United Monolithic Semiconductors

CHA6094-QKB

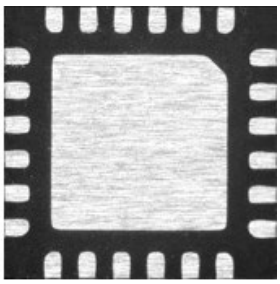
35-42.5GHz 2W Packaged Power Amplifier

GaN Monolithic Microwave IC in SMD leadless package

Description

The CHA6094-QKB is a GaN packaged Power Amplifier operating over 35-42.5GHz frequency band. It typically exhibits 33dBm saturated output power with 26dB small signal gain. For 256QAM modulation signal & 120MHz channel spacing the linear power is 29dBm with ACPR below -29dBc and it is 27dBm with EVM below 3.5%.

The CHA6094-QKB is designed for telecom applications such as 5G active phased array antennas, Satcom and Radar systems. It is manufactured on a robust GaN-on-SiC HEMT technology and packaged in a standard surface mount 4x4 plastic QFN which is RoHS compliant. RF input and output are 50Ω matched and integrate ESD RF protections.

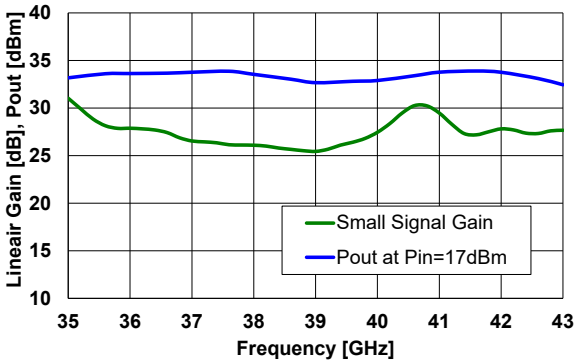


Main Features

- Frequency range: 35-42.5GHz
- Pout = 33dBm @ 17dBm input power
- Linear Gain = 26dB
- ACPR < -29dBc at 29dBm Average Pout(1)
- EVM < 3.5% at 27dBm Average Pout(1)
- DC bias: Vd=25V @ Idq=150mA
- 24L-QFN RoHS plastic package 4x4mm²
- MSL3

(1) 120MHz modulation bandwidth, 256QAM

Small Signal Gain & Output Power at Pin = 17dBm vs. Frequency, T°= 25°C



Main Electrical Characteristics

Tcase = +25°C (Tcase: QFN backside temperature)

Symbol	Parameter	Min	Typ	Max	Unit
Freq	Frequency range	35.0		42.5	GHz
Gain	Linear Gain		26		dB
ACPR	ACPR @ P_{AVG} = 27dBm with 256QAM & 120MHz modulation bandwidth		-33		dBc
P_{MAX}	Maximum Output Power at PAE_{MAX}		33		dBm

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Specifications

Tcase = +25°C, Vd = +25V (QFN reference plans)

Symbol	Parameter	Min	Typ	Max	Unit
Freq	Frequency range	35.0		42.5	GHz
Gain	Linear Gain		26		dB
IRL(*)	Input Return Losses		10		dB
ORL(*)	Output Return Losses		10		dB
PAE_{MAX}	Maximum Power Added Efficiency		13		%
P_{MAX}	Output Power at PAE_{MAX}		33		dBm
ACPR	Transmit ACPR@ P_{AVG}=25dBm, 256QAM 120MHz modulation bandwidth		-33		dBc
EVM	Transmit EVM @ P_{AVG}=25dBm for 256QAM, 120MHz modulation bandwidth		-32		dB
Vd	CW Drain Voltage		25		V
Vg	CW Gate Voltage		-2.9		V
Idq	Quiescent Drain bias current		150		mA

These values are representative of measurements performed on evaluation board - see paragraph "Evaluation board".

(*) Input and Output Return Loss are given at RF reference plan of Evaluation board (see Definition of the board reference planes section).

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Absolute Maximum Ratings (1)

Tcase = +25°C

Symbol	Parameter	Values	Unit
Vd	Drain bias voltage	27	V
Idq	Quiescent Drain bias current	250	mA
Vg	Gate bias voltage	-7 to -2	V
Pin	Maximum Input Power	21	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	20 to 25	V
Id	Quiescent Drain bias current	0 to 200	mA
Vg	Gate bias voltage	-5 to-2.8	V
Pin	Maximum Input Power	19	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

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

Typical Bias Conditions

Tcase=+25°C

Symbol	Pad N°	Parameter	Values	Unit
VG12	24	1st Gate bias voltage	-2.9	V
VG3	23	2nd Gate bias voltage	-2.9	V
VG4	22	3th Gate bias voltage	-2.9	V
VD12	21	1st Drain bias voltage	25	V
VD3N(*)	20	North 2nd Drain bias voltage	25	V
VD4N(*)	19	North 3th Drain bias voltage	25	V
VD3S(*)	10	South 2nd Drain bias voltage	25	V
VD4S(*)	12	South 3th Drain bias voltage	25	V

(*) It is possible to apply biasing on one side only (North or South) or on both sides (North and South)

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“Power ON” sequence

1. Bias HPA gate voltage Vg (VG12, VG3, VG4) close to Vpinch-off (Typically: Vg ≈ -5V)
2. Apply drain bias voltage Vd (VD12, VD3N, VD4N, VD3S, VD4S) (Typically: Vd = 25V)
3. Increase gate voltage Vg (VG12, VG3, VG4) up to quiescent bias drain current Idq
4. Apply RF signal

“Power OFF” sequence

1. Turn off RF signal
2. Bias HPA gate voltage Vg (VG12, VG3, VG4) close to Vpinch-off (Typically: Vg ≈ -5V)
3. Check that quiescent bias drain current Idq is close to 0mA
4. Turn drain bias voltage Vd (VD12, VD3N, VD4N, VD3S, VD4S) to 0V
5. Check that quiescent bias drain current Idq is close to 0mA
6. Turn gate voltage Vg (VG12, VG3, VG4) to 0V

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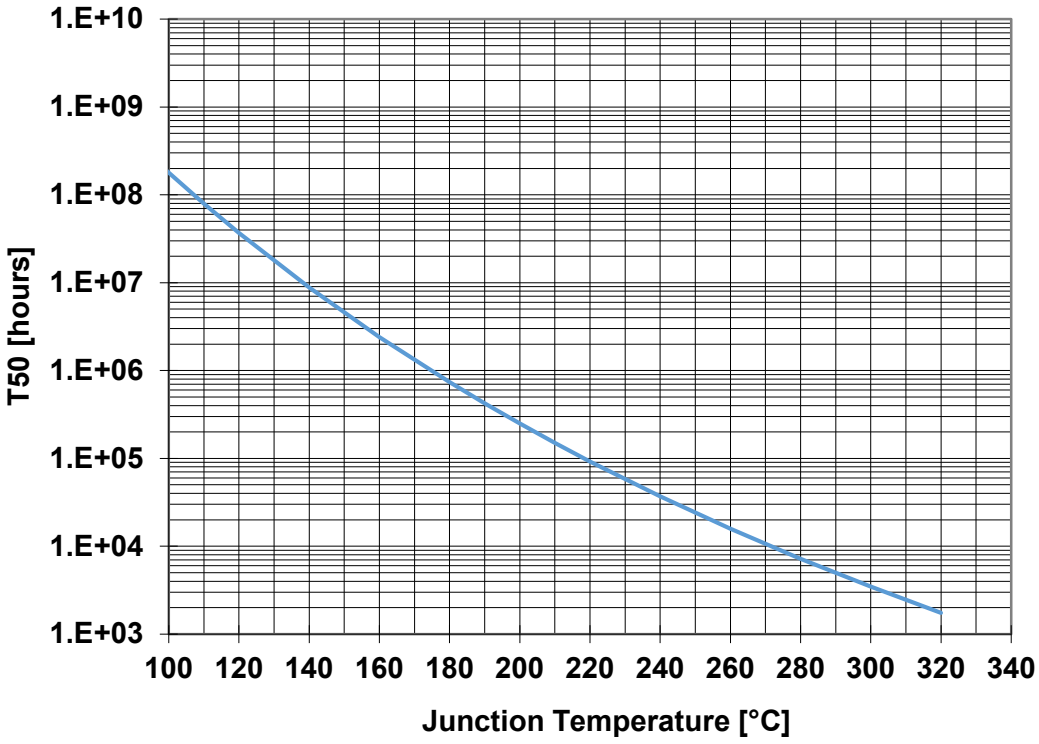
Device thermal performances

All figures given in this section are obtained assuming the QFN device is only cooled down by conduction through the package thermal pad (no convection mode is considered).
The temperature is monitored at the package back-side interface (Tcase).
The system maximum temperature must be adjusted in order to guarantee that Tjunction remains below the maximum value specified in the Recommended Operating Range table.
The system PCB must be designed to comply with this requirement.

