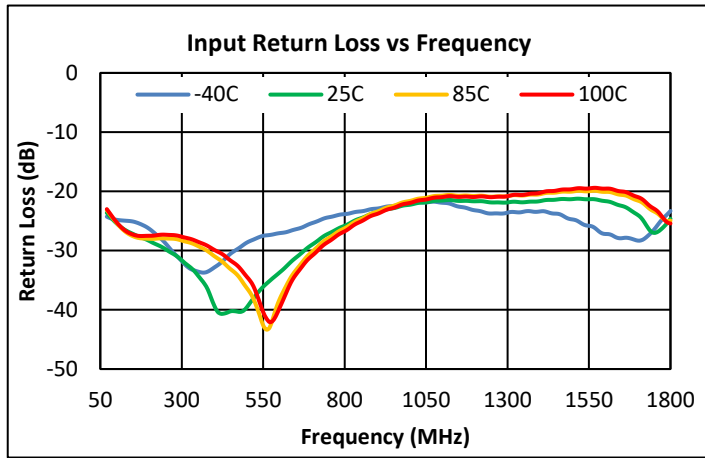
### Evaluation Board Bill of Materials for Upstream 5V

| Ref Des   | Description                       | Mfg Name        | Mfg Part #         |
|---|-----------------------------------|-----------------|--------------------|
| PCB   | PCB, QPL182X-4002                 | Qorvo           | QPL1820-4002(A)    |
| C1  | CAP, 0.3pF, +/-0.1pF, 25V, 0201   | MURATA          | GJM0335C1ER30BB01D |
| C7, C13, C14, C17,<br>C18, C19, C20                       | CAP, 0.01uF, 10%, 50V, X7R, 0402  | MURATA          | GCM155R71H103KA55D |
| C4, R3  | CAP, 1pF, +/-0.05pF, 50V          | MURATA          | GJM1555C1H1R0WB01D |
| C5, C6  | CAP, 0.022uF, 10%, 50V, X7R, 0402 | MURATA          | GCM155R71H223KA55D |
| C16   | CAP, 3300pF, 10%, 50V, X7R, 0402  | Kemet           | C0402C332K5RACTU   |
| L1  | RES, 0 OHM, 5%, 1/10W, 0402       | Kamaya, Inc     | RMC1/16SJPTH       |
| R5  | RES, 3.3K, 5%, 1/16W, 0402        | Kamaya, Inc     | RMC1/16S-332JTH    |
| R6  | RES, 604 OHM, 1%, 1/10W, 0402     | Kamaya, Inc     | RMC1/16SK6040FTH   |
| L2, L3  | IND, 470nH, 5%, 310mA             | Coilcraft, Inc. | 0402AF-471XJLW     |
| U1  | 1.8GHz 5V, Push Pull, 19dB gain   | Qorvo           | QPL1821            |
| T1,T2   | XFMR, BALUN, 1:1, 5-700MHz, 75R   | Mini-RF, Inc.   | MRFXF5R17          |
| J2,J3   | CONN, HDR, ST, 3-PIN, 0.100"      | SAMTEC INC.     | TSW-103-07-G-S     |
| J1,J4   | CONN, F FEM EDGE MOUNT, 75R       | Millimeter Wave | MW-846-C-DD-75     |
| HS  | HEATSINK, 50 x 50 x10, ALUMINUM   | Alpha Nova      | S08EFV05-A         |
| C2, C3, C9, C10, C11, C12,<br>C15, R1, R2, R4, R7, R8, R9 | NOT POPULATED ITEMS               |                 | DUMMY PART         |

### BOM Changes for Upstream 8V Operation

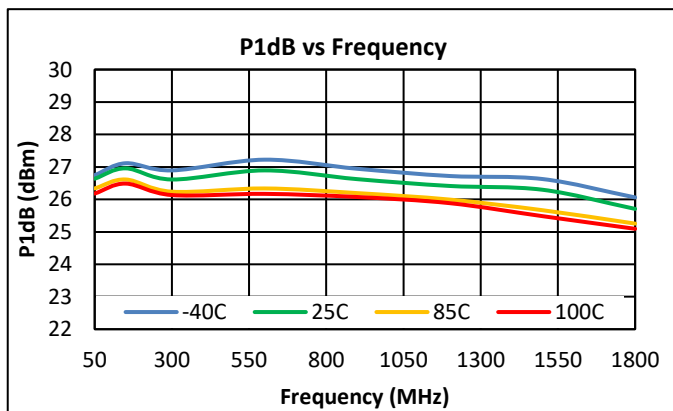
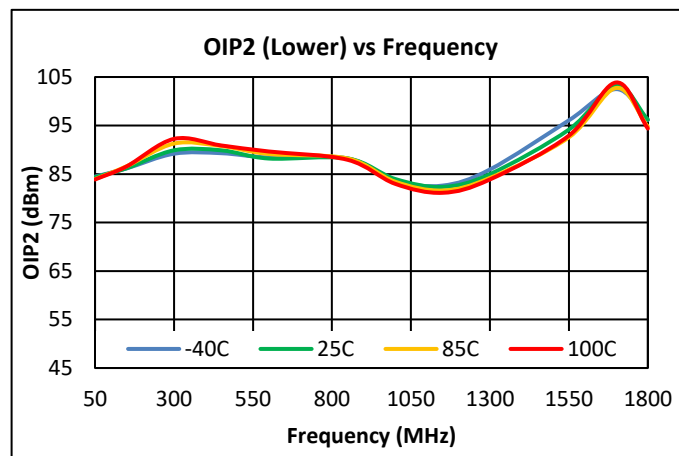
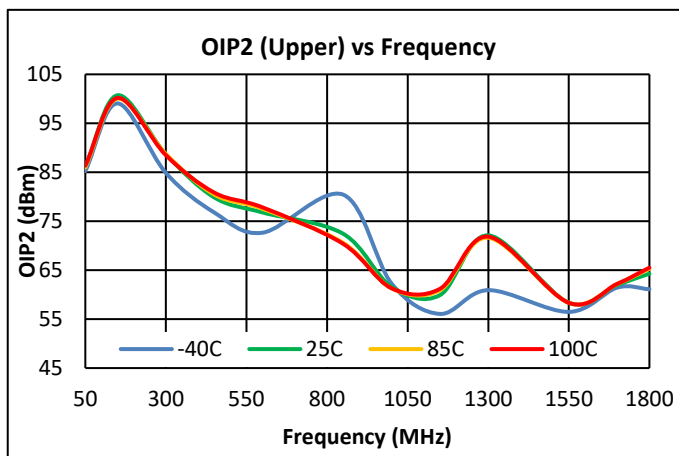
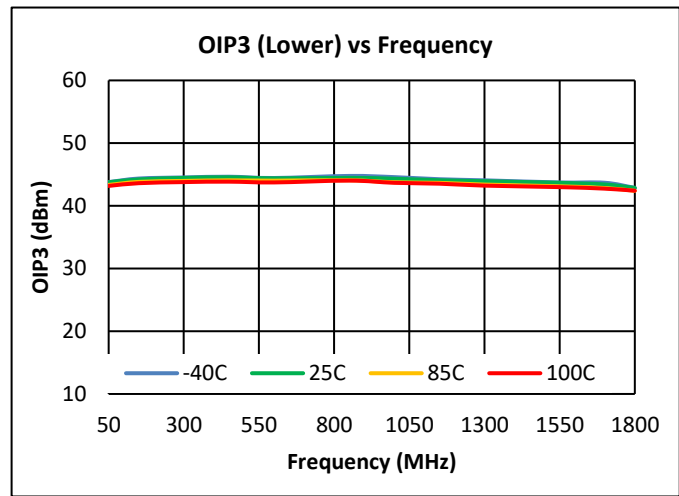
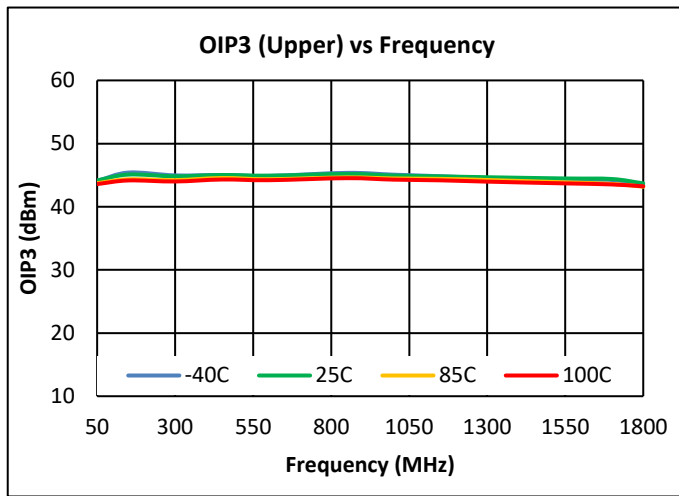
|    |                                |     |                 |
|----|--------------------------------|-----|-----------------|
| R6 | RES, 1.1K OHM, 1%, 1/16W, 0402 | KOA | RK73H1ETTP1101F |
|----|--------------------------------|-----|-----------------|

