# QPA2511

## 100 W, 50 V, 1.2 – 1.4 GHz, GaN on SiC Power Amplifier

## Product Overview

The QPA2511 is a 2-stage L-Band internally matched GaN Power Amplifier Module. The QPA2511 operates at pulsed RF conditions in frequency range 1.2 – 1.4 GHz providing typically 50 dBm of saturated output power with 29 dB of large-signal gain and 60% of power added efficiency.
The QPA2511 is matched to 50 Ohms with integrated bias circuits and DC blocking capacitor at input port. The QPA2511 in a SMD package provides good thermal properties and is ideal for use in both military and commercial pulsed radar systems.

Evaluation boards are available upon request.


25.0 x 12.5 x 3.488 mm SMD

## Key Features

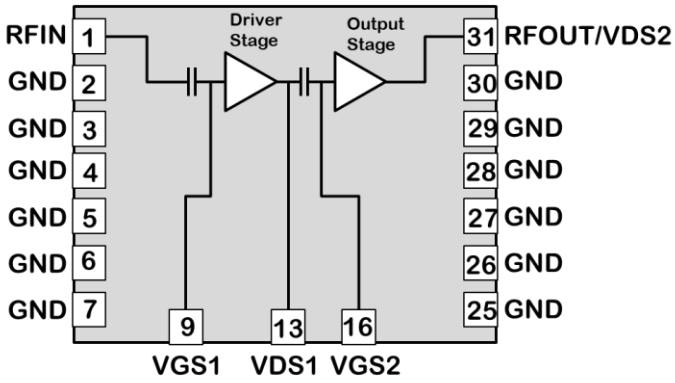
- Operating Frequency Range: 1.2 – 1.4 GHz
- Saturated Output Power $P_{SAT}$ > 50 dBm (1) (2)
- Power Added Efficiency at $P_{SAT}$ > 60% (1) (2)
- Large Signal Gain at $P_{SAT}$ > 29 dB (1) (2)
- Bias: $V_{DS1,2}$=+50 V, $I_{DQ1}$=10 mA, $I_{DQ2}$=100 mA
- Package Type: SMD
- Package Dimensions: 25.0 x 12.5 x 3.488 mm

Notes:

1. Pulsed RF signal on a reference fixture plane.
2. 3 dB gain compression.

Performance is typical across frequency. Please reference electrical specification table and data plots for more details.

## Functional Block Diagram




## Applications

- Military Radar
- Commercial Radar

## Ordering Information

| Part Number | Description |
|---|---|
| QPA2511 | QPA2511 50 Piece Tray |
| QPA2511EVBLPR2 | QPA2511 Evaluation Board |

## Absolute Maximum Ratings

| Parameter | Rating |
|---|---|
| Breakdown Voltage ($BV_{DG}$) | +145 V |
| Gate Voltage ($V_{G1,2}$) | −7 to +2 V |
| Drain Voltage ($V_{D1,2}$) | +55 V |
| RF Input Power, 50 Ohm load (3)(4) | 25 dBm |
| RF Input Power, 10:1 output VSWR (3)(4) | 25 dBm |
| Channel Temperature | 275°C |
| Storage Temperature | −65 to +150°C |

Notes:

3. At temperature +25°C
4. Pulse signal 10% Duty Cycle, 100 µs Pulse Width

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 | Unit |
|---|---|---|---|---|
| Driver Stage Gate Voltage ($V_{G1}$) | | −2.8 | | V |
| Output Stage Gate Voltage ($V_{G2}$) | | −2.8 | | V |
| Drain Voltage ($V_{D1,2}$) | | +50 | | V |
| Driver Stage Quiescent Current ($I_{DQ1}$) | | 10 | | mA |
| Output Stage Quiescent Current ($I_{DQ2}$) | | 100 | | mA |
| Operating Temperature | -40 | | +85 | °C |

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

## Electrical Specifications

| Parameter | Conditions | Min | Typ | Max | Units |
|---|---|---|---|---|---|
| Operating Frequency Range | | 1.2 | | 1.4 | GHz |
| Saturated Output Power | 3 dB Gain Compression | | 51.6 | | dBm |
| Large Signal Gain | 3 dB Gain Compression | | 32.8 | | dB |
| Drain Efficiency | 3 dB Gain Compression | | 69.0 | | % |
| Small Signal Gain | Frequency Range 1.2-1.4 GHz | | 35.8 | | dB |
| Input Return Loss | Frequency Range 1.2-1.4 GHz | | -10 | | dB |
| Output Return Loss | Frequency Range 1.2-1.4 GHz | | -10 | | dB |
| Driver Stage Gate Leakage ($I_{G1}$) | $V_{G1}$ = −3.7 V, $V_{D1}$ = +10 V | -4.0 | | | mA |
| Output Stage Gate Leakage ($I_{G2}$) | $V_{G2}$ = −3.7 V, $V_{D2}$ = +10 V | -21.0 | | | mA |

Test conditions unless otherwise noted: $V_{D1,2}$ = +50 V, $I_{DQ1}$ = 10 mA, $I_{DQ2}$ = 100 mA, T = +25°C, Pulsed RF CW (Duty Cycle = 10%, Pulse Width = 100 µs) on a reference fixture plane for 1.2-1.4 GHz.