Parameter	DC & RF conditions	Tjunction (°C)	R_{TH} (°C/W)	T50 (hours)
R_{TH} [1] Thermal Resistance (Junction to Case)	Vd= 25V Id= 150mA Pout= 23dBm Pdiss= 6 W	135	8.2	8.8E+06
	Vd= 25V Id= 150mA Pout= 31.5dBm Pdiss= 10.8W	200	10.6	2.5E+05

[1] Assuming 85°C Tcase



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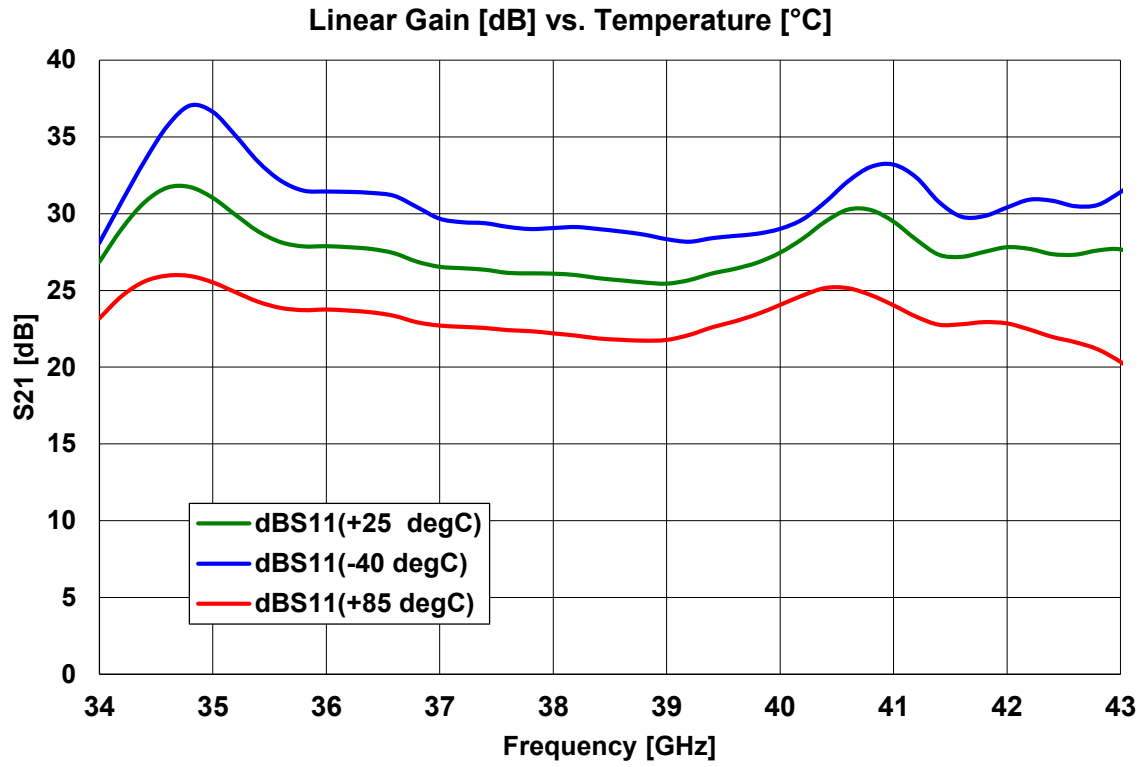
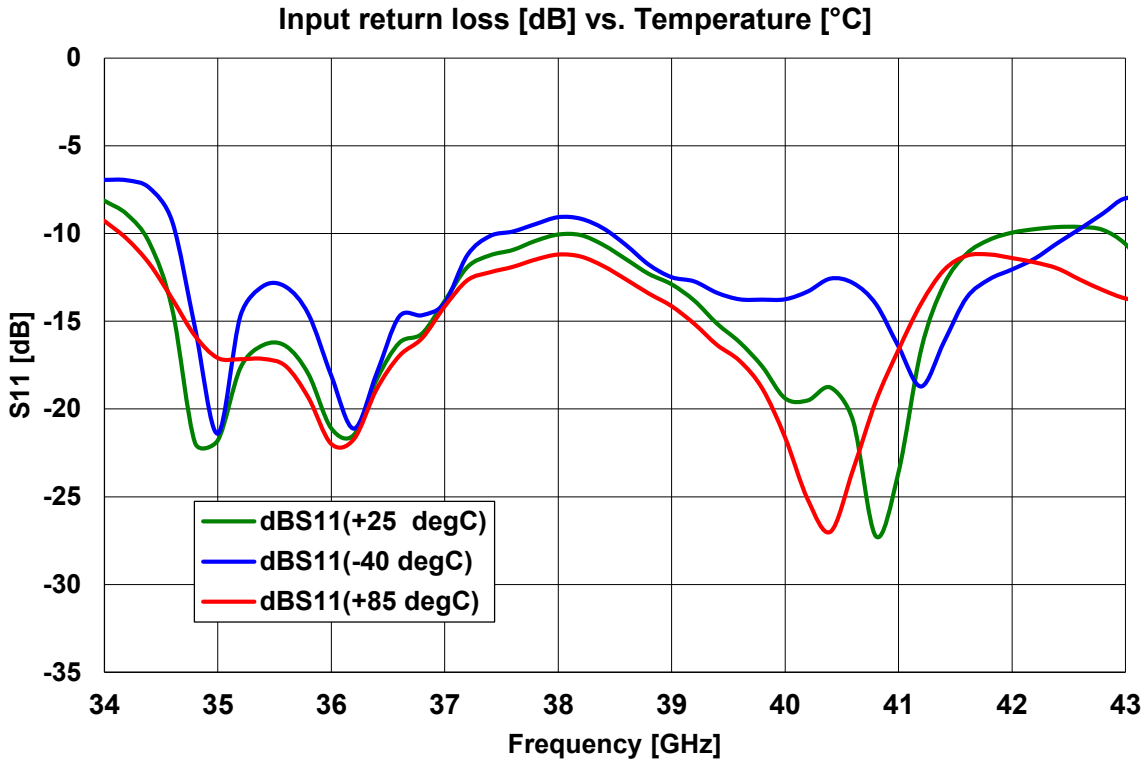
Typical on board Measurements: Small signal performance

Tcase=-40°C/+25°C/+85°C (QFN backside), Vd = +25V, Idq = 150mA





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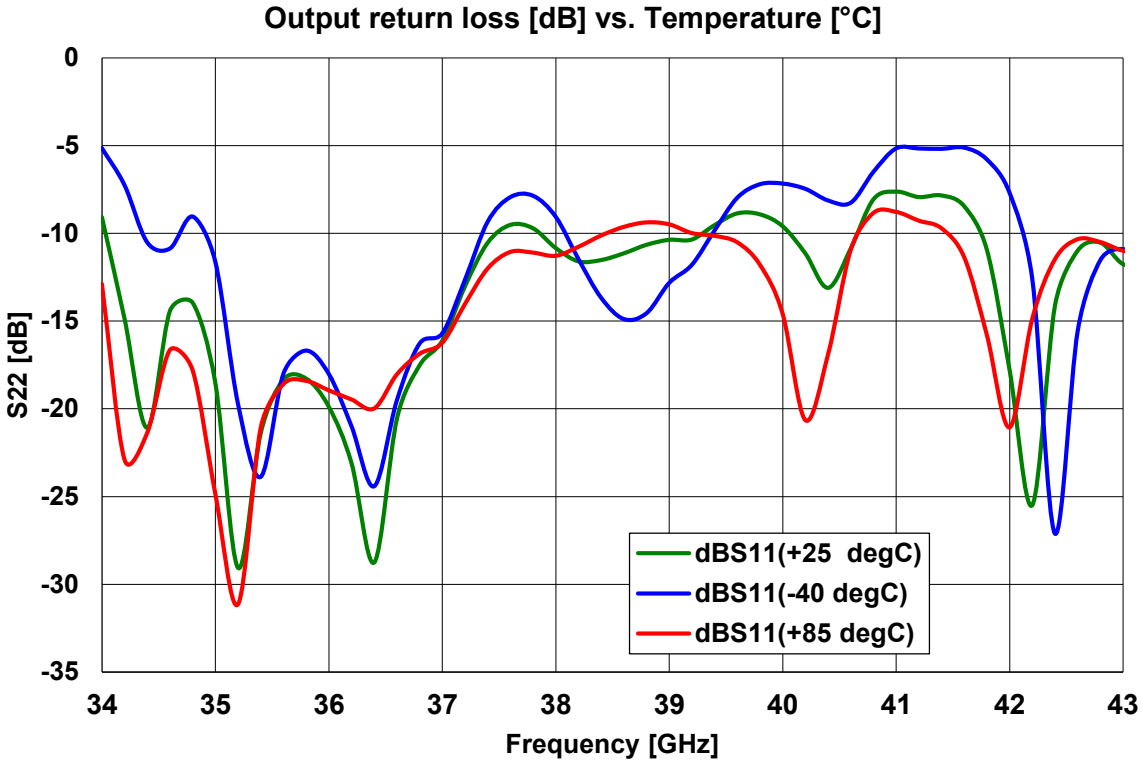

