# CHA7060-QAB

# 5.6-8.5GHz 12W High Power Amplifier

## GaN Monolithic Microwave IC in SMD leadless package

## Description

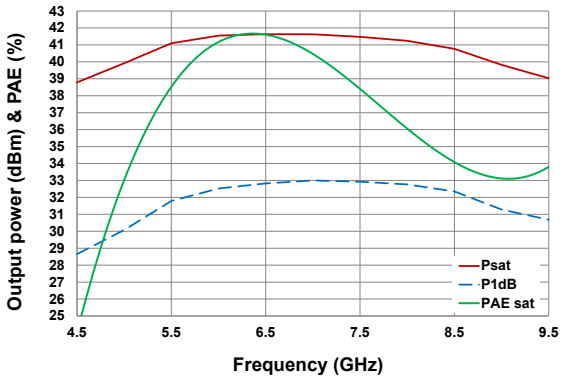
The CHA7060-QAB is a two stages monolithic GaN High Power Amplifier, reaching 12W output power over 5.6-8.5GHz bandwidth. It offers high linearity performance with 30dB of Gain and an EVM of 33dB @34dBm average Pout (56MHz modulation bandwidth, 4QAM). It is dedicated to a wide range of applications such as Point-to-Point Radio.
This circuit is manufactured on a robust GaN-on-SiC HEMT technology and packaged in a standard surface mount 6x6 plastic QFN which is RoHS compliant. Input and output are 50Ω matched and integrate ESD RF protections.


## Main Features

- RF bandwidth: 5.6-8.5GHz
- Linear Gain: 30dB
- Psat: 41dBm (@5dB gain comp)
- EVM: -33dB @34dBm average Pout (1)
- PAE : 40% @41dBm average Pout
- Low AM/AM & AM/PM
- DC bias: Vd = 20.0V @Idq = 420mA
- 38 leads QFN 6x6mm // MSL3

(1) *56MHz modulation bandwidth, 4QAM*

Output power & PAE vs. Frequency




## Main Electrical Characteristics

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

| Symbol | Parameter | Min | Typ | Max | Unit |
|---|---|---|---|---|---|
| Freq | Frequency range | 5.6 | | 8.5 | GHz |
| Gain | Linear Gain | | 30 | | dB |
| EVM | Error Vector Magnitude<br>$P_{out}$ = 34dBm 4QAM BW=56MHz | | -33 | | dB |
| $P_{sat}$ | Saturated Output power | | 41 | | dBm |
| Idq | Total drain current | | 420 | | mA |

BW = modulation bandwidth



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## Electrical Characteristics

Tcase.= +25°C, Vd = +20.0V

| Symbol | Parameter | Min | Typ | Max | Unit |
|---|---|---|---|---|---|
| Freq | Frequency range | 5.6 | | 8.5 | GHz |
| Gain | Linear Gain | | 30 | | dB |
| $RL_{in}$ | Input return loss | | 20 | | dB |
| $RL_{out}$ | Output return loss | | 10 | | dB |
| PAE | 5dB gain comp. / Pout ≈41dBm | | 40 | | % |
| $P_{sat}$ | Saturated Output power at 5dB gain compression | | 41 | | dBm |
| Vg | DC gate Voltage | | -2.9 | | V |
| Idq | Total drain current | | 420 | | mA |

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

Electrostatic discharge sensitive device observe handling precautions.



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## Typical Bias Conditions

Tcase.= +25°C

| Symbol | Parameter | Values | Unit |
|---|---|---|---|
| Vd | Drain voltage | 20 | V |
| Vg | Gate voltage | -3 | V |
| Id | DC Drain current | 420 | mA |

## Absolute Maximum Ratings (1)

Tcase.= +25°C

| Symbol | Parameter | Values | Unit |
|---|---|---|---|
| Vd | Drain bias voltage | 27 | V |
| Vg | Gate bias voltage | -7 to -2 | V |
| Id | Quiescent Drain bias current | 800 | mA |
| Pin | Maximum input power | +22 | dBm |

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

## Recommended Operating Range (2) (3)

Tcase.= +25°C

| Symbol | Parameter | Values | Unit |
|---|---|---|---|
| Vd | Drain bias voltage | 18 to 25 | V |
| Vg | Gate bias voltage | -5 to -2.5 | V |
| Id | Quiescent Drain bias current | 150 to 720 | mA |
| Pin | Maximum Input power | +20 | dBm |
| Tj | Maximum junction temperature | 200 | °C |

(2) Electrical performances are defined for specified test conditions

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

## Temperature Range

| | | | |
|---|---|---|---|
| Tcase | Operating temperature range | -40 to +85 | °C |
| Tstg | Storage temperature range | -55 to +125 | °C |



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## Biasing procedure

Device Power Up instructions:

1. Ground the device: Id =0A
2. Bias HPA gate voltage at Vg close to Vpinch-off (Typically: Vg ≈ -5V)
3. Set Vd bias voltage to 0V *(pinch off test)* : Id=0A
4. Apply Vd bias voltage (Typically: Vd = 20V*)*
5. Increase Vg up to quiescent bias drain current Idq=420mA
6. Apply RF input Power

Device Power Down instructions:

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. Decrease Vd bias voltage down 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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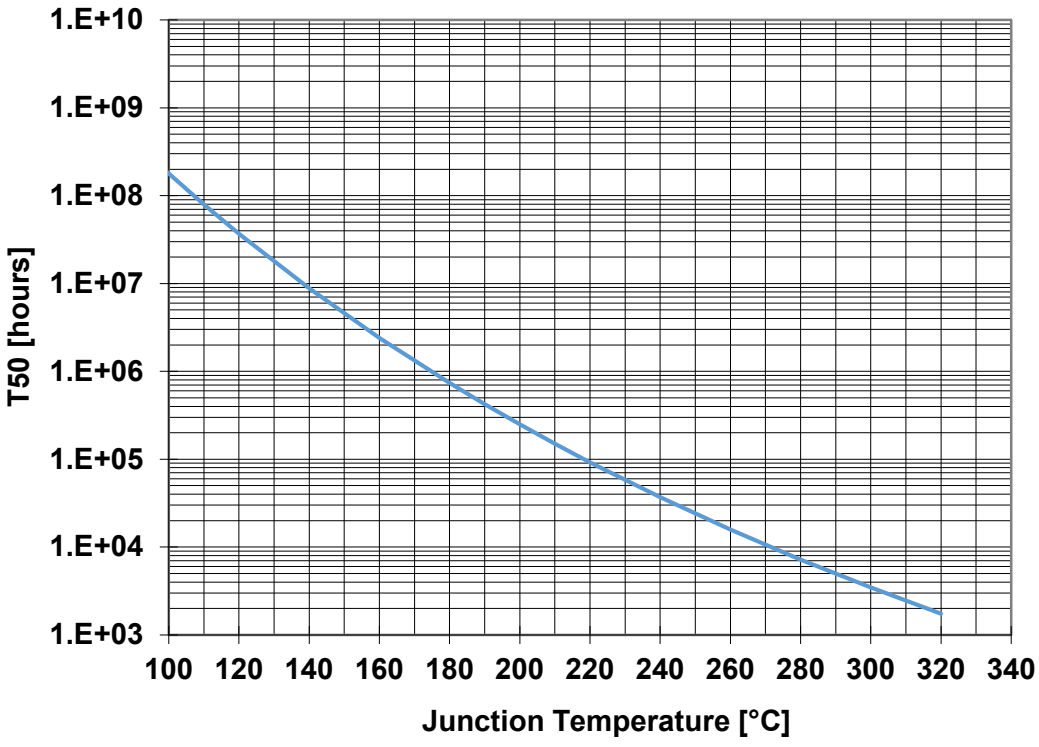
## Device thermal performances

