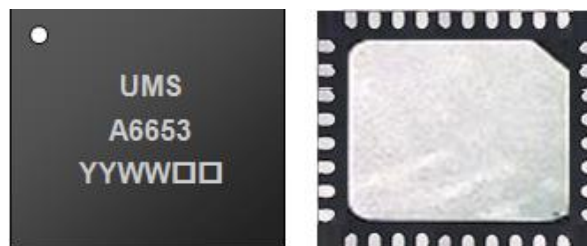


## 27- 33.5GHz Power Amplifier

GaAs Monolithic Microwave IC in SMD leadless package

### Description

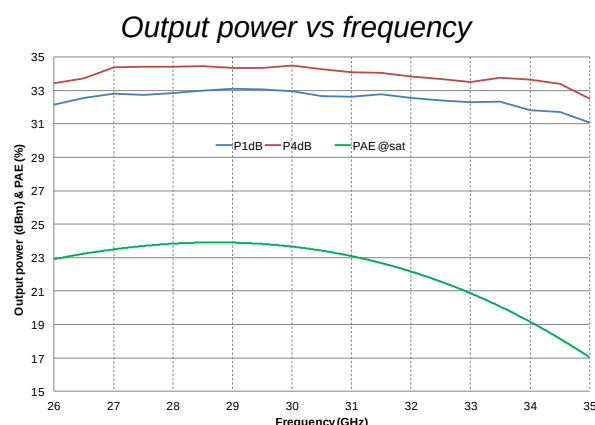
The CHA6653-QXG is a four stage monolithic GaAs high power circuit producing 1.8 Watt output power. It is highly linear, with possible gain control and integrates a power detector. ESD protections are included. It is designed for Point To Point Radio. The circuit is manufactured with a pHEMT process, 0.15µm gate length. It is supplied in RoHS compliant SMD package.



36 lead 6x5 mm QFN package

### Main Features

- Broadband performances: 27- 33.5GHz
- 32.5dBm saturated power
- 38dBm OIP3
- 20dB gain
- DC bias: Vd = 6.0Volt @ Id = 0.9A
- QFN 6x5
- MSL3



### Main Electrical Characteristics

Tamb.= +25°C

| Symbol | Parameter              | Min | Typ  | Max  | Unit |
|--------|------------------------|-----|------|------|------|
| Freq   | Frequency range        | 27  |      | 33.5 | GHz  |
| Gain   | Linear Gain            |     | 20   |      | dB   |
| Psat   | Saturated output power |     | 32.5 |      | dBm  |
| OIP3   | Output IP3             |     | 38   |      | dBm  |

## Electrical Characteristics

Tamb.= +25°C, Vd = +6.0V

| Symbol     | Parameter                                                                      | Min | Typ        | Max  | Unit  |
|------------|--------------------------------------------------------------------------------|-----|------------|------|-------|
| Fop        | Operating frequency range                                                      | 27  |            | 33.5 | GHz   |
| Gain       | Small Signal Gain                                                              |     | 20         |      | dB    |
| $\Delta G$ | Gain variation in temperature                                                  |     | $\pm 0.03$ |      | dB/°C |
| Psat       | Saturated Output Power in 27 - 30GHz<br>Saturated Output Power in 31 - 33.5GHz |     | 33<br>32.5 |      | dBm   |
| OIP3       | Output IP3                                                                     |     | 38         |      | dBm   |
| PAE        | PAE at saturation in 27 - 30GHz<br>PAE at saturation in 31 - 33.5GHz           |     | 23<br>20   |      | %     |
| CG         | Gain control range                                                             |     | 15         |      | dB    |
| Rlin       | Input Return Loss in 27 - 30GHz<br>Input Return Loss in 31 - 33.5GHz           |     | 13<br>10   |      | dB    |
| Rlout      | Output Return Loss                                                             |     | 12         |      | dB    |
| NF         | Noise figure at nominal gain                                                   |     | 6          |      | dB    |
| Dr         | Detection dynamic range(for output power detection up to Psat)                 |     | 30         |      | dB    |
| Vdetect    | Voltage detection $V_{REF}$ - $V_{DET}$ up to Psat                             |     | 10 to 2000 |      | mV    |
| Vg         | DC gate Voltage                                                                |     | -0.65      |      | V     |
| Idq        | Total drain current                                                            |     | 0.9        |      | A     |

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

**Absolute Maximum Ratings** <sup>(1)</sup>T<sub>amb.</sub> = +25°C

| Symbol           | Parameter                        | Values      | Unit |
|------------------|----------------------------------|-------------|------|
| V <sub>d</sub>   | DC Drain bias voltage without RF | 8           | V    |
| I <sub>d</sub>   | Drain bias quiescent current     | 1050        | mA   |
| V <sub>g</sub>   | Gate bias voltage                | -2 to 0     | V    |
| P <sub>in</sub>  | Maximum Input Power              | +15         | dBm  |
| T <sub>a</sub>   | Operating temperature range      | -40 to +95  | °C   |
| T <sub>stg</sub> | Storage temperature range        | -55 to +150 | °C   |

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

**Typical Bias Conditions**T<sub>amb.</sub> = +25°C

| Symbol          | Pad N° | Parameter                              | Values | Unit |
|-----------------|--------|----------------------------------------|--------|------|
| V <sub>d1</sub> | 8      | DC Drain voltage 1 <sup>st</sup> stage | 6.0    | V    |
| V <sub>d2</sub> | 6      | DC Drain voltage 2 <sup>nd</sup> stage | 6.0    | V    |
| V <sub>d3</sub> | 4, 23  | DC Drain voltage 3 <sup>rd</sup> stage | 6.0    | V    |
| V <sub>d4</sub> | 2, 25  | DC Drain voltage 4 <sup>th</sup> stage | 6.0    | V    |
| V <sub>g1</sub> | 19     | DC Gate voltage 1 <sup>st</sup> stage  | -0.65  | V    |
| V <sub>g2</sub> | 7, 21  | DC Gate voltage 2 <sup>nd</sup> stage  | -0.65  | V    |
| V <sub>g3</sub> | 5, 22  | DC Gate voltage 3 <sup>rd</sup> stage  | -0.65  | V    |
| V <sub>g4</sub> | 3, 24  | DC Gate voltage 4 <sup>th</sup> stage  | -0.65  | V    |

## Device thermal performances

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 (no convection mode considered).

