United Monolithic Semiconductors

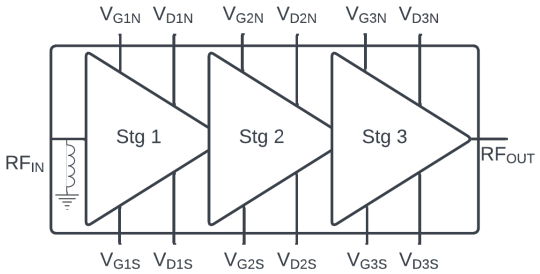
CHA8362-99F

26.5-31GHz 25W High Power Amplifier

GaN Monolithic Microwave IC

Description

The CHA8362-99F is a three stage High Power Amplifier operating between 26.5 and 31GHz and providing typically 25W of saturated output power associated to 30% of Power Added Efficiency. This amplifier exhibits 40dBm linear power with -33dBc ACPR & 19dBc NPR with 25% PAE. It also provides more than 25dB small signal gain. This HPA is dedicated to SatCom and 5G 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. Input & output are 50Ω matched.

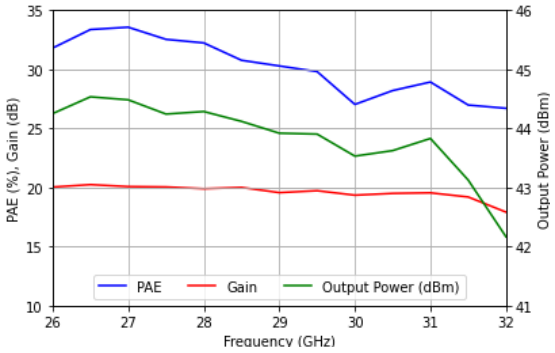


Main Features

- Frequency range: 26.5 – 31GHz
- High output power: 25W
- High PAE: 30%
- ACPR = -33dBc at 40dBm Average Pout(1)
- Linear Gain: 25dB
- DC bias: VD = 25V & Idq = 440mA
- Chip size: 3.6 x 3.6mm²
- Available in bare die form

(1) 100MHz modulation bandwidth, 256QAM

V_D = 25V, I_{dq} = 440mA, T_{BS} = 25°C, Pin = 25dBm



Main Electrical Characteristics

T_{BS} = 25°C (T_{BS}: chip backside temperature)

Symbol	Parameter	Min	Typ	Max	Unit
Freq	Frequency range	26.5		31	GHz
Gain	Linear Gain		25		dB
Pout	Output Power @ Pin=25dBm		44		dBm
ACPR	ACPR @ Pout = 40dBm with 256QAM modulation (BW=100MHz)		-33		dBc
NPR	Noise Power Ratio @ Pout = 40dBm (BW=45MHz)		19		dBc
PAE	Power Added Efficiency @ Pin = 25dBm		30		%

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Specifications

T_{BS} = +25°C, Vd = +25V, CW excitation

Symbol	Parameter	Min	Typ	Max	Unit
Freq	Frequency range	26.5		31	GHz
Gain	Linear Gain		25		dB
Pout	Output Power @ Pin = 25dBm (Psat)		44		dBm
PAE	Power Added Efficiency		30		%
Id	Drain current at saturation		3.5		A
S11	Input Return Loss		-9		dB
S22	Output return loss		-12		dB
Idq	Quiescent current		440		mA
Vd	Drain Voltage		25		V

These values are representative of on-board measurements as defined on the drawing in paragraph "Evaluation mother board".

Absolute Maximum Ratings (1)

T_{BS} = +25°C

Symbol	Parameter	Values	Unit
Vd	Drain bias voltage	27	V
Id	Quiescent Drain bias current	1000	mA
Vg	Gate bias voltage	-7 to -1	V
Pin	Maximum Input Power	30	dBm

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

Recommended Operating Range (2), (3)

Symbol	Parameter	Values	Unit
Vd	Drain bias voltage	18 to 25	V
Id	Drain bias current	300 to 700	mA
Vg	Gate bias voltage	-3.5 to -2.5	V
Pin	Maximum Input Power	25	dBm
Tj	Maximum Junction temperature(4)	200	°C

(2) Electrical performances are defined for specified test conditions

(3) Electrical performances are not guaranteed over all recommended operating conditions

(4) See Device thermal performances section.

Temperature Range

T_{BS}	Operating temperature range	-40 to +95	°C
Tstg	Storage temperature range	-55 to +150	°C

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Typical Bias Conditions

T_{BS} = 25°C

Symbol	Pad N°	Parameter	Values	Unit
V_G	4,8 11, 23, 26, 30	Gate voltage tuned for I_{dq} = 440mA	-3	V
V_D	6,10,14, 20, 24,28	Drain voltage	25	V

"Power ON" sequence

1. Bias HPA gate voltage at Vg close to Vpinch-off (Typically: $V_G \approx -5$)
2. Apply V_D bias voltage (Typically: V_D = 25V)
3. Increase gate voltage V_g up to quiescent bias drain current I_{dq}
4. Apply RF signal

"Power OFF" sequence

1. Turn off RF signal
2. Bias HPA gate voltage at Vg close to Vpinch-off (Typically: $V_G \approx -5V$)
3. Check that quiescent bias drain current I_{dq} is close to 0mA
4. Turn V_D bias voltage to 0V
5. Check that quiescent bias drain current I_{dq} is close to 0mA
6. Turn V_G bias voltage to 0V

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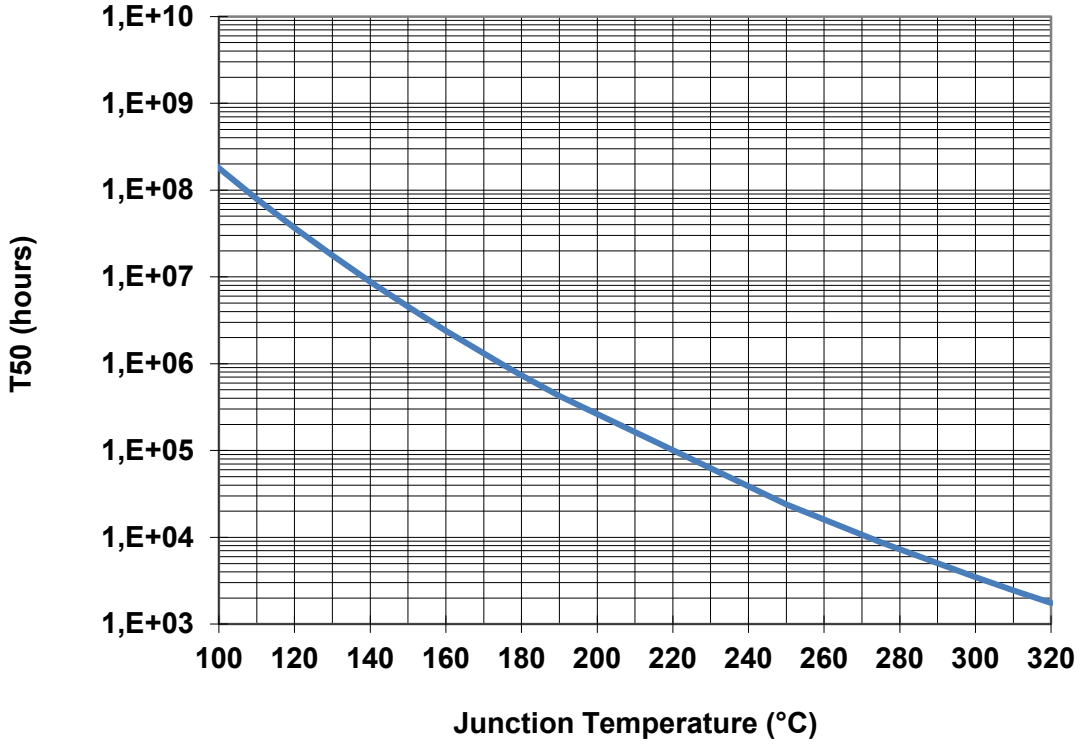
Device thermal performances

The device thermal performances below are based on UMS rules to evaluate the junction temperature.
This same procedure is the basis for junction temperature evaluation of the samples used to derive the Median lifetime and activation energy for the particular technology on which the CHA8362-99F is manufactured (GaN HEMT 0.15µm).
The temperature T_{BS} is defined as the chip backside temperature. The thermal resistance (Rth_eq), given in the following table, is for the full circuit in CW mode.

Thermal Resistance (1)	R_{th_eq}	T_{BS} = 25°C, Vd = 25V, Idq = 440 mA, Pin = 26 dBm, Freq = 29GHz, Pdiss = 56 W	1.27	°C/W
Junction Temperature	T_j		95	°C
Median Life	T50		>2E8	Hrs
Thermal Resistance (1)	R_{th_eq}	T_{BS} = 85°C, Vd = 25V, Idq = 440 mA, Pin = 26 dBm, Freq = 29GHz, Pdiss = 54 W	1.71	°C/W
Junction Temperature	T_j		184	°C
Median Life	T50		5.9E5	Hrs

(1) Thermal resistance measured at the backside of the chip



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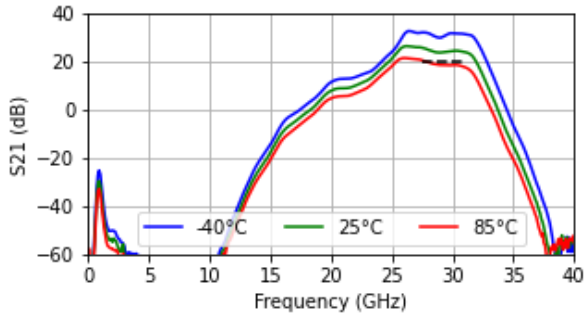
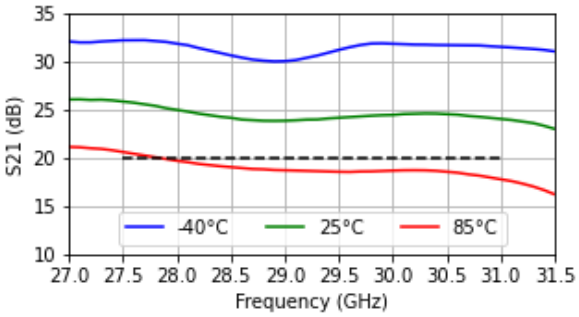
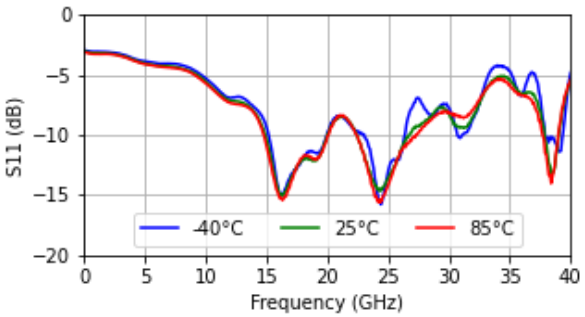
Typical Board Measurements: Small Signal Performances