## Thermal Information

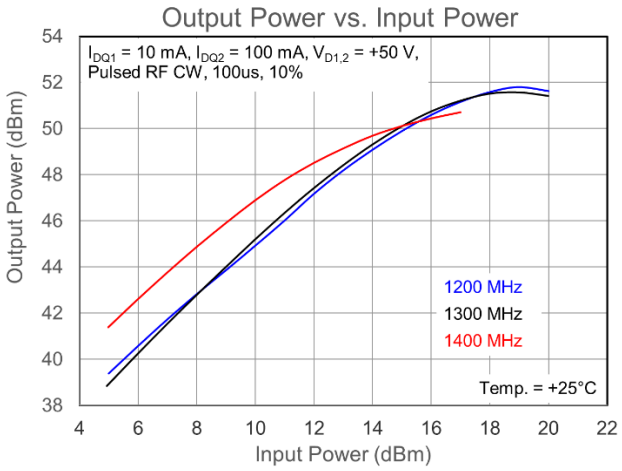
| Parameter | Test Conditions | Values | Units |
|---|---|---|---|
| Thermal Resistance ($\theta_{JC}$) (5)(6) | $T_{CASE}$ = +85°C, $V_{DS1,2}$ = +50 V, $I_{DQ1}$ = 10 mA, $I_{DQ2}$ = 100 mA. $P_{DISS}$ = 90.72 W, Pulsed RF CW | 1.07 | °C/W |
| Peak IR Surface Temperature ($T_{CH}$) (5)(6) | | 151 | °C |

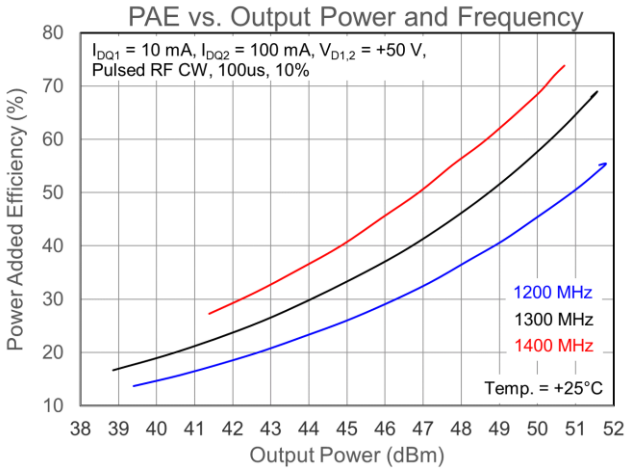
Notes:

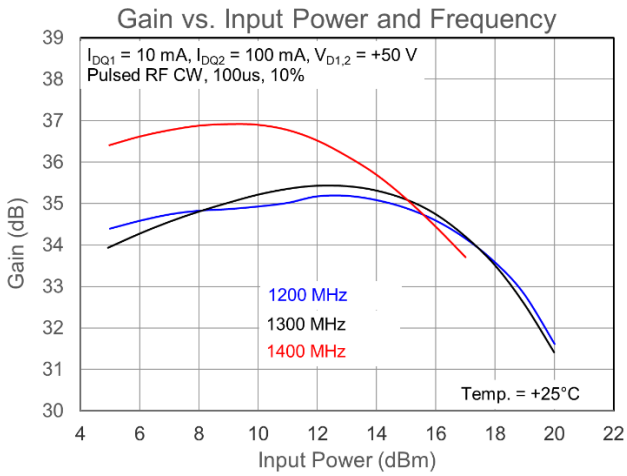
5. Thermal resistance is measured to package backside.
6. Pulsed CW (Duty Cycle = 10%, Pulse Width = 100 µs).
7. Refer to the following document: GaN Device Channel Temperature, Thermal Resistance, and Reliability Estimates

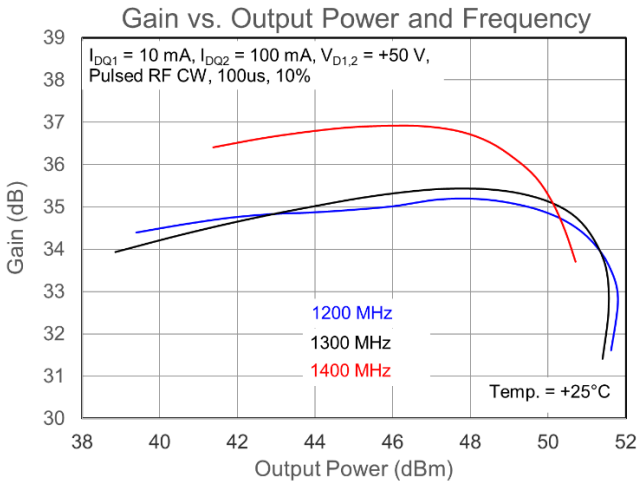
## QPA2511 EVB Performance Plots – 1200 – 1400 MHz Reference Design

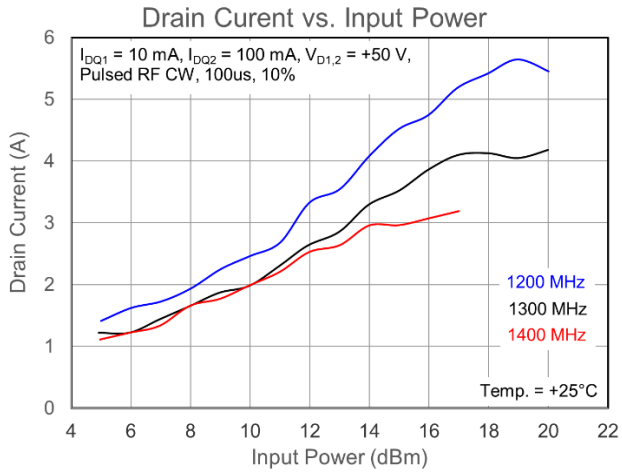
Notes: Refer to device reference planes where the performance was measured.

