ALTUM RF

ARF1200Q2

Features

- 22—31.5 GHz Low Noise and Driver Amplifier
- 22 dB Small-Signal Gain
- 1.6 dB Typical Noise Figure
- 8 dBm Typical Output P1dB
- > 10 dB Return Loss Input and Output
- +3.3 V, 15 mA Nominal Bias
- 16 Lead QFN, 2.5 mm × 2.5 mm

Applications

- 5G Networks
- Point-to-Point Radios
- VSAT
- ISM
- Satellite Communications

Description

ARF1200Q2 is a low noise and driver amplifier designed for high data-rate applications. With 22 dB of linear gain, 1.6 dB noise figure, 8 dBm output P1dB and low-current operation, it is well suited to demanding, high-order modulation schemes such as millimeter-wave 5G. The circuit draws 15 mA from a 3.3 V DC supply. The part is internally matched to 50 Ω with ESD protection. The part has internal bias regulation controlled by V_{BIAS}, or alternatively by a resistor between V_{DD} and V_{BIAS}.

The part is RoHS* compliant and built with the latest manufacturing techniques for reliability and quality control.

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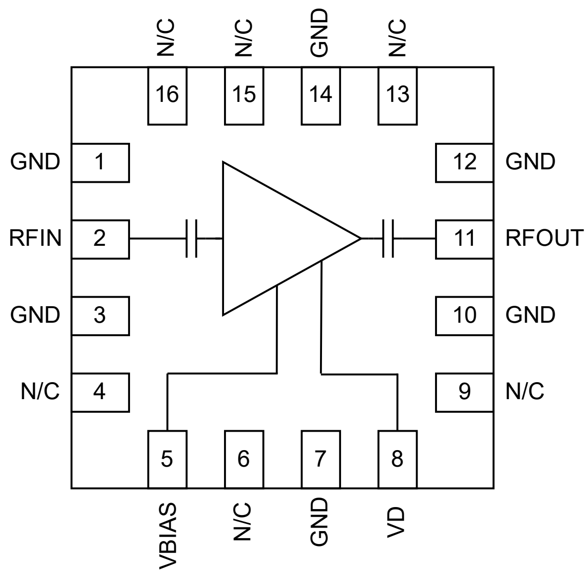
Functional Diagram



All not connected (N/C) pins should be connected to RF and thermal ground.

Pin	Pin Name	Description
2	RF_{IN}	RF Input
5	V_{BIAS}	Current Control & Power Down
8	V_{DD}	Power Supply
11	RF_{OUT}	RF Output
1, 3, 7, 10, 12, 14, Paddle	GND	Ground
4, 6, 9, 13, 15, 16	N/C	Unconnected Pins.

*RoHS compliant — European Union Directive 2011/65/EU

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Electrical Specifications[1,2]

Parameter	Test Conditions	Min	Typ	Max	Units
Frequency Range		22.0		31.5	GHz
Small-Signal Gain	24 GHz 26 GHz 28 GHz 31 GHz	20.0 19.5 18.0 17.0	22.0 21.5 20.0 18.5	24 23.5 22.0 20.5	dB
Gain Variation over Temperature			0.02		dB/°C
Noise Figure	24 GHz 26 GHz 28 GHz 31GHz		1.6 1.6 1.7 1.5		dB
Input Return Loss	24GHz 26 GHz 28 GHz 31 GHz		12 12 13 13		dB
Output Return Loss	24 GHz 26 GHz 28 GHz 31GHz		15 22 16 12		dB
Reverse Isolation	24 GHz 26 GHz 28 GHz 31GHz		46 40 40 37		dB
Output P1dB	24 GHz 26 GHz 28 GHz 31GHz		6 8 8 6		dBm
OIP3	24 GHz, P_{OUT}/tone = -5 dBm, ΔF = 10 MHz 26 GHz, P_{OUT}/tone = -5 dBm, ΔF = 10 MHz 28 GHz, P_{OUT}/tone = -5 dBm, ΔF = 10 MHz 31 GHz, P_{OUT}/tone = -5 dBm, ΔF = 10 MHz		15.0 17.0 19.5 17.0		dBm
V_{DD} Voltage	Safe Operating Range: 0 to 4.0 V	3.0	3.3	3.6	V
I_{DD} Current	V_{BIAS} = 2.5 V, V_{DD} = 3.3 V	12	15	17	mA
	V_{BIAS} = 4.0 V, V_{DD} = 4.0 V			35	mA
V_{BIAS} Voltage	Nominal Bias		2.5		V
	Operating Range	0		4.0	V
I_{BIAS} Current			0.9		mA

1. Parameters tested at 25°C in laboratory environment with standard 50 Ω matched equipment.
2. Nominal bias of V_{DD} = 3.3 V and V_{BIAS} = 2.5 V (I_{DD} ≈ 15 mA typical) .

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Absolute Maximum Ratings

Parameter	Conditions	Min	Max	Units
V_{DD} Voltage		0	4.4	V
I_{DD} Current		0	50	mA
V_{BIAS} Voltage		0	4.4	V
Total Dissipated Power			0.25	W
Maximum RF Input Power	Peak Power		+5	dBm
Channel Temperature			+175	°C
Operating Temperature Range		-40	+85	°C
Storage Temperature Range		-50	+125	°C
Moisture Sensitivity Level	IPC/JEDEC J-STD-020E	MSL1		
ESD Human Body Model (HBM)	JEDEC JS-001-2023	Class 1B		
ESD Charged Device Model (CDM)	JEDEC JS-002-2022	Class C3		

Stresses at or above those listed under Absolute Maximum Ratings may cause permanent damage to the product. This is a stress rating only; functional operation of the product at these or any other conditions above those indicated in the operational section of this specification is not implied. Operation beyond the maximum operating conditions for extended periods may affect product reliability.

ESD Sensitive Device

These devices are ESD sensitive. Proper handling for assembly and use must be maintained at all times. Please see JEDEC JESD625B for further information.

Thermal and Reliability Data

Parameter	Conditions[2,3]	Value	Units
Thermal Resistance (R_{TH})[4]	V_{DD} = 3.3 V, I_{DD} = 15 mA, Small Signal RF	204	°C/W
Channel Temperature (T_{CH})	V_{DD} = 3.3 V, I_{DD} = 15 mA, Small Signal RF	94	°C
Mean Time To Failure (MTTF)	V_{DD} = 3.3 V, I_{DD} = 15 mA, Small Signal RF	> 10^7	Hours

3. All thermal and reliability data is measured or simulated with 85°C at the package base, solder junction.
4. Thermal resistance is the difference between the package base (solder junction) temperature and the channel temperature, divided by the DC power consumption.

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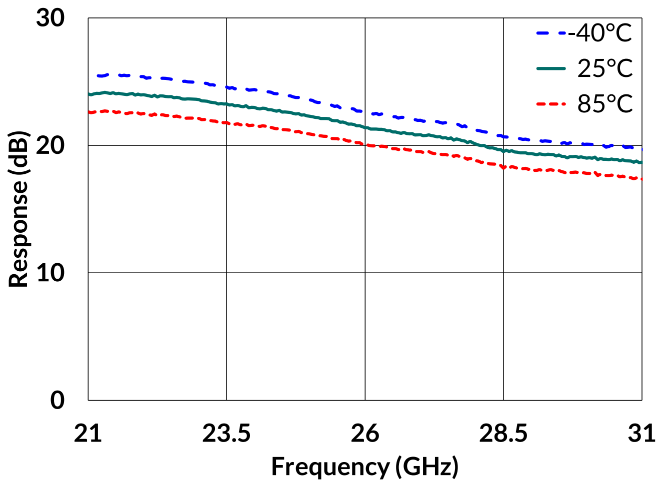
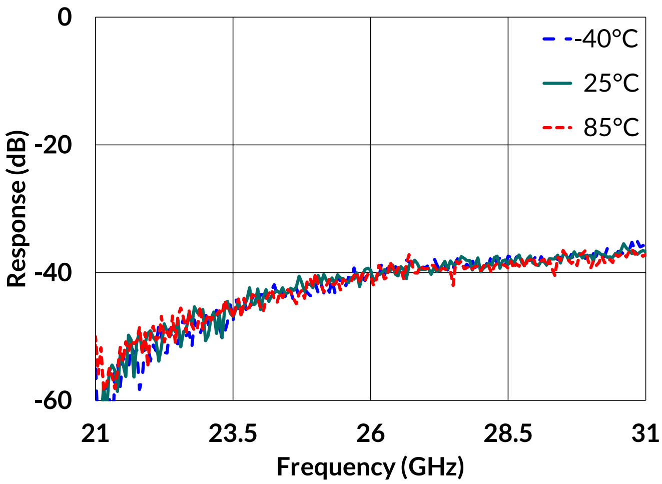
Measured Performance – Small Signal