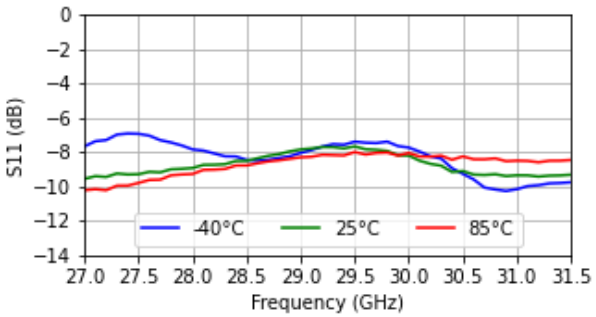
Performance versus temperature

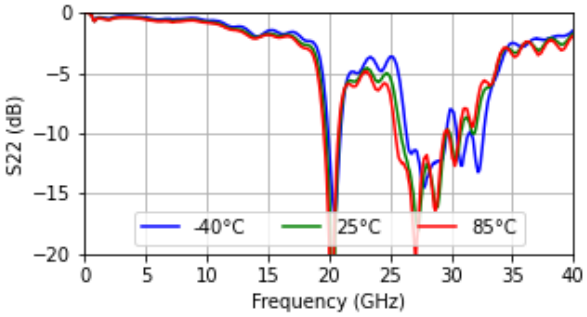
Test conditions : CW, V_D = 25V, I_{DQ} = 440mA, T_{BS} = -40°C / 25°C / 85 °C
Measurements reference planes are de-embedded at the wire bondings plane on the RF feed line.

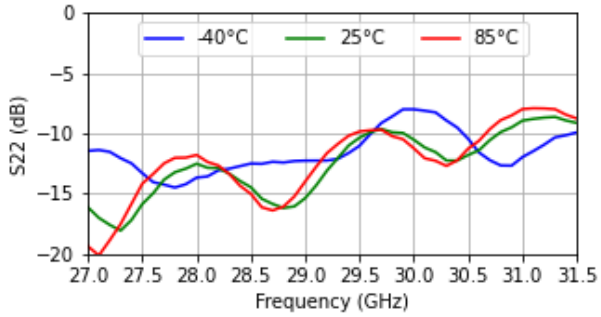












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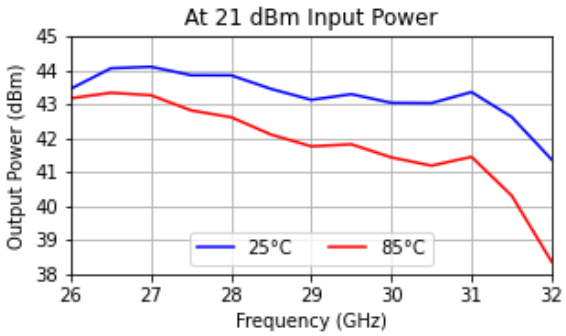
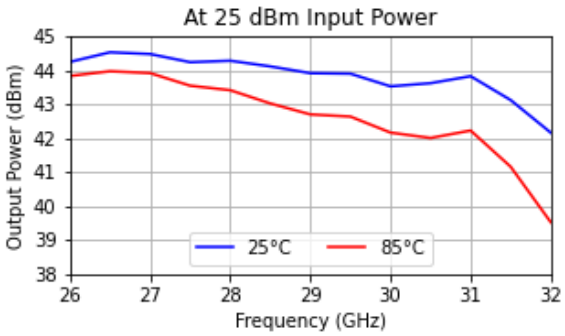
Typical Board Measurements: Large Signal Performances

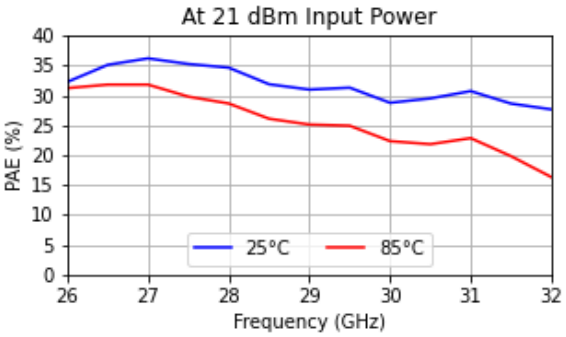
Performance versus frequency and temperature
Test conditions : CW, V_D = 25V, I_{DQ} = 440mA, T_{BS} = 25°C / 85 °C

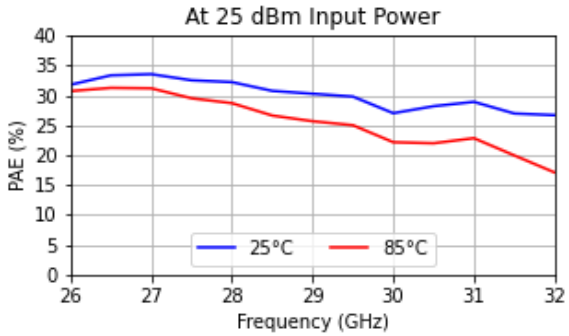
Output Power vs. Frequency & Chip Backside Temperature



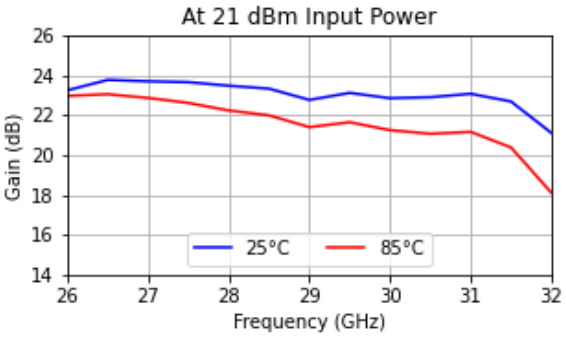


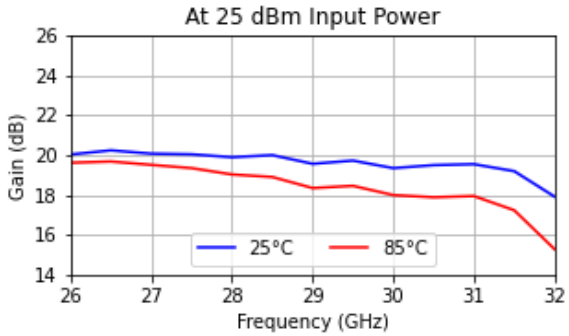
Power Added Efficiency vs. Frequency & Chip Backside Temperature



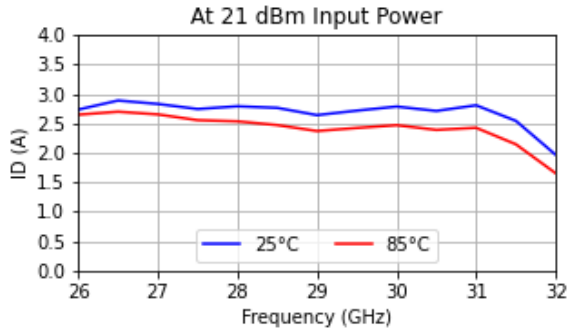


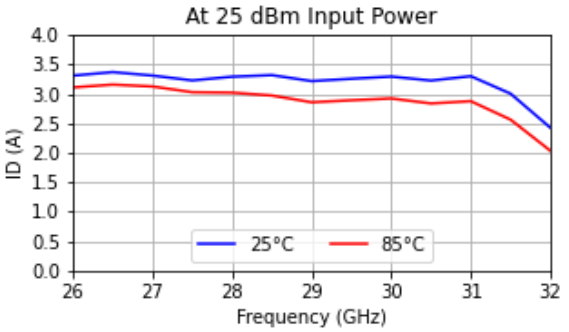
Gain vs. Frequency & Chip Backside Temperature





DC Drain current vs. Frequency & Chip Backside Temperature





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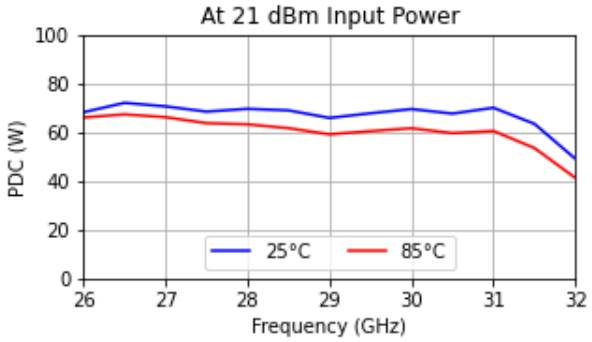
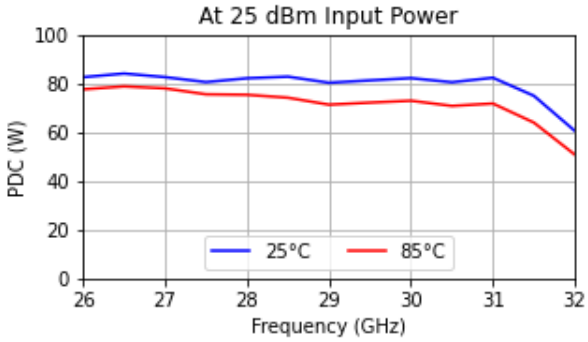
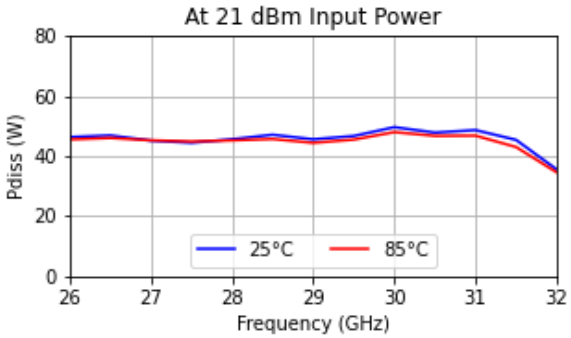
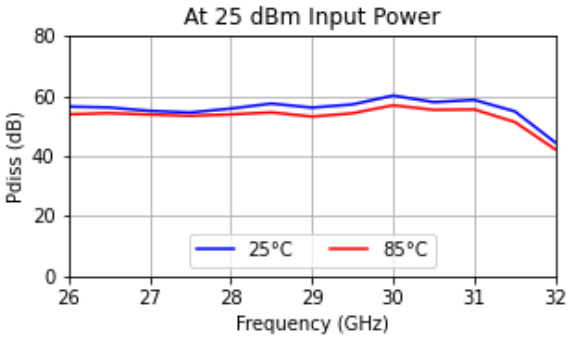
DC Power Consumption vs. Frequency & Chip Backside Temperature





