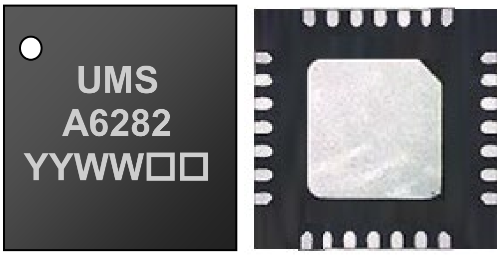
17.3-21.5GHz GaN Power Amplifier

GaN Monolithic Microwave IC in SMD leadless package

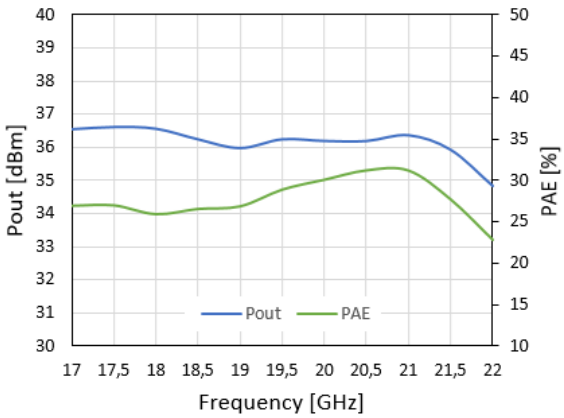
Description

The CHA6282-QCB is a three-stage GaN High Power Amplifier in the frequency band 17.3-21.5GHz. This HPA typically provides 4W output power associated to 28% of Power Added Efficiency. The circuit exhibits a small signal gain higher than 30dB. The overall power supply is 18V/260mA.
The circuit is a very versatile amplifier for high performance systems.
The circuit is dedicated to Space applications and well suited for a wide range of microwave applications and systems.
The product is developed on a robust 0.15µm gate length GaN on SiC HEMT process and is provided on low cost SMD RoHS compliant plastic package.



Main Features

- 17.3-21.5GHz frequency range
- Linear gain is 30 dB
- P_{out}=36dBm for P_{in}=18dBm
- NPR > 13dB for P_{out} = 2Watts
- PAE=28% at P_{sat}
- DC bias: Vd=18Volts @ Idq=260mA
- 28 Leads - QFN 5x5mm^2
- MSL3



Main Electrical Characteristics

T_{case}= +25°C T_{case}: QFN backside temperature

Symbol	Parameter	Min	Typ	Max	Unit
Freq	Frequency range	17.3		21.5	GHz
Gain	Linear Gain		30		dB
PAE	Power Added Efficiency		28		%
P_{sat}	Saturated Output Power		36		dBm
These values are representative of on board measurements as defined on the drawing in paragraph "Evaluation Board".					

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Specifications

T_{case}= +25°C, Vd = +18V, Idq=260mA

Symbol	Parameter	Min	Typ	Max	Unit
Freq	Frequency range	17.3		21.5	GHz
Gain	Linear Gain		30		dB
S_{11}	Input return loss		15		dB
S_{22}	Output return loss		15		dB
P_{sat}	Saturated output Power		36		dBm
NPR	Noise Power Ratio @Pout=2Watt		14		dB
PAE	Power Added Efficiency		28		%
Idq	Quiescent Current		0.26		A
Vd	Drain Voltage		18		V

“Power ON” sequence

1. Ground the device
2. Set the gate voltage to -5V
3. Apply the drain voltage Vd (Typically 18V)
4. Increase Vg up to quiescent bias drain current Idq
5. Apply RF signal

“Power OFF” sequence

1. Turn off RF signal
2. Decrease the gate voltage to -5V
3. Decrease the drain voltage to 0V
4. Turn off Vd supply
5. Turn off Vg supply

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Absolute Maximum Ratings [1]

T_{case} = +25°C

Symbol	Parameter	Values	Unit
Vd	Drain bias voltage	27	V
Id	Drain bias current (with RF signal at saturation)	1.1	mA
Vg	Gate bias voltage	-7 to -2	V
P_{in}	Maximum input power	20	dBm

[1] Operation of this device above anyone of these parameters may cause permanent damage.

Recommended Operating Range [3], [4]

Symbol	Parameter	Values	Unit
Vd	Drain bias voltage	18 to 25	V
Id	Drain bias current (without RF)	182 to 260	mA
Vg	Gate bias voltage	~ -2.5 to ~ -3	V
P_{in}	Maximum input power	18	dBm
Tj	Maximum Junction temperature [2]	200	°C

[2] Value is provided for T_{case}=95°C
[3] Electrical performances are defined for specified test conditions
[4] Electrical performances are not guaranteed over all recommended operating conditions

Temperature Range

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

Typical Bias Conditions

T_{case}= +25°C

Symbol	Pad N°	Parameter	Values	Unit
Vg	12, 24, 26, 28	Gate Voltage	~ -2.7	V
Vd	10, 11, 13, 23, 25	Drain Voltage	18	V

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Device thermal performances

The thermal performances of the device are based on UMS rules to evaluate the junction temperature (Tj). This temperature is defined as the peak temperature in the channel area.
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 CHA6282-QCB is fabricated (GaN Power PHEMT 0.15µm).
All the figures given in this section are obtained assuming that the QFN device is only cooled down by conduction through the package thermal pad (to be adapted to the assembly/package) (no convection mode considered).
The temperature is monitored at the package back-side interface (Tcase).
The system maximum temperature must be adjusted in order to guarantee that junction temperature Tj remains below the maximum value specified in the Recommended Operating Range table. So, the system PCB must be designed to comply with this requirement.
The thermal resistance (R_{TH}) is given in the tables below for the full circuit in CW mode.

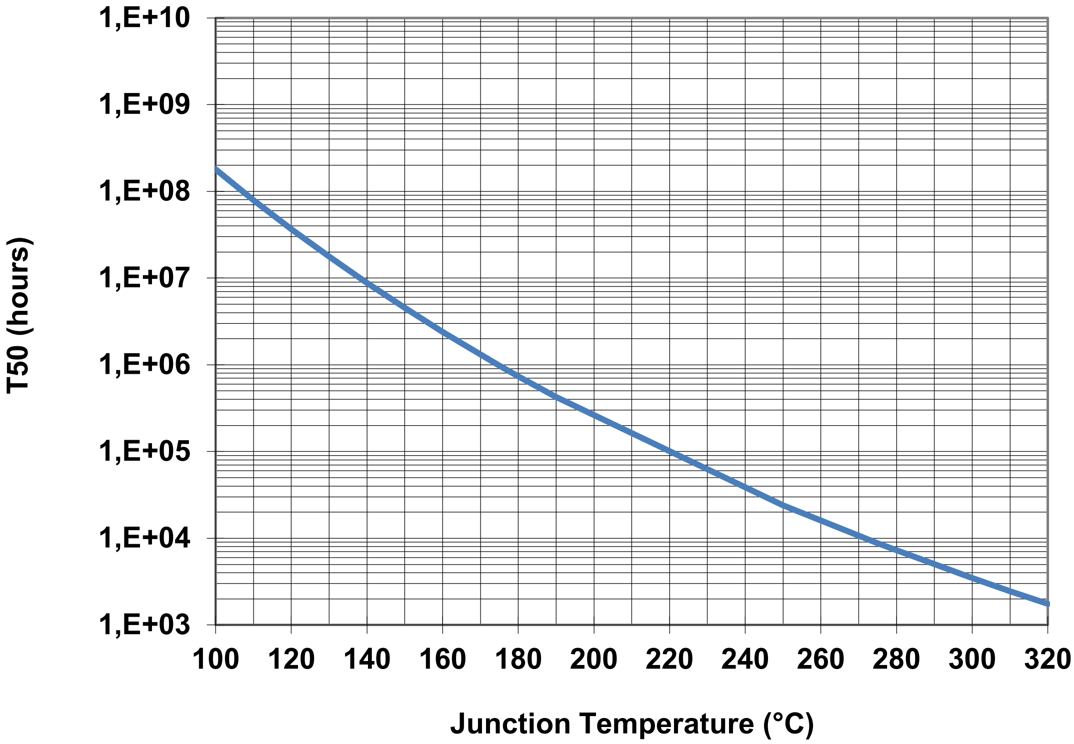
Parameter	Biasing conditions	Tj (°C)	RTH (°C/W)	T50 (hours)
RTH (1) Thermal Resistance (Junction to Case)	Psat=36.6dBm Pdiss= 10.25W CW	183	9.56	7.3E+05

[1] Assuming T_{case} = 85°C

Parameter	Biasing conditions	Tj (°C)	RTH (°C/W)	T50 (hours)
RTH (2) Thermal Resistance (Junction to Case)	Psat=36.6dBm Pdiss= 10.25W CW	160	8.78	2.4E+06

[2] Assuming T_{case} = 70°C

Median Life Time versus Junction Temperature



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Typical Package Sij parameters