Nominal Bias: V_{DD} = 3.3 V, V_{BIAS} = 2.5 V (I_{DD} ≈ 15 mA)

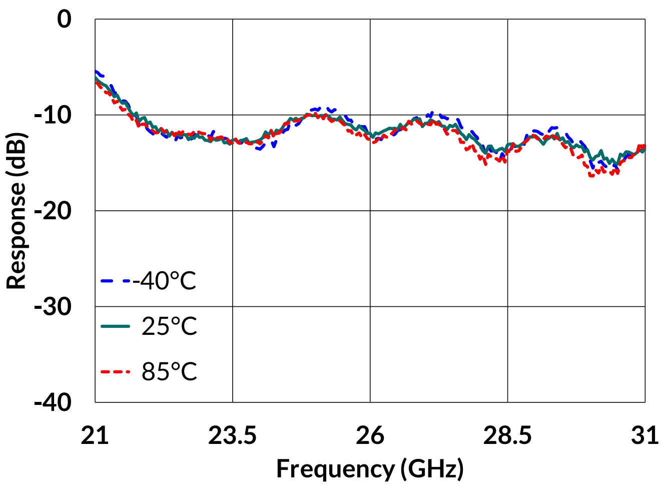
Gain



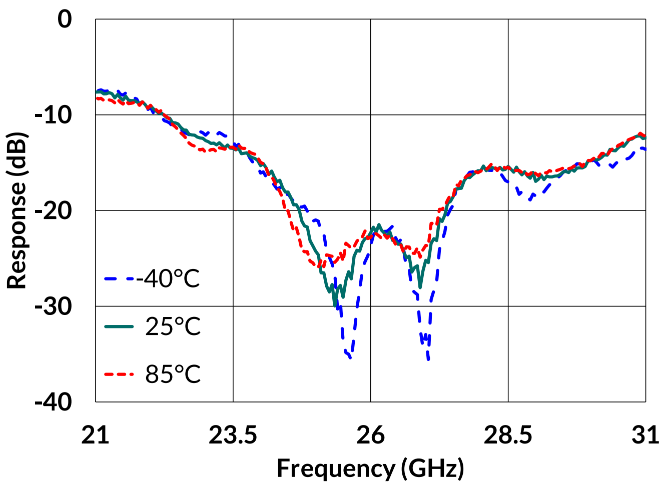
Reverse Isolation



Input Return Loss



Output Return Loss



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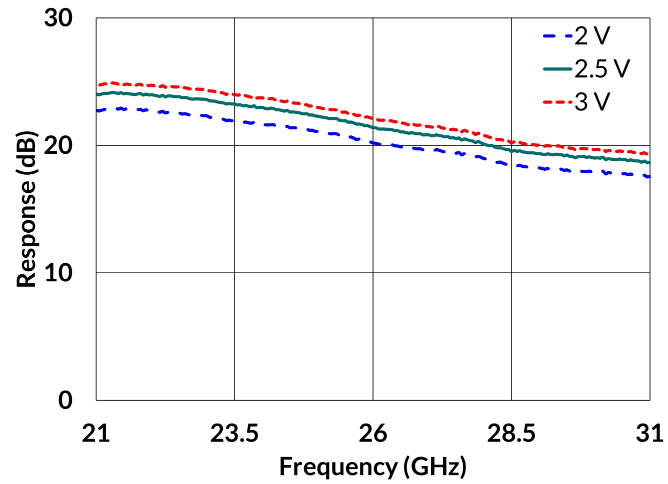
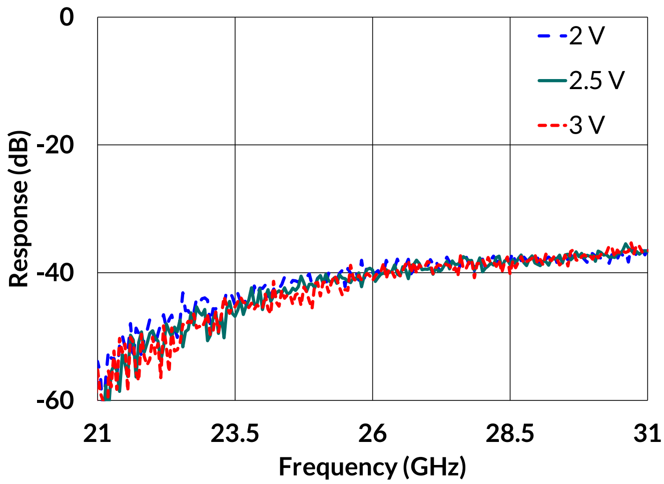
Measured Performance – Small Signal

Nominal Bias: V_{DD} = 3.3 V, V_{BIAS} = 2, 2.5 and 3 V (I_{DD} ≈ 10, 15 and 20 mA)

