United Monolithic Semiconductors

# CHA4253aQQG

# 17- 24GHz Medium Power Amplifier

## GaAs Monolithic Microwave IC

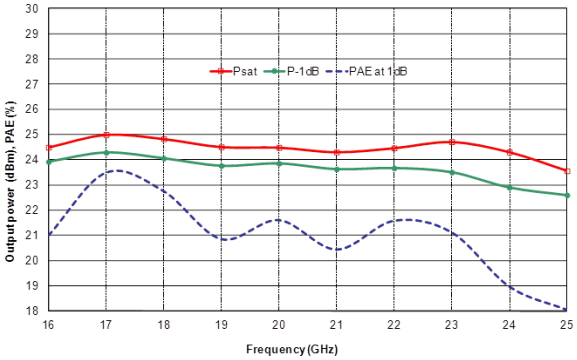
## Description

The CHA4253aQQG is a four stage monolithic medium power amplifier.
It is designed for a wide range of applications, from military to commercial communication systems.
The circuit is manufactured with a pHEMT process, 0.15µm gate length.
It is supplied in RoHS compliant SMD package.


## Main Features

- Broadband performances: 17- 24GHz
- 24dBm Pout for 1dB gain compression
- 23dB gain
- 33dBm OTOI
- DC bias: Vd= 4.0V, Id= 230mA
- QQG- QFN4x4
- MSL1

**Output power & PAE versus Frequency**




## Main Electrical Characteristics

Tamb.= +25°C

| Symbol | Parameter | Min | Typ | Max | Unit |
|---|---|---|---|---|---|
| Freq | Frequency range | 17.0 | | 24.0 | GHz |
| Gain | Linear Gain | | 23 | | dB |
| P-1dB | Output Power @1dB comp. | | 24 | | dBm |
| OTOI | 3rd order Intercept point | | 33 | | dBm |



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## Electrical Characteristics

Tamb.= +25°C, Vd = +4.0V

| Symbol | Parameter | Min | Typ | Max | Unit |
|---|---|---|---|---|---|
| Freq | Frequency range | 17.0 | | 24.0 | GHz |
| Gain | Linear Gain | | 23 | | dB |
| ΔG | Gain variation in temperature | | 0.04 | | dB/°C |
| OTOI | 3rd order Intercept point | | 33 | | dBm |
| $P_{-1dB}$ | Output power @ 1dB compression | | 24 | | dBm |
| Psat | Saturated Output Power | | 24.5 | | dBm |
| RLin | Input Return Loss | | 12 | | dB |
| RLout | Output Return Loss | | 15 | | dB |
| NF | Noise figure | | 7.5 | | dB |
| Id | Quiescent Drain current | | 230 | | mA |
| Vg | Gate voltage | | -0.7 | | V |

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

## Absolute Maximum Ratings (1)

Tamb.= +25°C

| Symbol | Parameter | Values | Unit |
|---|---|---|---|
| Vd | Drain bias voltage | 6V | V |
| Id | Drain bias quiescent current | 300 | mA |
| Vg | Gate bias voltage | -2 to +0.4 | V |
| Pin | Maximum input power | 10 | dBm |
| Tj | Junction temperature (2) | 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) Duration < 1s.

## Typical Bias Conditions

Tamb.= +25°C

| Symbol | Pad N° | Parameter | Values | Unit |
|---|---|---|---|---|
| Vd12 | 6 | DC Drain voltage 1st, 2nd stage | 4 | V |
| Vd34 | 7 | DC Drain voltage 3rd, 4th stage | 4 | V |
| Vg12 | 16 | DC Gate voltage 1st & 2nd stage | -0.7 | V |
| Vg34 | 14 | DC Gate voltage 3rd & 4th stage | -0.7 | 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.

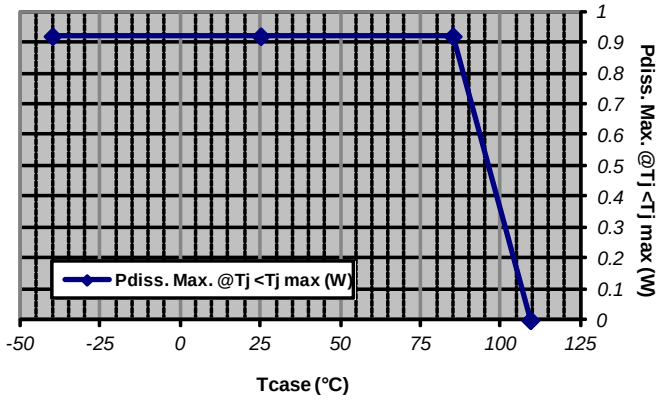
A derating must be applied on the dissipated power if the Tcase temperature can not be maintained below the maximum specified temperature (see the curve Pdiss. Max) in order to guarantee the nominal device life time (MTTF).

