ALTUM RF

ARF1218Q2

Features

- 23—26 GHz Low-Noise Amplifier
- 27 dB Small Signal Gain
- 2.6 dB Typical Noise Figure
- 9 dBm Typical Output P1dB
- > 9 dB Input and Output Return Loss
- 3.3 V, 6 mA Nominal Bias
- 16 Lead QFN, 2.5 mm × 2.5 mm

Applications

- ISM
- Telecommunications

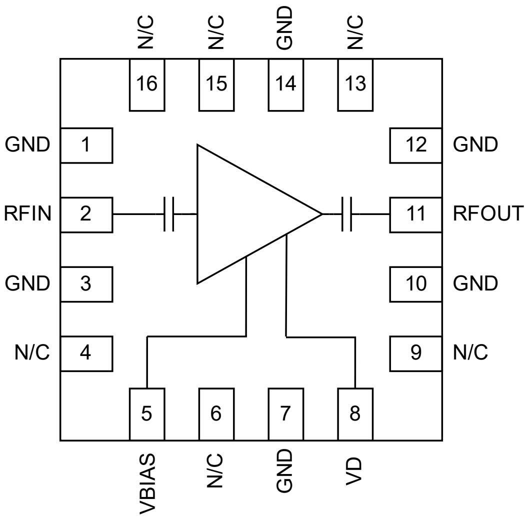
Description

ARF1218Q2 is an ultra-low power low-noise amplifier for applications using the 24 GHz ISM band, and adjacent telecommunications bands. With 27 dB of linear gain and an output P1dB of +9 dBm it is suitable for a wide variety of applications. 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 to optimize for reliability and quality control.

Export from The Netherlands/EU, no licence.

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}	Bias Control Voltage
8	V_{DD}	Supply Voltage
11	RF_{OUT}	RF Output
1,3,7,10,12,14	GND	Ground Connected Pins
4,6,9,13,15,16	N/C	Unconnected Pins
Paddle	GND	Ground

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

Electrical Specifications[1,2]

Parameter	Test Conditions	Min	Typ	Max	Units
Frequency Range		23		26	GHz
Small Signal Gain	23 GHz 24 GHz 25 GHz	25 25 24	28.5 27.0 26.0	29	dB
Gain Variation over Temperature				0.03	dB/°C
Noise Figure	23 GHz 24 GHz 25 GHz		3.4 2.6 2.1		dB
Input Return Loss	23 GHz 24 GHz 25 GHz		13 28 14		dB
Output Return Loss	23 GHz 24 GHz 25 GHz		15.0 9.0 8.5		dB
Reverse Isolation	23 GHz 24 GHz 25 GHz		46 46 44		dB
Output P1dB	23 GHz 24 GHz 25 GHz		4.0 9.0 4.5		dBm
Saturated Output Power	P3dB, 23 GHz P3dB, 24 GHz P3dB, 25 GHz		6.5 9.0 8.5		dBm
OIP3	23 GHz, P_{OUT}/tone = -10 dBm, ΔF = 10 MHz 24 GHz, P_{OUT}/tone = -10 dBm, ΔF = 10 MHz 25 GHz, P_{OUT}/tone = -10 dBm, ΔF = 10 MHz		11.0 12.5 12.5		dBm
V_{DD} Voltage	Safe Operating Range: 0 to 4.0 V	3.0	3.3	4.0	V
I_{DD} Current	V_{BIAS} = 3.0 V, V_{DD} = 3.3 V	4	6	8	mA
	V_{BIAS} = 4.0 V, V_{DD} = 4.0 V		11		mA
V_{BIAS} Voltage	Nominal Bias		3		V
	Operating Range	0		4.0	V
I_{BIAS} Current	V_{BIAS} = 3.0 V, V_{DD} = 3.3 V		0.5		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} = 3 V (I_{DD} ≈ 6 mA typical).

Absolute Maximum Ratings

Parameter	Conditions	Min	Max	Units
V_{DD} Voltage		0	4.4	V
V_{DD} Current		0	25	mA
V_{BIAS} Voltage		0	4.4	V
Total Dissipated Power			0.11	W
Maximum RF Input Power	Peak power		+4	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

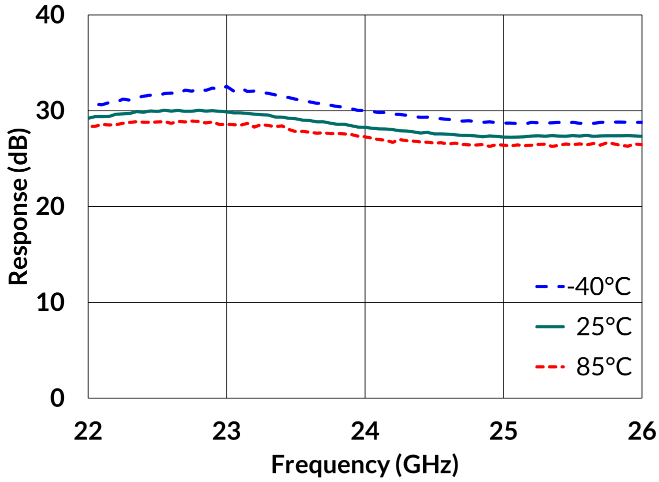
Parameter	Conditions[2,3]	Value	Units
Thermal Resistance (R_{TH})[4]	Quiescent Bias, No RF F_{IN} = 24 GHz, P_{IN} = -10 dBm, CW	412.5 531.1	°C/W
Channel Temperature (T_{CH})	Quiescent Bias, No RF F_{IN} = 24 GHz, P_{IN} = -10 dBm, CW	92.4 101.3	°C
Mean Time To Failure (MTTF)	Quiescent Bias, No RF F_{IN} = 24 GHz, P_{IN} = -10 dBm, CW	> 1×10^7 >1×10^7	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.

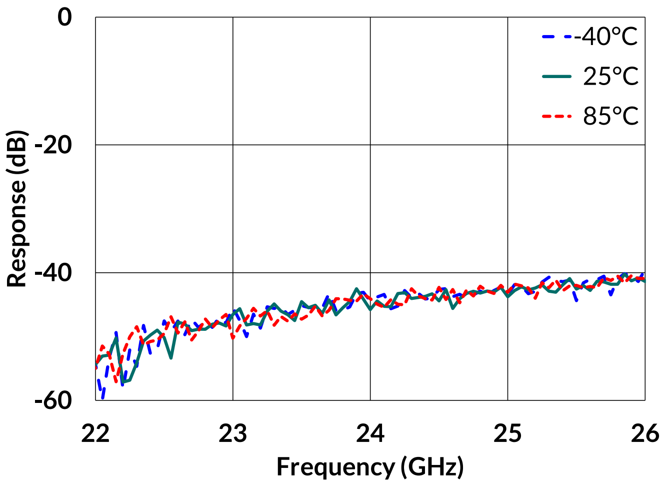
Measured Performance – Small Signal

Nominal Bias: V_{DD} = 3.3 V, V_{BIAS} = 3.0 V (I_{DD} ≈ 6 mA)

