# QPB9015

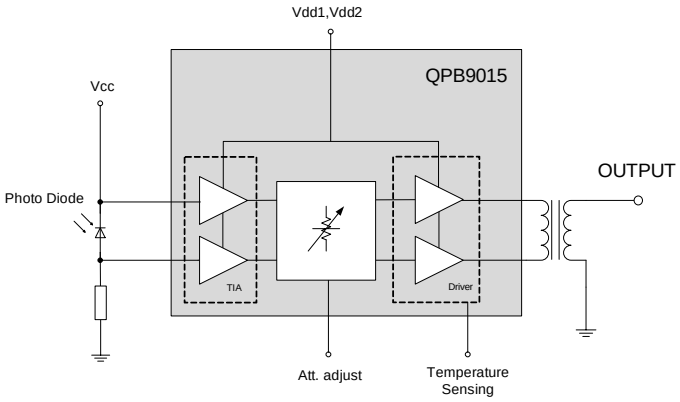
## xPON Video Receiver with integrated VCA


28 pin, 11.0 mm x 11.0 mm x 1.375 mm package

## Product Description

The QPB9015 is a video receiver integrated circuit (IC) which provides a low noise analog interface to optical access triplexer modules used in single family ONTs in fiber to the premise (FTTP) applications. The QPB9015 exhibits low input noise and distortion to meet critical FTTP link requirements. QPB9015 employs an integrated voltage controlled attenuator that provides, with external control circuitry, automatic gain control to maintain a constant +19 to +23 dBmV / channel output to insure consistent video quality.

## Functional Block Diagram




## Product Features

- 45 – 1218 MHz Operational Bandwidth
- Efficient Power Consumption: 1.5 W
- Low Noise: 3.5 pA / √Hz Equivalent Input Noise Current (EINC)
- Linearity: -65 dBc CSO and -66 dBc CTB at +22 dBmV RF Output per Channel (79-NTSC Equivalent Channels)
- Integrated VCA, 25 dB Attenuation Range
- Temperature Sensing Feature

## Applications

xPON RF Overlay Video Receiver for FTTX Triplexer-Equipped Optical Network Termination (ONT) and RFoG Network Interface Unit (NIU)

## Ordering Information

| Part No. | Description |
|---|---|
| QPB9015SB | Sample bag 5 pcs |
| QPB9015SR | 7” Reel with 100 pcs |
| QPB9015TR7 | 7” Reel with 250 pcs |
| QPB9015PCBA-410 | Fully assembled Evaluation Board |

## Absolute Maximum Ratings

| Parameter | Value / Range |
|---|---|
| Detector Bias over-voltage (Vcc) | +15 V |
| DC Supply over-voltage (Vdd1,Vdd2, Vc, MODE) | +6V |
| Storage Temperature | −40 to 100 °C |
| Operating Mounting Base Temperature | −40 to 85 °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.

## Recommended Operating Conditions

| Parameter | Min | Typ | Max | Units |
|---|---|---|---|---|
| Detector Bias Voltage (Vcc) | +11.4 | +12 | +12.6 | V |
| DC Supply Voltage (Vdd1,Vdd2) | +4.5 | +5 | +5.5 | V |
| Operating Mounting Base Temperature | -40 | | +85 | °C |

Electrical specifications are measured at specified test conditions in application circuit. Specifications are not guaranteed over all recommended operating conditions.

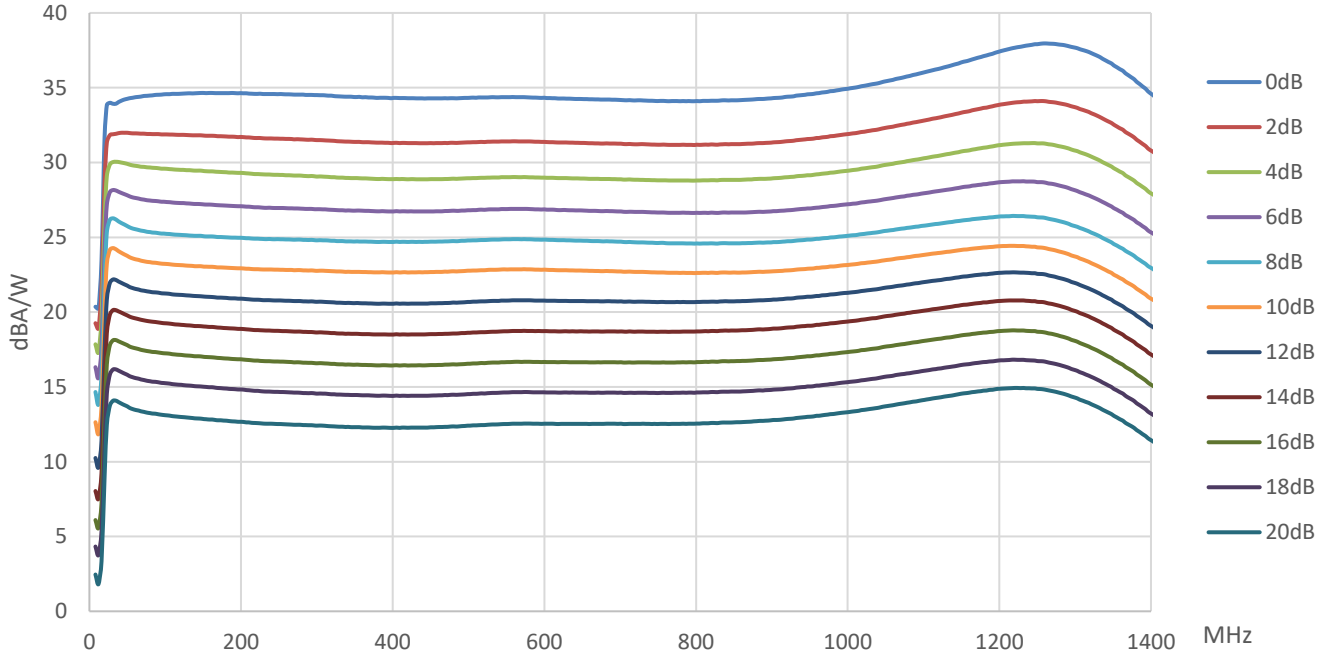
## Electrical Specifications – tested in evaluation circuit