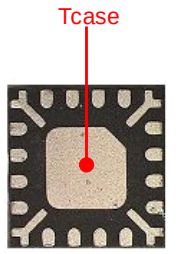
| DEVICE THERMAL SPECIFICATION : CHA4253aQQG | | | |
|---|---|---|---|
| Recommended max. junction temperature (Tj max) | : | 109 | °C |
| Junction temperature absolute maximum rating | : | 175 | °C |
| Max. continuous dissipated power (Pdiss. Max.) | : | 0.9 | W |
| => Pdiss. Max. derating above Tcase(1)= 85 °C | : | 38 | mW/°C |
| Junction-Case thermal resistance (Rth J-C)(2) | : | <26 | °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

6.4



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## Typical Package Sij parameters

Tamb.= +25°C, Vd = +4.0V, Id = 230mA

| Freq (GHz) | S11 (dB) | PhS11 (°) | S12 (dB) | PhS12 (°) | S21 (dB) | PhS21 (°) | S22 (dB) | PhS22 (°) |
|---|---|---|---|---|---|---|---|---|
| 2 | -0.730 | 123.2 | -63.711 | -6.2 | -69.063 | -19.0 | -0.761 | 122.7 |
| 2.5 | -0.818 | 108.9 | -60.605 | 32.4 | -62.846 | 45.7 | -0.824 | 107.8 |
| 3 | -0.889 | 93.9 | -80.897 | -91.2 | -63.457 | -101.8 | -0.871 | 92.9 |
| 3.5 | -0.991 | 78.5 | -60.653 | 0.0 | -63.035 | 0.0 | -0.926 | 76.8 |
| 4 | -1.122 | 62.7 | -82.251 | 151.3 | -71.708 | 12.1 | -1.013 | 60.6 |
| 4.5 | -1.313 | 46.1 | -71.038 | 17.2 | -64.931 | 159.5 | -1.105 | 43.5 |
| 5 | -1.612 | 29.2 | -67.796 | -42.8 | -55.944 | -159.0 | -1.178 | 25.6 |
| 5.5 | -2.064 | 13.5 | -84.782 | -143.9 | -37.521 | 105.8 | -1.258 | 7.0 |
| 6 | -2.252 | -2.3 | -71.634 | 179.9 | -29.698 | 13.5 | -1.365 | -13.0 |
| 6.5 | -2.374 | -18.8 | -86.383 | 9.9 | -25.728 | -54.4 | -1.466 | -34.4 |
| 7 | -2.411 | -35.5 | -76.642 | 85.1 | -22.287 | -108.9 | -1.587 | -56.4 |
| 7.5 | -2.553 | -53.4 | -65.973 | 16.6 | -19.062 | -156.7 | -1.689 | -79.6 |
| 8 | -2.807 | -73.4 | -57.797 | -35.6 | -15.918 | 156.3 | -1.895 | -105.8 |
| 8.5 | -3.106 | -92.5 | -61.487 | -72.0 | -13.083 | 112.8 | -2.119 | -131.9 |
| 9 | -3.437 | -111.1 | -58.268 | -112.3 | -10.411 | 70.6 | -2.569 | -158.7 |
| 9.5 | -3.744 | -129.8 | -53.604 | -159.7 | -7.919 | 30.1 | -3.050 | 175.5 |
| 10 | -4.119 | -148.9 | -52.704 | 154.8 | -5.729 | -9.6 | -3.768 | 150.1 |
| 10.5 | -4.624 | -167.6 | -51.720 | 128.3 | -3.607 | -47.9 | -4.610 | 124.2 |
| 11 | -5.000 | 174.6 | -51.281 | 98.9 | -1.635 | -84.6 | -5.691 | 99.1 |
| 11.5 | -5.412 | 155.5 | -51.977 | 85.1 | 0.380 | -120.5 | -6.935 | 75.3 |
| 12 | -6.006 | 137.4 | -52.427 | 71.2 | 2.321 | -155.2 | -8.434 | 51.2 |
| 12.5 | -6.561 | 119.3 | -54.460 | 58.2 | 4.409 | 170.5 | -10.254 | 27.7 |
| 13 | -7.192 | 101.3 | -52.056 | 58.2 | 6.459 | 136.3 | -12.708 | 5.0 |
| 13.5 | -7.821 | 83.3 | -51.474 | 52.7 | 8.618 | 102.4 | -15.917 | -17.6 |
| 14 | -8.574 | 66.0 | -49.641 | 30.7 | 10.961 | 68.3 | -21.061 | -41.1 |
| 14.5 | -9.476 | 50.2 | -52.379 | 26.7 | 13.479 | 33.2 | -36.427 | -69.4 |
| 15 | -10.598 | 37.2 | -49.987 | 19.8 | 16.282 | -3.3 | -25.516 | 100.2 |
| 15.5 | -11.463 | 26.8 | -50.339 | 10.8 | 19.272 | -44.5 | -17.628 | 73.8 |
| 16 | -12.173 | 20.0 | -49.840 | -4.0 | 21.933 | -90.8 | -14.862 | 46.8 |
| 16.5 | -12.377 | 17.9 | -49.950 | -14.7 | 23.964 | -142.6 | -13.179 | 28.7 |
| 17 | -11.523 | 13.9 | -50.695 | -42.6 | 24.674 | 164.5 | -11.997 | 5.4 |
| 17.5 | -10.464 | 2.8 | -52.234 | -56.5 | 24.263 | 116.0 | -12.390 | -17.8 |
| 18 | -10.569 | -11.6 | -72.354 | -15.8 | 24.017 | 74.4 | -14.325 | -24.0 |
| 18.5 | -11.713 | -19.2 | -57.420 | 33.1 | 23.906 | 32.9 | -13.449 | -27.4 |
| 19 | -11.467 | -22.2 | -56.914 | 13.9 | 23.424 | -6.2 | -13.393 | -37.2 |
| 19.5 | -11.136 | -28.8 | -54.933 | -2.0 | 23.237 | -43.4 | -14.040 | -43.4 |
| 20 | -10.861 | -39.1 | -53.015 | 1.5 | 23.489 | -79.4 | -13.984 | -48.0 |
| 20.5 | -10.972 | -49.8 | -52.555 | 7.8 | 23.585 | -117.4 | -14.192 | -52.3 |
| 21 | -11.122 | -63.0 | -52.100 | -17.7 | 23.717 | -155.5 | -13.594 | -56.0 |
| 21.5 | -12.282 | -73.8 | -49.378 | -12.2 | 23.677 | 166.7 | -13.879 | -66.0 |
| 22 | -13.692 | -84.9 | -47.135 | -18.4 | 23.695 | 129.6 | -14.959 | -70.5 |
| 22.5 | -15.153 | -87.1 | -49.422 | 11.2 | 24.074 | 93.9 | -15.768 | -52.8 |
| 23 | -17.851 | -88.8 | -44.268 | -34.4 | 24.814 | 53.8 | -13.893 | -55.7 |
| 23.5 | -19.454 | -73.3 | -43.006 | -46.5 | 25.271 | 12.9 | -12.633 | -56.1 |
| 24 | -18.605 | -51.9 | -47.877 | -47.5 | 26.081 | -32.6 | -13.531 | -67.6 |
| 24.5 | -15.959 | -40.6 | -46.682 | -66.3 | 26.115 | -82.2 | -12.795 | -49.3 |
| 25 | -11.350 | -46.7 | -47.170 | -53.9 | 25.590 | -134.0 | -8.978 | -47.8 |
| 25.5 | -8.897 | -63.9 | -49.365 | -43.8 | 23.981 | 172.9 | -5.884 | -61.9 |