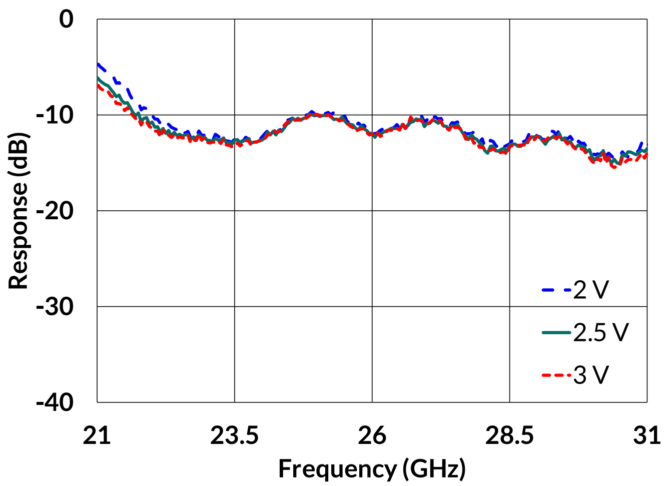
Gain



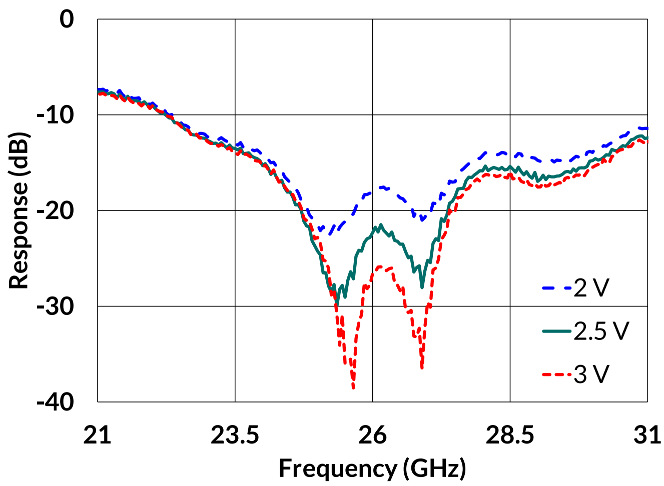
Reverse Isolation



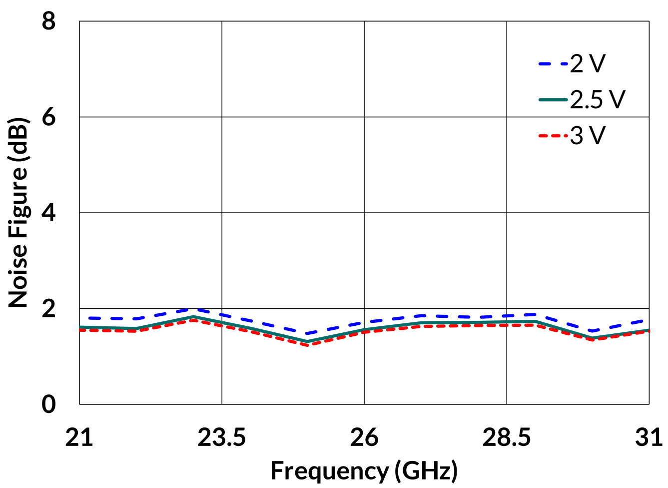
Input Return Loss



Output Return Loss



Noise Figure



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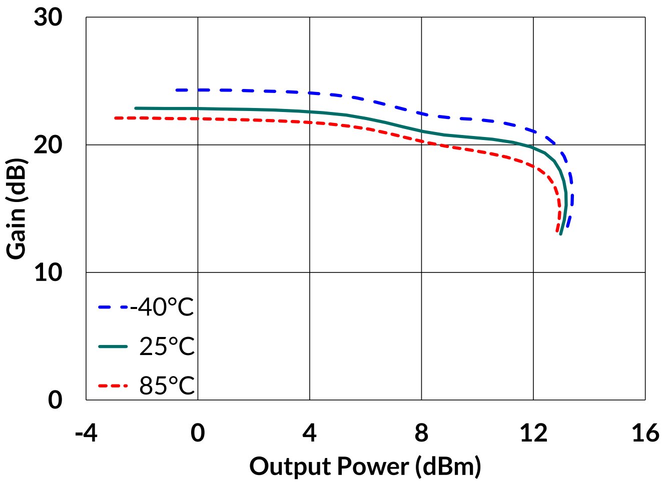
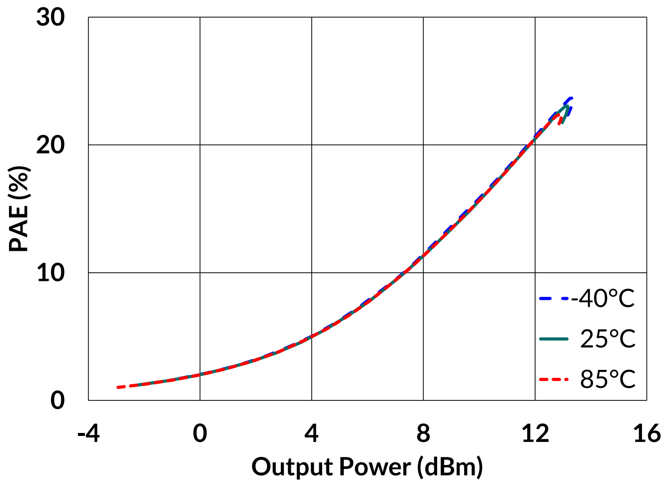
Measured Performance – Large Signal

Nominal Bias: V_{DD} = 3.3 V, V_{BIAS} = 2.5 V (I_{DD} ≈ 15 mA)

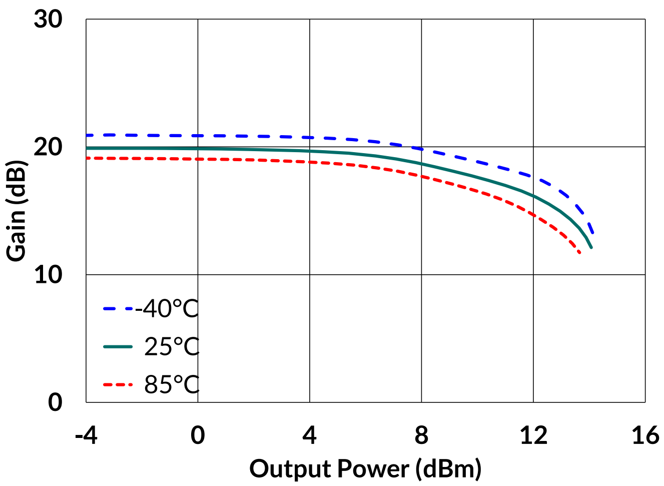
Gain vs Output Power at 24 GHz



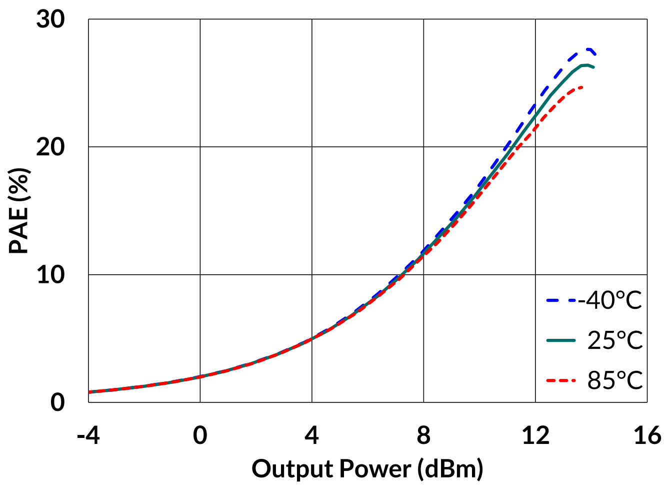
PAE vs Output Power at 24 GHz



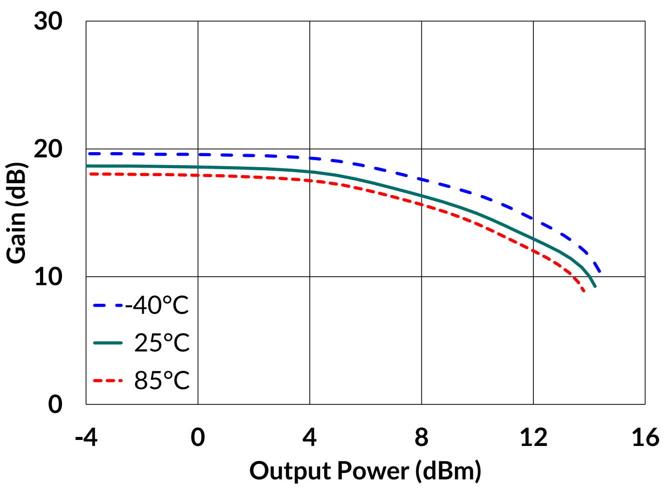
Gain vs Output Power at 28 GHz



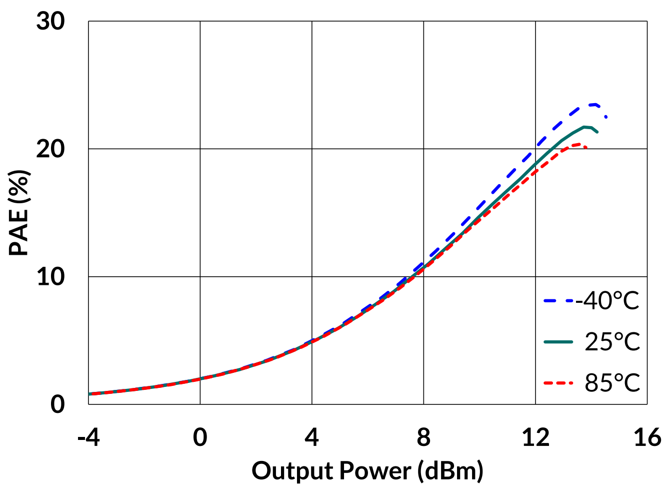
PAE vs Output Power at 28 GHz



Gain vs Output Power at 31 GHz



PAE vs Output Power at 31 GHz



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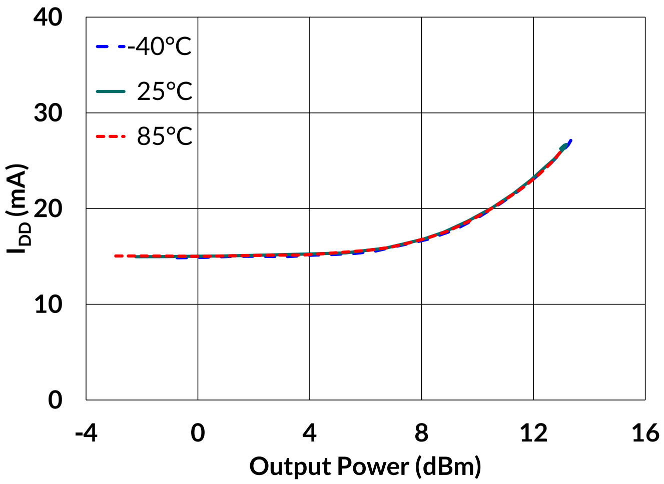
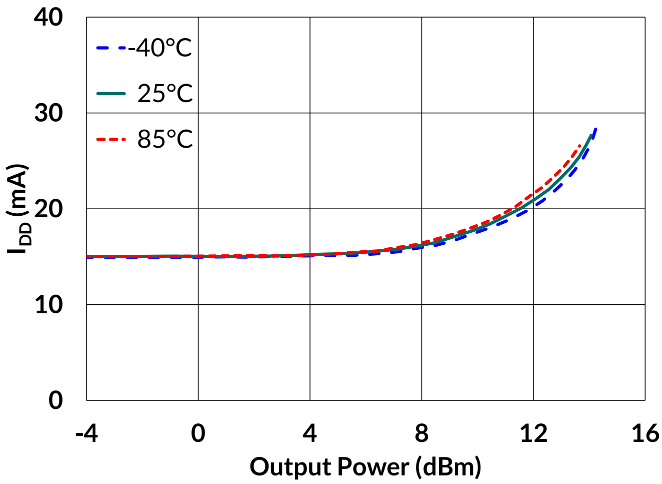
Measured Performance – Large Signal