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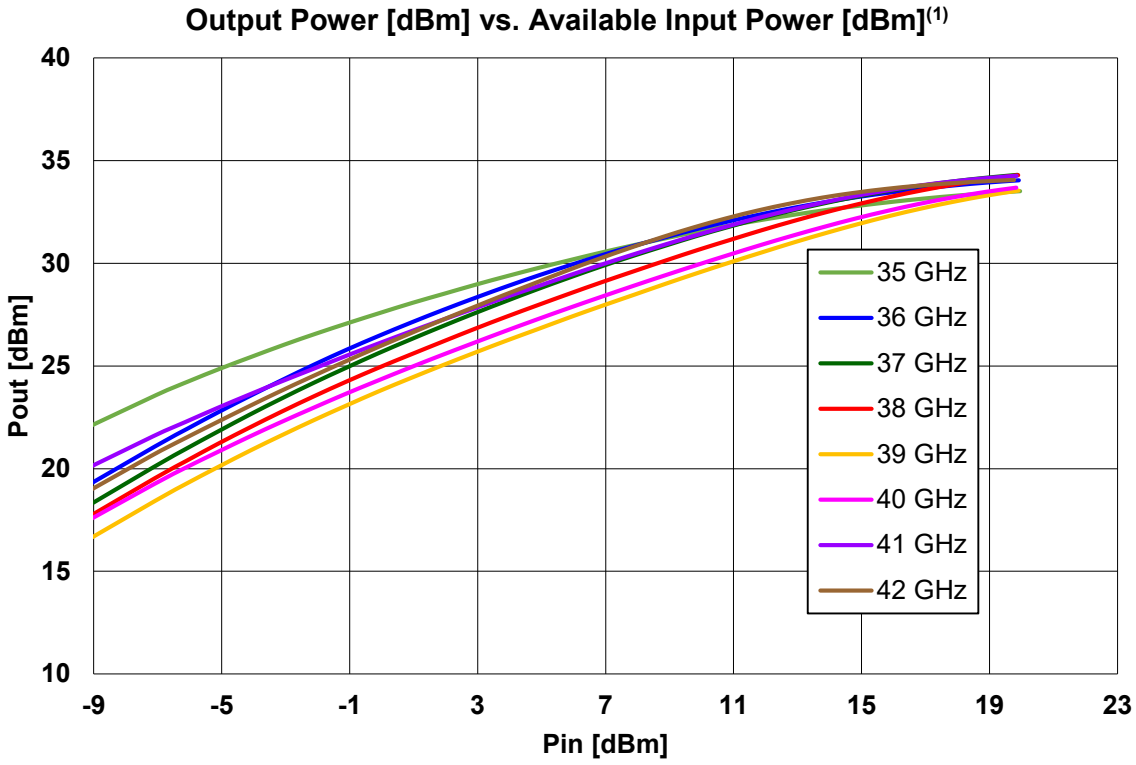
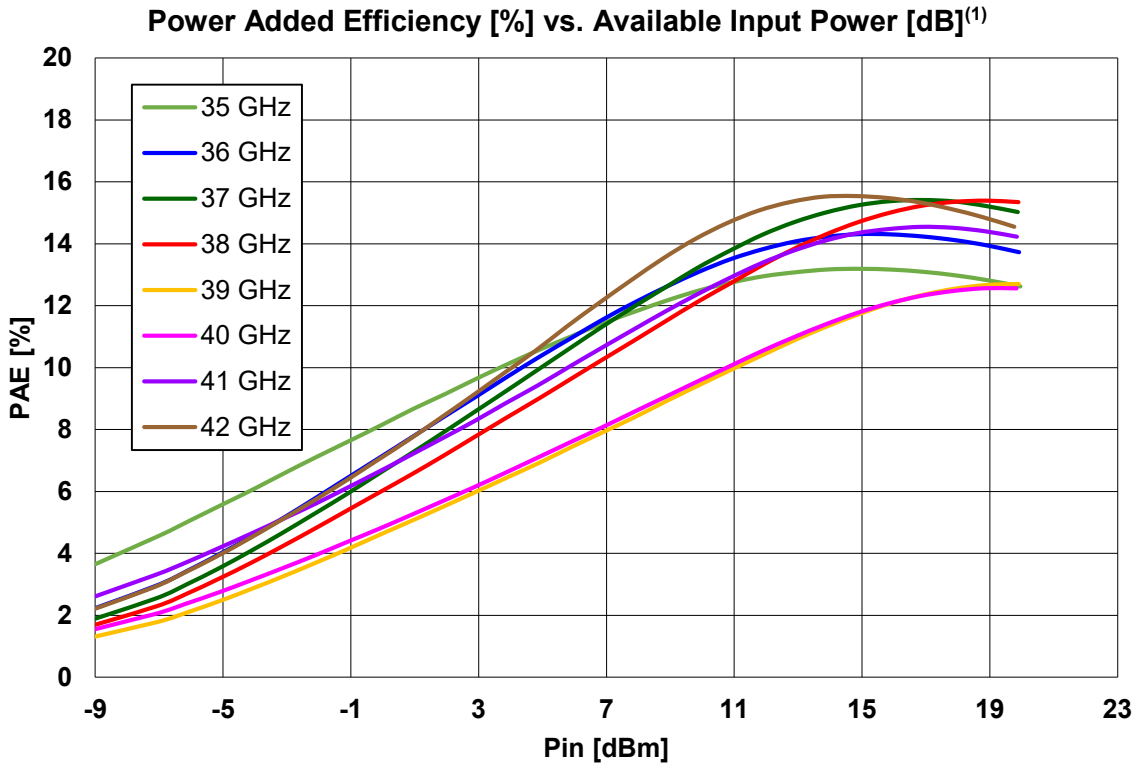
Typical on board Measurements: Large signal performance

Tcase=+25°C (QFN backside), Vd = +25V, Idq = 150mA





(1) The temperature is fixed at Tcase = 25°C with Pout = 33dBm.

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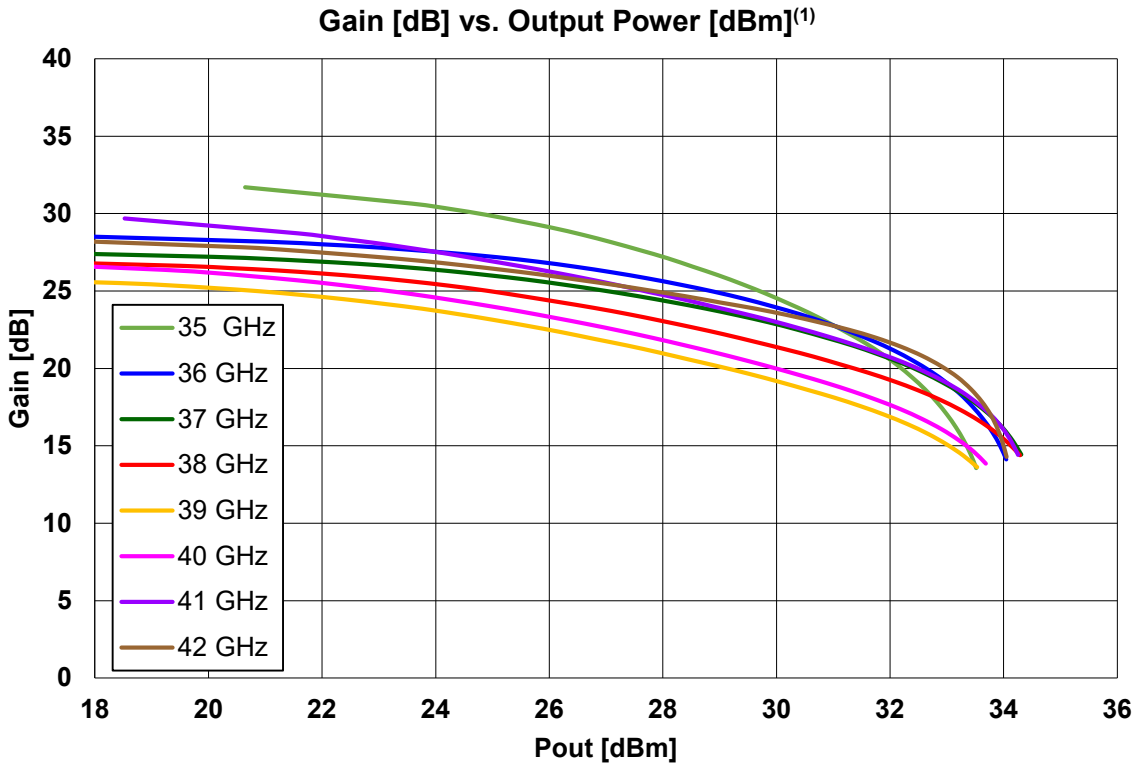