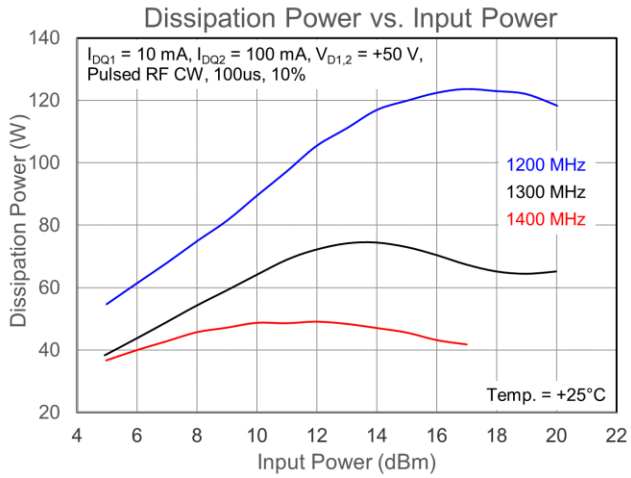


## QPA2511 EVB Performance Plots – 1200 – 1400 MHz Reference Design

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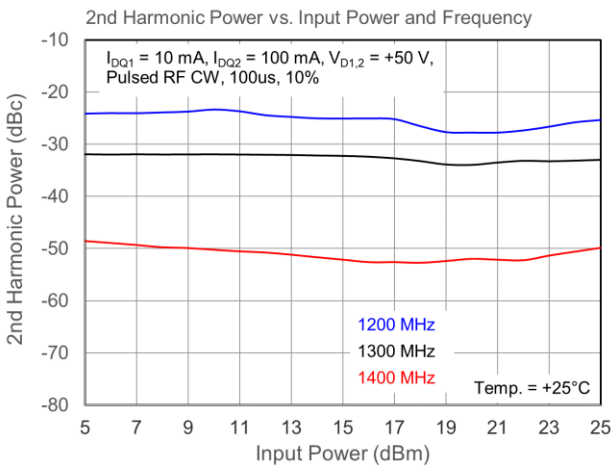
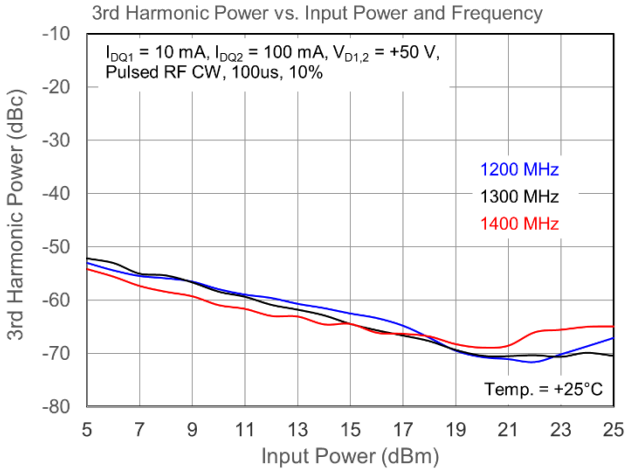
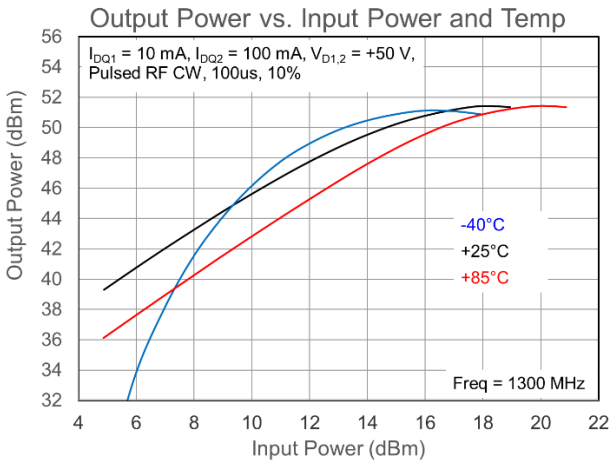
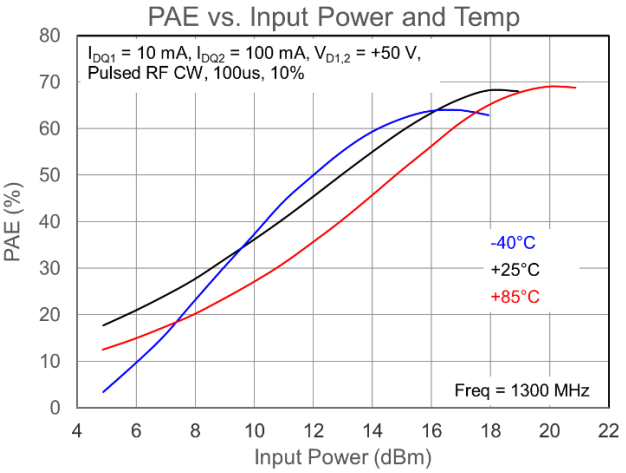
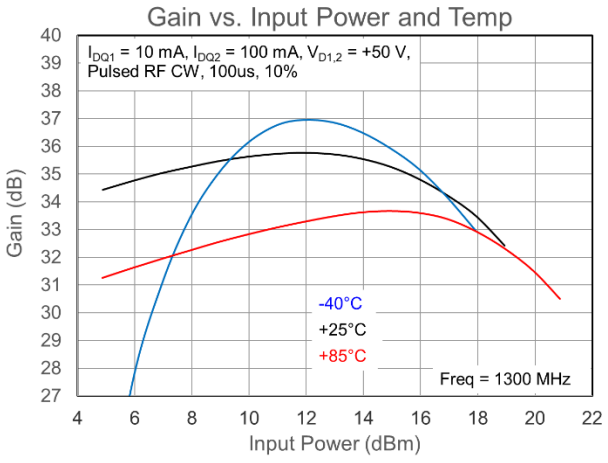