Performance Data, Downstream 5V





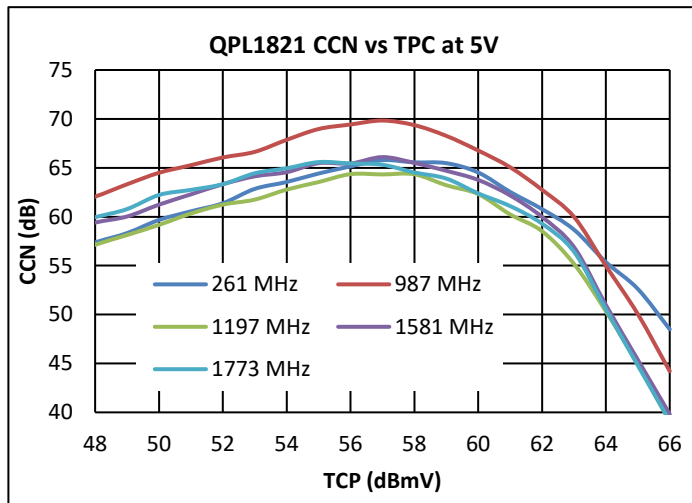
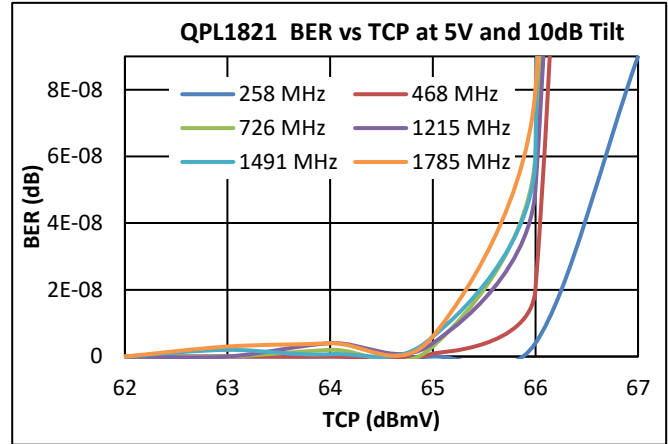
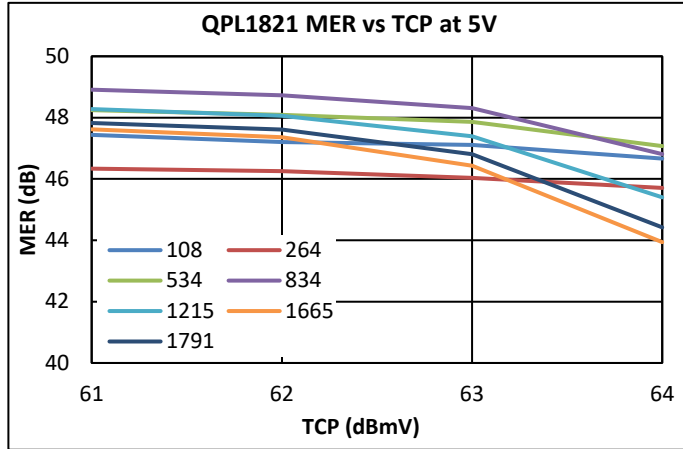
**Performance Data, Downstream 5V (cont'd)**



**Notes:**

- (1) 5V OIP3: +12dBm / tone output @  $\Delta f = 6\text{MHz}$
- (2) 5V OIP2: +12dBm / tone output @  $\Delta f = 53\text{MHz}$

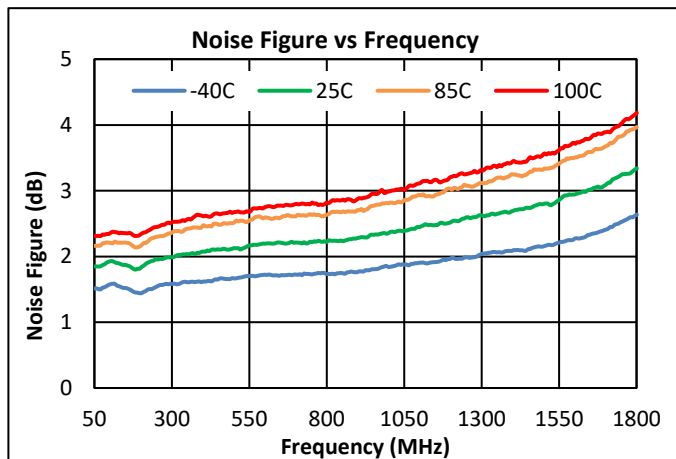
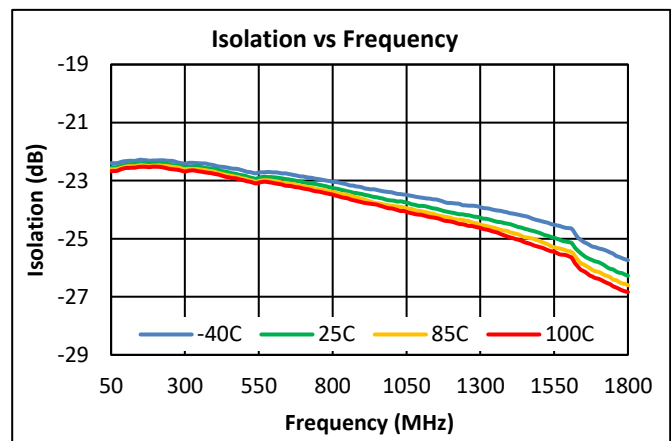
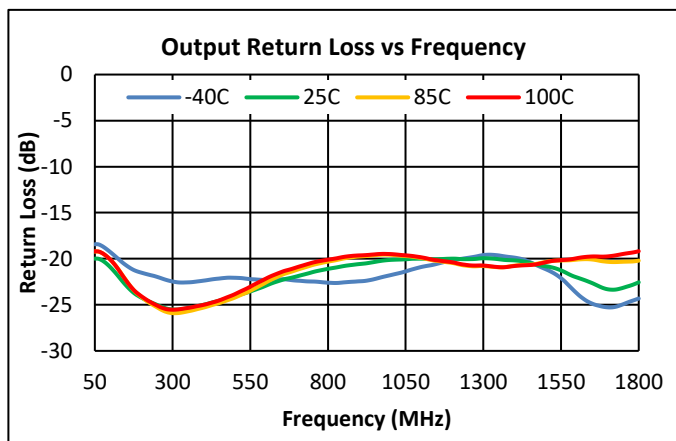
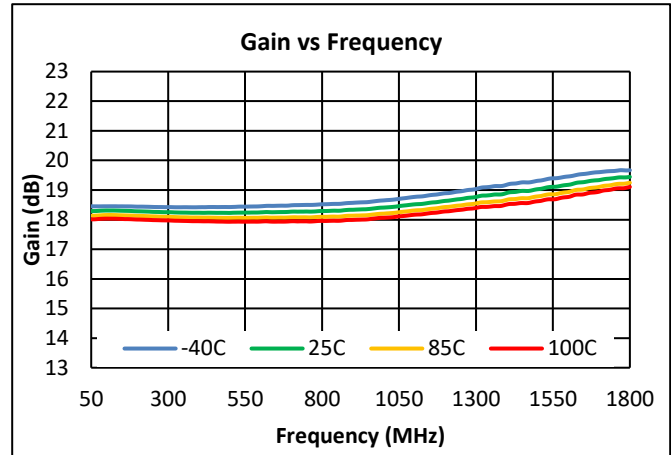
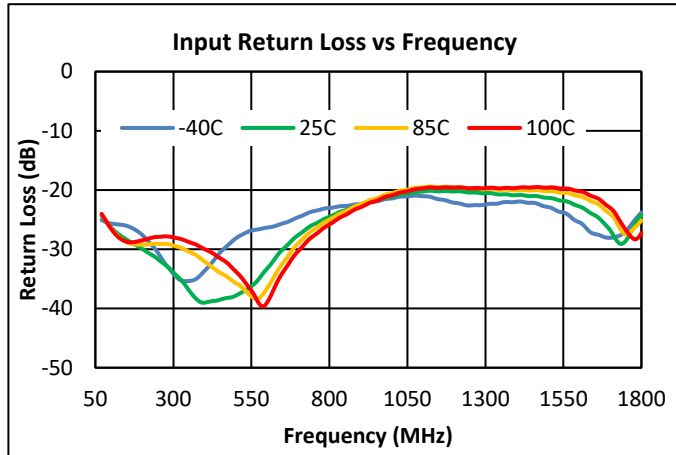
### Performance Data, Downstream 5V (cont'd)