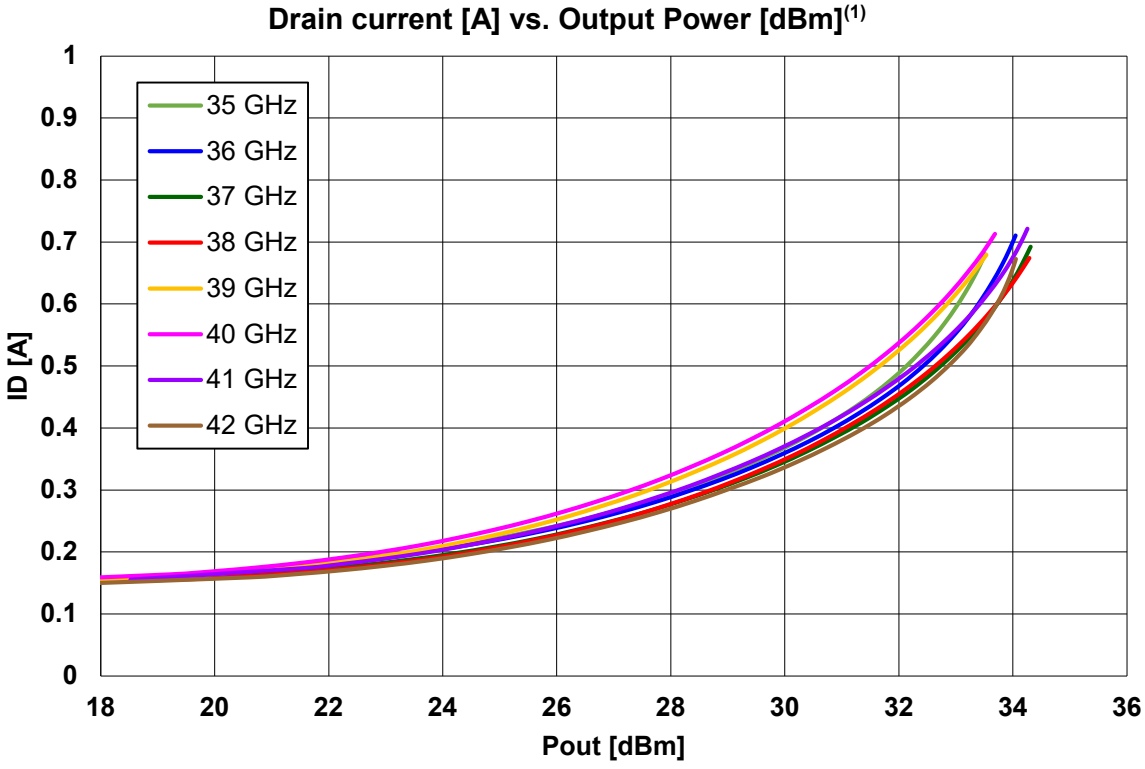

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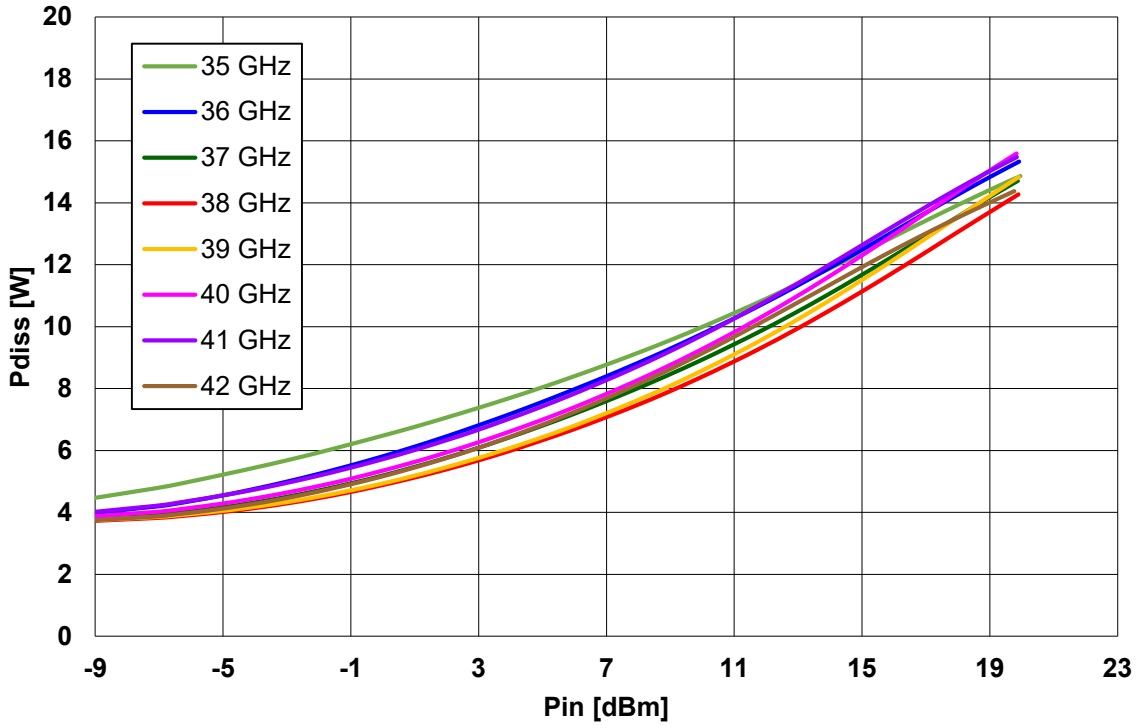
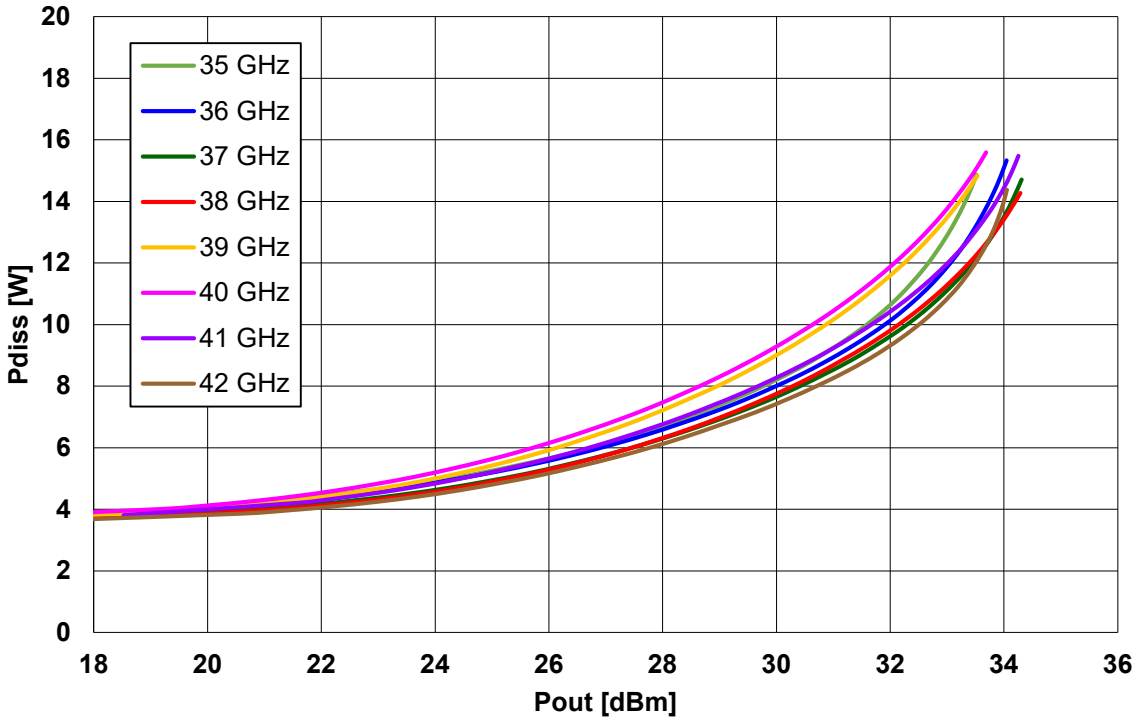
Typical on board Measurements: Large signal performance

Tcase=+25°C (QFN backside), Vd = +25V, Idq = 150mA

Dissipated power [W] vs. Available Input Power [dBm](1)



Dissipated power [W] vs. Output Power [dBm](1)



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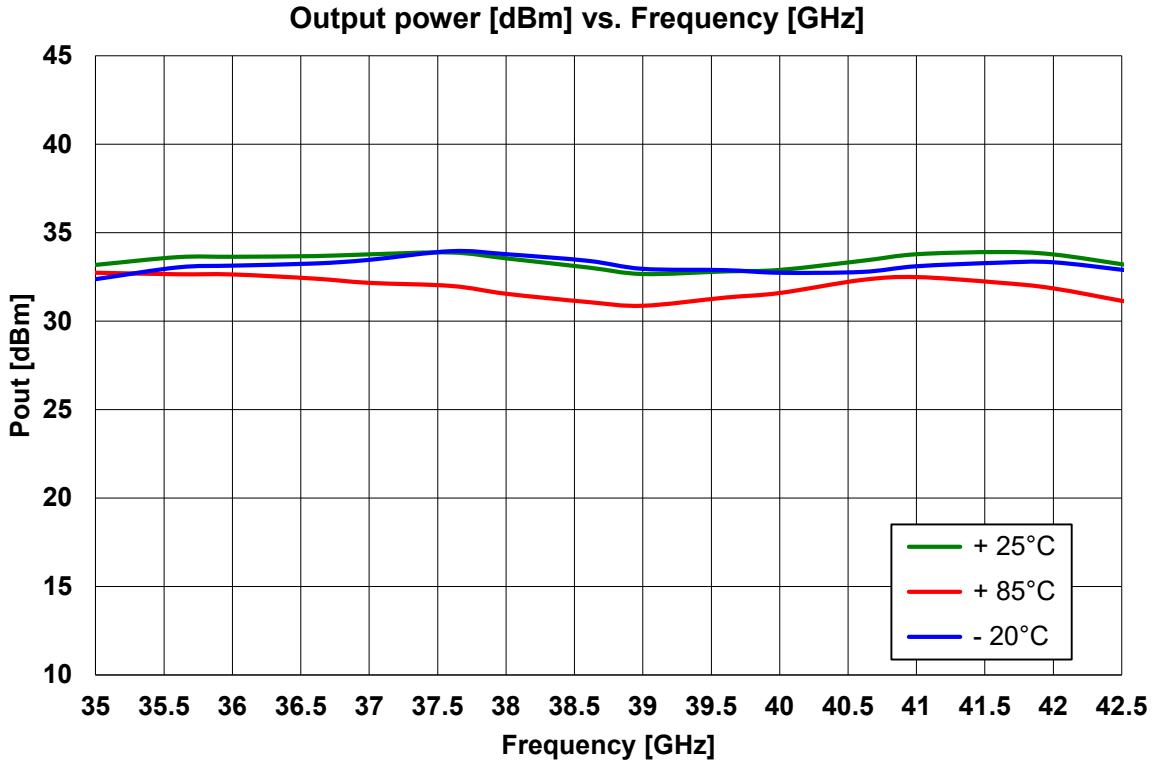
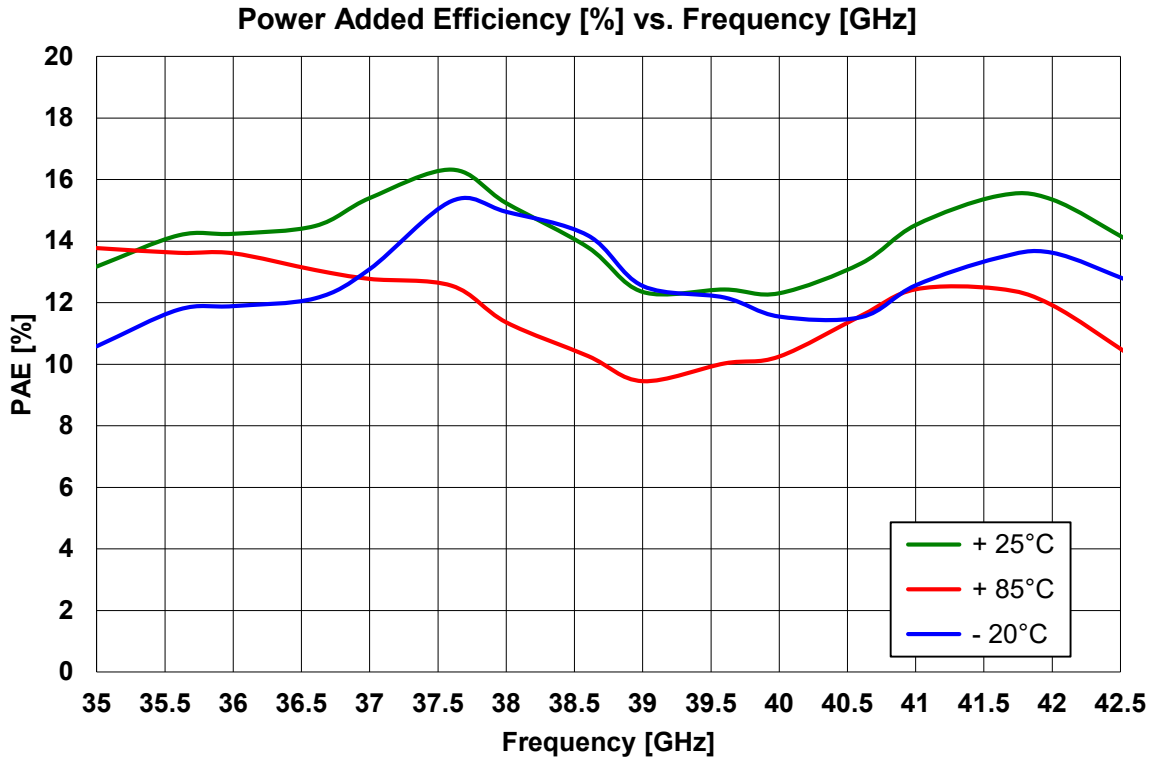
Typical on board Measurements: Large signal performance

