United Monolithic Semiconductors

# CHA6356-QXG

# 21.2 - 23.6GHz Power Amplifier

## GaAs Monolithic Microwave IC in SMD leadless package

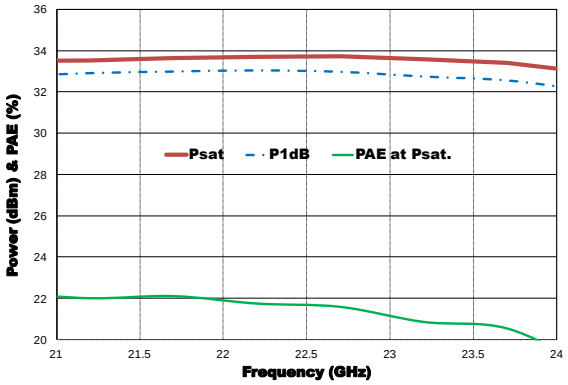
## Description

The CHA6356-QXG is a three stage monolithic GaAs high power circuit producing 2 Watt output power. It integrates a power detector and allows gain control. ESD protections are included.
It is designed for Point To Point Radio or K-band Sat-Com application.
The circuit is manufactured with a pHEMT process, 0.15µm gate length.
It is supplied in RoHS compliant SMD package.


## Main Features

- Frequency range: 21.2- 23.6GHz
- 33.5dBm saturated power
- 42dBm OIP3
- 20dB gain
- DC bias: Vd = 6.0Volt @ Id = 1.3A
- QFN5x6
- MSL3

*Power & PAE*




## Main Electrical Characteristics

Tamb.= +25°C

| Symbol | Parameter | Min | Typ | Max | Unit |
|---|---|---|---|---|---|
| Freq | Frequency range | 21.2 | | 23.6 | GHz |
| Gain | Linear Gain | | 20 | | dB |
| Psat | Saturated output power | | 33.5 | | dBm |
| OIP3 | Output IP3 | | 42 | | dBm |



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## Electrical Characteristics

Tamb.= +25°C, Vd = +6V

| Symbol | Parameter | Min | Typ | Max | Unit |
|---|---|---|---|---|---|
| Fop | Operating frequency range | 21.2 | | 23.6 | GHz |
| Gain | Small Signal Gain | | 20 | | dB |
| Psat | Saturated Output Power | | 33.5 | | dBm |
| ΔG | Gain variation in temperature | | +/- 0.03 | | dB/°C |
| OIP3 | Output IP3 | | 42 | | dBm |
| PAE | PAE at saturation | | 22 | | % |
| CG | Gain regulation range | | 15 | | dB |
| NF | Noise Figure @ nominal gain | | 4.5 | | dB |
| Rlin | Input Return Loss | | 18 | | dB |
| Rlout | Output Return Loss | | 14 | | 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 2800 | | mV |
| Vg | DC gate Voltage | | -0.85 | | V |
| Idet | Detector current | | 850 | | µA |
| Idq | Total drain current | | 1.3 | | A |

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



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## Absolute Maximum Ratings (1)

Tamb.= +25°C

| Symbol | Parameter | Values | Unit |
|---|---|---|---|
| Vd | Drain bias voltage | 6.5V | V |
| Id | Drain bias quiescent current | 1700 | mA |
| Vg | Gate bias voltage | -2 to 0 | V |
| Pin | Maximum peak input power overdrive (2) | +20 | dBm |
| Tj | Junction temperature | 175 | °C |
| Ta | Operating temperature range | -40 to +85 | °C |
| Tstg | Storage temperature range | -55 to +150 | °C |

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

(2) Thermal Resistance channel to ground paddle =9.3°C/W for Tamb. = +85°C with 6.0V & 1.3A.

## Typical Bias Conditions

Tamb.= +25°C

| Symbol | Pad Nº | Parameter | Values | Unit |
|---|---|---|---|---|
| VD1 | 7, 20 | DC Drain voltage 1st stage | 6.0 | V |
| VD2 | 5, 22 | DC Drain voltage 2nd stage | 6.0 | V |
| VD3 | 3, 24 | DC Drain voltage 3rd stage | 6.0 | V |
| VG1 | 8, 19 | DC Gate voltage 1st stage | -0.85 | V |
| VG2 | 6, 21 | DC Gate voltage 2nd stage | -0.85 | V |
| VG3 | 4, 23 | DC Gate voltage 3rd stage | -0.85 | V |
| DC | 1 | DC Detector voltage | 6.0 | V |



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## Device thermal performances

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

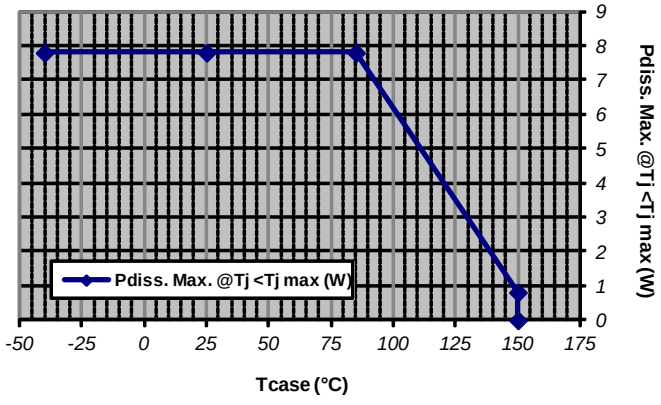
A derating must be applied on the dissipated power if the Tcase temperature can not be maintained below the maximum temperature specified (see the curve Pdiss. Max) in order to guarantee the nominal device life time (MTTF).

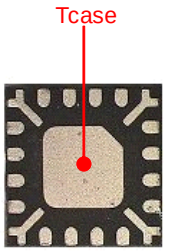
| DEVICE THERMAL SPECIFICATION : CHA6356-QXG | | | |
|---|---|---|---|
| Recommended max. junction temperature (Tj max) | : | 158 | °C |
| Junction temperature absolute maximum rating | : | 175 | °C |
| Max. continuous dissipated power (Pdiss. Max.) | : | 7.8 | W |
| => Pdiss. Max. derating above Tcase(1)= 85 °C | : | 107 | mW/°C |
| Junction-Case thermal resistance (Rth J-C)(2) | : | <9 | °C/W |
| Minimum Tcase operating temperature(3) | : | -40 | °C |
| Maximum Tcase operating temperature(3) | : | 85 | °C |
| Minimum storage temperature | : | -55 | °C |
| Maximum storage temperature | : | 150 | °C |

*(1) Derating at junction temperature constant = Tj max.*

*(2) Rth J-C is calculated for a worst case considering the **hottest junction** of the MMIC and all the devices biased.*

*(3) Tcase=Package back side temperature measured under the die-attach-pad (see the drawing below).*