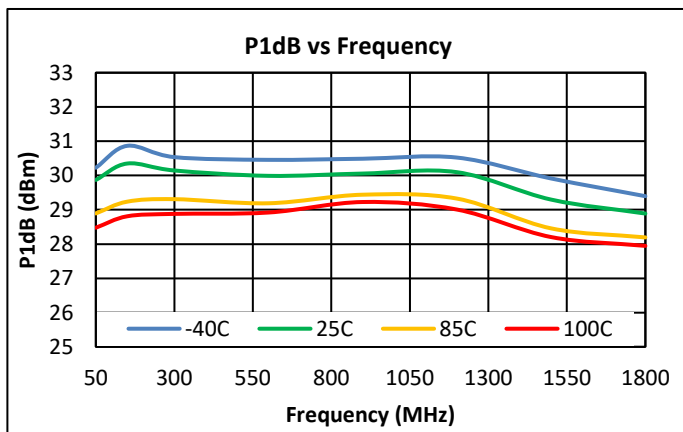
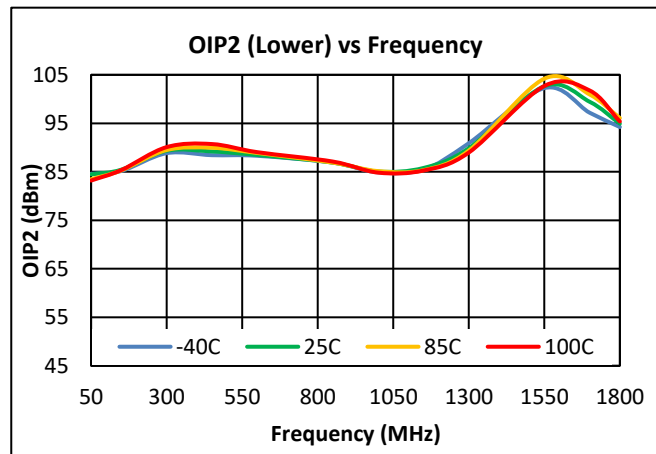
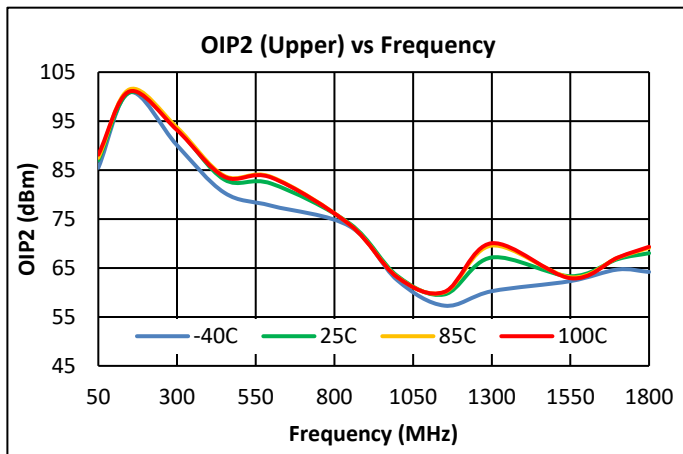
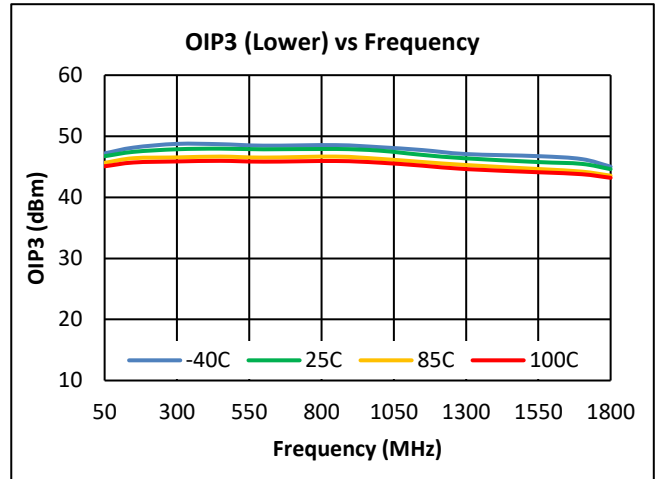
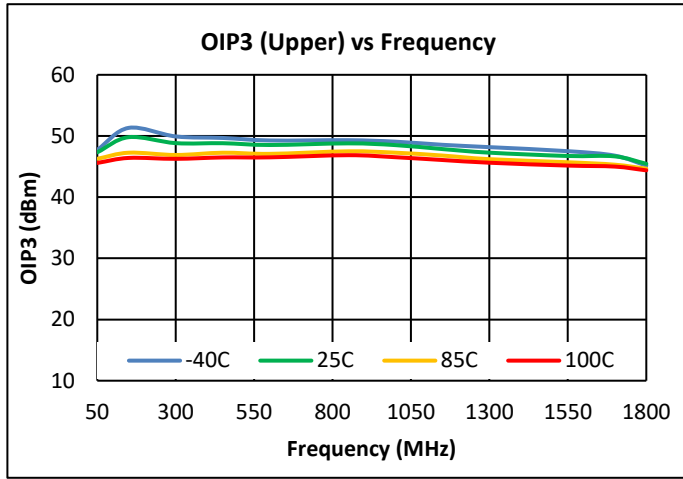
**Notes:**

- (1) MER & BER Test Conditions: (261 – 1791 MHz, 280 Ch SC-QAM, 10dB tilt, 0dB offset)
- (2) MER is uncorrected
- (3) CCN Test conditions: 10dB tilt, 6dB offset at 1.026GHz, 261-1791MHz loading

Performance Data, Downstream 8V



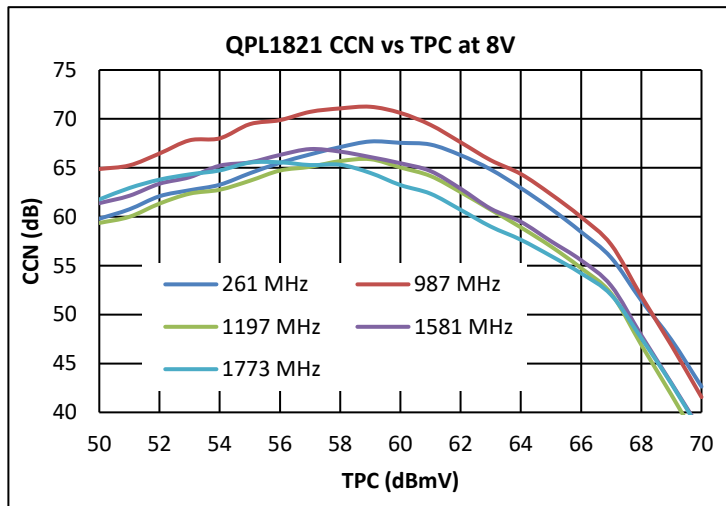
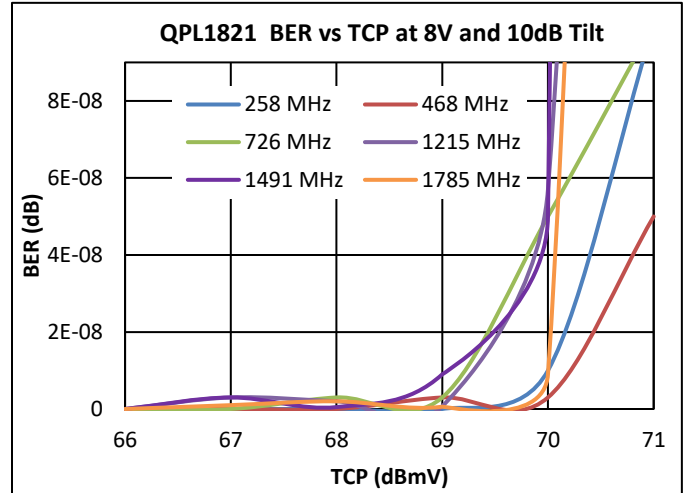
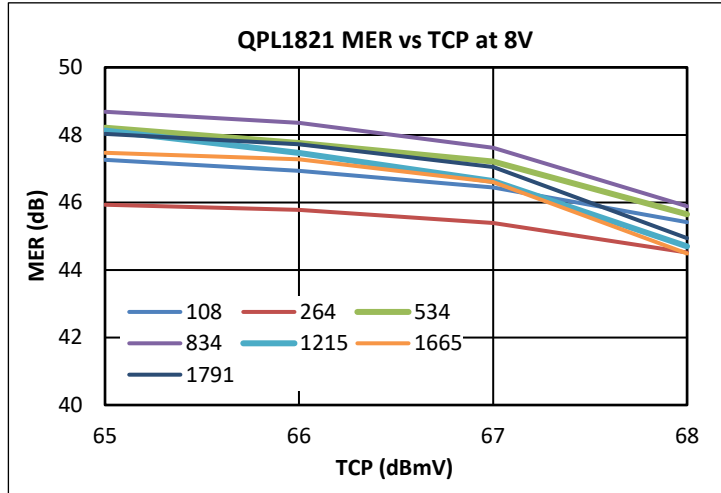
**Performance Data, Downstream 8V (Cont'd)**



