United Monolithic Semiconductors

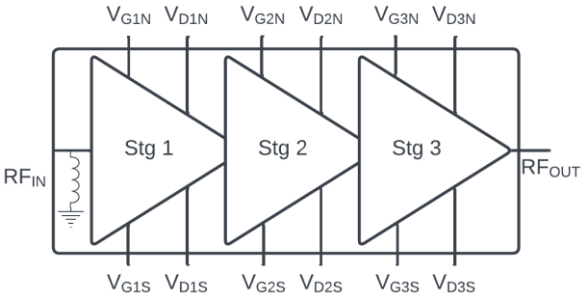
CHA8682-98F

25-29GHz 25W Power Amplifier

GaN Monolithic Microwave IC in bare die

Description

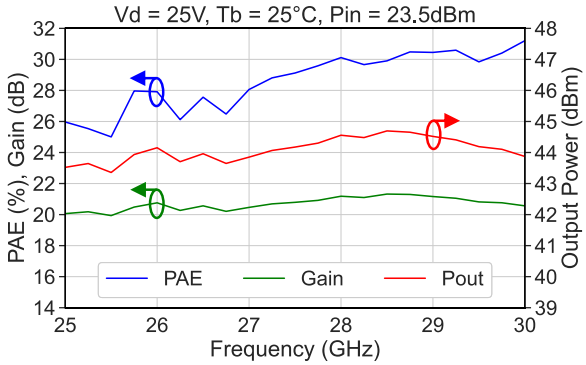
The CHA8682-98F is a 3-stage high power amplifier operating between 25 and 29GHz and providing typically 25W of saturated output power associated to 28% of Power Added Efficiency at 25V drain voltage. It exhibits 8W of linear power with -25dBc IMD3. This HPA is dedicated to 5G and Satcom applications and well suited for a wide range of microwave applications and systems. The circuit is manufactured on a robust GaN-on-SiC HEMT process and is available in bare die form with mechanical protection. Input and output are 50Ω matched. The drain bias range, from 18V to 25V, offers a saturated output power from 15W to 25W.



Main Features

- Frequency Range: 25-29GHz
- 25W Output Power with 28% PAE
- ACPR = -30dBc at 39dBm Average Pout(1)
- Linear Gain: 25dB
- DC bias: Vd=25V and Idq=340mA
- Chip size: 3.6x3.6mm²

(1) 100MHz Modulation Bandwidth, 256QAM



Main Electrical Characteristics

Tb = 25°C (Tb: die backside temperature)

Symbol	Parameter	Min	Typ	Max	Unit
Freq	Frequency range	25		29	GHz
Gain	Linear gain		27		dB
Psat	Saturated output power		44		dBm
PAE	Power added efficiency		28		%
IMD3	IMD3 (Pout/tone = 36dBm, Δf = 10MHz)		-25		dBc
ACPR	ACPR at Pout = 39dBm with 256QAM (100MHz Modulation Bandwidth)		-30		dBc

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Specifications

Tb = 25°C, Vd = 25V, CW mode (Tb: die backside temperature)

Symbol	Parameter	Min	Typ	Max	Unit
Freq	Frequency range	25		29	GHz
Gain	Linear gain		29		dB
Psat	Saturated output power		44		dBm
PAE	Power added efficiency		28		%
Id	Drain current at saturation		3.8		A
S11	Input return loss		-8		dB
S22	Output return loss		-8		dB
IMD3	IMD3 (Pout/tone = 36dBm, Δf = 10MHz)		-25		dBc
ACPR	ACPR at Pout = 39dBm with 256QAM (100MHz Modulation Bandwidth)		-30		dBc
Idq	Quiescent current		340		mA
Vd	Drain voltage		25		V

These values are representative of on-board measurements. Measurement is de-embedded at the wire-bonding plane of the RF lines.

Absolute Maximum Ratings (1)

Tb = 25°C

Symbol	Parameter	Values	Unit
Vd	Drain bias voltage	27	V
Idq	Quiescent drain current (without RF signal)	1000	mA
Vg	Gate bias voltage	-7 to -1.5	V
Pin	Maximum input power	30	dBm

(1) Operation of this device above any of these parameters may cause permanent damage.

Recommended Operating Range (2), (3)

Symbol	Parameter	Values	Unit
Vd	Drain bias voltage	18 to 25	V
Idq	Quiescent drain current (without RF signal)	300 to 700	mA
Vg	Gate bias voltage	-5 to -2.5	V
Pin	Maximum input power	27.5	dBm
Tj	Maximum junction temperature(4)	200	°C

(2) Electrical performance is defined for specified test conditions.

(3) Electrical performance is not guaranteed over all recommended operating conditions.

(4) See Device Thermal Performance section.

Temperature Range

Tb	Operating temperature range	-40 to +85	°C
Tstg	Storage temperature range	-55 to +150	°C

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Typical Bias Conditions

Tb = 25°C

Symbol	Pad Number	Description	Values	Unit
Vg	4, 8, 12, 20, 24, 28	Gate voltage	-3	V
Vd	6, 10, 14, 18, 22, 26	Drain voltage	25	V

“Power ON” sequence

1. Bias HPA gate voltage at Vg close to Vpinch-off (Typically: Vg ≈ -5V)
2. Apply Vd bias voltage (Typically: Vd = 25V)
3. Increase gate voltage Vg up to quiescent bias drain current Idq
4. Apply RF signal

“Power OFF” sequence

1. Turn off RF signal
2. Bias HPA gate voltage at Vg close to Vpinch-off (Typically: Vg ≈ -5V)
3. Check that quiescent bias drain current Idq is close to 0mA
4. Turn Vd bias voltage to 0V
5. Check that quiescent bias drain current Idq is close to 0mA
6. Turn Vg bias voltage to 0V

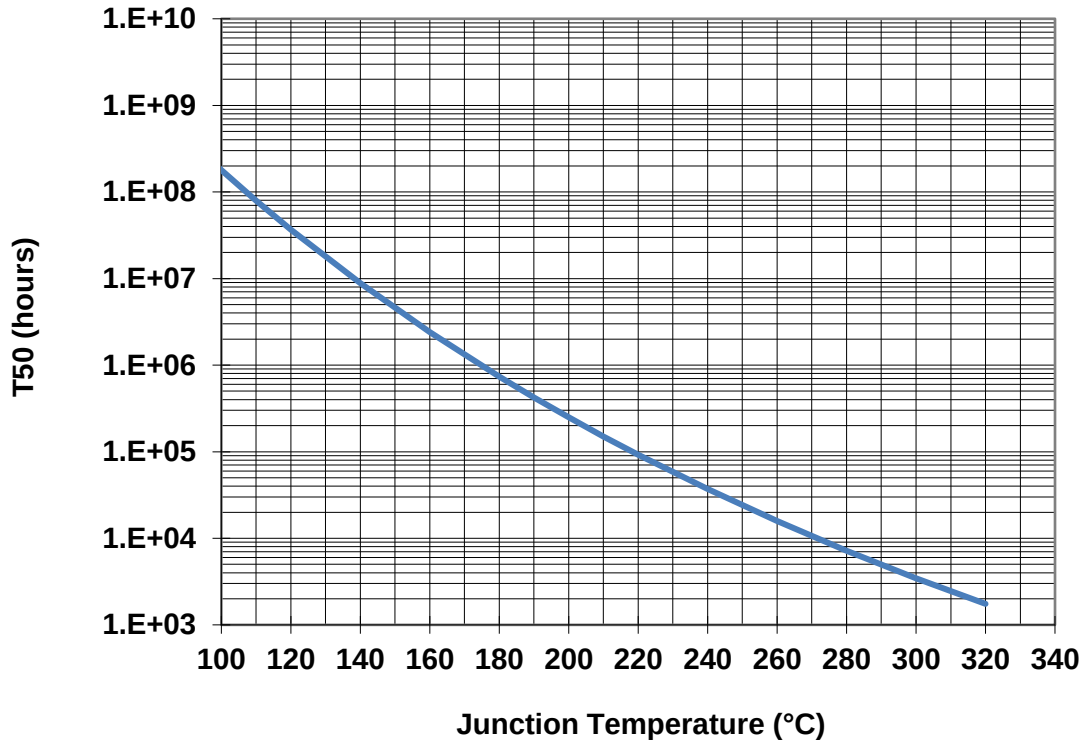
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Device Thermal Performance

All the figures given in this section are obtained assuming that the device is only cooled down by conduction through the thermal pad (no convection mode considered).
The temperature is monitored at the chip back-side interface (Tb).
For nominal operating, the system maximum temperature must be adjusted in order to guarantee that the Junction Temperature remains below the maximum value specified in the Recommended Operating Ratings table.
Therefore, the system PCB must be designed to comply with this requirement.

Parameter	Biasing conditions	Tjunction (°C)	R_{TH} (°C/W)	T50 (hours)
Rth(1) Thermal Resistance (Junction to die backside)	Vd = 20V Idq = 340mA Pout = 42.5dBm Pdiss = 51W	157	1.41	3.0E+06
	Vd = 25V Idq = 340mA Pout = 44dBm Pdiss = 69W	190	1.51	4.4E+05

(1) Assuming Tb = 85°C

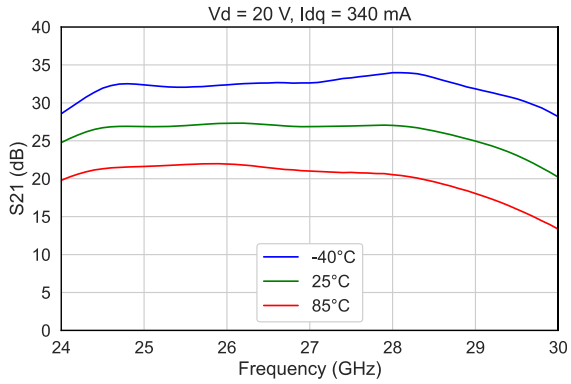


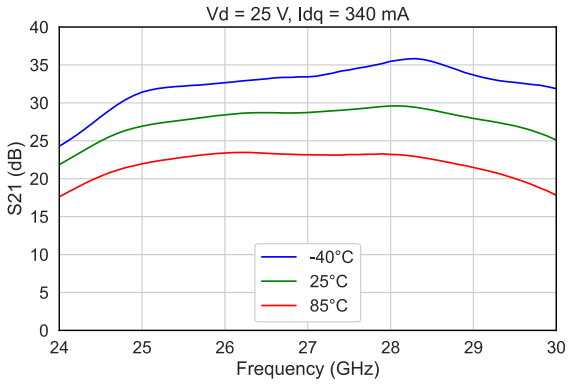
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Typical Board Measurements: Small Signal Performance

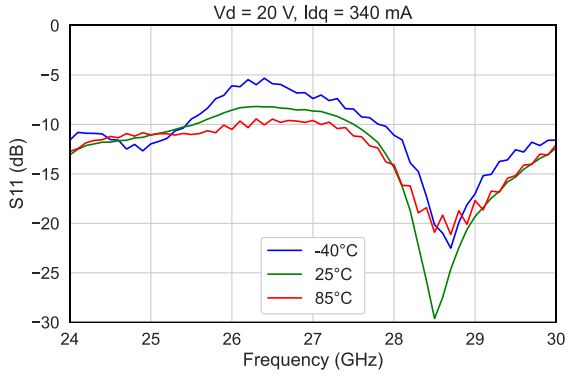
Test conditions: CW, Vd = 20V / 25V, Idq = 340mA, Tb = -40°C / 25°C / 85°C
Measurement reference is at the connector plane for S11 and S22, and de-embedded at the wire-bonding plane of the RF lines for S21.

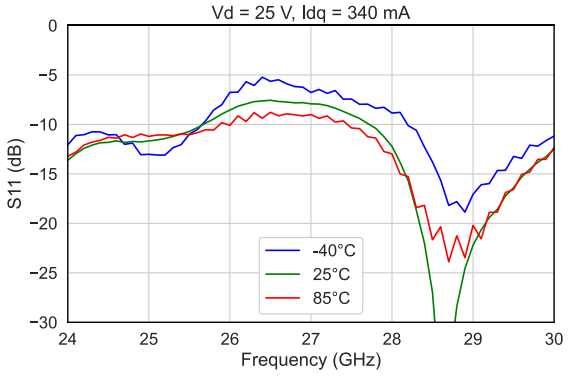
Linear Gain vs. Freq. and Temperature



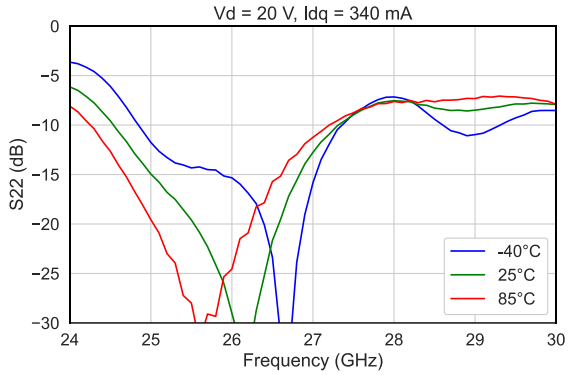


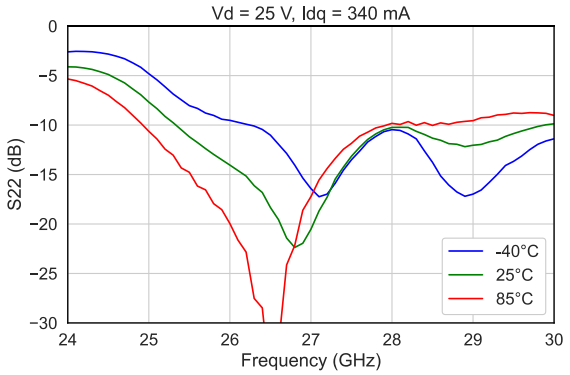
Input Return Loss vs. Freq. and Temperature





Output Return Loss vs. Freq. and Temperature



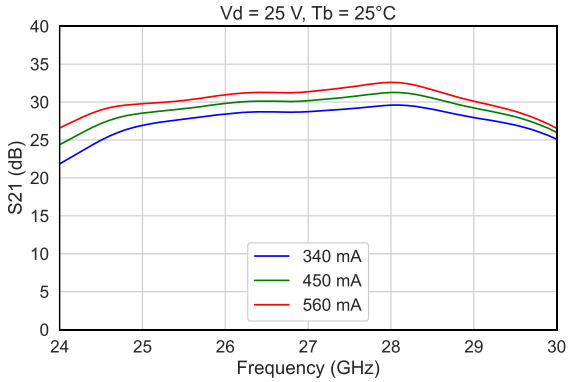


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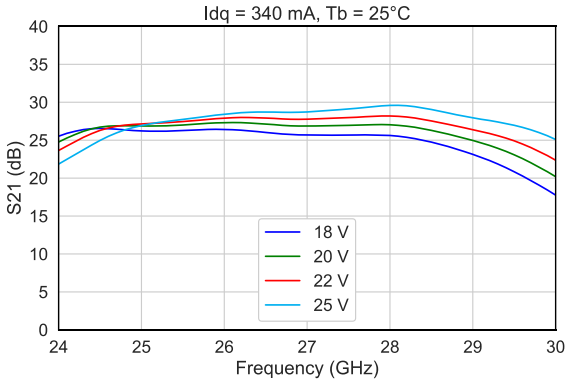
Typical Board Measurements: Small Signal Performance

Test conditions: CW, Tb = 25°C
Measurement reference is at the connector plane for S11 and S22, and de-embedded at the wire-bonding plane of the RF lines for S21.