Example: QFN 16L 3x3
Location of temperature reference point (Tcase) on package's bottom side



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## Typical Package Sij parameters

Tamb.= +25°C, Vd = +6V, Id = 1300mA

| Freq (GHz) | S11 (dB) | PhS11 (°) | S12 (dB) | PhS12 (°) | S21 (dB) | PhS21 (°) | S22 (dB) | PhS22 (°) |
|---|---|---|---|---|---|---|---|---|
| 1 | -0.414 | 156.2 | -73.770 | 99.8 | -73.330 | 4.3 | -0.299 | 155.8 |
| 2 | -0.541 | 131.5 | -73.384 | 53.7 | -78.135 | 7.0 | -0.495 | 131.1 |
| 3 | -0.667 | 104.1 | -71.320 | 58.3 | -75.463 | -3.6 | -0.687 | 103.9 |
| 4 | -2.088 | 66.2 | -64.404 | 28.7 | -67.133 | 21.3 | -3.741 | 74.9 |
| 5 | -6.237 | 68.8 | -68.624 | -151.7 | -71.395 | 175.1 | -3.342 | 73.8 |
| 6 | -5.020 | 50.4 | -68.331 | 30.4 | -69.456 | 29.5 | -3.044 | 50.1 |
| 7 | -5.217 | 27.8 | -65.479 | -2.2 | -64.668 | -38.6 | -3.307 | 25.2 |
| 8 | -5.726 | 4.1 | -69.860 | -59.0 | -67.388 | -39.7 | -3.719 | -1.4 |
| 9 | -6.073 | -21.4 | -67.716 | -14.8 | -74.019 | -21.6 | -4.505 | -32.5 |
| 10 | -6.597 | -48.2 | -61.953 | -80.2 | -65.246 | -29.0 | -5.659 | -66.7 |
| 11 | -7.429 | -76.9 | -57.920 | -143.6 | -60.041 | -29.9 | -7.255 | -104.0 |
| 12 | -8.541 | -108.0 | -55.590 | 149.5 | -42.647 | -70.9 | -9.759 | -143.5 |
| 13 | -10.487 | -144.4 | -54.870 | 100.3 | -28.090 | -142.3 | -13.681 | 176.4 |
| 14 | -13.929 | 168.4 | -54.928 | 75.1 | -14.422 | 127.2 | -23.328 | 130.9 |
| 15 | -19.097 | 94.0 | -53.426 | 59.2 | -2.267 | 15.7 | -24.497 | -69.6 |
| 16 | -18.791 | -3.6 | -51.127 | 45.6 | 7.156 | -109.9 | -17.083 | -109.7 |
| 17 | -15.960 | -75.4 | -54.760 | 9.6 | 13.717 | 120.1 | -16.829 | -130.3 |
| 18 | -19.082 | -133.7 | -49.119 | 18.4 | 17.995 | -10.6 | -18.821 | -138.4 |
| 19 | -24.182 | -93.4 | -47.738 | -14.5 | 20.484 | -136.3 | -16.444 | -123.7 |
| 20 | -19.596 | -132.7 | -47.859 | -49.9 | 21.358 | 98.8 | -16.288 | -136.5 |
| 21 | -18.555 | 177.2 | -54.511 | -58.8 | 20.688 | -20.2 | -16.633 | -134.0 |
| 22 | -22.444 | 106.8 | -51.969 | -21.2 | 19.562 | -128.9 | -17.220 | -128.2 |
| 23 | -27.941 | -3.9 | -48.925 | -21.3 | 19.619 | 122.7 | -16.107 | -122.3 |
| 24 | -25.000 | -90.3 | -47.679 | -40.4 | 19.880 | -1.7 | -13.638 | -119.7 |
| 25 | -24.519 | -155.6 | -42.340 | -31.6 | 16.701 | -147.9 | -11.594 | -136.8 |
| 26 | -27.392 | -127.3 | -40.176 | -67.8 | 7.237 | 77.9 | -11.681 | -165.7 |
| 27 | -23.100 | -120.2 | -38.911 | -85.1 | -3.420 | -26.6 | -13.771 | 160.1 |
| 28 | -16.543 | -137.6 | -36.840 | -114.7 | -13.054 | -115.1 | -17.184 | 112.1 |
| 29 | -12.498 | -168.2 | -36.523 | -137.7 | -22.251 | 174.1 | -19.473 | 38.3 |
| 30 | -9.962 | 157.7 | -36.450 | -160.7 | -31.980 | 126.6 | -17.184 | -33.2 |
| 31 | -8.771 | 123.9 | -36.602 | 178.1 | -40.595 | 137.4 | -15.351 | -92.2 |
| 32 | -8.649 | 87.3 | -36.094 | 150.6 | -38.033 | 148.5 | -13.335 | -155.4 |
| 33 | -9.533 | 42.1 | -40.457 | 121.9 | -41.617 | 127.6 | -9.801 | 147.8 |
| 34 | -10.924 | -29.5 | -43.517 | 115.6 | -46.351 | 113.5 | -6.945 | 104.4 |
| 35 | -8.097 | -116.9 | -46.137 | 109.2 | -48.926 | 131.7 | -4.999 | 71.0 |
| 36 | -4.314 | -178.1 | -49.039 | 104.7 | -45.760 | 151.7 | -4.439 | 43.3 |
| 37 | -2.218 | 140.5 | -46.798 | 159.6 | -43.979 | 156.8 | -6.552 | 17.3 |
| 38 | -1.185 | 108.2 | -38.359 | 140.5 | -39.640 | 137.2 | -9.898 | 61.2 |
| 39 | -0.966 | 82.9 | -37.092 | 114.8 | -36.878 | 99.1 | -3.015 | 48.5 |
| 40 | -0.729 | 60.9 | -37.276 | 81.6 | -35.367 | 75.5 | -1.652 | 26.8 |