**Notes:**

- (1) 8V OIP3: +15dBm /tone output @  $\Delta f = 6\text{MHz}$
- (2) 8V OIP2: +15dBm/tone output @  $\Delta f = 53\text{MHz}$

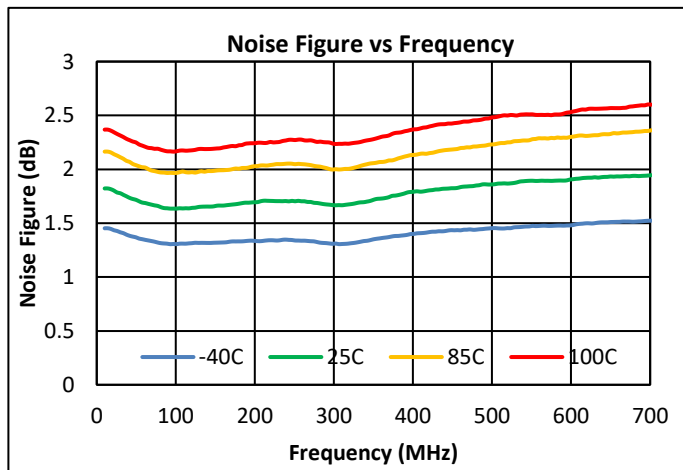
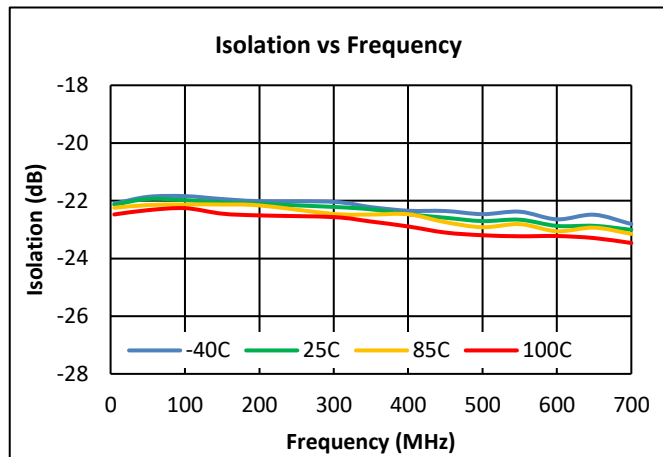
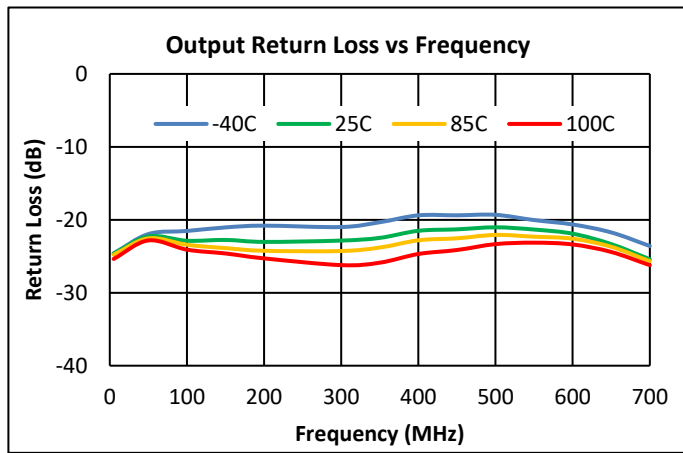
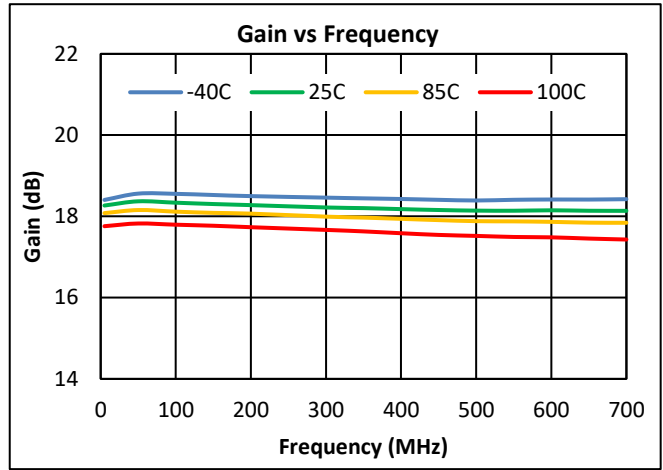
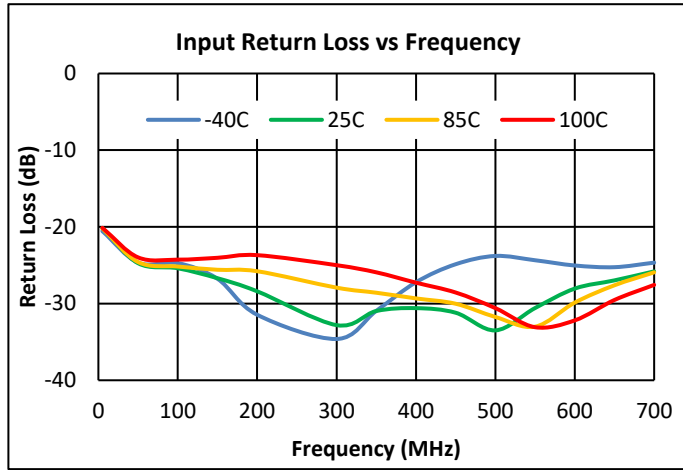
### Performance Data, Downstream 8V (Cont'd)