T_{case}= +25°C, Vd = +18V, Idq = 260mA

Freq (GHz)	dBS11	PhS11	dBS12	PhS12	dBS21	PhS21	dBS22	PhS22
1	-2.16	44.59	-86.28	-42.81	-85.36	-49.93	-1.56	47.78
2	-2.55	-91.43	-78.15	-178.05	-41.39	-13.92	-1.69	-78.03
3	-3.37	135.23	-83.98	95	-33.26	13.77	-2.24	150.39
4	-3.97	-2.7	-85.79	-29.67	-34.88	-166.67	-2.85	10.72
5	-4.52	-153.73	-84	-40.84	-33.32	30.64	-3.14	-126.75
6	-4.15	53.87	-85.02	-91.8	-33.16	-140.54	-3.95	96.41
7	-3.69	-86.88	-81.53	156.13	-38.63	38.65	-4.84	-52.83
8	-3.65	132.4	-78.1	67.55	-57.33	48.7	-4.46	164.76
9	-3.3	-9.31	-62.04	-1.91	-44.74	-79.67	-4.72	29.38
10	-2.9	-143.45	-61.21	179.47	-43.37	167.89	-4.17	-104.94
11	-3.07	85.78	-63.39	24.94	-39.84	0.85	-3.35	115.57
12	-3.57	-47.37	-65.31	-103.54	-52.02	-144.22	-3.81	-21.82
13	-4.2	173.98	-64.92	99.84	-26.13	5.26	-3.82	-159.34
14	-4.98	33.41	-70.2	-36.09	-5.88	-156.7	-4.84	56.11
15	-7.15	-108.25	-80.19	-119.22	10.61	19.15	-6.78	-96.78
16	-12.02	87.62	-72.13	160.52	23.76	157.23	-8.73	105.13
17	-12.61	-83.93	-72.61	62.62	28.05	-79.46	-11.33	-55.42
18	-14.57	152.78	-70.99	-54.49	27.82	69.96	-12.2	140.5
19	-20.36	16.63	-70.23	-173.83	27.17	-119.78	-11.88	8.63
20	-19.04	-158.45	-68.29	73.12	27.6	54.37	-15.25	-122.57
21	-18.45	113.57	-69.53	-59.77	28.45	-140.72	-16.17	77.36
22	-11.05	68.39	-72.36	166.32	27.84	6.94	-21.9	-42.91
23	-7.07	-45.64	-81.8	96.43	23.53	142.92	-15.94	-22.78
24	-6.68	163.86	-74.52	27.08	13.34	-82	-10.13	-152.31
25	-4.94	27.92	-70.64	-108.06	-2.23	84.5	-8.58	73.56
26	-4.21	-82.55	-73.19	119.48	-21.23	-75.42	-6.59	-62.63
27	-4.51	165.7	-91.92	-48.43	-37.88	-95.75	-4.97	176.09
28	-5.06	42.67	-75.08	-65.82	-36.03	140.71	-4.66	60.54
29	-4.7	-81.63	-69.56	-158.95	-40.83	4.06	-4.87	-60.91
30	-4.21	166.72	-85.07	123.07	-47.01	-128.5	-4.7	174.87
31	-4.23	59.91	-71.05	-108.96	-54.32	114.32	-4.24	57.82
32	-4.41	-49.37	-70.68	81	-59.76	6.78	-3.94	-51.74
33	-4.81	-159.63	-76.76	-91.27	-64.7	-113.57	-4.15	-158.86
34	-5.28	81.72	-73.77	-27.25	-66.15	88.32	-4.86	87.5
35	-4.52	-36.68	-76.73	-146.68	-81.21	-116.51	-4.84	-39.28
36	-3.75	-134.51	-72.09	75.88	-67.56	91.83	-3.79	-147.85
37	-4.35	134.14	-63.46	-24.65	-62.51	-30.25	-3.94	117.88
38	-6.6	17.13	-66.6	-151.34	-68.39	-153.6	-5.32	6.69
39	-6.09	-124.26	-75.32	92.27	-68.46	103.35	-5.17	-122.28
40	-4.39	131.46	-74.97	38.65	-67.82	-95.49	-4.13	131.03

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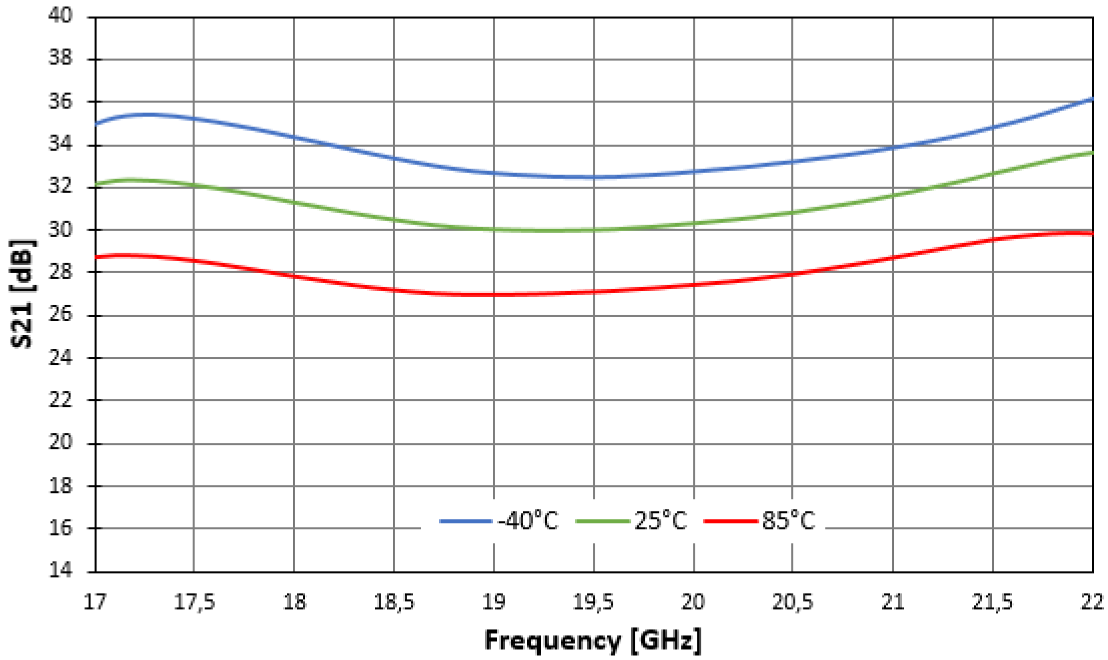
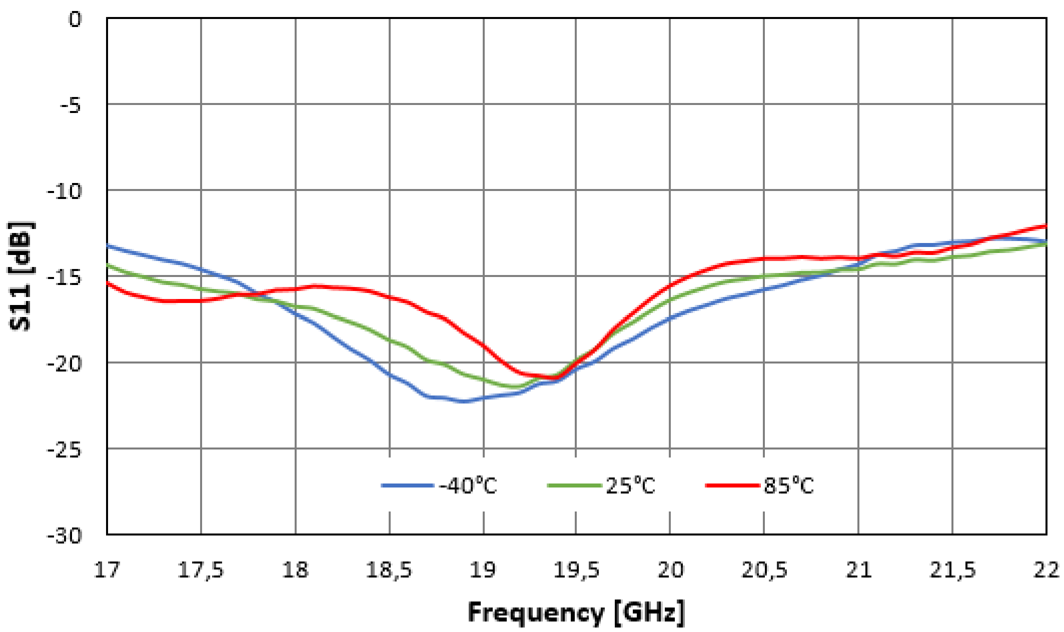
Typical Board Measurements : Small Signal Performances

T_{case}= -40°C / 25°C / 85°C (Backside QFN), Vd = +18V, Idq = 260mA (Adjusted at T_{case}=25°C).
Board losses are de-embedded. Measurements are given in the QFN access plan.

Linear Gain versus Frequency & temperature



Input Return Losses versus Frequency & temperature



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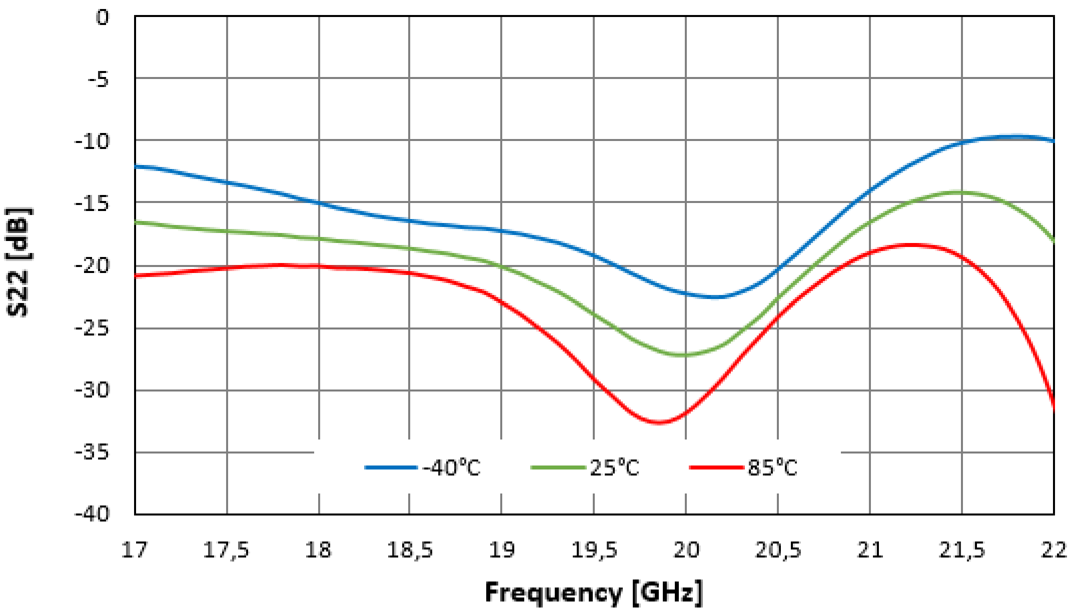
Output Return Losses versus Frequency & temperature