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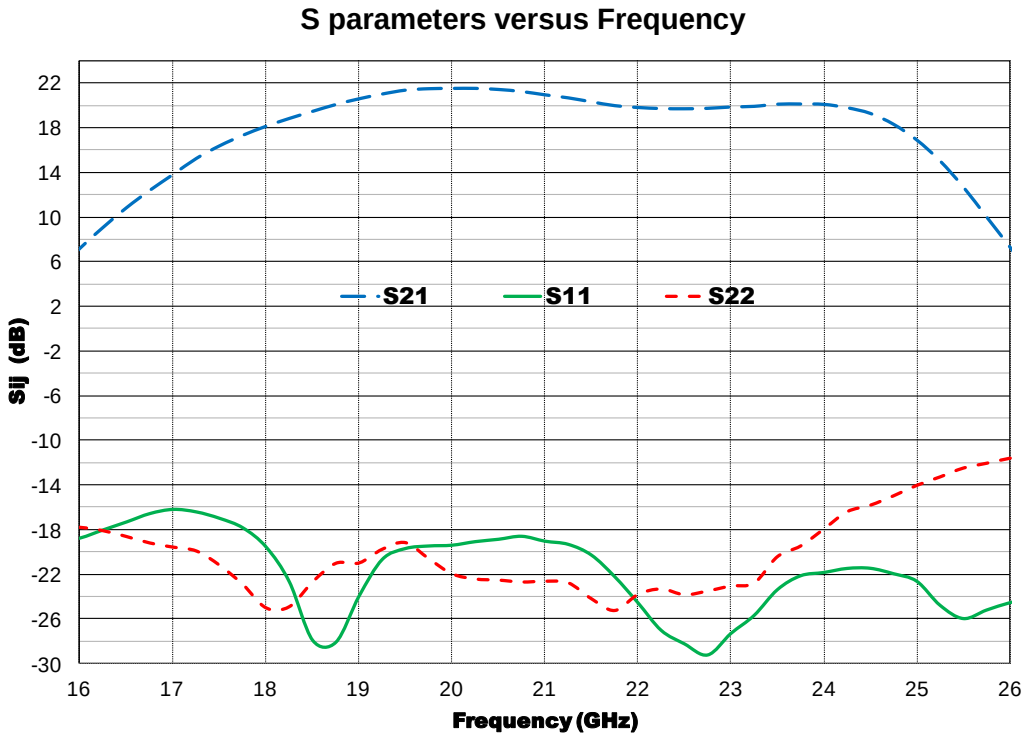
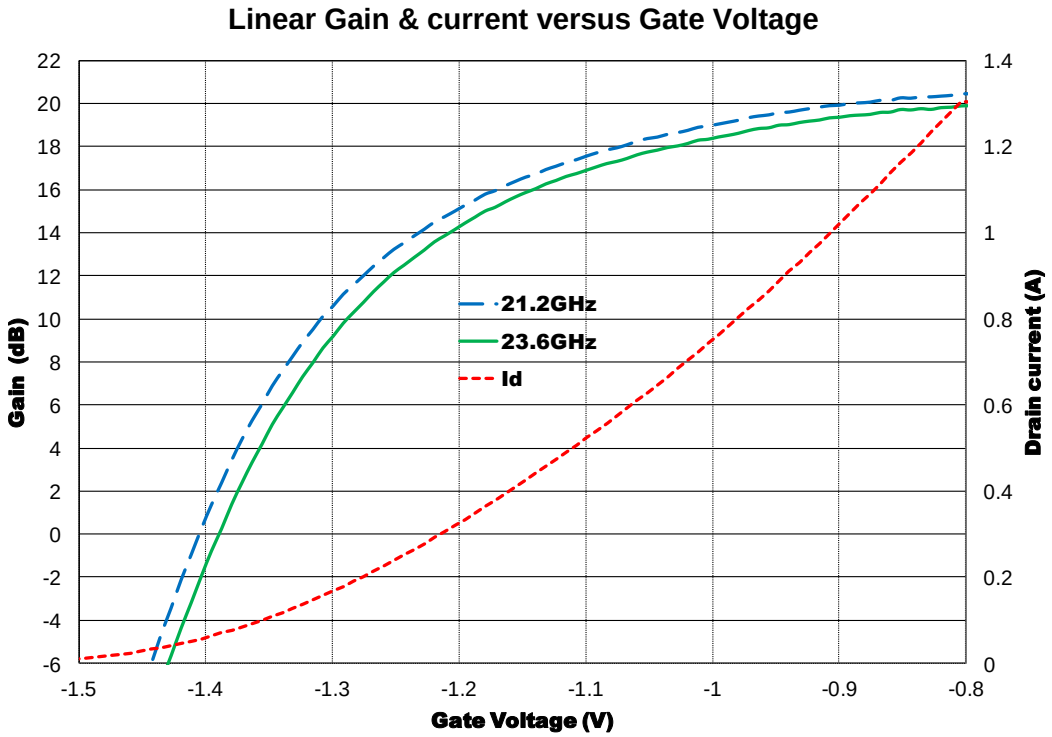
## Typical board Measurements

Tamb.= +25°C, Vd = +6V, Id = 1300mA
Measurement in the plan of the QFN, using the proposed land pattern & board, as defined in paragraph “Evaluation mother board”



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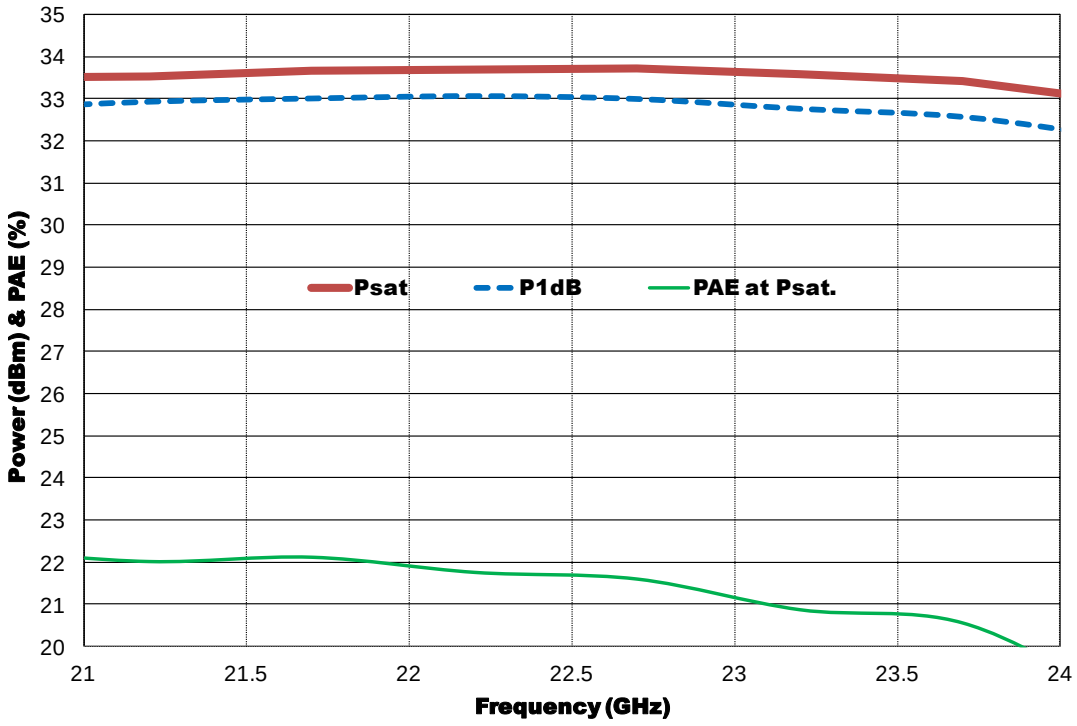
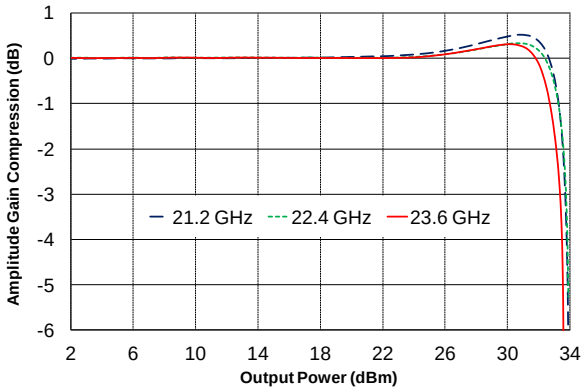
## Typical Board Measurements