Dissipated Power vs. Frequency & Chip Backside Temperature





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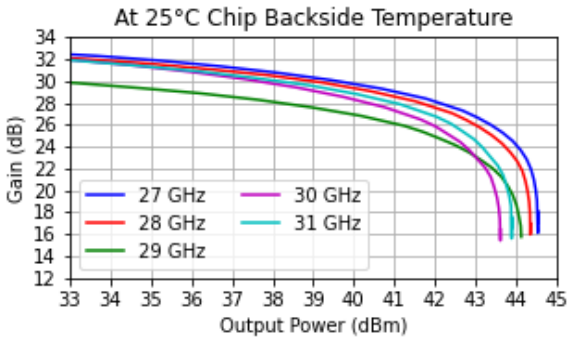
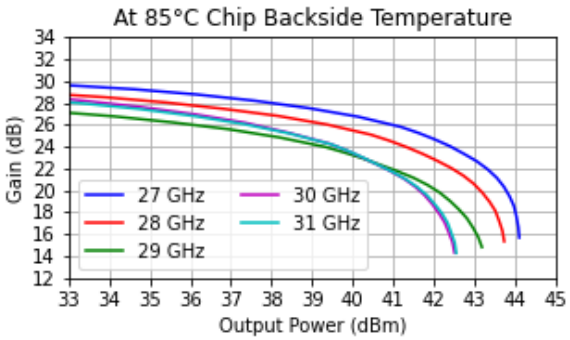
Typical Board Measurements: Large Signal Performances

Performance versus output power and frequency

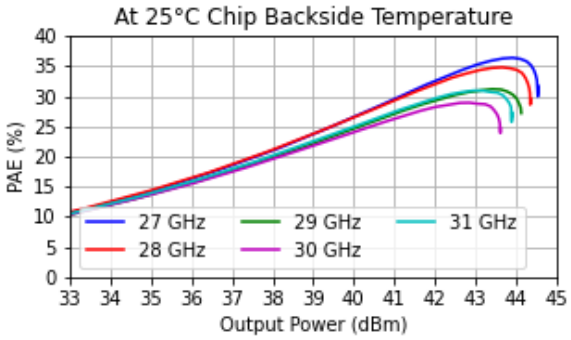
Test conditions : CW, V_D = 25V, I_{DQ} = 440mA, T_{BS} = 25°C / 85 °C

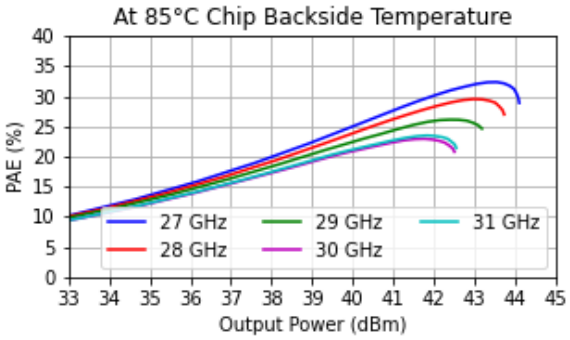
Gain vs. Output Power & Frequency



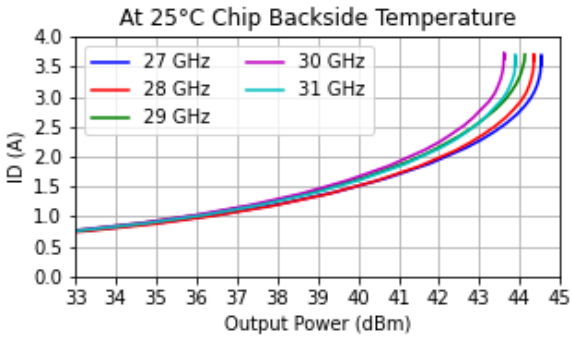


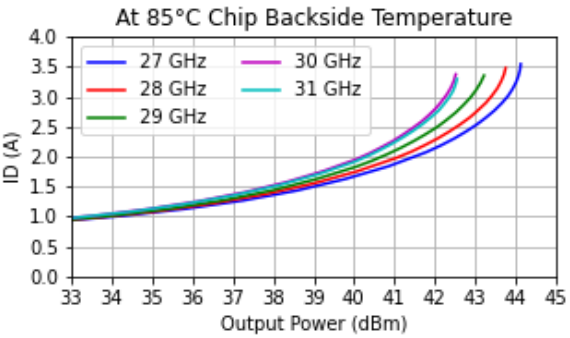
Power Added Efficiency vs. Output Power & Frequency





DC Drain Current vs. Output Power & Frequency





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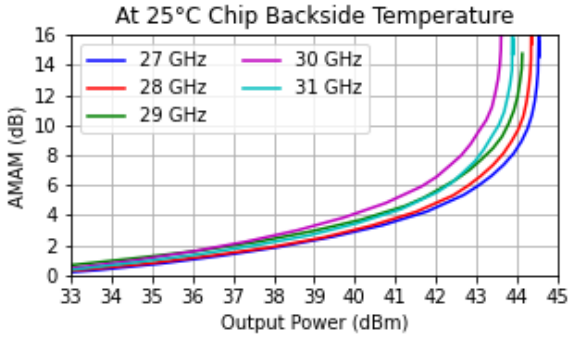
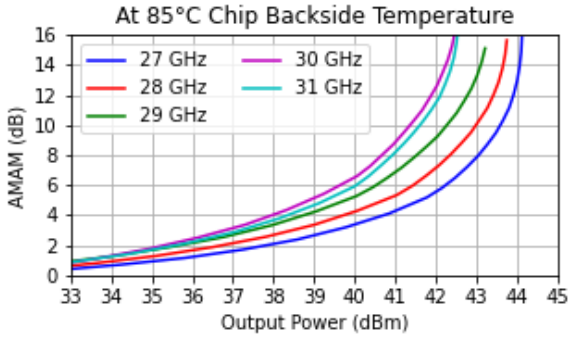
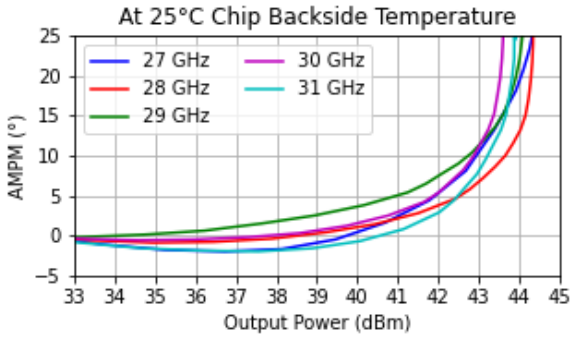
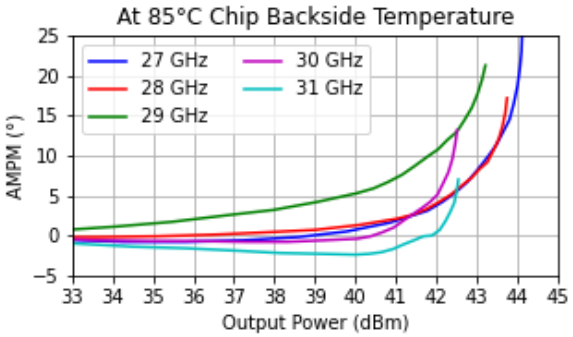
AMAM vs. Output Power & Frequency



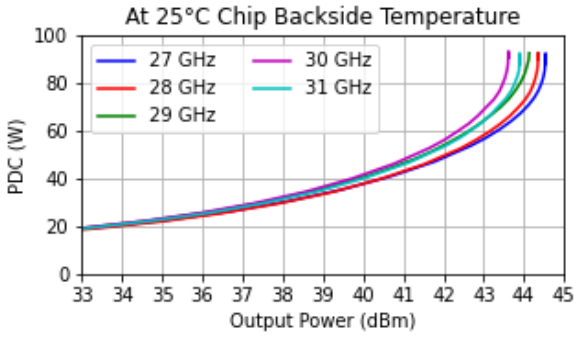


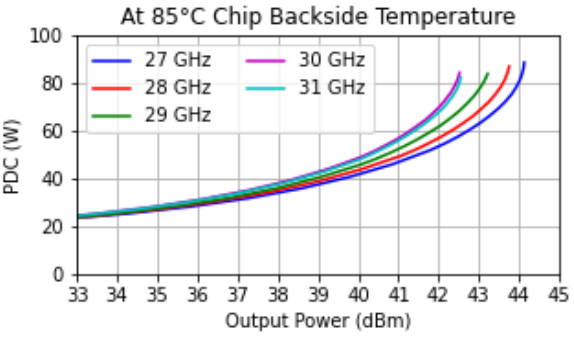
AMPM vs. Output Power & Frequency



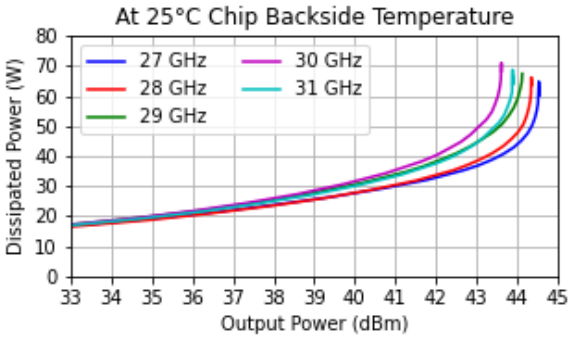


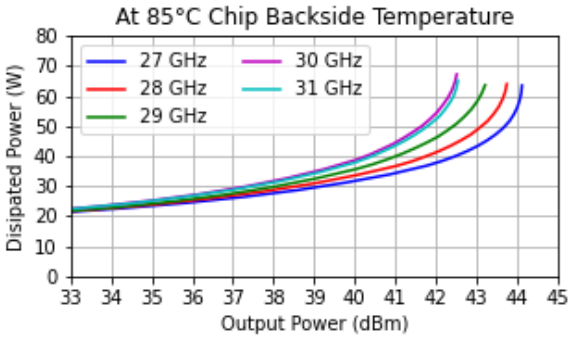
DC Power Consumption vs. Output Power & Frequency