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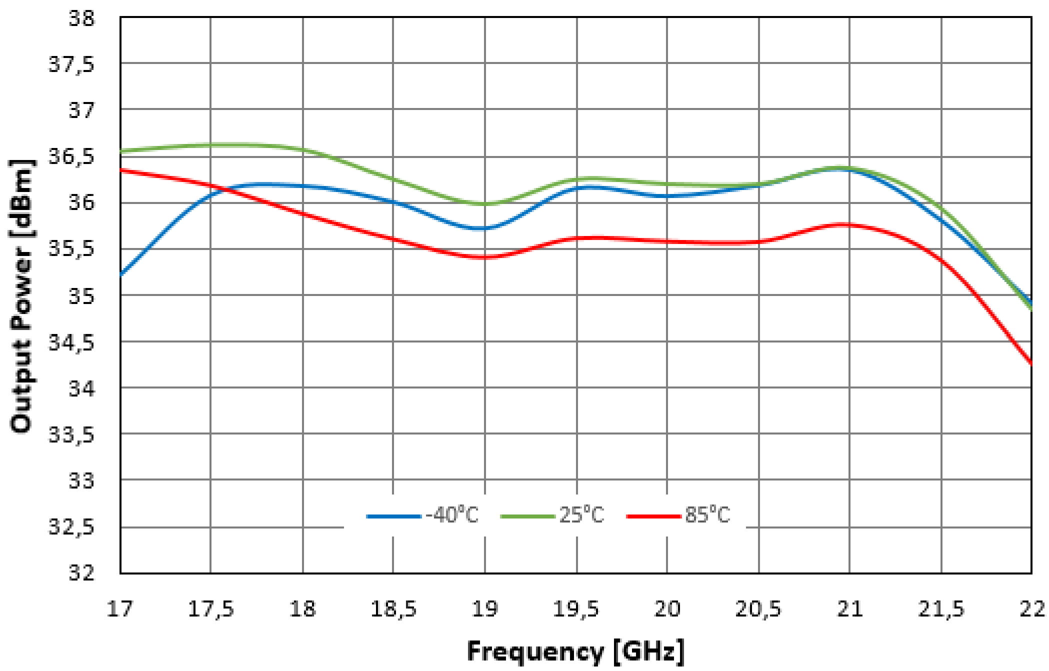
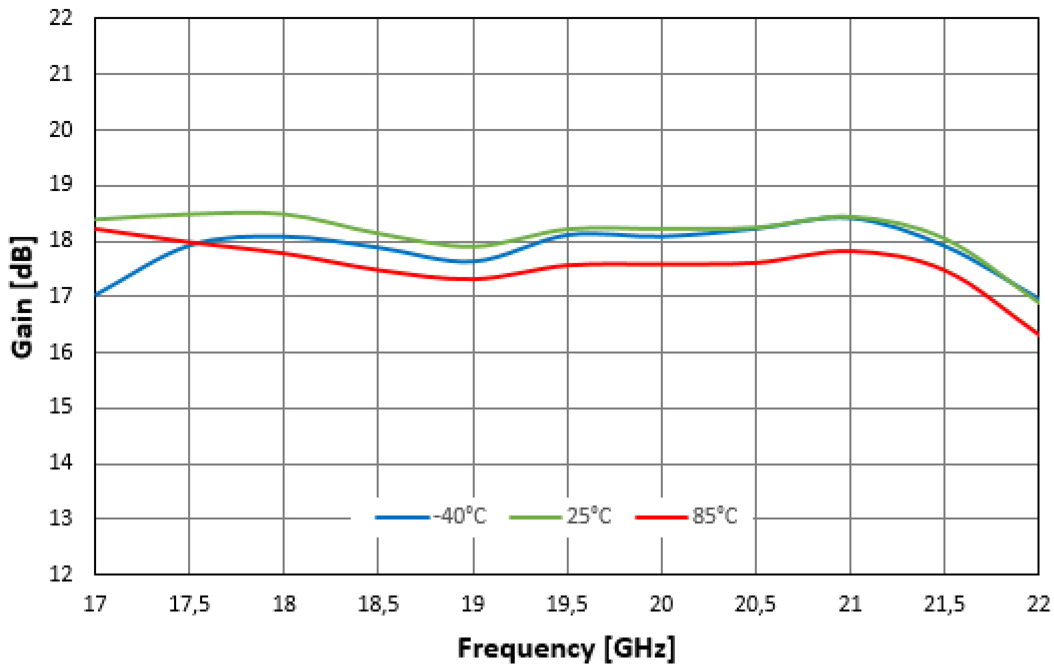
Typical Board Measurements : Non-linear performances

CW measurements: P_{in}=18dBm, Vd = +18V, Idq = 260mA (Adjusted at T_{case}=25°C).
Board losses are de-embedded. Measurements are given in the QFN access plan.

Output power versus Frequency & temperature



Gain versus Frequency & temperature



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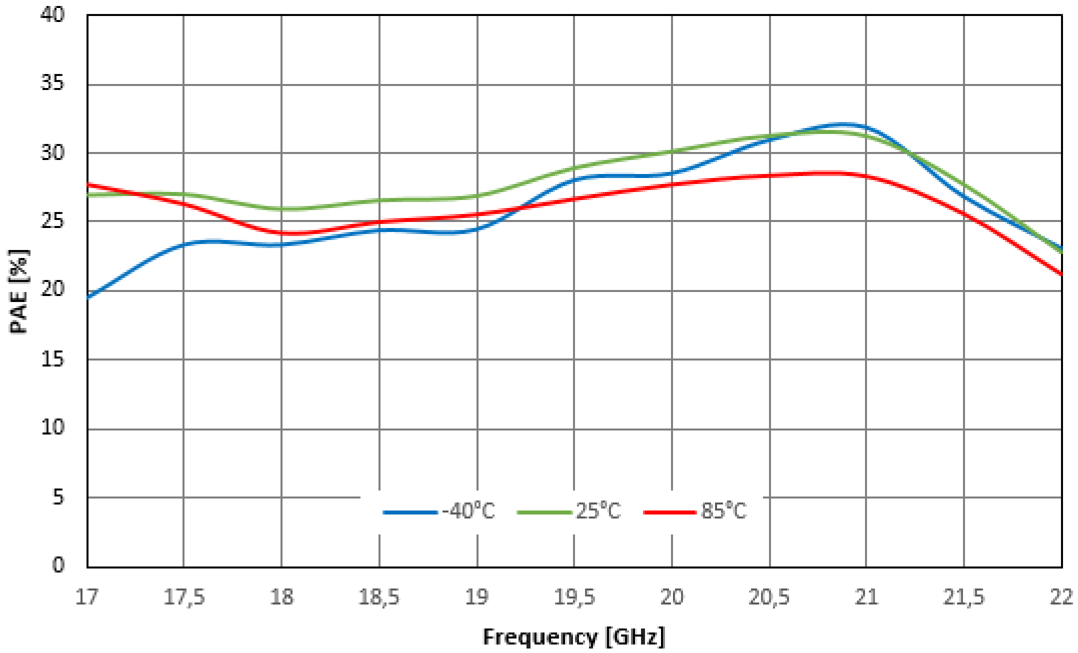
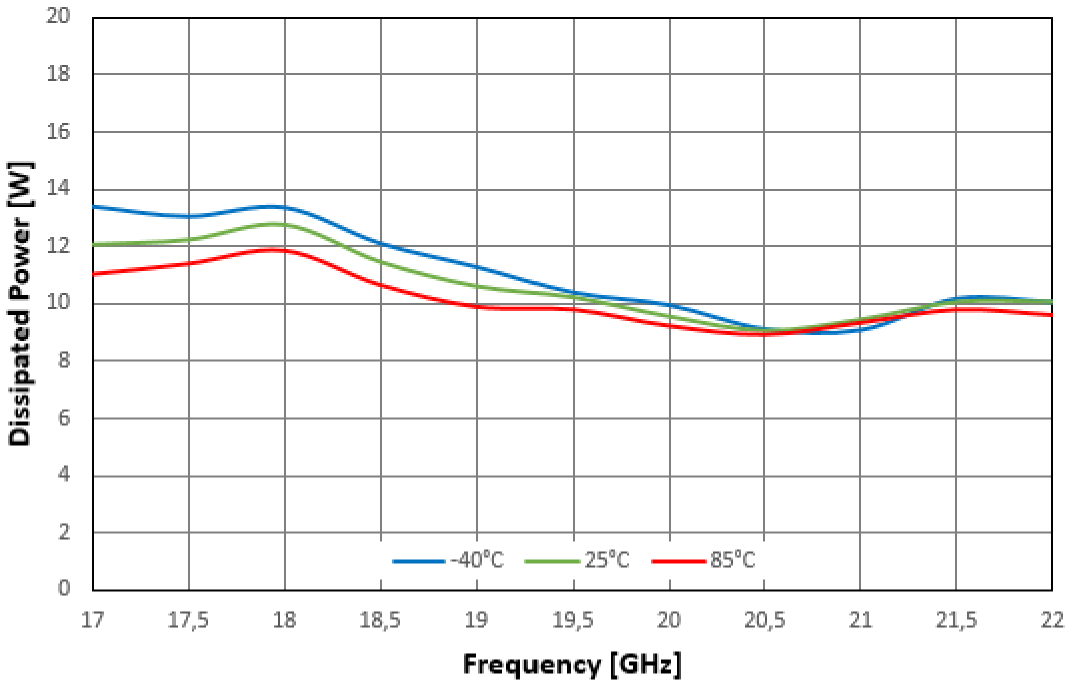
Typical Board Measurements : Non-linear performances

CW measurements: P_{in}=18dBm, Vd = +18V, Idq = 260mA (Adjusted at T_{case}=25°C).
Board losses are de-embedded. Measurements are given in the QFN access plan.

Power Added Efficiency vs Frequency & temperature



Dissipated Power versus Frequency & temperature



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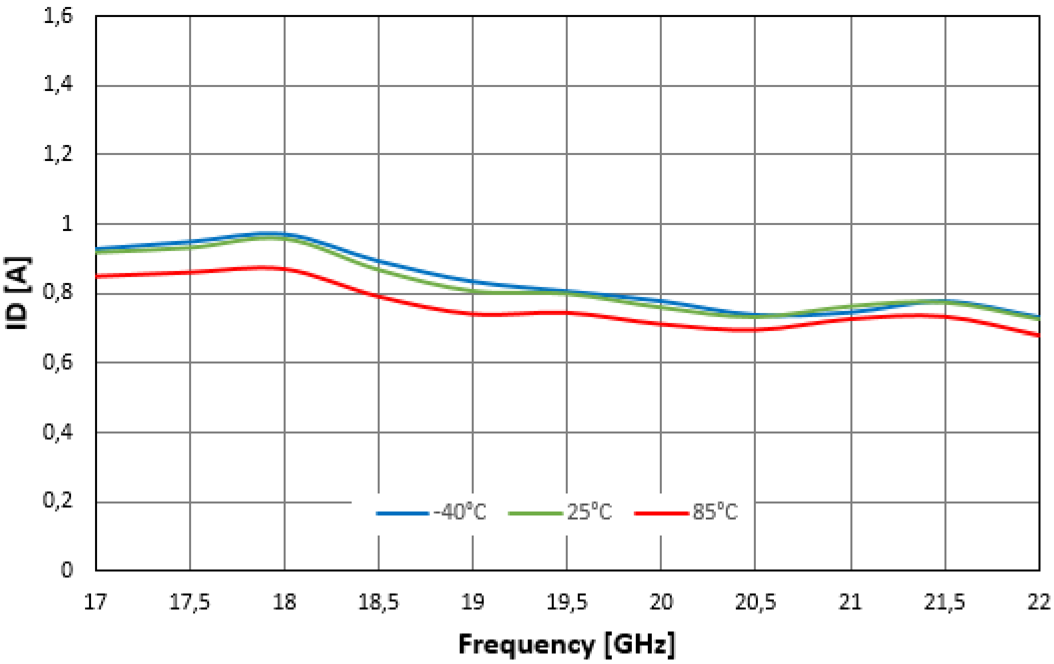
Typical Board Measurements : Non-linear performances

CW measurements: P_{in}=18dBm, Vd = +18V, Idq = 260mA (Adjusted at T_{case}=25°C).
Board losses are de-embedded. Measurements are given in the QFN access plan.