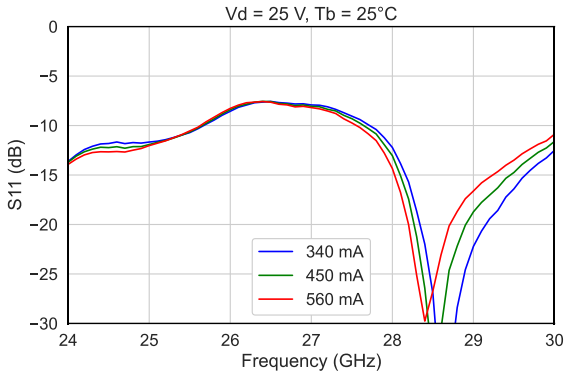
Linear Gain vs. Freq. and Idq



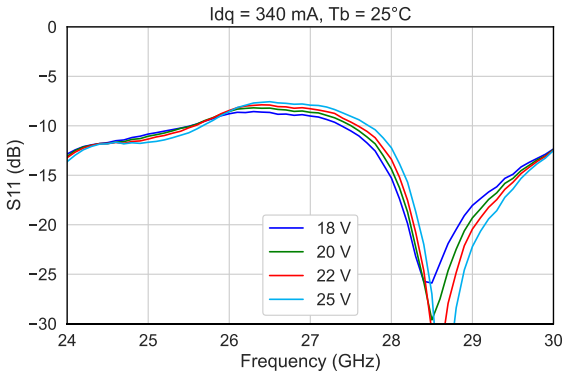
Linear Gain vs. Freq. and Vd



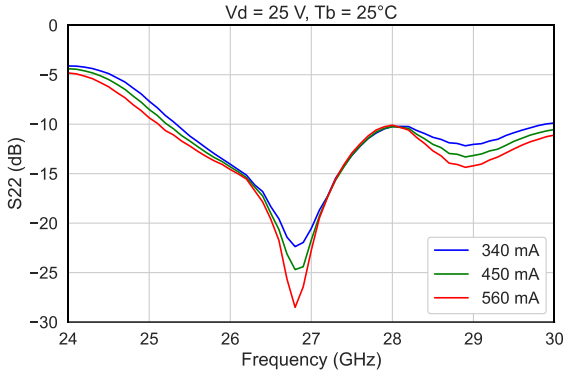
Input Return Loss vs. Freq. and Idq



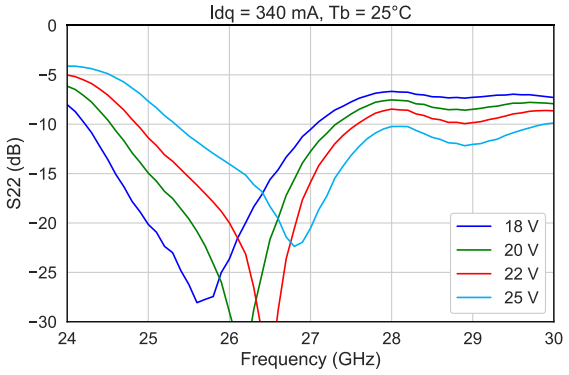
Input Return Loss vs. Freq. and Vd



Output Return Loss vs. Freq. and Idq



Output Return Loss vs. Freq. and Vd

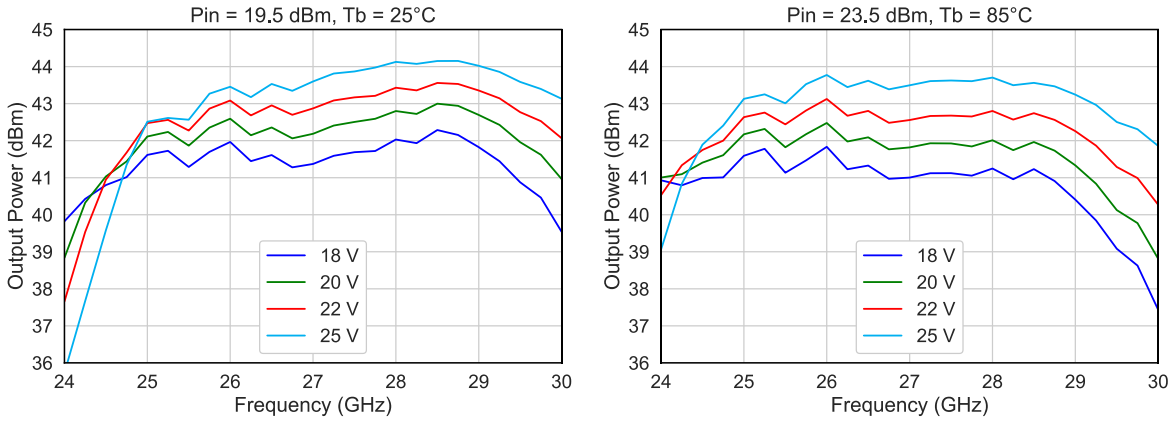


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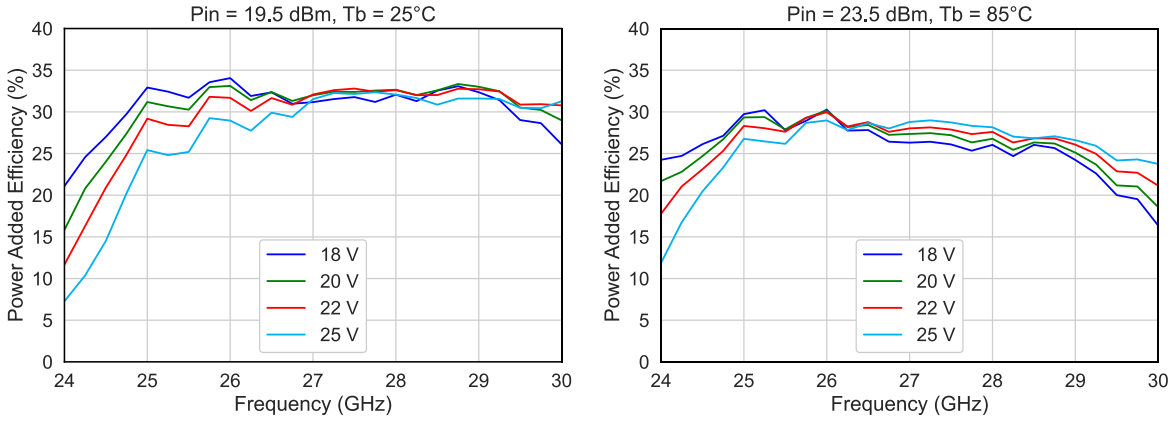
Typical Board Measurements: Large Signal Performance

Test conditions: CW, Idq = 340mA, Tb = 25°C / 85°C
Measurement reference plane is de-embedded at the wire-bonding plane of the RF lines.

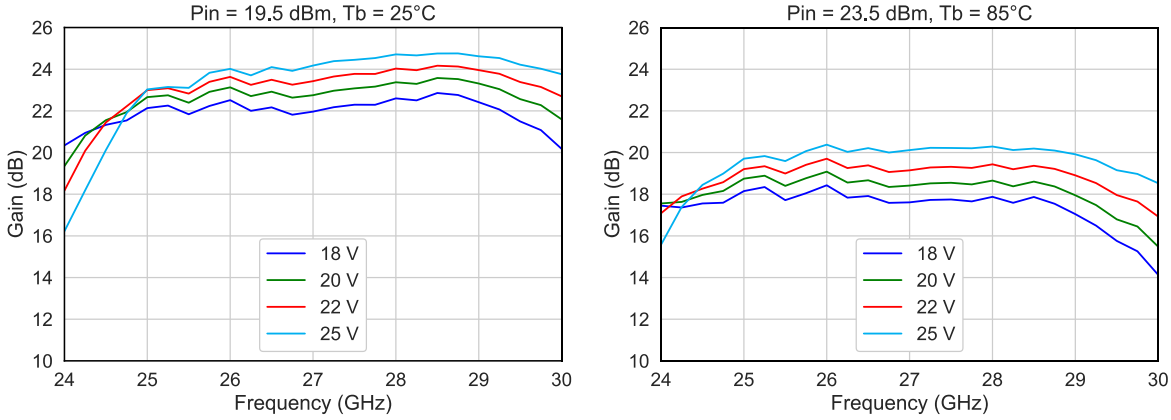
Output Power vs. Freq. and Drain Voltage



Power Added Efficiency vs. Freq. and Drain Voltage



Gain vs. Freq. and Drain Voltage

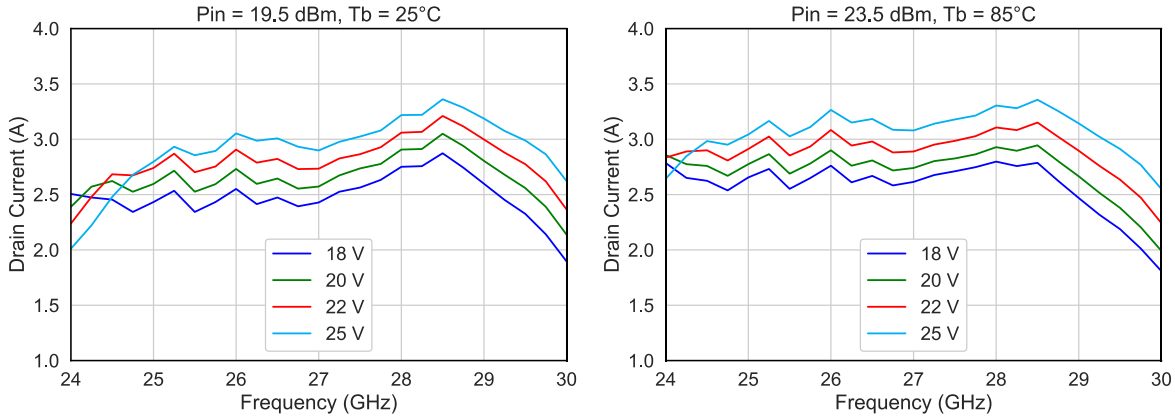


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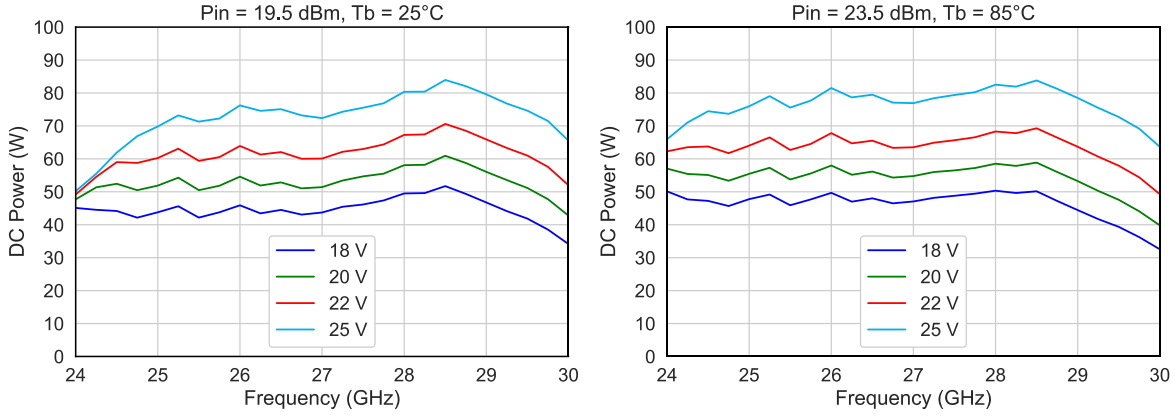
Typical Board Measurements: Large Signal Performance

Test conditions: CW, Idq = 340mA, Tb = 25°C / 85°C
Measurement reference plane is de-embedded at the wire-bonding plane of the RF lines.

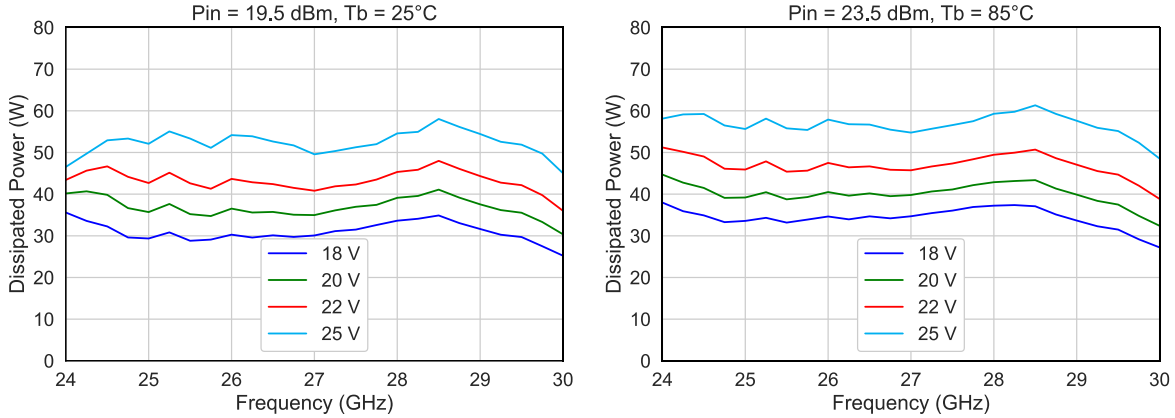
Drain Current vs. Freq. and Drain Voltage



DC Power Consumption vs. Freq. and Drain Voltage



Dissipated Power vs. Freq. and Drain Voltage

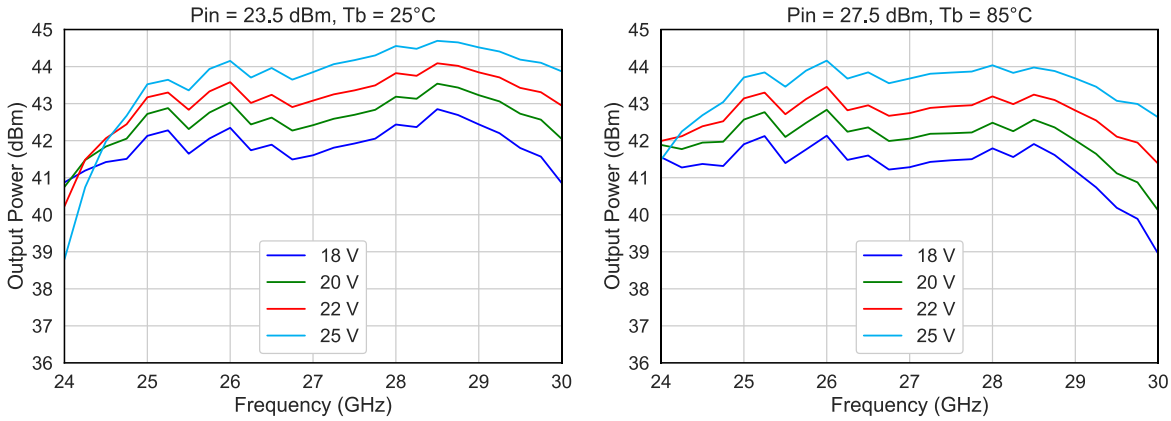


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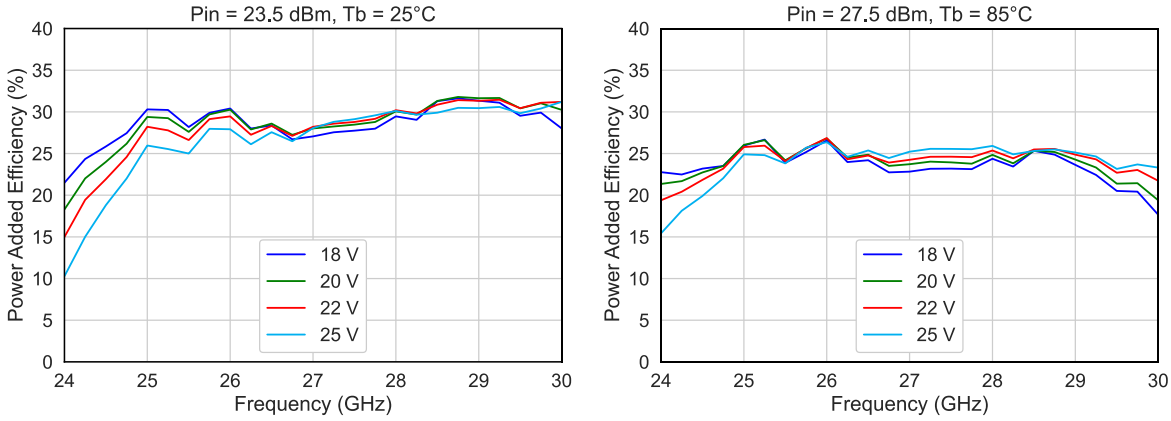
Typical Board Measurements: Large Signal Performance

Test conditions: CW, Idq = 340mA, Tb = 25°C / 85°C
Measurement reference plane is de-embedded at the wire-bonding plane of the RF lines.