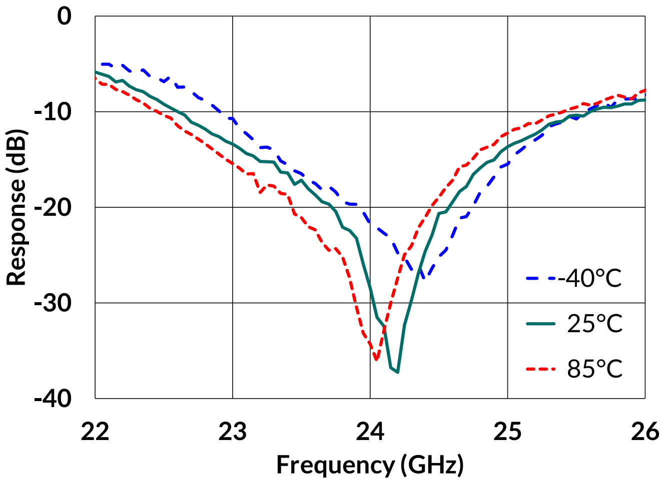
Gain



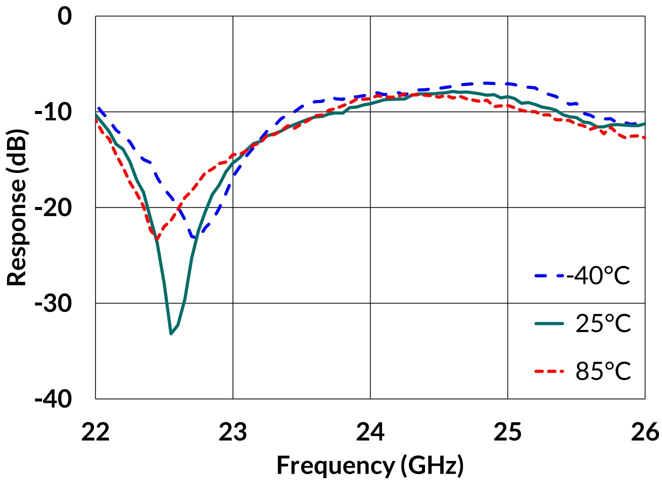
Reverse Isolation



Input Return Loss



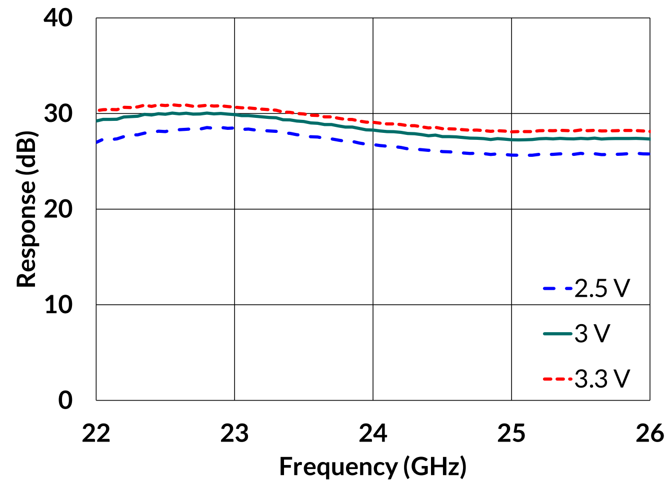
Output Return Loss



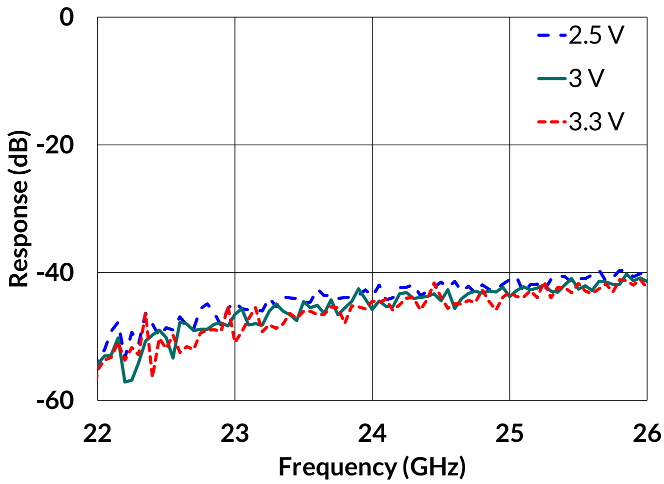
Measured Performance – Small Signal

Room temperature: V_{DD} = 3.3 V, V_{BIAS} = 2.5, 3.0 and 3.3 V (I_{DD} ≈ 4, 6 and 8 mA)

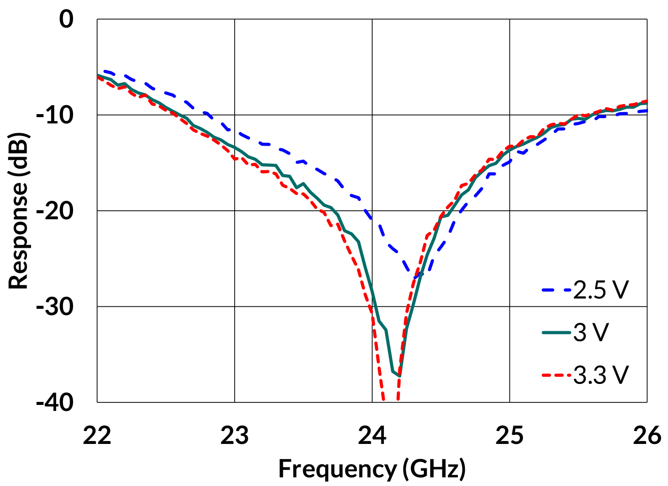
Gain



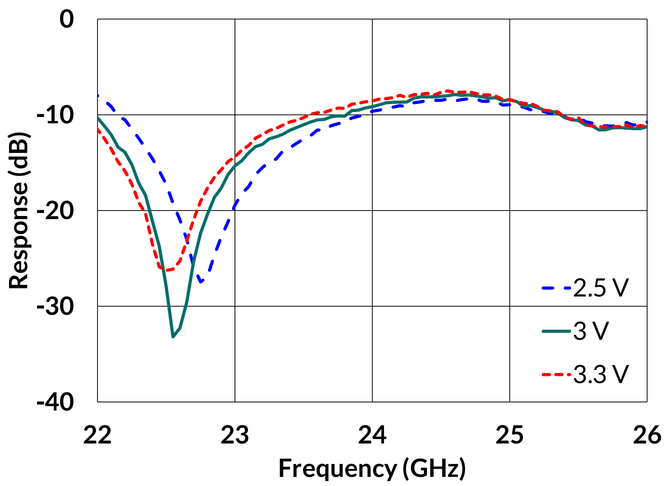
Reverse Isolation



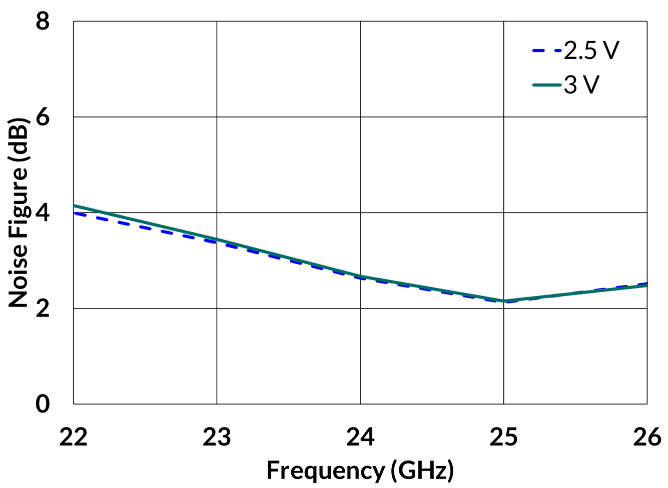
Input Return Loss



Output Return Loss



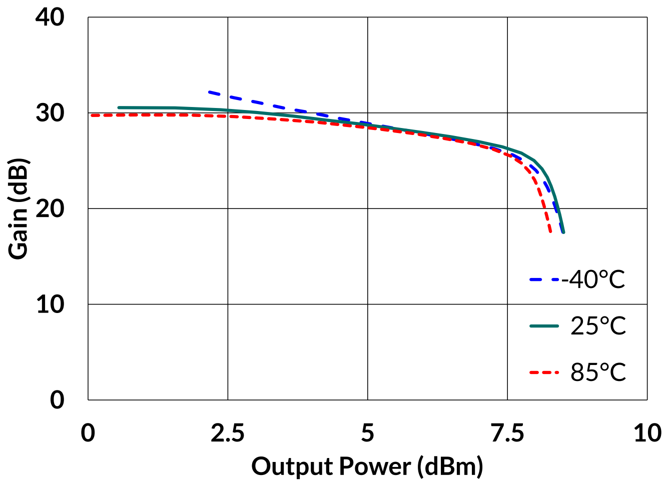
Noise Figure



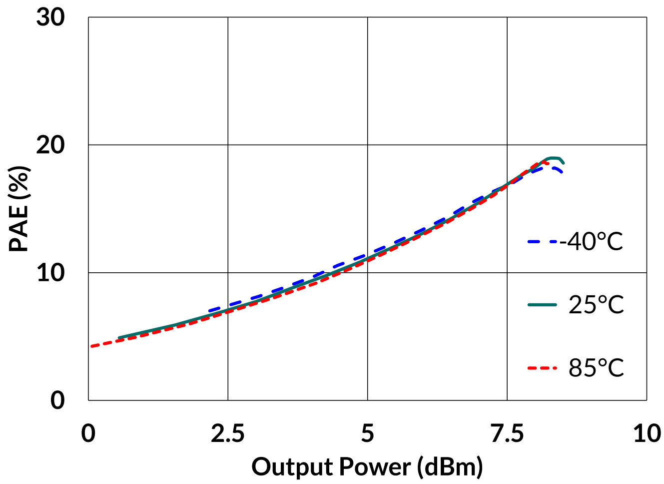
Measured Performance – Large Signal

Nominal Bias: V_{DD} = 3.3 V, V_{BIAS} = 3.0 V (I_{DDQ} ≈ 6 mA)