Drain current vs Frequency & temperature



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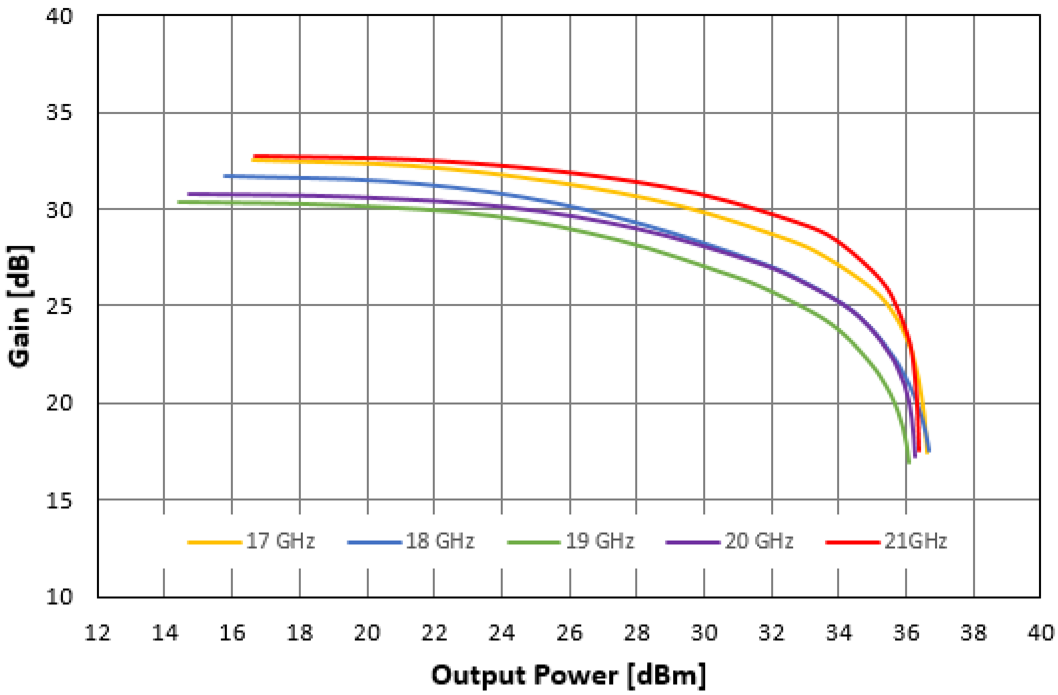
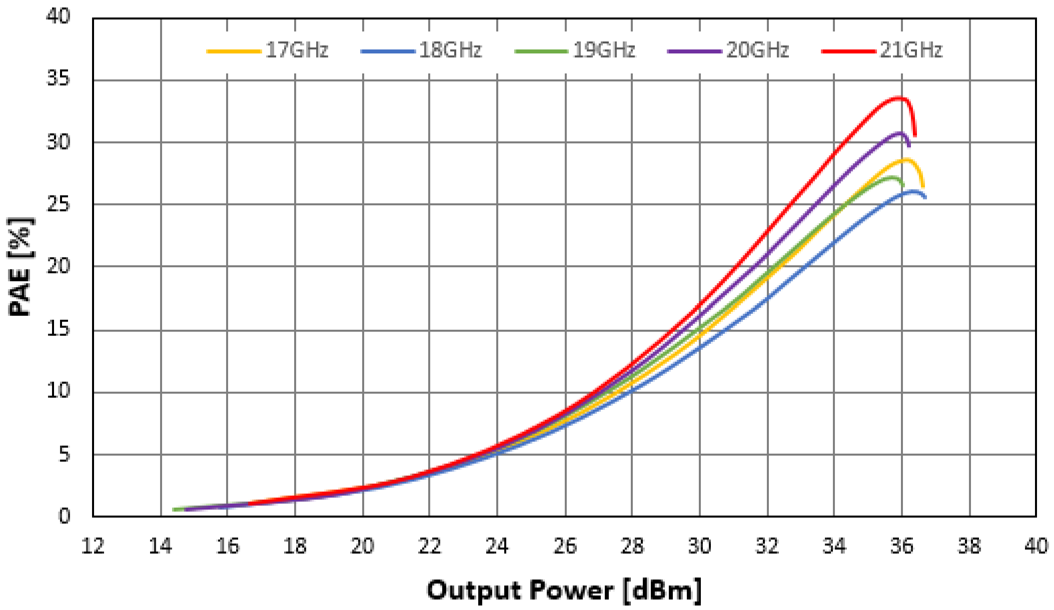
Typical Board Measurements : Non-linear performances

CW measurements: T_{case}=+25°C, Vd = +18V, Idq = 260mA (Adjusted at T_{case}=25°C).
Board losses are de-embedded. Measurements are given in the QFN access plan.

Gain versus Output Power & Frequency



Power Added Efficiency versus Output Power & Frequency



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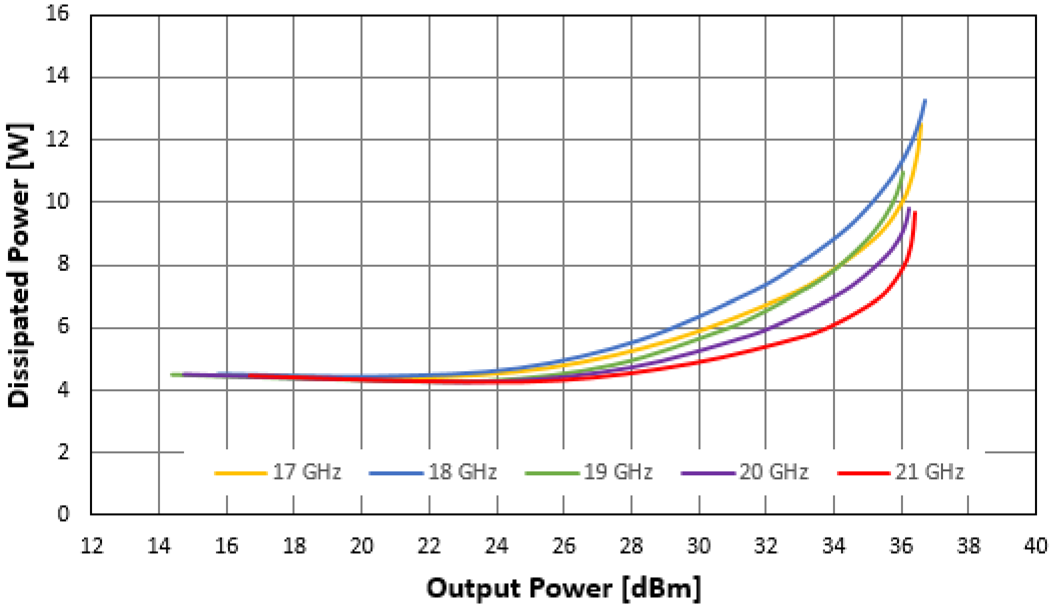
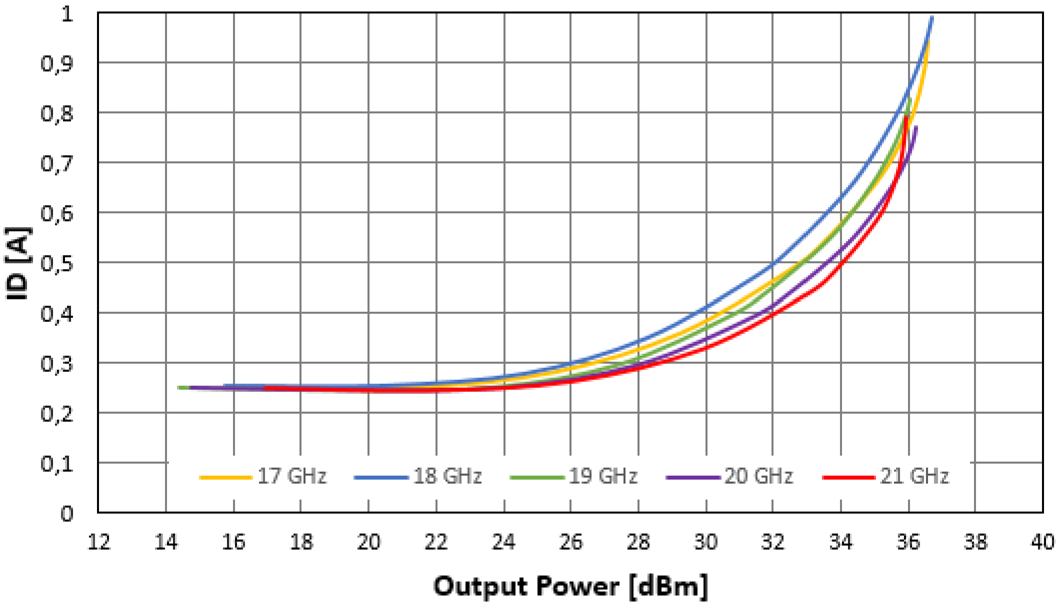
Typical Board Measurements : Non-linear performances

CW measurements: T_{case}=+25°C, Vd = +18V, Idq = 260mA (Adjusted at T_{case}=25°C).
Board losses are de-embedded. Measurements are given in the QFN access plan.