| Parameter | Conditions (Vcc=12V, Vdd1=Vdd2=5V, TMB=30°C, ZL=75Ω, ATT=0…20dB) | Min | Typ | Max | Units |
|---|---|---|---|---|---|
| Supply Current ($I_{DD}$) | Steady state operation, current draw during attenuation state transitions is higher. | | 300 | | mA |
| Frequency Range | | 45 | | 1218 | MHz |
| Spectral sensitivity [1] | 0dBm optical input, 1310nm | 900 | | | V/W |
| Gain (O/E) | 1218MHz, ATT=0dB | | 37 | | dBA/W |
| Gain Slope [2] | 45MHz to 1218MHz | | 1 | | dB |
| Gain Flatness [3] | 45MHz to 1218MHz | | 2 | | dB |
| Output Return Loss (S22) | 45MHz to 1218MHz | | -15 | | dB |
| Equivalent Input Noise (EINC) | 45MHz to 1218MHz, ATT=0dB | | 3.5 | | pA/ √Hz |
| Optical Input Power | | | | +2 | dBm |
| CSO | Source: 79 NTSC analog channels (55.25 to 547.25MHz), flat, OMI = 2.82%/ch; | | -65 | | dBc |
| CTB | DUT: +2 dBm optical input power, attenuator set to RFOUT = +22 dBmV per channel | | -66 | | dBc |
| | | | | | |
| Voltage Control Range, Positive Attenuation Slope | MODE Pin Logic High: Control voltage Vc=5V is lowest insertion loss | 0 | 0…3 | 5 | V |
| Voltage Control Range, Negative Attenuation Slope | MODE Pin Logic Low: Control voltage Vc=0V is lowest insertion loss | 0 | 0…3 | 5 | V |
| MODE Pin Logic Low | | | | 0.4 | V |
| MODE Pin Logic High | | 1 | | | V |
| Attenuator Range | | | 0…25 | | dB |
| | | | | | |
| Thermal Resistance | $T_{REF}$ taken at +85 °C from backside of PCB under the QPB9015 | | 26.5 | | K/W |
| | | | | | |

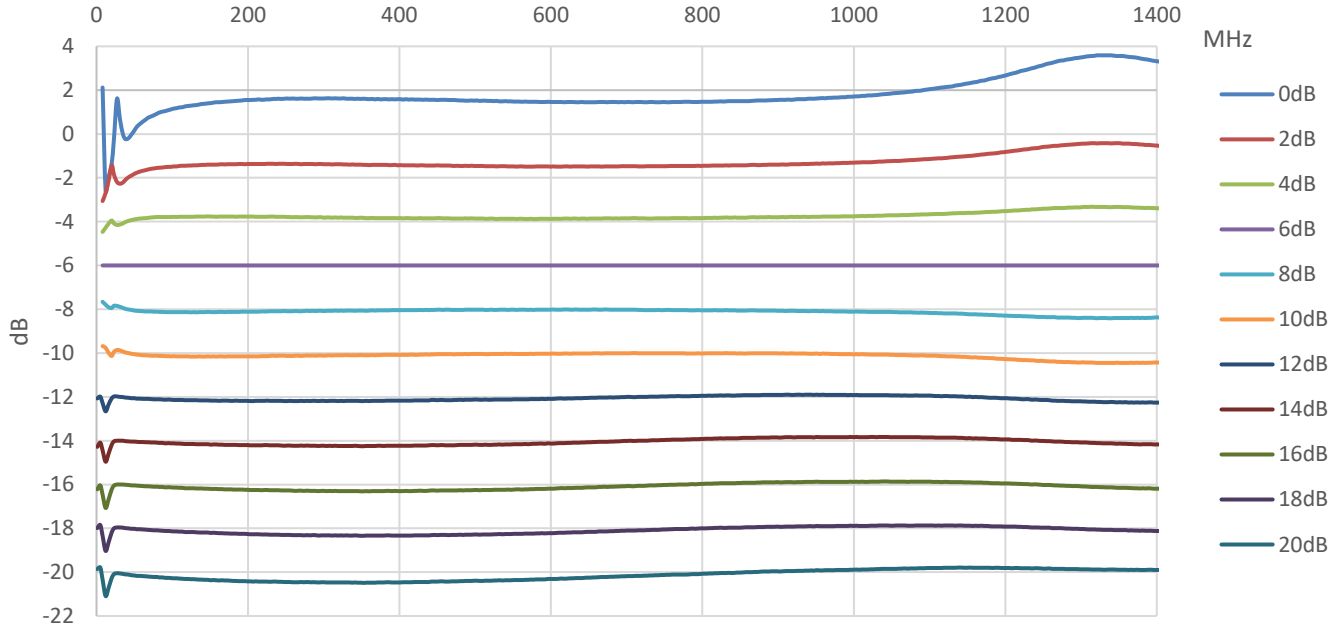
1. Measured between OPS pin and GND on evaluation board.
2. The slope is defined as the difference between the gain at start frequency and the gain at stop frequency.
3. Measured as sum of positive and negative deviation from a straight line between gain at start frequency and gain at stop frequency.

Composite Second Order (CSO) - The CSO parameter (both sum and difference products) is defined by ANSI/SCTE 6.
Composite Triple Beat (CTB) The CTB parameter is defined by ANSI/SCTE 6.