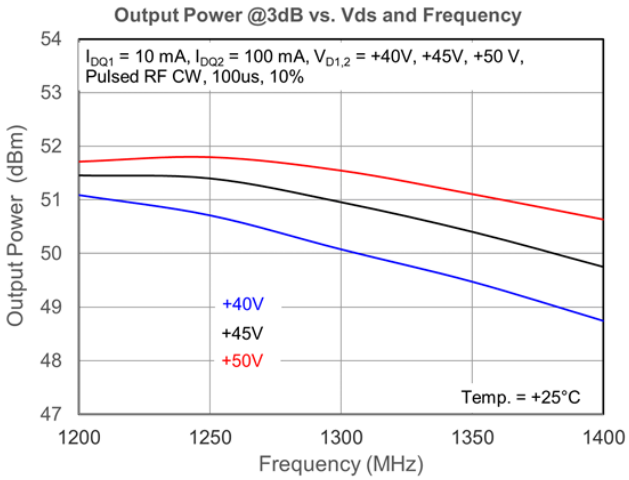



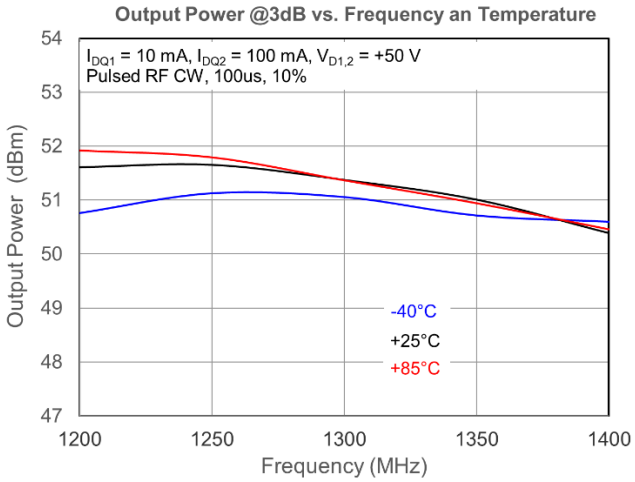



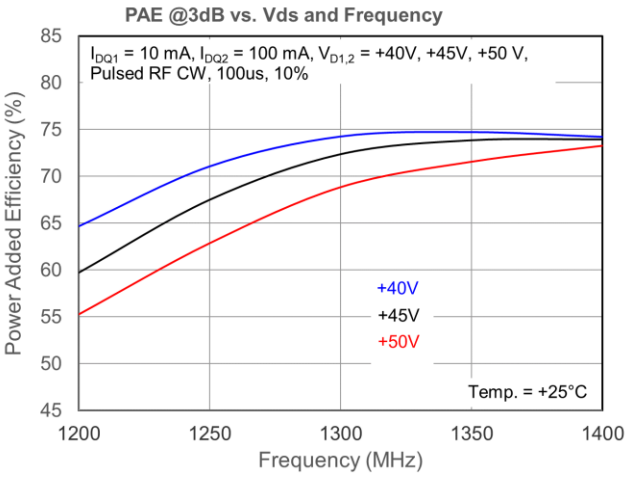



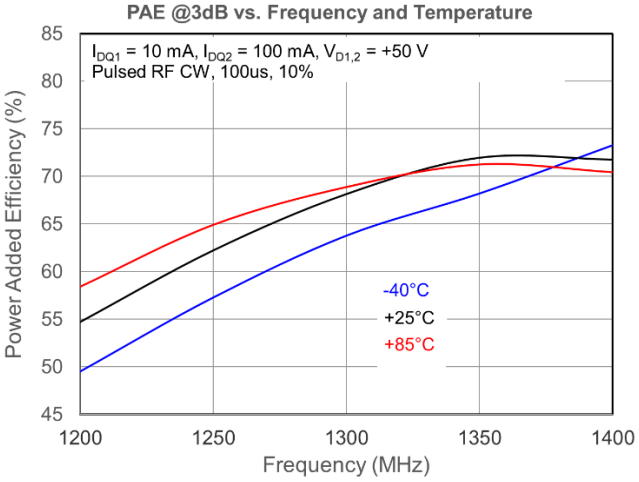
## QPA2511 EVB Performance Plots at 3dB Gain Compression

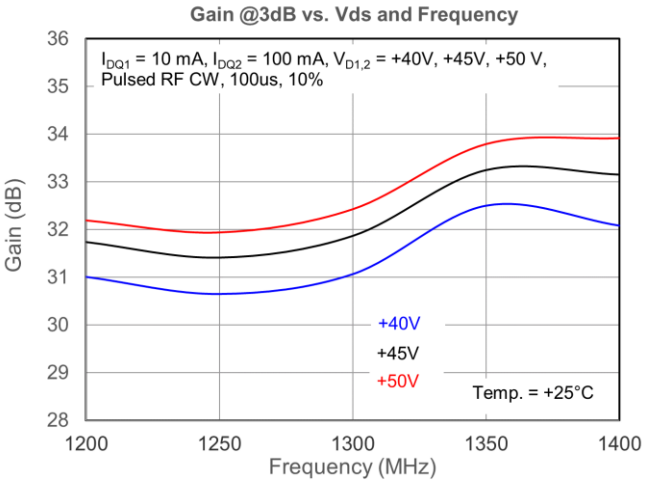
Notes: Refer to device reference planes where the performance was measured.