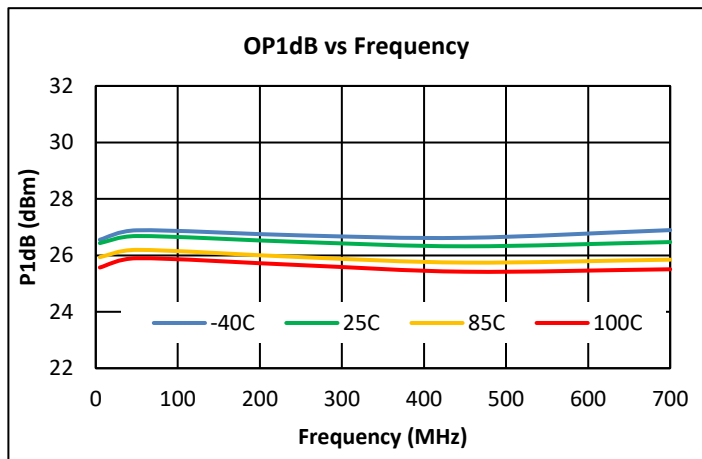
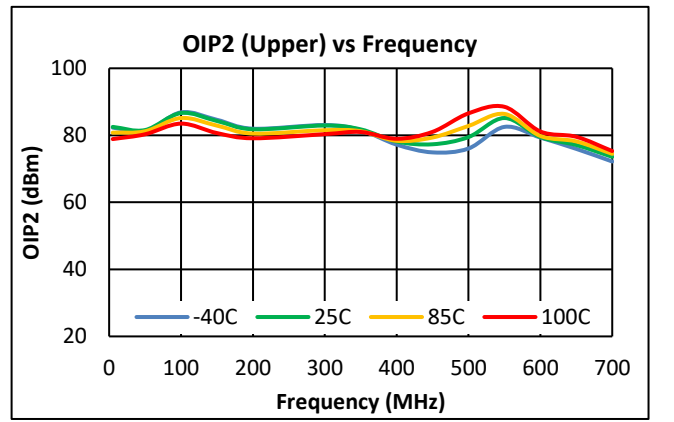
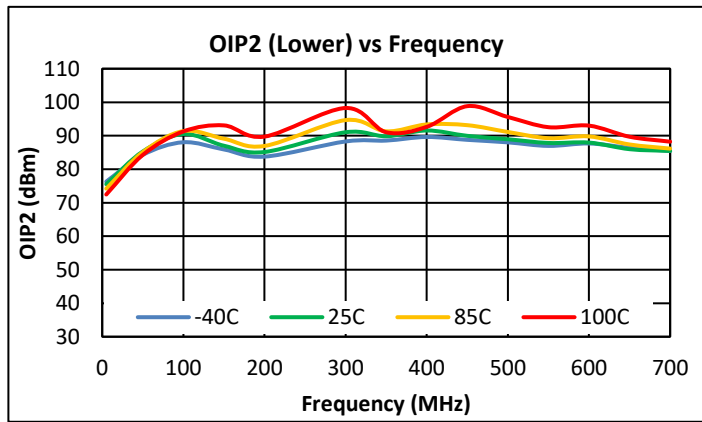
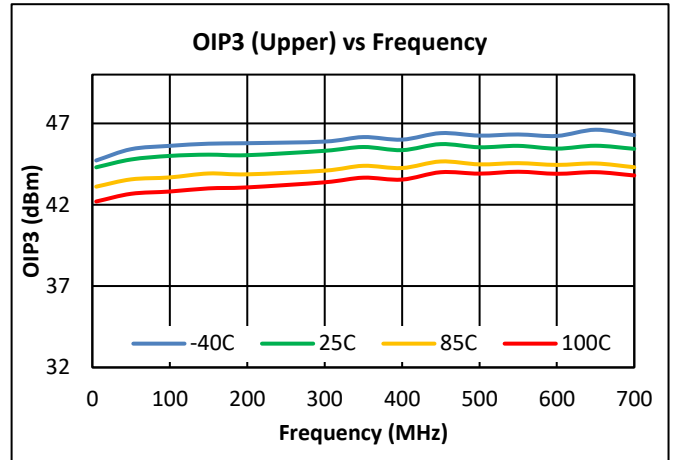
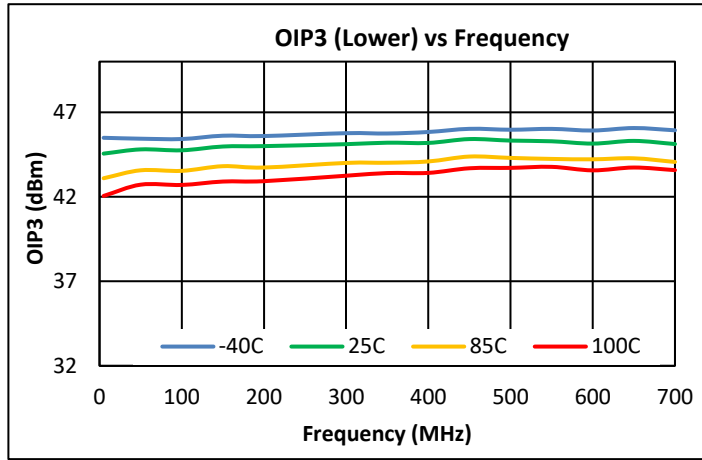
**Notes:**

- (1) MER & BER Test Conditions: (261 – 1791 MHz, 280 Ch SC-QAM, 10dB tilt, 0dB offset)
- (2) MER is uncorrected
- (3) CCN Test conditions: 10dB tilt, 6dB offset at 1.026GHz, 261-1791MHz loading

Performance Data, Upstream 5V



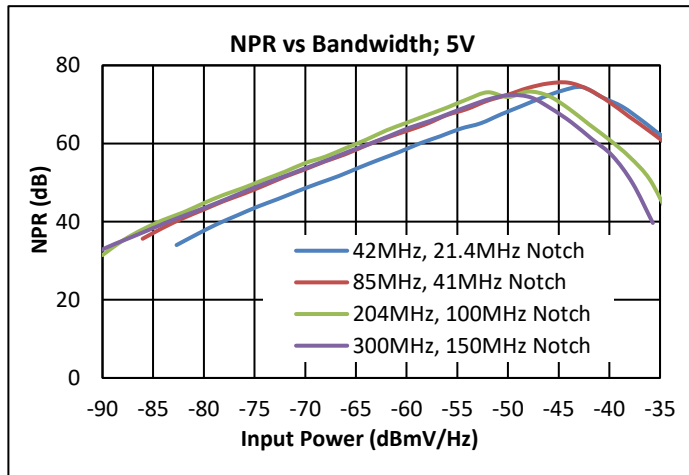
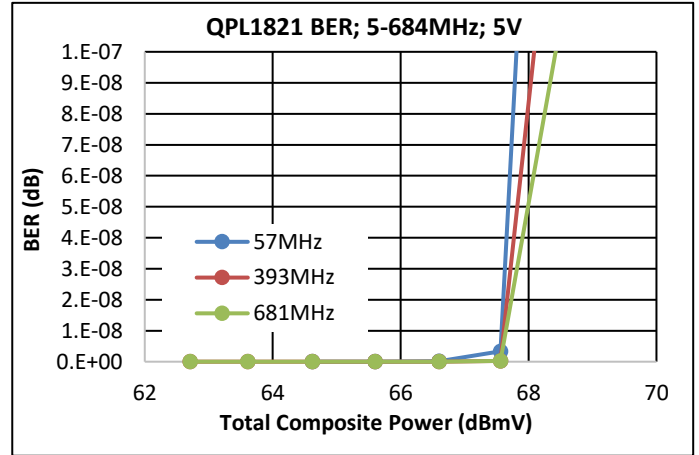
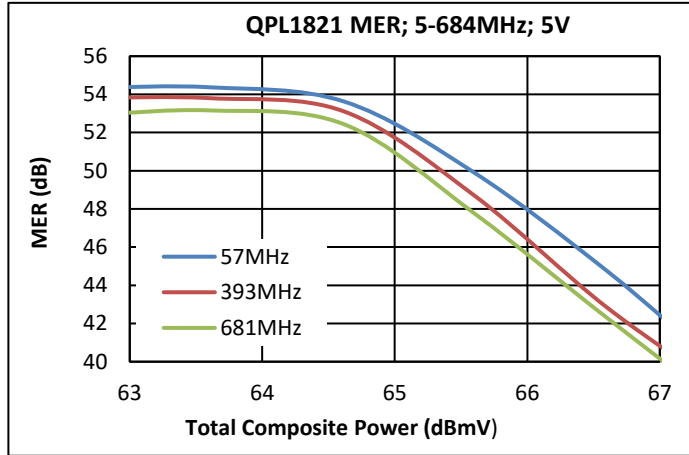
Performance Data, Upstream 5V (Cont'd)



Notes:

- (1) 5V OIP3: +12dBm / tone output @  $\Delta f = 6\text{MHz}$
- (2) 5V OIP2: +12dBm / tone output @  $\Delta f = 53\text{MHz}$