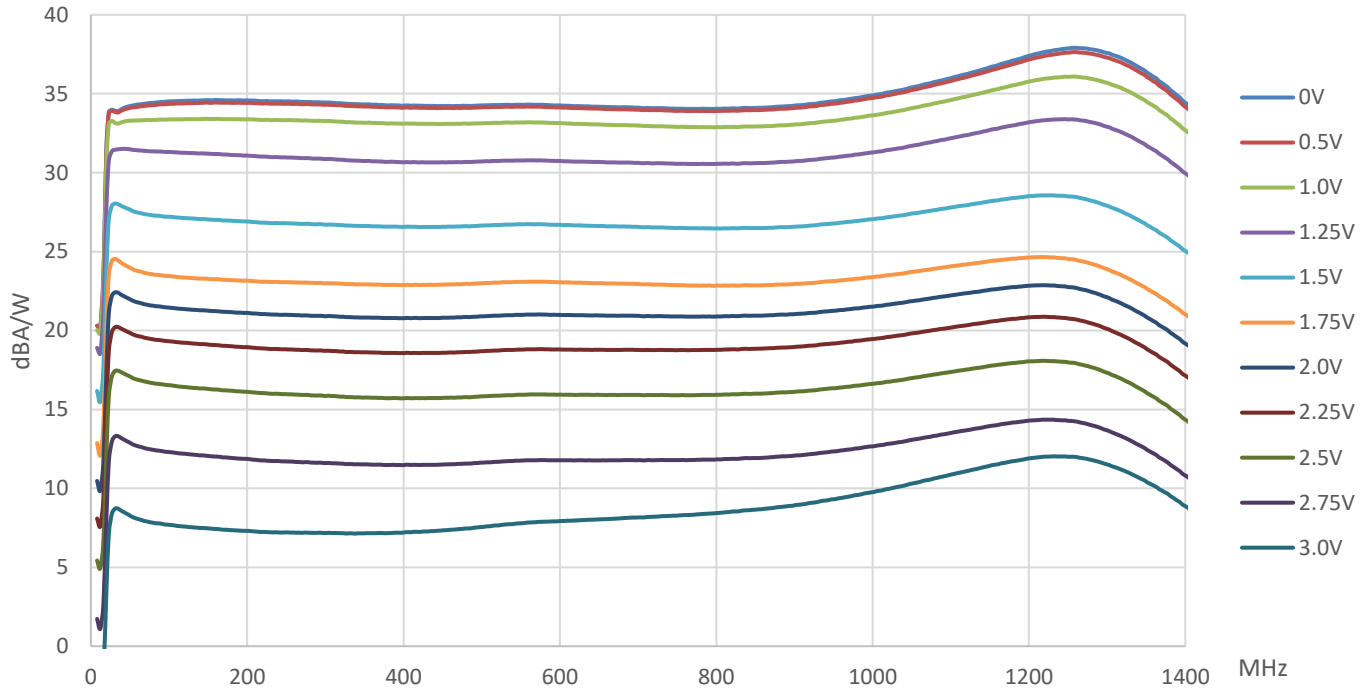
## QPB9015 Gain vs. ATT, typ. values



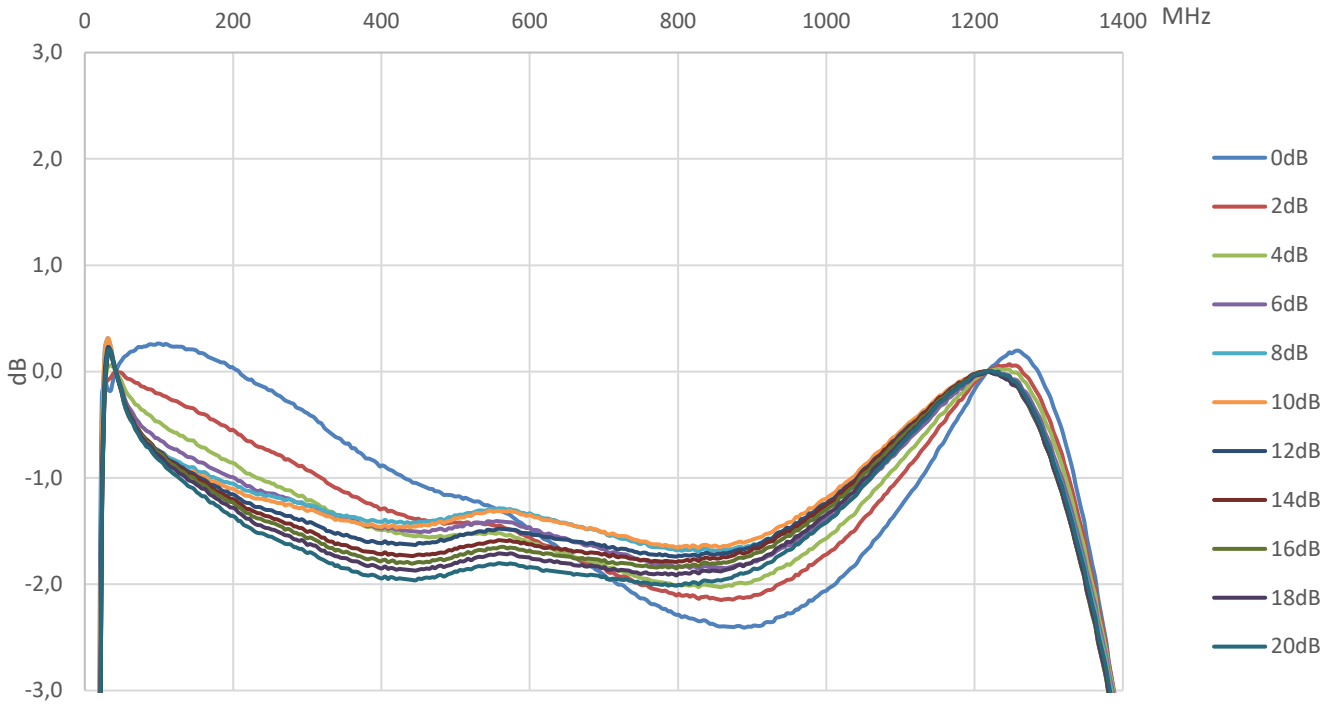

## QPB9015 Gain change vs. ATT, reference 45 MHz, 6 dB