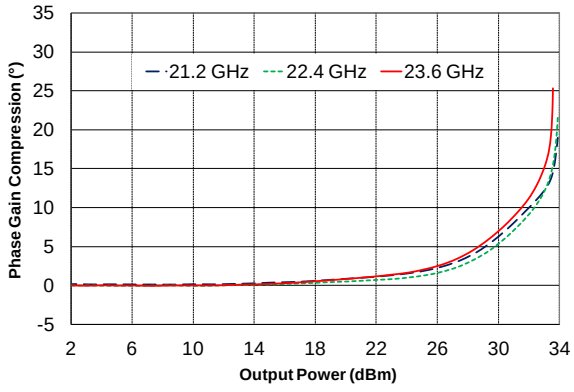
Tamb.= +25°C, Vd = +6V, Id = 1300mA

**Output power & PAE versus Frequency**




**Amplitude & Phase variation versus Output Power**



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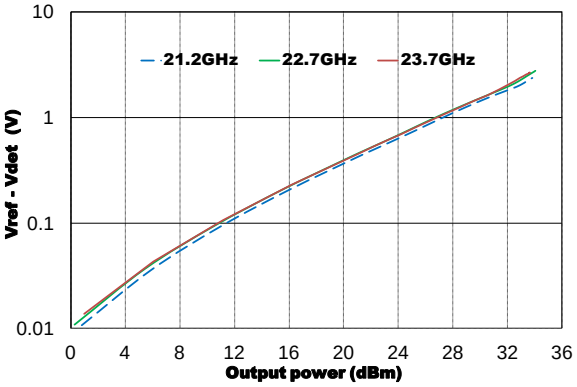
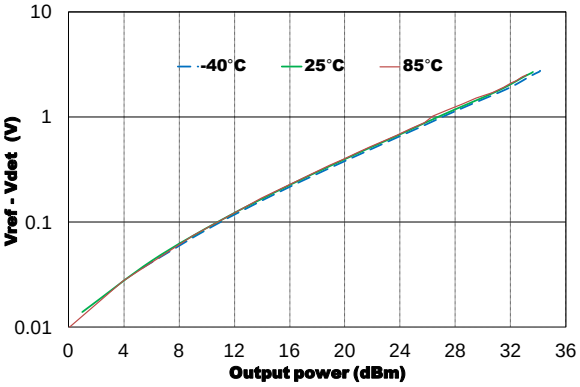
## Typical bord Measurements

Tamb.= +25°C, Vd = +6V, Id = 1300mA

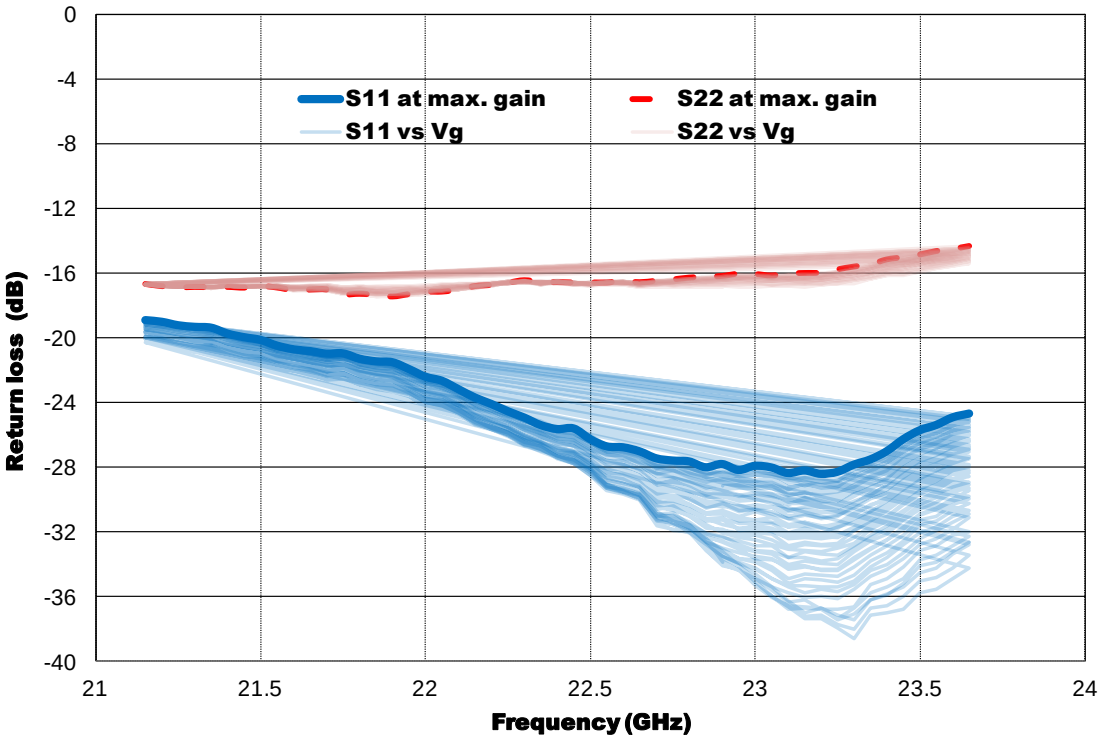
### Power Detector versus Pout & Frequency