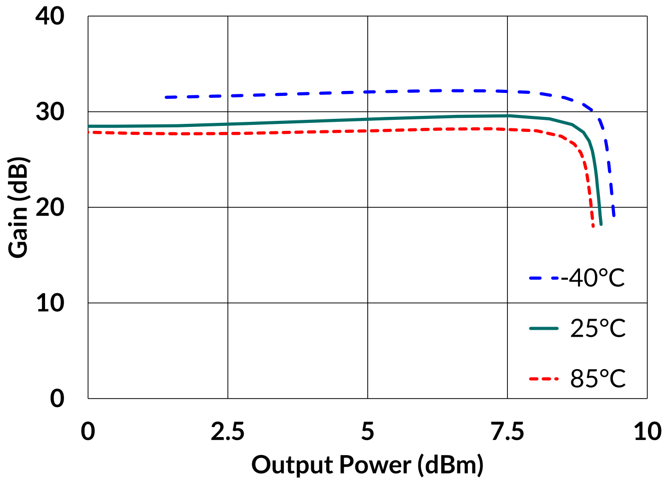
Gain vs Output Power at 23 GHz



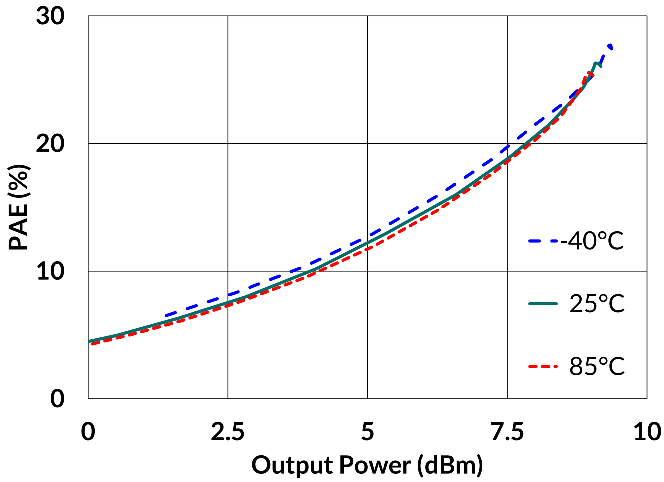
PAE vs Output Power at 23 GHz



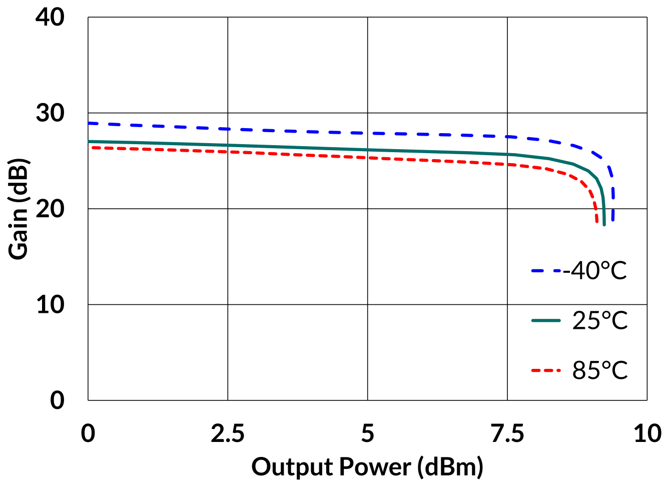
Gain vs Output Power at 24 GHz



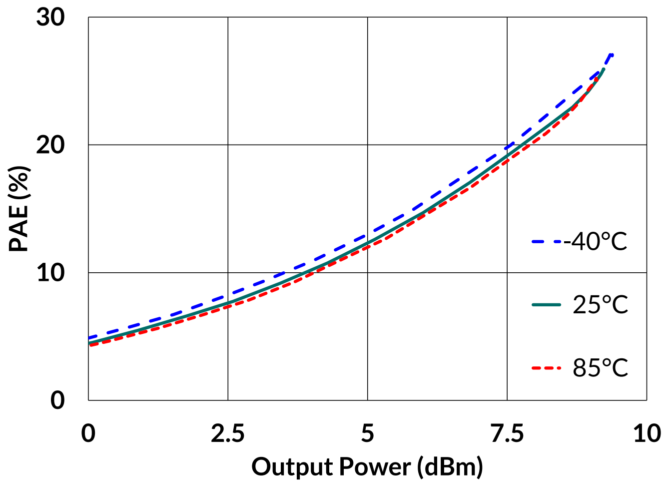
PAE vs Output Power at 24 GHz



Gain vs Output Power at 25 GHz



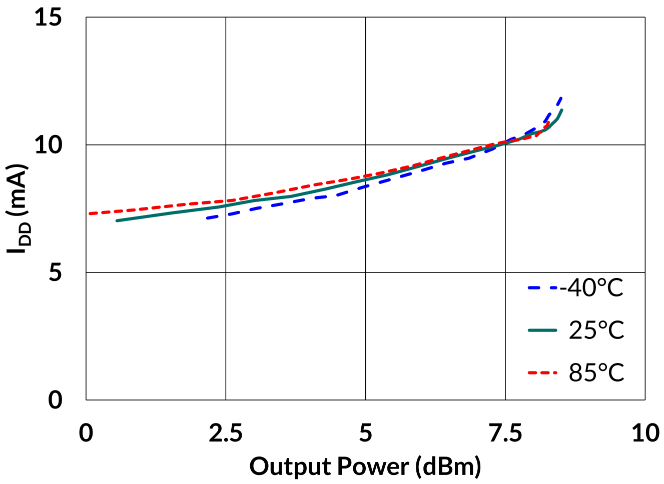
PAE vs Output Power at 25 GHz



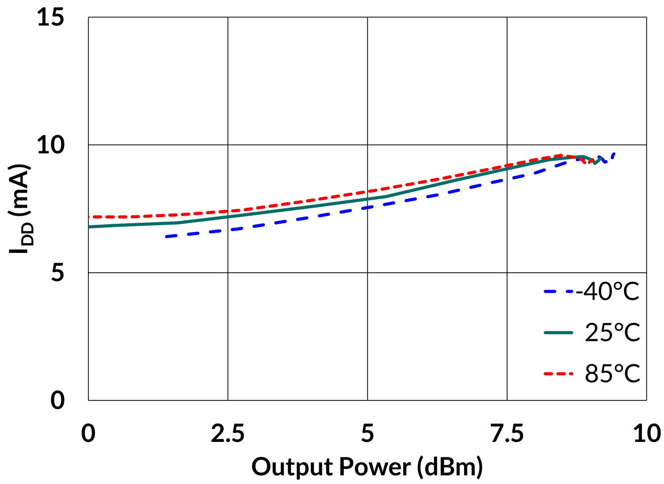
Measured Performance – Large Signal

Nominal Bias: V_{DD} = 3.3 V, V_{BIAS} = 3.0 V (I_{DDQ} ≈ 6 mA)