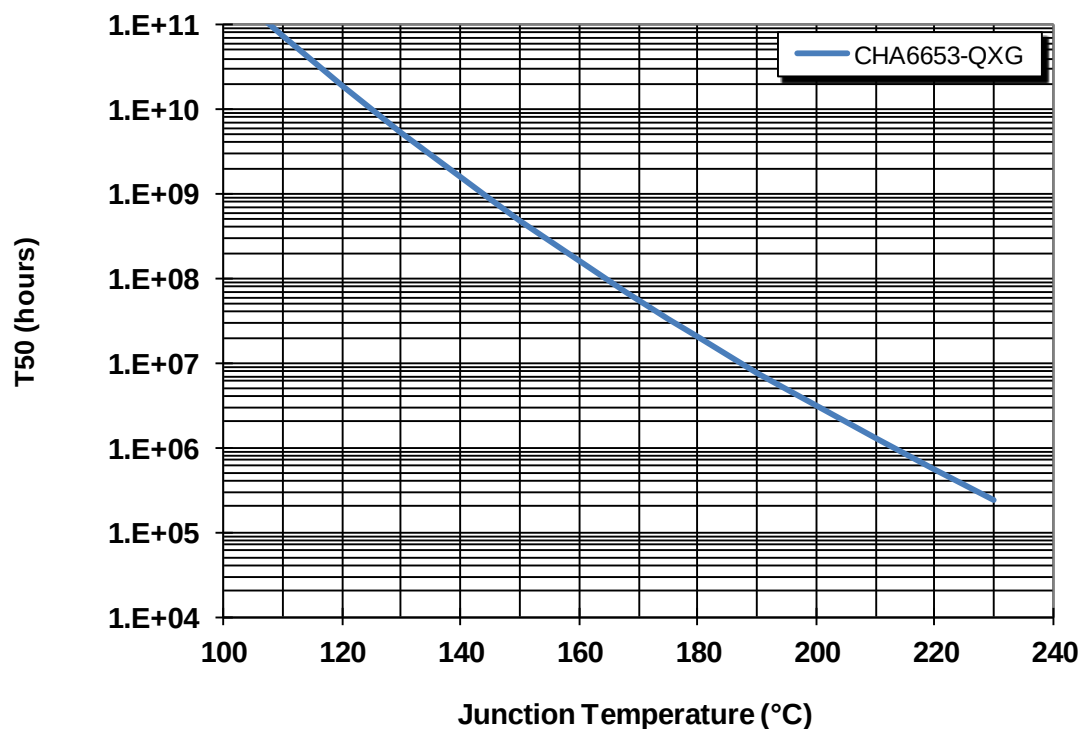
The temperature is monitored at the package back-side interface (Tcase).

The system maximum temperature must be adjusted in order to guarantee that Tjunction remains below the maximum value specified in the Absolute Maximum Ratings table.

So, the system PCB must be designed to comply with this requirement.

| Parameter                                                                | Biasing conditions                 | Tjunction (°C) | R <sub>TH</sub> (°C/W) | T50 (hours) |
|--------------------------------------------------------------------------|------------------------------------|----------------|------------------------|-------------|
| R <sub>TH</sub> <sup>(1)</sup><br>Thermal Resistance ( Junction to Case) | Vd= 6V<br>Id= 900mA<br>Pdiss= 5.4W | 168            | 15.4                   | 6.8E+07     |

<sup>(1)</sup> Assuming 85°C Tcase



**Typical Package Sij parameters**

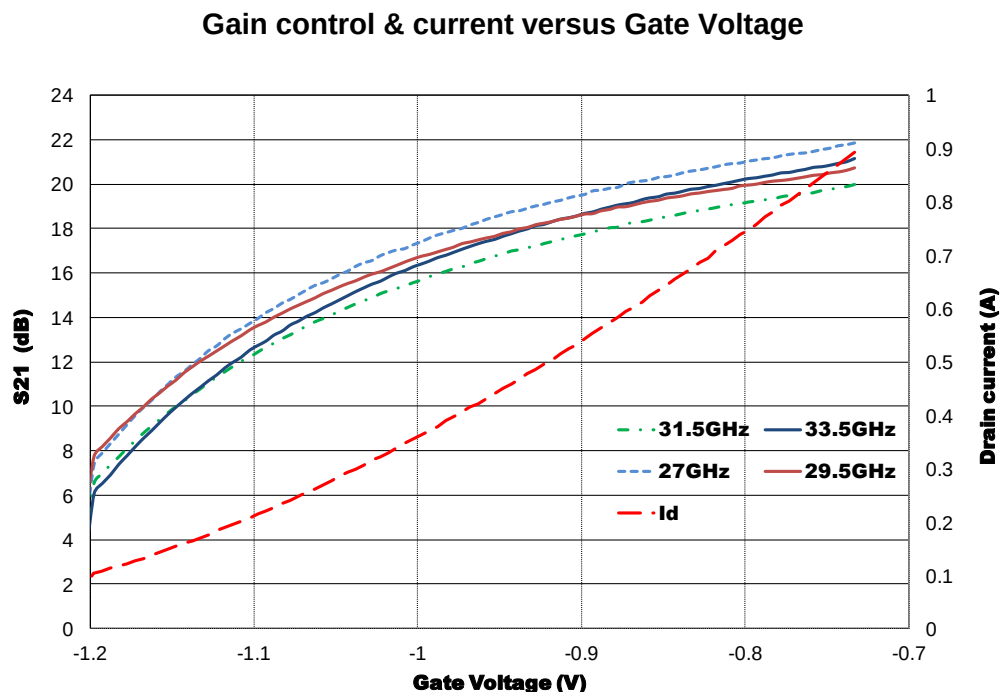
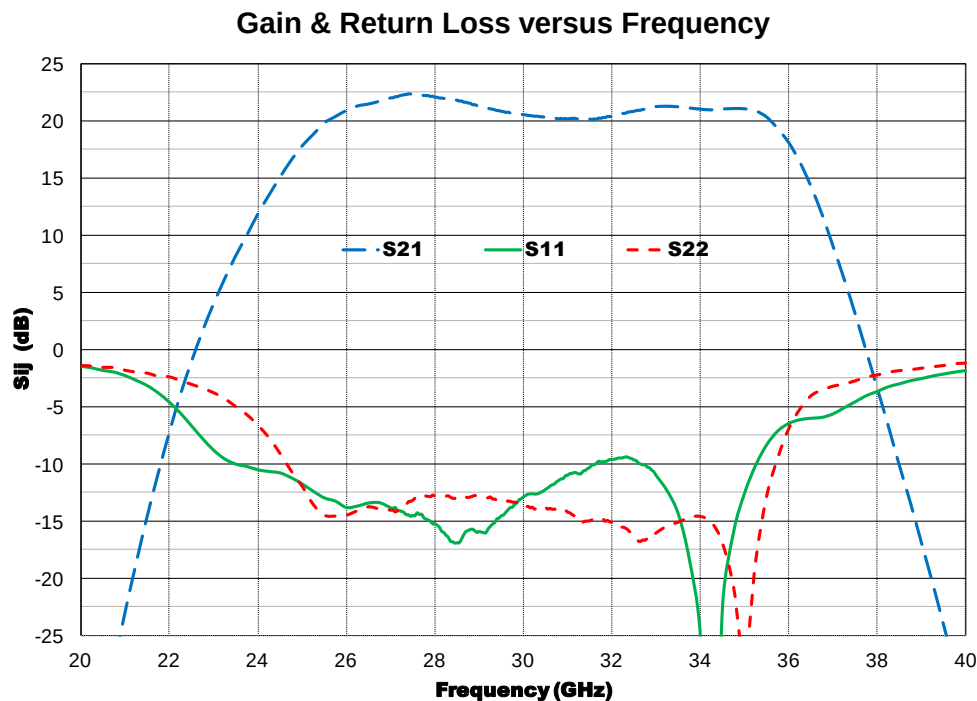
Tamb.= +25°C, Vd = +6.0V, Id = 900mA