Dissipated Power versus Output Power & Frequency



Drain Current versus Output Power & Frequency



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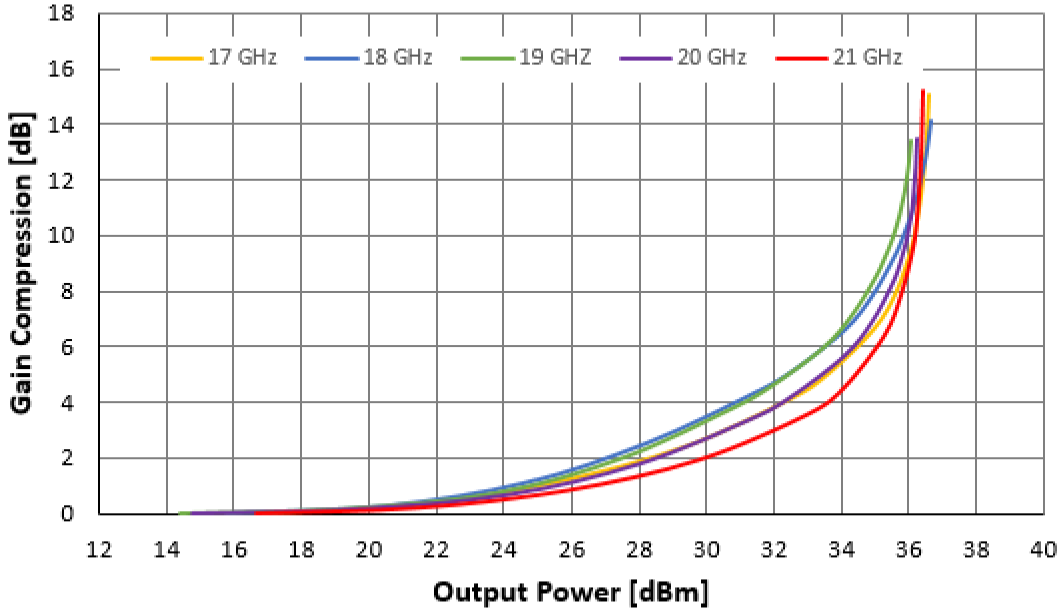
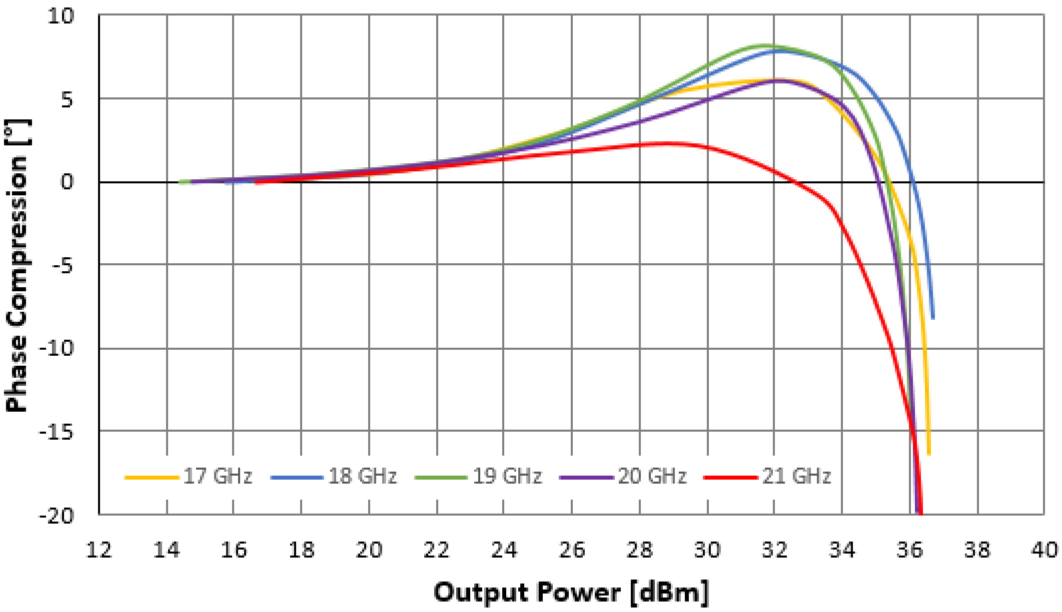
Typical Board Measurements : Non-linear performances

CW measurements: T_{case}=+25°C, Vd = +18V, Idq = 260mA (Adjusted at T_{case}=25°C).
Board losses are de-embedded. Measurements are given in the QFN access plan.

Compression versus Output Power & Frequency



Phase Compression versus Output Power & Frequency



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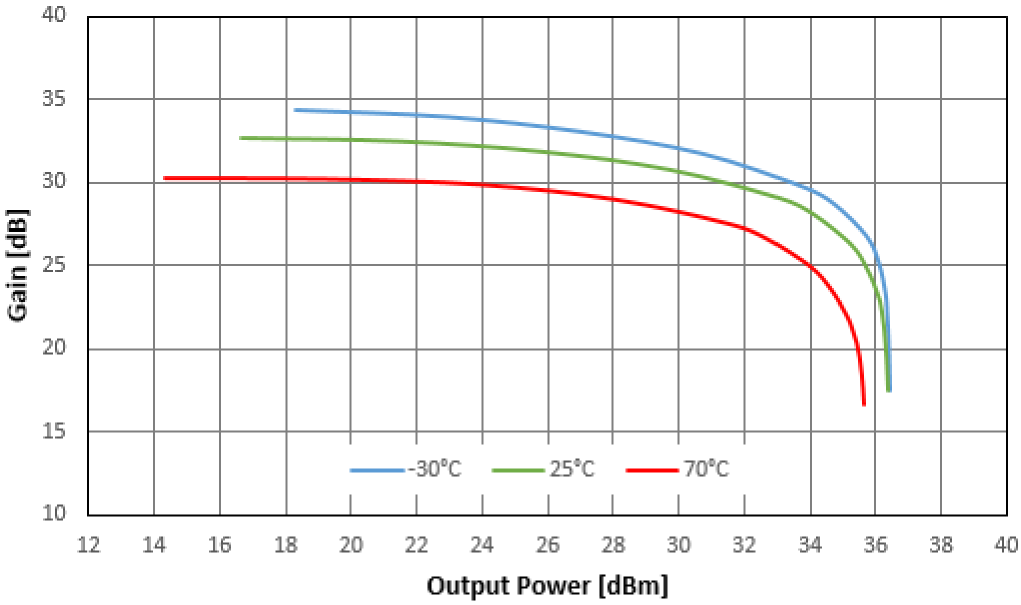
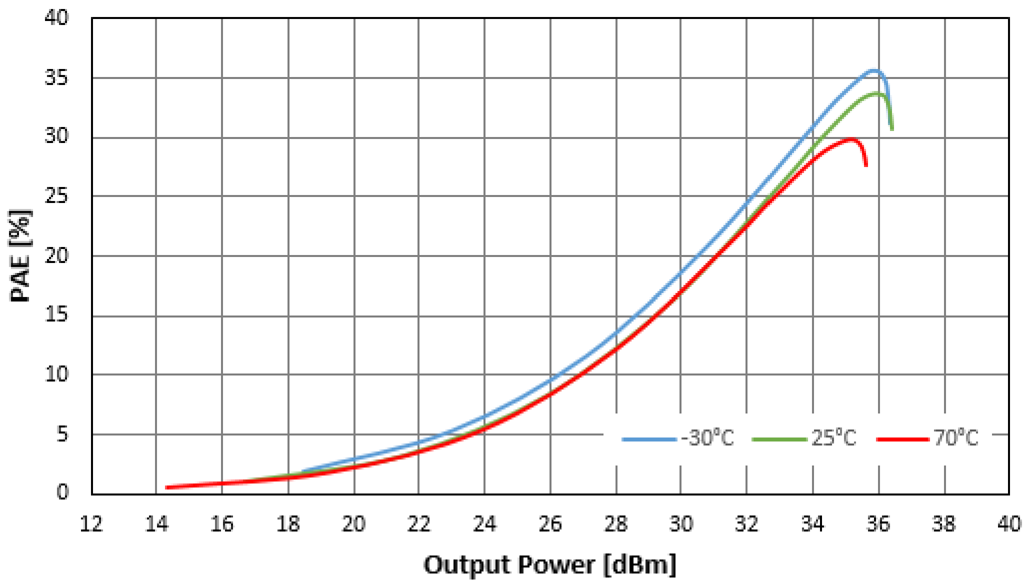
Typical Board Measurements : Non-linear performances

CW measurements:Vd = +18V, Idq = 260mA (Adjusted at T_{case}=25°C), Frequency=21GHz.
Board losses are de-embedded. Measurements are given in the QFN access plan.