### Power Detector versus Pout & Temperature




### Return Losses versus Gain Control



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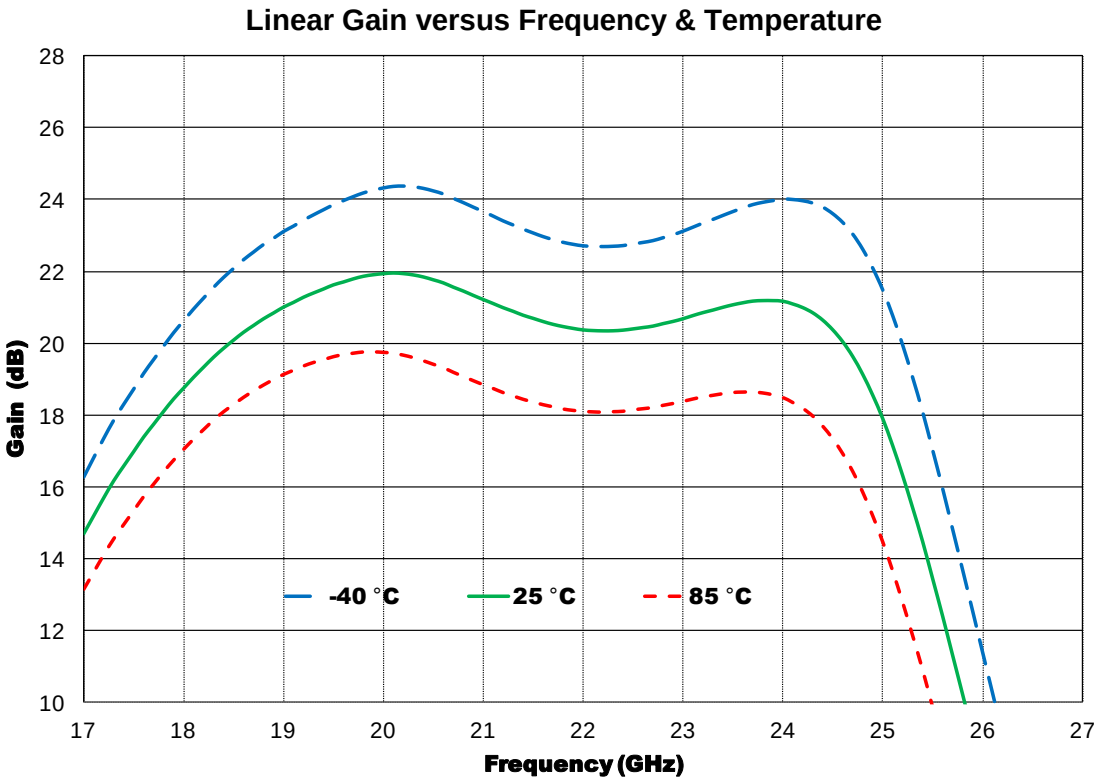
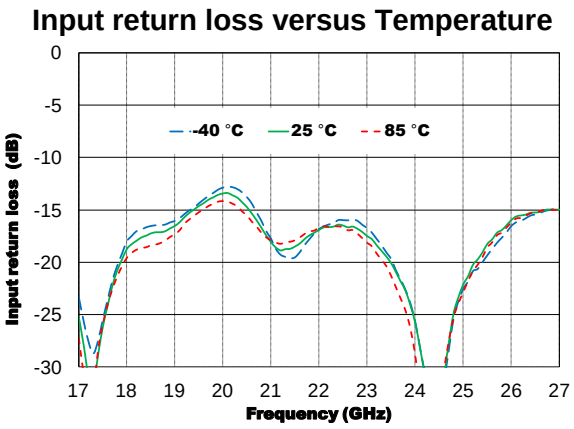
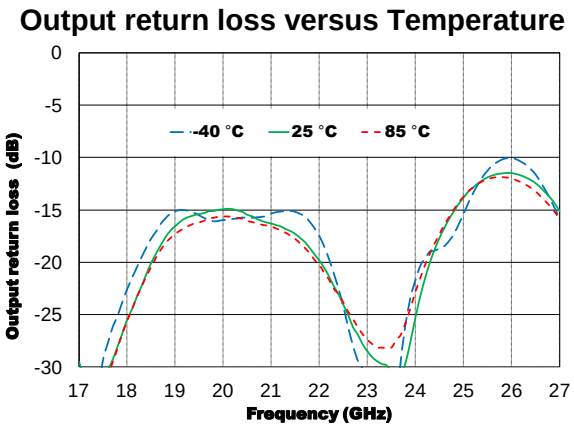
## Typical bord Measurements

Tamb.= +25°C, Vd = +6V, Id = 1300mA



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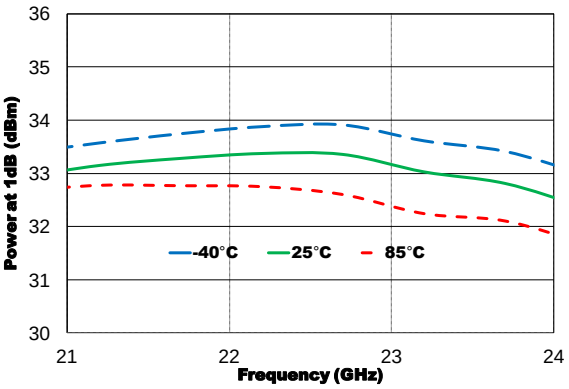
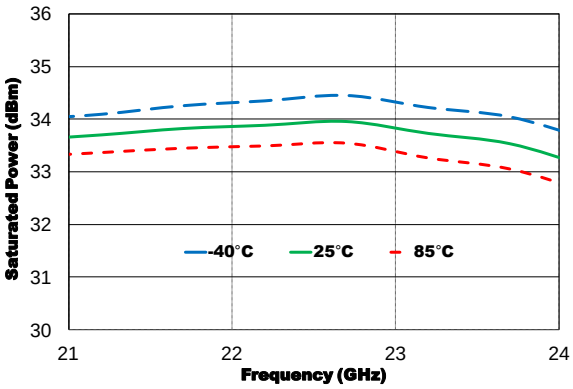
## Typical Board Measurements