Tcase= -20°C/+25°C/85°C (QFN backside), Vd = +25V, Idq = 150mA, Pin= 17dBm





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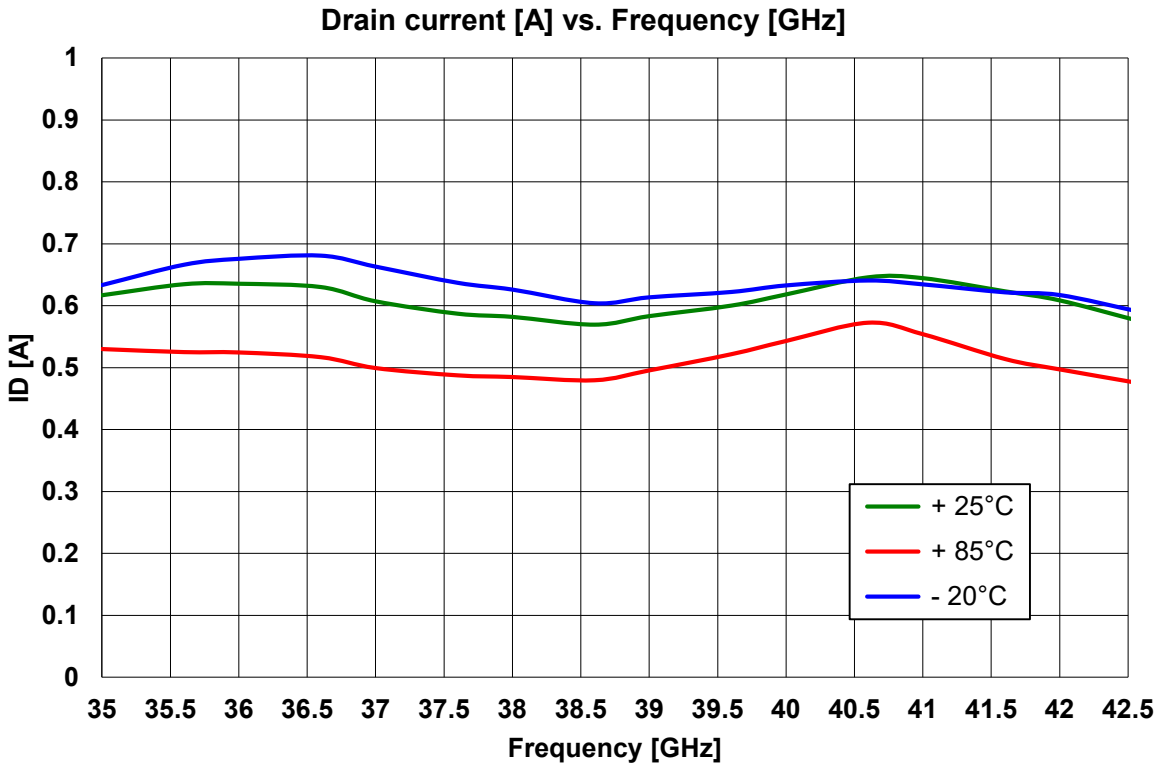

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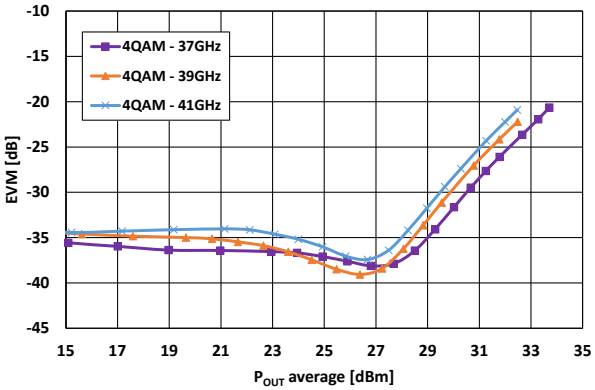
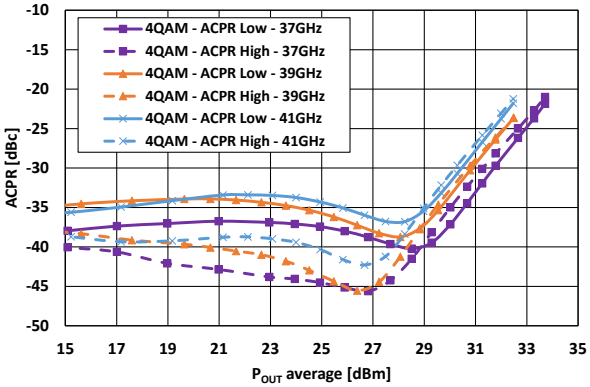
Typical Board Measurements: Linearity performance with modulated signals

Tcase = +25°C, Vd = +25V, Idq = 60mA, 4QAM (PAPR ~ 5.2dB) / 64QAM (PAPR ~ 7.3dB) / 256QAM (PAPR ~ 7.3dB), **SR = 50MSym/s**, Roll-Off = 0.2, $f_{CARRIER}$ = 37/ 39/ 41GHz, Evaluation board decoupling : 10Ω+100pF / 10Ω+1nF/ 10Ω+1µF, QFN reference planes

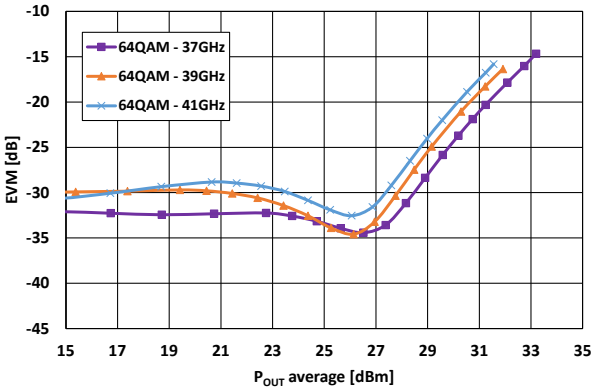
4QAM: EVM [dB] vs. Average Output Power [dBm] @ 25°C



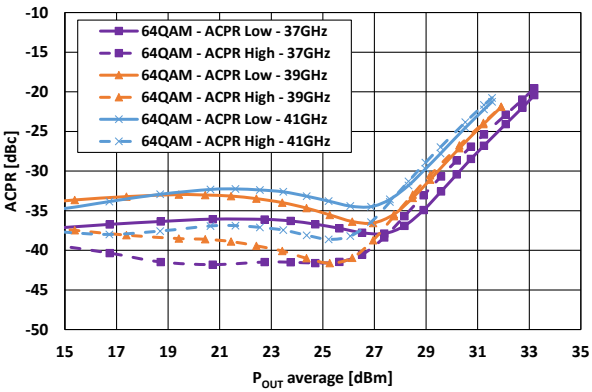
4QAM: ACPR [dBc] vs. Average Output Power [dBm] @ 25°C



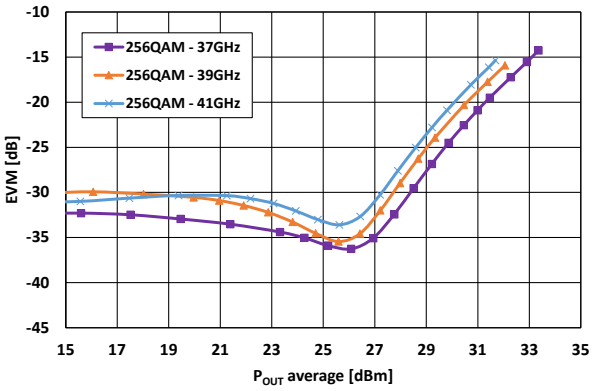
64QAM: EVM [dB] vs. Average Output Power [dBm] @ 25°C



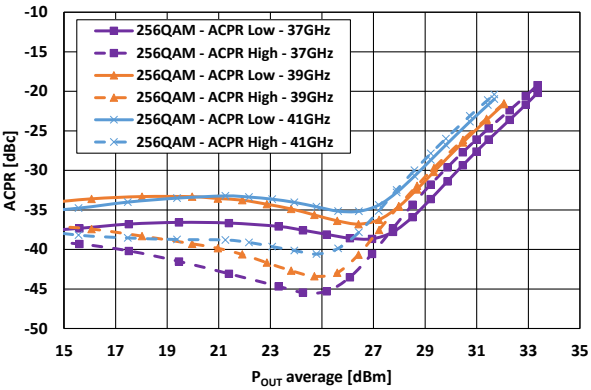
64QAM: ACPR [dBc] vs. Average Output Power [dBm] @ 25°C