ATT, typ. values



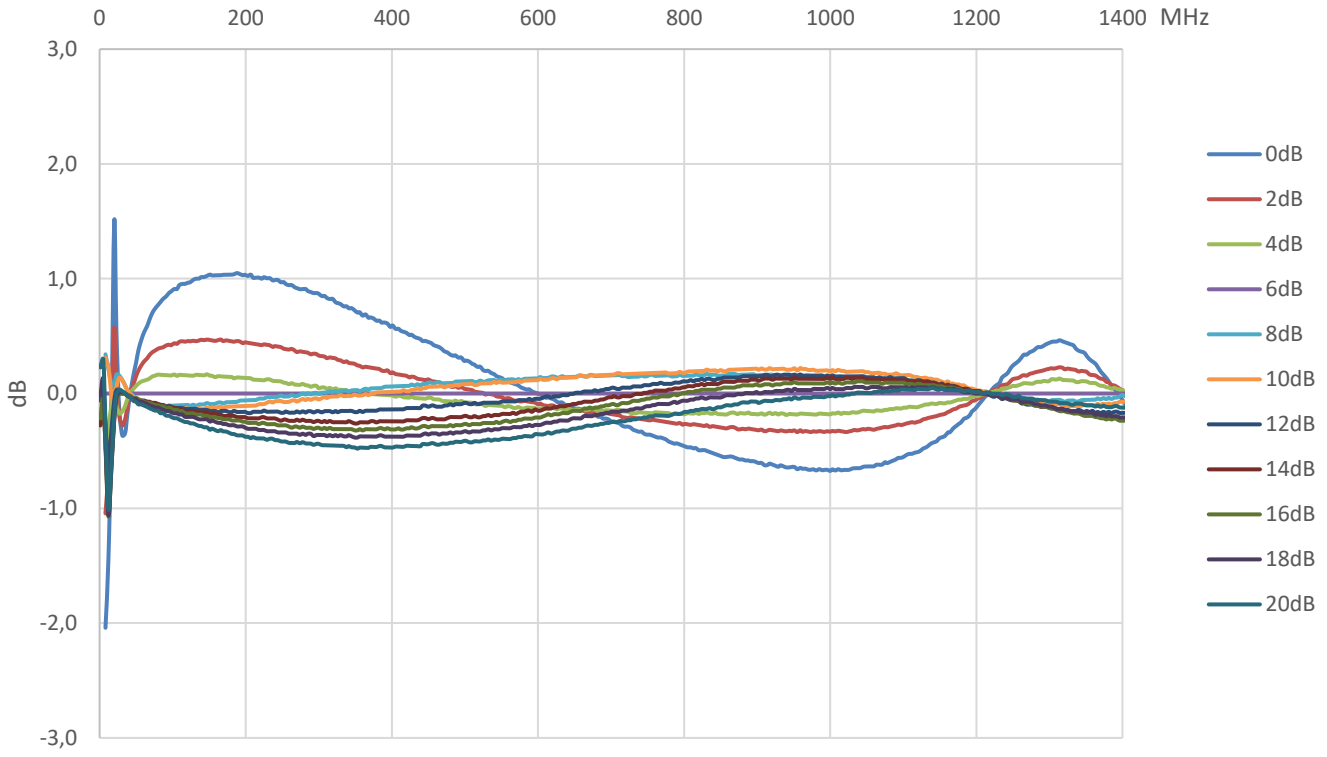
## QPB9015 Gain vs. Vc



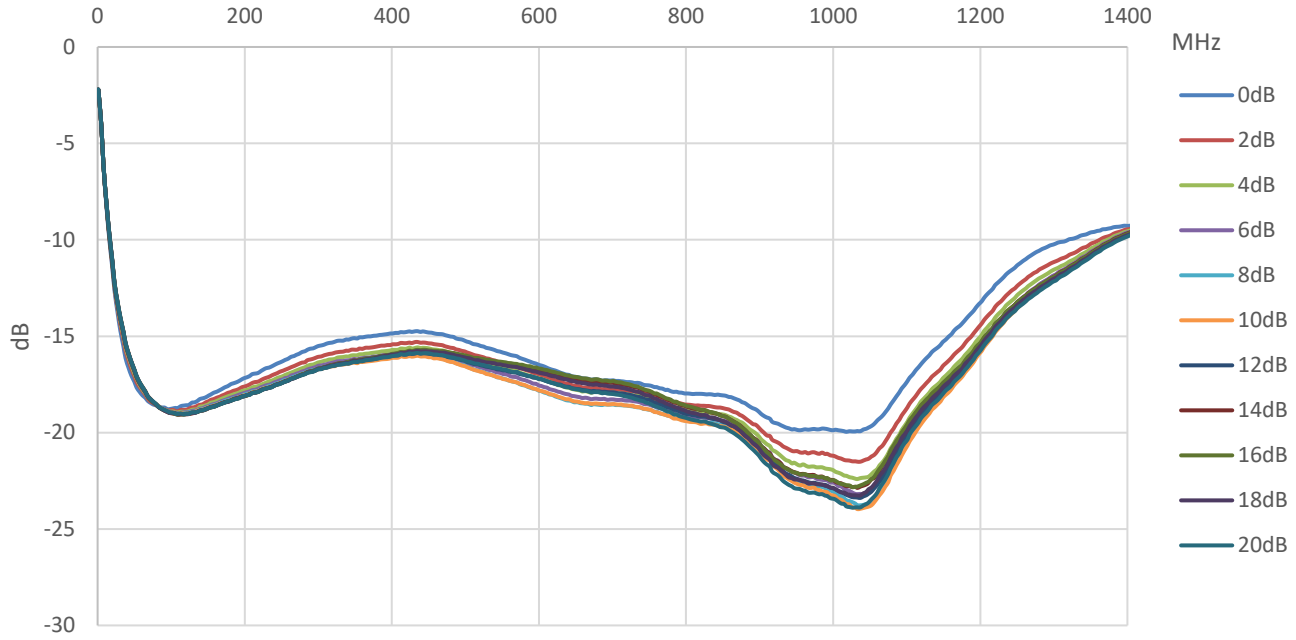
## QPB9015 Flatness vs. ATT (45-1218 MHz), typ. values