Tamb.= +25°C, Vd = +6V, Id = 1300mA

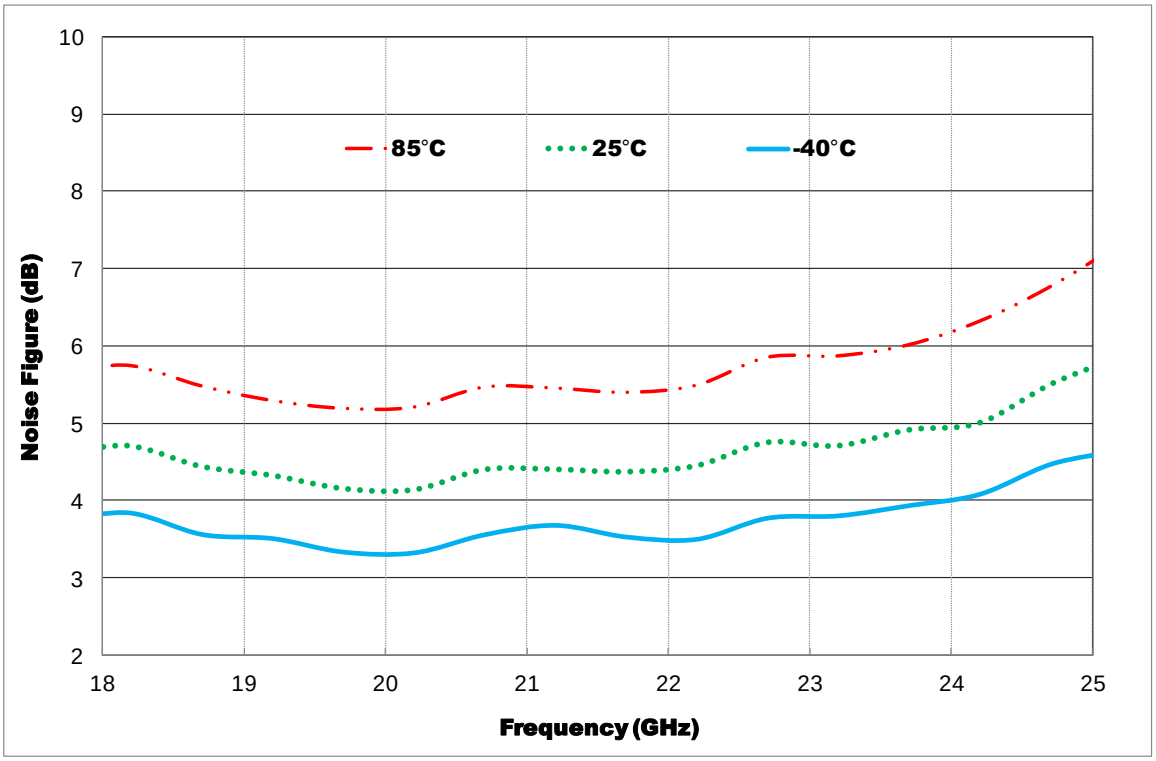
### Power at 1dB compression versus Temperature




### Saturated Power versus Temperature




### Noise Figure versus Frequency & Temperature



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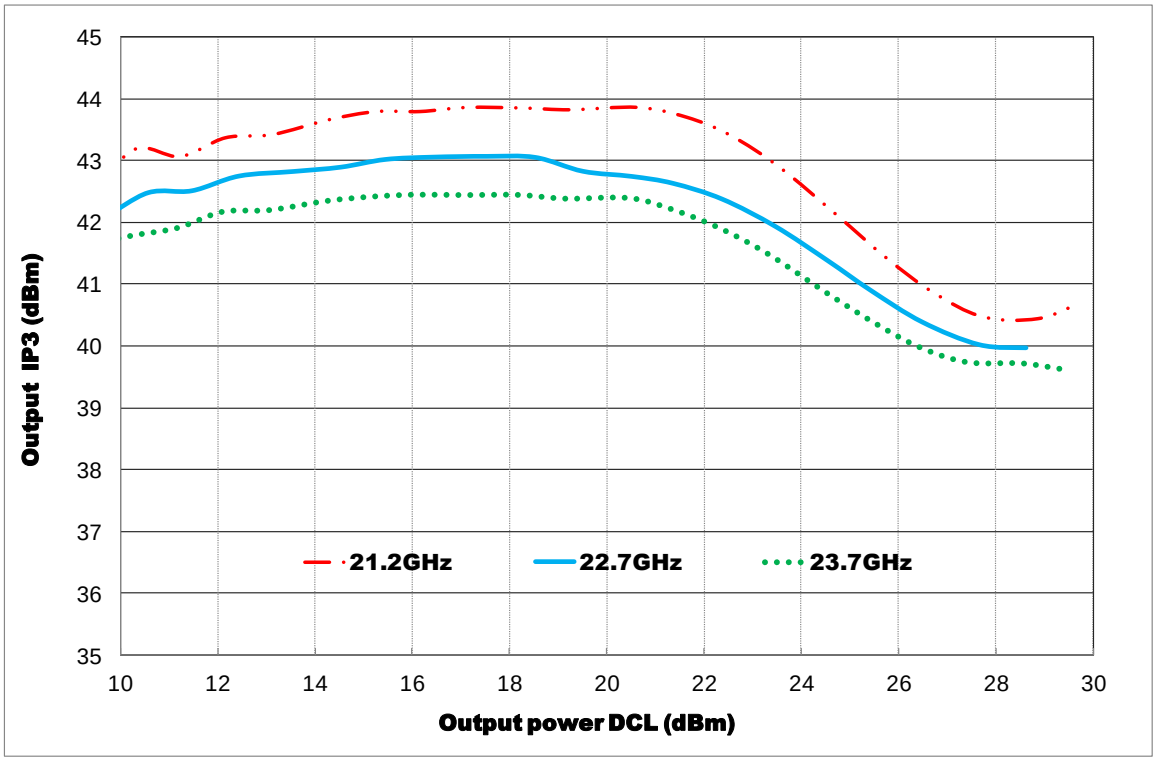
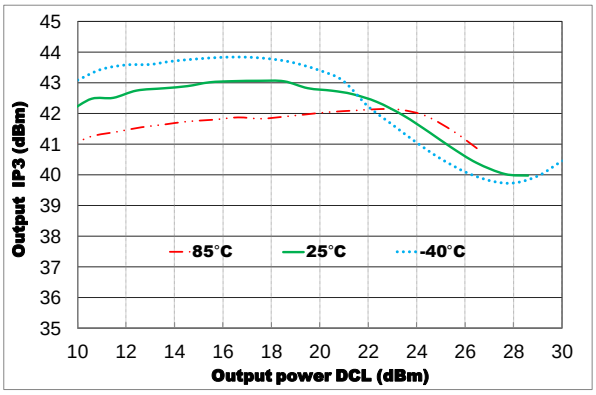
## Typical Board Measurements