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 Tj remains below the maximum value specified in the Recommended Operating Range table.
The system PCB must be designed to comply with this requirement.

| Parameter | Biasing conditions | Tj (°C) | RTH (°C/W) | T50 (hours) |
|---|---|---|---|---|
| RTH (1) Thermal Resistance (Junction to Case) | Vd= 20V<br>Idq= 420mA<br>Pout = 32dBm<br>Pdiss= 12W CW | 155 | 5.80 | 3.3E+6 |
| | Vd= 20V<br>Idq= 420mA<br>Pout = 40dBm<br>Pdiss= 25W CW | 198 | 4.52 | 2.8E+5 |

(1) Assuming 85°C Tcase



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## Typical Package Sij parameters

Tcase= +25°C, Vd = +20.0V, Id = 420mA

| Freq (GHz) | S11 (dB) | PhS11 (°) | S12 (dB) | PhS12 (°) | S21 (dB) | PhS21 (°) | S22 (dB) | PhS22 (°) |
|---|---|---|---|---|---|---|---|---|
| 3 | -3.7 | 42.7 | -83.7 | 34.5 | -24.9 | -75.0 | -1.4 | -48.2 |
| 3.5 | -6.7 | 7.8 | -80.8 | 59.1 | -1.4 | -94.6 | -1.7 | -88.4 |
| 4 | -12.4 | -26.6 | -75.8 | -82.6 | 17.1 | 152.3 | -3.8 | -143.7 |
| 4.5 | -22.1 | -36.6 | -61.7 | 151.3 | 26.3 | 20.6 | -12.3 | 107.7 |
| 5 | -24.8 | -23.3 | -59.0 | 67.6 | 28.6 | -97.6 | -9.7 | -72.2 |
| 5.5 | -31.6 | -93.7 | -60.5 | 3.8 | 28.9 | 169.9 | -9.3 | -141.3 |
| 6 | -26.9 | 149.3 | -64.6 | -55.7 | 29.0 | 89.7 | -11.8 | 168.6 |
| 6.5 | -22.2 | 97.5 | -66.4 | -160.5 | 29.1 | 15.0 | -12.6 | 115.7 |
| 7 | -22.9 | 48.1 | -60.5 | 100.3 | 29.2 | -58.8 | -11.2 | 51.5 |
| 7.5 | -28.6 | -15.0 | -56.6 | 30.8 | 29.1 | -133.7 | -9.4 | -10.3 |
| 8 | -31.1 | -132.1 | -54.4 | -31.2 | 28.3 | 150.3 | -10.1 | -65.7 |
| 8.5 | -29.8 | 171.9 | -53.9 | -95.4 | 26.9 | 73.7 | -16.0 | -111.5 |
| 9 | -31.1 | -100.7 | -54.8 | -163.3 | 24.9 | -4.0 | -22.5 | -5.4 |
| 9.5 | -16.1 | -119.6 | -58.4 | 118.6 | 21.9 | -85.8 | -11.1 | -25.1 |
| 10 | -9.5 | -154.6 | -64.5 | -9.1 | 16.8 | -168.2 | -6.6 | -50.1 |
| 10.5 | -5.9 | 170.6 | -59.4 | -128.2 | 9.6 | 120.7 | -3.7 | -78.1 |
| 11 | -4.2 | 140.4 | -54.7 | -177.7 | 2.2 | 65.3 | -2.3 | -105.0 |
| 11.5 | -3.4 | 116.1 | -54.6 | 135.0 | -4.3 | 18.9 | -1.6 | -128.2 |
| 12 | -3.1 | 97.9 | -55.7 | 116.5 | -9.8 | -26.8 | -1.3 | -148.7 |
| 12.5 | -2.4 | 84.1 | -54.1 | 90.7 | -15.6 | -77.6 | -1.1 | -167.2 |
| 13 | -1.5 | 68.4 | -55.2 | 73.5 | -22.2 | -124.2 | -0.9 | 175.7 |
| 13.5 | -0.9 | 51.7 | -56.6 | 66.9 | -29.2 | -171.5 | -0.8 | 159.6 |
| 14 | -0.7 | 36.1 | -55.1 | 56.8 | -36.2 | 148.7 | -0.7 | 144.1 |
| 14.5 | -0.6 | 22.0 | -55.6 | 52.0 | -41.3 | 109.2 | -0.7 | 129.5 |
| 15 | -0.5 | 9.1 | -54.6 | 38.1 | -45.3 | 64.9 | -0.7 | 115.0 |
| 15.5 | -0.5 | -2.7 | -53.1 | 33.1 | -48.1 | 33.8 | -0.7 | 101.1 |
| 16 | -0.4 | -14.3 | -52.1 | 14.8 | -50.0 | 9.5 | -0.7 | 87.4 |
| 16.5 | -0.4 | -25.5 | -51.6 | -18.4 | -50.9 | -20.4 | -0.7 | 73.7 |
| 17 | -0.4 | -36.2 | -59.3 | -70.5 | -58.0 | -70.1 | -0.7 | 60.3 |
| 17.5 | -0.4 | -46.2 | -63.6 | 74.4 | -62.8 | 77.4 | -0.7 | 47.2 |
| 18 | -0.4 | -56.2 | -59.9 | 41.0 | -59.7 | 38.3 | -0.7 | 34.2 |
| 18.5 | -0.3 | -66.4 | -54.8 | 37.9 | -55.3 | 39.6 | -0.8 | 21.3 |
| 19 | -0.4 | -76.9 | -55.8 | 36.1 | -55.7 | 33.9 | -0.8 | 8.1 |



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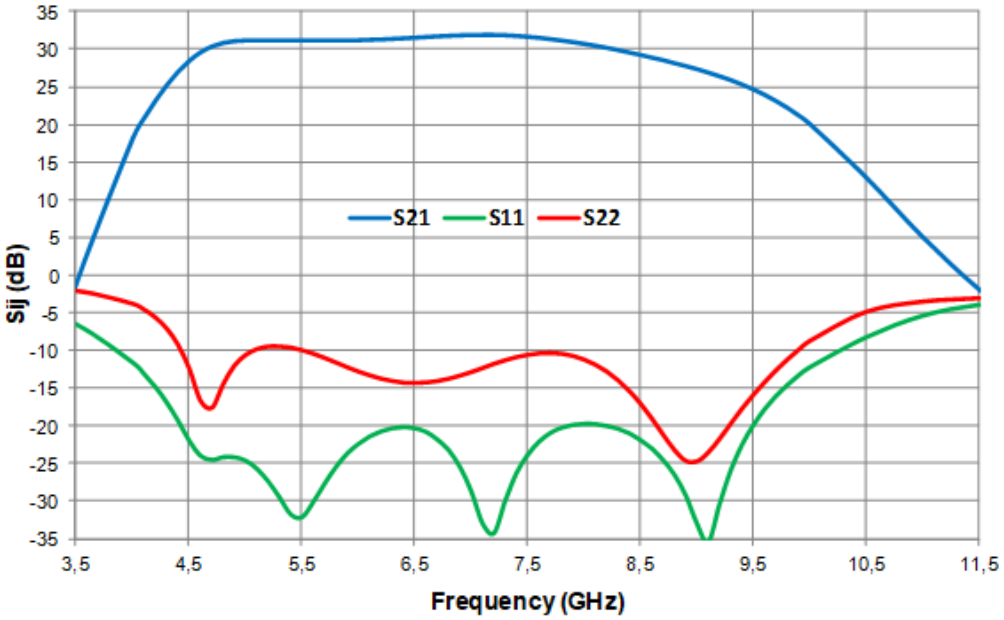
## Typical Board Measurements

Tcase= +25°C, Vd = 20V, Vg set in order to get Id = 420mA
Losses due to board are de-embedded. Measurements are given in the QFN's access planes.