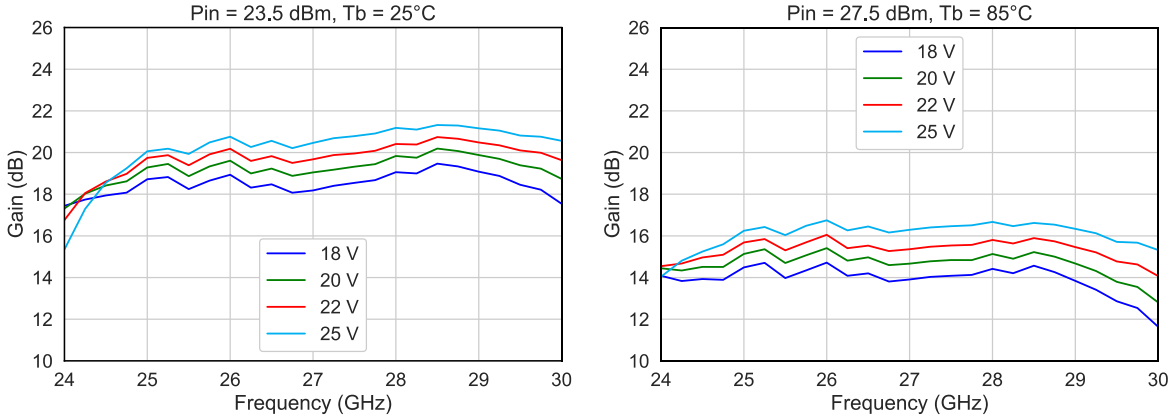
Output Power vs. Freq. and Drain Voltage



Power Added Efficiency vs. Freq. and Drain Voltage



Gain vs. Freq. and Drain Voltage

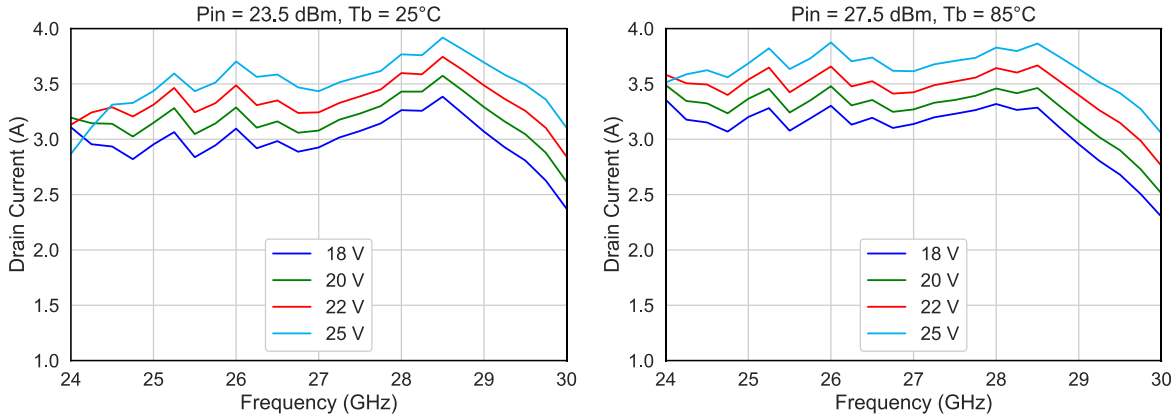


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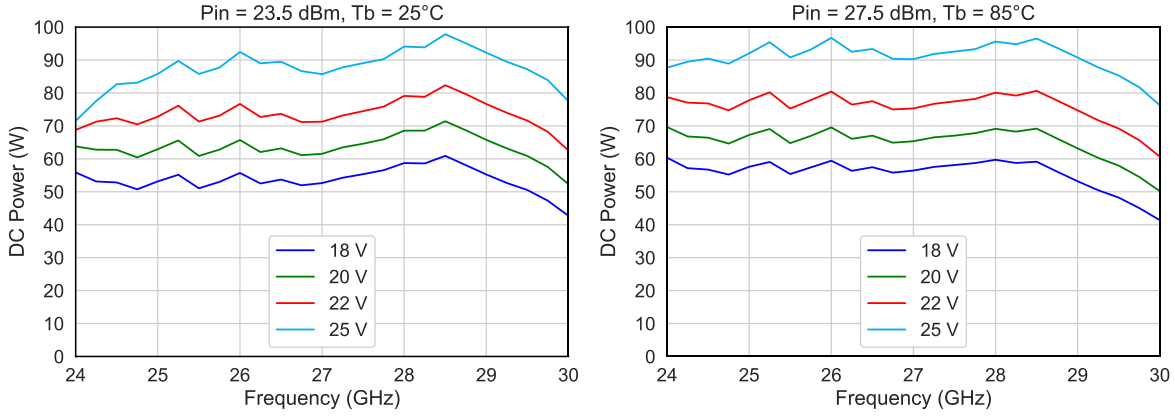
Typical Board Measurements: Large Signal Performance

Test conditions: CW, Idq = 340mA, Tb = 25°C / 85°C
Measurement reference plane is de-embedded at the wire-bonding plane of the RF lines.

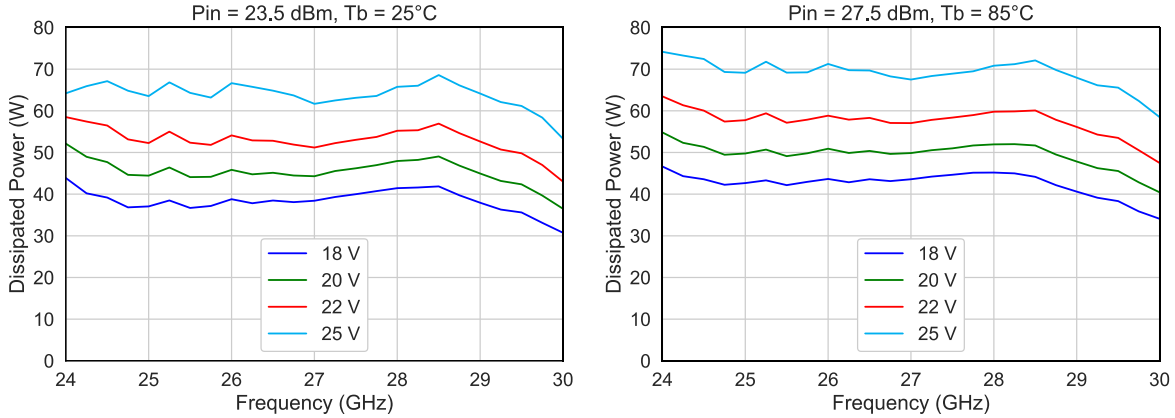
Drain Current vs. Freq. and Drain Voltage



DC Power Consumption vs. Freq. and Drain Voltage



Dissipated Power vs. Freq. and Drain Voltage

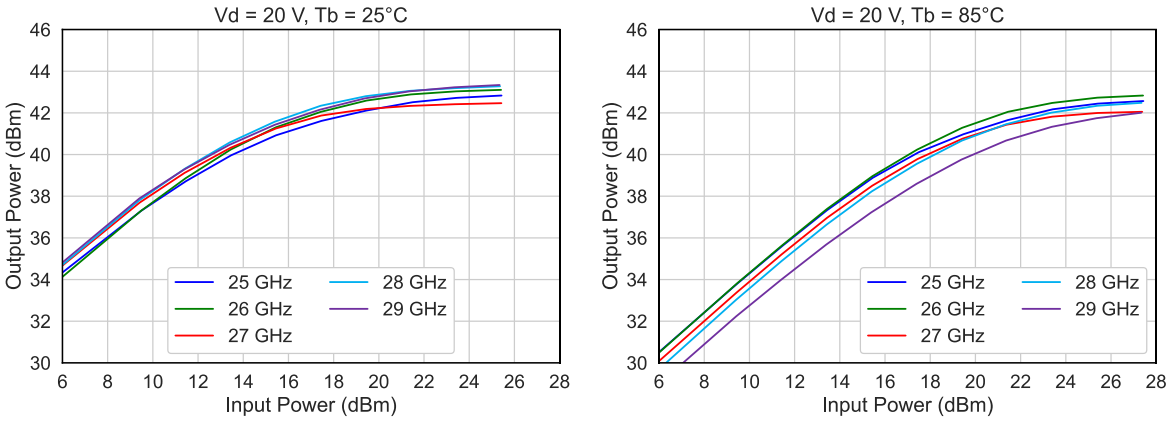


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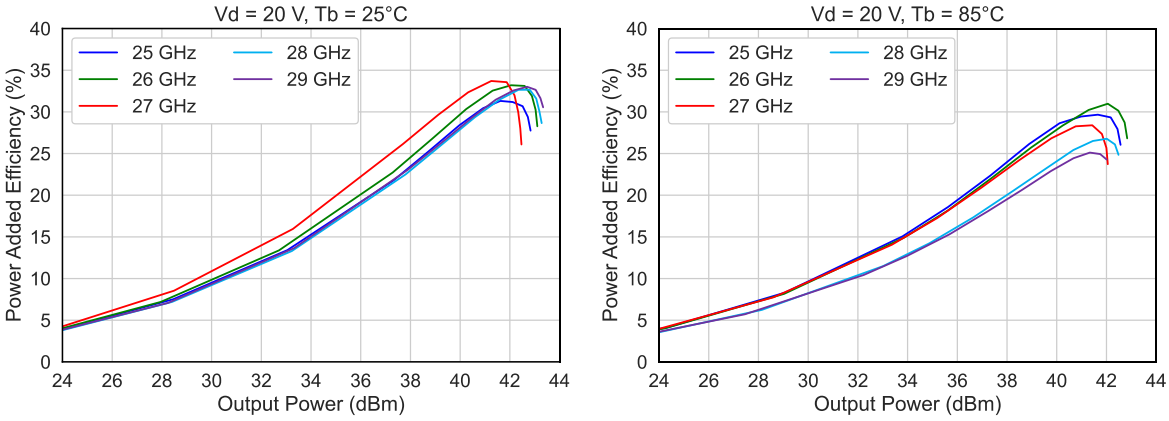
Typical Board Measurements: Large Signal Performance

Test conditions: CW, Vd = 20V, Idq = 340mA, Tb = 25°C / 85°C
Measurement reference plane is de-embedded at the wire-bonding plane of the RF lines.

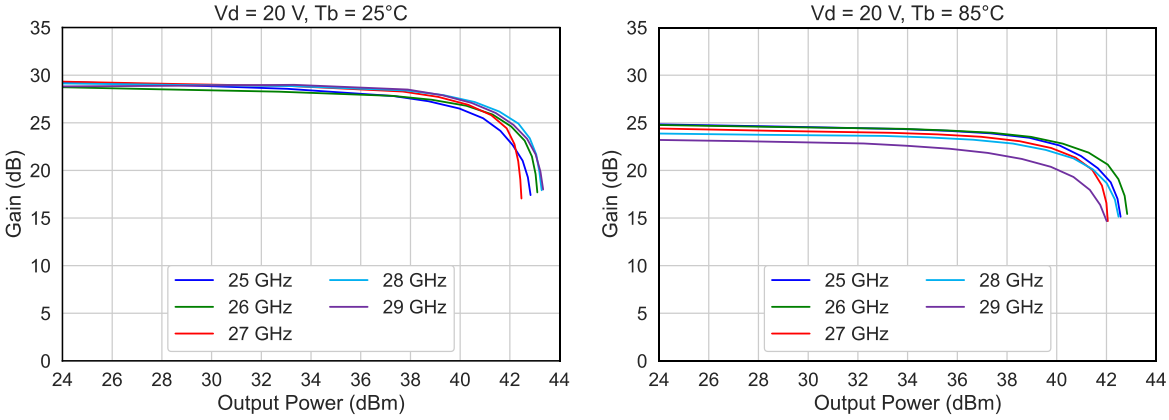
Output Power vs. Input Power and Freq.



Power Added Efficiency vs. Output Power and Freq.



Gain vs. Output Power and Freq.

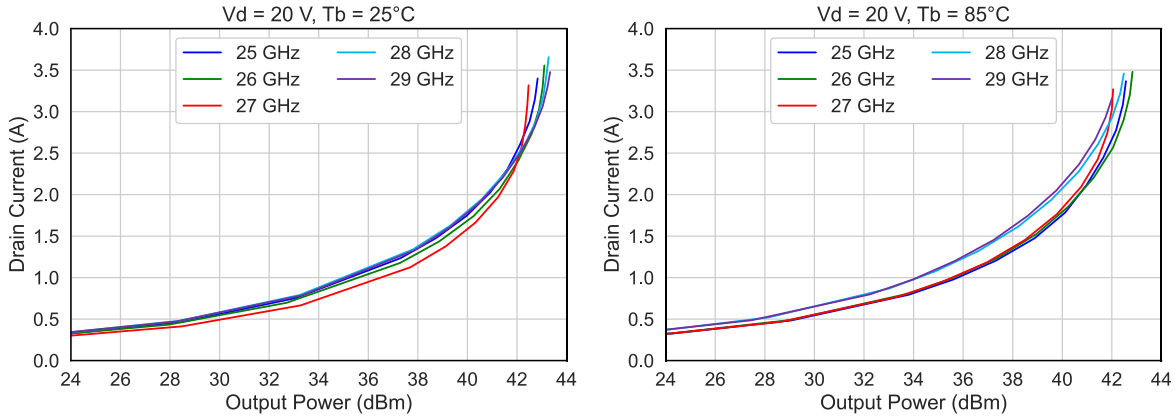


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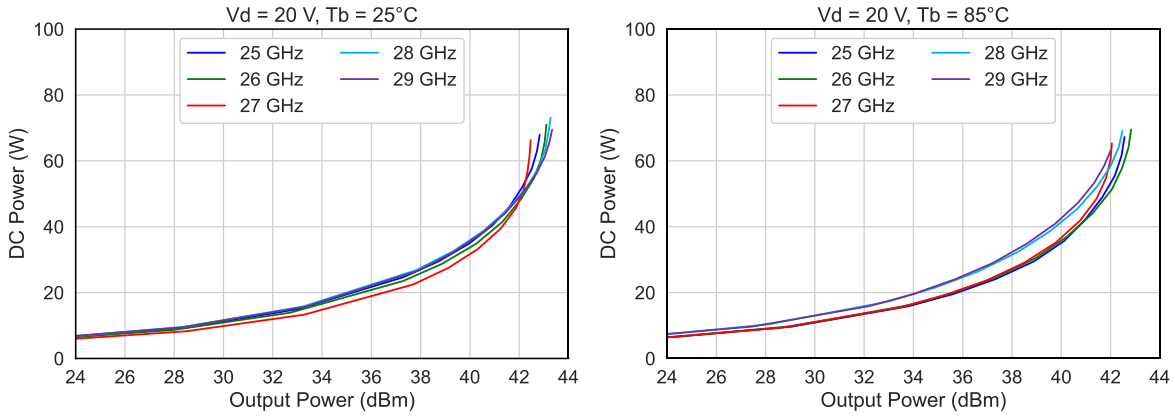
Typical Board Measurements: Large Signal Performance

Test conditions: CW, Vd = 20V, Idq = 340mA, Tb = 25°C / 85°C
Measurement reference plane is de-embedded at the wire-bonding plane of the RF lines.