Nominal Bias: V_{DD} = 3.3 V, V_{BIAS} = 2.5 V (I_{DD} ≈ 15 mA)

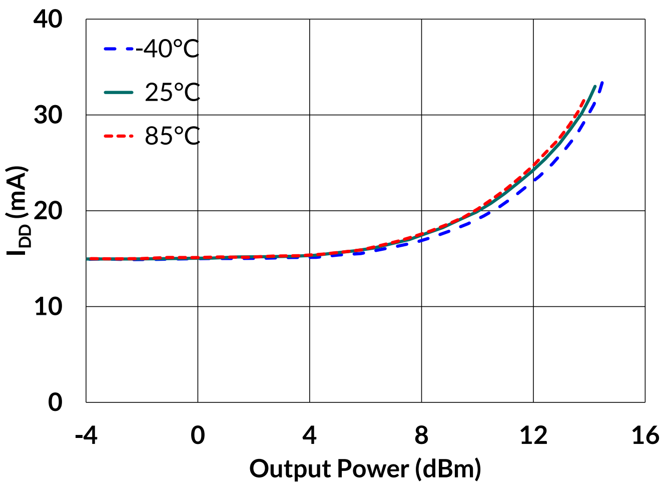
I_{DD} vs Output Power at 24 GHz



I_{DD} vs Output Power at 28 GHz



I_{DD} vs Output Power at 31 GHz



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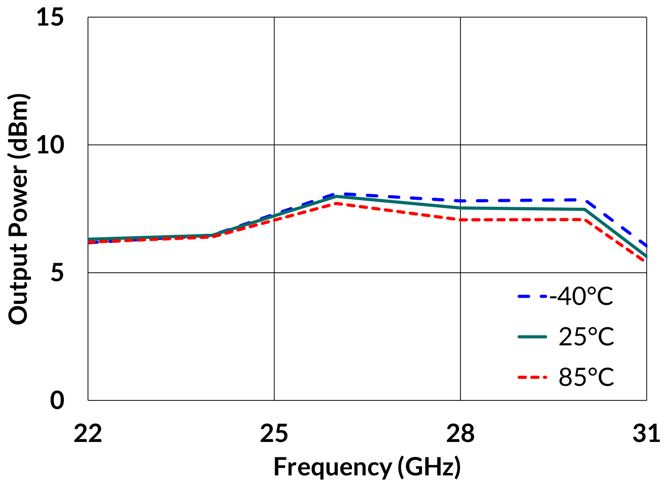
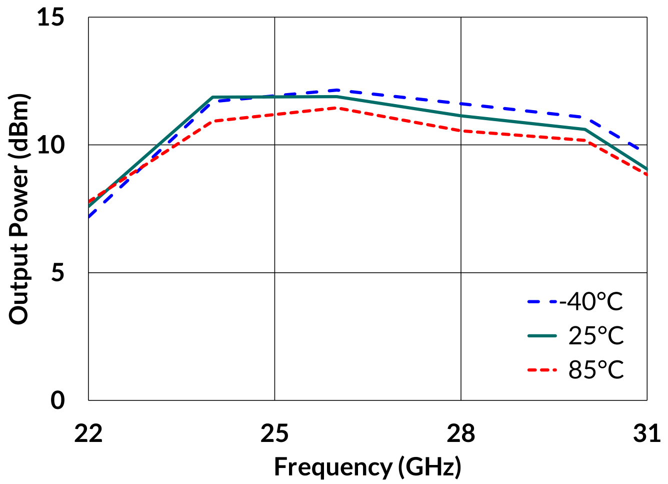
Measured Performance – Large Signal

Nominal Bias: V_{DD} = 3.3 V, V_{BIAS} = 2.5 V (I_{DD} ≈ 15 mA)