| Freq<br>(GHz) | S11<br>(dB) | PhS11<br>(°) | S21<br>(dB) | PhS21<br>(°) | S12<br>(dB) | PhS12<br>(°) | S22<br>(dB) | PhS22<br>(°) |
|---------------|-------------|--------------|-------------|--------------|-------------|--------------|-------------|--------------|
| 1             | -0.1        | 163.8        | -72.6       | -108.4       | -68.7       | 125.8        | -0.1        | 164.6        |
| 2             | -0.2        | 147.7        | -71.3       | 81.2         | -65.8       | 84.6         | -0.1        | 149.6        |
| 3             | -0.2        | 132.4        | -75.9       | 170.5        | -68.2       | 83.6         | -0.2        | 134.1        |
| 4             | -0.2        | 117.2        | -66.0       | -1.5         | -65.1       | 58.9         | -0.2        | 118.4        |
| 5             | -0.2        | 102.0        | -66.2       | 24.8         | -64.0       | 17.0         | -0.2        | 102.7        |
| 6             | -0.2        | 88.0         | -60.3       | -2.5         | -59.1       | -6.0         | -0.2        | 86.6         |
| 7             | -0.2        | 73.5         | -67.5       | -11.6        | -65.0       | -50.2        | -0.2        | 69.8         |
| 8             | -0.2        | 60.5         | -64.1       | -41.2        | -62.9       | -48.0        | -0.3        | 57.2         |
| 9             | -0.3        | 45.3         | -63.7       | -92.4        | -62.8       | -78.6        | -0.3        | 40.2         |
| 10            | -0.3        | 29.4         | -79.0       | -93.3        | -68.4       | -100.5       | -0.4        | 23.4         |
| 11            | -0.4        | 12.8         | -70.5       | -94.8        | -64.2       | -88.0        | -0.4        | 5.9          |
| 12            | -0.4        | -4.1         | -64.4       | -148.8       | -61.6       | -163.8       | -0.5        | -12.1        |
| 13            | -0.5        | -22.0        | -67.8       | 78.0         | -70.3       | 94.2         | -0.7        | -31.0        |
| 14            | -0.5        | -40.2        | -61.4       | -110.8       | -59.3       | -123.0       | -1.3        | -55.4        |
| 15            | -0.6        | -59.4        | -58.1       | 129.5        | -54.3       | 125.3        | -6.8        | -57.2        |
| 16            | -0.7        | -78.7        | -65.3       | 157.3        | -60.9       | 36.3         | -1.9        | -61.2        |
| 17            | -0.7        | -99.4        | -51.4       | 123.7        | -55.1       | 87.2         | -1.3        | -85.0        |
| 18            | -0.9        | -121.1       | -46.3       | 66.1         | -48.2       | 46.9         | -1.2        | -106.4       |
| 19            | -1.0        | -145.4       | -50.5       | 37.6         | -49.0       | 5.8          | -1.3        | -128.4       |
| 20            | -1.4        | -174.9       | -41.6       | 140.2        | -55.5       | 18.3         | -1.4        | -153.1       |
| 21            | -2.2        | 145.0        | -22.9       | 96.2         | -48.9       | -2.7         | -1.8        | 178.2        |
| 22            | -4.6        | 84.3         | -7.2        | 6.1          | -46.6       | -48.1        | -2.4        | 147.2        |
| 23            | -8.8        | -10.5        | 4.1         | -108.2       | -50.0       | -34.6        | -3.8        | 109.6        |
| 24            | -10.5       | -117.5       | 11.9        | 135.5        | -46.0       | -50.9        | -6.6        | 68.9         |
| 25            | -11.7       | 147.3        | 17.8        | 16.2         | -44.2       | -66.9        | -11.9       | 39.4         |
| 26            | -13.8       | 45.3         | 20.9        | -104.9       | -43.5       | -86.9        | -14.5       | 42.1         |
| 27            | -13.8       | -31.1        | 22.0        | 143.4        | -43.6       | -123.4       | -14.0       | 22.8         |
| 28            | -15.2       | -63.9        | 22.1        | 35.2         | -44.9       | -124.2       | -12.8       | -6.6         |
| 29            | -15.9       | -63.6        | 21.4        | -64.1        | -44.0       | -150.8       | -12.8       | -45.7        |
| 30            | -12.8       | -68.7        | 20.6        | -156.3       | -44.9       | -133.7       | -13.6       | -90.0        |
| 31            | -11.0       | -89.0        | 20.2        | 113.9        | -45.0       | -135.2       | -14.2       | -135.3       |
| 32            | -9.6        | -121.1       | 20.5        | 23.7         | -42.5       | -145.9       | -15.1       | -173.5       |
| 33            | -11.0       | -173.5       | 21.3        | -75.6        | -40.7       | -169.6       | -16.0       | 165.2        |
| 34            | -25.0       | 120.5        | 21.0        | 176.6        | -41.2       | 179.9        | -14.6       | 136.8        |
| 35            | -12.5       | -117.1       | 21.1        | 59.3         | -37.7       | 173.4        | -27.1       | 149.4        |
| 36            | -6.4        | 172.2        | 18.1        | -84.0        | -34.2       | 145.8        | -6.9        | 171.1        |
| 37            | -5.6        | 130.0        | 9.1         | 134.9        | -35.0       | 98.9         | -3.2        | 117.4        |
| 38            | -3.6        | 99.1         | -3.4        | 23.3         | -36.7       | 75.3         | -2.2        | 86.2         |
| 39            | -2.5        | 72.3         | -16.9       | -59.6        | -39.2       | 41.8         | -1.6        | 59.2         |
| 40            | -1.8        | 51.2         | -32.0       | -132.6       | -42.9       | 43.7         | -1.2        | 36.0         |