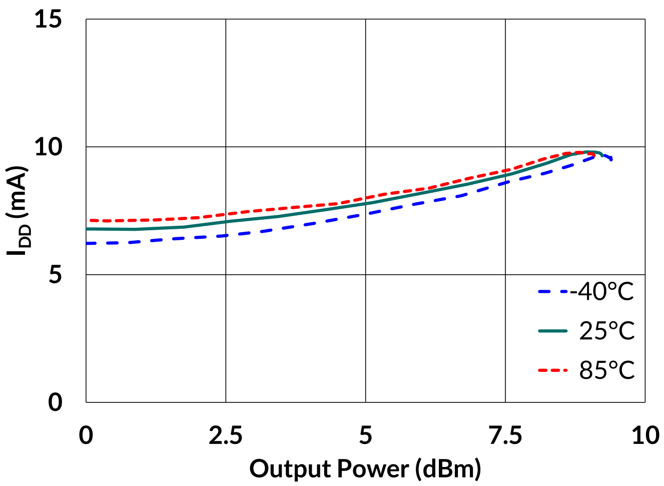
I_{DD} vs Output Power at 23 GHz



I_{DD} vs Output Power at 24 GHz



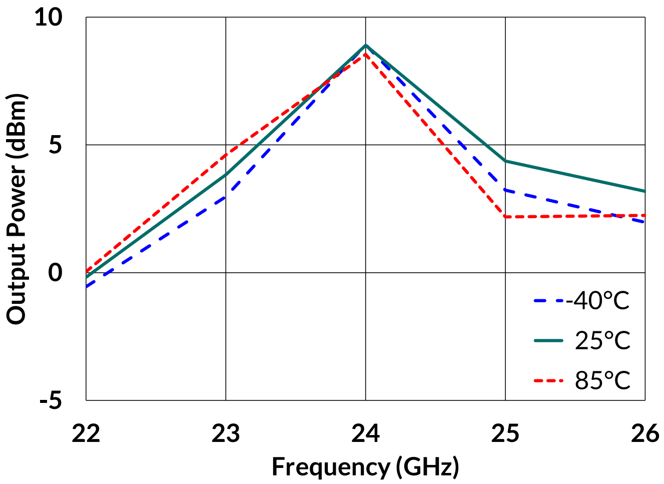
I_{DD} vs Output Power at 25 GHz



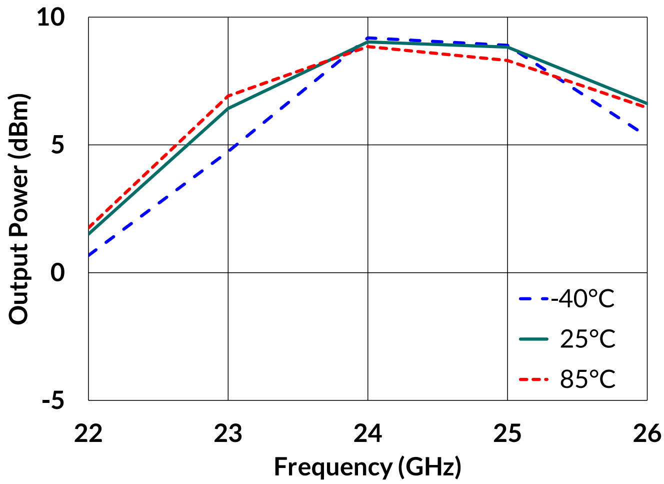
Measured Performance – Large Signal

Nominal Bias: V_{DD} = 3.3 V, V_{BIAS} = 3.0 V (I_{DDQ} ≈ 6 mA)