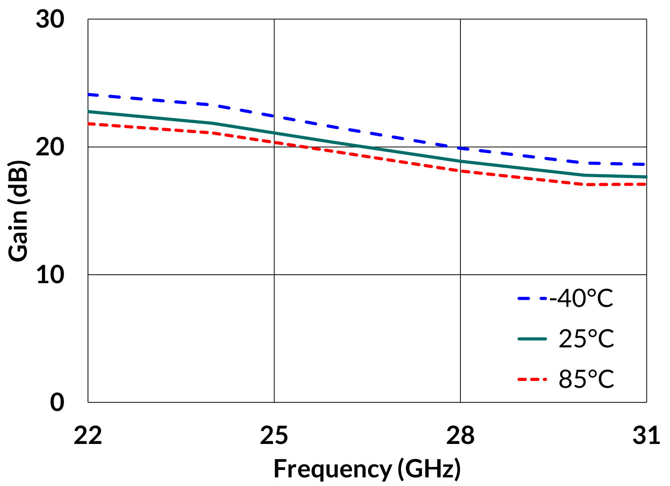
Output P1dB



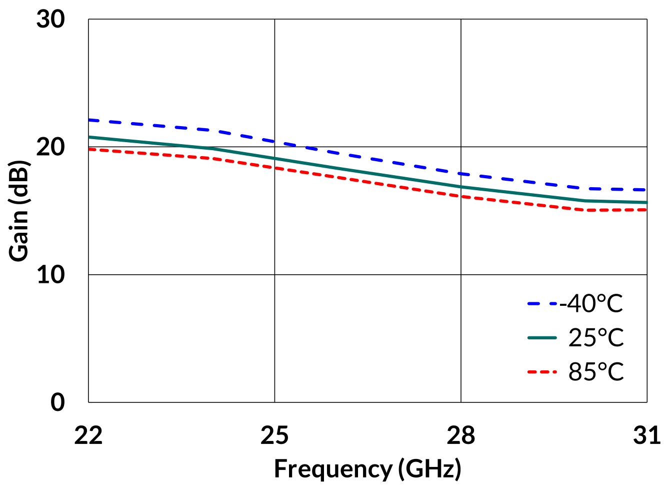
Output P3dB



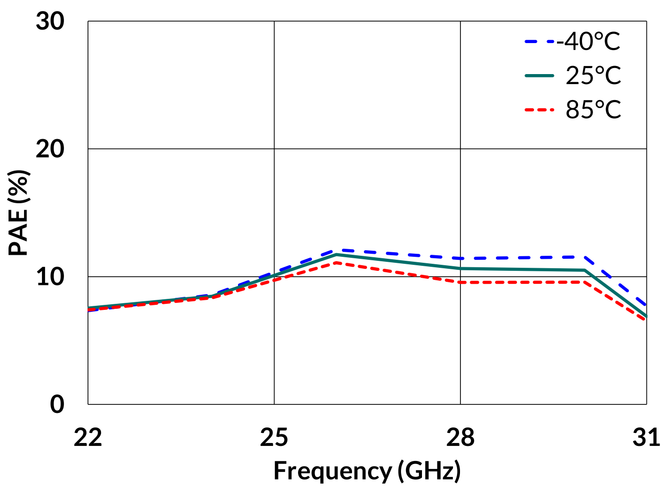
Gain at P1dB



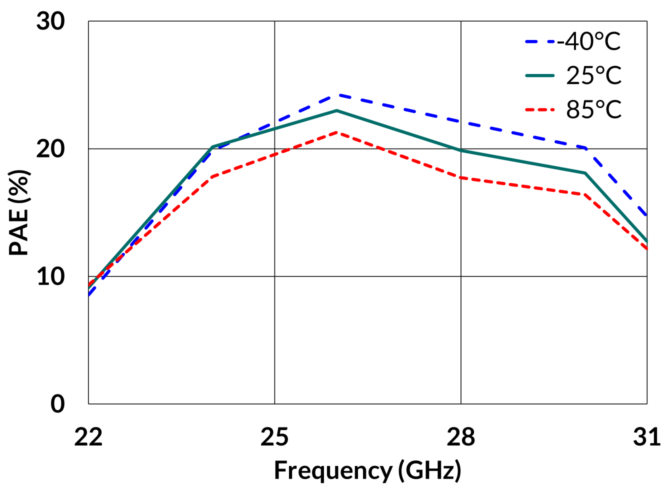
Gain at P3dB



PAE at P1dB



PAE at P3dB



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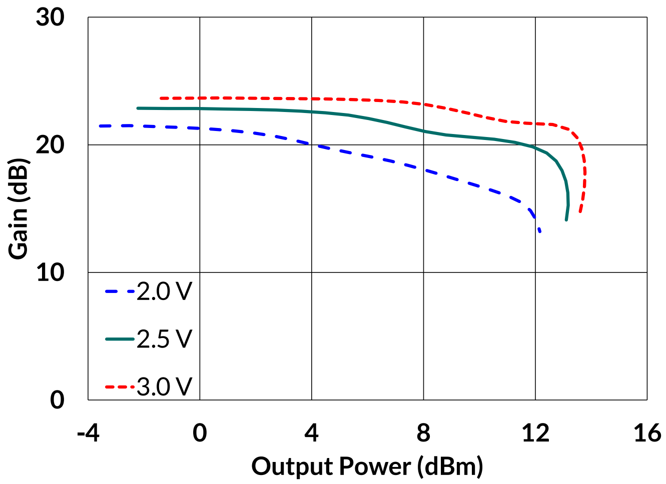
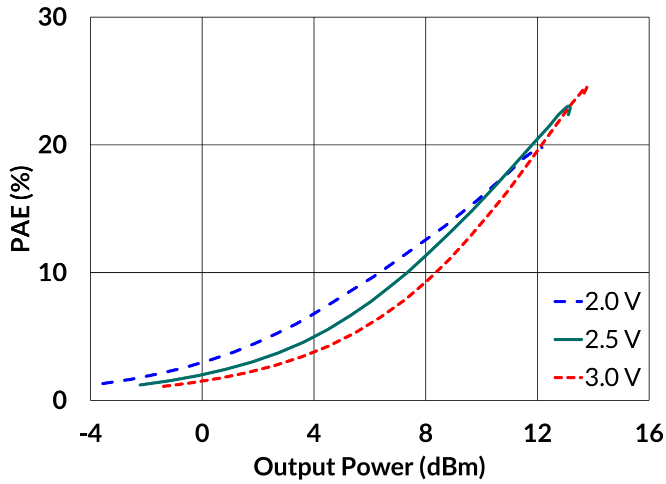
Measured Performance – Large Signal

Room Temperature : V_{DD} = 3.3 V, V_{BIAS} = 2.0, 2.5 and 3.0 V (I_{DD} ≈ 10, 15 and 20 mA)

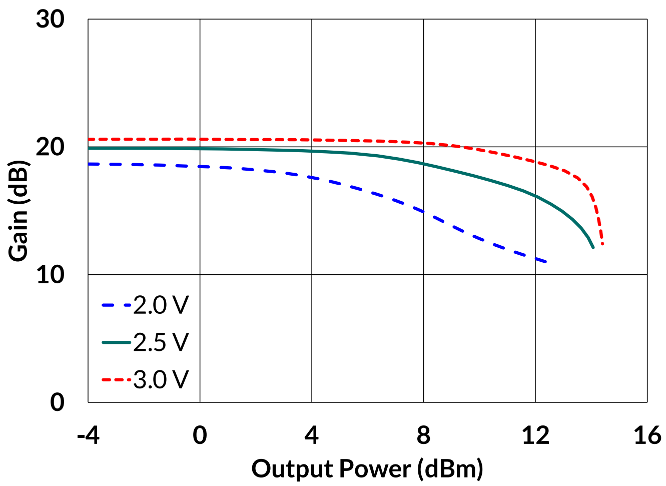
Gain vs Output Power at 24 GHz



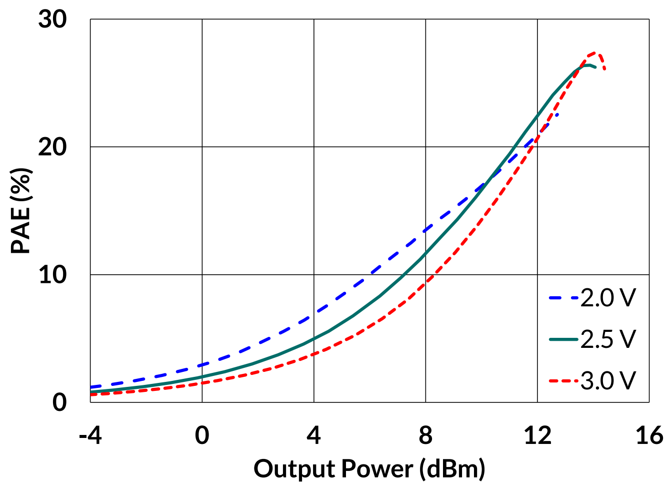
PAE vs Output Power at 24 GHz



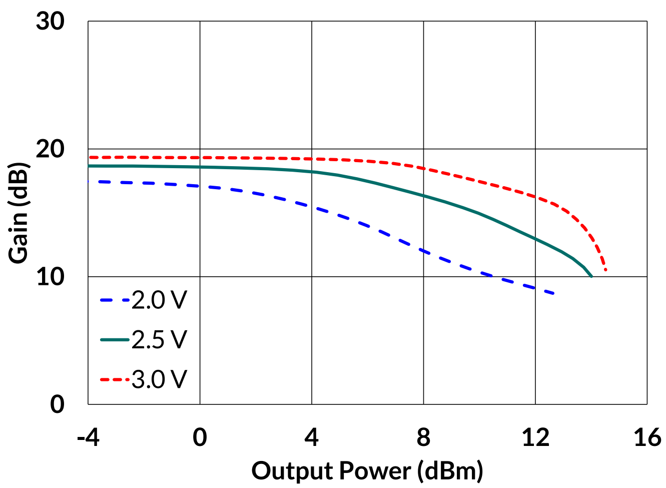
Gain vs Output Power at 28 GHz



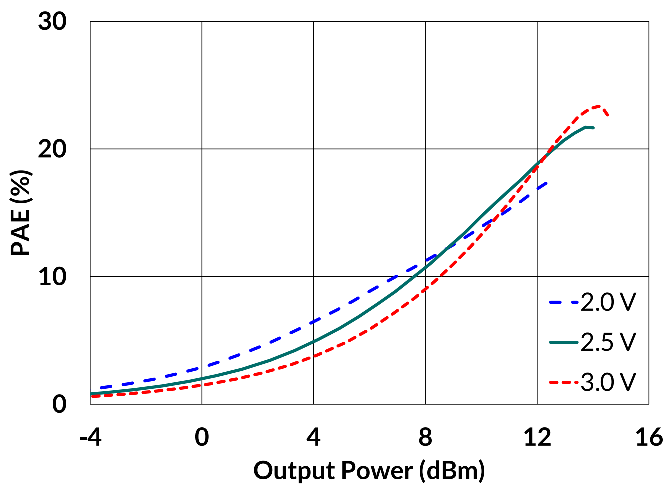
PAE vs Output Power at 28 GHz



Gain vs Output Power at 31 GHz



PAE vs Output Power at 31 GHz



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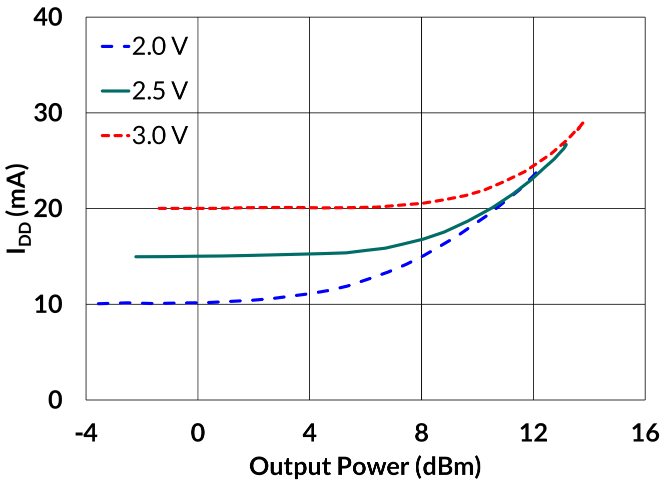
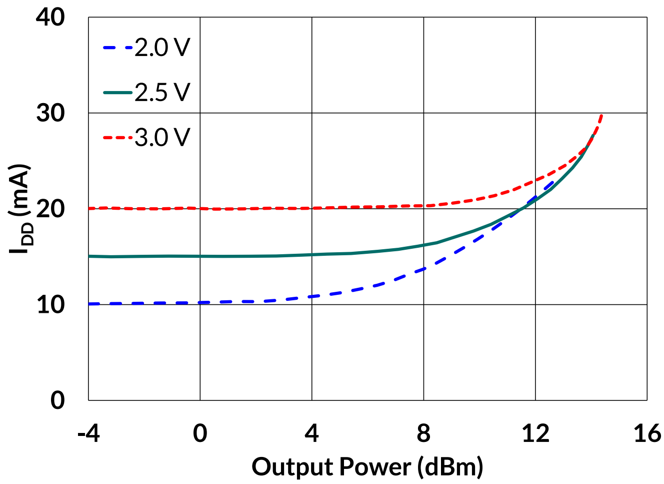
Measured Performance – Large Signal