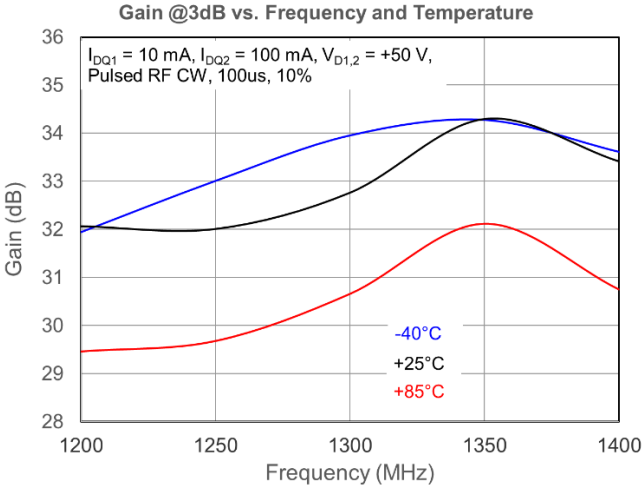


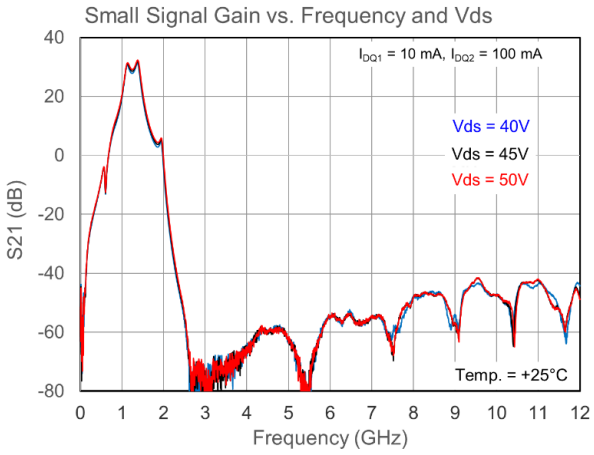



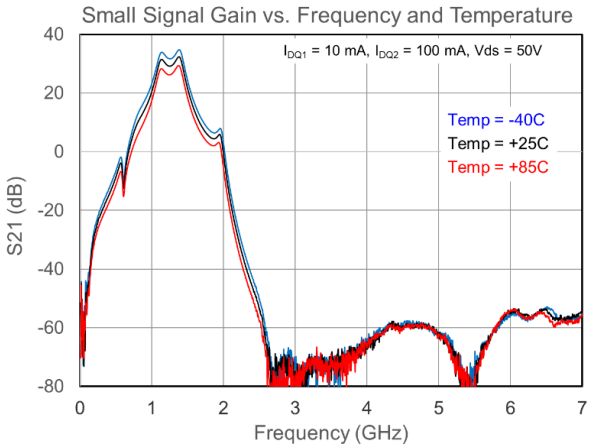



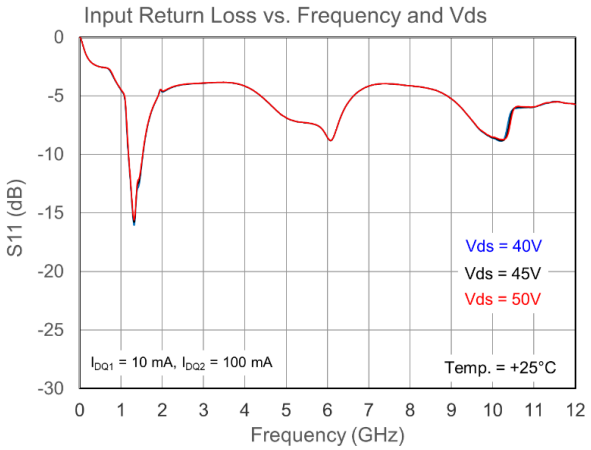



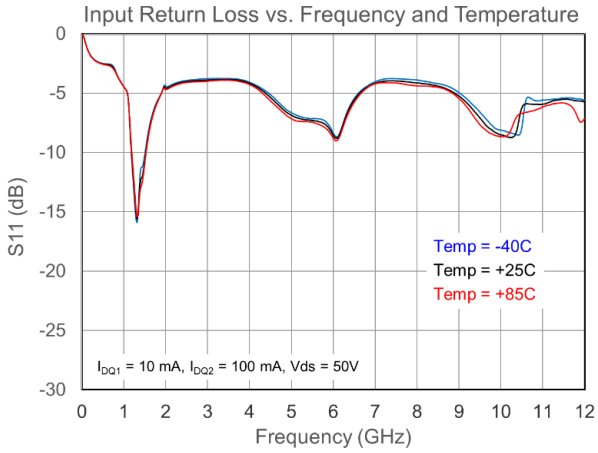
## QPA2511 Typical Performance – S-Parameters

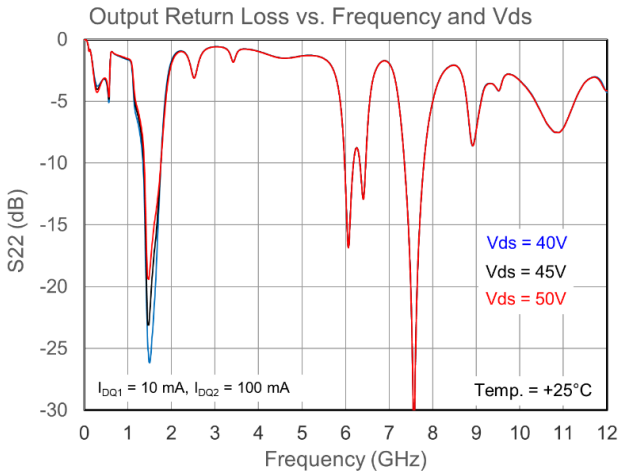
Notes: Refer to EVB reference planes where S-Parameters were measured.