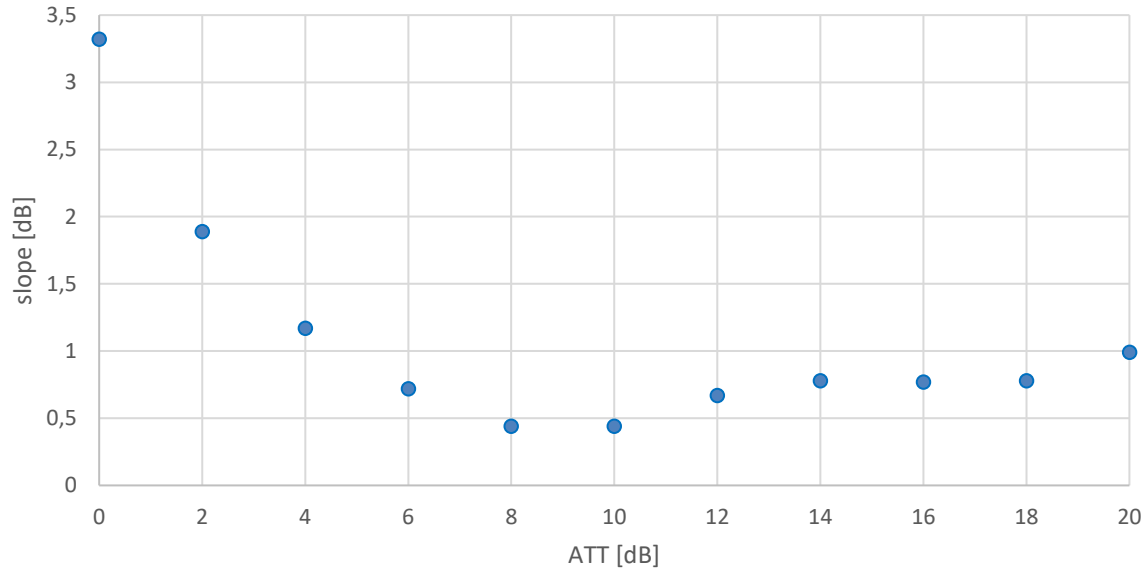

## QPB9015 Flatness change vs. ATT, reference 6 dB ATT, typ. values



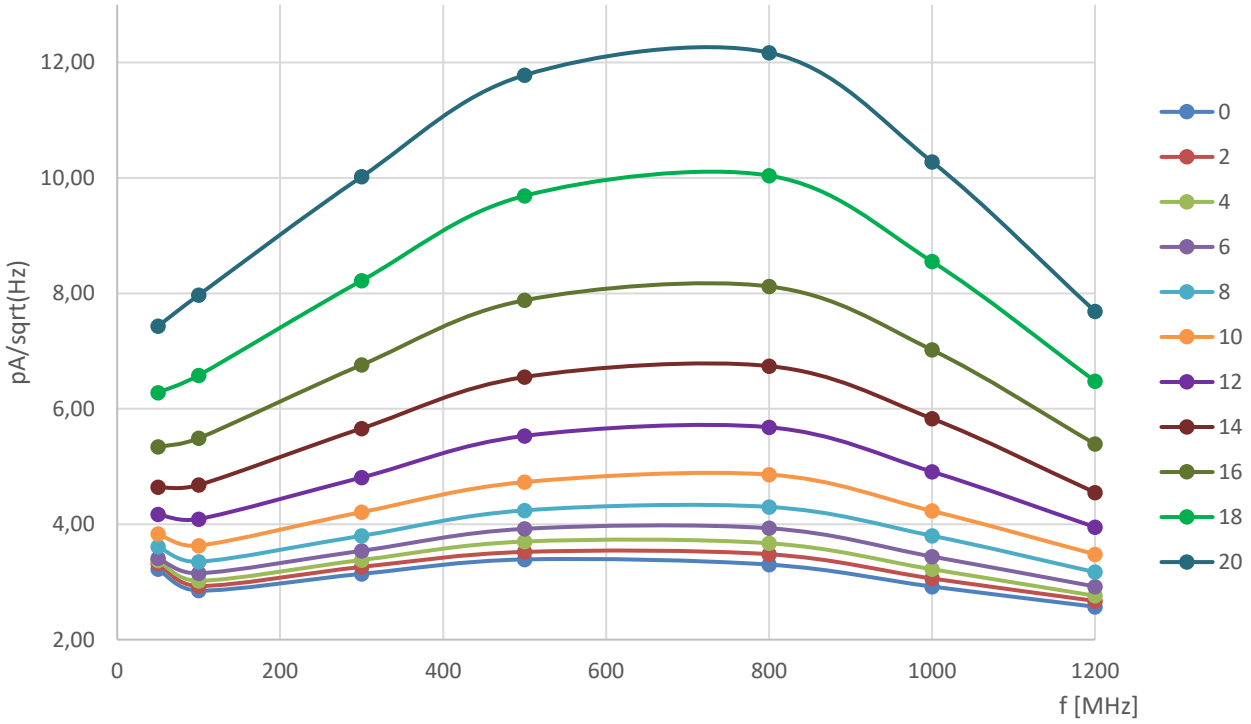
## QPB9015 S22 vs. ATT, typical values