Room Temperature: V_{DD} = 3.3 V, V_{BIAS} = 2.0, 2.5 and 3.0 V (I_{DD} ≈ 10, 15 and 20 mA)

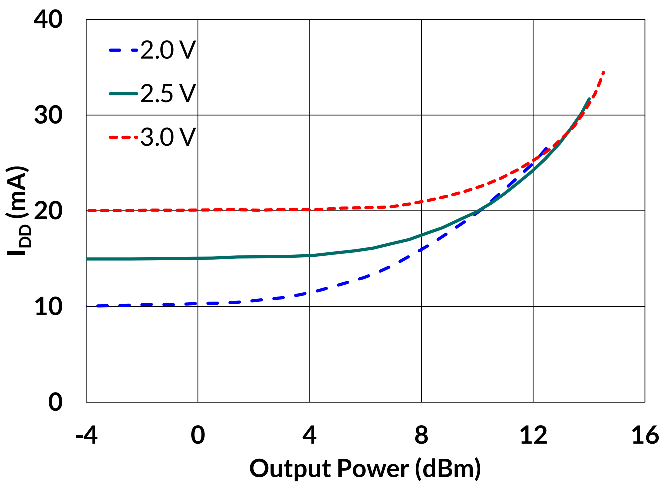
I_{DD} vs Output Power at 24 GHz



I_{DD} vs Output Power at 28 GHz



I_{DD} vs Output Power at 31 GHz



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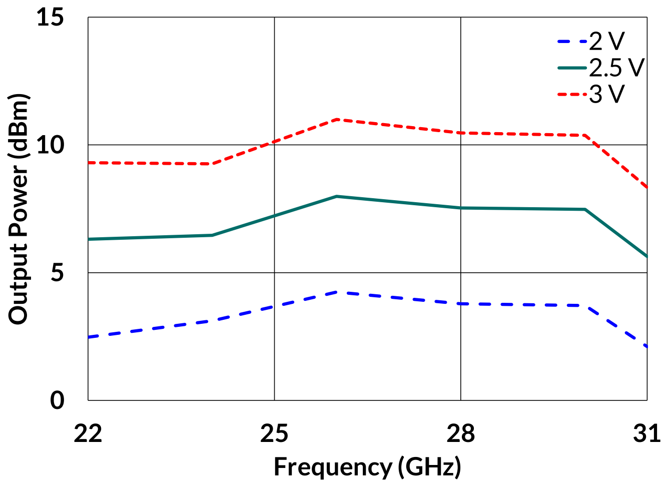
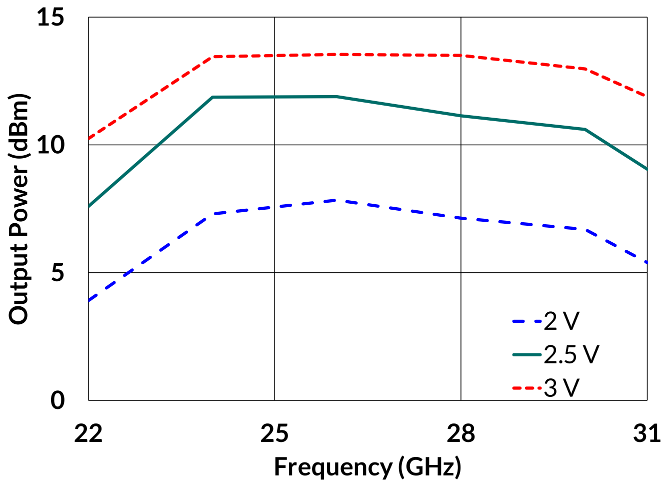
Measured Performance – Large Signal

Room Temperature: V_{DD} = 3.3 V, V_{BIAS} = 2.0, 2.5 and 3.0 V (I_{DD} ≈ 10, 15 and 20 mA)