### Performance Data, Upstream 5V (Cont'd)

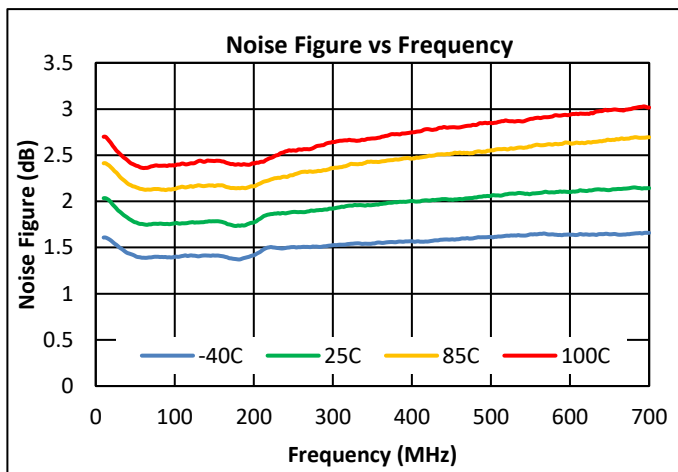
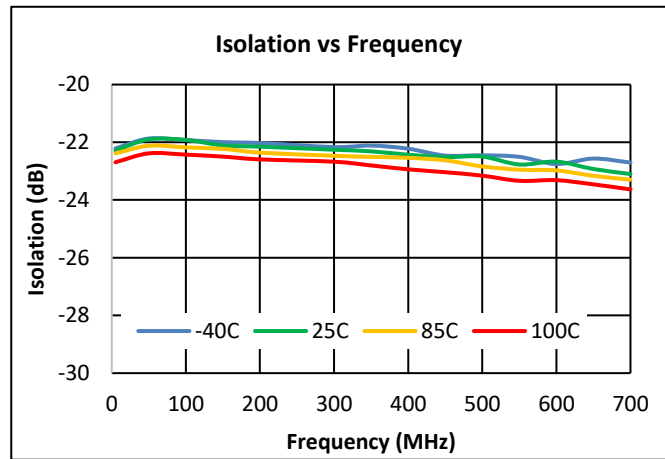
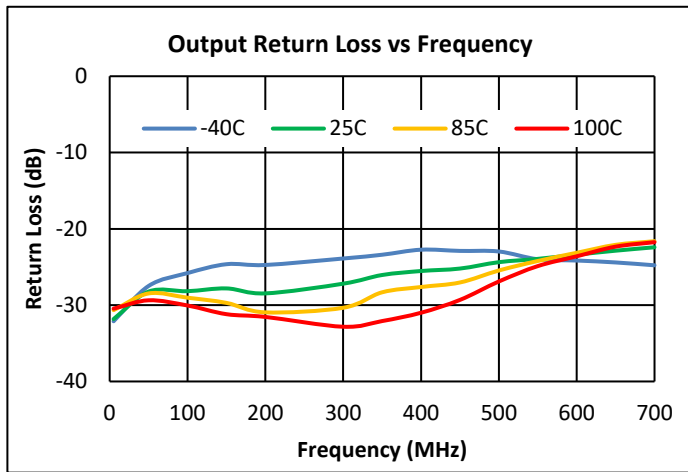
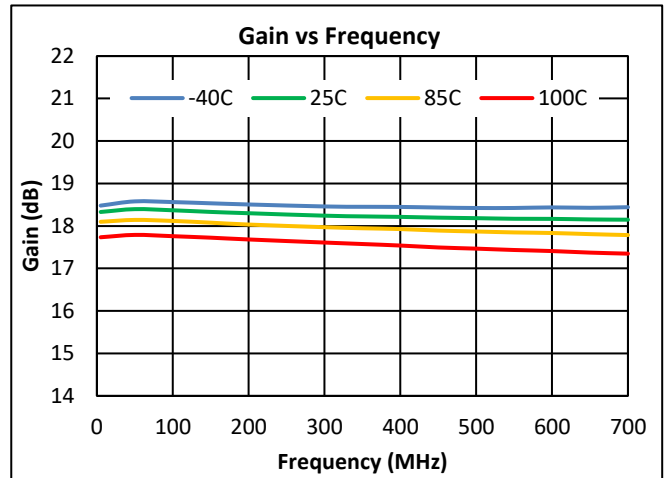
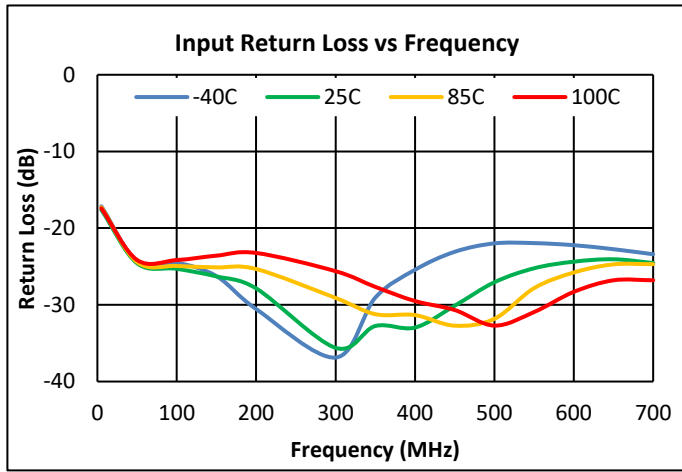


**Notes:**

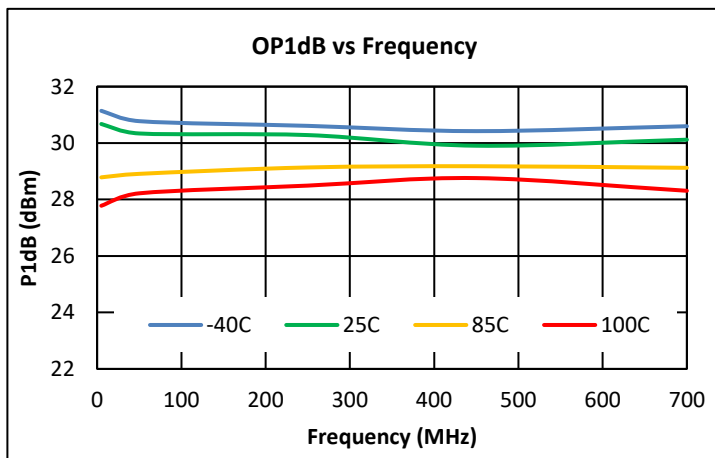
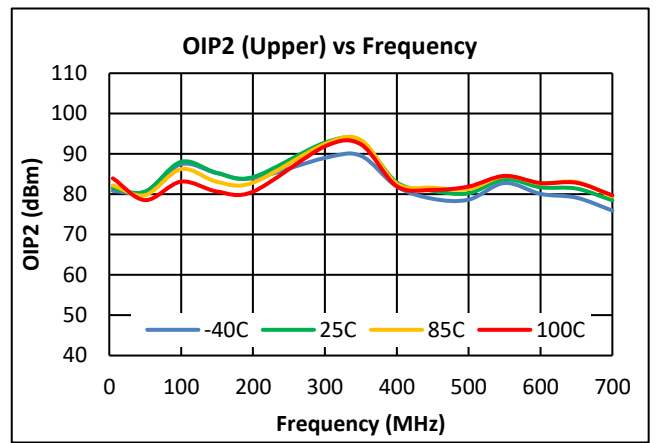
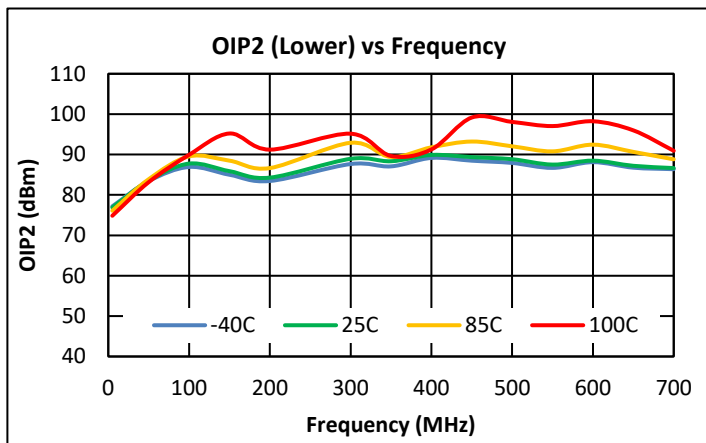
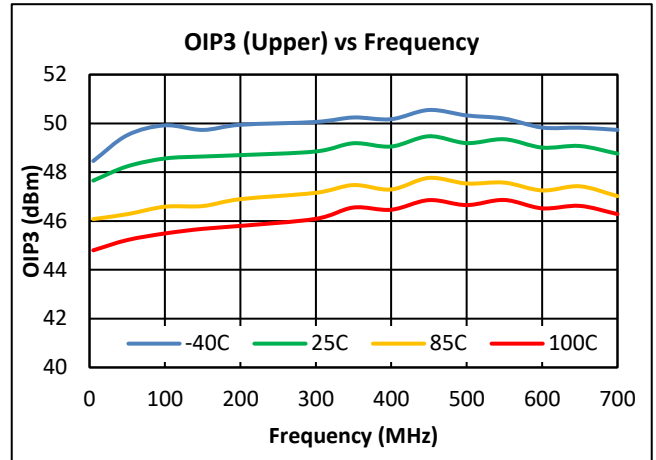
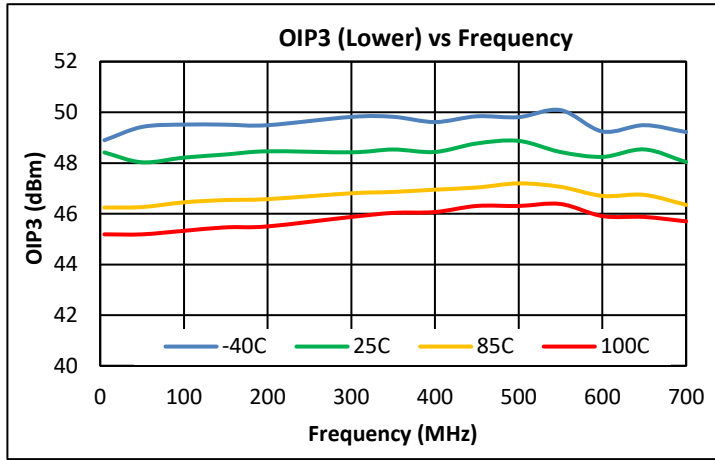
- (1) MER & BER Test Conditions: (5 – 694 MHz, 111 Ch SC-QAM, 0dB tilt)
- (2) MER is source corrected