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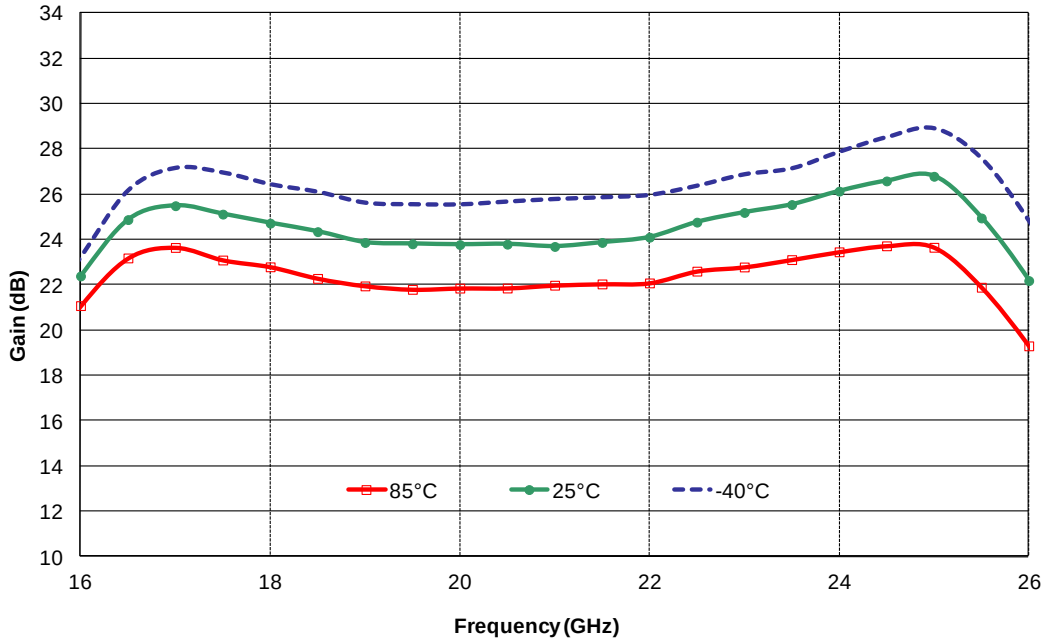
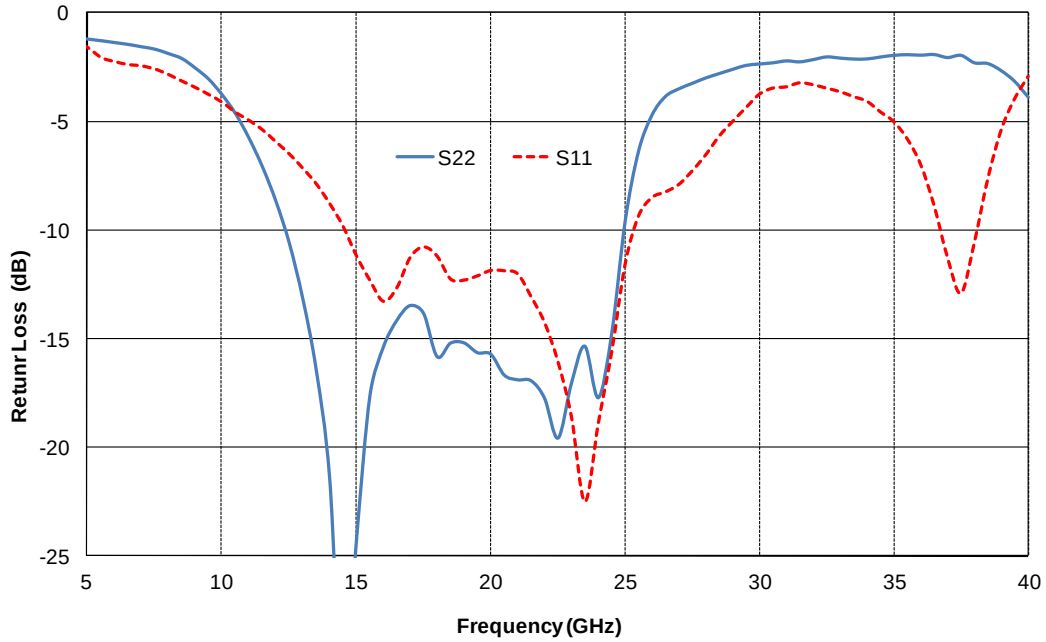
## Typical Board Measurements