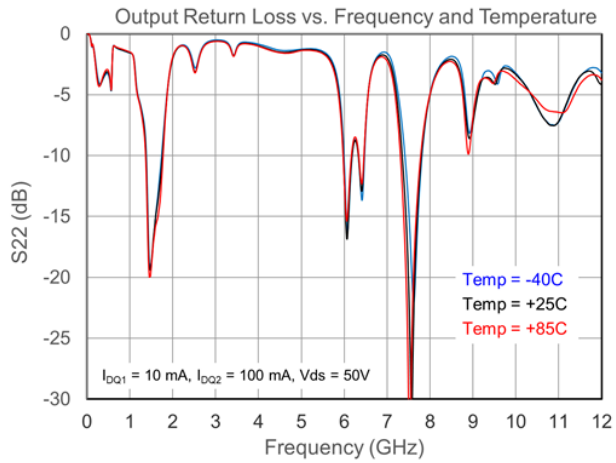


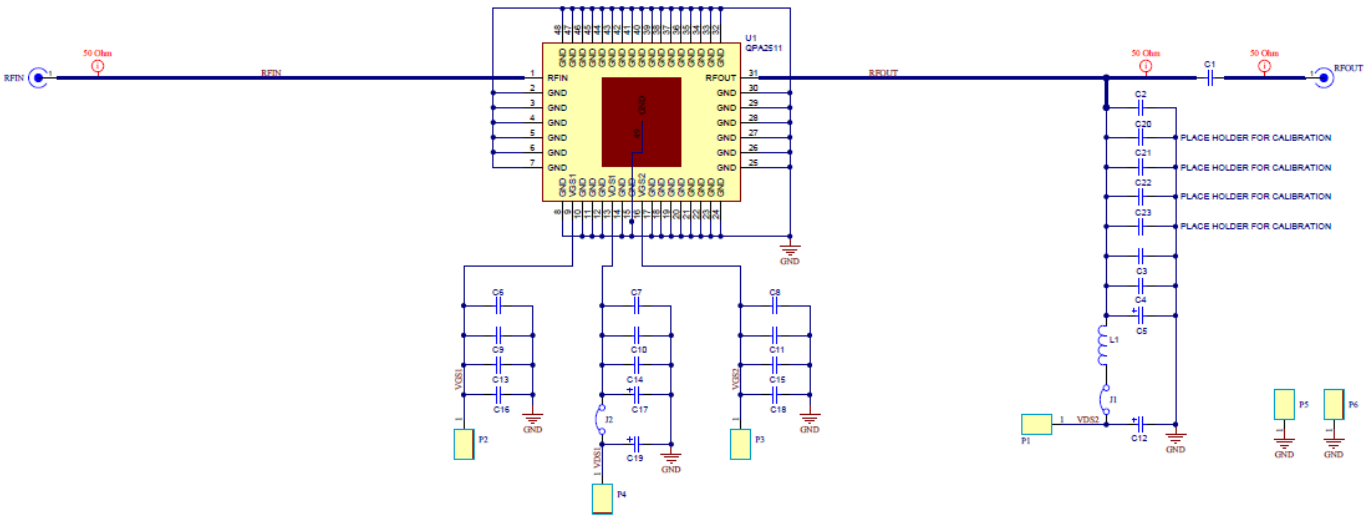



## QPA2511 Evaluation Board Schematic

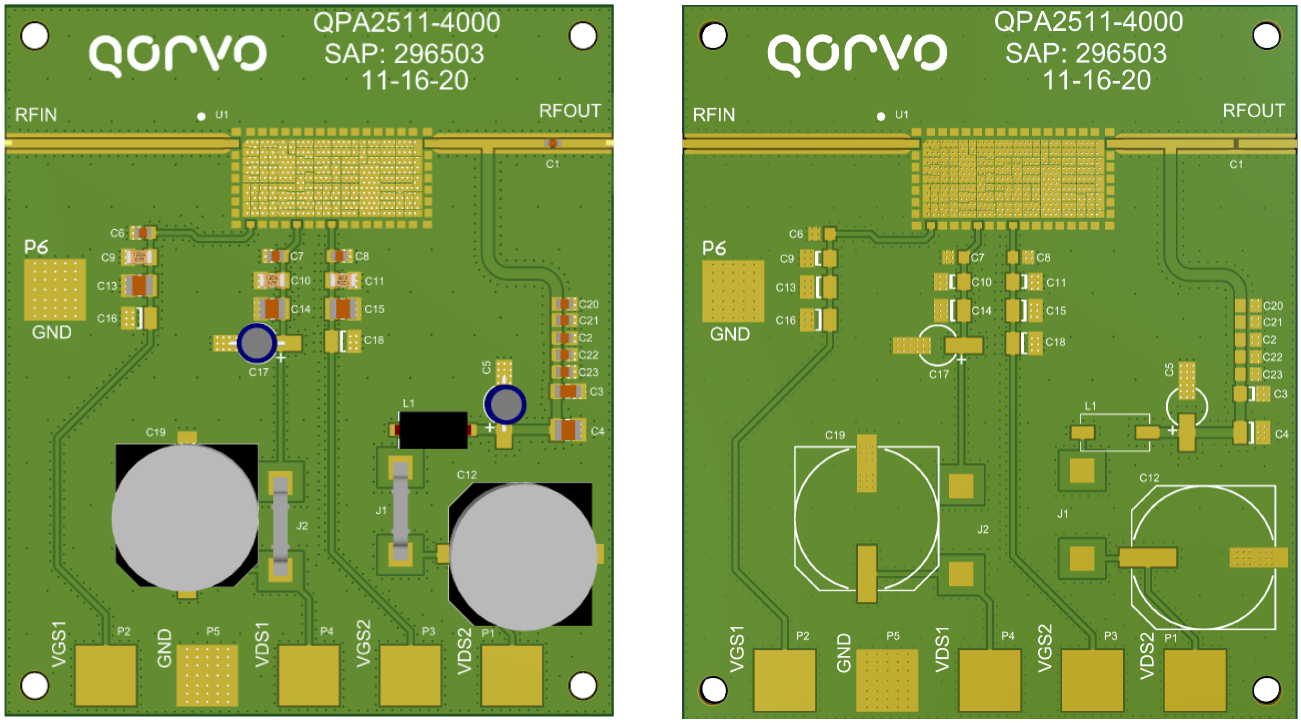



## Bill of Materials

| Reference Des. | Value | Description | Manuf. | Part Number |
|---|---|---|---|---|
| C1, C6, C7, C8, C21 | 27 pF | Capacitor, 27pF, +/-5%, 250V, HI-Q, 0603 | ATC | 600S270JT250XT |
| C3, C9, C10, C11 | 1000 pF | Capacitor, 1000pF, 10%, 500V, X7R, 1206 | Samsung | CL31B102KGFNFNE |
| C4, C13, C14, C15 | 0.1 µF | Capacitor, 0.1uF, 10%, 100V, X7R, 1206 | TDK | C3216X7R2A104K160AA |
| C5, C17 | 10 µF | Capacitor, 10uF, 20%, 100V, AL ELEC, AX | Panasonic | ECA-2AM100 |
| C12, C19 | 220 µF | Capacitor, 220uF, 20%, 100V, ALU-ELECT, SMD | CDE | AFK227M2AR44T-F |
| C16, C18 | 10 µF | Capacitor, 10uF, 10%, 25V, X7R, 1210 | Kemet | C1210T106K3RALTM |
| L1 | 115 Ohm | Ferrite Bead, 115 Ohm, 10A, SMD | Laird | 28F0181-1SR-10 |
| RFIN, RFOUT | – | SMA Connector | Powell Electronics | PSF-S00-000 |
| U1 | – | 100W 50V 1.2 – 1.4 GHz GaN PA EHS | Qorvo | QPA2511.ELPR |
| J1, J2 | - | Jumper Connector | | |
| | | | | |