### Typical Board Measurements

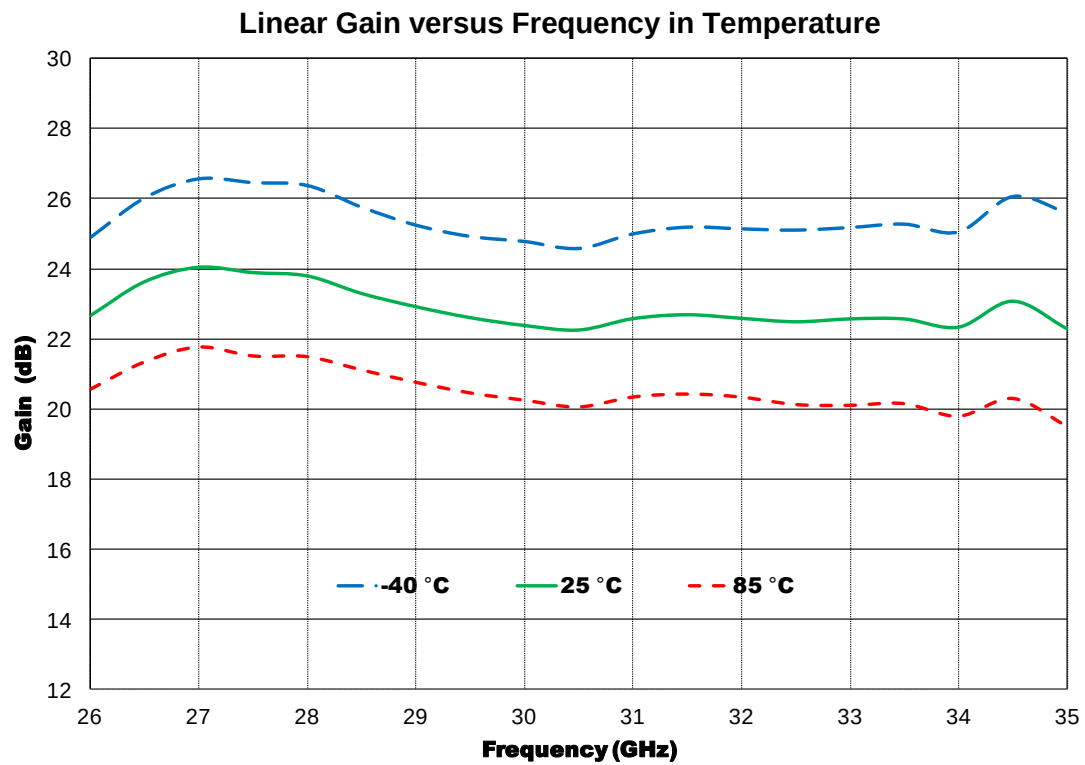
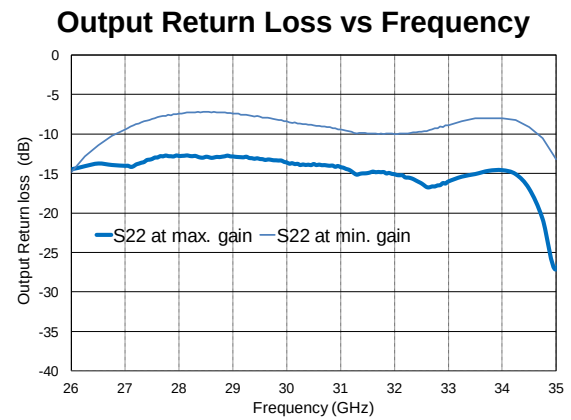
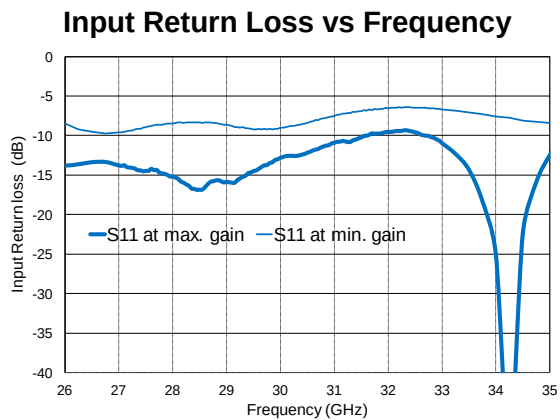
Tamb.= +25°C, Vd = +6.0V, Id = 900mA

Measurement performed in the access plans of the QFN, using the proposed land pattern & board, as defined in paragraph "Evaluation mother board"