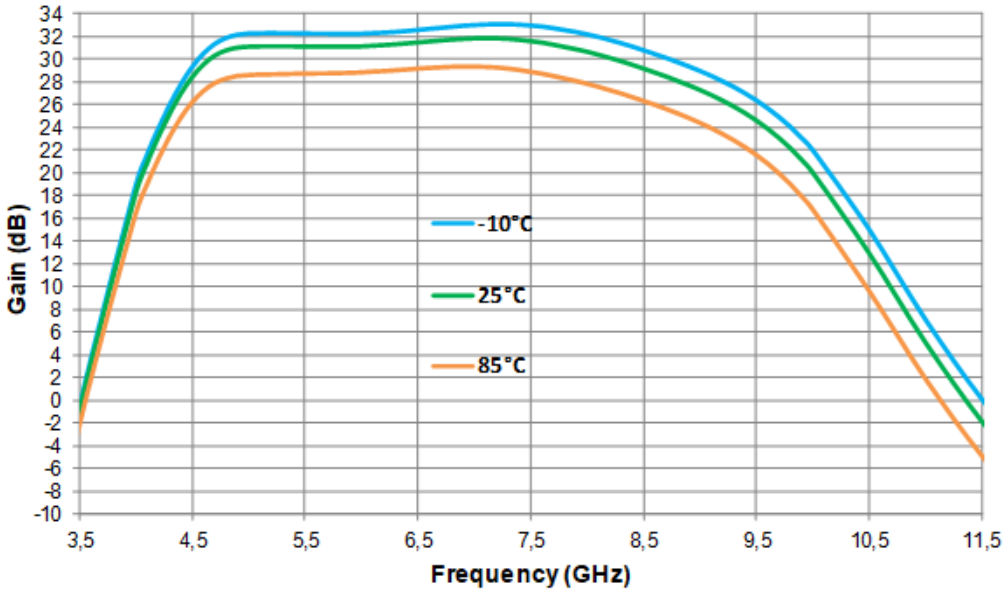
*(Vg fixed for all the temperature)*

**Gain & Return Losses vs. Frequency**




**Gain vs. Frequency in Temperature**

*(Vg fixed for all the temperature)*



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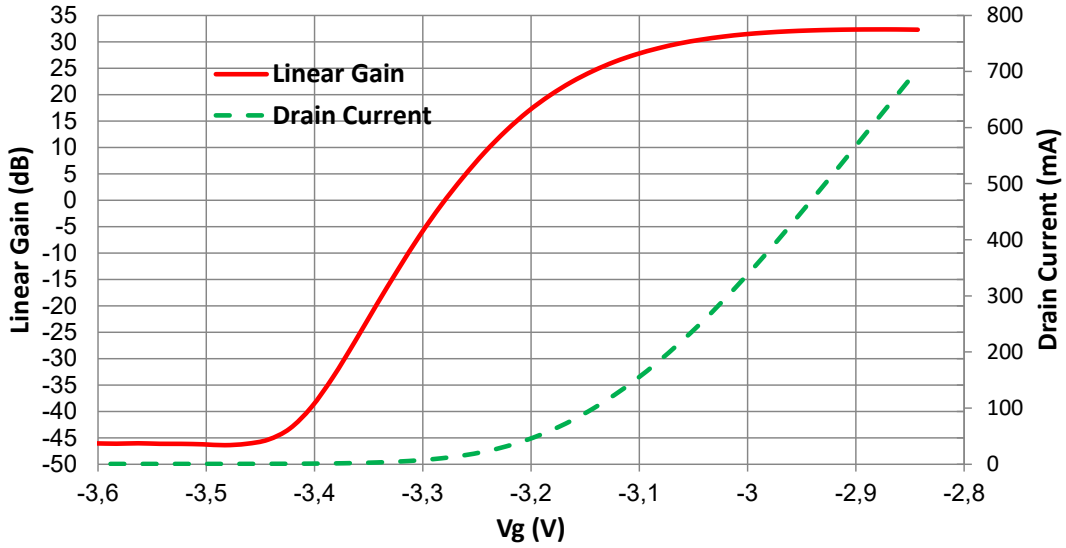
## Typical Board Measurements

Tcase= +25°C, Vd = 20V, Vg set in order to get Id = 420mA
Losses due to board are de-embedded. Measurements are given in the QFN's access planes.