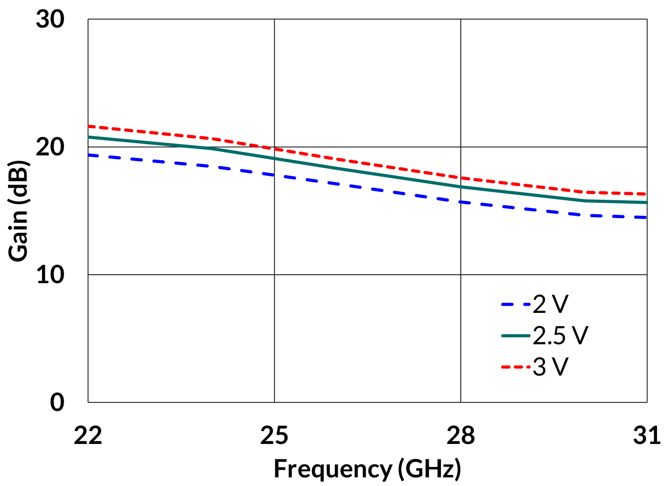
Output P1dB



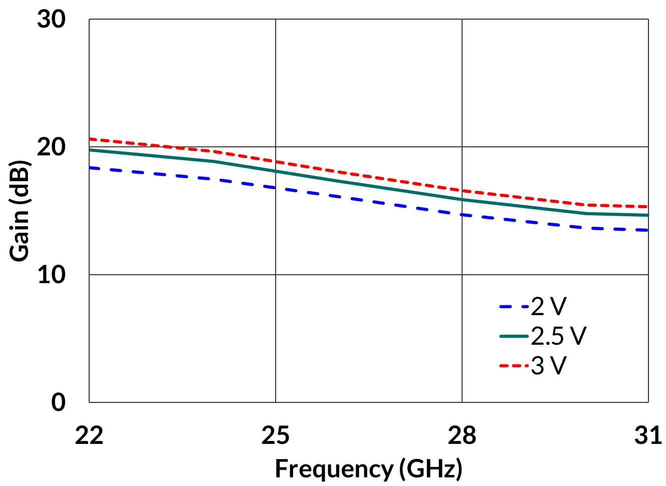
Output P3dB



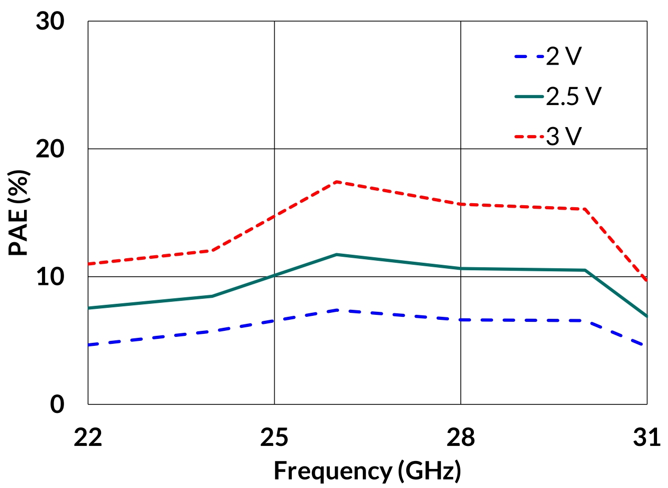
Gain at P1dB



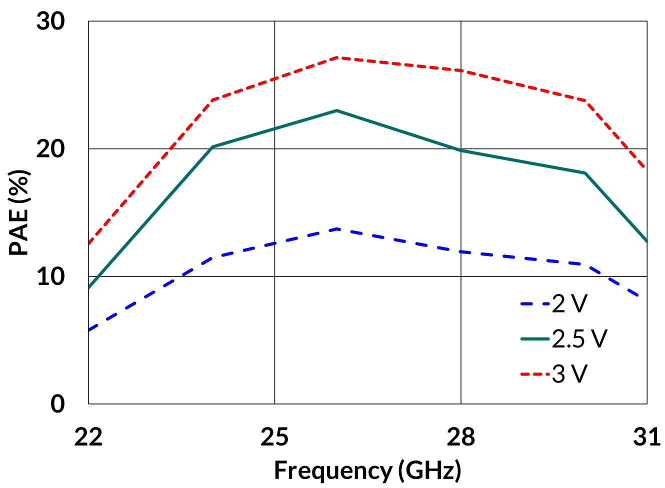
Gain at P3dB



PAE at P1dB



PAE at P3dB



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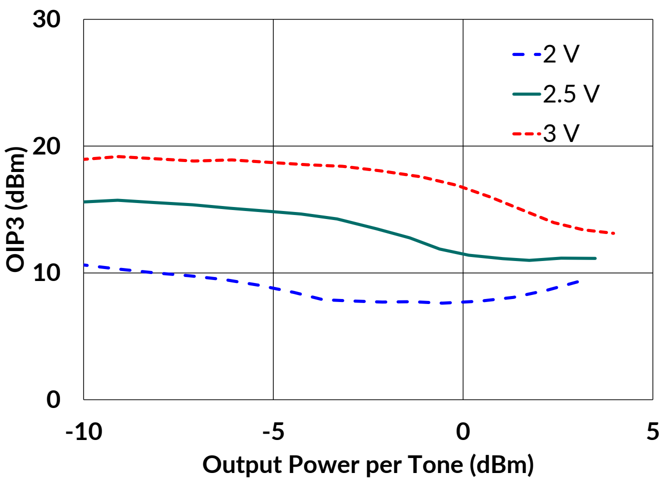
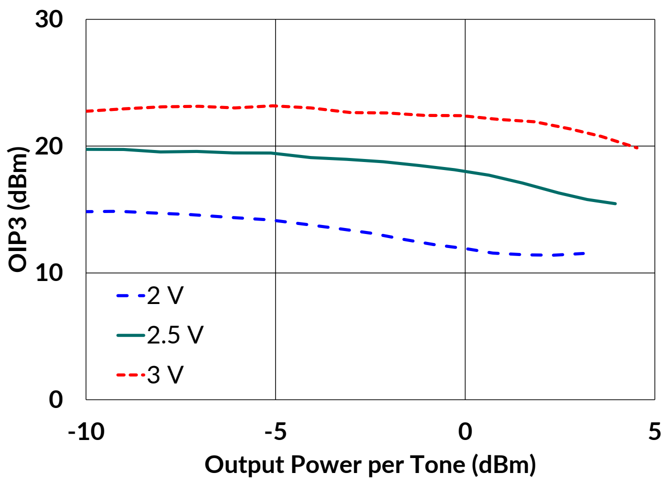
Measured Performance – Linearity

Room Temperature: V_{DD} = 3.3 V, V_{BIAS} = 2.0, 2.5 and 3.0 V (I_{DD} ≈ 10, 15 and 20 mA), ΔF = 10 MHz

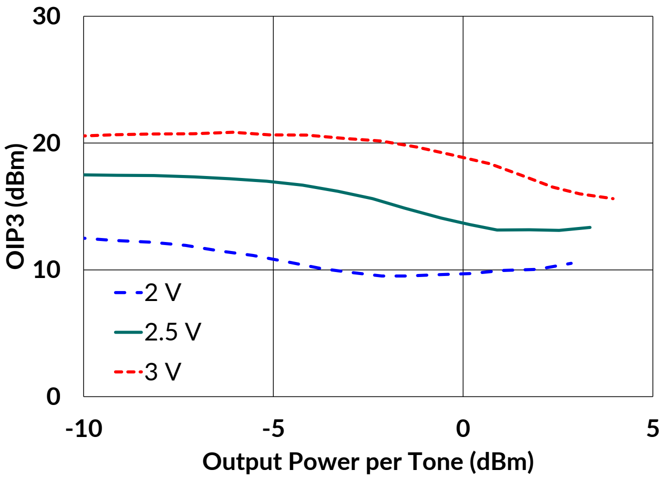
OIP3 versus P_{OUT}/tone at 24 GHz



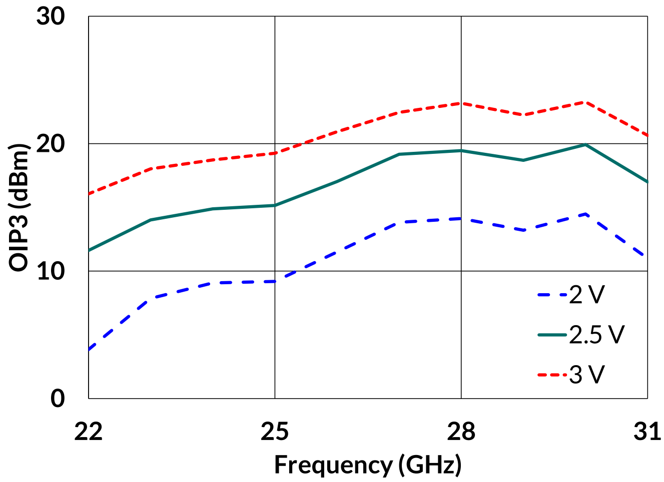
OIP3 versus P_{OUT}/tone at 28 GHz



OIP3 versus P_{OUT}/tone at 31 GHz



OIP3 at P_{OUT}/tone = -5 dBm



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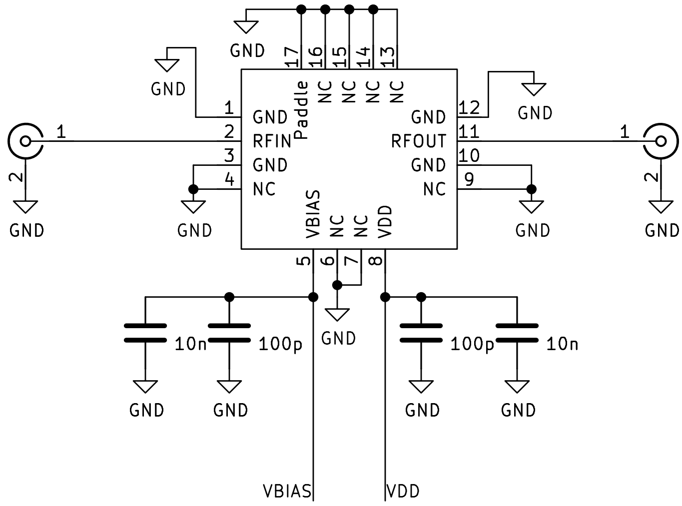
Application Schematic

Biasing

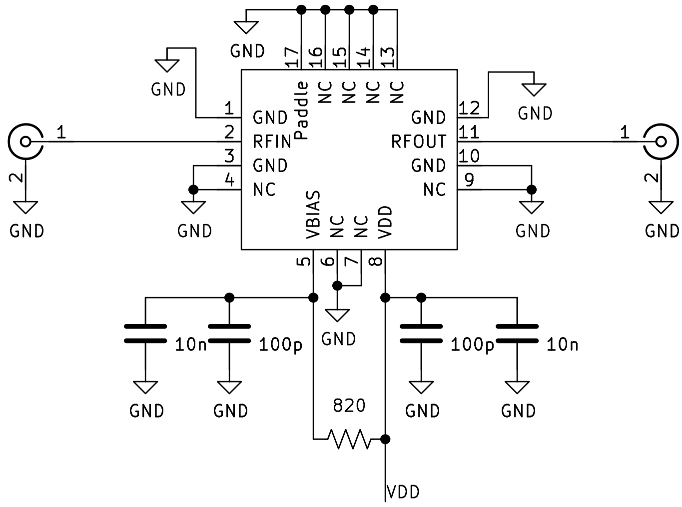
ARF1200Q2 has two biasing methods. The first is V_{DD} and V_{BIAS} which can be biased with separate power supplies. By altering V_{BIAS} the current of V_{DD} will change the performance. The second method ties V_{BIAS} to V_{DD} via a resistor. The value of the resistor determines the current of the device and some resistor and current values are provided in the evaluation board section. This method enables the ARF1200Q2 to be biased by a single supply.

Additionally, while the exact bypass network will be customer specific, we recommend as a minimum to have a 100 pF capacitor and 10 nF capacitor on both the V_{DD} and V_{BIAS} lines.

The Altum RF evaluation board ships with pads for biasing via a resistor but typically this isn't populated.