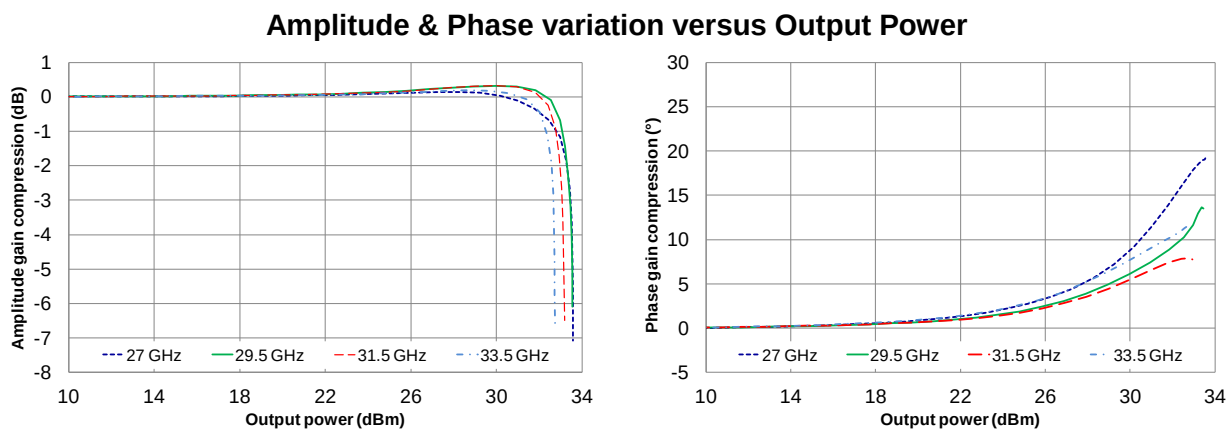
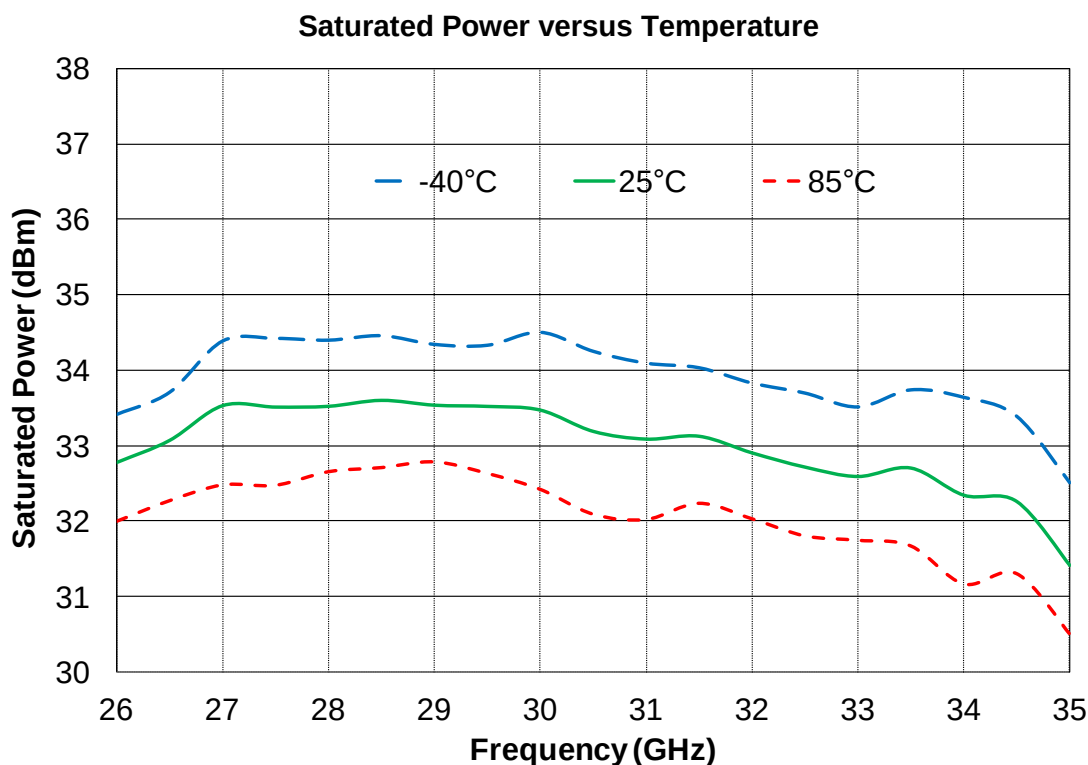
## Typical Board Measurements