Performance Data, Upstream 8V

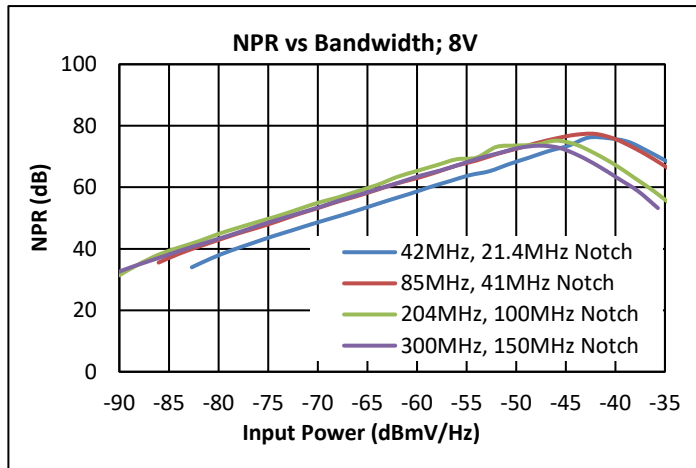
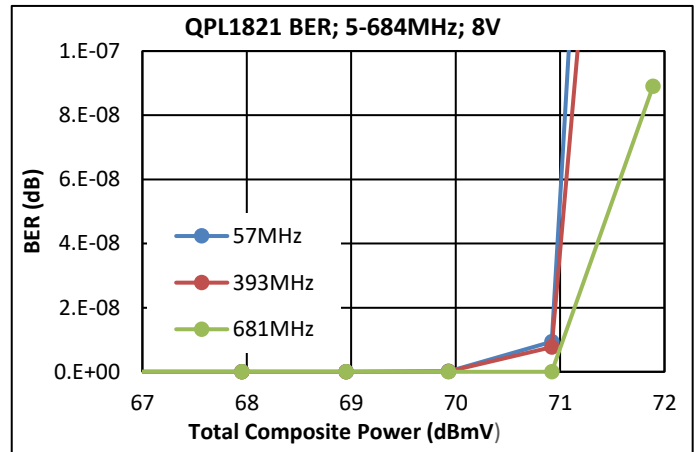
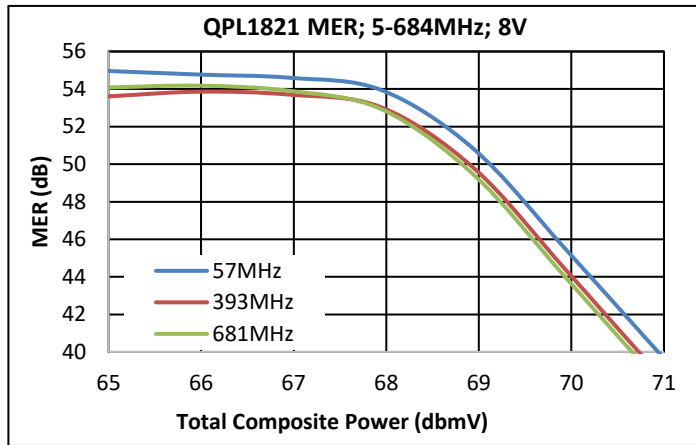


**Performance Data, Upstream 8V (Cont'd)**



- Notes:
- (1) 8V OIP3: +15dBm / tone output @  $\Delta f = 6\text{MHz}$
  - (2) 8V OIP2: +15dBm/tone output @  $\Delta f = 53\text{MHz}$

### Performance Data, Upstream 8V (Cont'd)

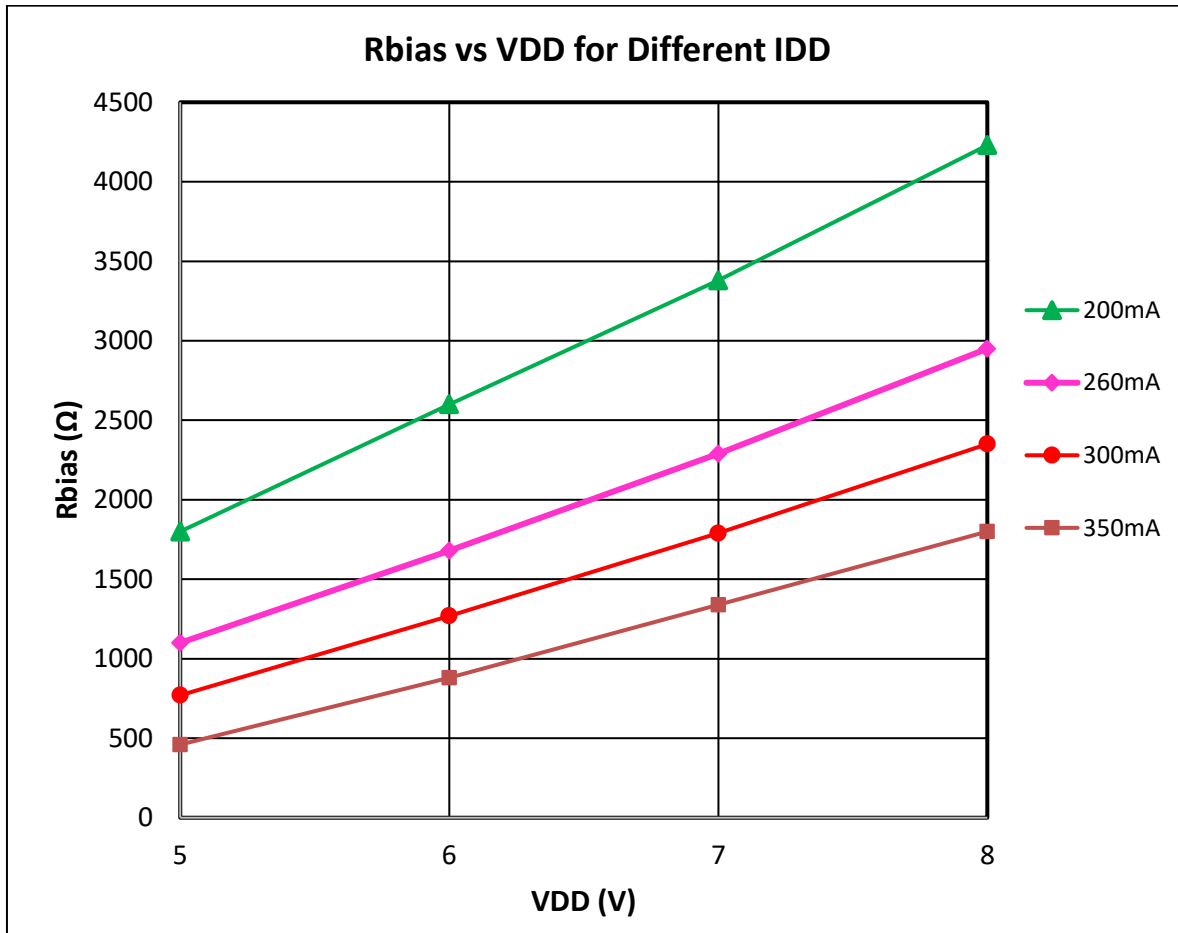


**Notes:**

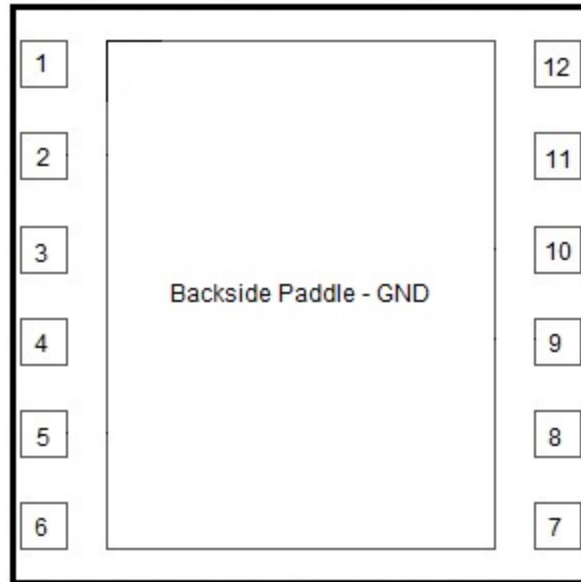
- (1) MER & BER Test Conditions: (5 – 694 MHz, 111 Ch SC-QAM, 0dB tilt)
- (2) MER is corrected