**Linear Gain & Drain Current vs. Gate Voltage at 7GHz**



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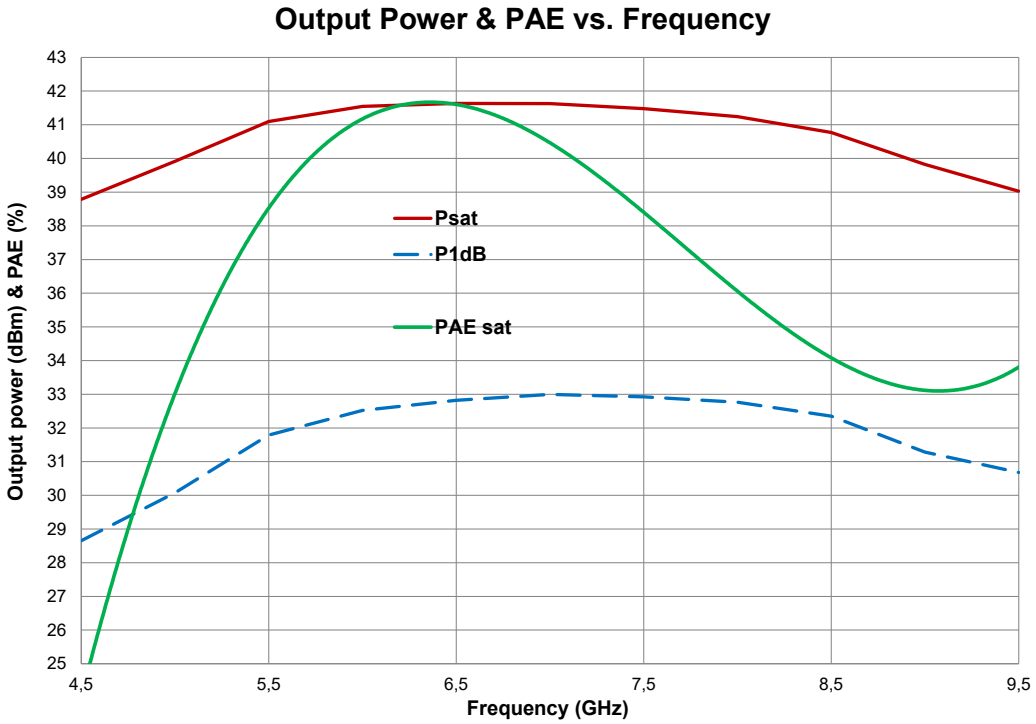
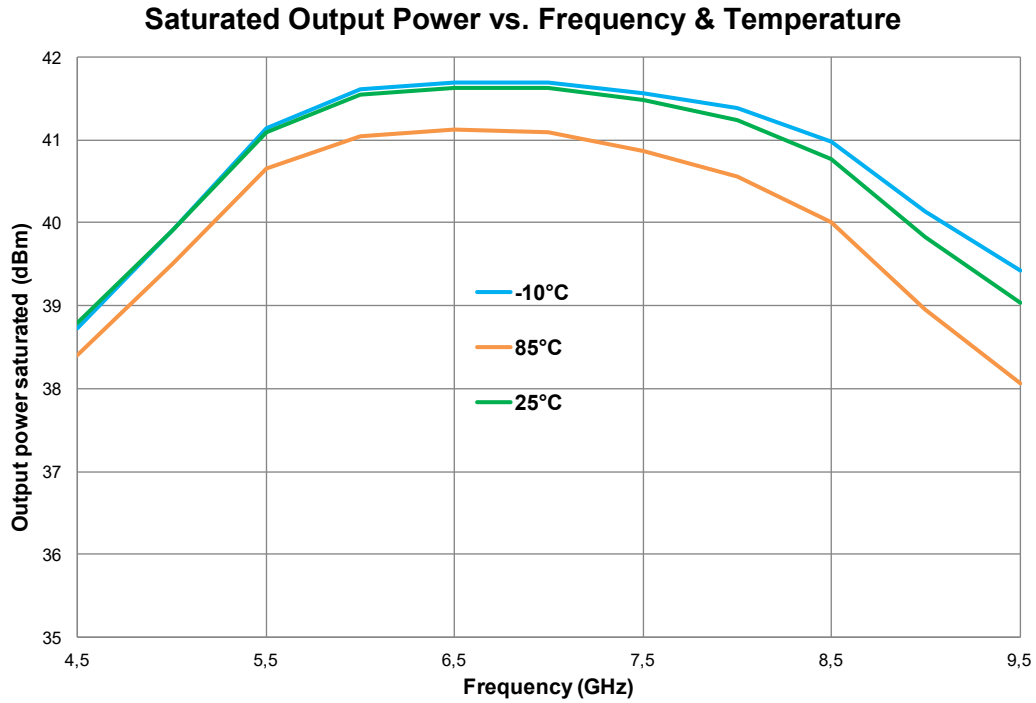
## Typical Board Measurements

Tcase= +25°C, Vd = 20V, Vg set in order to get Id = 420mA, Pin = 20 dBm
Losses due to board are de-embedded. Measurements are given in the QFN's access planes.



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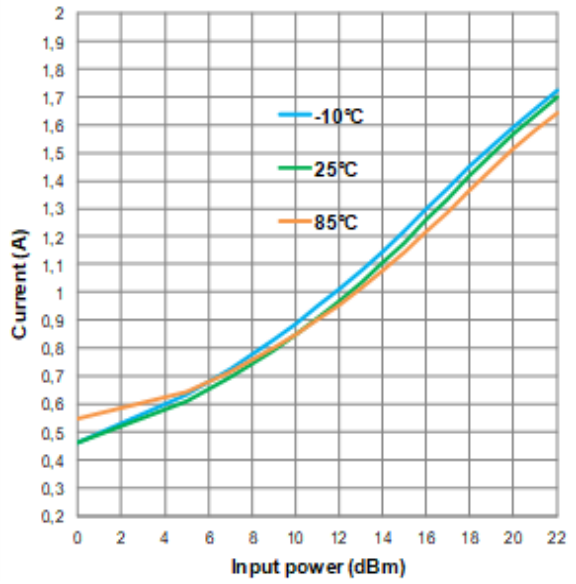
## Typical Board Measurements

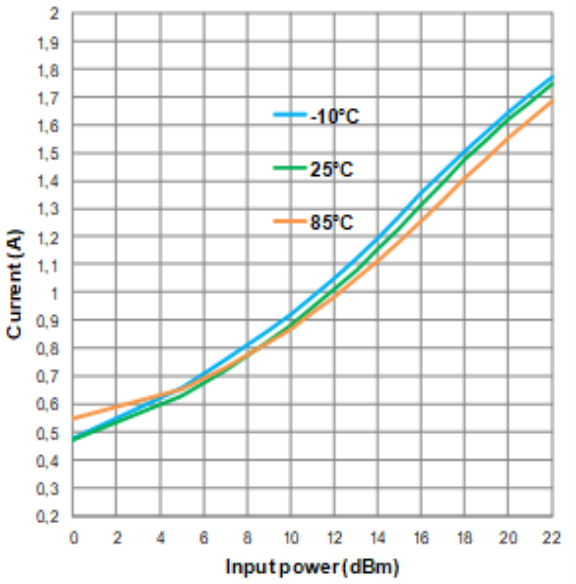
Tcase.= +25°C, Vd = 20V, Vg set in order to get Id = 420mA
Losses due to board are de-embedded. Measurements are given in the QFN's access planes.

*(Vg fixed for all the temperature)*

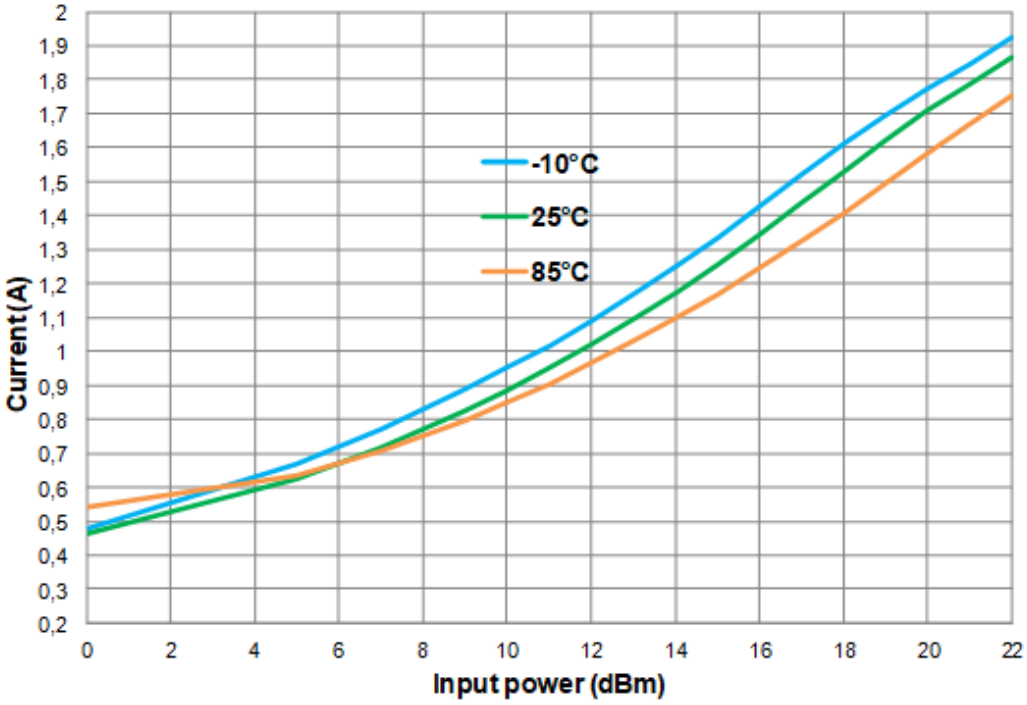
**Total Drain Current vs. Output Power at 6GHz**