Tamb.= +25°C, Vd = +6.0V, Id = 900mA



### Typical Board Measurements

Tamb.= +25°C, Vd = +6.0V, Id = 900mA

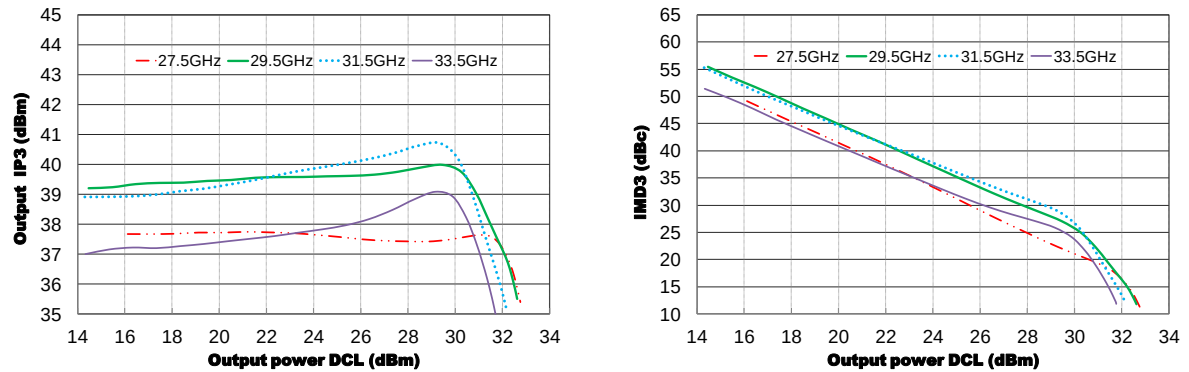




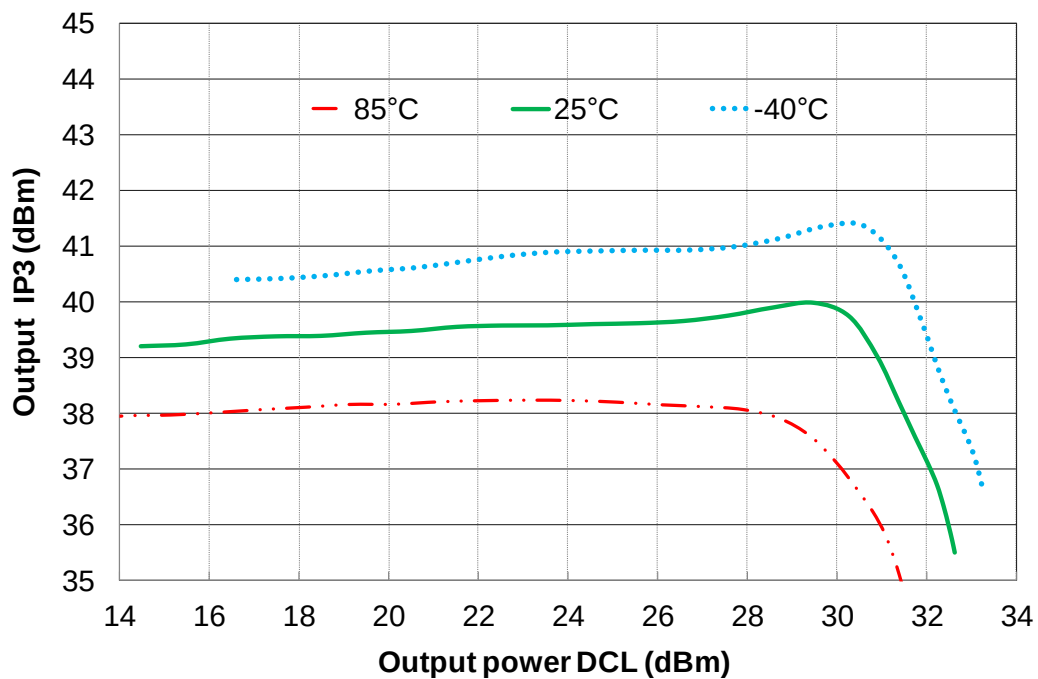
## Typical Board Measurements

Tamb.= +25°C, Vd = +6.0V, Id = 900mA

### Output IP3 & IMD3 versus Output Power

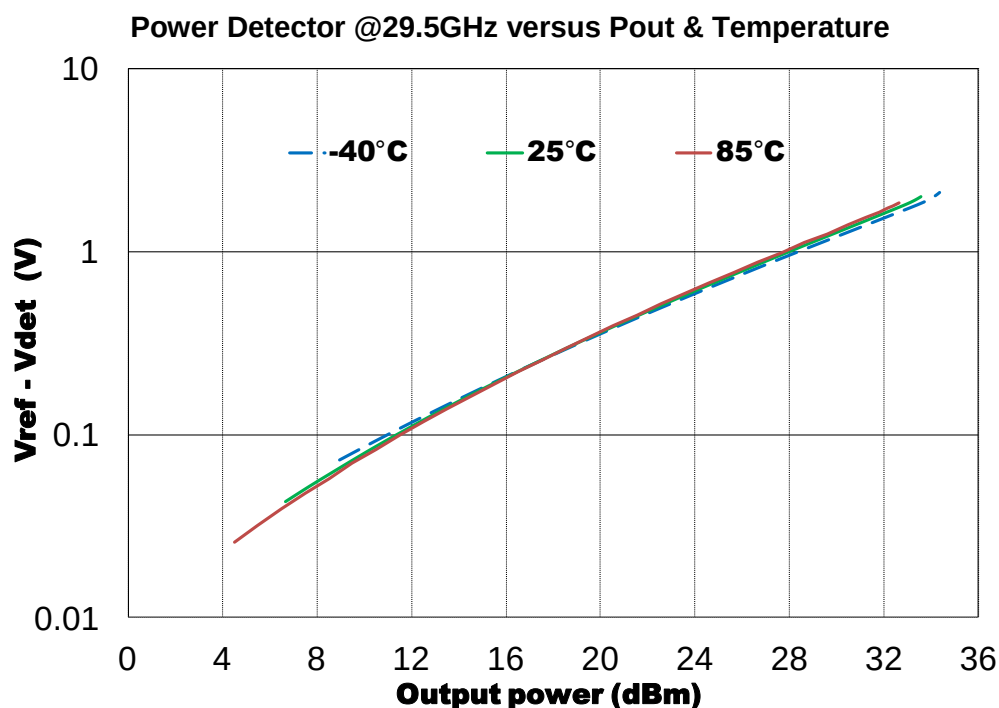
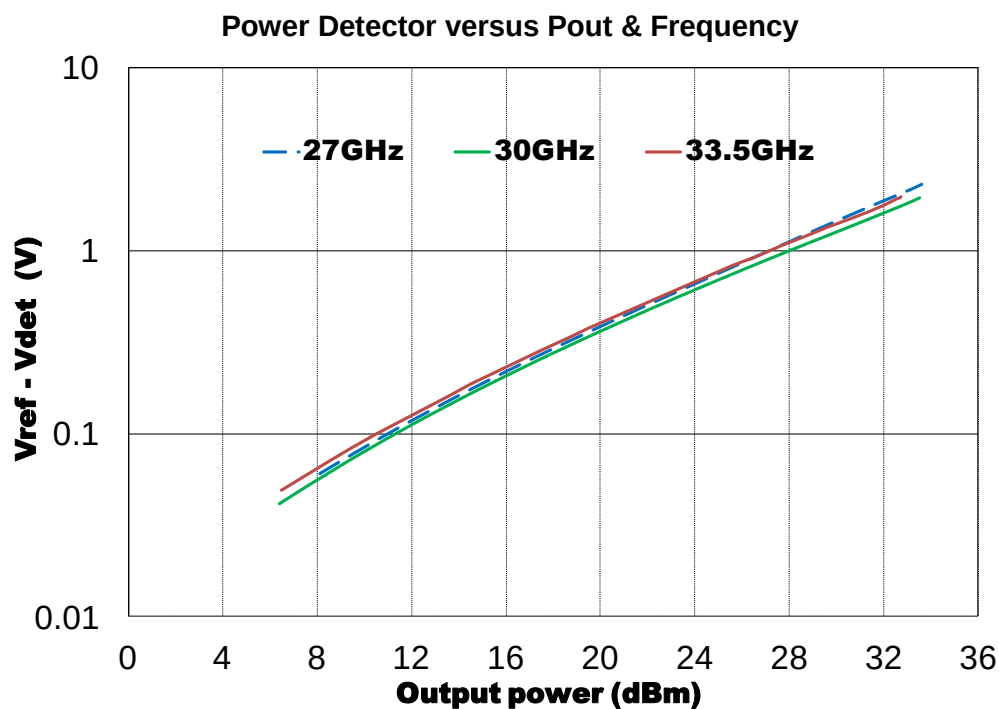


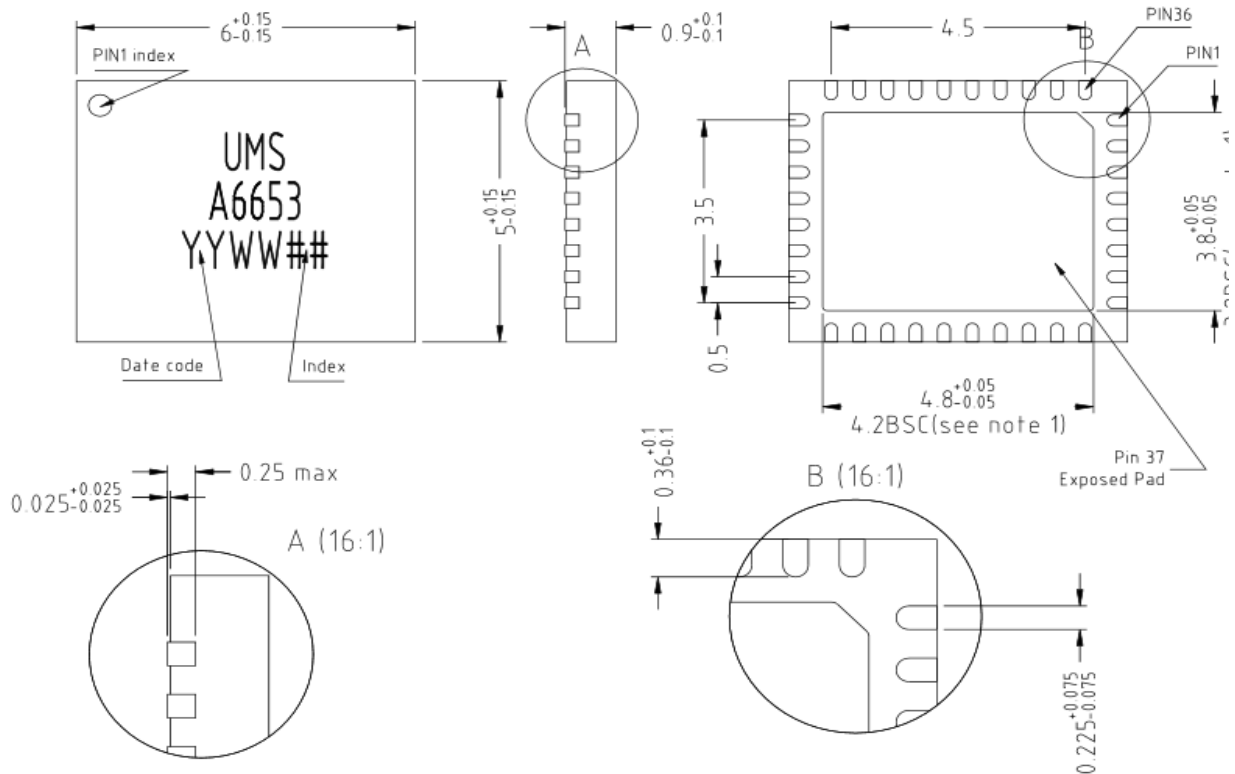
### Output IP3 with temperature at 29.5GHz