Tamb.= +25°C, Vd = +4.0V, Id = 230mA
These values are representative of onboard measurements as defined on the drawing in paragraph "Evaluation mother board".

**Linear Gain versus Frequency in Temperature**




**Return losses versus Frequency**



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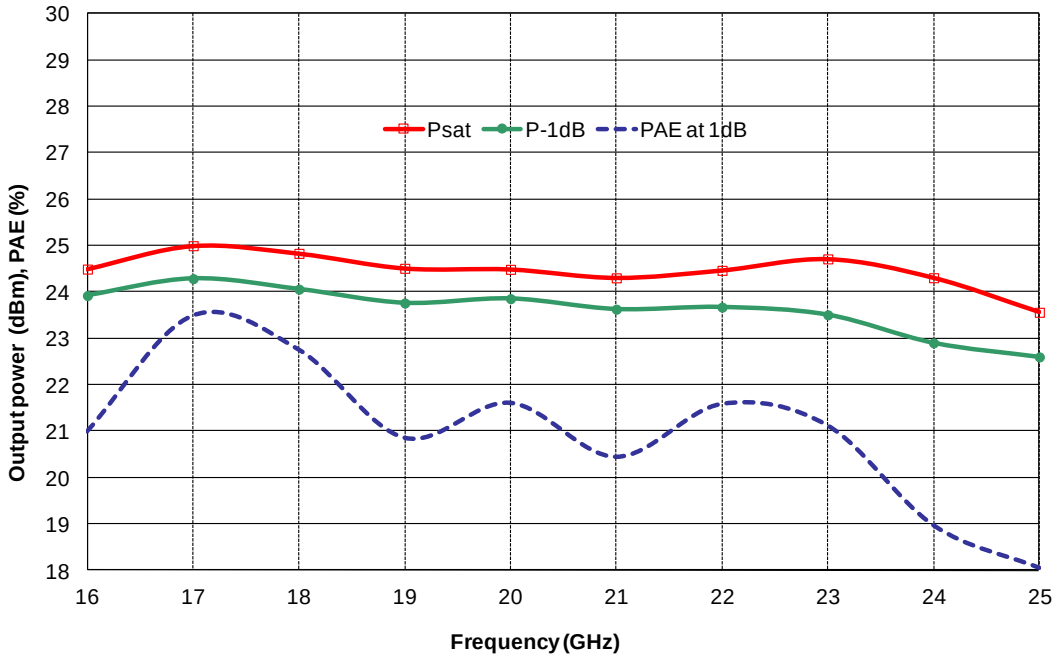
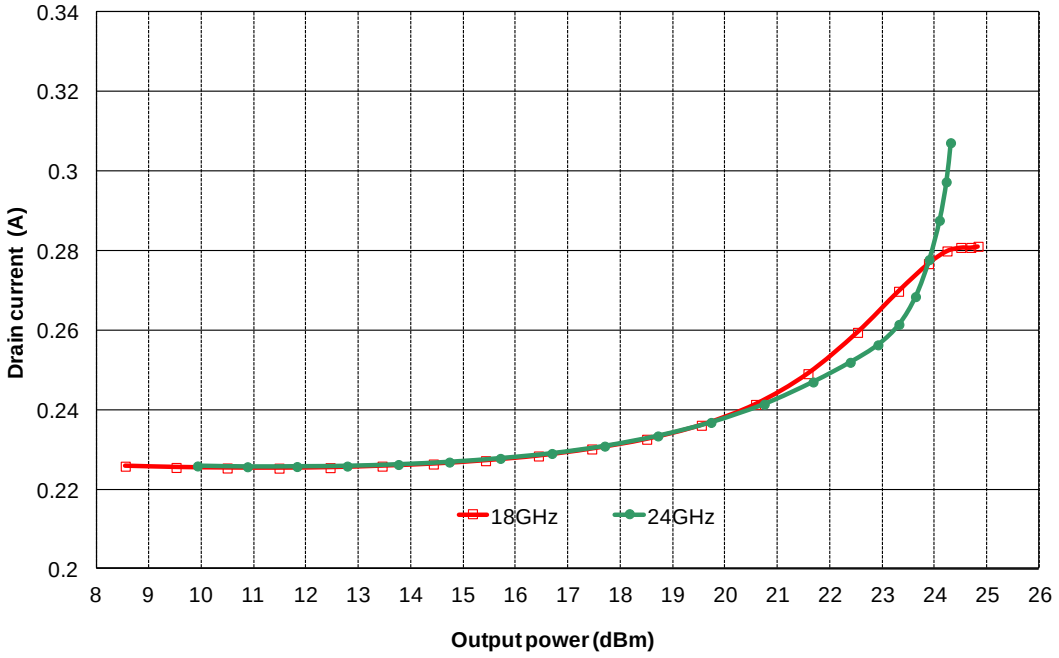
## Typical Board Measurements