**Total Drain Current vs. Output Power at 7.5GHz**




**Total Drain Current vs. Output Power at 8.5GHz**



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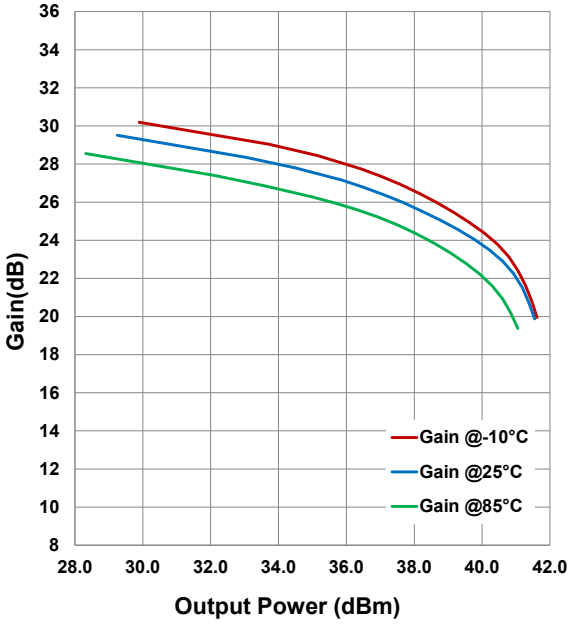
## Typical Board Measurements

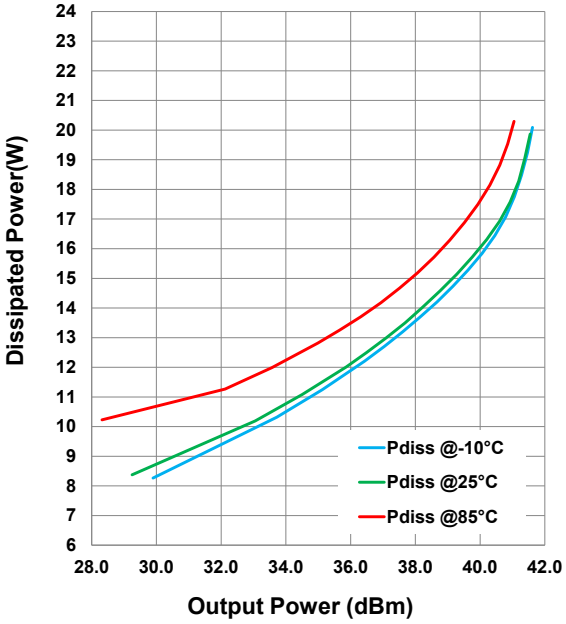
Tcase.= +25°C, Vd = 20V, Vg set in order to get Id = 420mA
Losses due to board are de-embedded. Measurements are given in the QFN's access planes.

*(Vg fixed for all the temperature)*

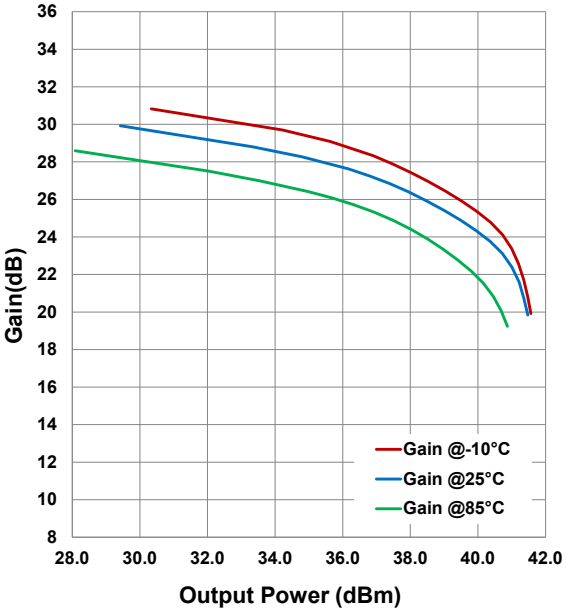
**Gain vs. Output Power at 6GHz**



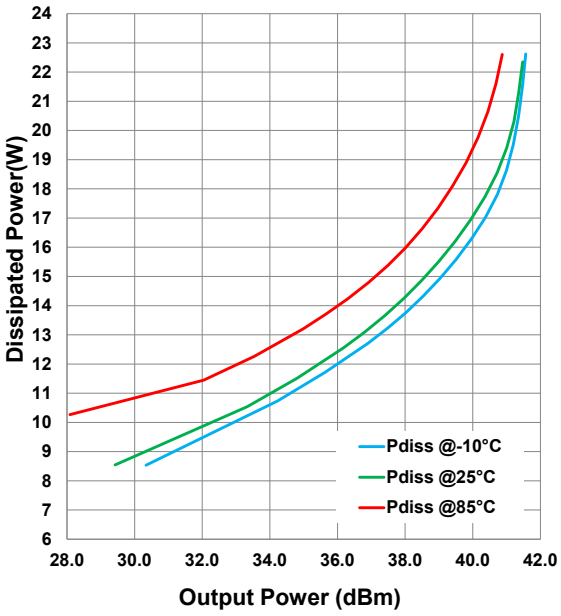

**Dissipated Power vs. Output Power at 6GHz**




**Gain vs. Output Power at 7.5GHz**




**Dissipated Power vs. Output Power at 7.5GHz**



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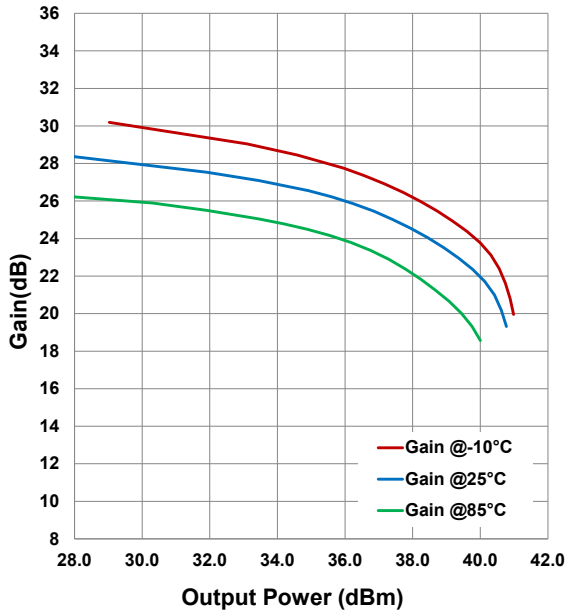
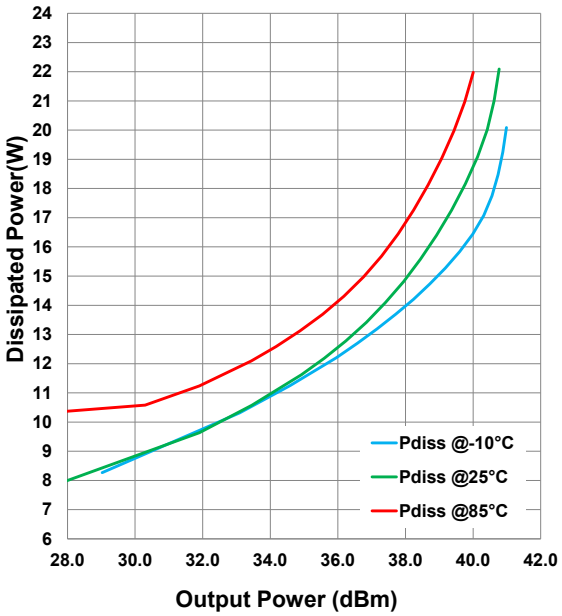
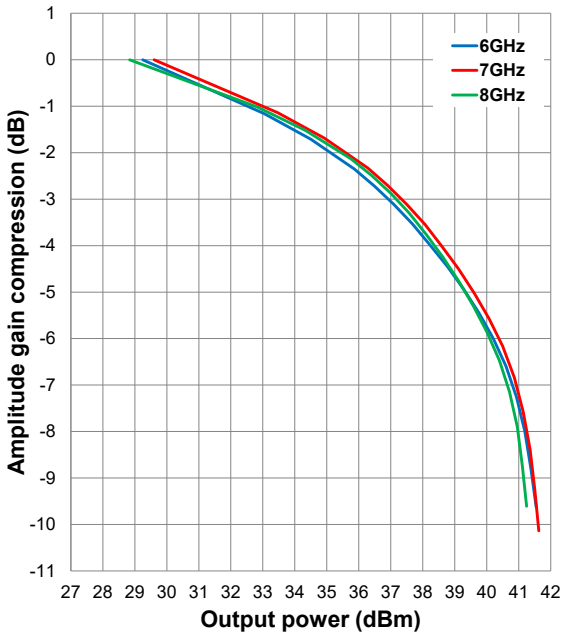
### Gain vs. Output Power at 8.5GHz