Dissipated Power vs. Output Power & Frequency





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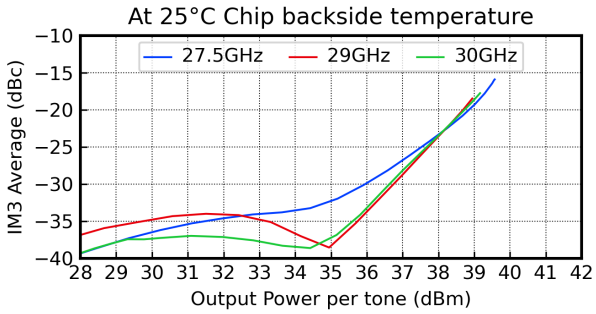
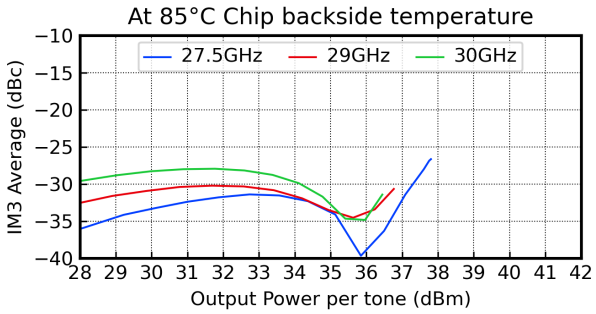
Typical Board Measurements: Intermodulation Distortion

Performance versus output power and frequency

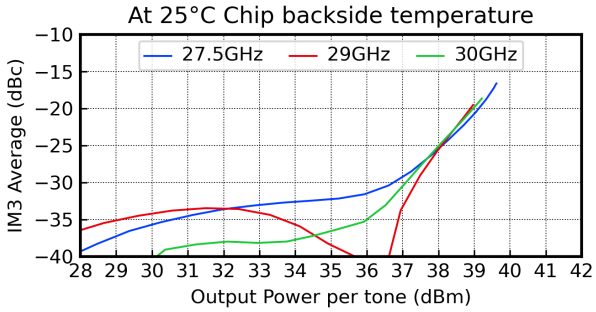
Test conditions : CW, V_D = 25V, Idq = 330mA

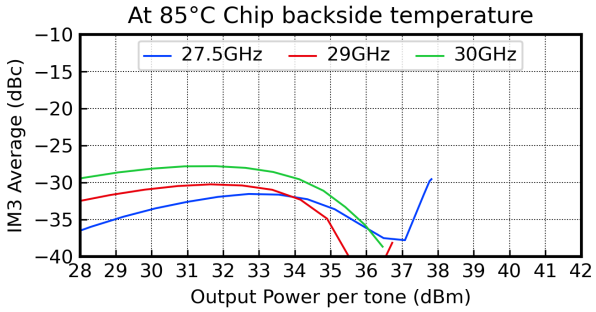
IMD3 vs. Output Power per Tone & Central Frequency, ΔF = 10MHz



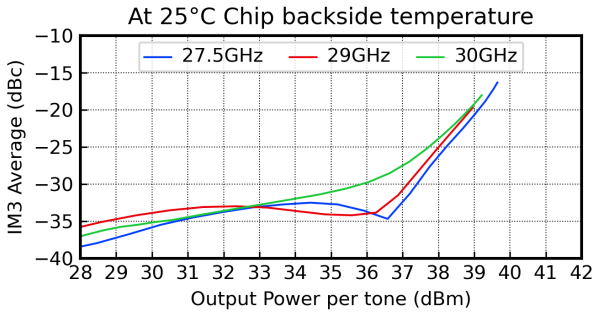


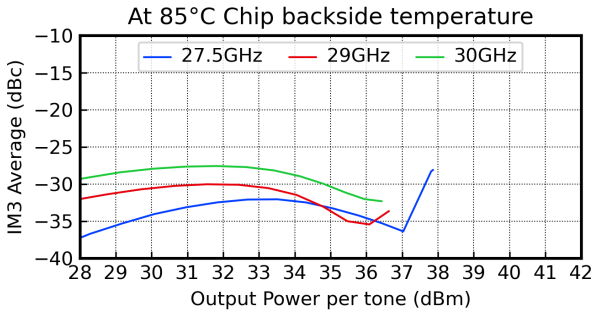
IMD3 vs. Output Power per Tone & Central Frequency, ΔF = 50MHz





IMD3 vs. Output Power per Tone & Central Frequency, ΔF = 100MHz





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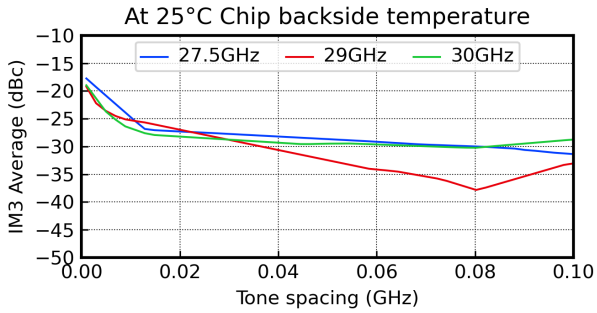
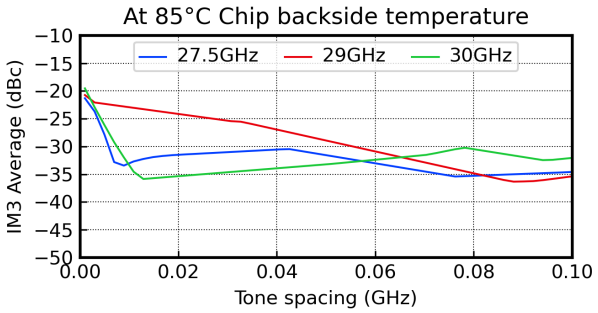
Typical Board Measurements: Intermodulation Distortion

Performance versus output power and frequency

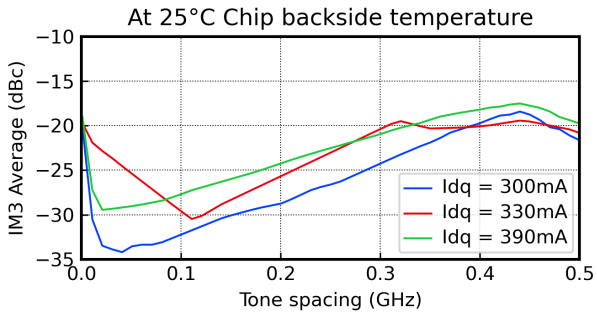
Test conditions : CW, V_D = 25V, Idq = 330mA, Pout/Tone = 37dBm at T_{BS} = 25°C, Pout/Tone = 36.5dBm at T_{BS} = 85°C

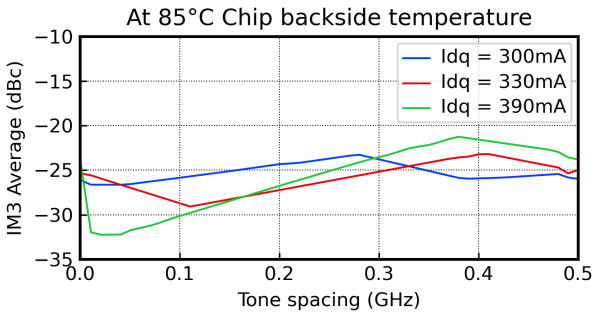
IMD3 vs. Tone spacing & Central Frequency





IMD3 vs. Tone spacing & Quiescent Current @30GHz





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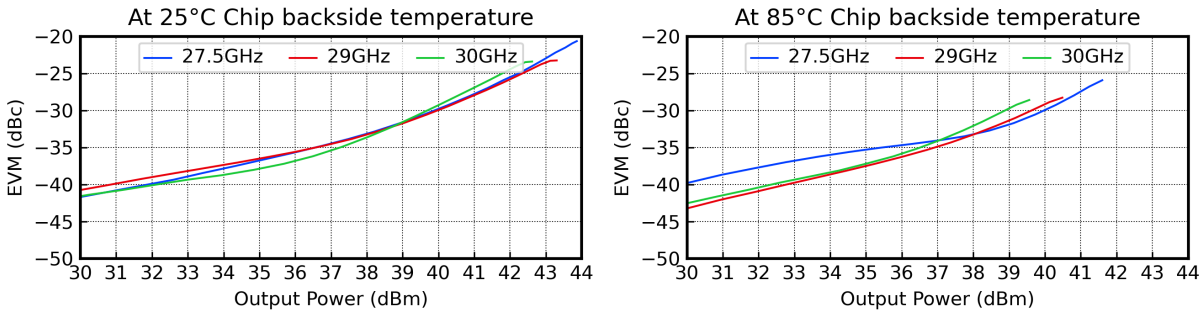
Typical Board Measurements: Modulation Measurements

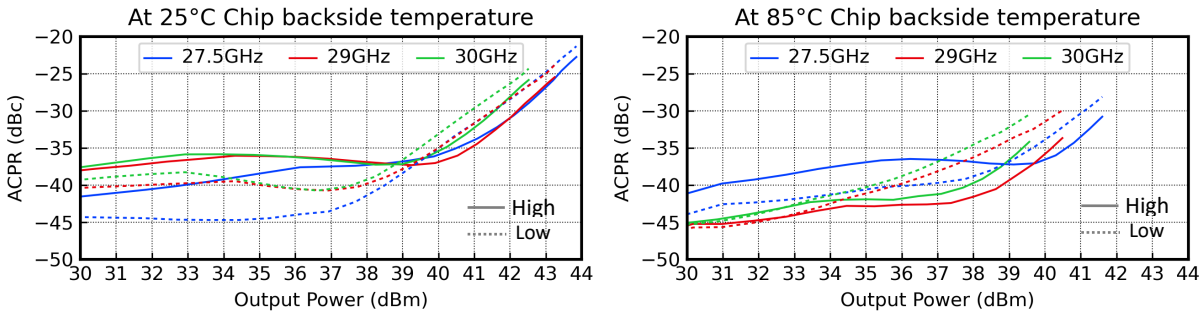
Performance versus output power and frequency

Test conditions : V_D = 25V, Idq = 330mA, 8PSK, BW = 15 MHz, Roll-off = 0.2, PAPR = 5.1dB

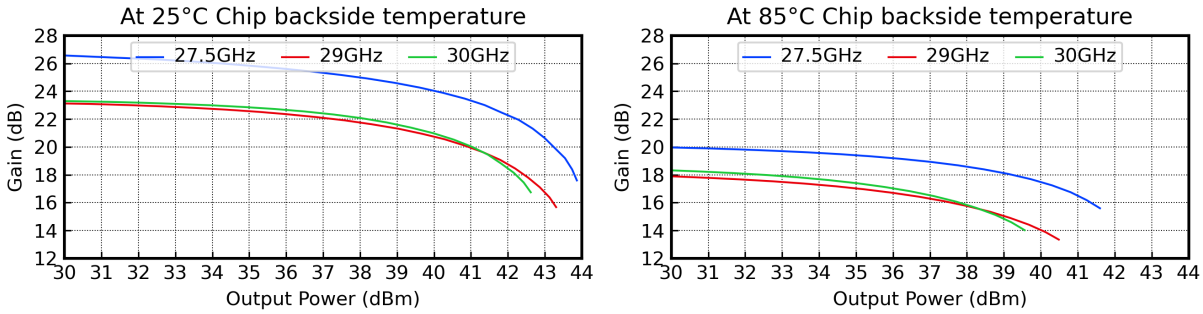
EVM vs. Output Power & Central Frequency