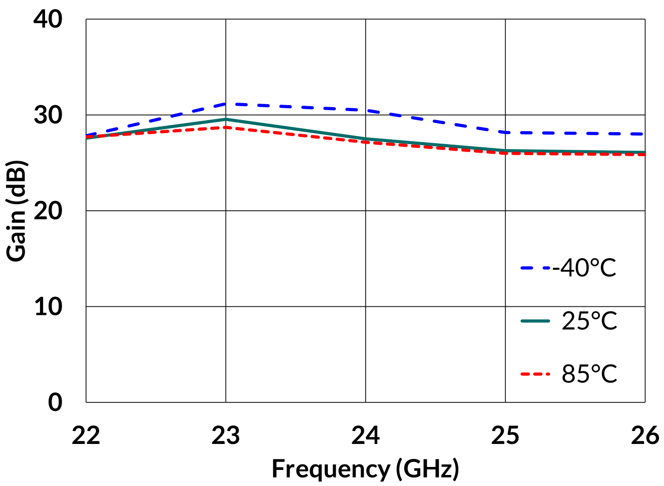
Output P1dB



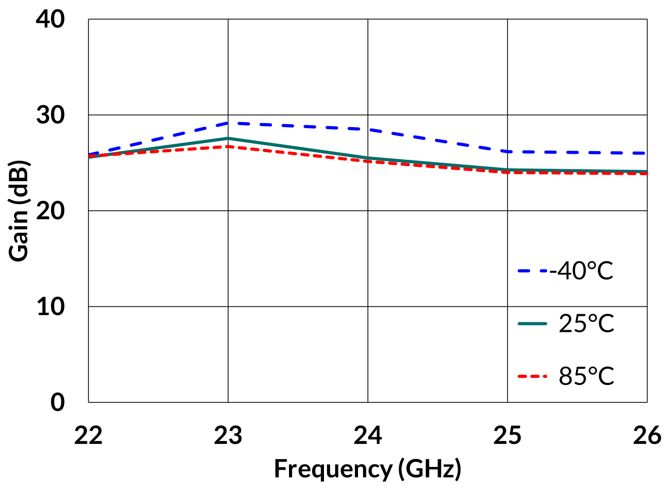
Output P3dB



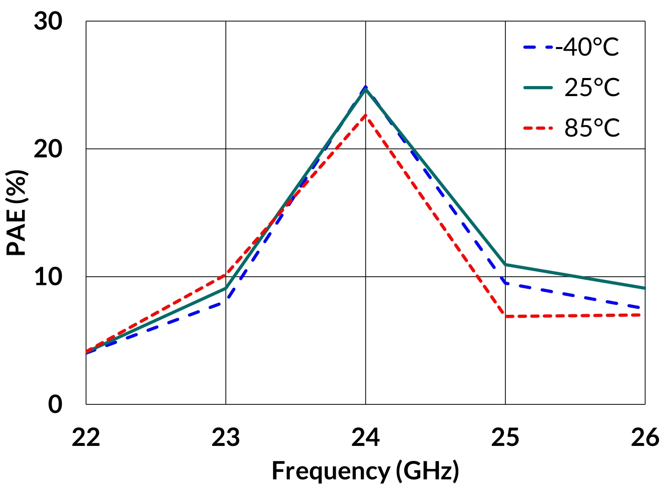
Gain at P1dB



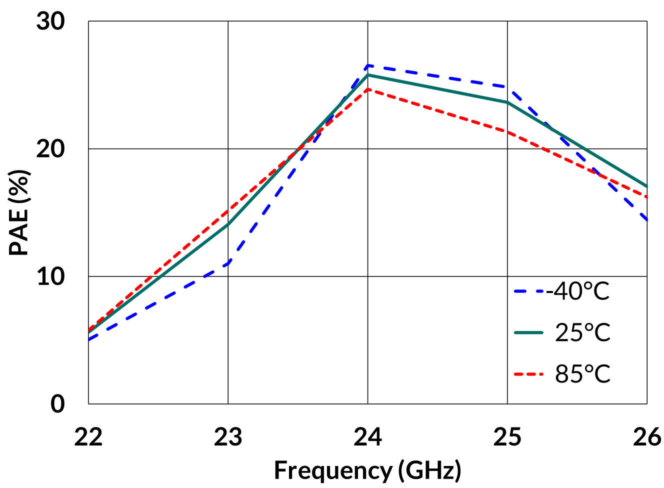
Gain at P3dB



PAE at P1dB



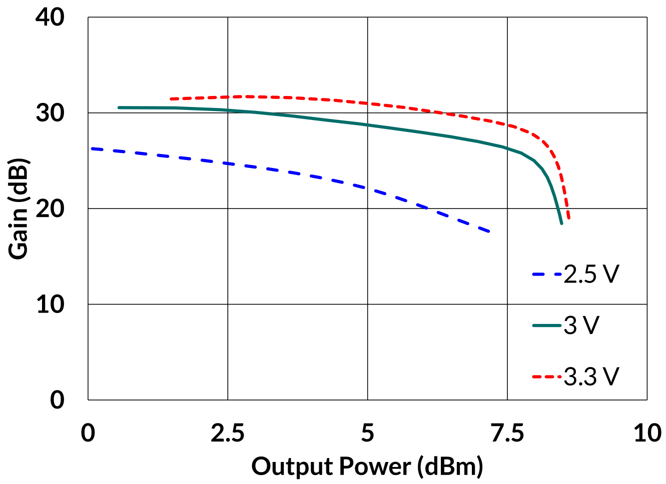
PAE at P3dB



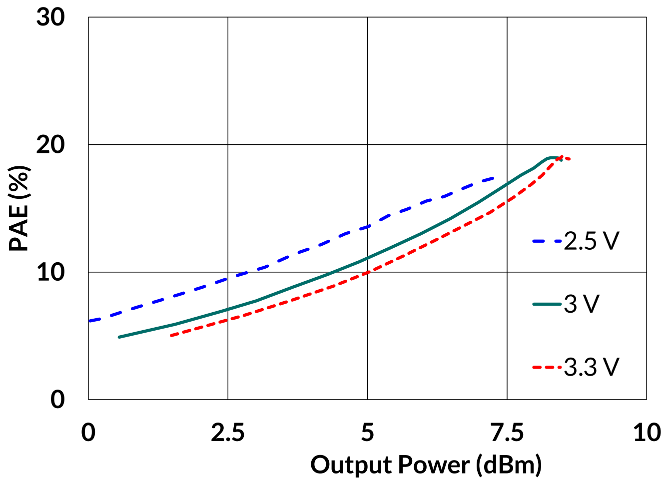
Measured Performance – Large Signal

Room temperature: V_{DD} = 3.3 V, V_{BIAS} = 2.5, 3.0 and 3.3 V (I_{DDQ} ≈ 4, 6 and 8 mA)

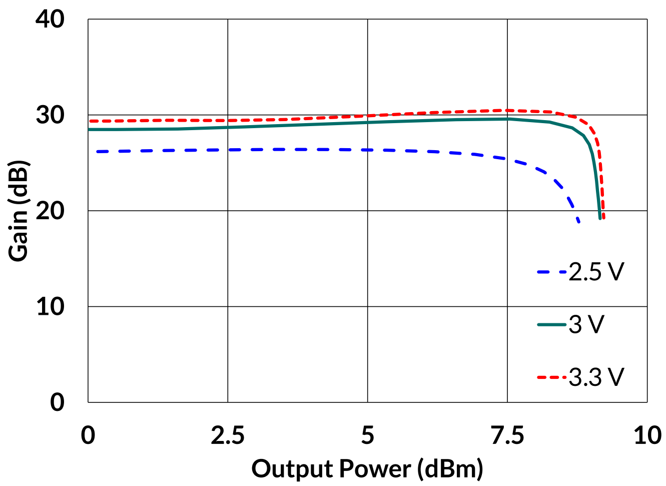
Gain vs Output Power at 23 GHz



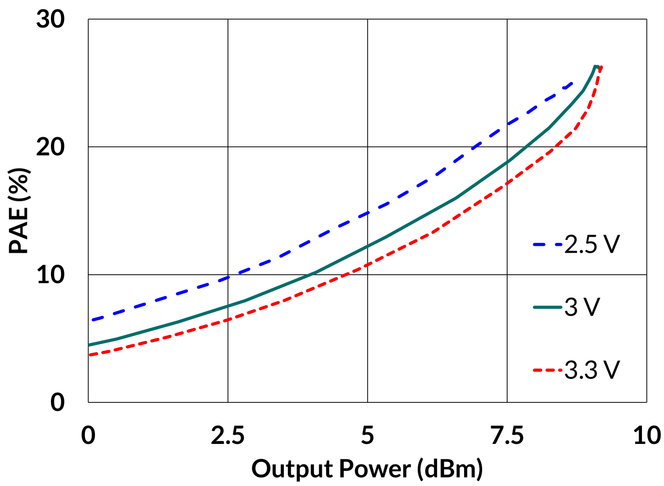
PAE vs Output Power at 23 GHz



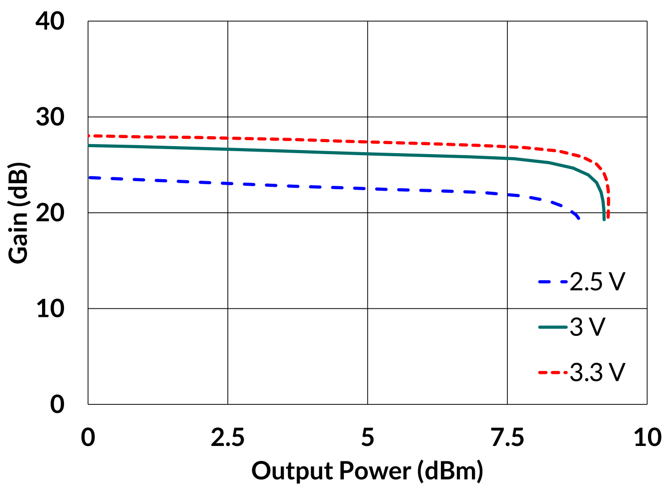
Gain vs Output Power at 24 GHz



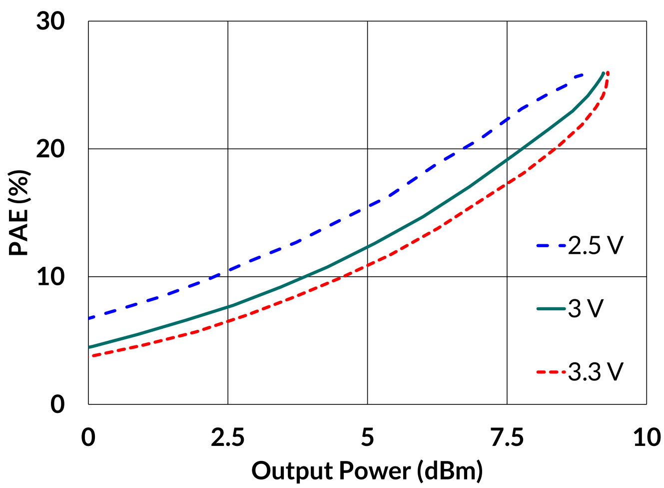
PAE vs Output Power at 24 GHz



Gain vs Output Power at 25 GHz



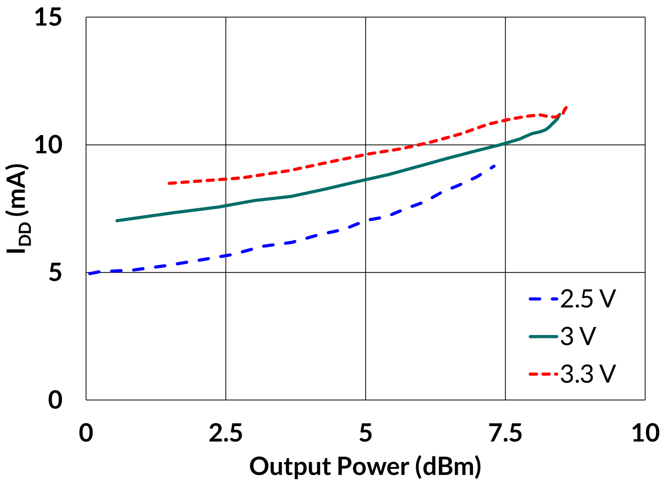
PAE vs Output Power at 25 GHz



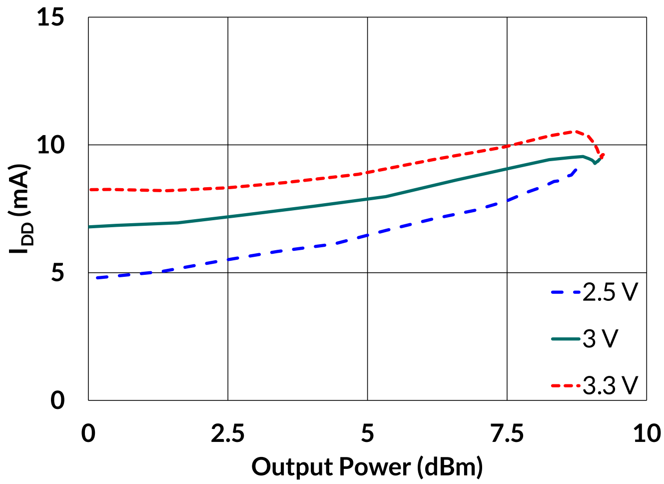
Measured Performance – Large Signal

Room temperature: V_{DD} = 3.3 V, V_{BIAS} = 2.5, 3.0 and 3.3 V (I_{DDQ} ≈ 4, 6 and 8 mA)