Gain versus Output Power & Temperature



Power Added Efficiency versus Output Power & Temperature



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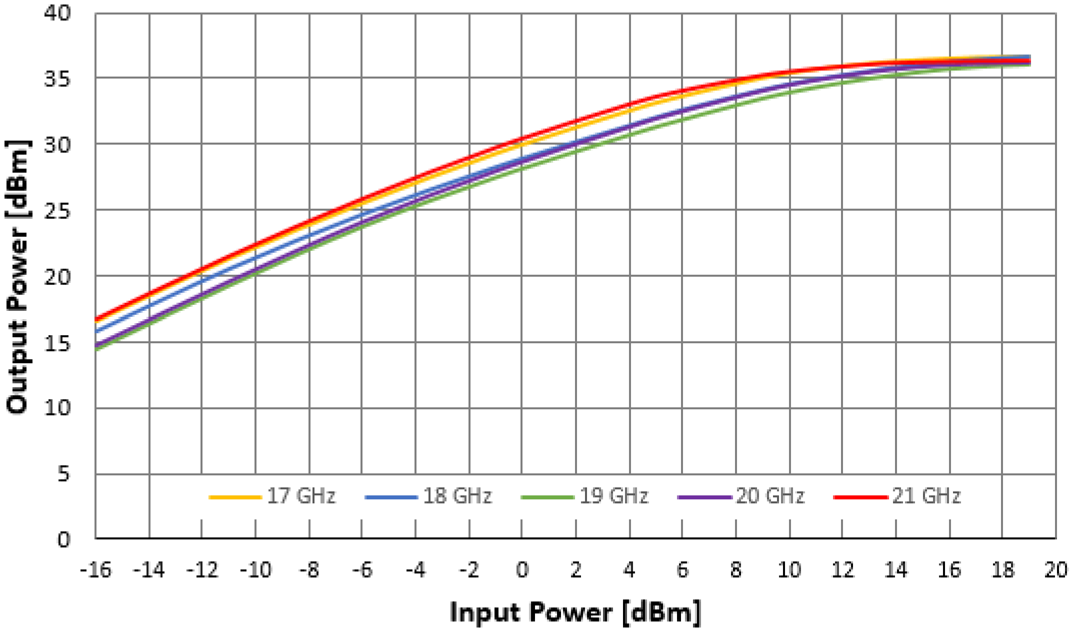
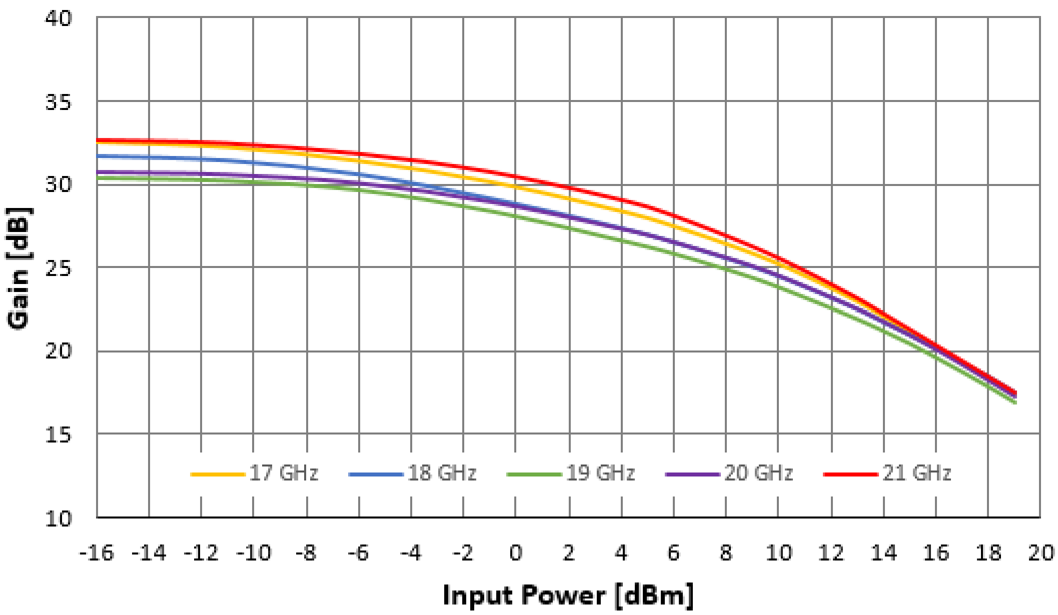
Typical Board Measurements : Non-linear performances

CW measurements: T_{case}=+25°C, Vd = +18V, Idq = 260mA (Adjusted at T_{case}=25°C).
Board losses are de-embedded. Measurements are given in the QFN access plan.

Output Power vs Input Power & Frequency



Gain versus Input Power & Frequency



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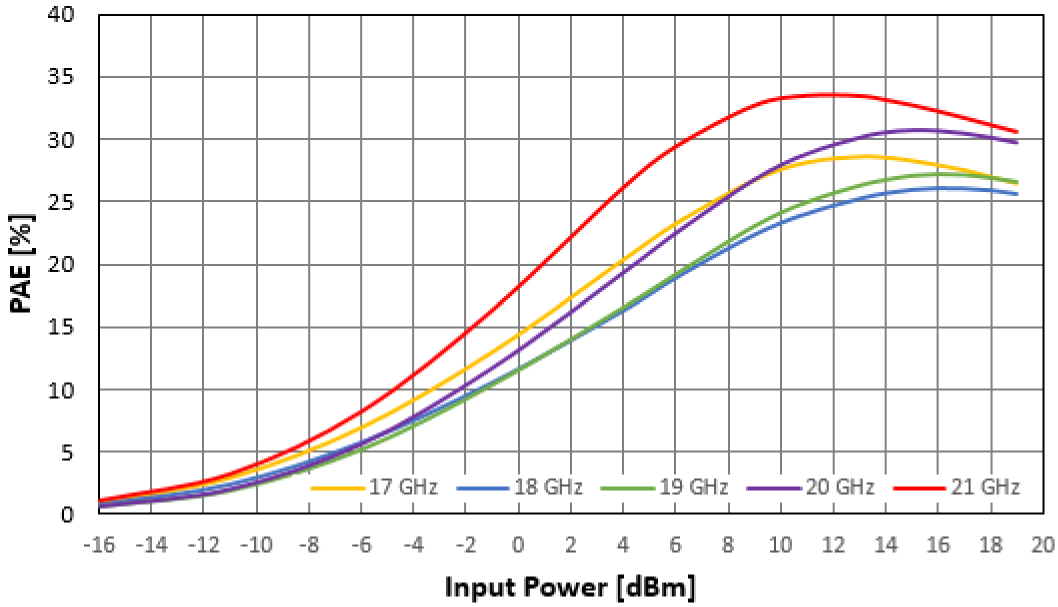
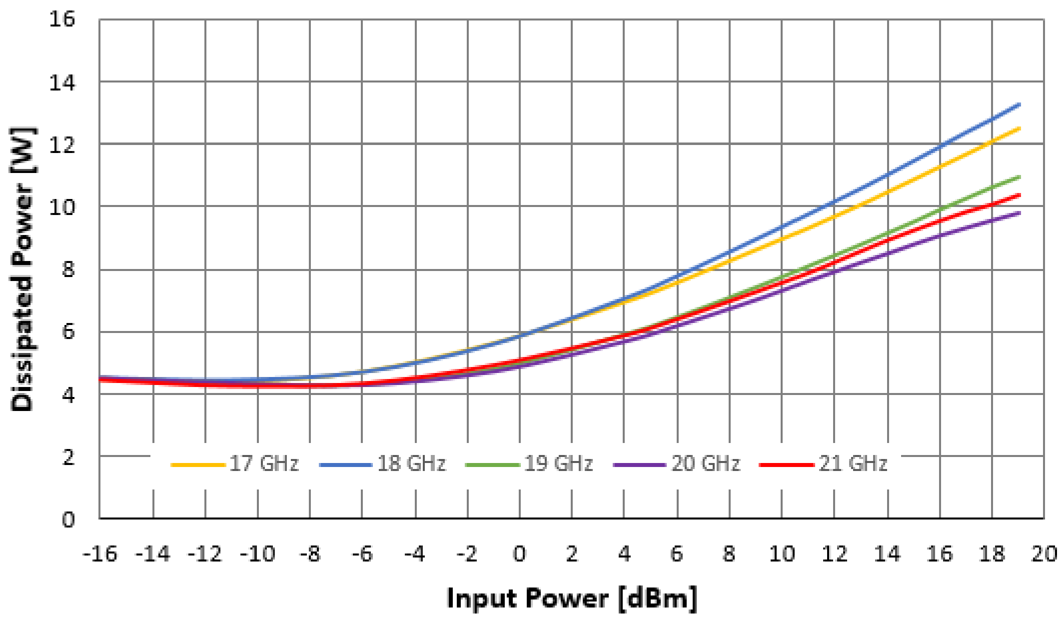
Typical Board Measurements : Non-linear performances

CW measurements: T_{case}=+25°C, Vd = +18V, Idq = 260mA (Adjusted at T_{case}=25°C).
Board losses are de-embedded. Measurements are given in the QFN access plan.

Power Added Efficiency vs Input Power & Frequency



Compression versus Input Power & Frequency



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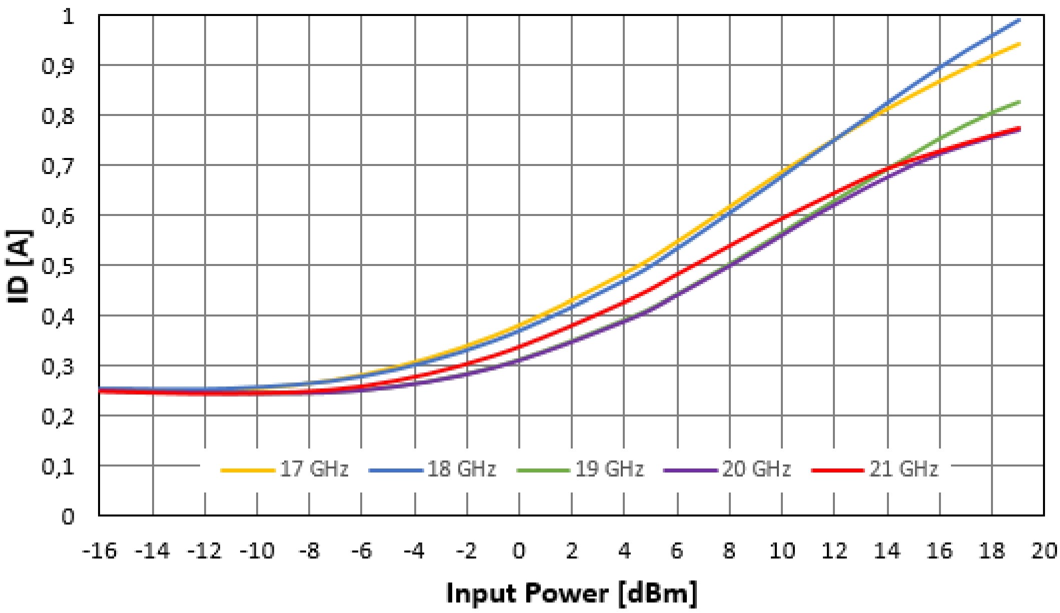
Typical Board Measurements : Non-linear performances

CW measurements: T_{case}=+25°C, Vd = +18V, Idq = 260mA (Adjusted at T_{case}=25°C).
Board losses are de-embedded. Measurements are given in the QFN access plan.