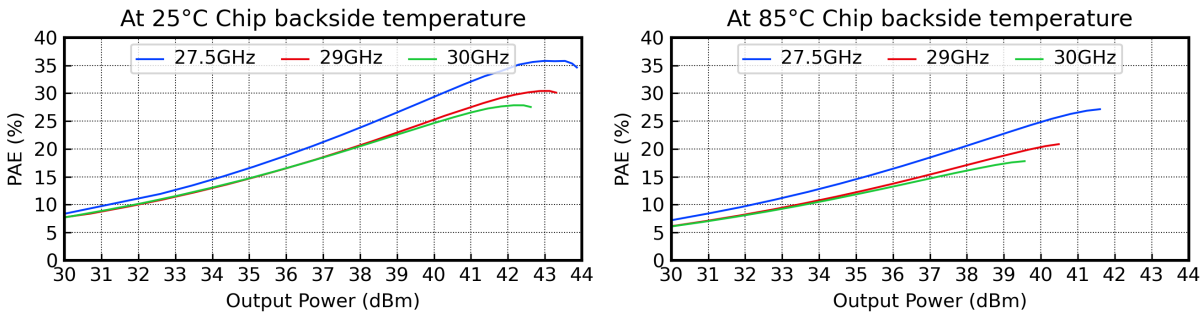
ACPR vs. Output Power & Central Frequency



Gain vs. Output Power & Central Frequency



PAE vs. Output Power & Central Frequency



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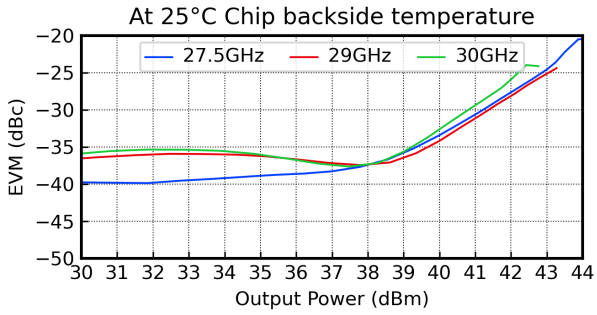
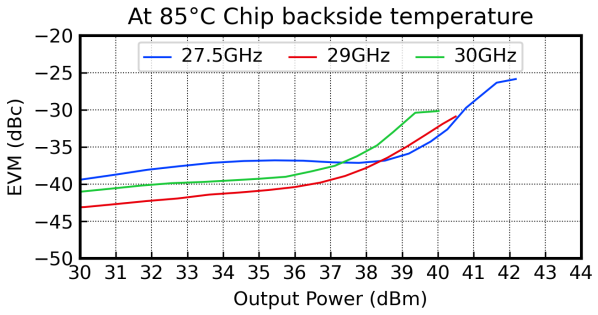
Typical Board Measurements: Modulation Measurements

Performance versus output power and frequency

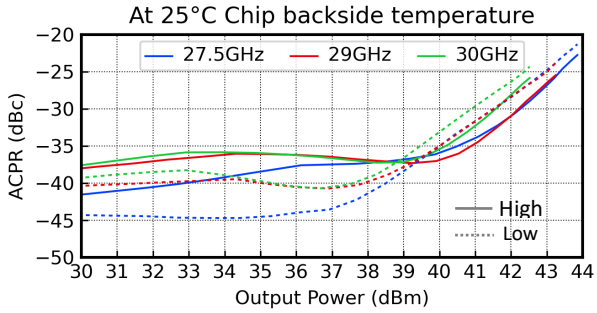
Test conditions : V_D = 25V, Idq = 330mA, 8PSK, BW = 30 MHz, Roll-off = 0.2, PAPR = 5.1dB

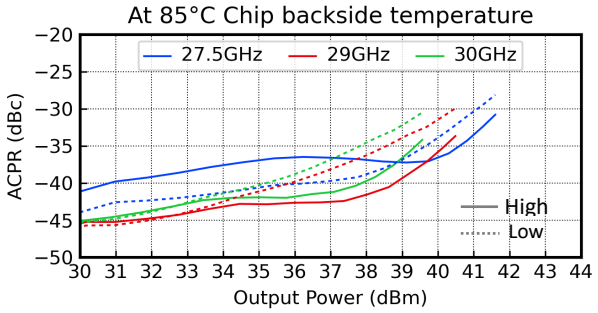
EVM vs. Output Power and Central Frequency



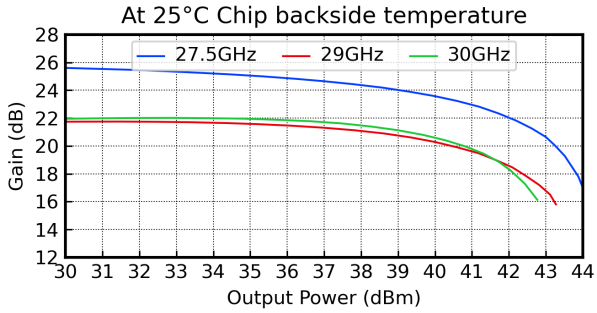


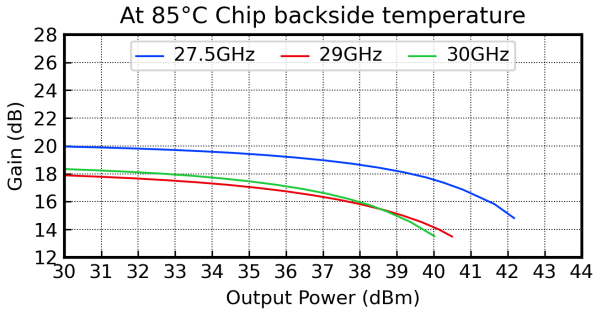
ACPR vs. Output Power & Central Frequency



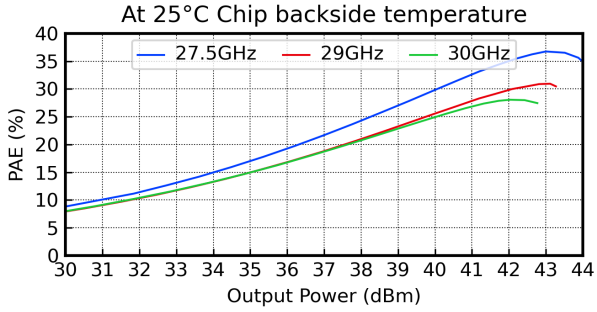


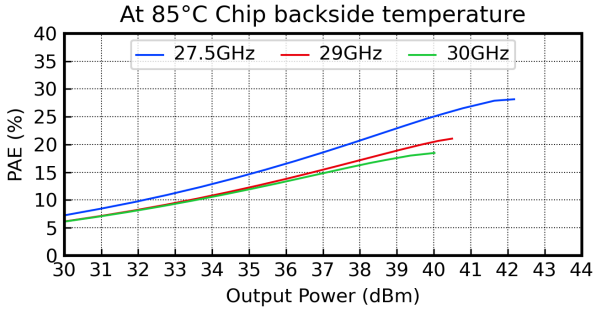
Gain vs. Output Power & Central Frequency





PAE vs. Output Power & Central Frequency





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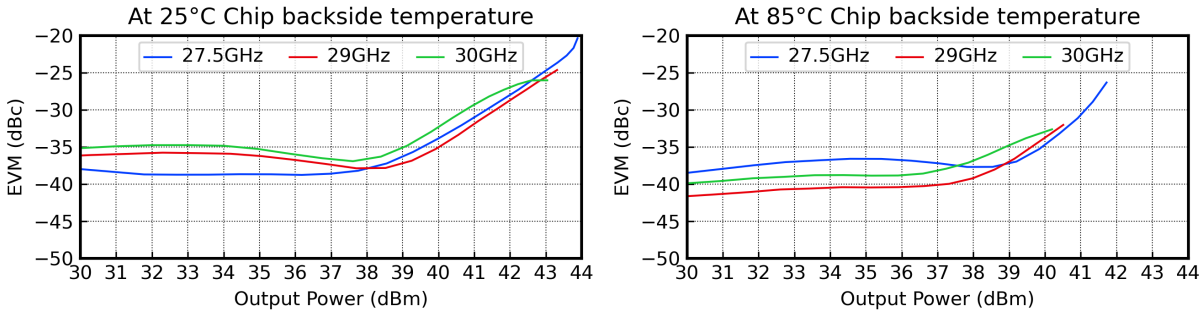
Typical Board Measurements : Modulation Measurements

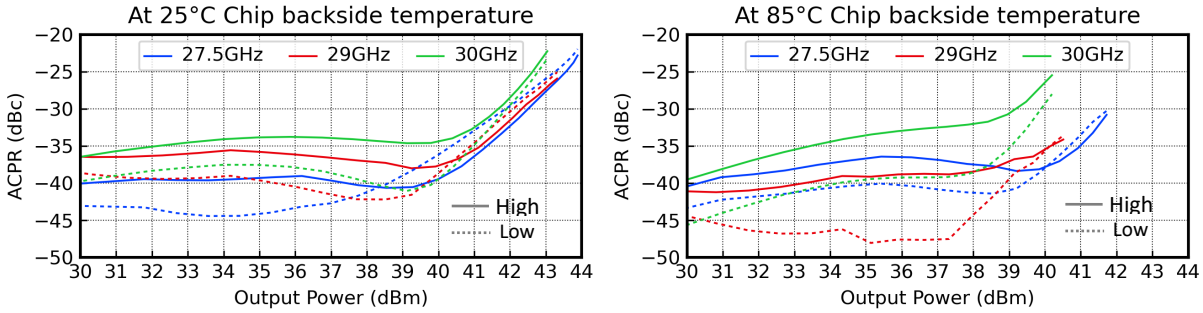
Performance versus output power versus frequency

Test conditions : V_D = 25V, Idq = 330mA, 8PSK, BW = 100 MHz, Roll-off = 0.2, PAPR = 5.1dB