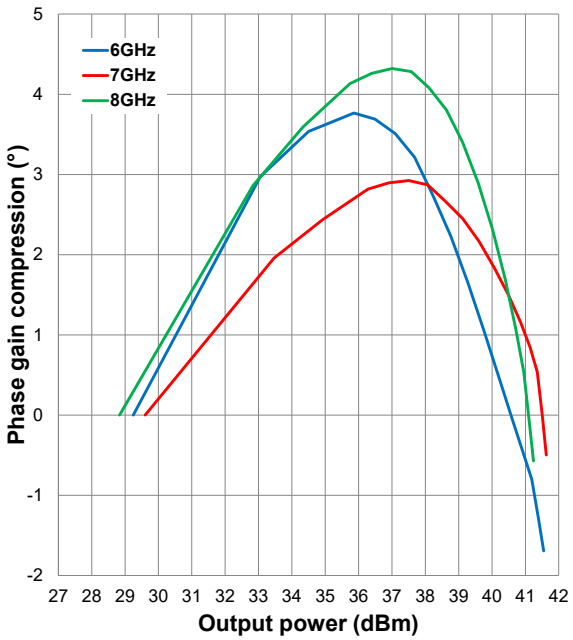



### Dissipated Power vs. Output Power at 8.5GHz




### Gain Amplitude & Gain Phase variation vs. Output Power



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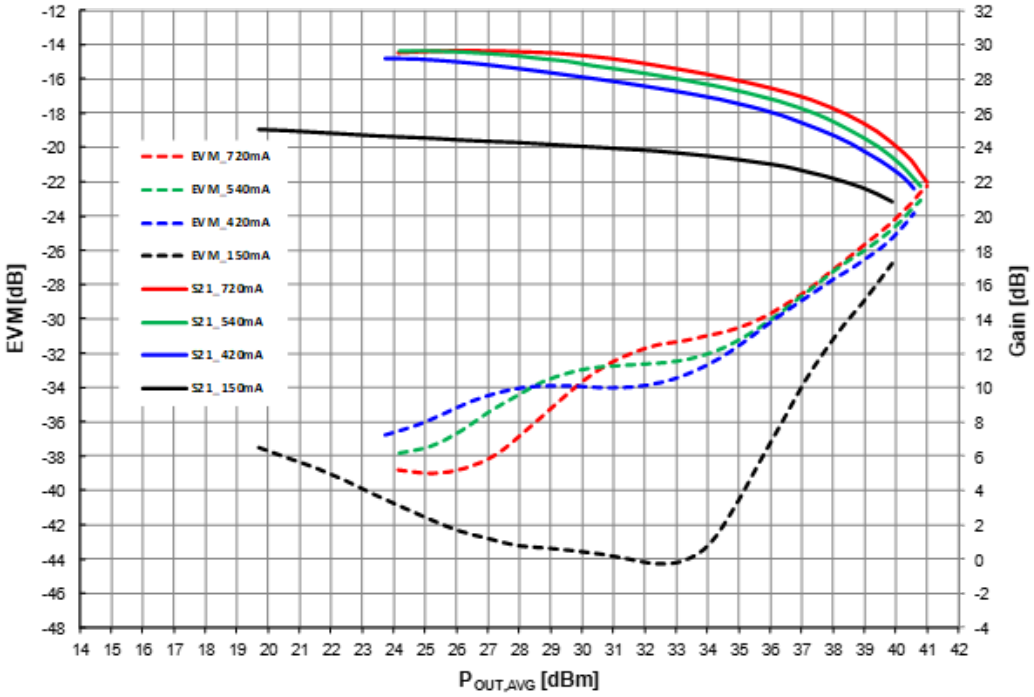
## Typical Board Measurements

Tcase.= +25°C, Vd = 20V, Vg set in order to get Id = 420mA

**Error Vector Magnitude & Gain vs. Output Power**

Freq = 7.5GHz ; 150 / 420 / 540 / 720mA

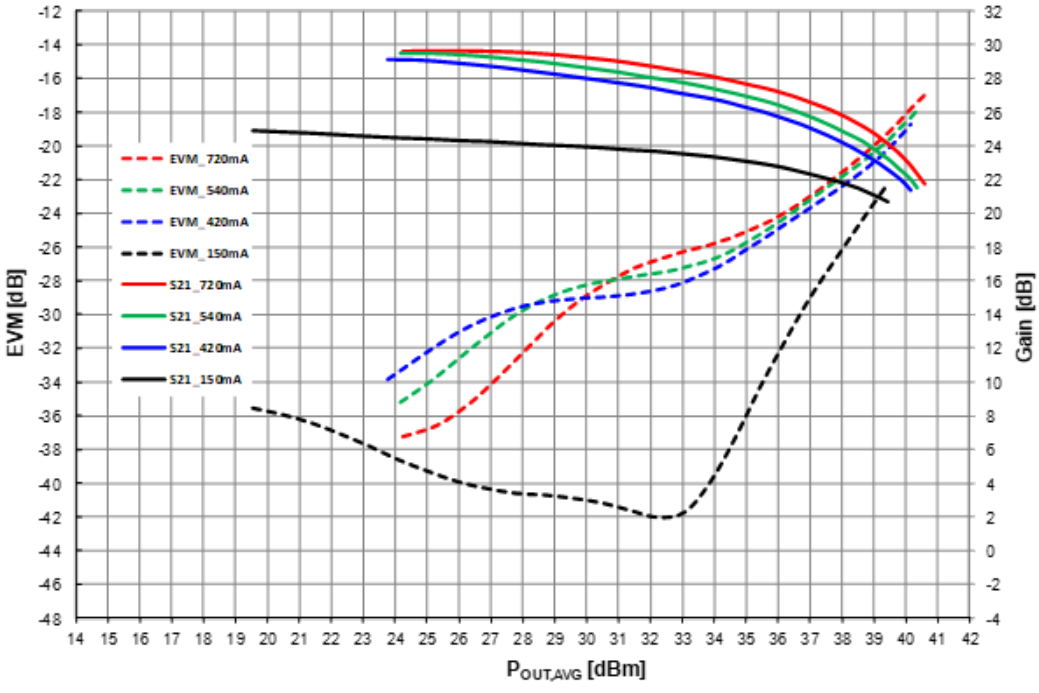
Channel Spacing =56MHz, Modulation = QAM4