Drain Current vs Input Power & Frequency



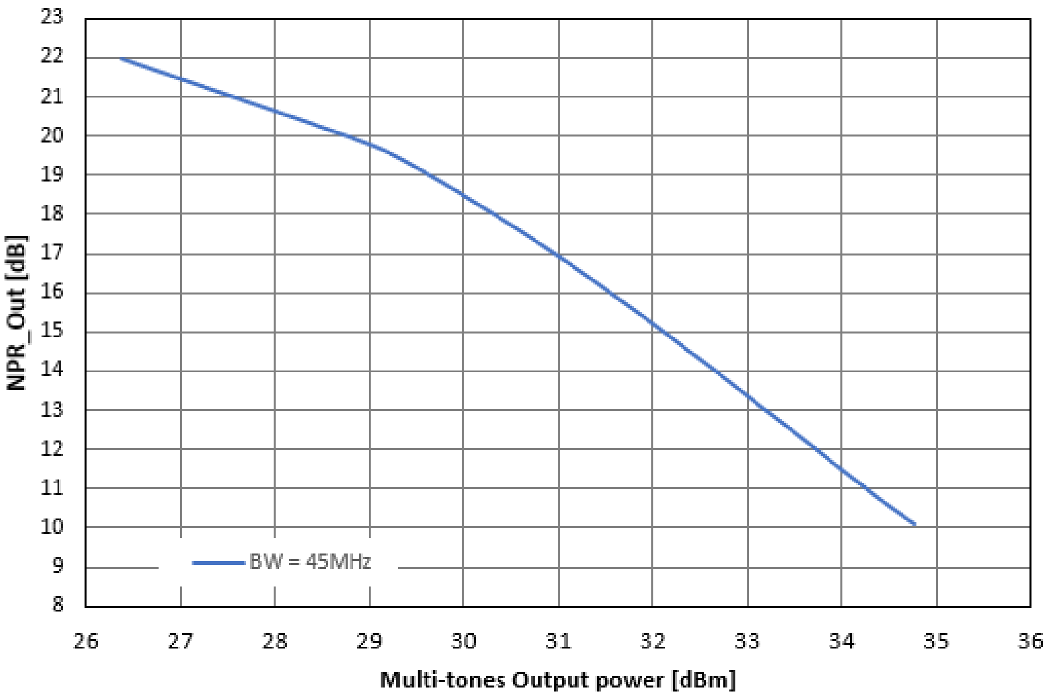
Typical Board Measurements : NPR performances

T_{case}=+25°C, Vd = +18V, Idq = 260mA

Center Frequency : 19GHz

Measured bandwidth : 45MHz

Notch width : 10%



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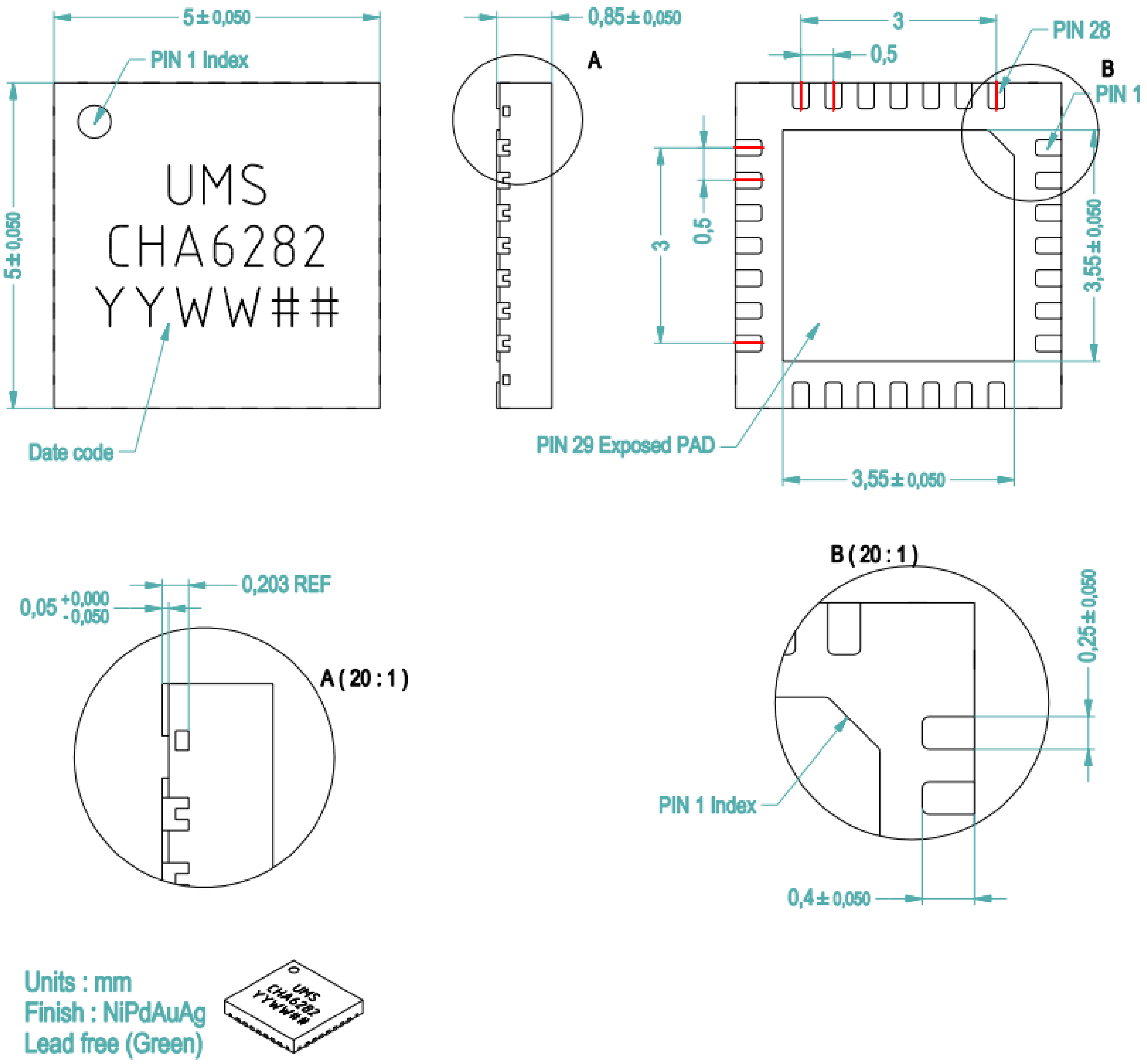
Package outline (1)



NiPdAuAg, Lead Free	(Green)	1- Nc	11- D4	21- Nc
Units :	mm	2- Nc	12- G4	22- GND(2)
From the standard :	JEDEC MO-220	3- GND(2)	13- D3	23- D2
	(VGGD)	4- RF in	14- GND(2)	24- G3
		5- GND(2)	15- Nc	25- D1
		6- Nc	16- Nc	26- G2
		7- Nc	17- GND(2)	27- GND(2)
		8- GND(2)	18- RF out	28- G1
		9- Nc	19- GND(2)	29- GND(2)
		10- D5	20- Nc	

(1) The package outline drawing included to this data-sheet is given for indication. Refer to the application note AN0017 (https://www.ums-rf.com) for exact package dimensions.

(2) It is strongly recommended to ground all pins marked “GND” through the PCB board. Ensure that the PCB board is designed to provide the best possible ground to the package.

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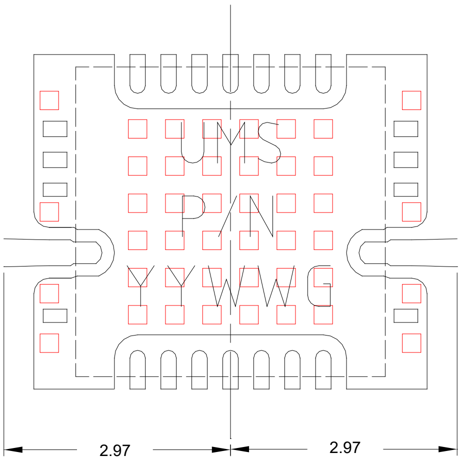
Definition of the Sij reference planes

The reference planes used for Sij measurements given above are symmetrical from the symmetrical axis of the package (see drawing beside). The input and output reference planes are located at 2.97mm offset (input wise and output wise respectively) from this axis. Then, the given Sij parameters incorporate the land pattern of the evaluation board recommended in paragraph "Evaluation board".



ESD sensitivity

Standard	Value
MIL-STD-1686C	HBM Class 1 (<2000V)
ESD STM5.1-1998	HBM Class 0 (<250V)

Package Information

Parameter	Value
Package body material	RoHS-compliant
	Low stress Injection Molded Plastic
Lead finish	100% NiPdAuAg
MSL Rating	MSL3

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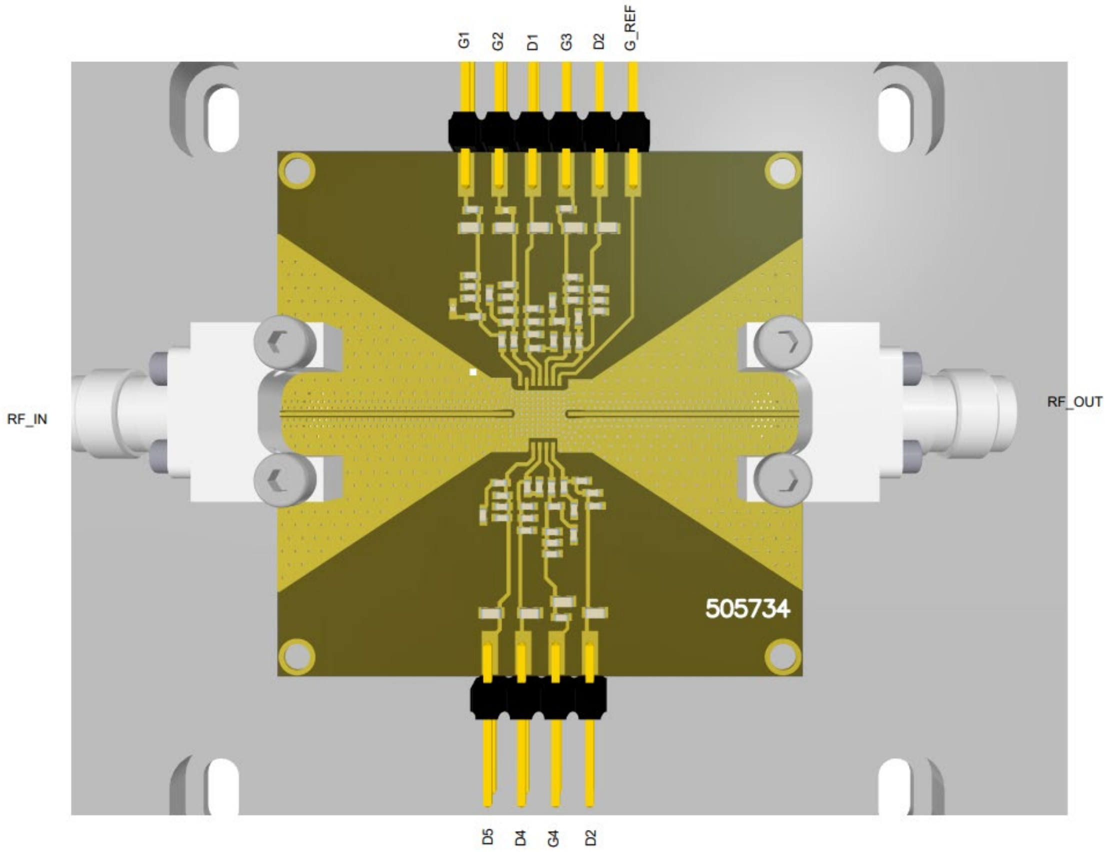
Evaluation board

- ■ Compatible with the proposed footprint.
- ■ Based on typically Ro4003 / 8mils or equivalent.
- ■ Using a micro-strip to coplanar transition to access the package.
- ■ Recommended for the implementation of this product on a module board.
- ■ Decoupling capacitors of 100pF, 1nF, 10nF, 100nF and 1µF (±10%) are recommended for all DC accesses.
- ■ See application note AN0017 for details.