Tamb.= +25°C, Vd = +6V, Id = 1300mA

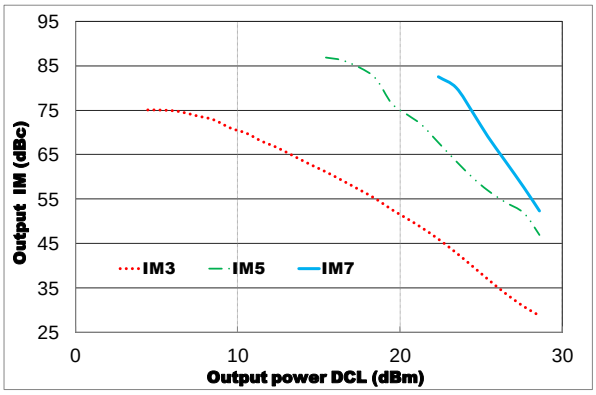
**Output IP3 versus Output Power**




**OIP3 versus temperature**
***at 22.7GHz***




**IMD3 versus Output Power**



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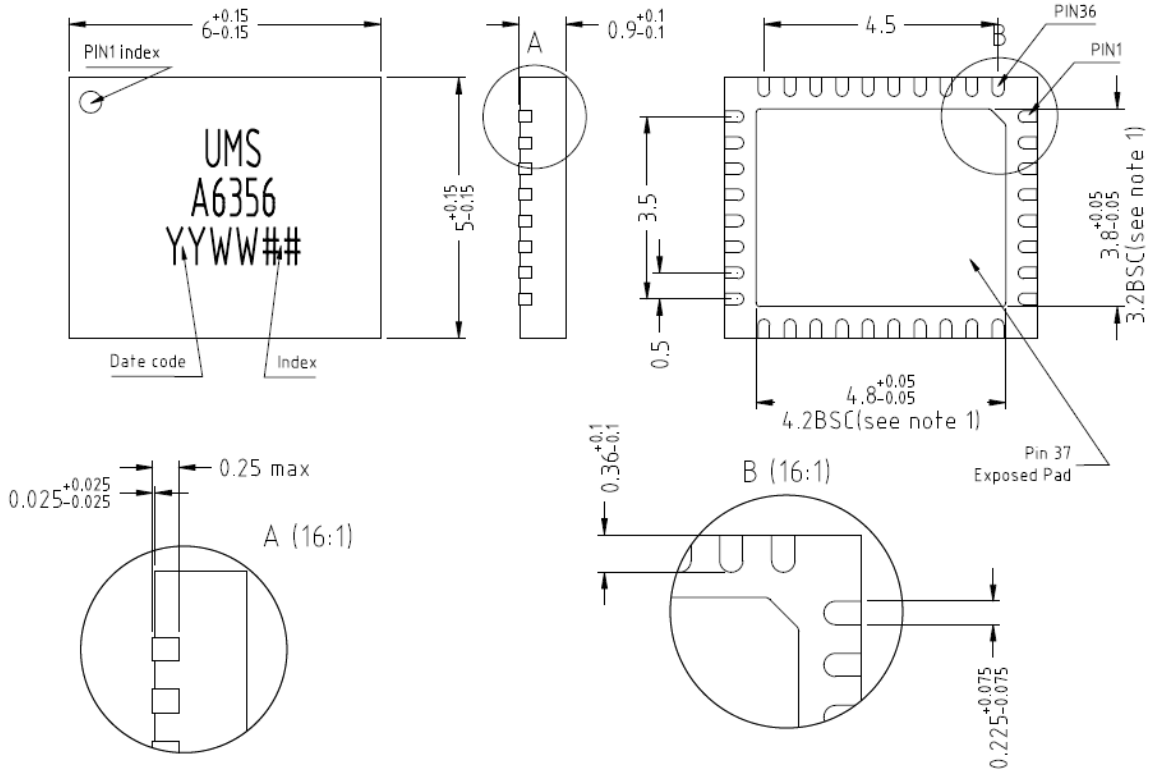
## Package outline (1)




| | | | | |
|---|---|---|---|---|
| Matte tin, Lead Free (Green) | | 1- DC | 13- RF in | 25- Gnd(2) |
| Units : | mm | 2- DET | 14- Gnd(2) | 26- Nc |
| From the standard : | JEDEC MO-220 | 3- VD3 | 15- Nc | 27- Gnd(2) |
| | (VGGD) | 4- VG3 | 16- Nc | 28- Nc |
| 37- | GND | 5- VD2 | 17- Nc | 29- Gnd(2) |
| | | 6- VG2 | 18- Nc | 30- RF out |
| | | 7- VD1 | 19- VG1 | 31- Nc |
| | | 8- VG1 | 20- VD1 | 32- Nc |
| | | 9- Nc | 21- VG2 | 33- Nc |
| | | 10- Nc | 22- VD2 | 34- Nc |
| | | 11- Nc | 23- VG3 | 35- REF |
| | | 12- Nc | 24- VD3 | 36- 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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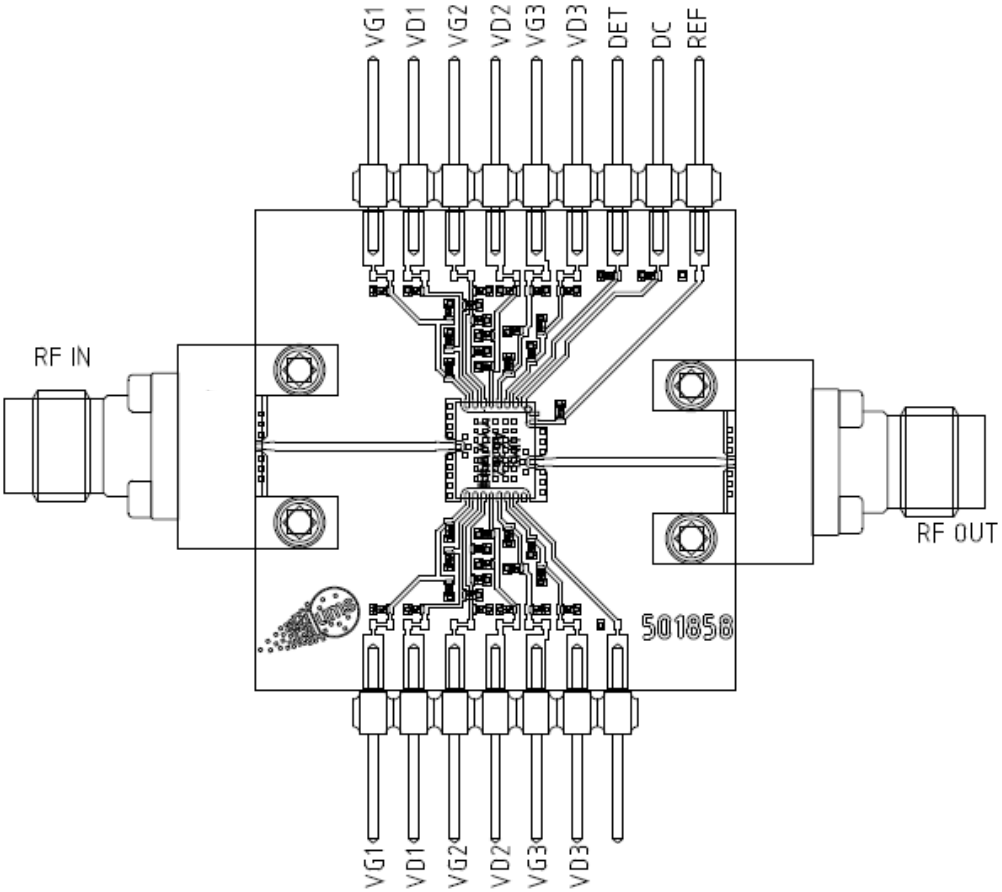
## Evaluation mother board

- Compatible with the proposed footprint.
- Based on typically Ro4350 / 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 ±5%, 10nF ±10% and 1µF ±10% are recommended for all DC accesses.
- A 10KΩ resistor is recommended on VREF & VDET accesses for the detector
- See application note AN0017 for details.