## Typical Board Measurements

Tamb.= +25°C, Vd = +6.0V, Id = 900mA



Package outline <sup>(1)</sup>

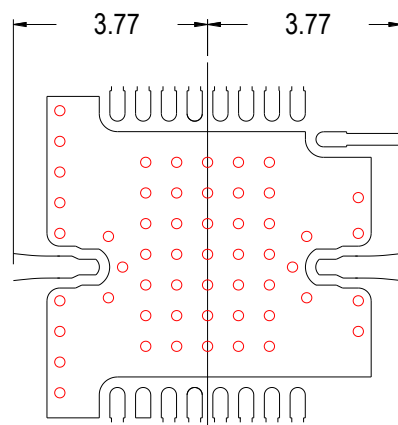
|                                         |        |                        |                        |
|-----------------------------------------|--------|------------------------|------------------------|
| Matte tin, Lead Free (Green)            | 1- DET | 13- Gnd <sup>(2)</sup> | 25- Vd4                |
| Units : mm                              | 2- Vd4 | 14- RF in              | 26- NC                 |
| From the standard : JEDEC MO-220 (VGGD) | 3- Vg4 | 15- Gnd <sup>(2)</sup> | 27- Gnd <sup>(2)</sup> |
| 37- GND                                 | 4- Vd3 | 16- NC                 | 28- NC                 |
|                                         | 5- Vg3 | 17- NC                 | 29- NC                 |
|                                         | 6- Vd2 | 18- NC                 | 30- Gnd <sup>(2)</sup> |
|                                         | 7- Vg2 | 19- Vg1                | 31- RF out             |
|                                         | 8- Vd1 | 20- NC                 | 32- Gnd <sup>(2)</sup> |
|                                         | 9- NC  | 21- Vg2                | 33- NC                 |
|                                         | 10- NC | 22- Vg3                | 34- NC                 |
|                                         | 11- NC | 23- Vd3                | 35- NC                 |
|                                         | 12- NC | 24- Vg4                | 36- REF                |

<sup>(1)</sup> 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.

<sup>(2)</sup> 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.

## 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 3.77mm offset (input wise and output wise respectively) from this axis. Then, the given Sij parameters incorporate the land pattern of the evaluation motherboard recommended in paragraph "Evaluation motherboard".



## ESD sensitivity

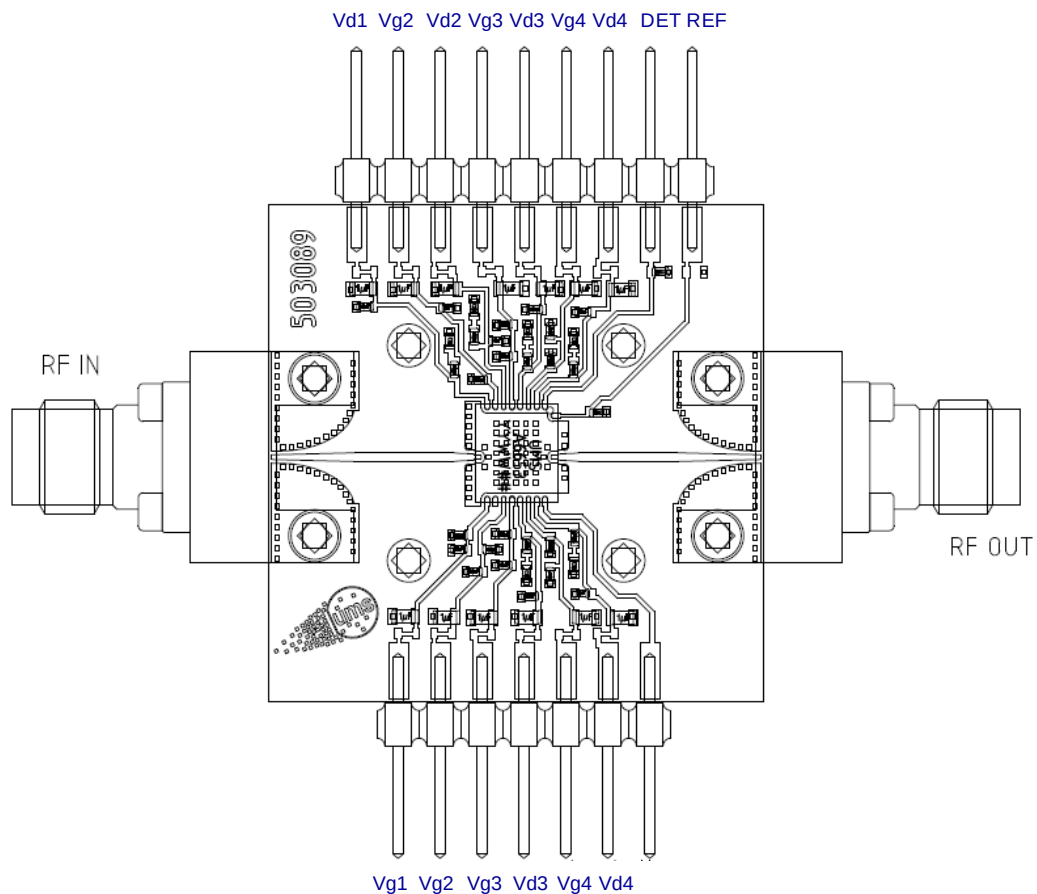
| Standard      | Value                |
|---------------|----------------------|
| MIL-STD-1686C | HBM Class 1 (<2000V) |
|               |                      |