## QPA2511 Evaluation Board Layout and Stencil

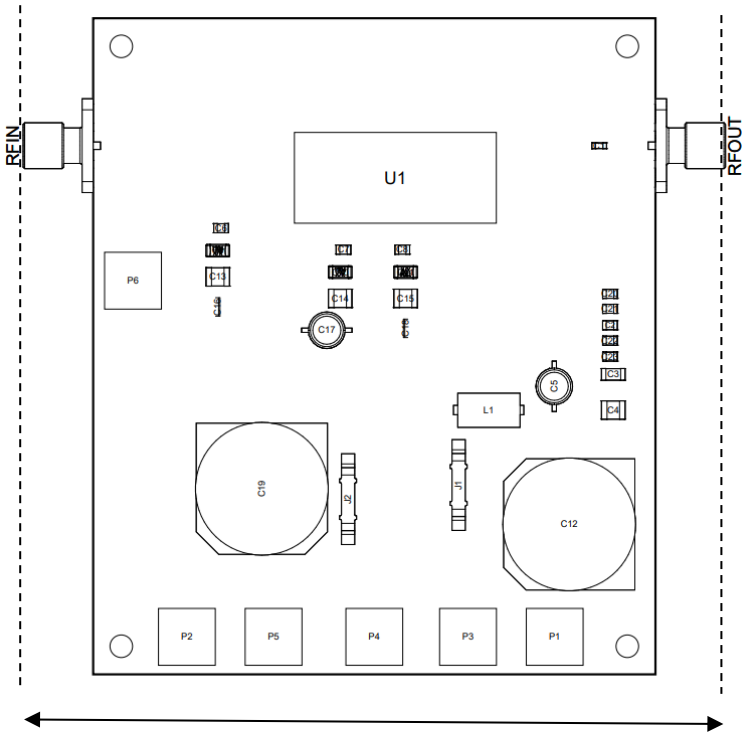
TOP VIEW (POPULATED)




Notes:

1. PCB Rogers 4350B 0.020in, 2 Layers, Copper 1.0oz. (2 oz Finish Thickness)
2. Stencil thickness 0.006” [150 um]

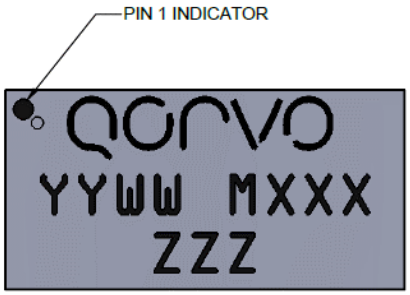
## QPA2513 Evaluation Board Reference Plane for S-Parameters

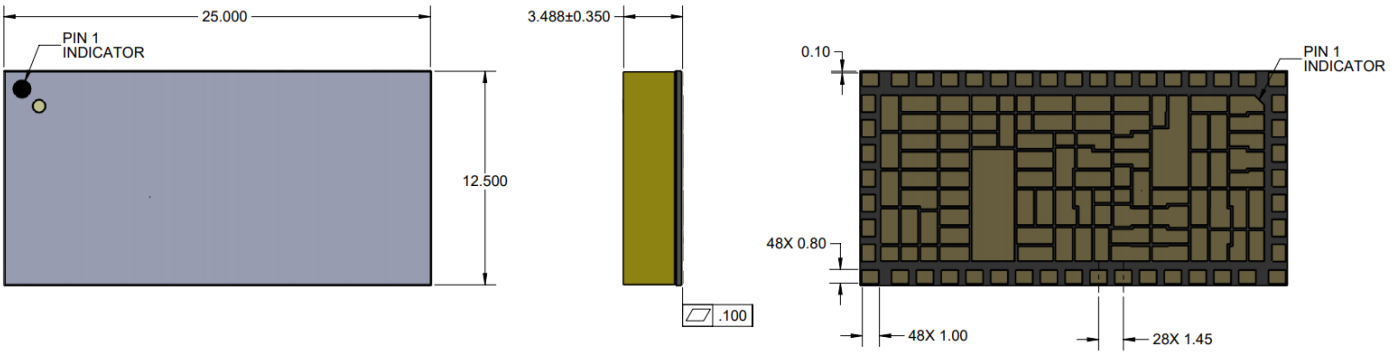



EVB Reference Planes

## Package Marking and Dimensions

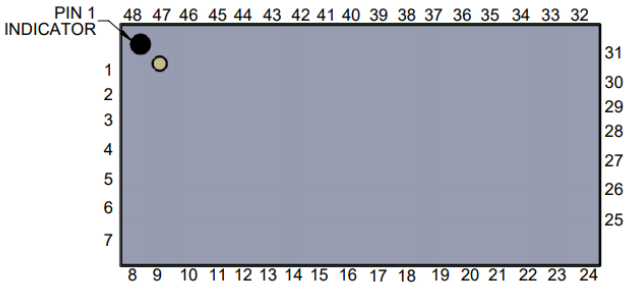
Marking: QORVO Logo
YY – Calendar Year of Assembly Lot
WW – Week Number of the Assembly Lot
MXXX – Batch ID
ZZZ – Part Number Within One Assembly Lot

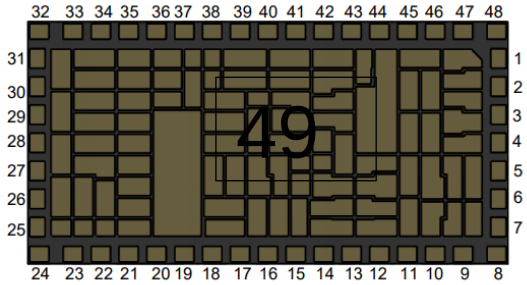



Notes:
1. All dimensions are in millimeters. Angles are in degrees.
2. General tolerance is ±0.05 unless otherwise noted.
3. Package Base: Laminate
4. Package Lid: FR-4.
5. Contact plating: Au, Thickness is 0.1 µm MIN.