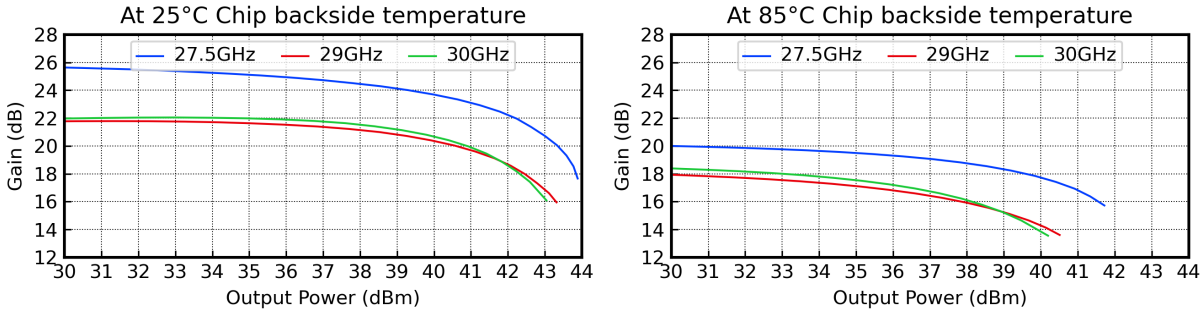
EVM vs. Output Power & Central Frequency



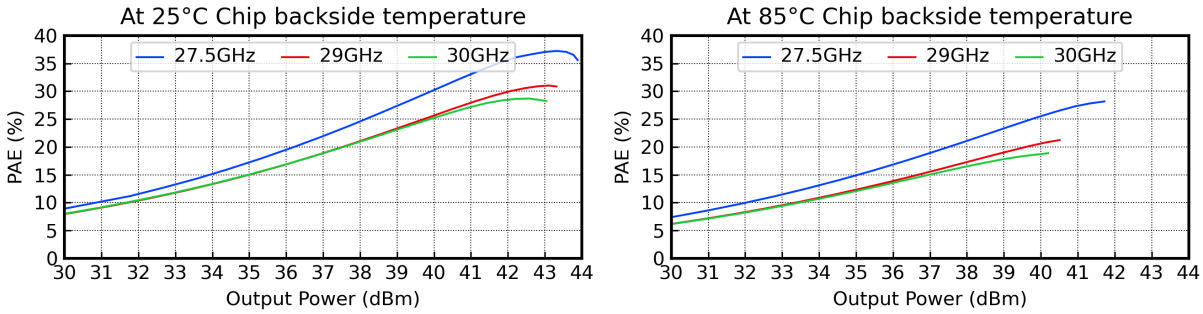
ACPR vs. Output Power & Central Frequency



Gain vs. Output Power & Central Frequency



PAE vs. Output Power & Central Frequency



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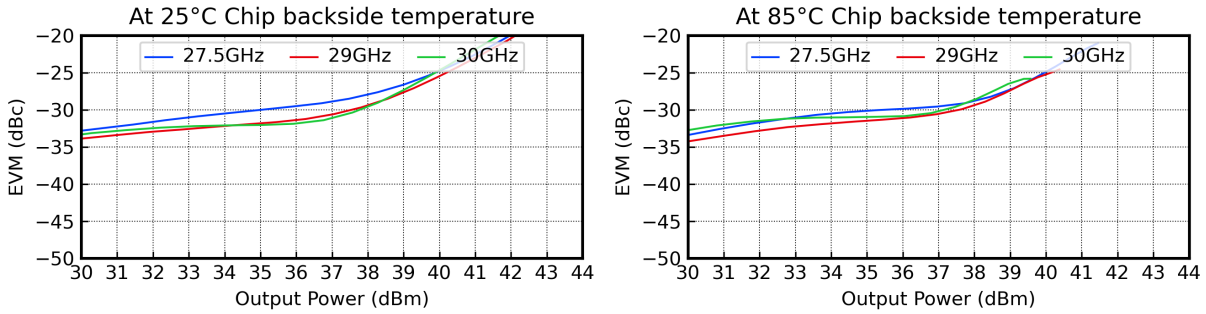
Typical Board Measurements: Modulation Measurements

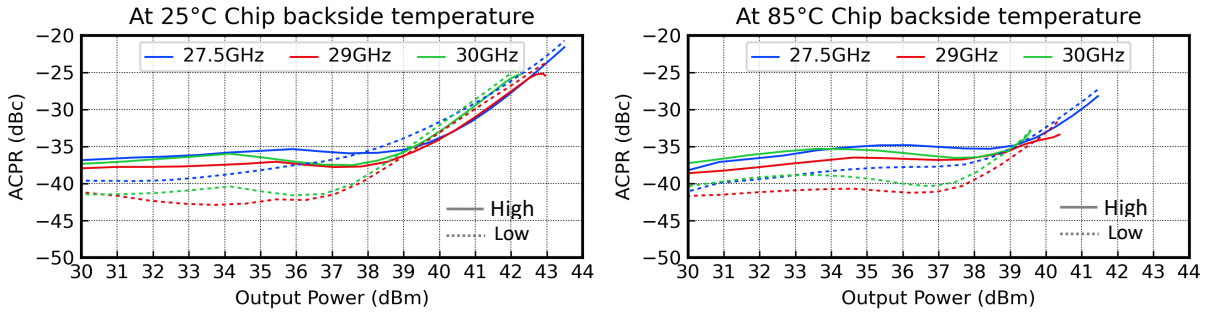
Performance versus output power and frequency

Test conditions : V_D = 25V, Idq = 330mA, 256QAM, BW=100MHz, Roll-off=0.2, PAPR = 7.2dB

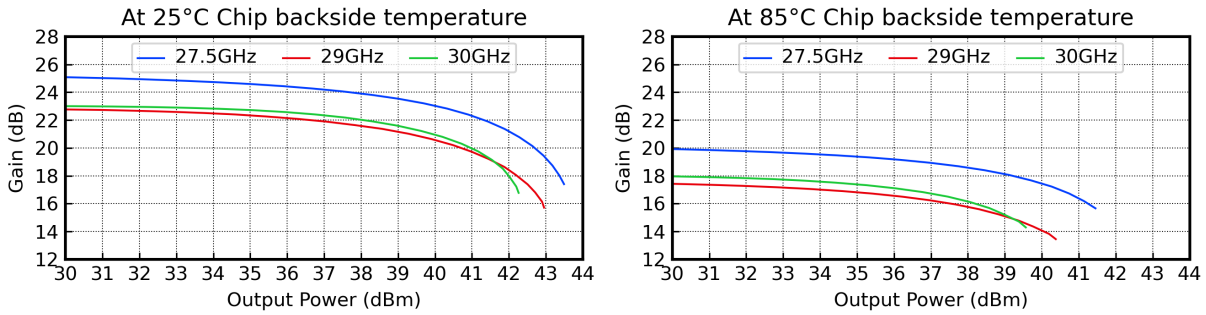
EVM vs. Output Power & Central Frequency



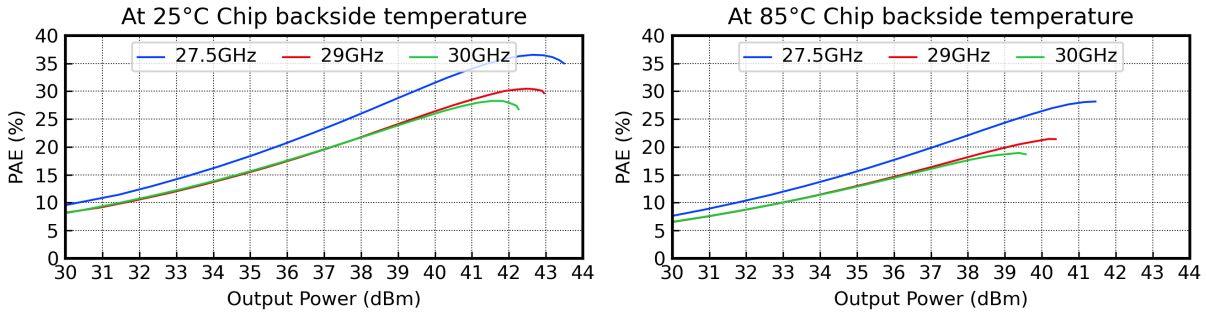
ACPR vs. Output Power & Central Frequency



Gain vs. Output Power & Central Frequency



PAE vs. Output Power & Central Frequency



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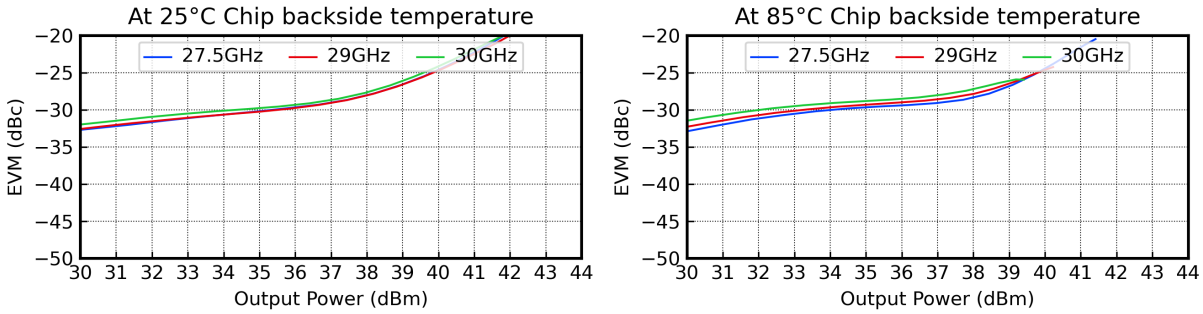
Typical Board Measurements: Modulation Measurements

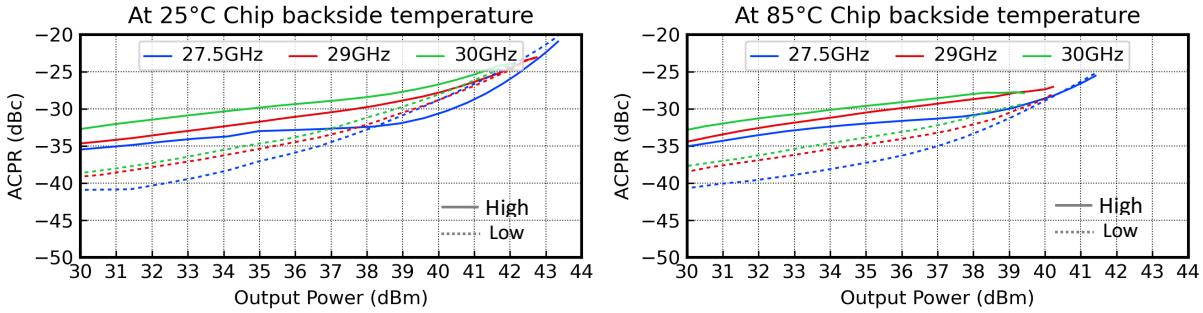
Performance versus output power and frequency

Test conditions : V_D = 25V, Idq = 330mA, 256QAM, BW=400MHz, Roll-off=0.2, PAPR = 7.2dB