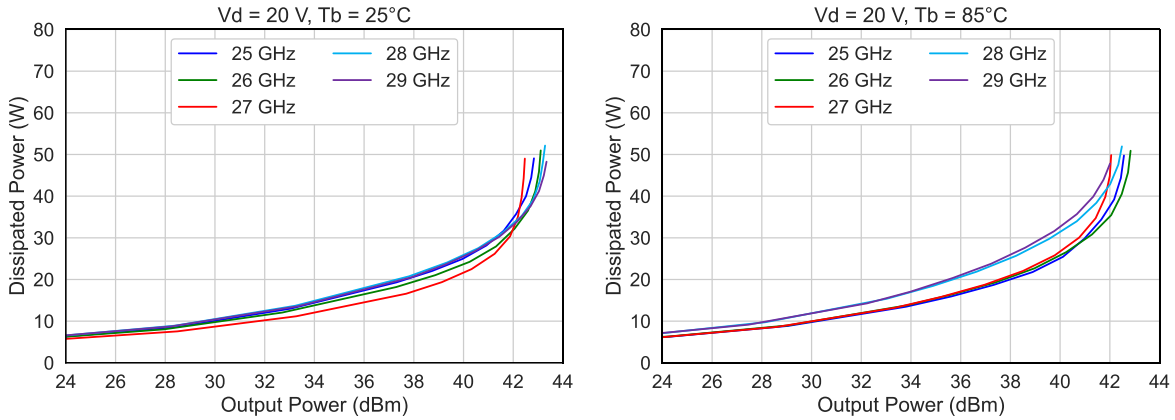
Drain Current vs. Output Power and Freq.



DC Power Consumption vs. Output Power and Freq.



Dissipated Power vs. Output Power and Freq.

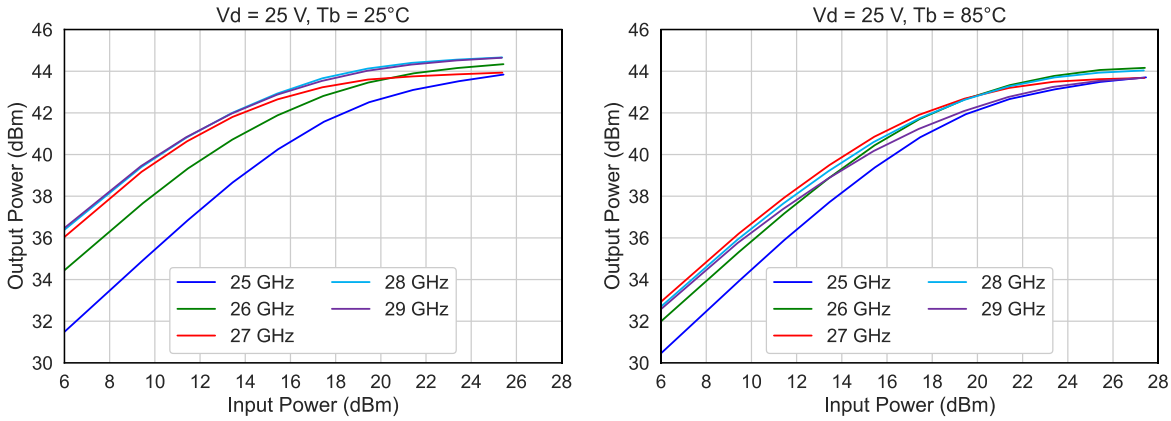


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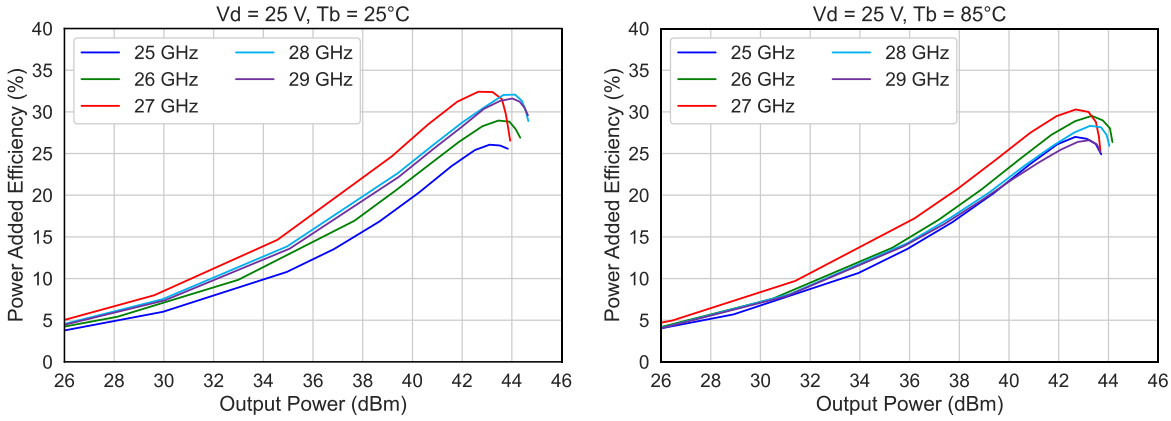
Typical Board Measurements: Large Signal Performance

Test conditions: CW, Vd = 25V, Idq = 340mA, Tb = 25°C / 85°C
Measurement reference plane is de-embedded at the wire-bonding plane of the RF lines.

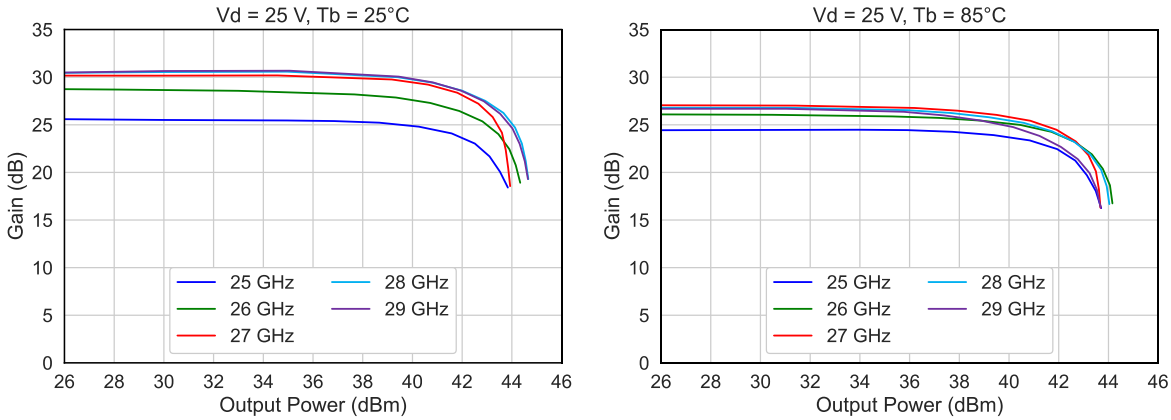
Output Power vs. Input Power and Freq.



Power Added Efficiency vs. Output Power and Freq.



Gain vs. Output Power and Freq.

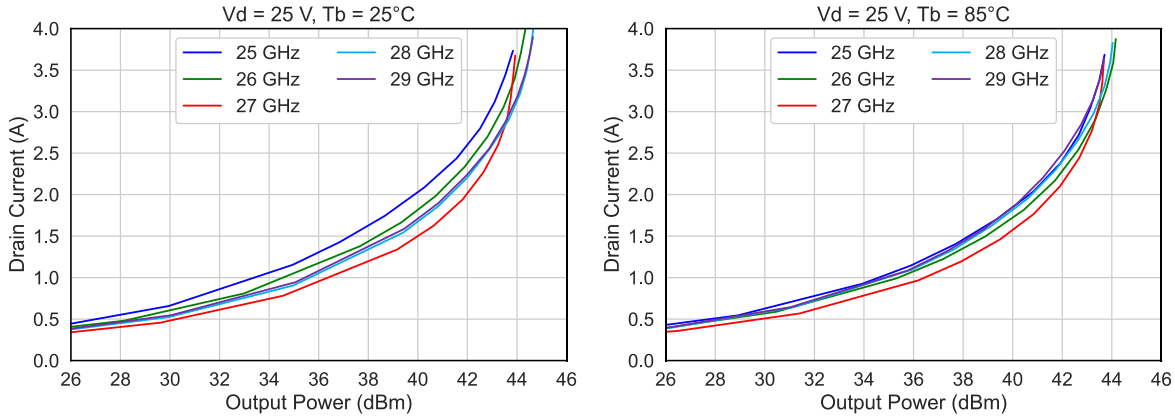


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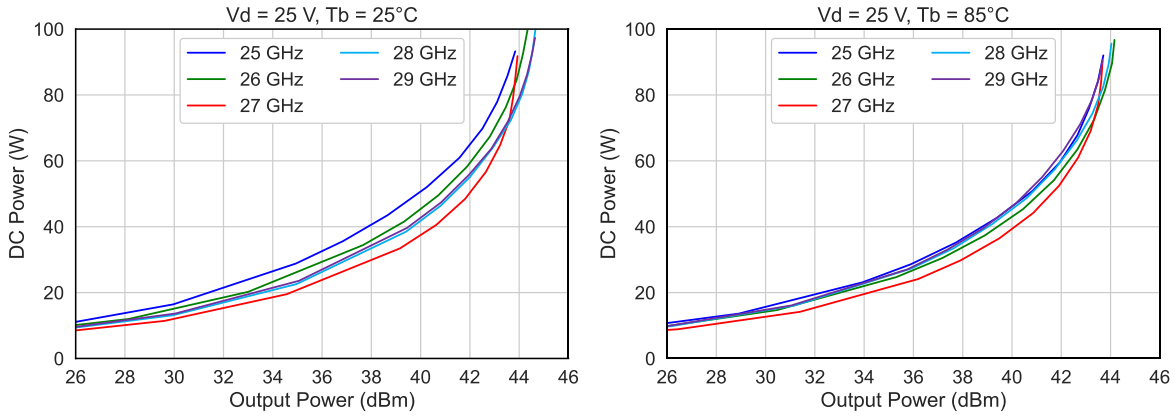
Typical Board Measurements: Large Signal Performance

Test conditions: CW, Vd = 25V, Idq = 340mA, Tb = 25°C / 85°C
Measurement reference plane is de-embedded at the wire-bonding plane of the RF lines.

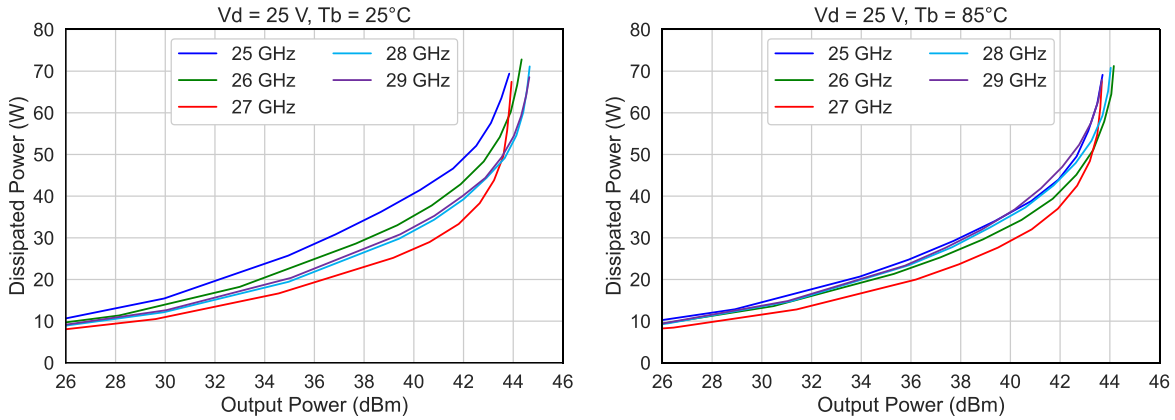
Drain Current vs. Output Power and Freq.



DC Power Consumption vs. Output Power and Freq.



Dissipated Power vs. Output Power and Freq.

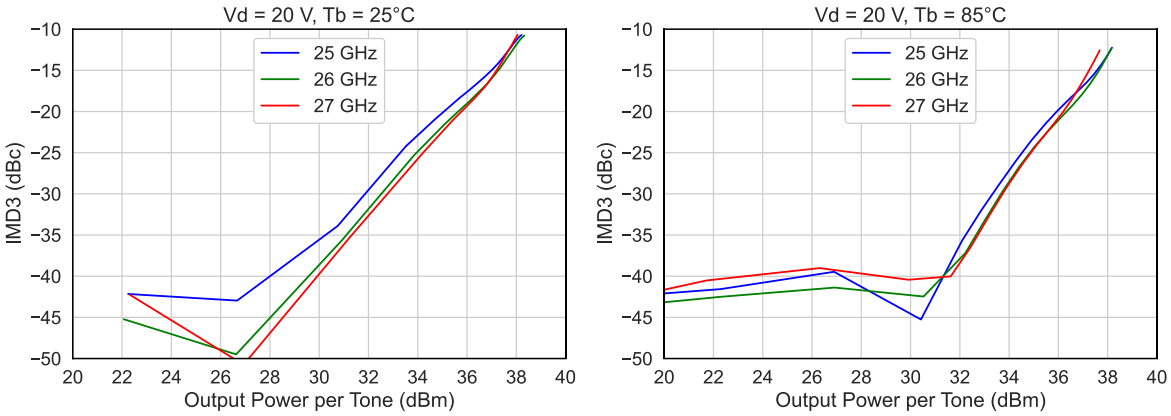


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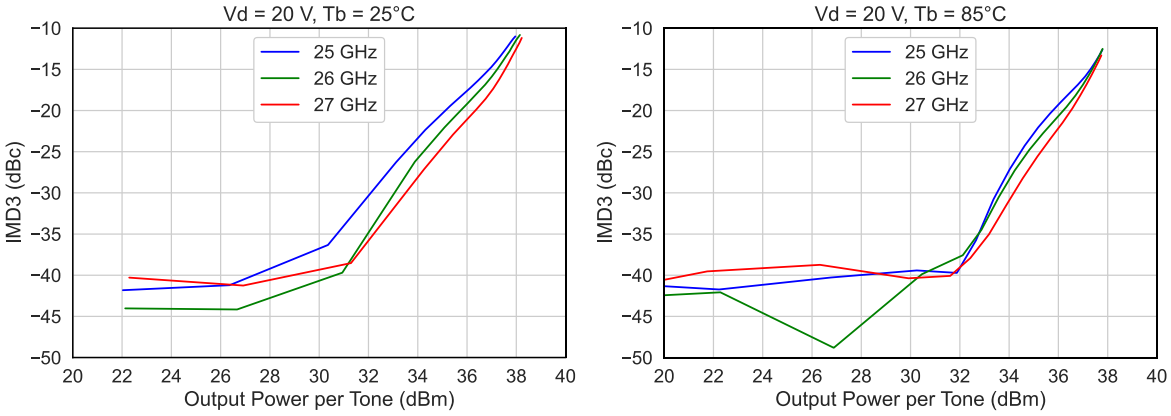
Typical Board Measurements: Intermodulation Distortion

Test conditions: CW, Vd = 20V, Idq = 340mA, Tb = 25°C / 85°C
Measurement reference plane is de-embedded at the wire-bonding plane of the RF lines.

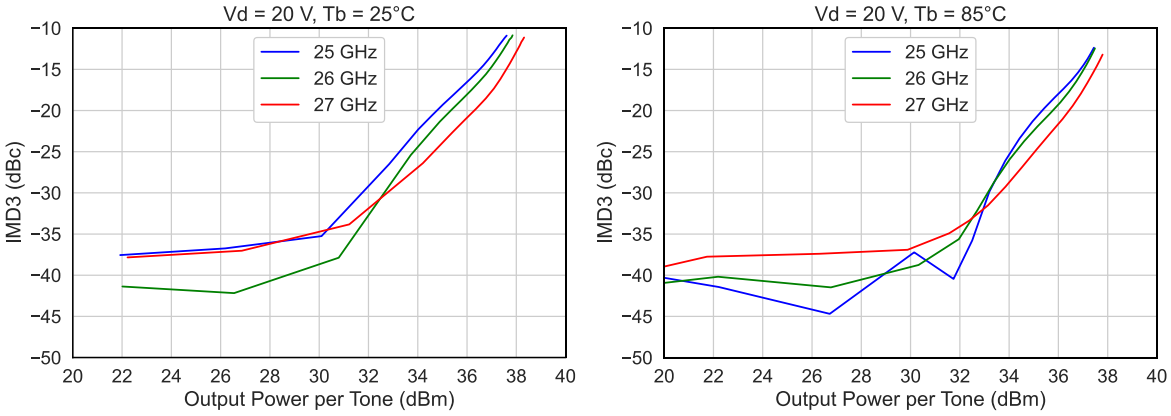
IMD3 at 10MHz Tone Separation vs. Output Power per Tone and Freq.