## Pin Configuration and Description



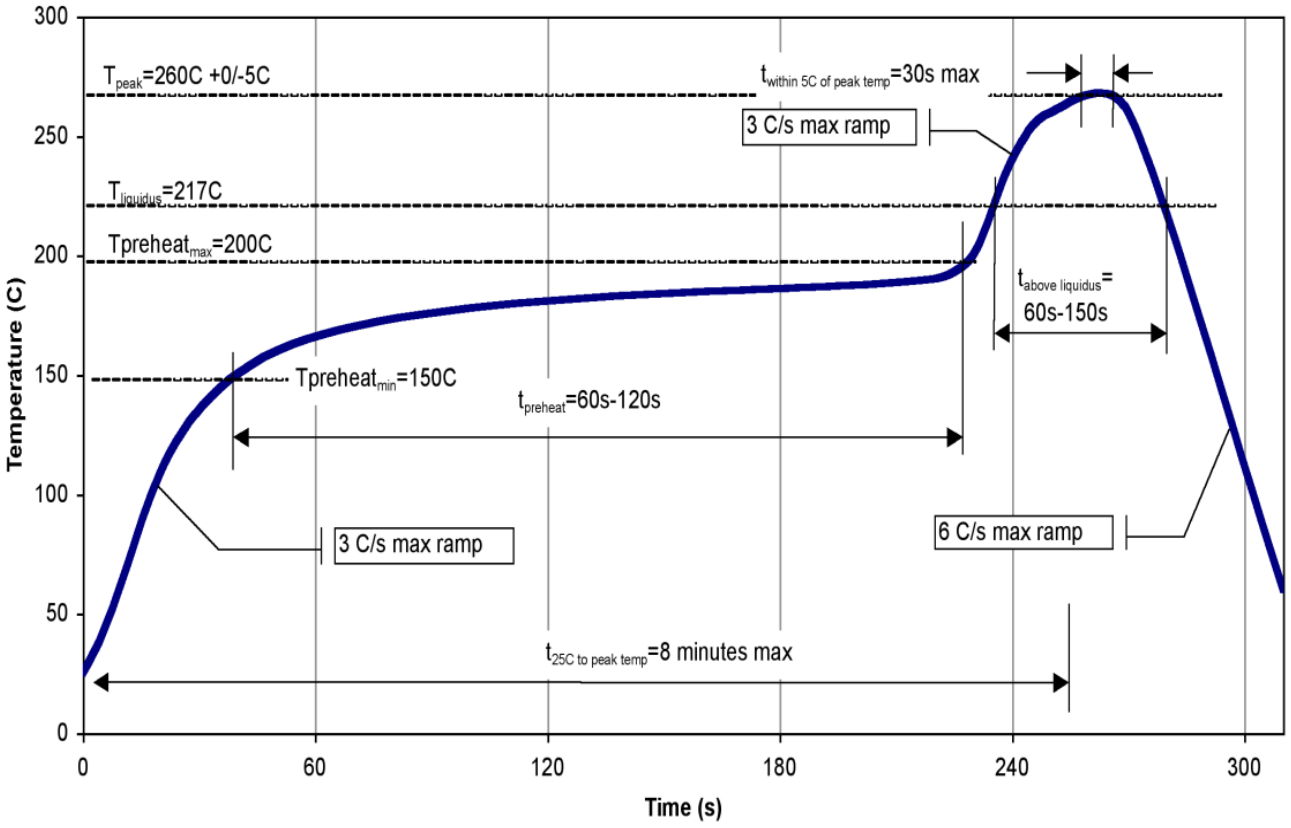




| Pin Number | Label | Description |
|---|---|---|
| 1 | RF IN | RF Input |
| 2, 3, 4, 5, 6, 7, 8 | GND | RF/DC ground. |
| 9 | $V_{GS1}$ | Driver Stage Gate Voltage |
| 10, 11, 12 | GND | RF/DC ground. |
| 13 | $V_{DS1}$ | Driver Stage Drain Voltage |
| 14, 15 | GND | RF/DC ground. |
| 16 | $V_{GS2}$ | Output Stage Gate Voltage |
| 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29. 30 | GND | RF/DC ground. |
| 31 | RF OUT, $V_{DS2}$ | RF output, Output Stage Drain Voltage |
| 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48 | GND | RF/DC ground. |
| 49 (Backside Paddle) | GND | RF/DC ground. |
| | | |

## Power Amplifier Module Biasing Procedure

| Bias On | Bias Off |
|---|---|
| 1. Turn ON $V_{GS1}$ to −5 V.<br>2. Turn ON $V_{GS2}$ to −5 V.<br>3. Turn ON $V_{DS1}$ and $V_{DS2}$ to +50 V.<br>4. Slowly adjust $V_{GS1}$ until $I_{DQ1}$ = 10 mA. (Typically, $V_{G1}$ = −2.8 V.)<br>5. Slowly adjust $V_{GS2}$ until $I_{DQ2}$ = 100 mA. (Typically, $V_{G1}$ = −2.8 V.)<br>6. Turn ON RF. | 1. Turn OFF RF.<br>2. Adjust $V_{GS1}$ and $V_{GS2}$ to −5 V.<br>3. Turn OFF $V_{DS1}$ and $V_{DS2}$.<br>4. Wait two (2) seconds to allow drain capacitors to discharge.<br>5. Turn OFF $V_{GS1}$ and $V_{GS2}$. |

## Recommended Solder Temperature Profile



## Handling Precautions

| Parameter | Rating | Standard |
|---|---|---|
| ESD – Human Body Model (HBM) | Class 1B | ANSI/ESDA/JEDEC Standard JS-001 |
| ESD – Charged Device Model (CDM) | Class C3 | ANSI/ESDA/JEDEC Standard JS-002 |
| MSL – Moisture Sensitivity Level | MSL3 | IPC/JEDEC Standard J-STD-020 |

Caution!
ESD-Sensitive Device

## Solderability

Compatible with lead-free (260°C max. reflow temp.) soldering process. Package lead plating is ENEPIG.
Solder rework not recommended.

This package is air-cavity and non-hermetic, and therefore cannot be subjected to water washing. The use of no-clean solder to avoid washing after soldering is highly recommended.

## 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:

- Antimony Free
- TBBP-A ($C_{15}H_{12}Br_4O_2$) Free
- PFOS Free
- SVHC Free

## Contact Information

For the latest specifications, additional product information, worldwide sales and distribution locations:

**Web:** www.qorvo.com **Tel: 1-844-890-8163**

**Email:** customer.support@qorvo.com

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