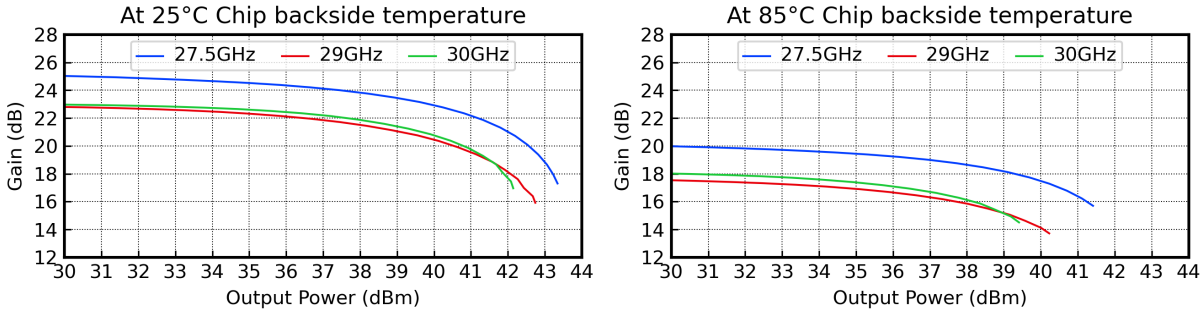
EVM vs. Output Power & Central Frequency



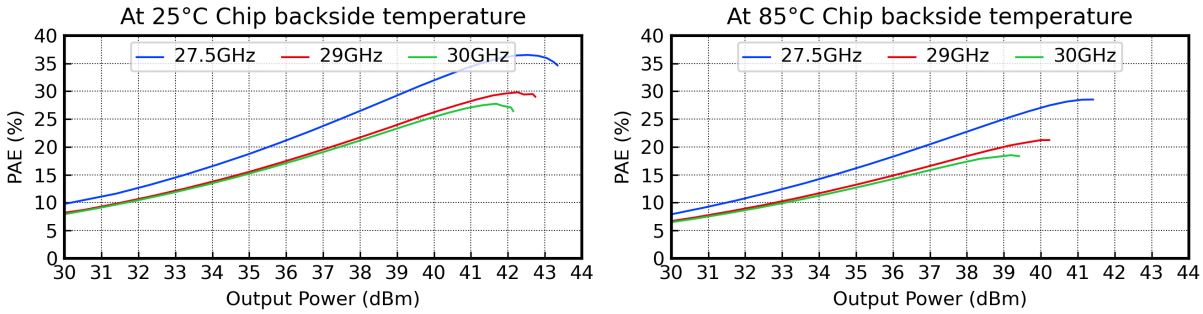
ACPR vs. Output Power & Central Frequency



Gain vs. Output Power & Central Frequency



PAE vs. Output Power & Central Frequency



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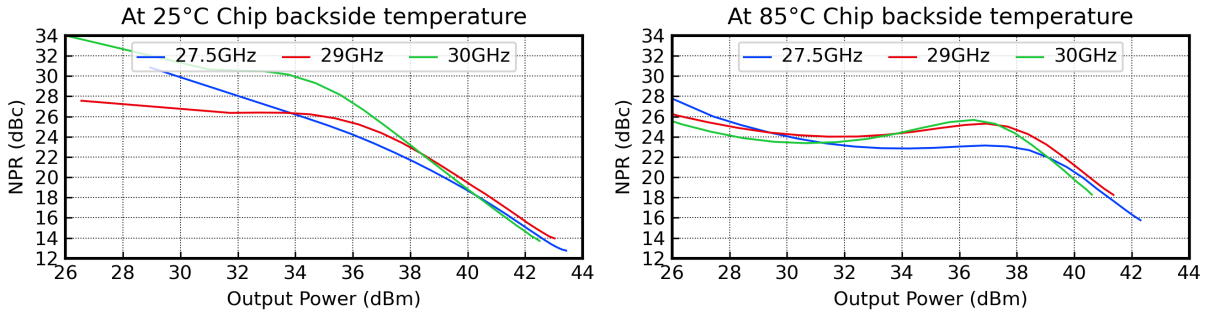
Typical Board Measurements: Noise Power Ratio

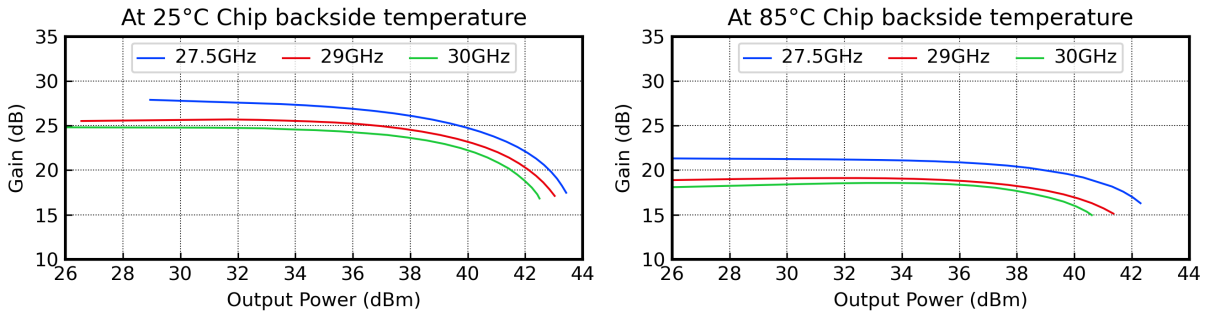
Performance versus output power and frequency

Test conditions : V_D = 25V, Idq = 330mA, BW = 45MHz, Notch: 10%, Number of tones: 4501

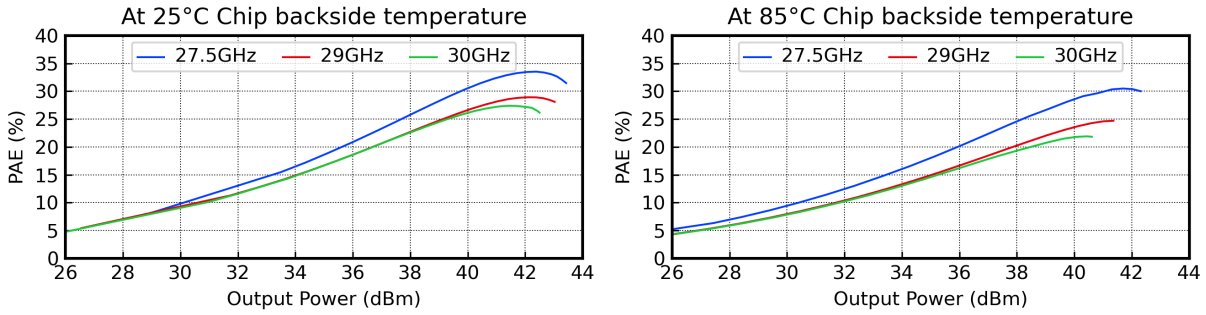
NPR vs. Output Power & Central Frequency



ACPR vs. Output Power & Central Frequency



Gain vs. Output Power & Central Frequency



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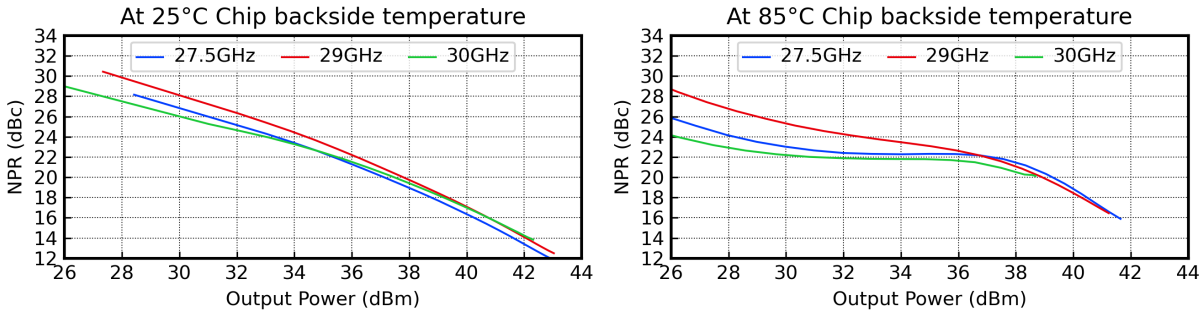
Typical Board Measurements: Noise Power Ratio

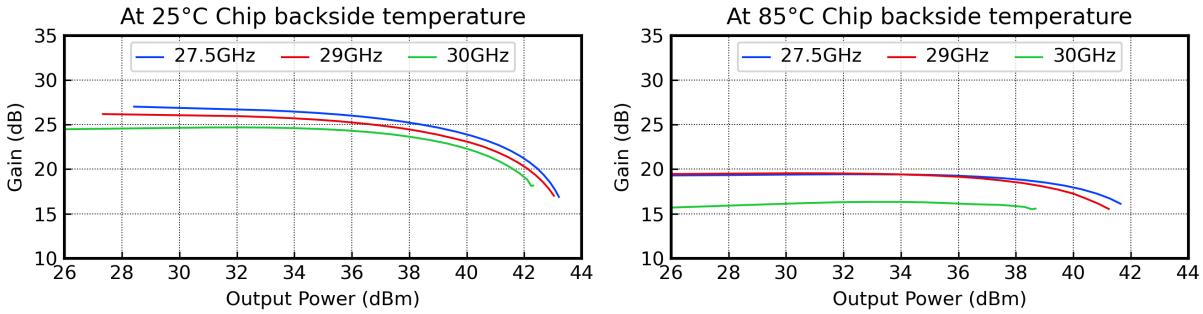
Performance versus output power and frequency

Test conditions : V_D = 25V, Idq = 330mA, BW = 1GHz, Notch: 10%, Number of tones: 10 001

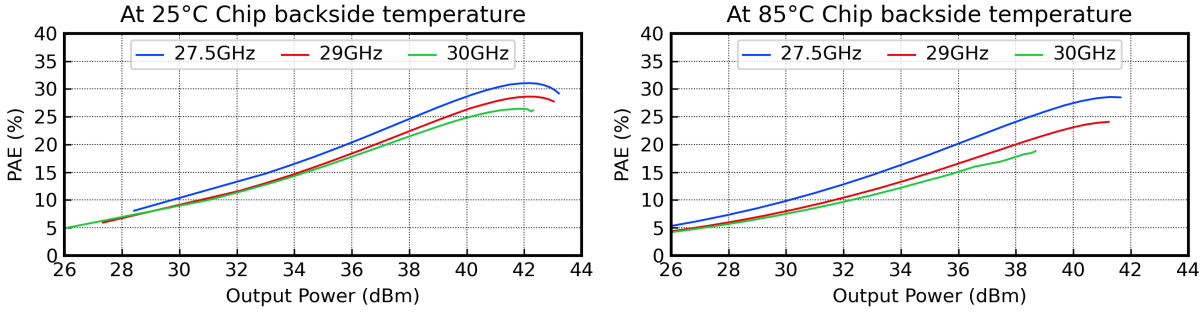
NPR vs. Output Power & Central Frequency