256QAM: EVM [dB] vs. Average Output Power [dBm] @ 25°C



256QAM: ACPR [dBc] vs. Average Output Power [dBm] @ 25°C



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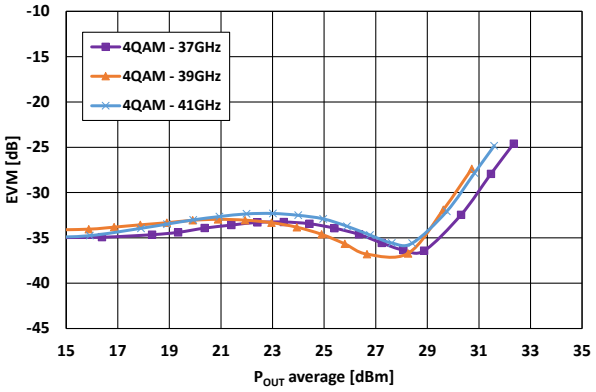
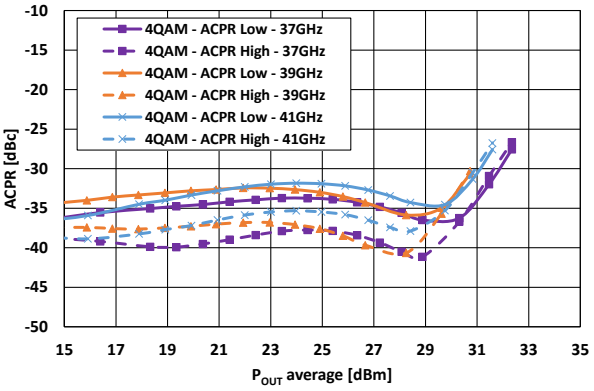
Typical Board Measurements: Linearity performance with modulated signals

Tcase = +85°C, Vd = +25V, Idq = 60mA, 4QAM (PAPR ~ 5.2dB) / 64QAM (PAPR ~ 7.3dB) / 256QAM (PAPR ~ 7.3dB), **SR = 50MSym/s**, Roll-Off = 0.2, $f_{CARRIER}$ = 37/ 39/ 41GHz, Evaluation board decoupling : 10Ω+100pF / 10Ω+1nF/ 10Ω+1µF, QFN reference planes

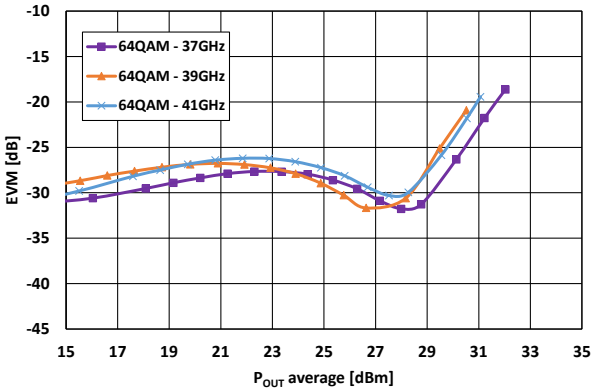
4QAM: EVM [dB] vs. Average Output Power [dBm] @ 85°C



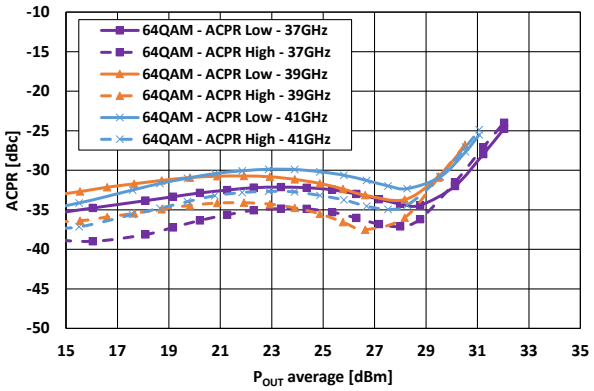
4QAM: ACPR [dBc] vs. Average Output Power [dBm] @ 85°C



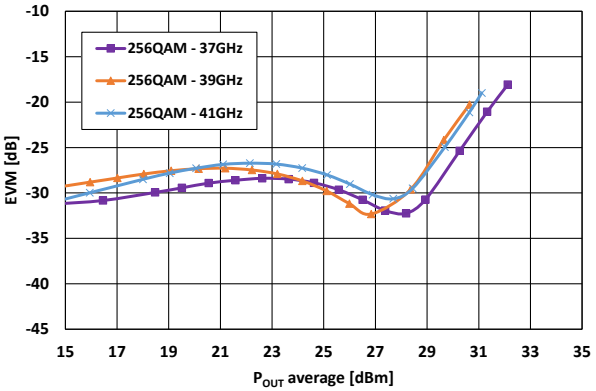
64QAM: EVM [dB] vs. Average Output Power [dBm] @ 85°C



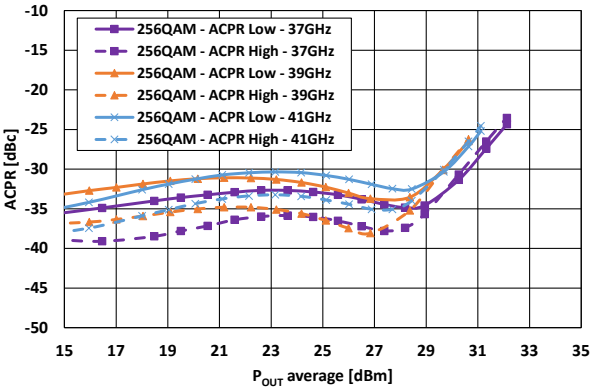
64QAM: ACPR [dBc] vs. Average Output Power [dBm] @ 85°C



256QAM: EVM [dB] vs. Average Output Power [dBm] @ 85°C



256QAM: ACPR [dBc] vs. Average Output Power [dBm] @ 85°C



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Typical Board Measurements: Linearity performance with modulated signals

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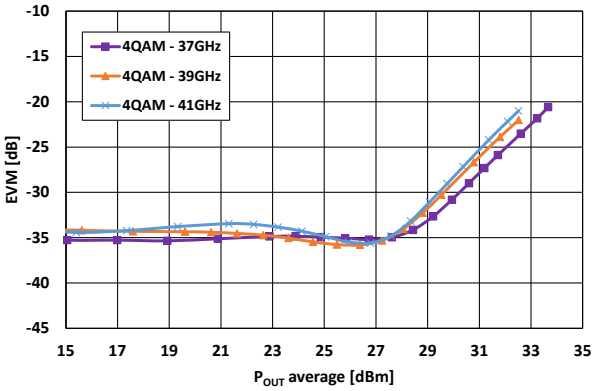
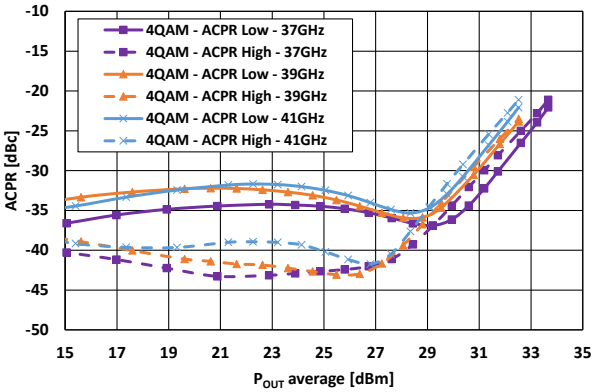
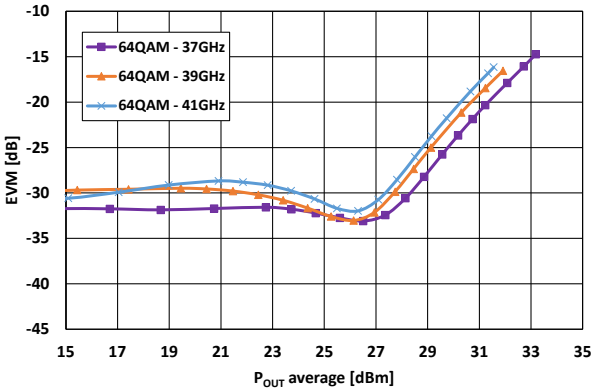
4QAM: EVM [dB] vs. Average Output Power [dBm] @ 25°C



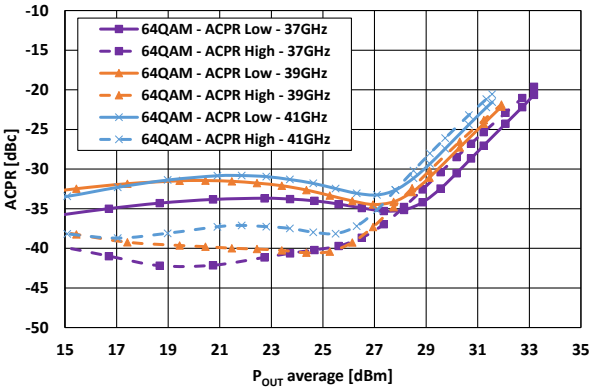
4QAM: ACPR [dBc] vs. Average Output Power [dBm] @ 25°C



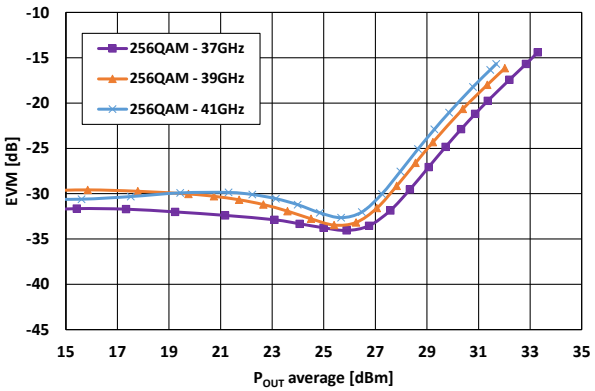
64QAM: EVM [dB] vs. Average Output Power [dBm] @ 25°C