Tamb.= +25°C, Vd = +4.0V, Id = 230mA

**Output power & PAE versus Frequency**




**Current versus Output Power**



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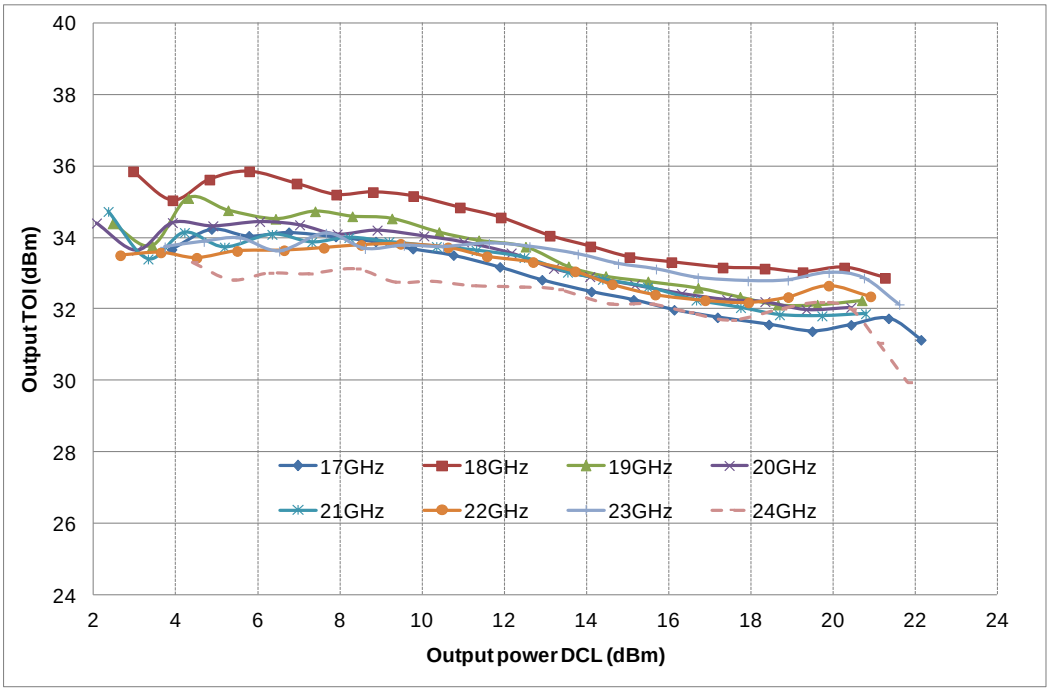
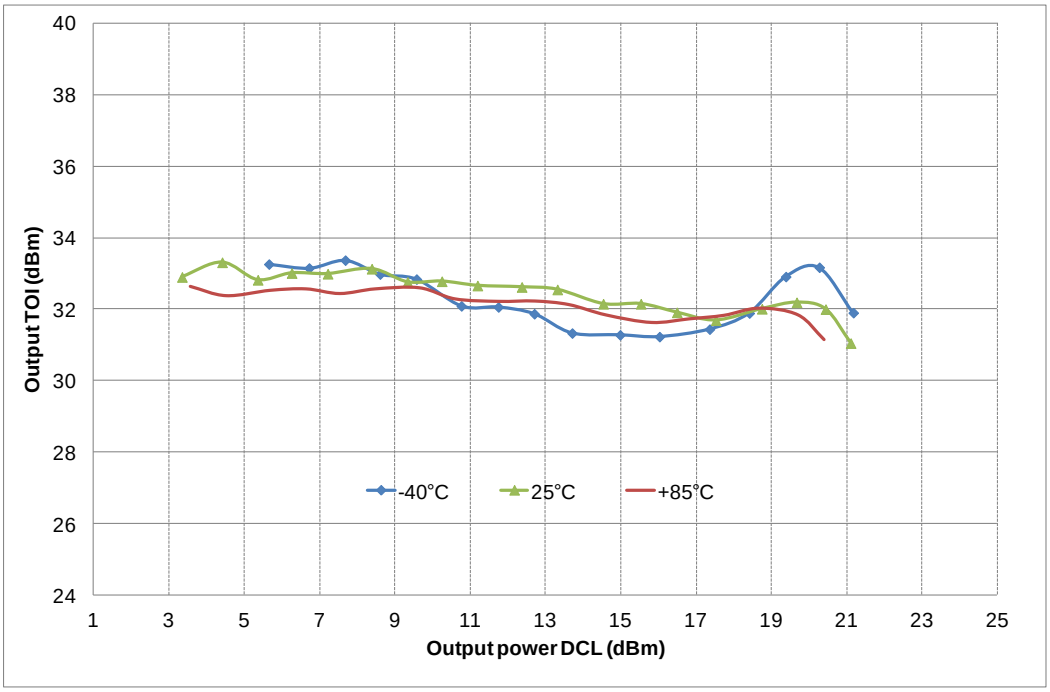
## Typical Board Measurements