Gain vs. Output Power & Central Frequency



PAE vs. Output Power & Central Frequency



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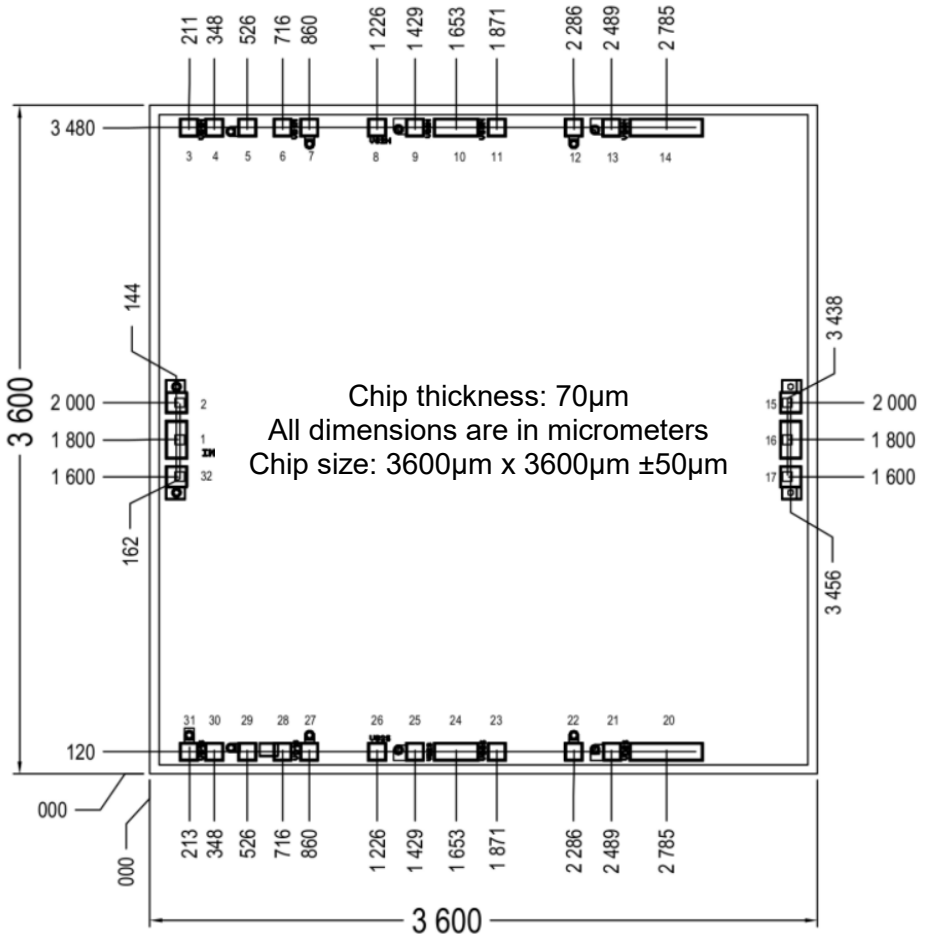
Mechanical Drawing



PAD Number	Name	Description	Pad size
1	RF IN	Input RF port	185µm x 200µm
4	G1	DC Gate voltage, 1st Stage, North	100µm x 100µm
6	D1	DC Drain voltage, 1st Stage, North	100µm x 100µm
8	G2	DC Gate voltage, 2d stage, North	100µm x 100µm
10	D2	DC Drain voltage, 2d stage, North	245µm x 100µm
11	G3	DC Gate voltage 3d stage, North	100µm x 100µm
14	D3	DC Drain voltage, 3d stage, North	400µm x 96µm
16	RF OUT	Output RF port	185µm x 200µm
20	D3	DC Drain voltage, 3d stage, South	400µm x 96µm
23	G3	DC Gate voltage 3d stage, South	100µm x 100µm
24	D2	DC Drain voltage, 2d stage, South	245µm x 100µm
26	G2	DC Gate voltage, 2d stage, South	100µm x 100µm
28	D1	DC Drain voltage, 1st Stage, South	100µm x 100µm
30	G1	DC Gate voltage, 1st Stage, South	100µm x 100µm
2,3,5,7,9,12, 13,15,17,21,22, 25,27,29,31,32	GND	Ground	100µm x 100µm

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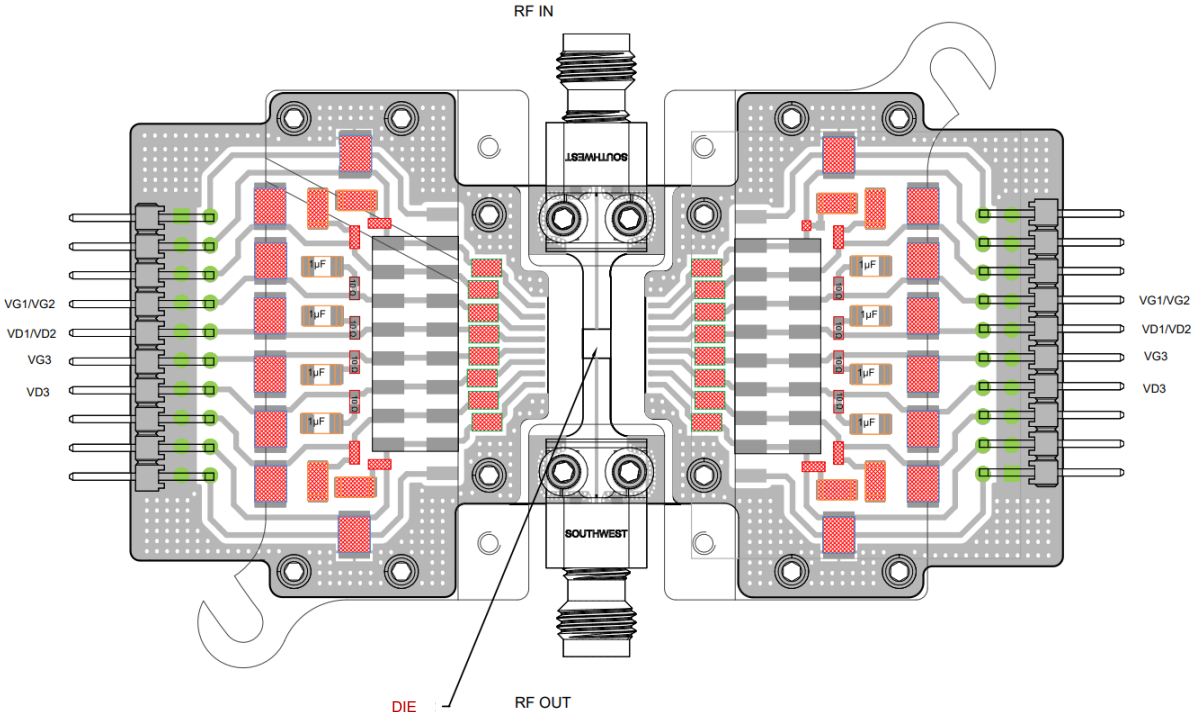
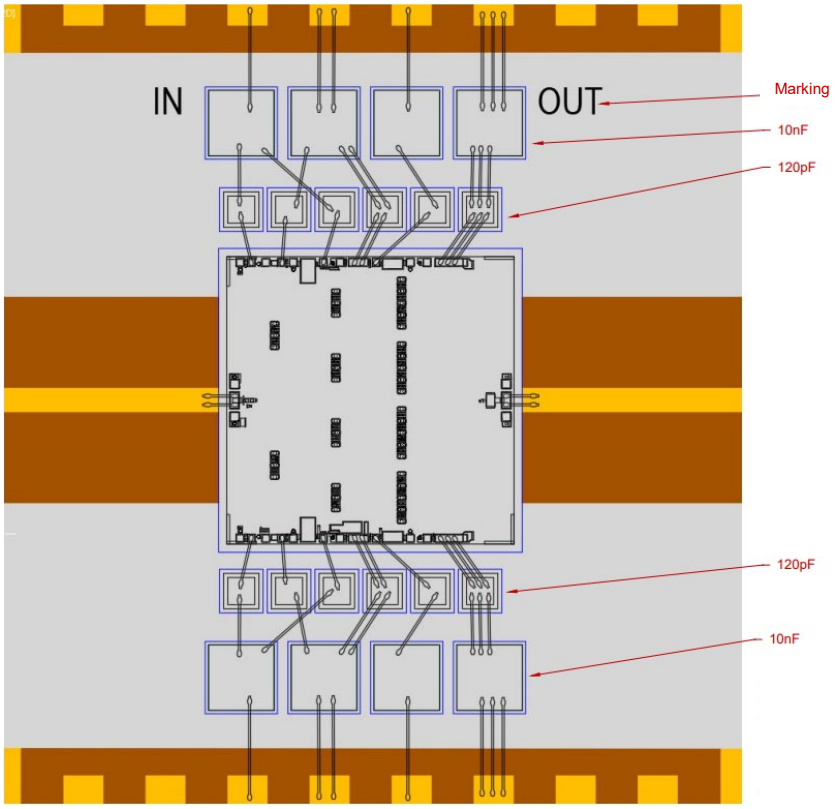
Recommended Assembly Plan





3 levels of decoupling capacitors have been used: 2 on the tab and 1 on the board. The first level is composed of 120 pF chip capacitors. The second level is composed of 10nF chip capacitors. The third level is made with 1µF SMD 1206 capacitors (and 10 ohms added in series). The first two levels should be as close as possible to the die.

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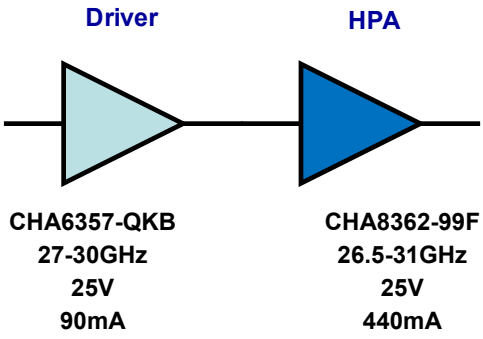
Recommended UMS Power chain

The CHA8362-99F is recommended with the CHA6357-QKB as driver.
Total Gain: > 50dB
For more information about the CHA6357-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 https://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 https://www.ums-rf.com.

Recommended ESD management

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

Ordering Information

Chip form :	CHA8362-99F/00

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