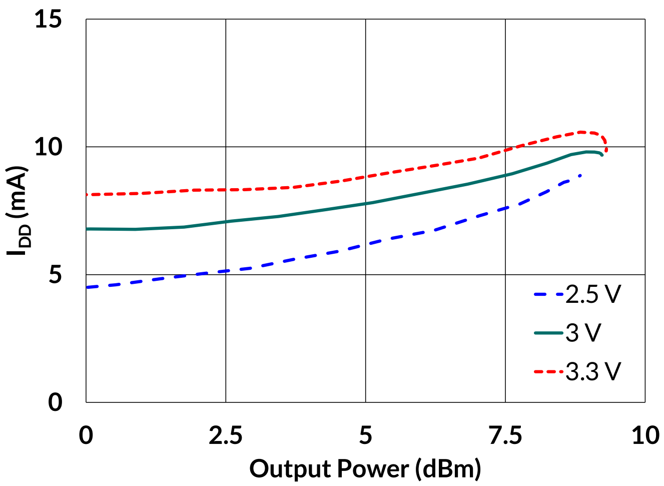
I_{DD} vs Output Power at 23 GHz



I_{DD} vs Output Power at 24 GHz



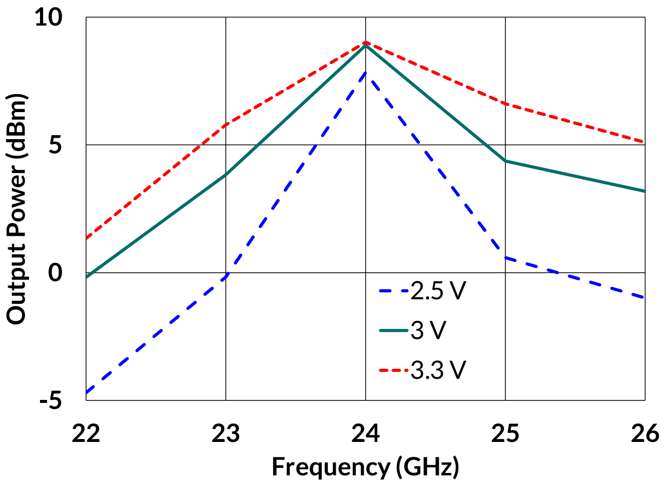
I_{DD} vs Output Power at 25 GHz



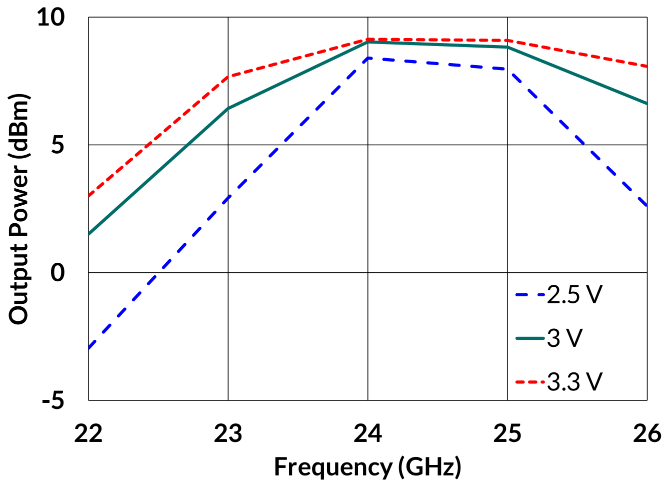
Measured Performance – Large Signal

Room temperature: V_{DD} = 3.3 V, V_{BIAS} = 2.5, 3.0 and 3.3 V (I_{DDQ} ≈ 4, 6 and 8 mA)