Individual Biasing of V_{DD} and V_{BIAS}



Biasing through resistor

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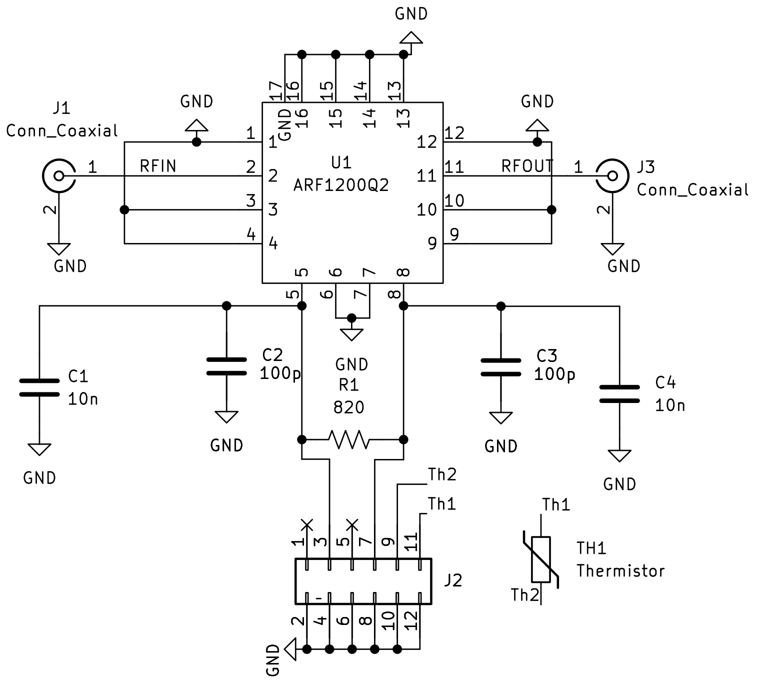
Evaluation Board Schematic



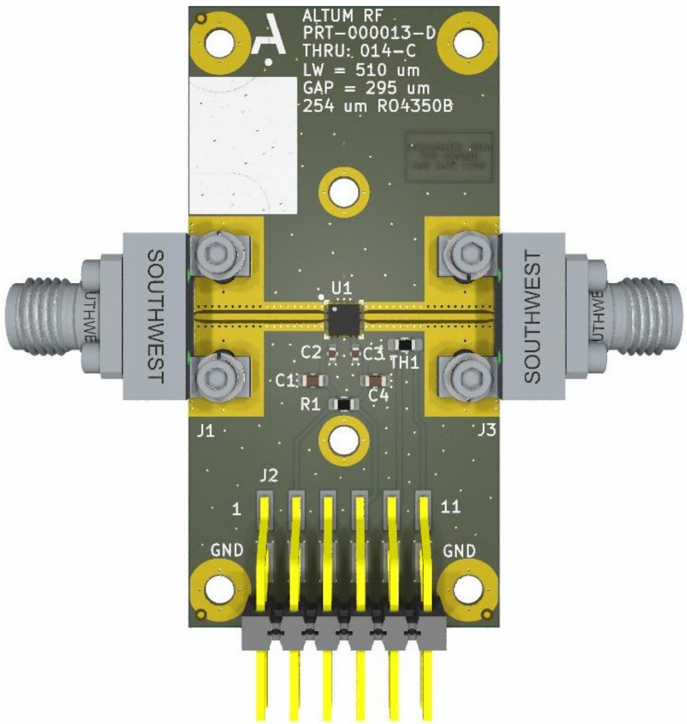
J2 Pin	Description
3	V_{BIAS}
7	V_{DD}
1,5	Unconnected
9,11	Thermistor (optional)
2,4,6,8,10,12	Ground

Bias Control[5]			
V_{DD} (V)	I_{DD} (mA)	V_{BIAS} (V)	R1 (Ω)
3.3	23	3.3	0
3.3	20	3.0	270
3.3	15	2.5	820
3.3	10	2.0	1.8k
4.0	32	4.0	0
4.0	15	3.3	1.8k

Bill of Materials

Description	Reference	Quantity
ARF1200Q2	U1	1
10 nF 0603 Capacitor	C1,C4	2
100 pF 0402 Capacitor	C2,C3	2
820 Ω 0603 Resistor (optional)	R1	1
12 pin Samtec TSM-106-01-F-DH	J2	1
Southwest Microwave 2.92mm 1092-01A-6 or equivalent	J1,J3	2

Evaluation Board Layout



Recommended land-pattern and sample board layout for 254 μm thick RO4350B are available on request.

Contact Altum RF Application Support for further information.

5. V_{BIAS} can be supplied externally, or can be generated using the resistor R1 between the V_{DD} rail and the V_{BIAS} pin.

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Application Notes

1. Bias Turn-on Sequence

V_{DD} and V_{BIAS} can be safely applied in any order, or simultaneously.

The part has internal bias regulation. V_{BIAS} can be supplied externally or can be generated using the resistor R1. Refer to Bias Control table for suggested operating bias condition.

The part can be turned off by applying 0 V to V_{BIAS} or to V_{DD}.

2. Reflow Information

MSL level 1 as per IPC/JEDEC J-STD-020E.

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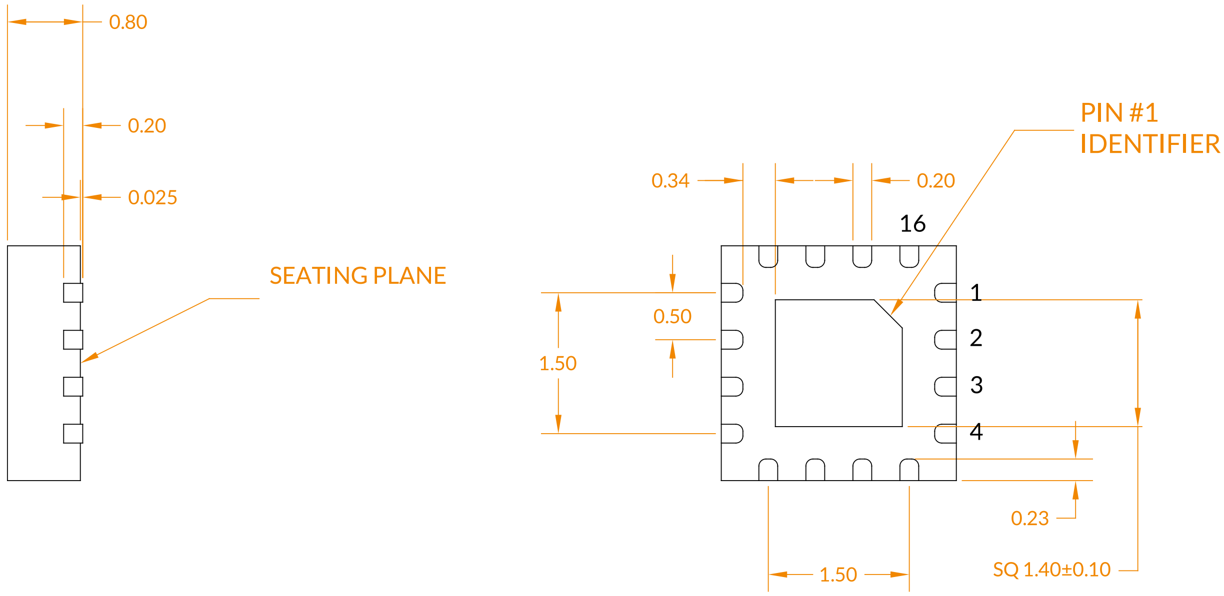
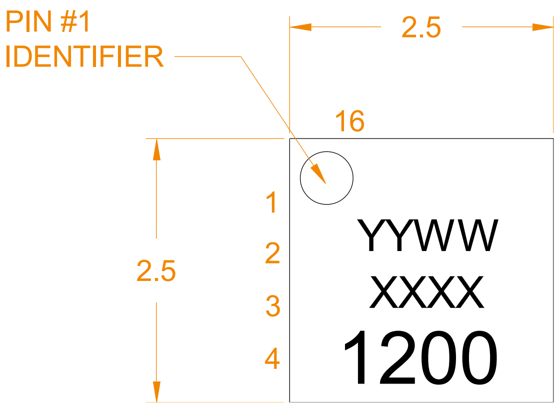
Package Information

Outline Drawing





YYWW is the date code

XXXX is the lot code

1200 is the part number

All dimensions are in millimeters.
Package leads and exposed pad are plated with NiPdAu.

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Ordering Information

Part Number	Delivery Format	Quantity
ARF1200Q2-TR500	Tape and Reel	500 pcs
ARF1200Q2-TR2500	Tape and Reel	2500 pcs

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Advance: Expected performance based on feasibility analysis, simulations or measured data. All content is subject to change.
Preliminary: Measured performance based on prototype parts. Specifications including maximum and minimum values are subject to change.
Final: Guaranteed performance of qualified and production released part.

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