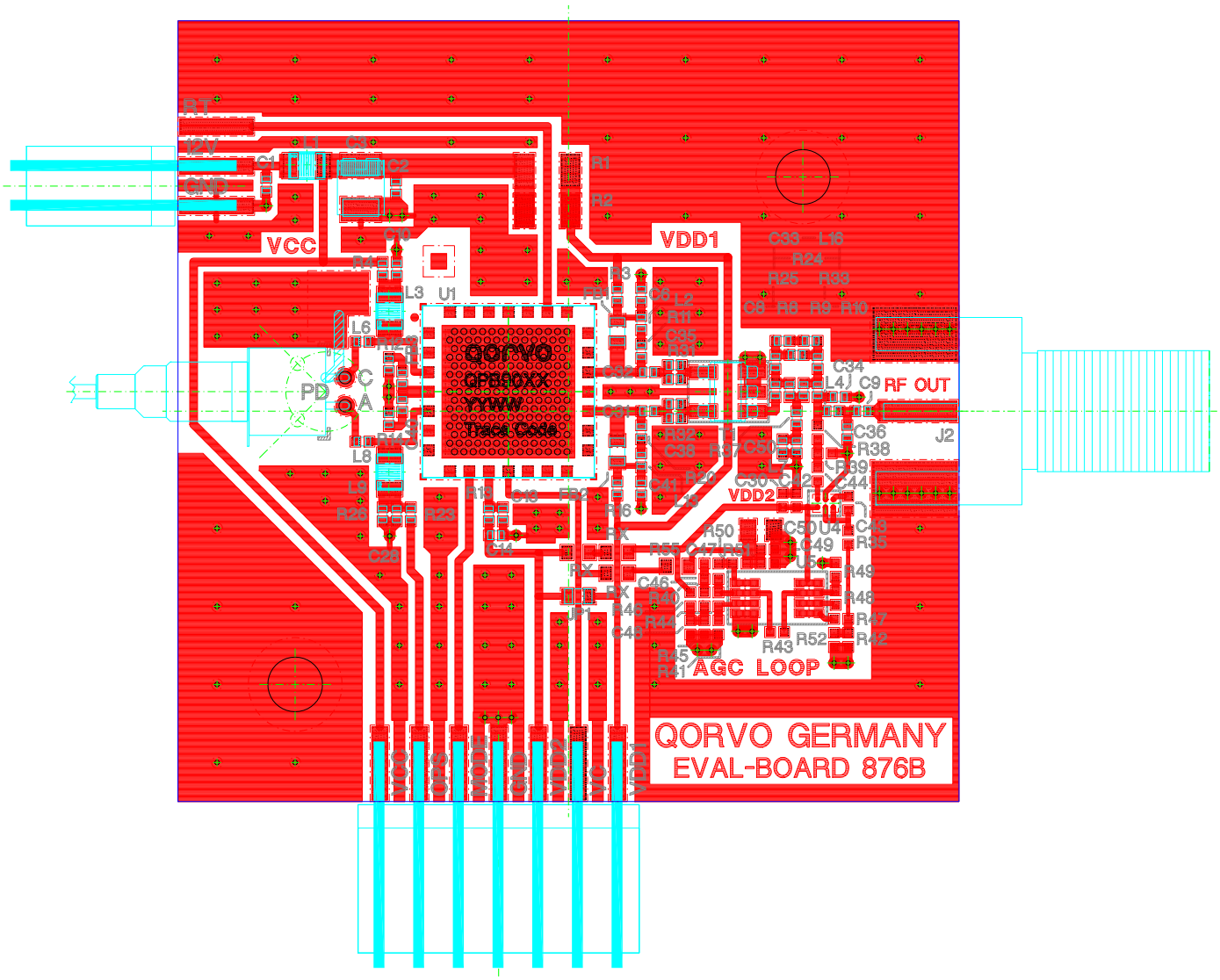

## QPB9015 Gain slope vs. ATT, typical values



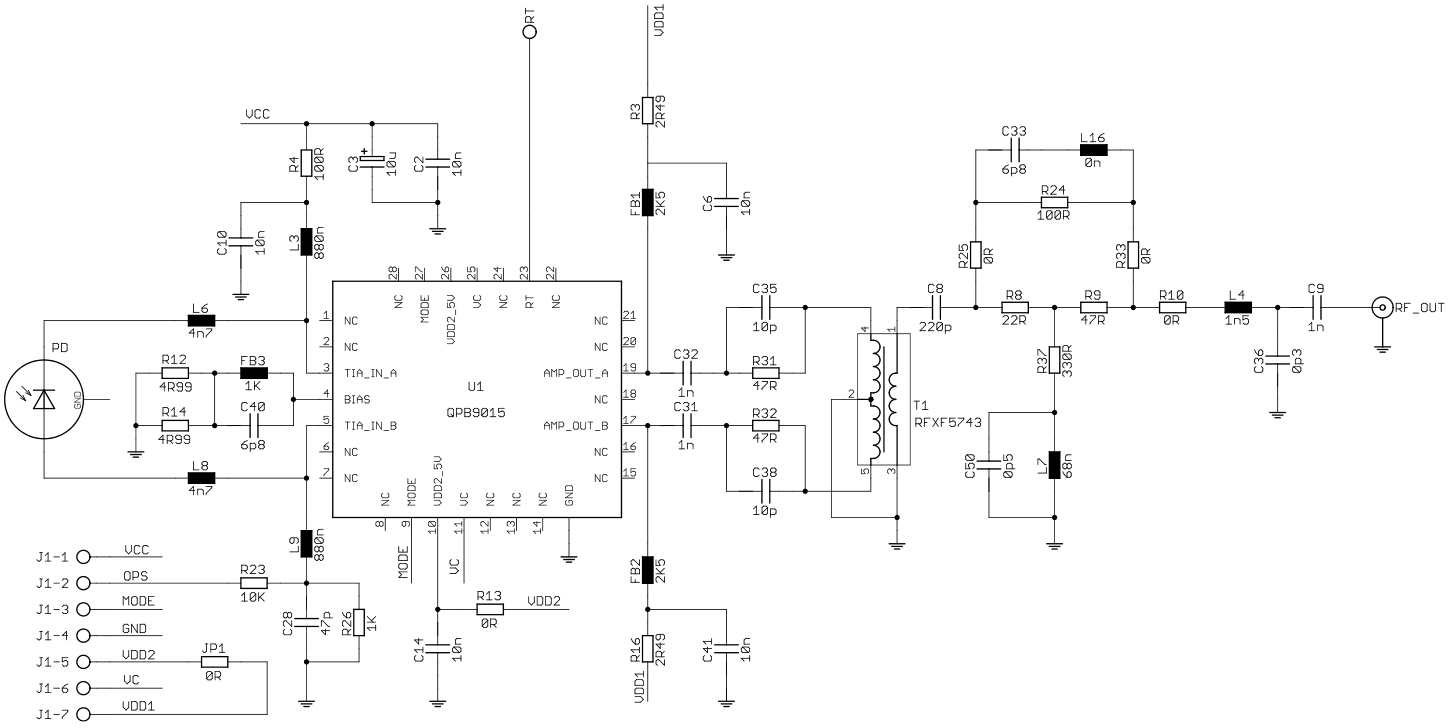
## QPB9015 EINC vs. ATT, typical values, $T_{MB}$=30°C