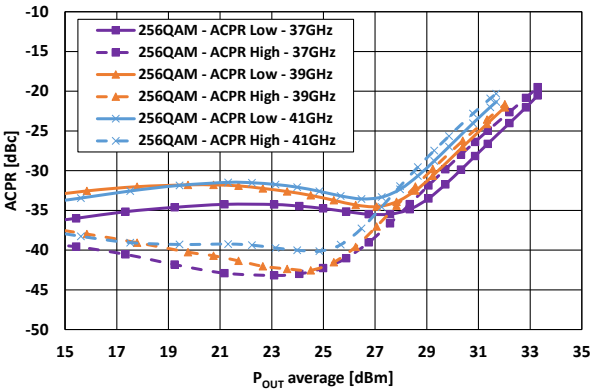
64QAM: ACPR [dBc] vs. Average Output Power [dBm] @ 25°C



256QAM: EVM [dB] vs. Average Output Power [dBm] @ 25°C



256QAM: ACPR [dBc] vs. Average Output Power [dBm] @ 25°C



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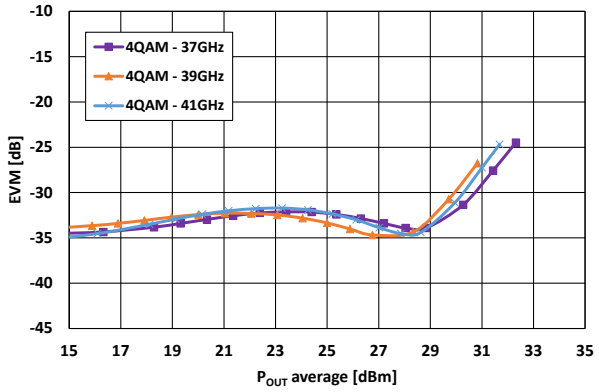
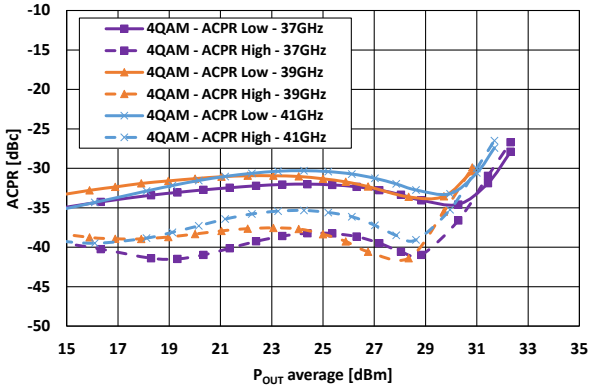
Typical Board Measurements: Linearity performance with modulated signals

Tcase = +85°C, Vd = +25V, Idq = 60mA, 4QAM (PAPR ~ 5.2dB) / 64QAM (PAPR ~ 7.3dB) / 256QAM (PAPR ~ 7.3dB), **SR = 100MSym/s**, Roll-Off = 0.2, $f_{CARRIER}$ = 37/ 39/ 41GHz, Evaluation board decoupling : 10Ω+100pF / 10Ω+1nF/ 10Ω+1µF, QFN reference planes

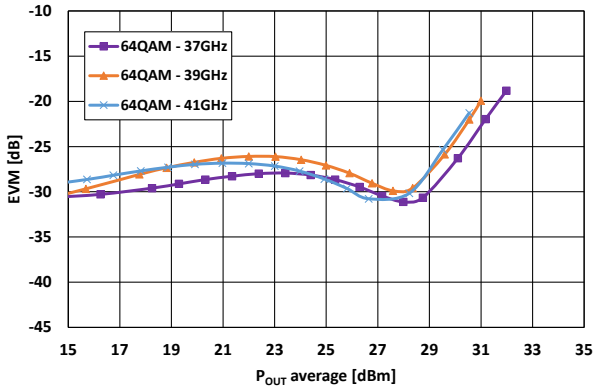
4QAM: EVM [dB] vs. Average Output Power [dBm] @ 85°C



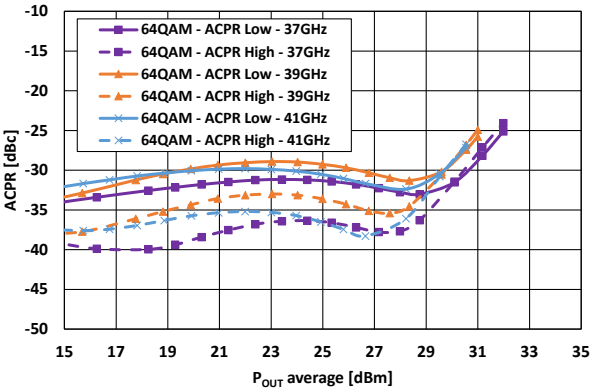
4QAM: ACPR [dBc] vs. Average Output Power [dBm] @ 85°C



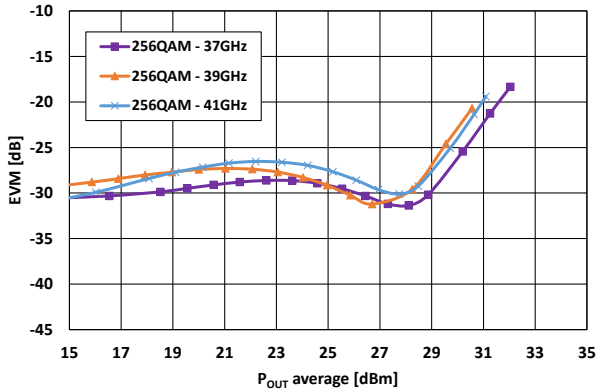
64QAM: EVM [dB] vs. Average Output Power [dBm] @ 85°C



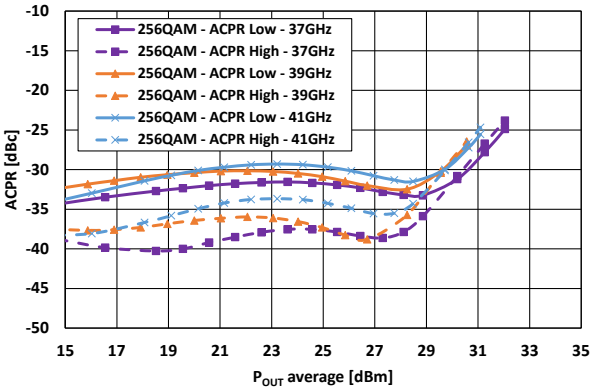
64QAM: ACPR [dBc] vs. Average Output Power [dBm] @ 85°C



256QAM: EVM [dB] vs. Average Output Power [dBm] @ 85°C



256QAM: ACPR [dBc] vs. Average Output Power [dBm] @ 85°C



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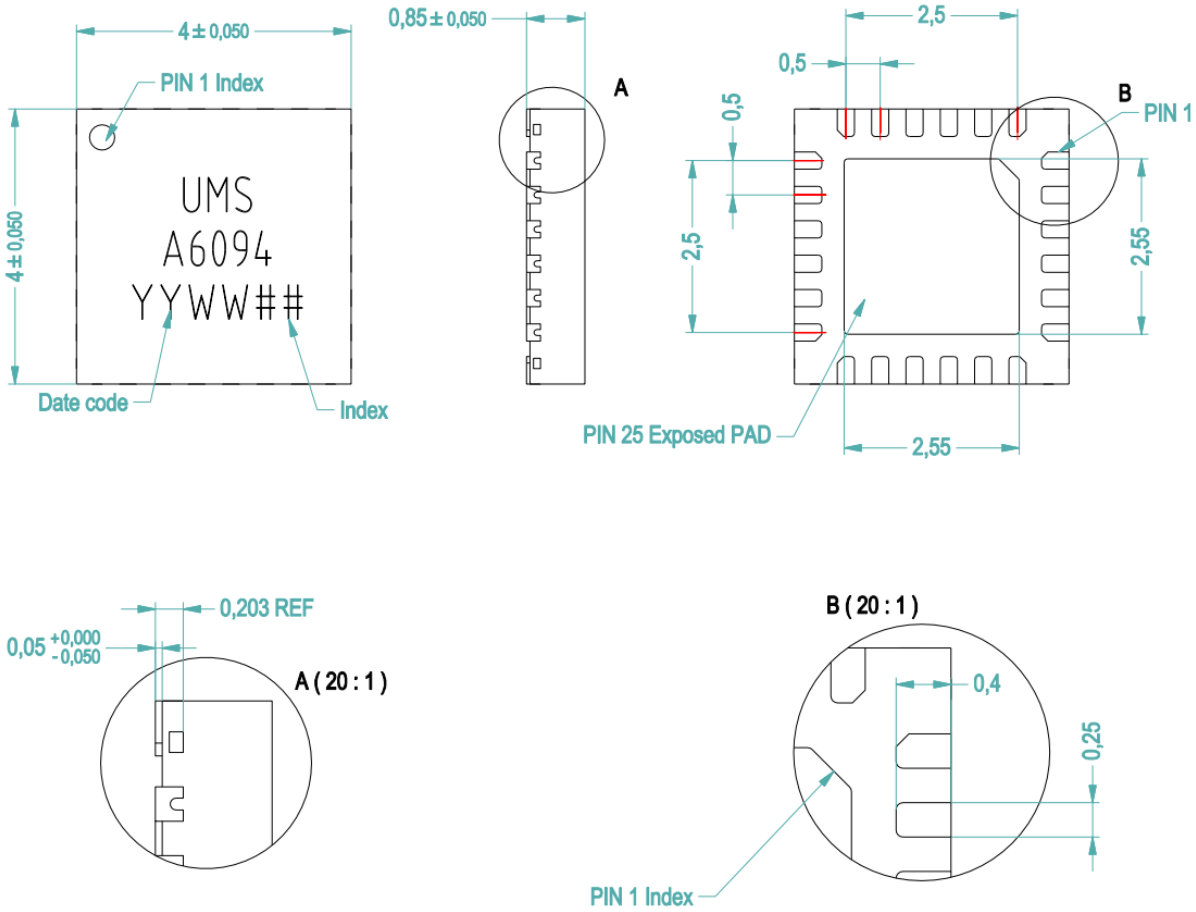
Package outline (1)