IMD3 at 100MHz Tone Separation vs. Output Power per Tone and Freq.



IMD3 at 200MHz Tone Separation vs. Output Power per Tone and Freq.

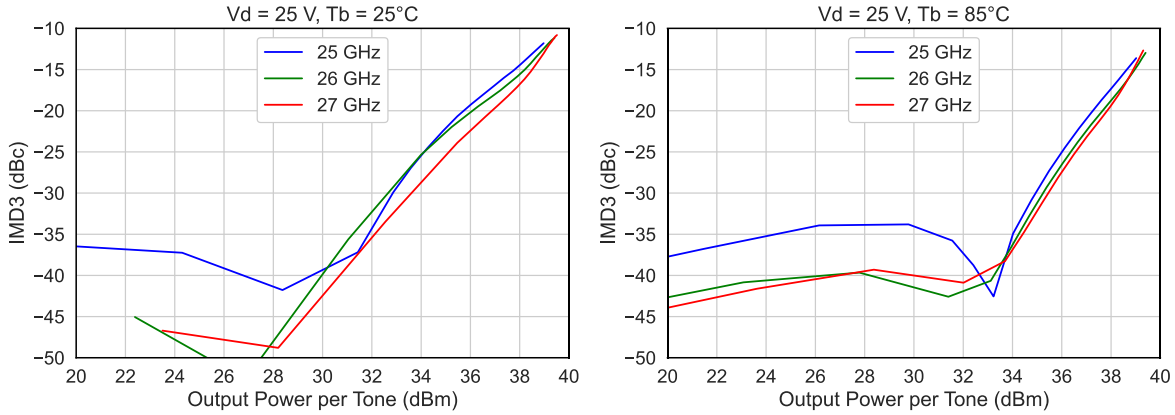


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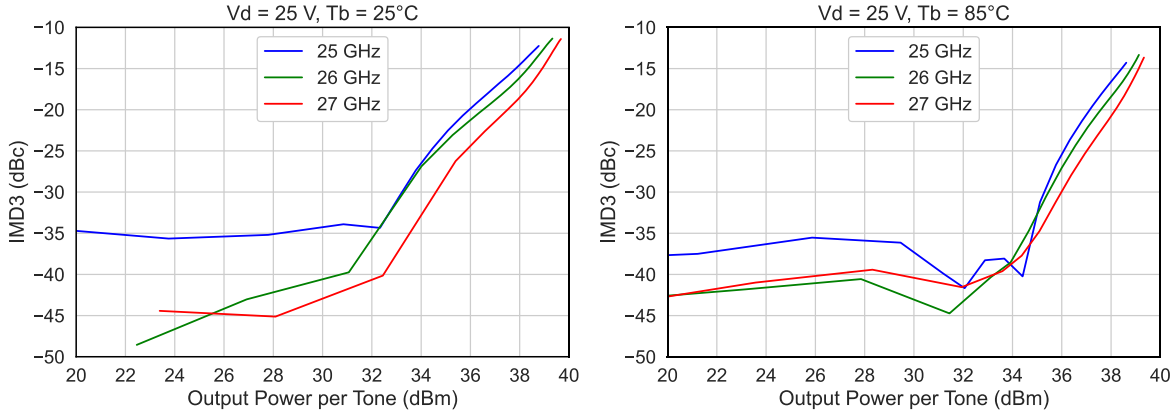
Typical Board Measurements: Intermodulation Distortion

Test conditions: 2-tones CW measurements, Vd = 25V, Idq = 340mA, Tb = 25°C / 85°C
Measurement reference plane is de-embedded at the wire-bonding plane of the RF lines.

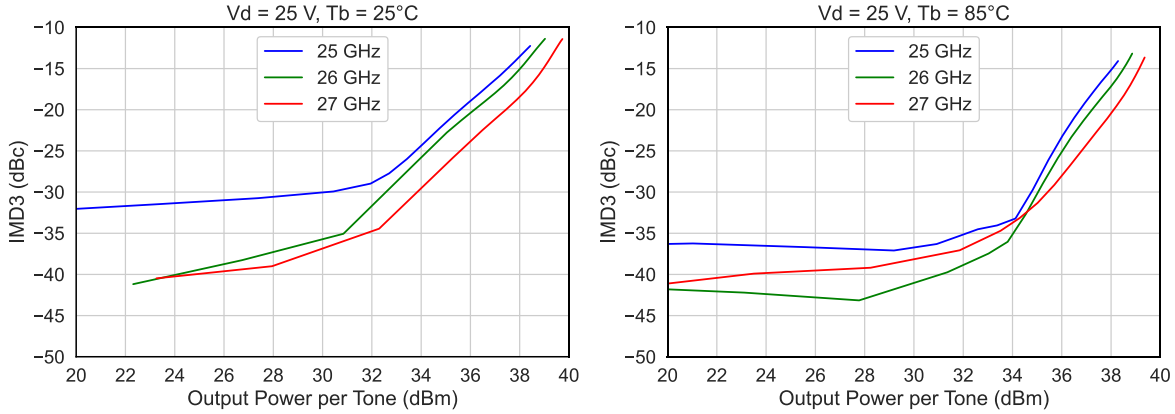
IMD3 at 10MHz Tone Separation vs. Output Power per Tone and Freq.



IMD3 at 100MHz Tone Separation vs. Output Power per Tone and Freq.



IMD3 at 200MHz Tone Separation vs. Output Power per Tone and Freq.

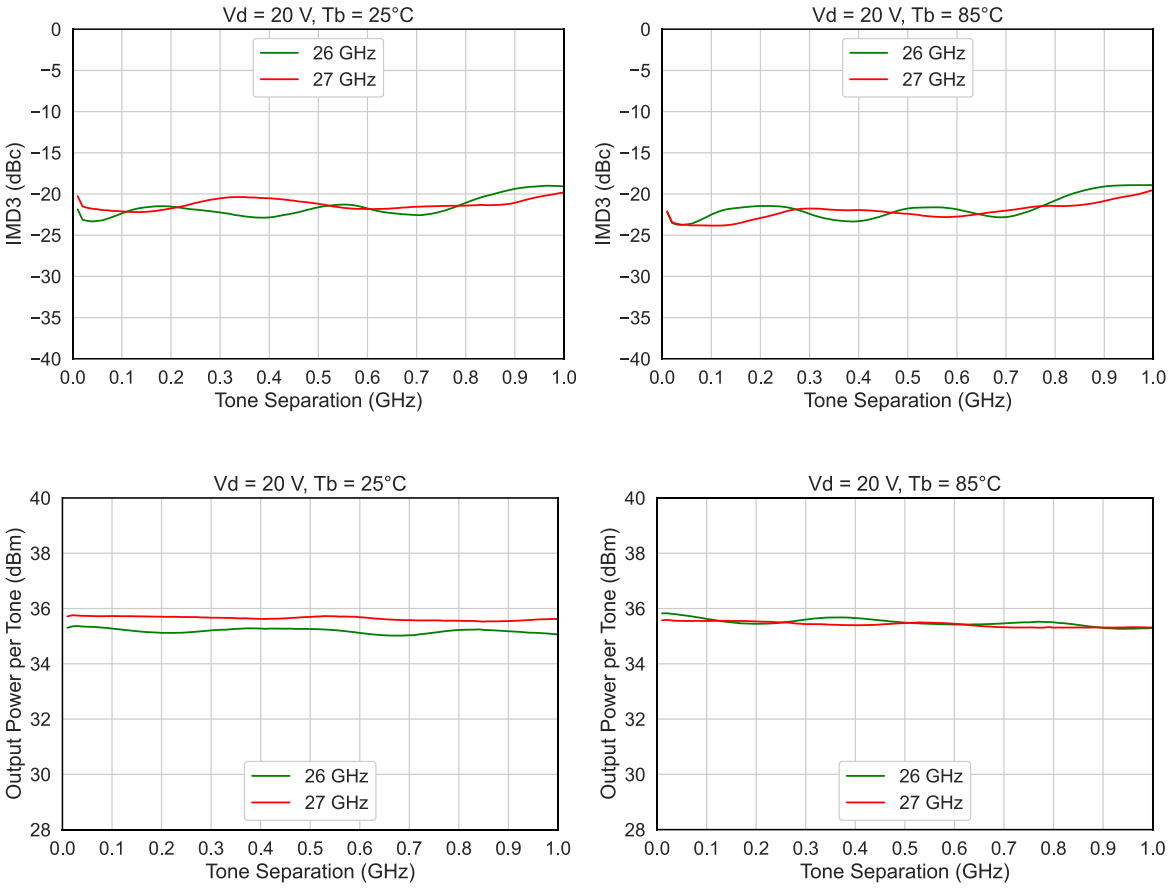


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Typical Board Measurements: Intermodulation Distortion

Test conditions: 2-tones CW measurements, Vd = 20V, Idq = 340mA, Tb = 25°C / 85°C
Measurement reference plane is de-embedded at the wire-bonding plane of the RF lines.

IMD3 with associated Output Power per Tone vs. Tone Separation and Freq.

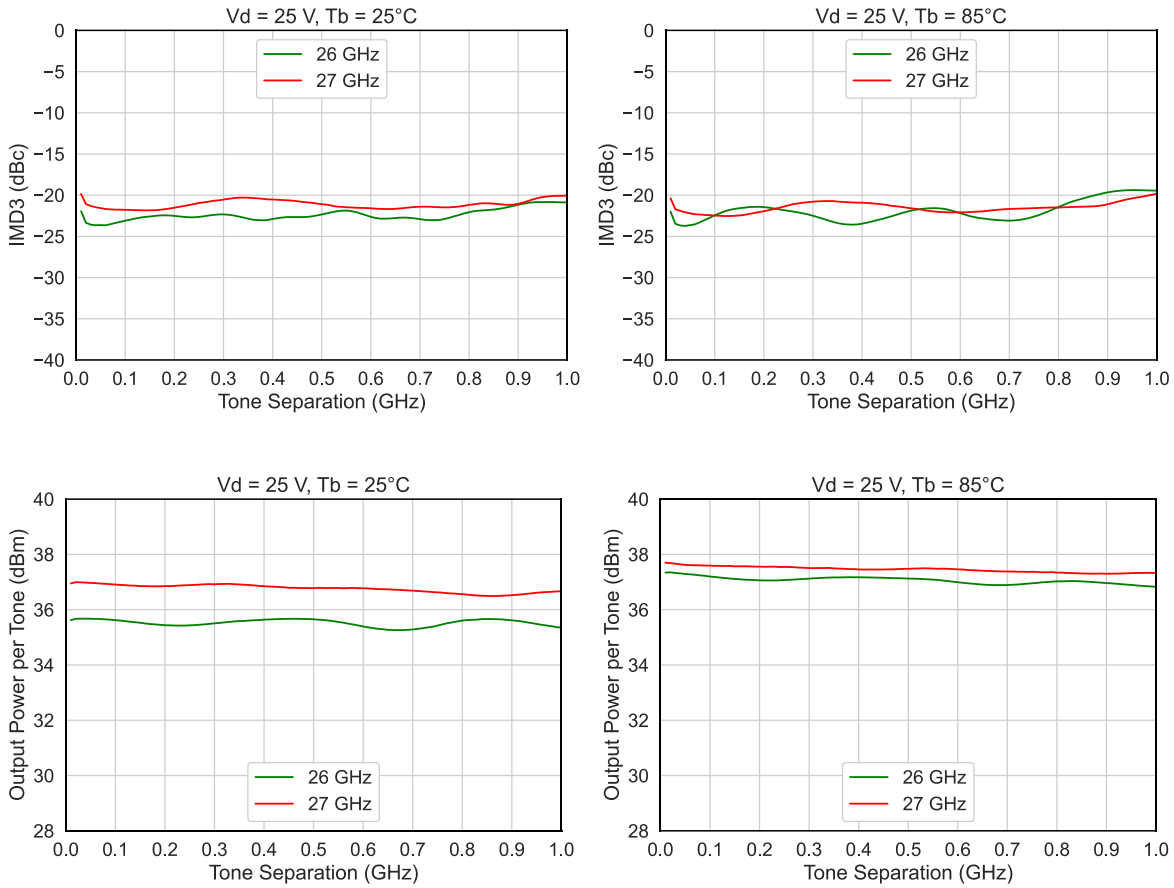


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Typical Board Measurements: Intermodulation Distortion

Test conditions: 2-tones CW measurements, Vd = 25V, Idq = 340mA, Tb = 25°C / 85°C
Measurement reference plane is de-embedded at the wire-bonding plane of the RF lines.

IMD3 with associated Output Power per Tone vs. Tone Separation and Freq.

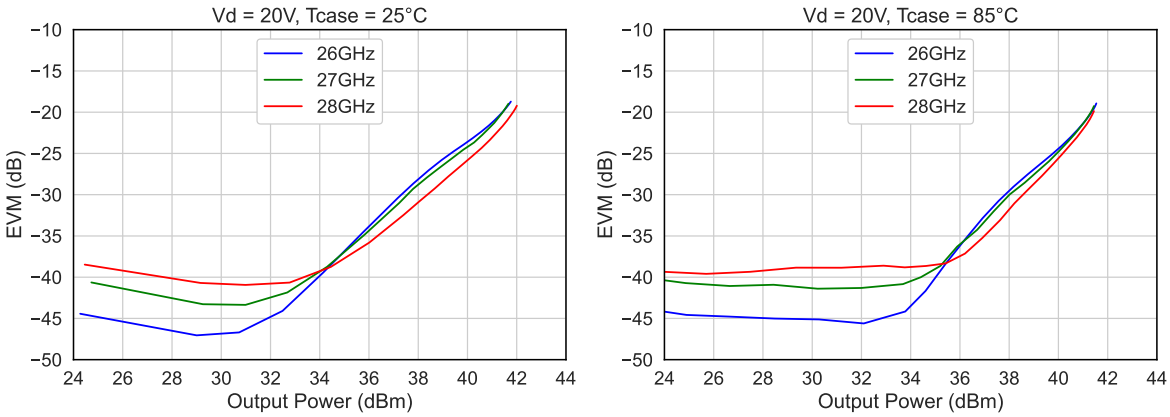


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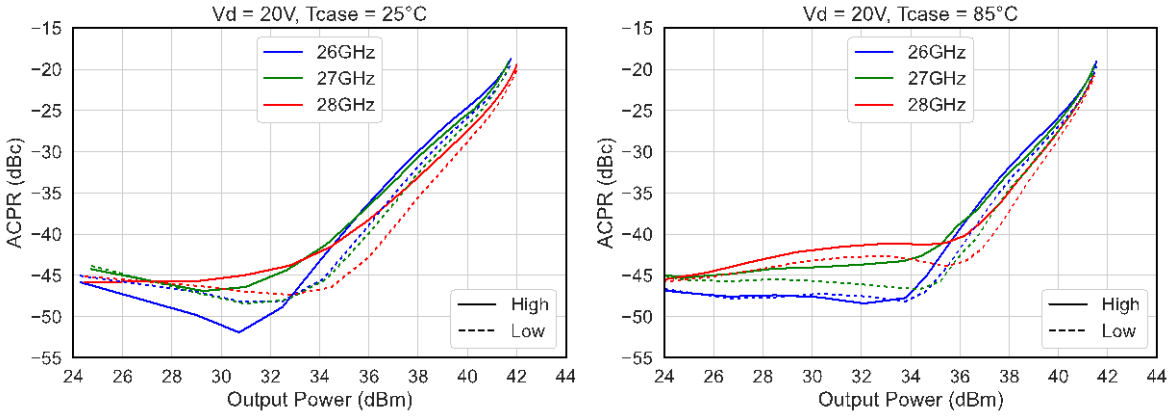
Typical Board Measurements: Modulated Measurements

Test conditions: Vd = 20V, Idq = 340mA, 8PSK, BW = 30MHz, Roll-off = 0.2, PAPR = 5.0dB
Measurement reference plane is de-embedded at the wire-bonding plane of the RF lines.