## Evaluation Board Assembly Drawing



## Evaluation Board Schematic

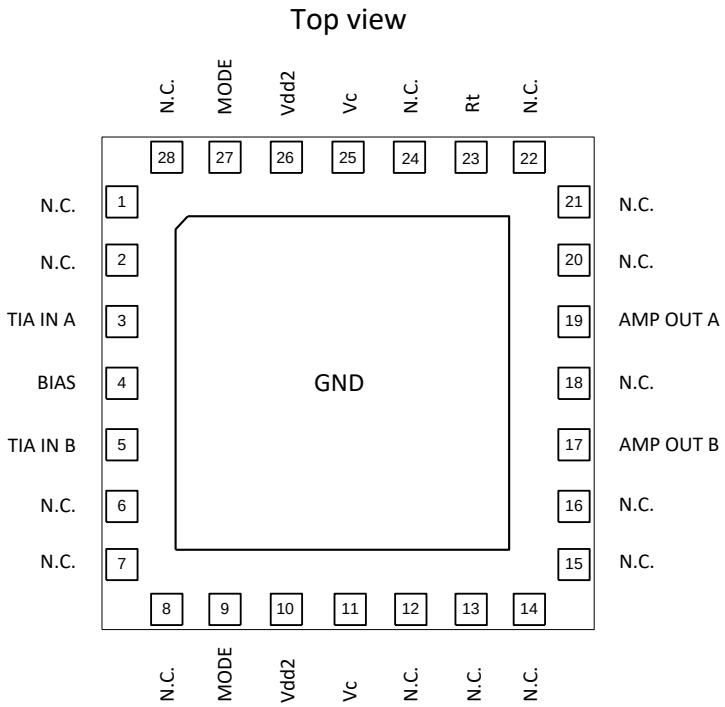


## Evaluation Board Bill of Materials (BOM)

| Ref. Designator | Value, package | Description | Manufacturer | Part Number |
|---|---|---|---|---|
| FB1, FB2 | 2k5, 0603 | Impedance bead | Taiyo Yuden | BK 1608 LM 252 |
| FB3 | 1k, 0402 | Impedance bead | Taiyo Yuden | BK 1005 HM 102 |
| T1 | | Transformer | MiniRF | RFXF5743 |
| L3, L9 | 880nH, 0805 | Inductor, wirewound | Gowanda | CC0805-880J |
| L6, L8 | 4n7, 0402 | Inductor, Thin Film | Murata | LQP15 series |
| L4 | 1n5, 0402 | Inductor, Multilayer | Taiyo Yuden | HK1005-1N5J-T |
| L7 | 68nH, 0402 | Inductor, wirewound | Murata | LQW15AN68NJ80D |
| L16, R10, R25, R33, JP1, R13 | 0R, 0402 | Jumper 0R | various | |
| R4, R24 | 100R, 5%, 0402 | Resistor | various | |
| R8 | 22R, 5%, 0402 | Resistor | various | |
| R9, R31, R32 | 47R, 5%, 0402 | Resistor | various | |
| R12, R14 | 4R99, 5%, 0402 | Resistor | various | |
| R26 | 1k, 1%, 0402 | Resistor | various | |
| R23 | 10k, 5%, 0402 | Resistor | various | |
| R37 | 330R, 5%, 0402 | Resistor | various | |
| R3, R16 | 2R49, 5%, 0402 | Resistor | various | |
| C33, C40 | 6p8, 5%, C0G, 0402 | Capacitor | Murata, Taiyo Yuden | |
| C50 | 0p5, +-0.1p, C0G, 0402 | Capacitor | Murata, Taiyo Yuden | |
| C8 | 220p, 10%, X7R, 0402 | Capacitor | Murata, Taiyo Yuden | |
| C36 | 0p3, +-0.1p, C0G, 0402 | Capacitor | Murata, Taiyo Yuden | |
| C35, C38 | 10p, 5%, C0G, 0402 | Capacitor | Murata, Taiyo Yuden | |
| C9, C31, C32 | 1n, 10%, X7R, 0402 | Capacitor | Murata, Taiyo Yuden | |
| C2, C6, C10, C14, C41 | 10n, 10%, X7R, 0402 | Capacitor | Murata, Taiyo Yuden | |
| C28 | 47p, 10%, C0G, 0402 | Capacitor | Murata, Taiyo Yuden | |
| C3 | 10uF, 16V, 10%, size B | Tantalum capacitor | AVX, Kemet | |
| J2 | | Connector F-type | Amphenol | 222181 |
| P2 | | Connector 2.54mm pin spacing | various | |
| PD | | InGaAs PIN Photodetector Diode | Beijing SWT Science & Technology | PDS133-CSA-C0104 |
| U1 | | Video Receiver | Qorvo | QPB9015 |
| all others | DNI | | | |

Notes: L6, L8 can be optimized in application circuit for gain slope/flatness
C36, L4 can be optimized in application circuit for output matching
Evaluation pcb material: FR4, 1.5mm thickness

## Pin Configuration



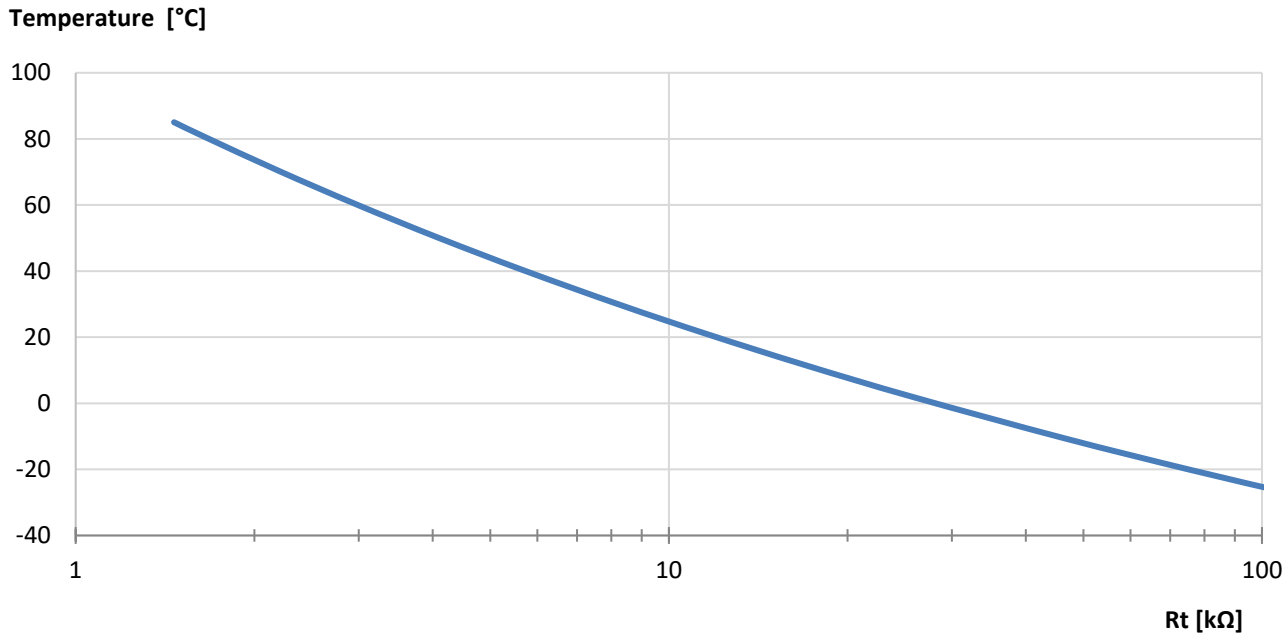

## Pin Description

| Pin No. | Label | Description |
|---|---|---|
| 3 | TIA IN A | Input to the TIA stage of the receiver |
| 4 | BIAS | Biasing for the first stage. The current flowing through this pin is used to control the biasing for the first stage amplifier |
| 5 | TIA IN B | Input to the TIA stage of the receiver |
| 9,27 | MODE | Attenuator slope control (0V: negative slope or 5V: positive slope) |
| 10,26 | Vdd2 | +5V supply voltage for attenuator and output stage |
| 11,25 | Vc | Attenuator control input, 0V to 5V |
| 17 | AMP out B | RF output B and +5V supply voltage for TIA |
| 19 | AMP out A | RF output A and +5V supply voltage for TIA |
| 23 | Rt | 10k NTC close to output stage die, monitoring of output die temperature |
| GND | GND | Backside GND connection |
| 1,2,6-8, 12-16,18,20-22,24,28 | N.C. | |