**Error Vector Magnitude & Gain vs. Output Power**

Freq = 7.5GHz ; 150 / 420 / 540 / 720mA

Channel Spacing =56MHz, Modulation = QAM2048



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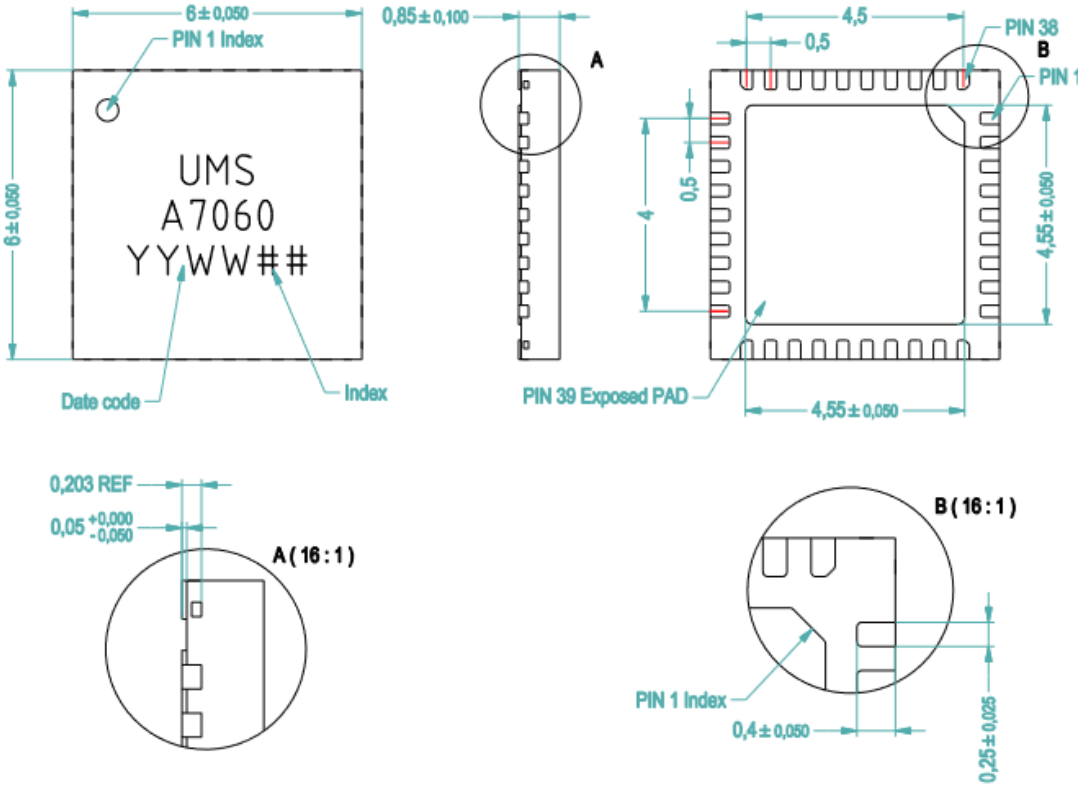
## Package outline (1)




| | | | | | | | |
|---|---|---|---|---|---|---|---|
| NiPdAuAg, Lead Free | (Green) | 1- | NC | 14- | NC | 27- | NC |
| Units : | mm | 2- | NC | 15- | VG2 | 28- | NC |
| From the standard : | JEDEC MO-220 | 3- | NC | 16- | SH(3) | 29- | NC |
| | (VJJD) | 4- | GND(2) | 17- | VD2 | 30- | NC |
| 39- | GND(2) | 5- | RF IN | 18- | NC | 31- | VD2 |
| NC : | Not Connected | 6- | GND(2) | 19- | NC | 32- | G_ref(3) |
| | | 7- | NC | 20- | NC | 33- | VG2 |
| | | 8- | NC | 21- | NC | 34- | NC |
| | | 9- | NC | 22- | NC | 35- | VD1 |
| | | 10- | NC | 23- | GND(2) | 36- | VG1 |
| | | 11- | NC | 24- | RF OUT | 37- | NC |
| | | 12- | VG1 | 25- | GND(2) | 38- | NC |
| | | 13- | VD1 | 26- | NC | | |

(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. Ensure that the PCB is designed to provide the best possible ground to the package.
(3) SH (lead 16) is to access to the temperature monitoring diode, and G-ref (lead 32) is equal to other GND pads.



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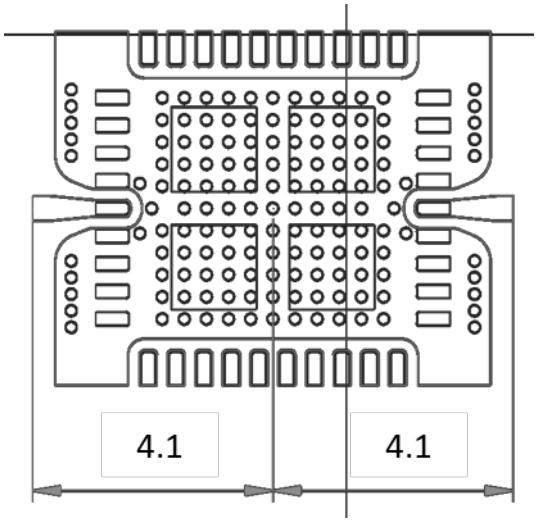
## Definition of the Sij reference planes

Reference planes used for Sij and Power measurements are symmetrical from the central axis of the package (see drawing beside). Input and output reference planes are located at 4.1mm offset (input wise and output wise respectively) from this axis.