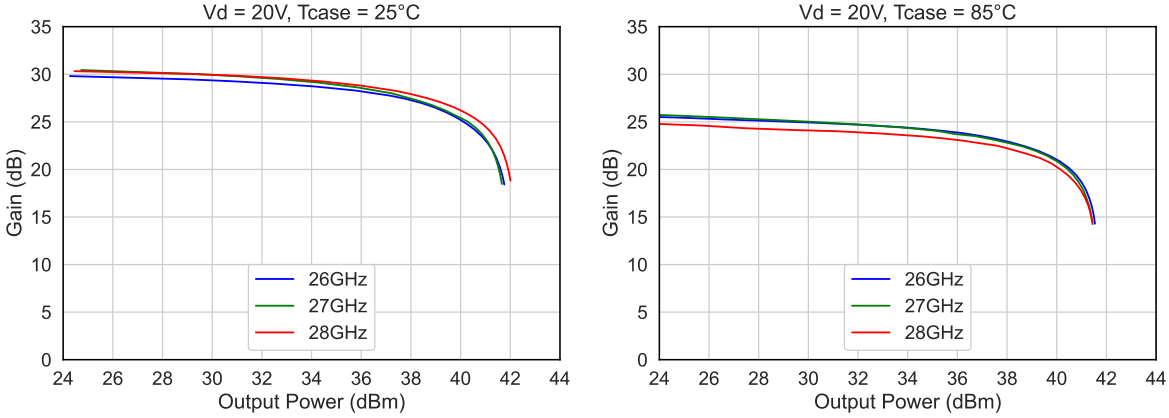
EVM vs. Output Power and Freq.



ACPR vs. Output Power and Freq.



Gain vs. Output Power and Freq.

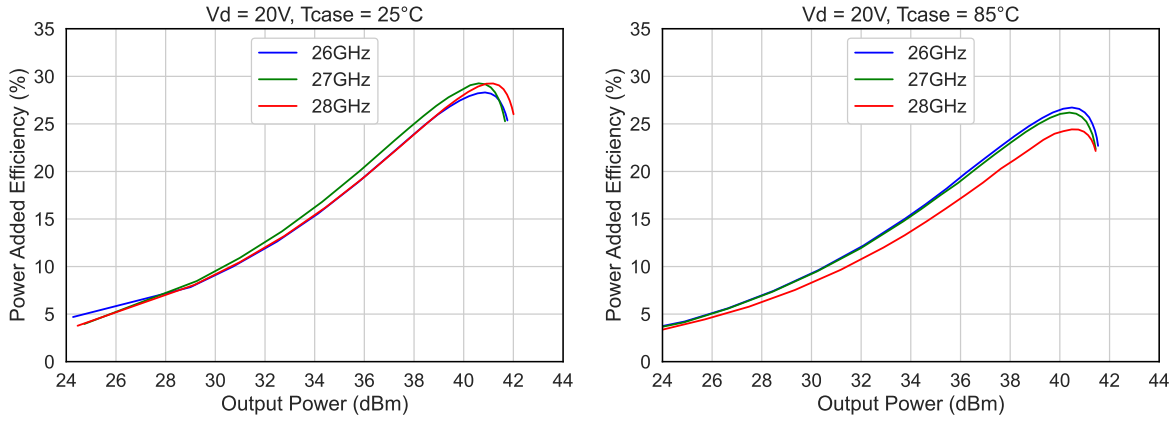


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Power Added Efficiency vs. Output Power and Freq.

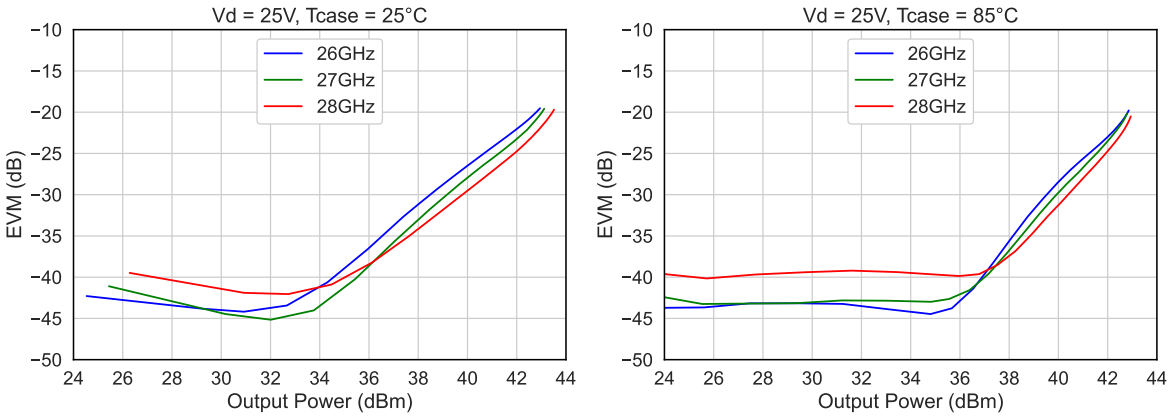


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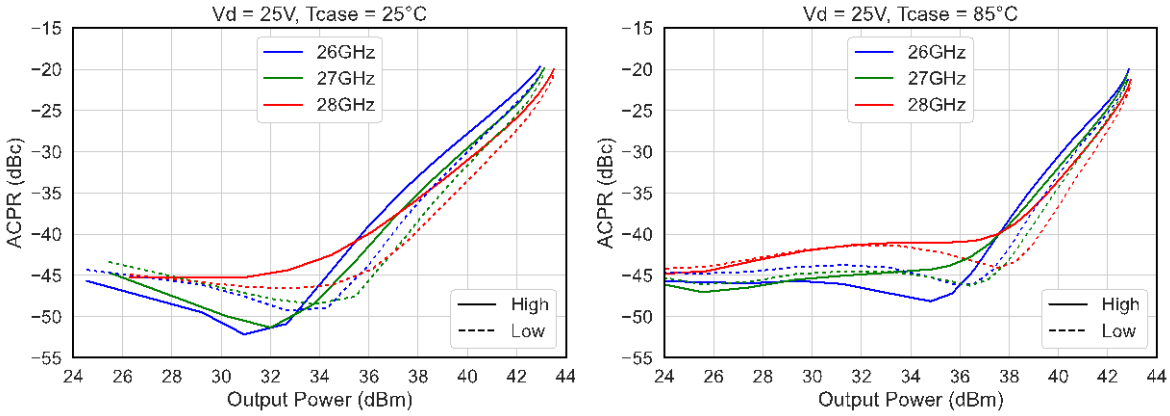
Typical Board Measurements: Modulated Measurements

Test conditions: Vd = 25V, Idq = 340mA, 8PSK, BW = 30MHz, Roll-off = 0.2, PAPR = 5.0dB
Measurement reference plane is de-embedded at the wire-bonding plane of the RF lines.

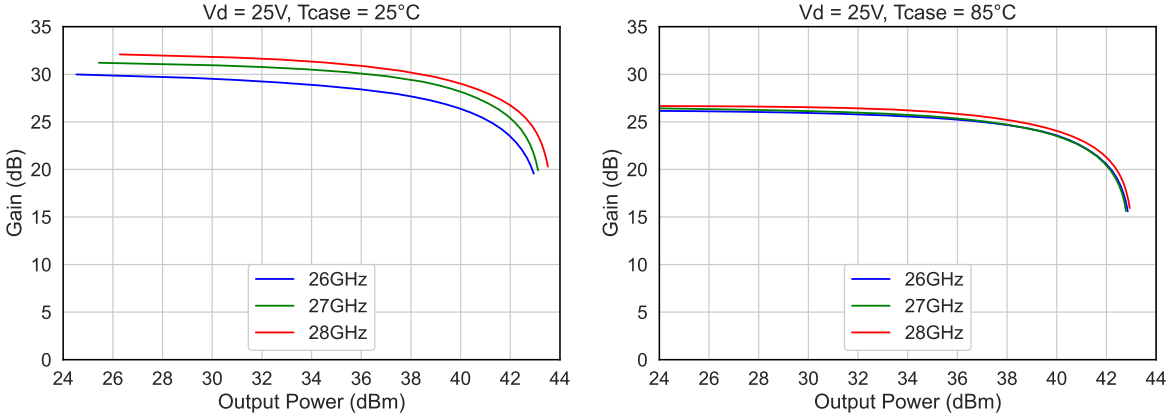
EVM vs. Output Power and Freq.



ACPR vs. Output Power and Freq.



Gain vs. Output Power and Freq.

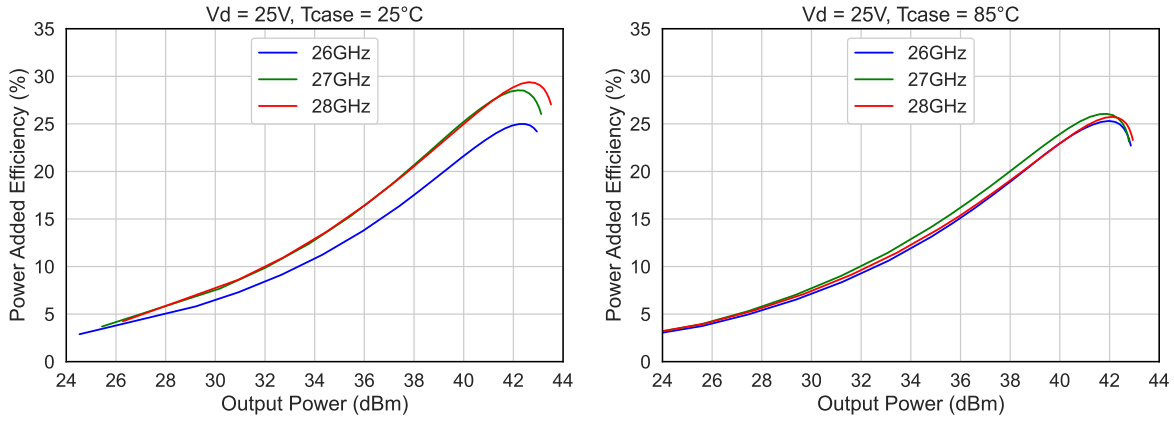


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Power Added Efficiency vs. Output Power and Freq.

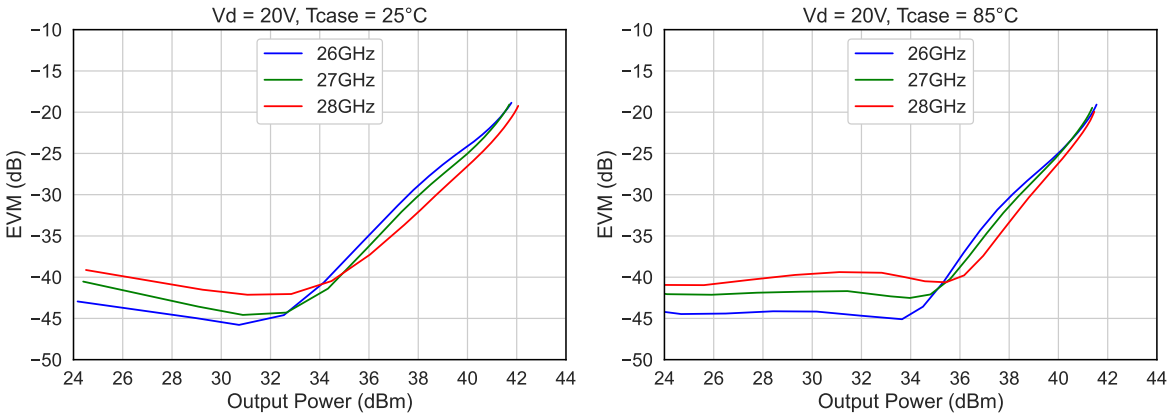


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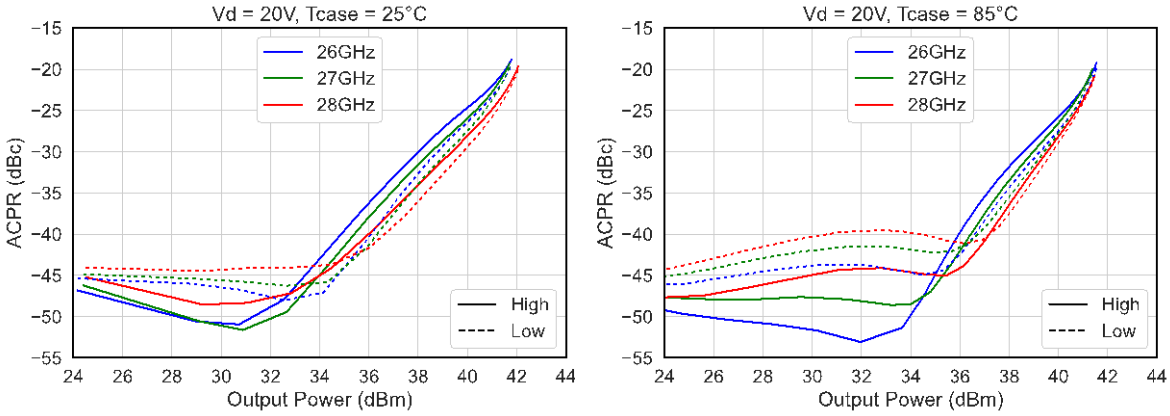
Typical Board Measurements: Modulated Measurements

Test conditions: Vd = 20V, Idq = 340mA, 8PSK, BW = 100MHz, Roll-off = 0.2, PAPR = 5.0dB
Measurement reference plane is de-embedded at the wire-bonding plane of the RF lines.

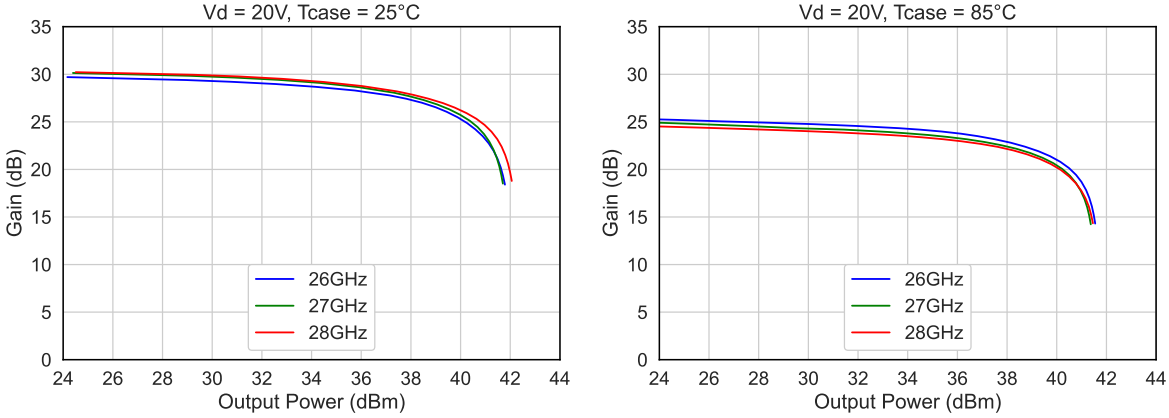
EVM vs. Output Power and Freq.



ACPR vs. Output Power and Freq.



Gain vs. Output Power and Freq.