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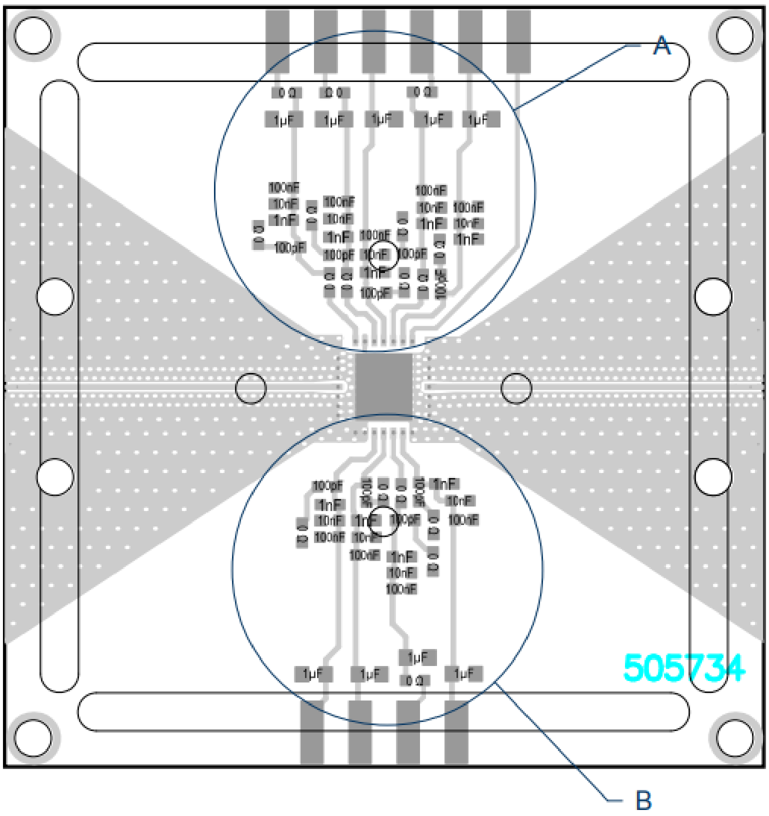

5 levels of decoupling capacitor have been used :
First level of capacitor is 100pF, second level is 1nF, third level 10nF, fourth level 100nF and fifth level is 1µF

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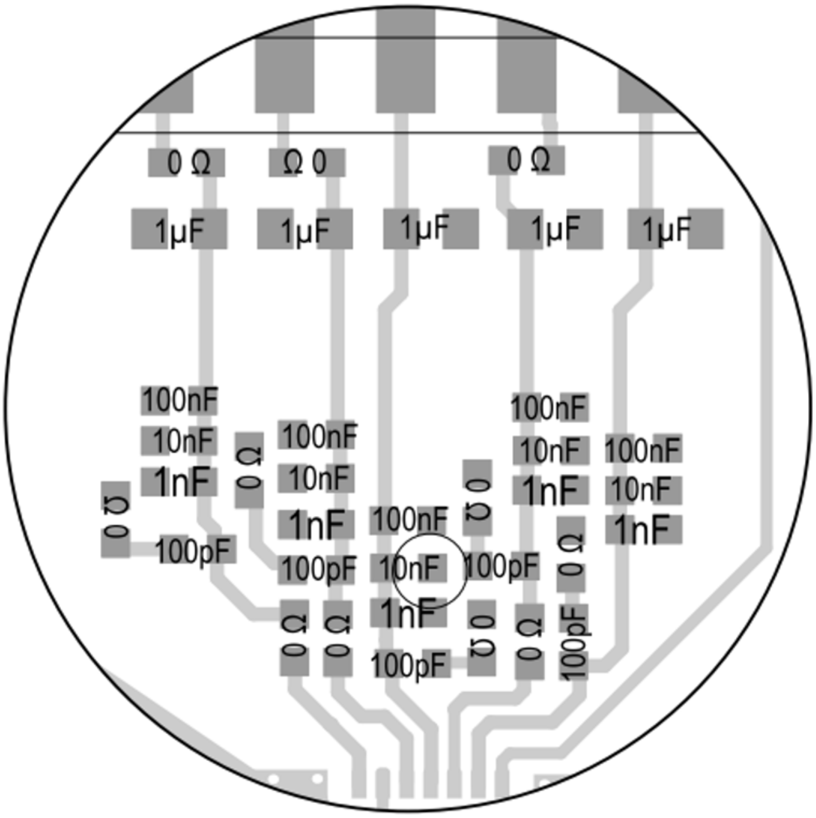
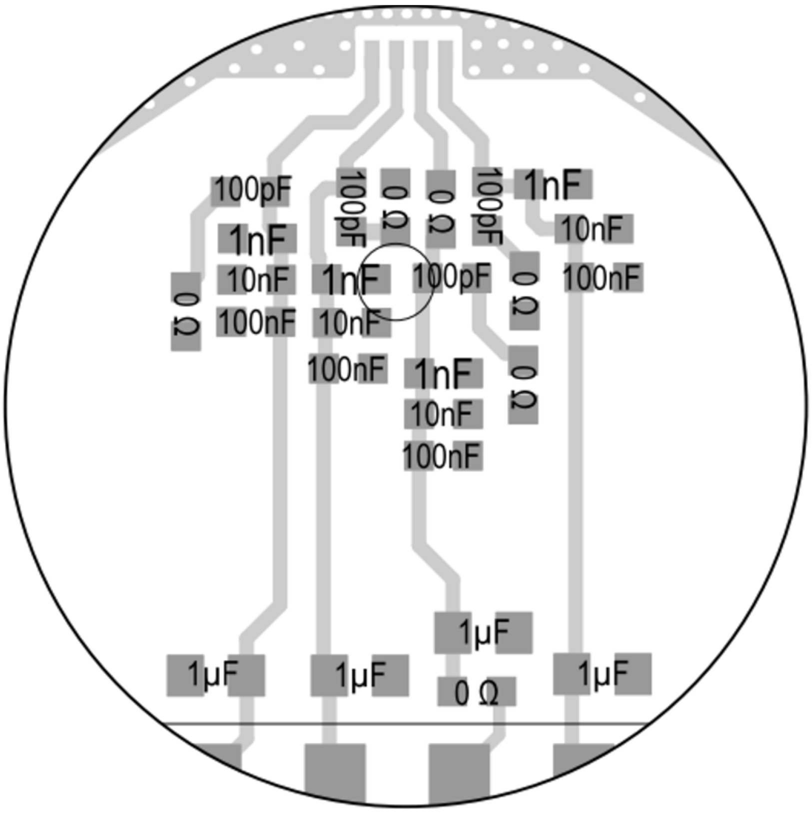
Détail A



Détail B



Note: All board measurements are performed using shielded cables, even for DC bias, to ensure safe operation.

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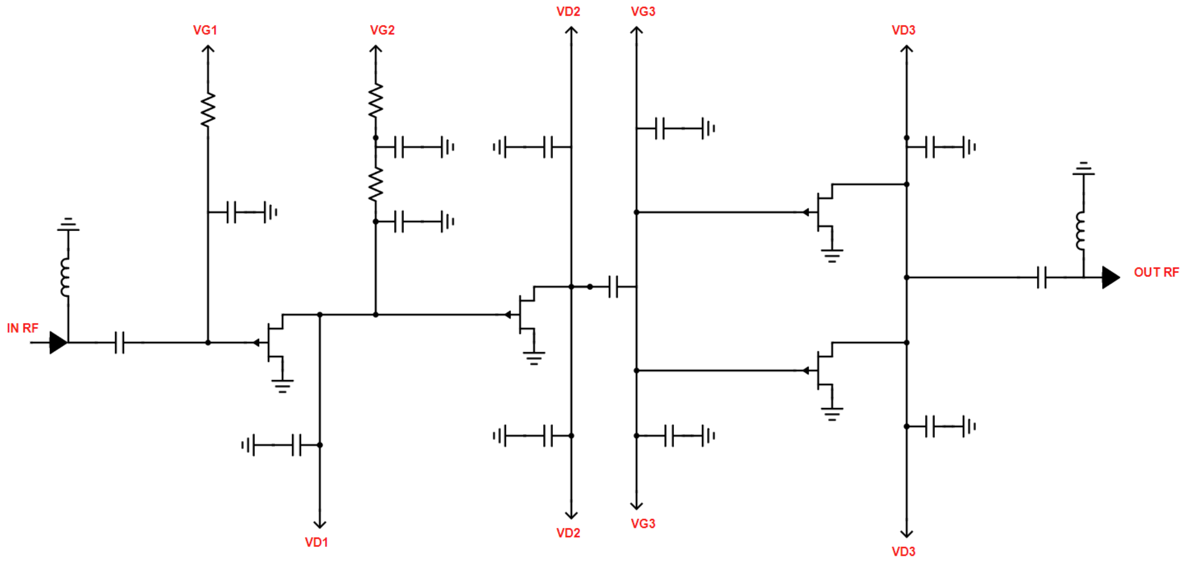
DC Schematic

Due to ESD protection circuits on RF input and output, an external capacitance might be requested to isolate the product from external voltage that could be present on the RF accesses.



The DC connections do not include any decoupling capacitor in package, therefore it is mandatory to provide a good external DC decoupling (100pF, 1nF, 10nF, 100nF, 1µF) on the PC board, as close as possible to the package.

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Recommended package footprint

Refer to the application note AN0017 available at https://www.ums-rf.com for package foot print recommendations.

SMD mounting procedure

For the mounting process standard techniques involving solder paste and a suitable reflow process can be used. For further details, see application note AN0017 at https://www.ums-rf.com.

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

QFN 5x5 package:	CHA6282-QCB/XY	
	Stick: XY = 20	Tape & reel: XY = 21

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