## Package Information

| Parameter             | Value                               |
|-----------------------|-------------------------------------|
| Package body material | RoHS-compliant                      |
|                       | Low stress Injection Molded Plastic |
| Lead finish           | 100% matte tin (Sn)                 |
| MSL Rating            | MSL3                                |

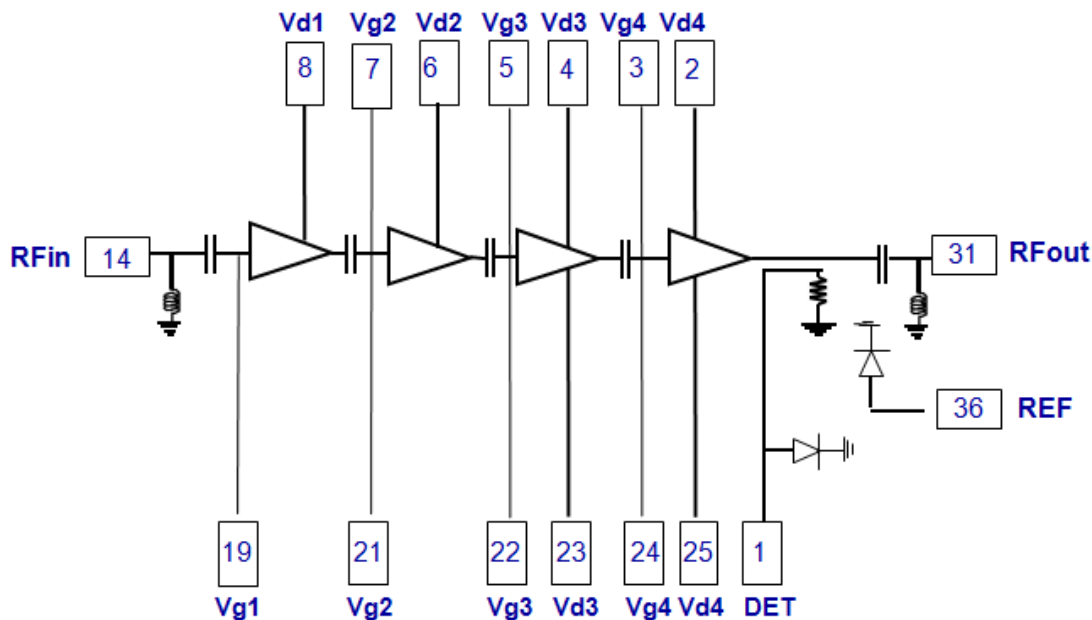
## Evaluation mother board

- Compatible with the proposed footprint.
- Based on typically Ro4350B / 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.
- Decoupling capacitors of 100pF  $\pm 5\%$ , 10nF  $\pm 10\%$  and 1 $\mu$ F  $\pm 10\%$  are recommended for DC accesses.
- A 10K $\Omega$  resistor is recommended on VREF & VDET accesses for the detector
- See application note AN0017 for details.



### Notes

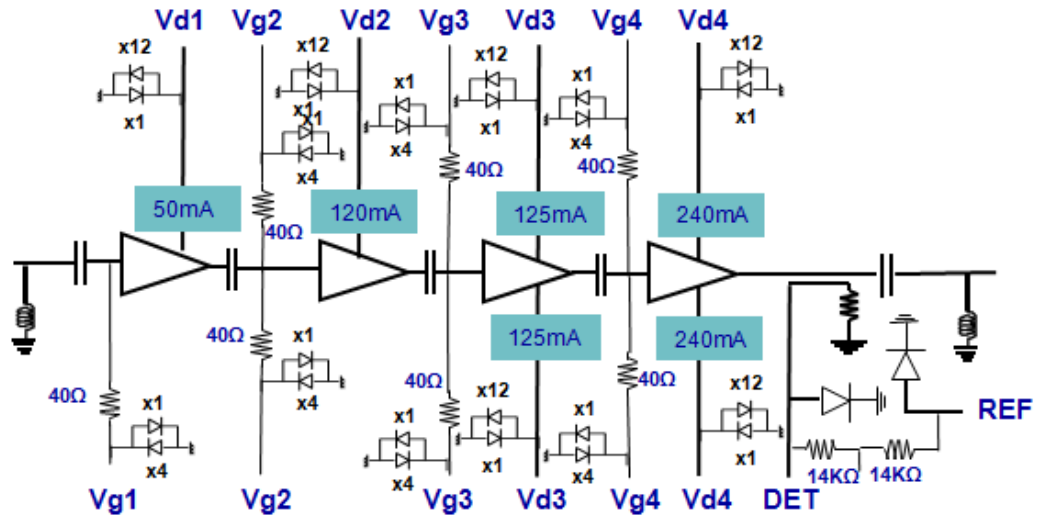
Due to ESD protection circuits on RF input and output, an external capacitance might be requested to isolate the product from external voltage potentially present on the RF accesses.



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

A 10K $\Omega$  resistor is recommended in parallel to VDET, and VREF accesses.

The circuit includes ESD protections on all RF and DC leads

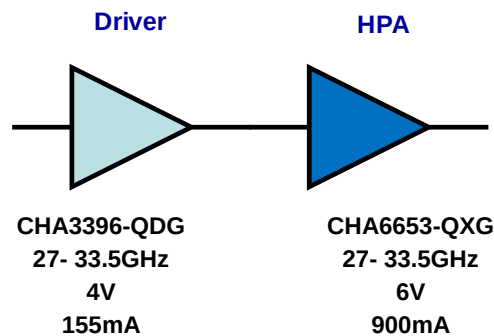
**DC Schematic****6V, 900mA****Recommended UMS Power chain**

The CHA6653-QXG is recommended with the CHA3396-QDG as driver.

Total Gain: 44dB

Gain control: 30dB with the both amplifiers.

For more information about the CHA3396-QDG, see our web site [www.ums-gaas.com](http://www.ums-gaas.com)



### Recommended package footprint

Refer to the application note AN0017 available at <https://www.ums-rf.com> for package footprint 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.

### 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 6x5 package:

CHA6653-QXG/XY

Stick: XY = 20

Tape & reel: XY = 21

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