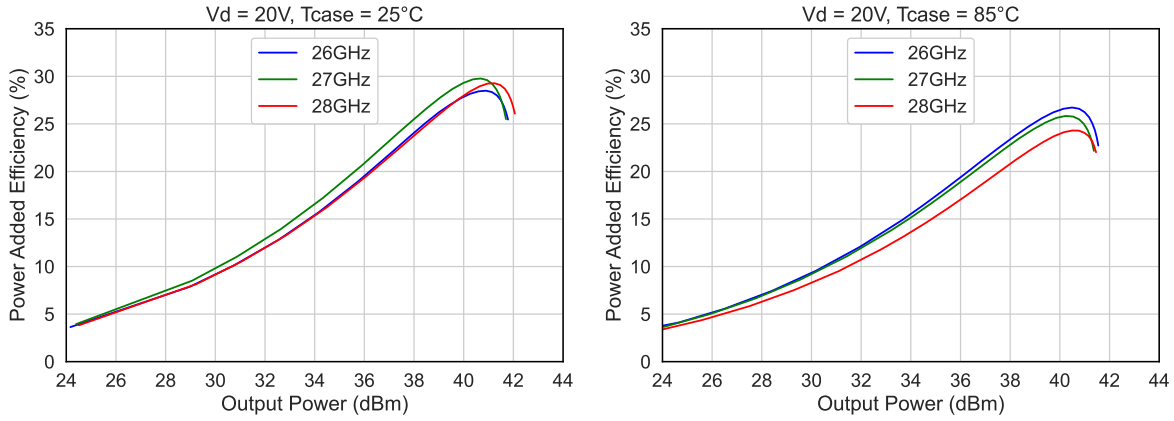


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Typical Board Measurements: Modulated Measurements

Test conditions: Vd = 20V, Idq = 340mA, 8PSK, BW = 100MHz, Roll-off = 0.2, PAPR = 5.0dB
Measurement reference plane is de-embedded at the wire-bonding plane of the RF lines.

Power Added Efficiency vs. Output Power and Freq.

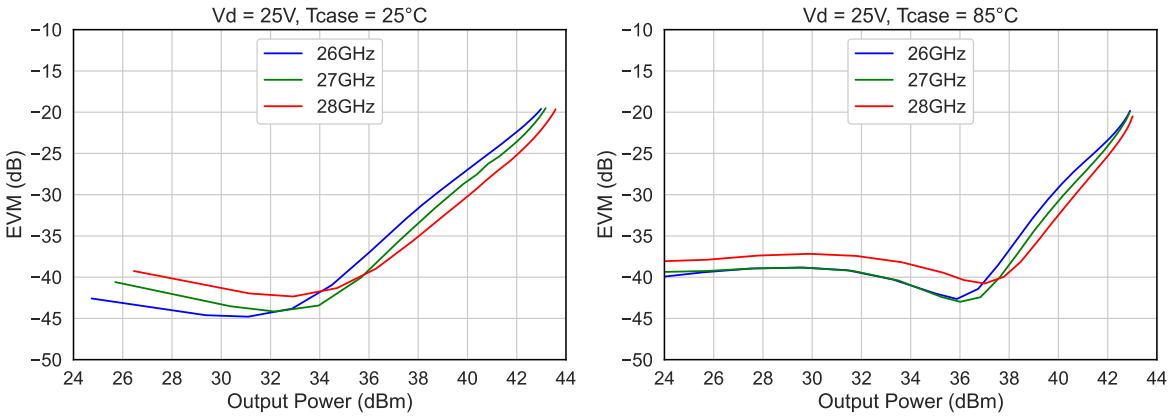


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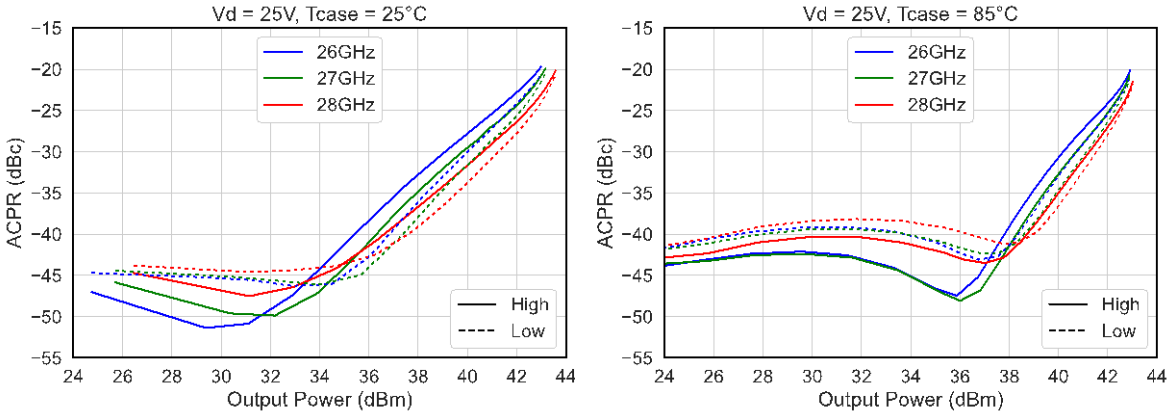
Typical Board Measurements: Modulated Measurements

Test conditions: Vd = 25V, Idq = 340mA, 8PSK, BW = 100MHz, Roll-off = 0.2, PAPR = 5.0dB
Measurement reference plane is de-embedded at the wire-bonding plane of the RF lines.

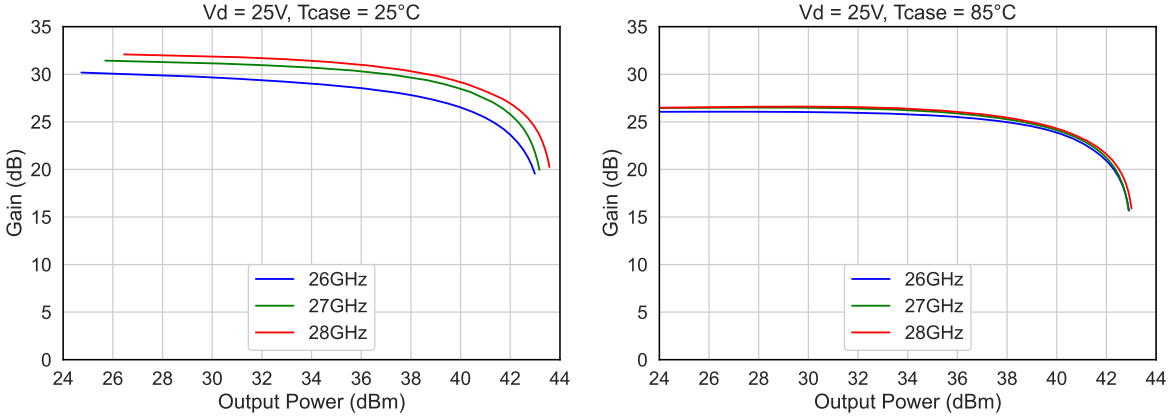
EVM vs. Output Power and Freq.



ACPR vs. Output Power and Freq.



Gain vs. Output Power and Freq.

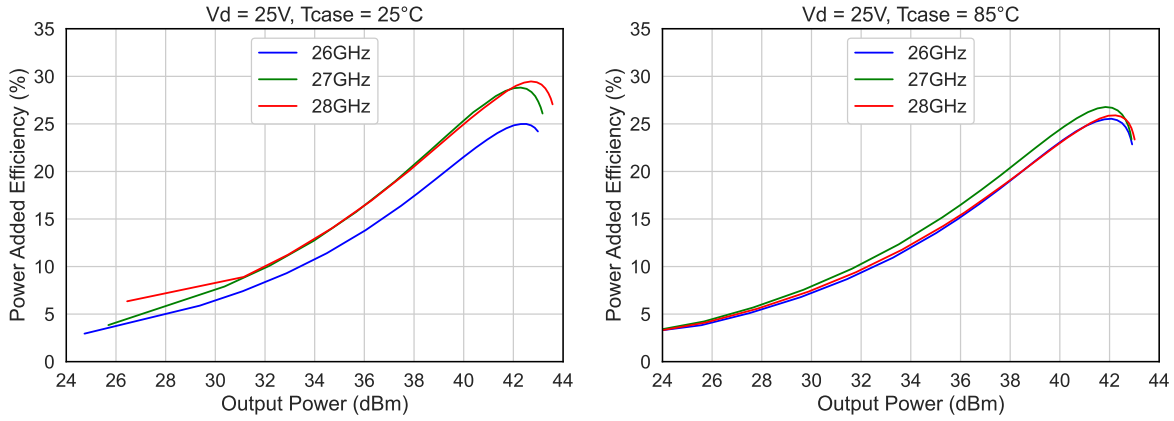


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Test conditions: Vd = 25V, Idq = 340mA, 8PSK, BW = 100MHz, Roll-off = 0.2, PAPR = 5.0dB
Measurement reference plane is de-embedded at the wire-bonding plane of the RF lines.

Power Added Efficiency vs. Output Power and Freq.

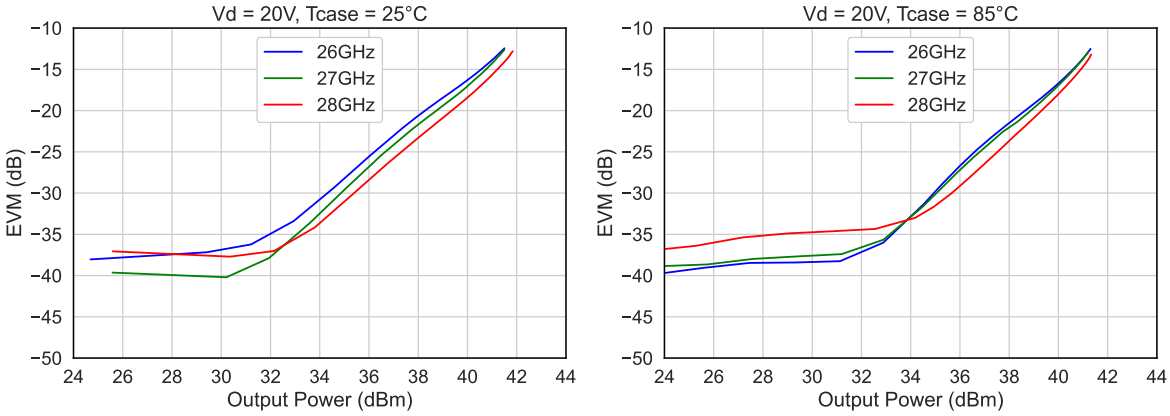


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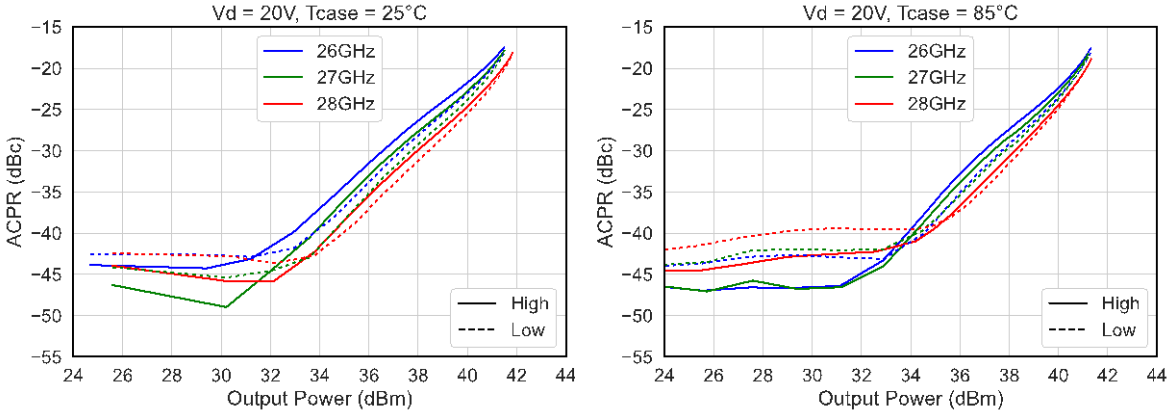
Typical Board Measurements: Modulated Measurements

Test conditions: Vd = 20V, Idq = 340mA, 256QAM, BW = 100MHz, Roll-off = 0.2, PAPR=7.2dB
Measurement reference plane is de-embedded at the wire-bonding plane of the RF lines.

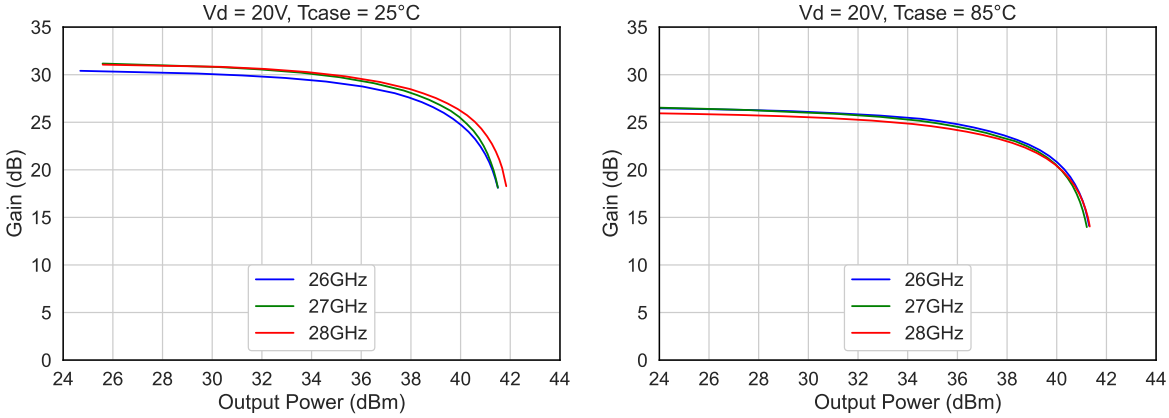
EVM vs. Output Power and Freq.



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Gain vs. Output Power and Freq.

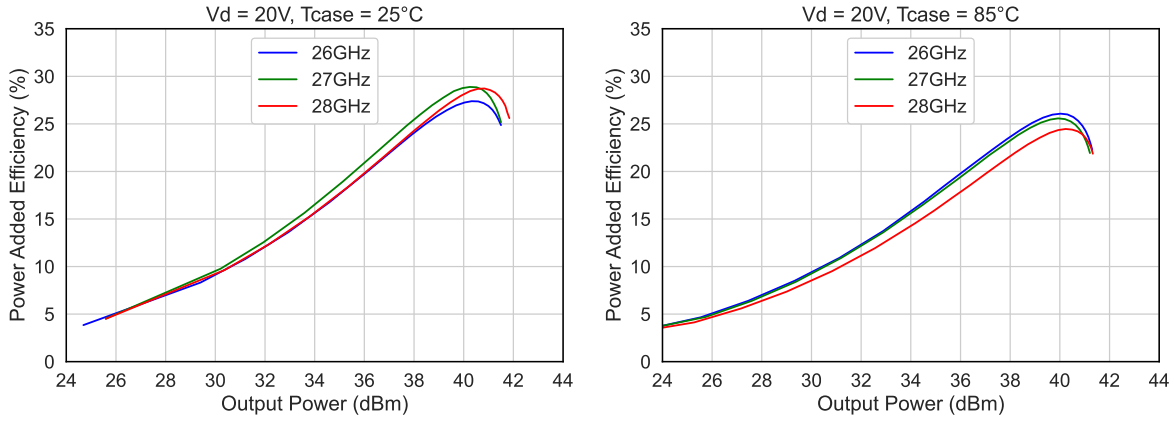


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Typical Board Measurements: Modulated Measurements

Test conditions: Vd = 20V, Idq = 340mA, 256QAM, BW = 100MHz, Roll-off = 0.2, PAPR=7.2dB
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Power Added Efficiency vs. Output Power and Freq.