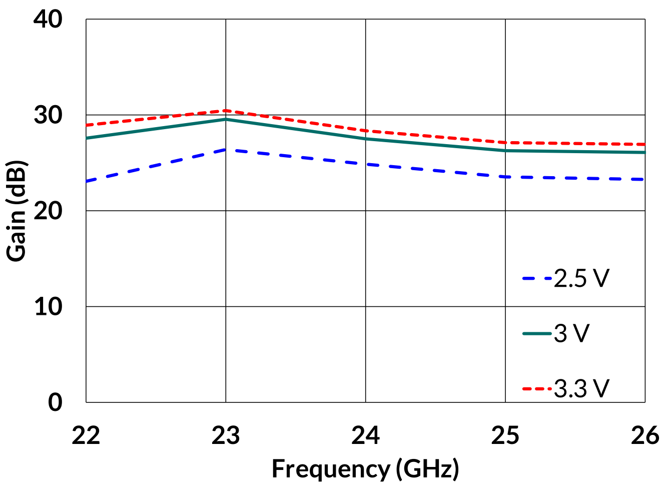
Output P1dB



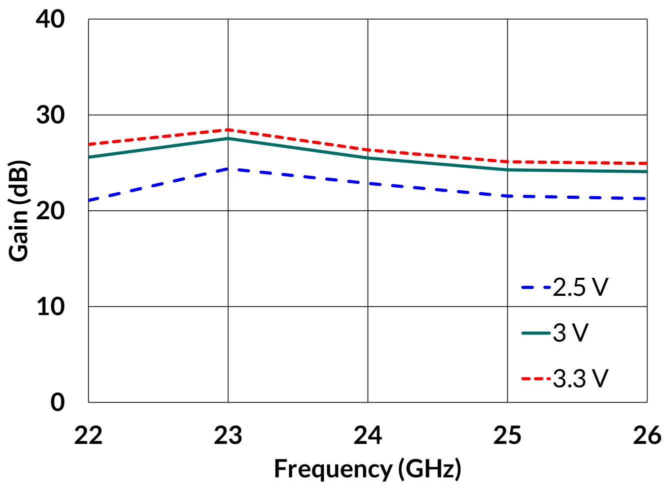
Output P3dB



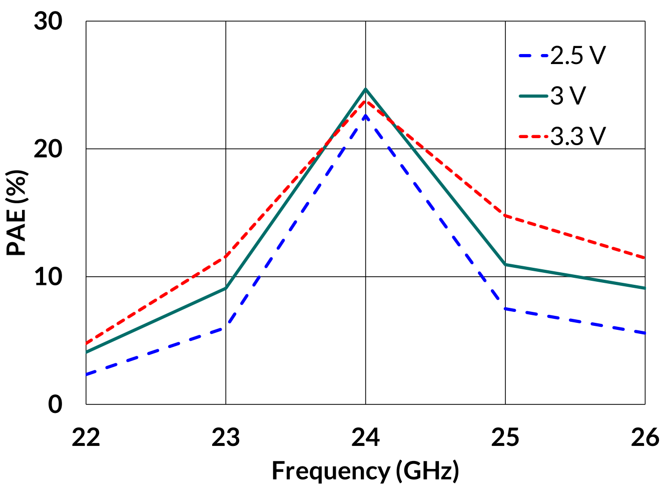
Gain at P1dB



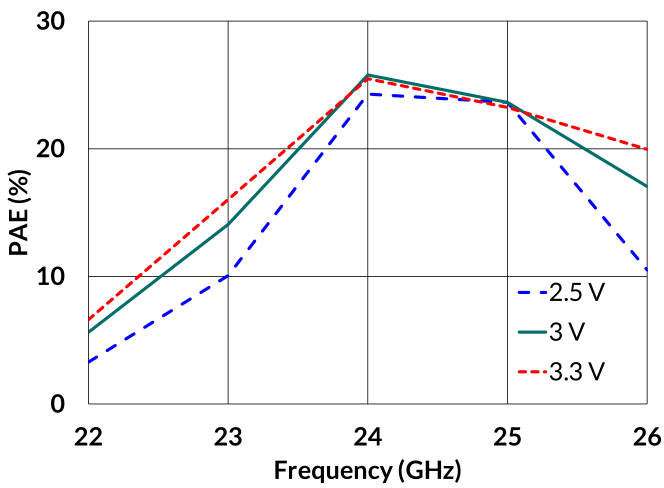
Gain at P3dB



PAE at P1dB



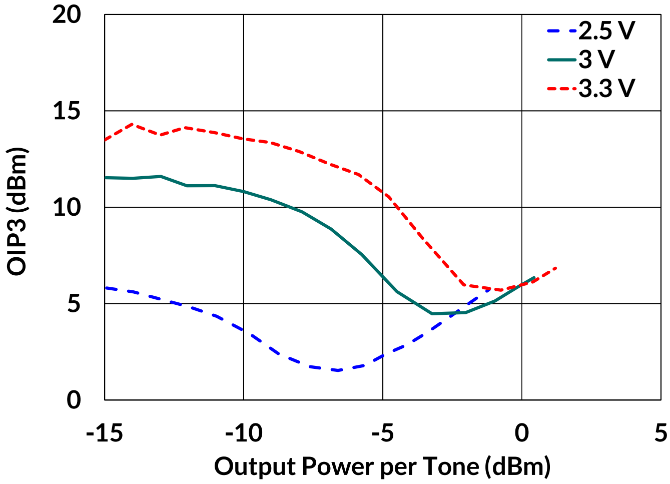
PAE at P3dB



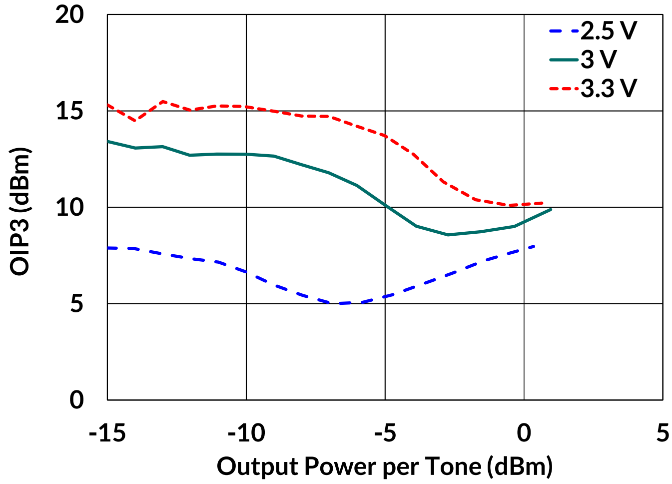
Measured Performance – Large Signal

Room temperature: V_{DD} = 3.3 V, V_{BIAS} = 2.5, 3.0 and 3.3 V (I_{DDQ} ≈ 4, 6 and 8 mA) , ΔF = 10 MHz

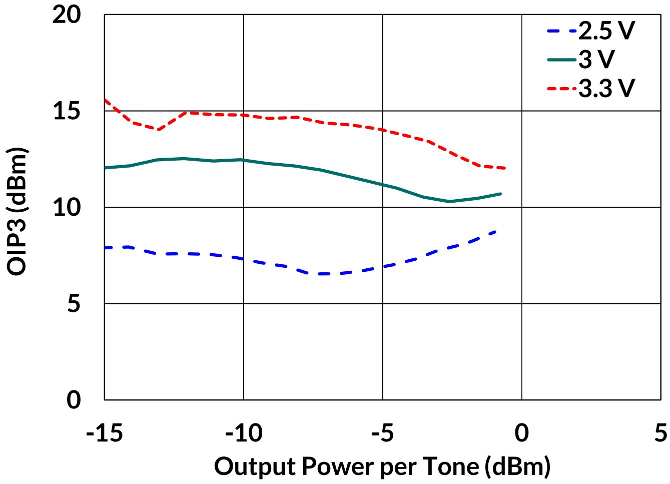
OIP3 versus P_{OUT}/tone at 23 GHz



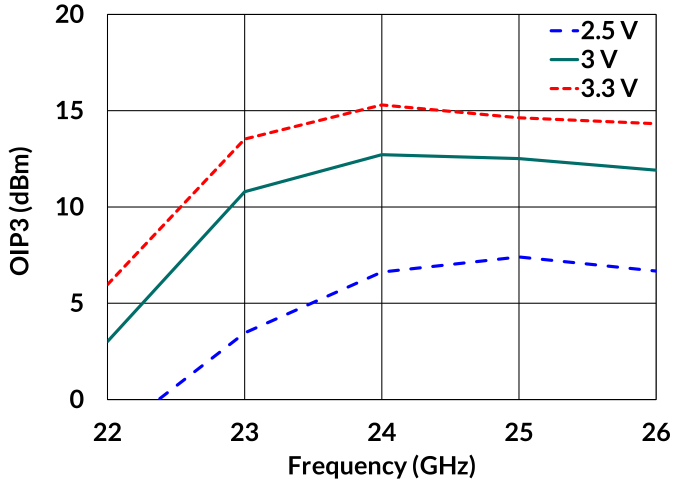
OIP3 versus P_{OUT}/tone at 24 GHz



OIP3 versus P_{OUT}/tone at 25 GHz



OIP3 at P_{OUT}/tone = -10 dBm



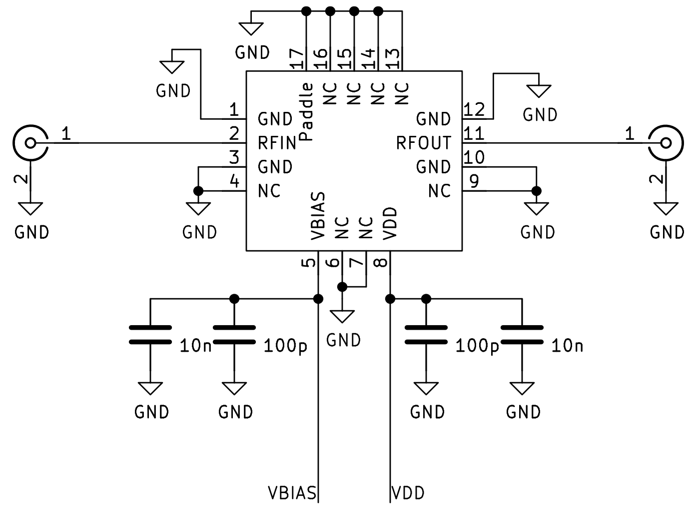
Application Schematic

Biasing

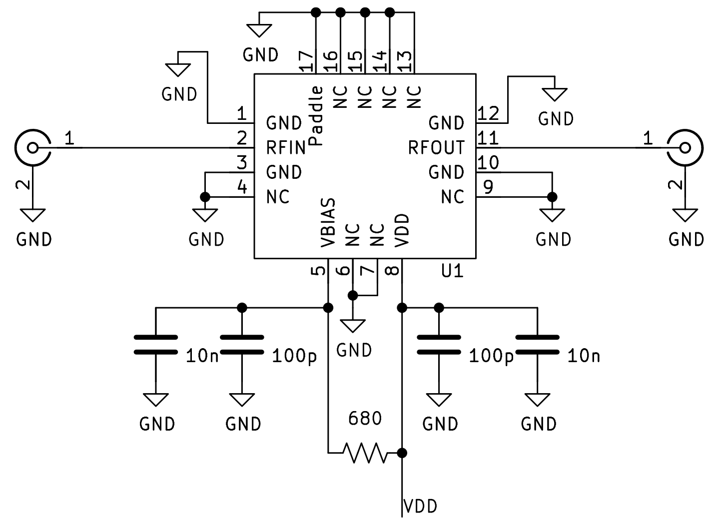
ARF1218Q2 has two biasing methods. The first is V_{DD} and V_{BIAS} which can be biased with separate power supplies. By altering V_{BIAS} the current of V_{DD} will change the performance. The second method ties V_{BIAS} to V_{DD} via a resistor. The value of the resistor determines the current of the device and some resistor and current values are provided in the evaluation board section. This method enables the ARF1218Q2 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.