## ESD sensitivity

| Standard | Value |
|---|---|
| Human Body Model (HBM) | 1A |

## 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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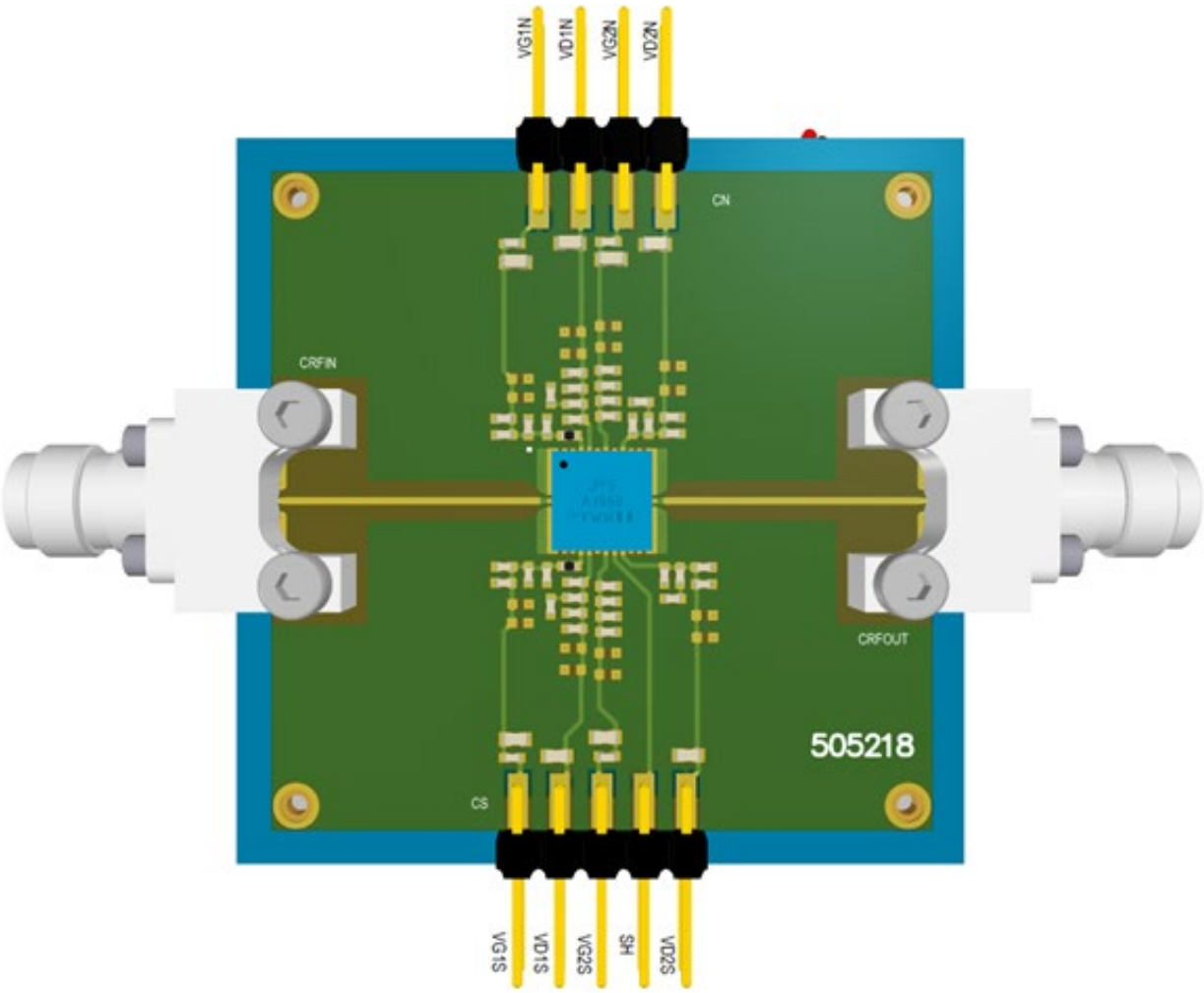
## Evaluation Board

Compatible with the proposed footprint.
- Based on typically 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: 100pF ±5%, 1nF ±5%, 10nF ±10%, 100nF ±10%, 1µF ±10% are recommended for all package DC pins.
- Serial resistors: 100Ω on the first stage of the gate (North and South).




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



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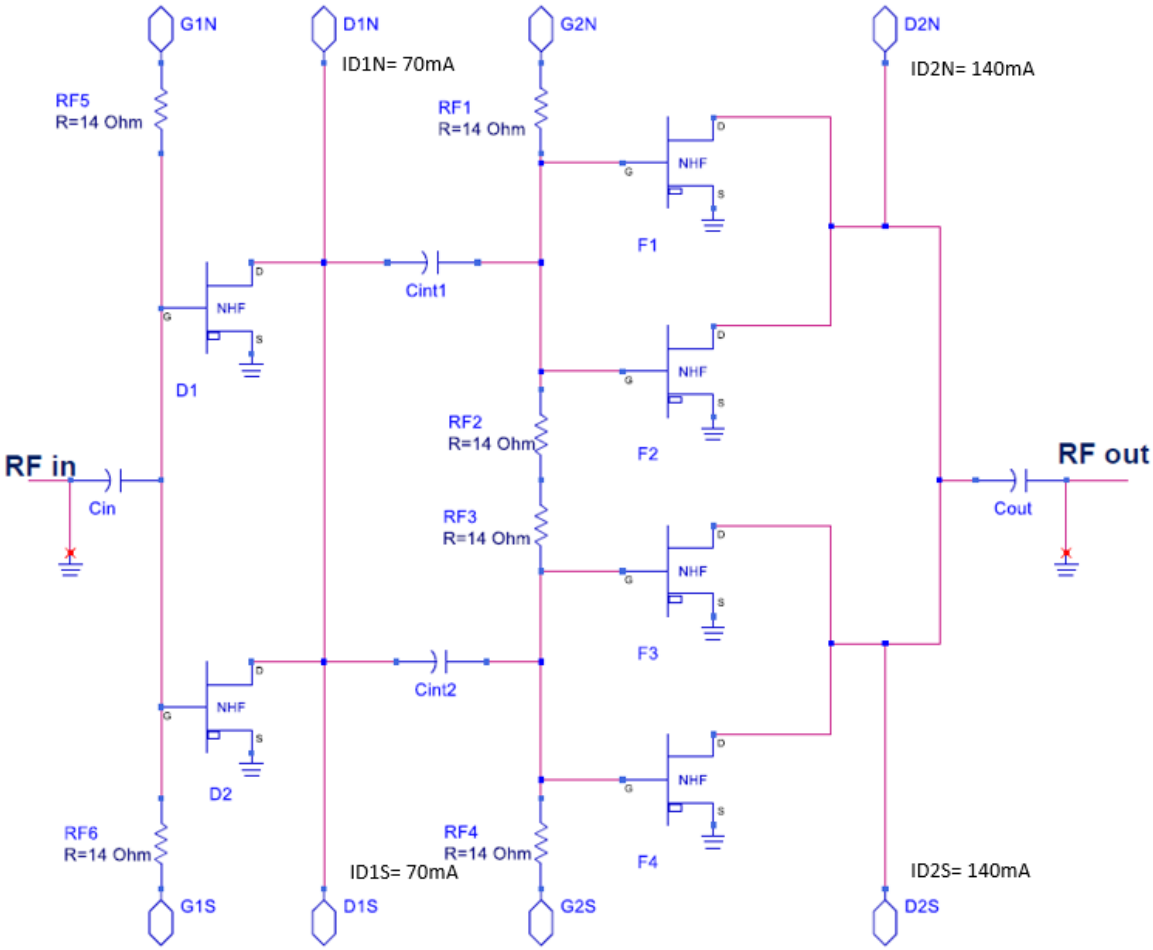
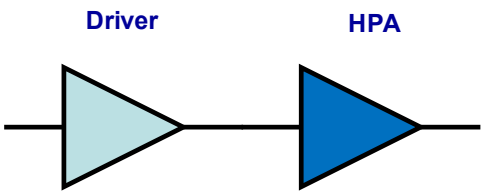
## DC Schematic




## Recommended UMS Power chain

The CHA7060-QAB is recommended with the CHA4350-QDG as driver.
Total Gain: 56dB
Gain control: 40dB with the both amplifiers.
For more information about the CHA4350-QDG, see our web site www.ums-rf.com




**CHA4350-QDG**
**5.5- 11.7GHz**
**4V**
**125mA**

**CHA7060-QAB**
**5.6- 8.5GHz**
**20V**
**420mA**



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## Notes

ESD protections are implemented on RF access to increase robustness against ESD events.

The DC connections do not include any decoupling capacitor in package, therefore it is mandatory to provide a good external DC decoupling on the PC board, as close as possible to the package.

## 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 6x6 package: | CHA7060-QAB/XY | |
| | Stick: XY = 20 | Tape & reel: XY = 21 |





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