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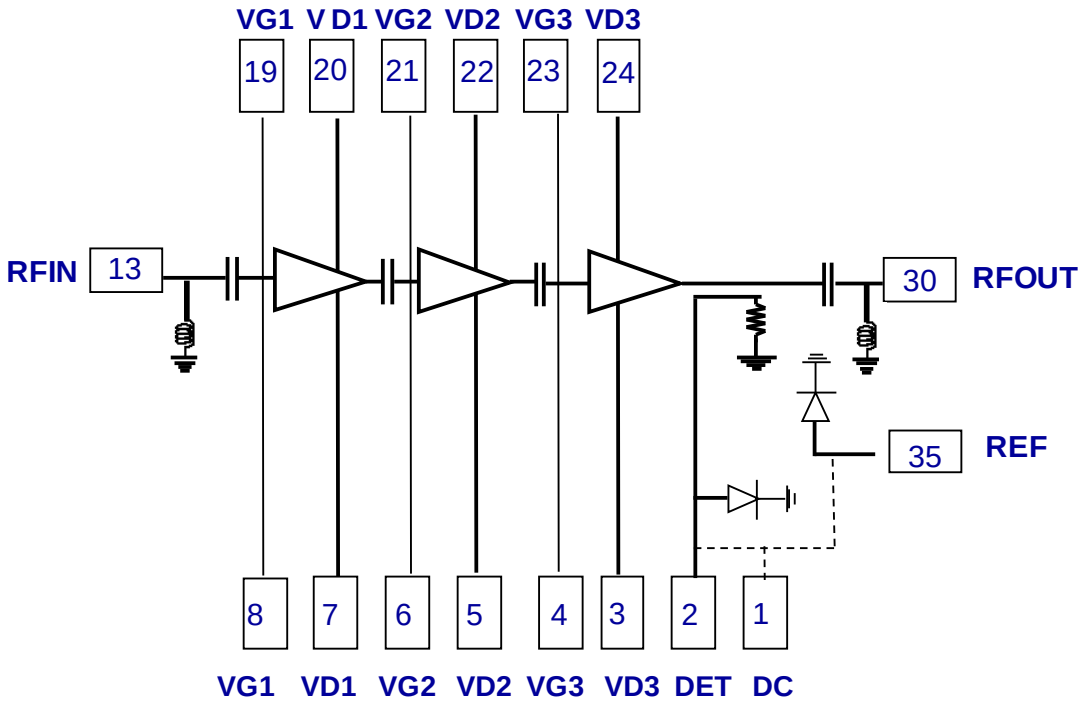
## Notes

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, 10nF, 1µF) on the PC board, as close as possible to the package.

A 10KΩ resistor is recommended in parallel to VDET, and VREF accesses.

The circuit includes ESD protections on all RF and DC leads

## Package Information

| Parameter | Value |
|---|---|
| Package body material | RoHS-compliant |
| | Low stress Injection Molded Plastic |
| Lead finish | 100% matte tin ( Sn) |
| MSL Rating | 3 |



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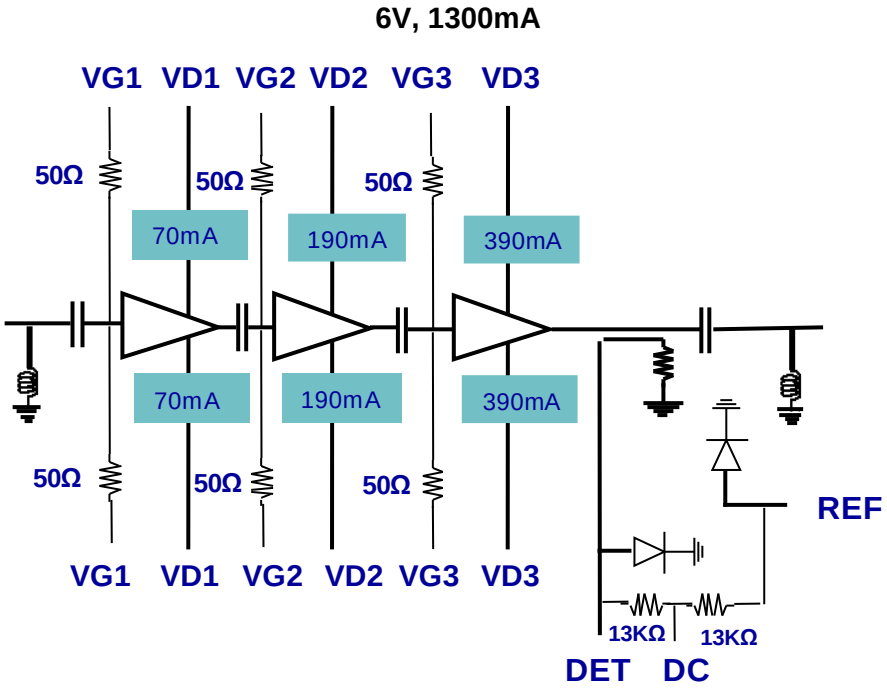
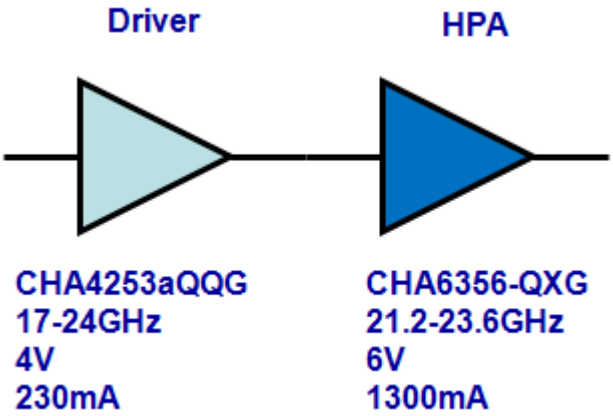
## DC Schematic




## Recommended UMS Power chain

The CHA6356-QXG could be associated with the CHA4253aQQG as driver.
Total Gain: 44dB
Gain control: 30dB with the both amplifiers.
For more information, please see the CHA4253aQQG datasheet.



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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.

## 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 5x6 package: | CHA6356-QXG/XY | |
| | Stick: XY = 20 | Tape & reel: XY = 21 |





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