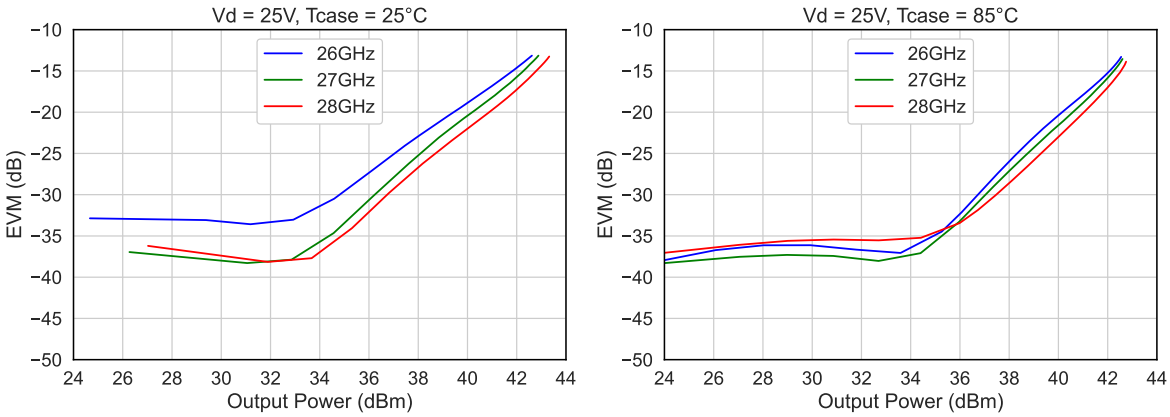


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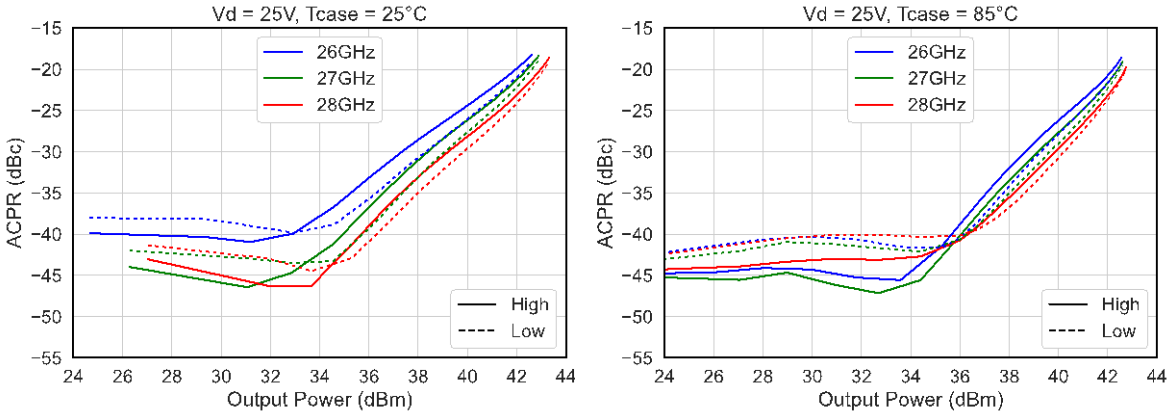
Typical Board Measurements: Modulated Measurements

Test conditions: Vd = 25V, Idq = 340mA, 256QAM, BW = 100MHz, Roll-off = 0.2, PAPR=7.2dB
Measurement reference plane is de-embedded at the wire-bonding plane of the RF lines.

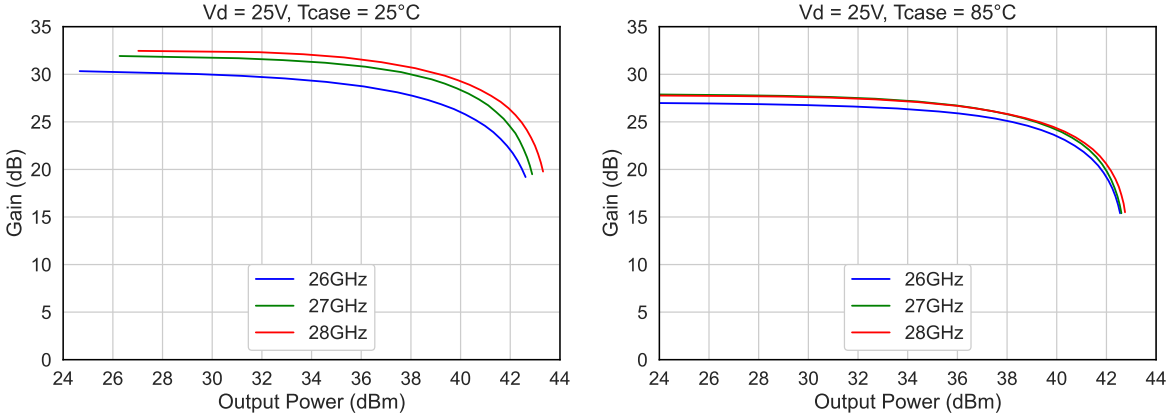
EVM vs. Output Power and Freq.



ACPR vs. Output Power and Freq.



Gain vs. Output Power and Freq.

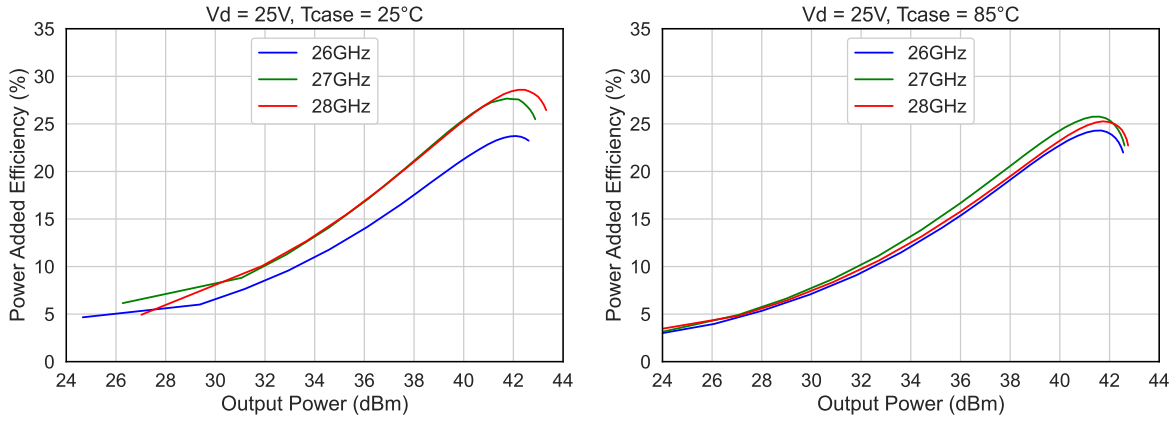


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Typical Board Measurements: Modulated Measurements

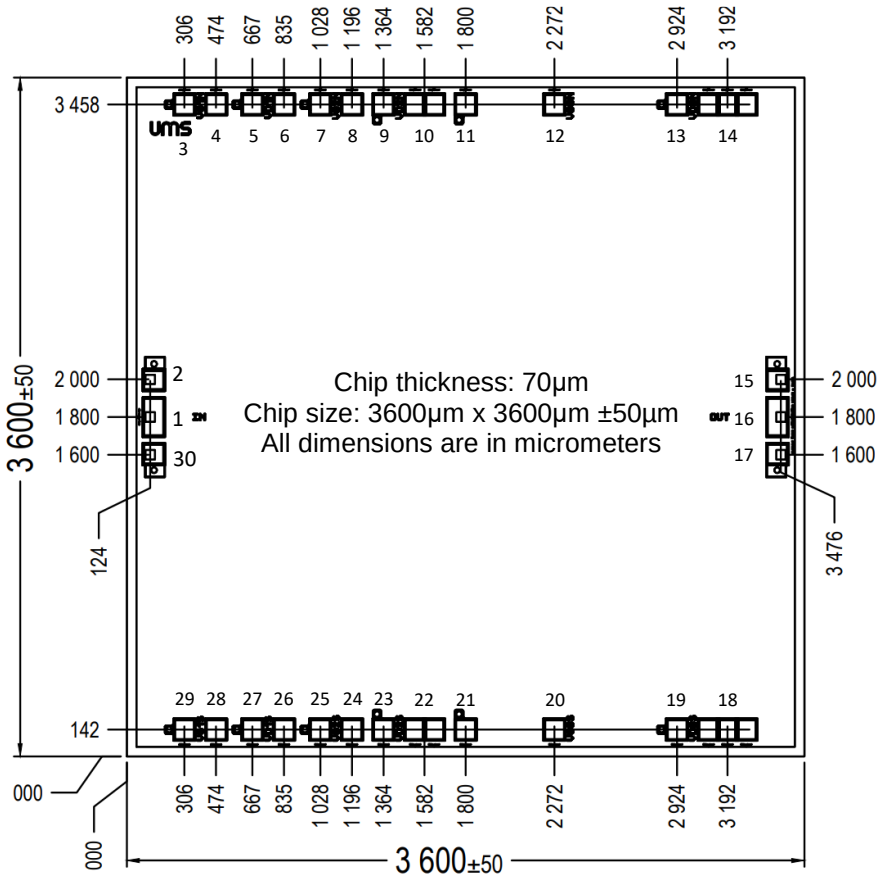
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Power Added Efficiency vs. Output Power and Freq.



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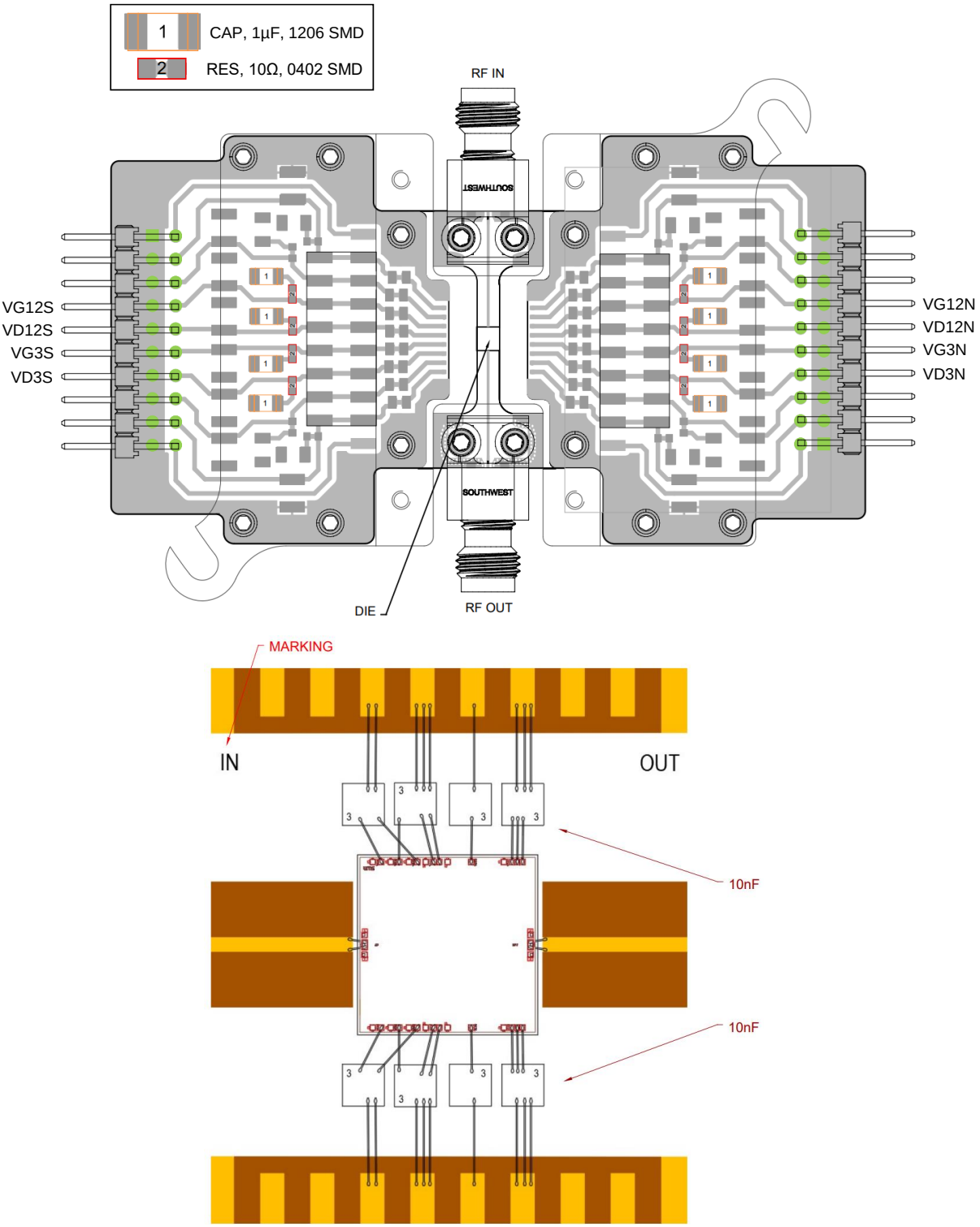
Mechanical data



Pad Number	Name	Description	Pad Opening Size
1	RF IN	Input RF port	194µm x 102µm
4	VG1N	DC Gate voltage, 1st stage, North	100µm x 100µm
6	VD1N	DC Drain voltage 1st stage, North	100µm x 100µm
8	VG2N	DC Gate voltage 2nd stage, North	100µm x 100µm
10	VD2N	DC Drain voltage, 2nd stage, North	200µm x 100µm
12	VG3N	DC Gate voltage 3rd stage, North	100µm x 100µm
14	VD3N	DC Drain voltage 3rd stage, North	300µm x 100µm
16	RF OUT	Output RF port	194µm x 102µm
18	VD3S	DC Drain voltage 3rd stage, South	300µm x 100µm
20	VG3S	DC Gate voltage 3rd stage, South	100µm x 100µm
22	VD2S	DC Drain voltage, 2nd stage, South	200µm x 100µm
24	VG2S	DC Gate voltage 2nd stage, South	100µm x 100µm
26	VD1S	DC Drain voltage 1st stage, South	100µm x 100µm
28	VG1S	DC Gate voltage, 1st stage, South	100µm x 100µm
2, 3, 5, 7, 9, 11, 13, 15, 17, 19, 21, 23, 25, 27, 29, 30	GND	Ground	100µm x 100µm

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Recommended Assembly Plan



Two levels of decoupling capacitors are recommended, one on the tab and the other on the PCB. The first level is composed of 10nF chip capacitors, the second level is composed of 1µF SMD capacitors with 10Ω SMD series resistors. The first level should be as close as possible to the die.

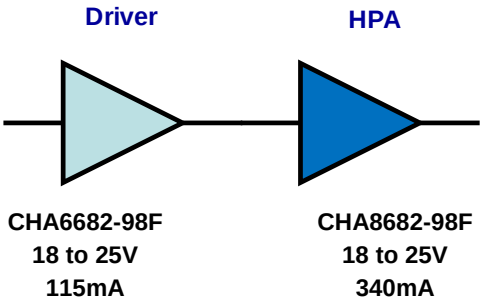
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ESD Sensitivity

Parameter	Classification	Standard
Human Body Model (HBM)	1A	ANSI/ESDA/JEDEC – JS-001

Recommended UMS Power chain

The CHA8682-98F is recommended with the CHA6682-QKB as driver.
Total Gain: > 50dB
For more information about the CHA6682-QKB, see our web site www.ums-rf.com



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Recommended reflow process assembly

Refer to the application note AN0001 available at http://www.ums-rf.com for die attach.

Recommended environmental management

UMS products are compliant with the regulation in particular with the directives RoHS N°2011/65 and REACh N°1907/2006. More environmental data are available in the application note AN0019 also available at http://www.ums-rf.com.

Recommended ESD management

Refer to the application note AN0020 available at http://www.ums-rf.com for ESD sensitivity and handling recommendations for the UMS products.

Evaluation Board (EVB)

Refer to the application note AN0030 available at http://www.ums-rf.com for information and recommendations related to the evaluation board.

Ordering Information

Chip form:	CHA8682-98F/00
Evaluation Board:	EVB-CHA8682-98F

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