Tamb.= +25°C, Vd = +4.0V, Id = 230mA

**Output TOI versus Output Power DCL & Frequency**




**Output TOI versus Output Power DCL in Temperature at 24GHz**



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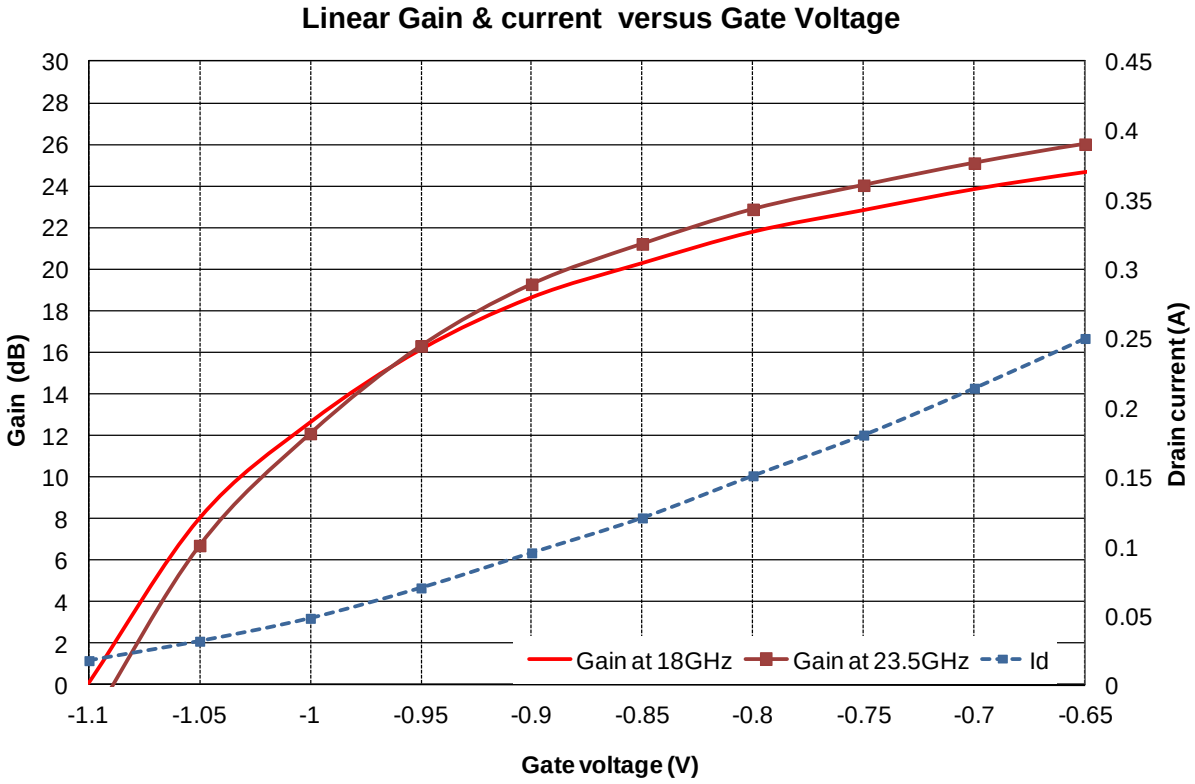
## Typical Board Measurements