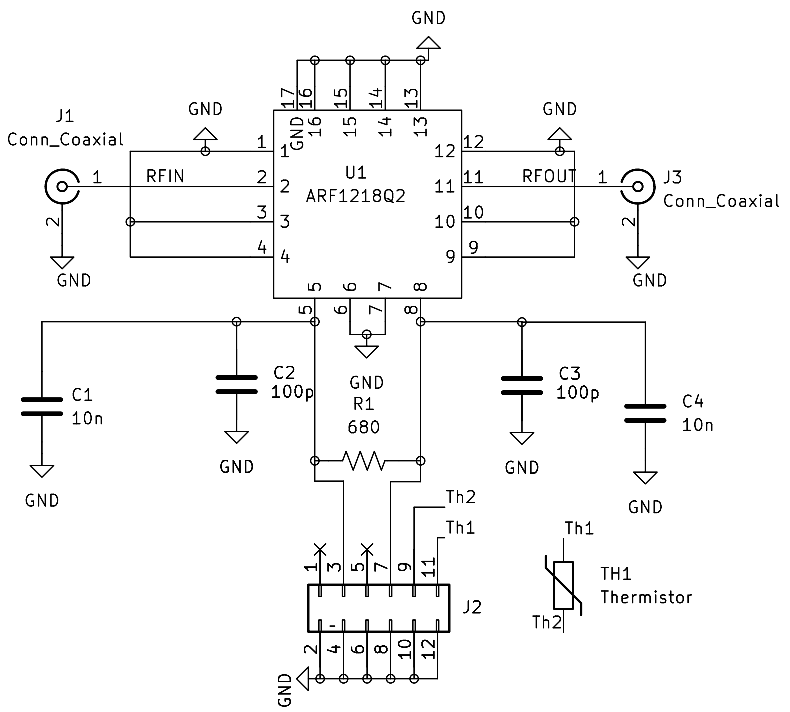


Individual Biasing of V_{DD} and V_{BIAS}



Biasing through resistor

Evaluation Board Schematic



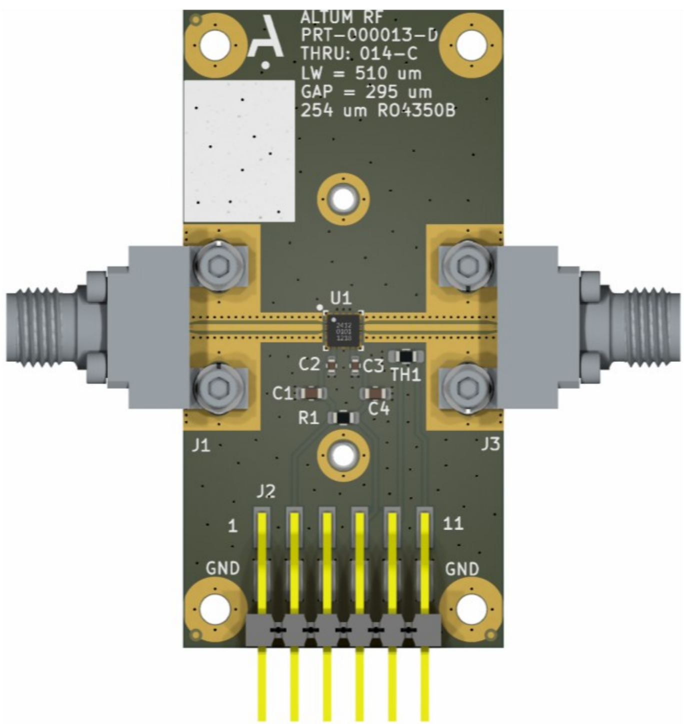
J2 Pin	Description
3	V_{BIAS}
7	V_{DD}
1,5	Unconnected
9,11	Thermistor (optional)
2,4,6,8,10,12	Ground

Bias Control[5]			
V_{DD} (V)	I_{DD} (mA)	V_{BIAS} (V)	R1 (Ω)
3.3	8	3.3	0
3.3	6	3.0	680
3.3	4	2.5	1.8k
4.0	11	4.0	0
4.0	6	3.3	820

Bill of Materials

Description	Reference Designator	Quantity
ARF1218Q2	U1	1
10 nF 0603 Capacitor	C1,C4	2
100 pF 0402 Capacitor	C2,C3	2
680 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 part	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.

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.

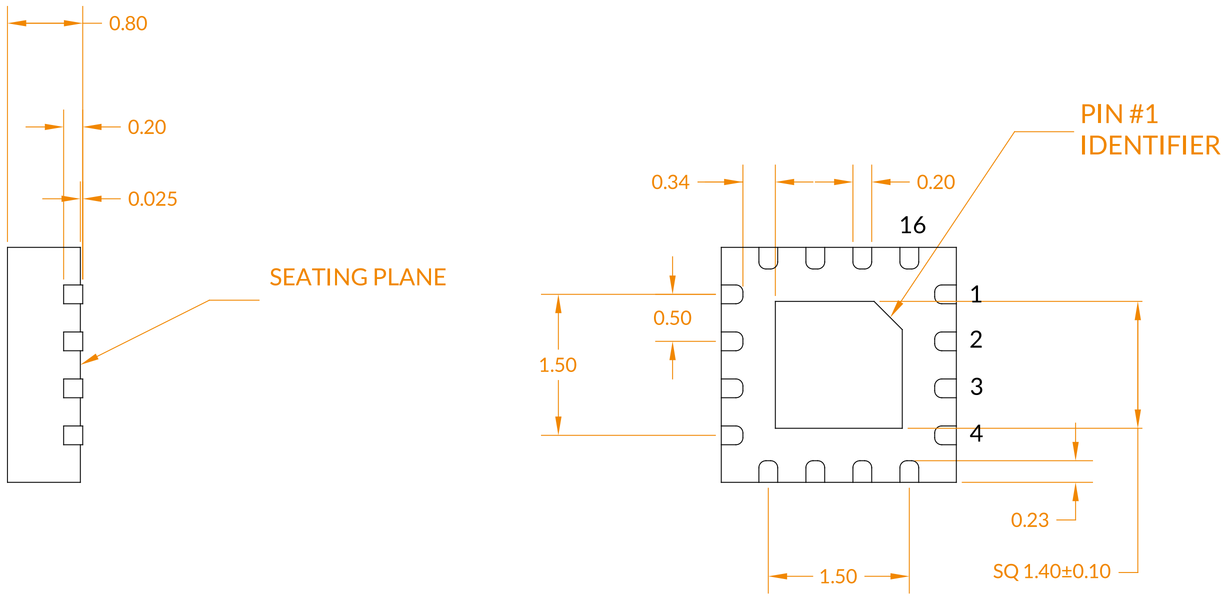
The part can be turned off by applying 0 V to V_{BIAS} or to V_{DD}.

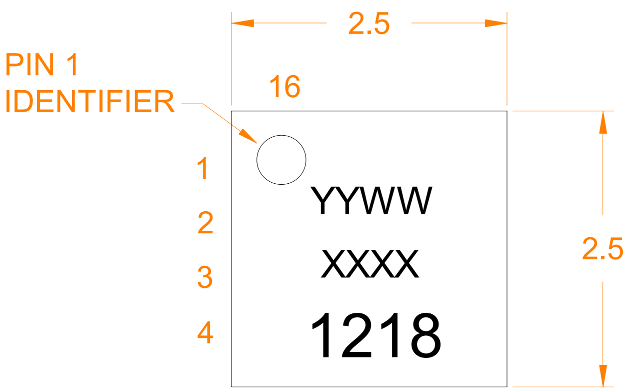
2. Reflow Information

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

Package Information

Outline Drawing





YYWW is the date code
XXXX is the lot code
1218 is the part number

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

Ordering Information

Part Number	Delivery Format	Quantity
ARF1218Q2-TR500	Tape and Reel	500 pcs
ARF1218Q2-TR2500	Tape and Reel	2500 pcs

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Document Information

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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