Package pinout

Ni-Pd-Au-Ag, Lead Free (Green)		1- NC	9- NC	17- NC
Units : mm		2- NC	10- VD3S	18- NC
From the standard : JEDEC MO-220		3- GND(2)	11- GND(2)	19- VD4N
(VGGD)		4- RF in	12- VD4S	20- VD3N
25- GND(2)		5- GND(2)	13- NC	21- VD12
NC : Not Connected		6- NC	14- GND(2)	22- VG4
		7- NC	15- RF out	23- VG3
		8- GND(2)	16- GND(2)	24- VG12

(1) Refer to the application note AN0017 (https://www.ums-rf.com) for general consideration and recommendations for Molded Plastic QFN/DFN packages.
(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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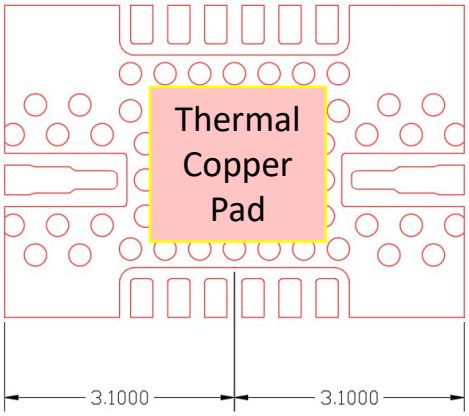
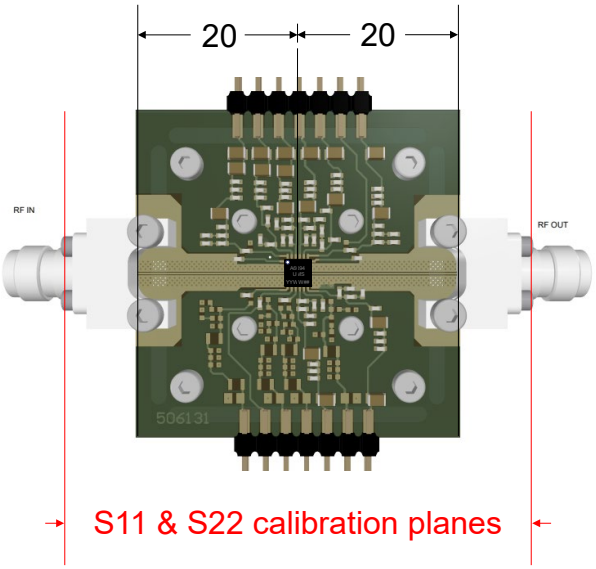
Definition of the QFN reference planes

Reference planes used for S21 and Power measurements are symmetrical from the central axis of the package (see drawing beside). Input and output reference planes are located at 3.1mm offset (input wise and output wise respectively) from this axis.



Definition of the evaluation board reference planes

Reference planes used for S11 and S22 measurements are symmetrical from the central axis of the package (see drawing beside also called calibration planes).Input and output reference planes are located at 20mm offset from the central axis. S11 and S22 measurements include this given PCB pattern, RF lines of the evaluation board and RF connectors.



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ESD sensitivity

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

Package Information

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

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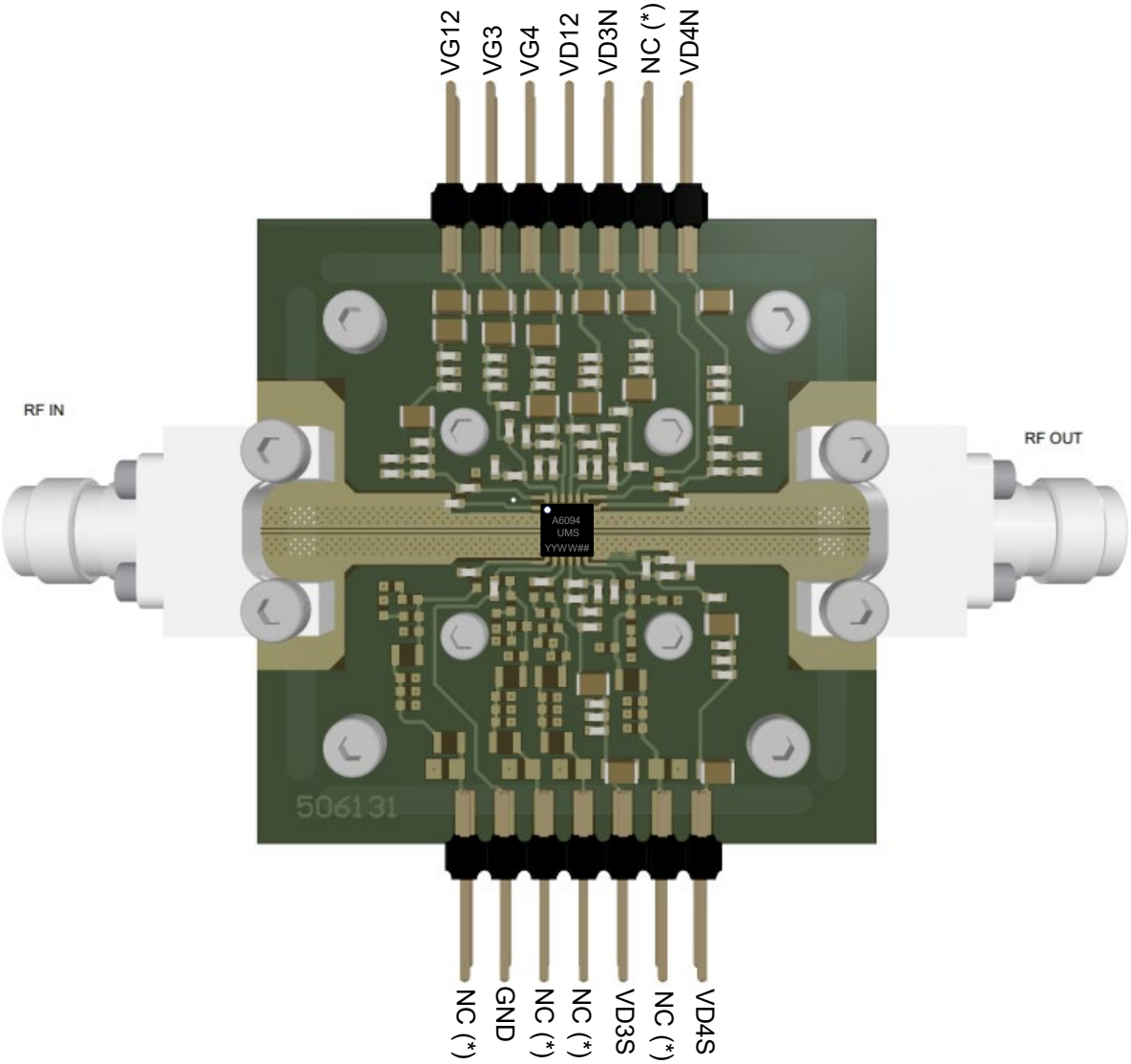
Evaluation board

■ Compatible with the proposed footprint.
■ Based on typically MT77 / 10mils or equivalent.
■ Using a micro-strip to coplanar transition to access the package.
■ Recommended for the implementation of this product on a module board.
■ Low frequency decoupling circuit of 10Ω ±10% resistor in series with 100pF ±5% capacitor, 10Ω ±10% resistor in series with 1nF ±10% capacitor and 10Ω ±10% resistor in series with 1µF ±10% capacitor are recommended for each DC access.
■ To ensure safe operation, all measurements must be performed using **shielded cables**, **even for DC bias**.



(*) Pins not connected.

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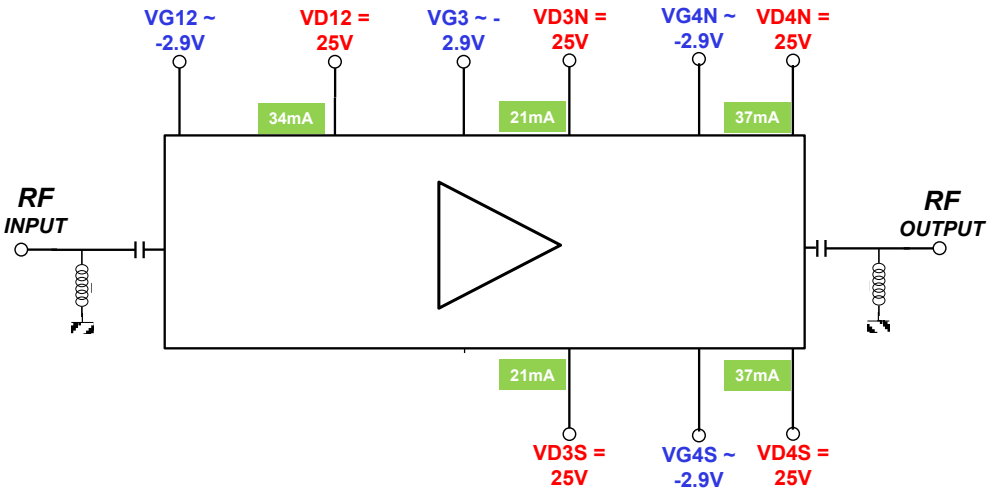
DC Schematic



The DC pins do not include any decoupling capacitor in package, therefore it is mandatory to provide a good external DC decoupling (10Ω ±10% resistor in series with 100pF ±5% capacitor, 10Ω ±10% resistor in series with 1nF ±10% capacitor and 10Ω ±10% resistor in series with 1µF ±10% capacitor) on the PCB as close as possible to the QFN 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.

Description of Evaluation Board

Refer to the application note AN0031 available at https://www.ums-rf.com for the description of Evaluation Board for Packaged Die and recommendations for this UMS package product.

Ordering Information

QFN 4x4 package:	CHA6094-QKB/XY	
	Stick: XY = 20	Tape & reel: XY = 21

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