Tamb.= +25°C, Vd = +4.0V, Id = 230mA



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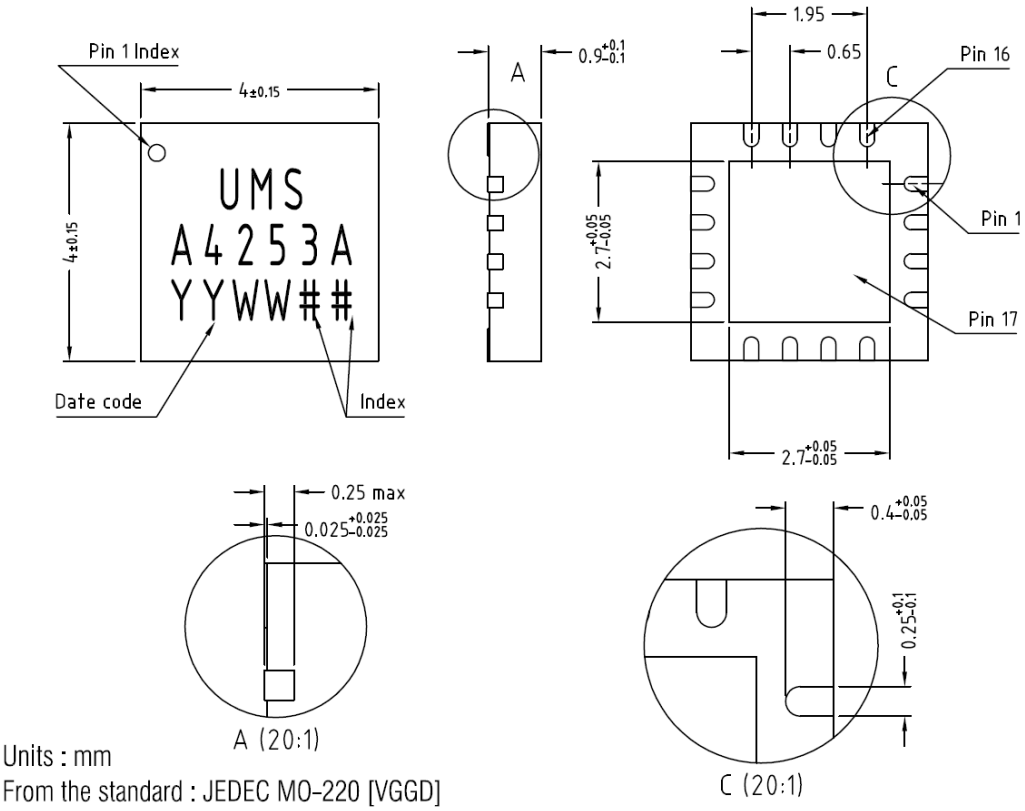
## Package outline (1)




Units : mm
From the standard : JEDEC MO-220 [VGGD]
Matt tin, Lead free (Green)

| | | | | |
|---|---|---|---|---|
| Matt tin, Lead Free | (Green) | 1- NC | 7- Vd34 | 13- NC |
| Units : | mm | 2- Gnd(2) | 8- NC | 14- Vg34 |
| From the standard : | JEDEC MO-220 | 3- RF IN | 9- NC | 15- Nc |
| | (VGGD) | 4- NC | 10- Gnd(2) | 16- Vg12 |
| 17- | GND | 5- Gnd(2) | 11- RF OUT | |
| | | 6- Vd12 | 12- NC | |

(1) The package outline drawing included in this data-sheet is given for indication. Refer to the application note AN0017 (http://www.ums-gaas.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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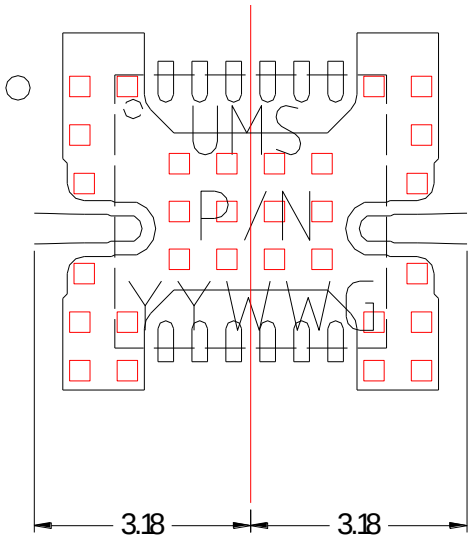
## Definition of the Sij reference planes

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 3.18mm 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 mother 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% matte Sn |
| MSL Rating | MSL1 |