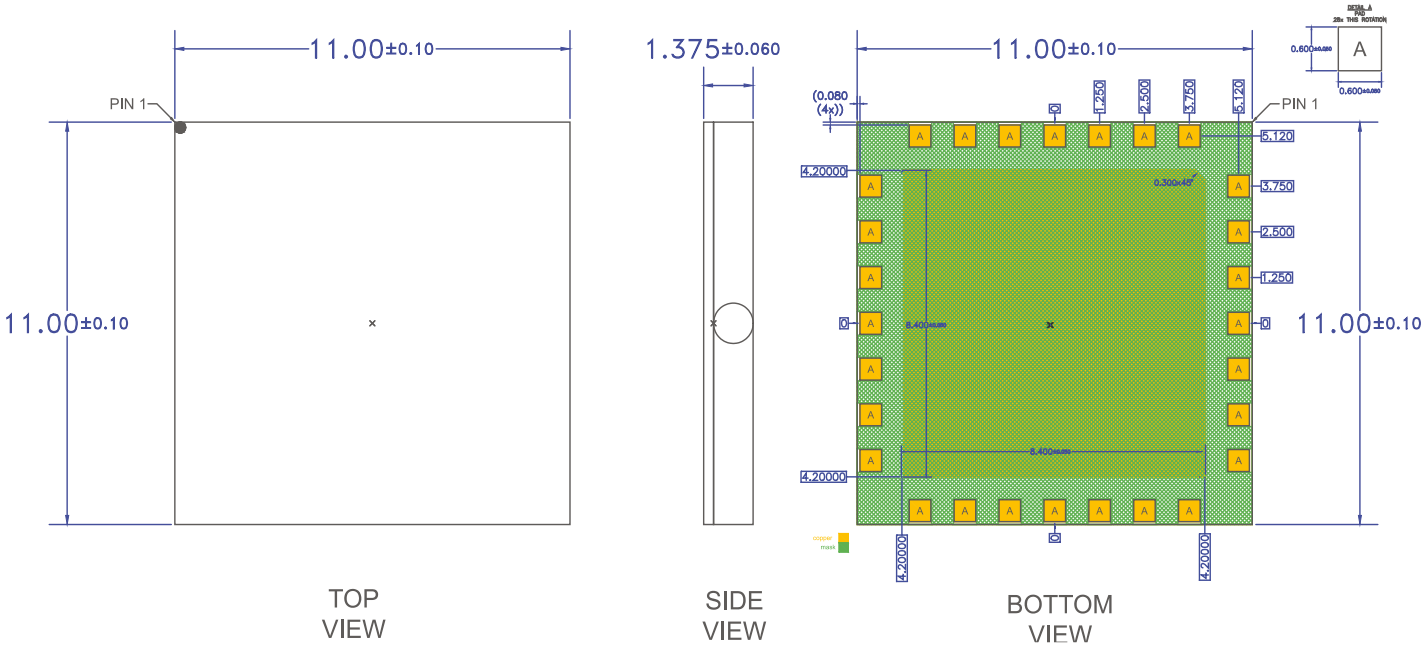
Notes: Pin 9 and 27 (MODE) are connected internally inside QPB9015
Pin 10 and 26 (Vdd2) are connected internally inside QPB9015
Pin 11 and 25 (Vc) are connected internally inside QPB9015

## QPB9015 Temperature Sensing Feature

The QPB9015 provides an internal 10k NTC resistor connected to GND for temperature sensing. This resistor is located close to the amplifier stage. The resistor value can be correlated to the module backside temperature. If it is used as part of a voltage divider, current through the NTC should be limited to 1mA or less to minimize heating up of the NTC.

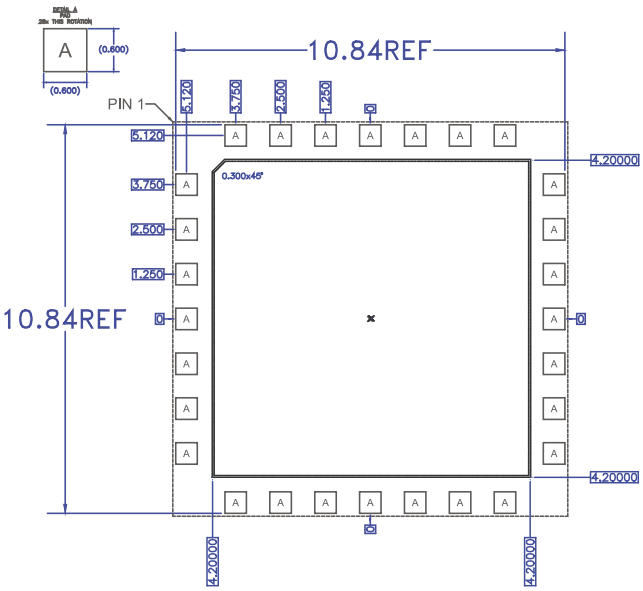


## Package Outline Drawing (Dimensions in millimeters)

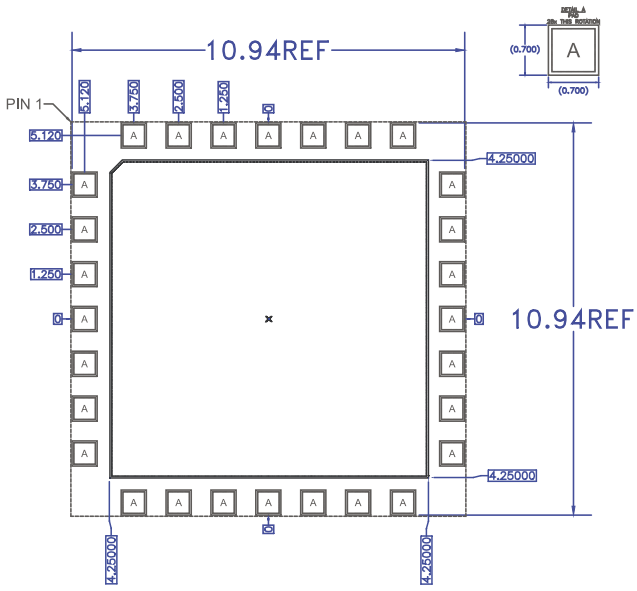



Notes:
1. Dimension and tolerance formats conform to ASME Y14.5M-1994.
2. The terminal #1 identifier and terminal numbering conform to JESD 95-1 SPP-012.
3. Co-planarity applies to the exposed ground/thermal pad as well as the contact pins.
4. Package body length/width does not include plastic flash protrusion across mold parting line.

## PCB Metal Land Pattern (Dimensions in millimeters)




RECOMMENDED
LAND PATTERN




RECOMMENDED
LAND PATTERN MASK

Notes:

1. All dimensions are in millimeters. Angles are in degrees.
2. Use 2 oz. copper minimum for top and bottom layer metal.
3. Vias are required under the backside paddle of this device for proper RF/DC grounding and thermal dissipation. A via drill diameter of 0.4mm and a minimum via wall copper plating thickness of 25um is recommended. Ensure good package backside paddle solder attach for reliable operation and best electrical performance. Open vias are preferred to allow flux and gases to escape during reflow soldering and therefore to minimize voiding. In any case the module backside temperature should not exceed 85 °C.