IADJ Resistor Value

The Resistor Rbias is used to set the device current. In the application circuit, the value of Rbias is set to get an IDD of 260mA which is optimal for linearity at 5V. In applications where higher linearity is required, or higher supply rail is present, the IDD can be adjusted by varying the value of Rbias. (See graph below for downstream application)



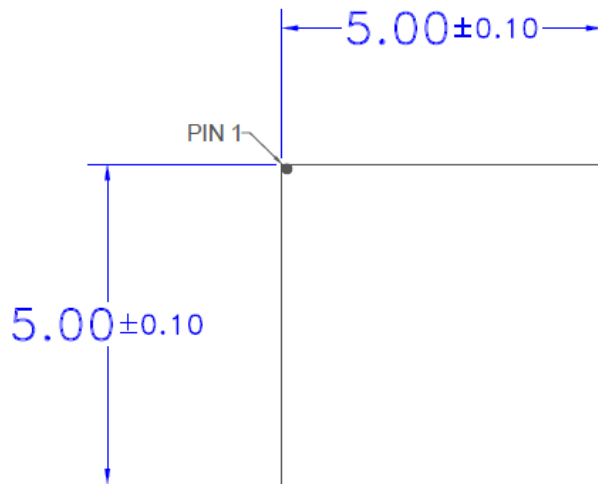
**Pin Configuration and Description**



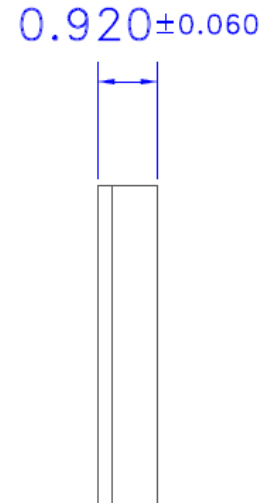
**5 x 5 12-pin Laminate MCM**

| Pin Number | Label       | Description   |
|------------|-------------|---|
| 1          | NC          | No internal connection, recommend connecting to EVB GND |
| 2          | RFIN+       | RF Input +  |
| 3          | GND         | Must be connected to EVB GND                            |
| 4          | GND         | Must be connected to EVB GND                            |
| 5          | RFIN-       | RF input -  |
| 6          | NC          | No connect pin. Leave it open. Do not connect to GND.   |
| 7          | IADJ        | IDD current set   |
| 8          | RFOUT-/VDD2 | RF output - and VDD through RF Choke                    |
| 9          | VG2         | Cascode device bias resistor divider                    |
| 10         | NC          | No internal connection, recommend connecting to EVB GND |
| 11         | RFOUT+/VDD  | RF output + and VDD through RF Choke                    |
| 12         | NC          | No internal connection, recommend connecting to EVB GND |
| Paddle     | GND         | DC/RF/Thermal/GND. (Maximize vias in this area)         |

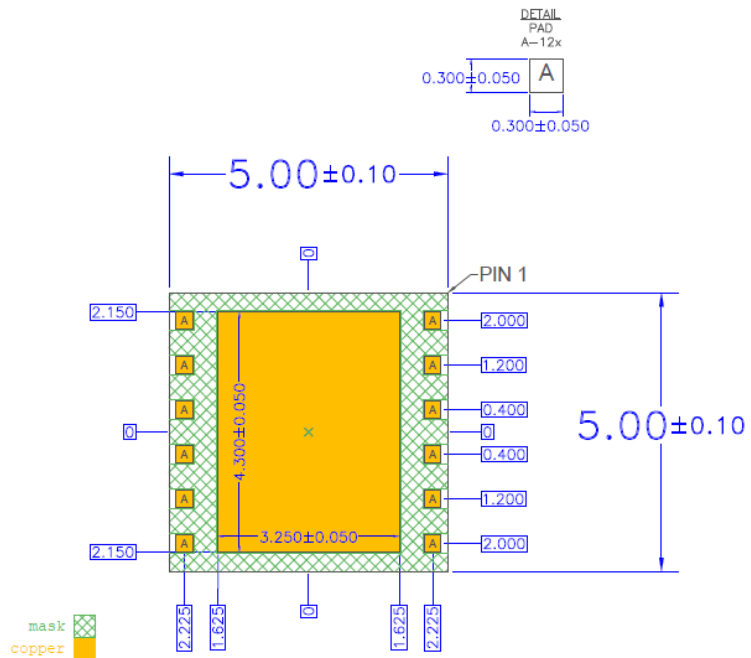
### Package Outline



TOP VIEW



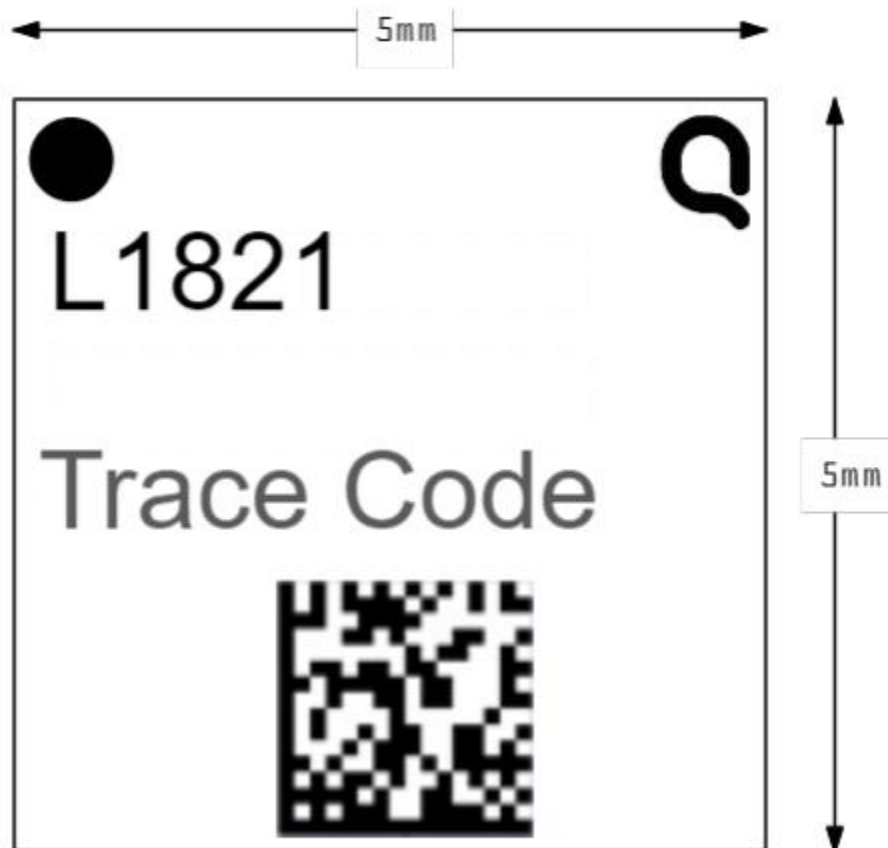
SIDE VIEW



BOTTOM VIEW


### Package Marking

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- Pin 1 Indicator
- Qorvo Logo - Use Q5D
- Trace Code to be assigned by SubCon

## Handling Precautions

| Parameter                        | Rating                    | Standard                   | <br>Caution! ESD Sensitive Device |
|----------------------------------|---------------------------|----------------------------|--|
| ESD – Human Body Model (HBM)     | Class 1B (500V to <1000V) | ANSI / ESDA / JEDEC JS-001 |  |
| ESD – Charged Device Model (CDM) | Class C3 ( $\geq 1000V$ ) | ANSI / ESDA / JEDEC JS-002 |  |
| MSL – Moisture Sensitivity Level | MSL3                      | IPC / JEDEC J-STD-020      |  |

## 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: ENEPIG

## 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:

- PFOS 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
- 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)**