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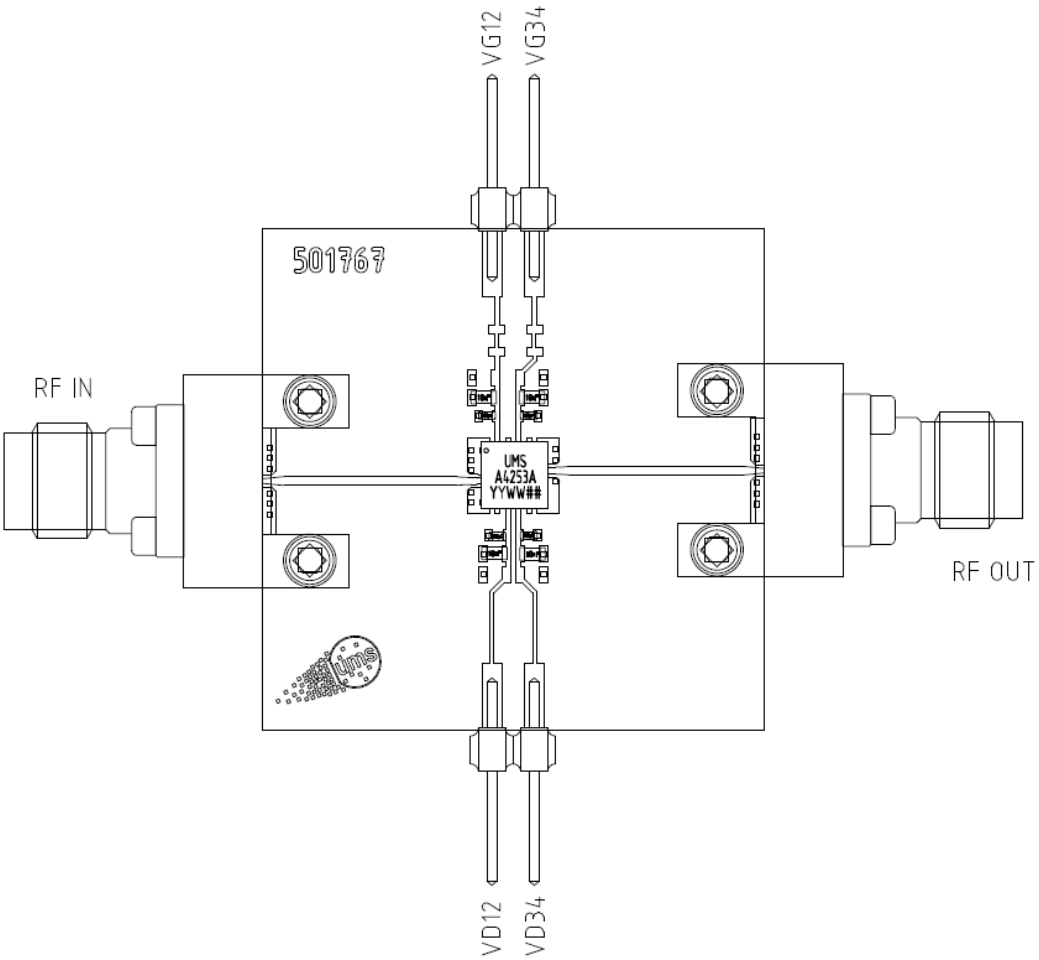
## Evaluation mother board

- 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% and 10nF ±10% are recommended for all DC accesses.
- See application note AN0017 for details.



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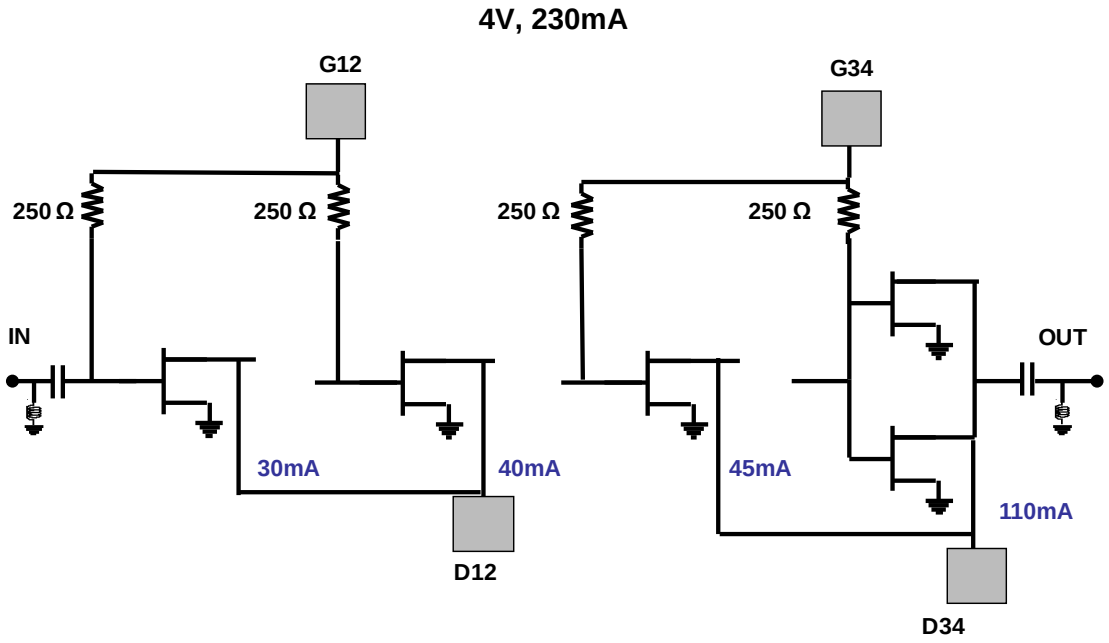
## DC Schematic



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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) 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 http://www.ums-gaas.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 http://www.ums-gaas.com.

## Recommended ESD management

Refer to the application note AN0020 available at http://www.ums-gaas.com for ESD sensitivity and handling recommendations for the UMS package products.

## Ordering Information

| | | |
|---|---|---|
| QFN 4x4 package: | CHA4253aQQG/XY | |
| | Stick: XY = 20 | Tape & reel: XY = 21 |





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