

## 20-30GHz Medium Power Amplifier

### GaAs Monolithic Microwave IC in SMD package

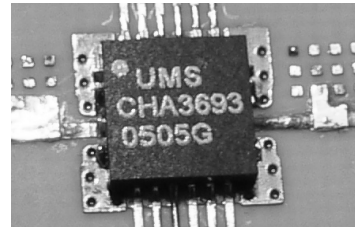
#### Description

The CHA3693-QDG is a high gain broadband 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 PM-HEMT process: 0.15µm gate length.

It is supplied in RoHS compliant SMD package.

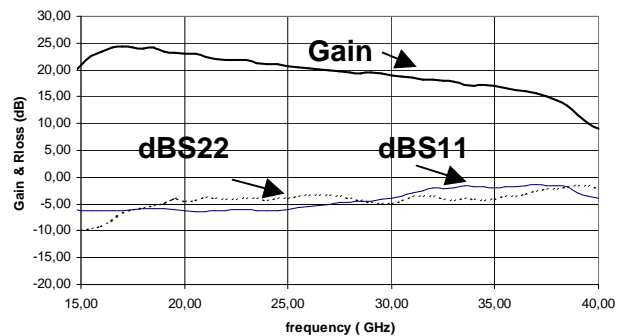
CHA3693-QDG on a Board



#### Main Features

- Broadband performance 20-30GHz
- 20dBm output power
- 20dB gain
- 330mA Low DC power consumption
- 28dBm 3<sup>rd</sup> order intercept point
- Output power level detector
- 24L-QFN4x4 SMD package

Typical measurements  
Gain & Rloss (dB)



#### Main Characteristics

Tamb = +25°C, Vd= +3,5V Id=330mA

| Symbol | Parameter                                   | Min  | Typ  | Max | Unit |
|--------|---|------|------|-----|------|
| Fop    | Operating Frequency range                   | 20   |      | 30  | GHz  |
| G      | Smal signal Gain                            | 18   | 20   |     | dB   |
| IP3    | 3rd order intercept point (Pin/tone=-10dBm) | 26.5 | 27.5 |     | dBm  |
| Id     | Bias current                                |      | 330  | 400 | mA   |

ESD Protections: Electrostatic discharge sensitive device observe handling precautions!

**Electrical Characteristics\***T<sub>amb</sub> = +25°C, V<sub>d</sub> = +3,5V I<sub>d</sub> = 330mA

| Symbol         | Parameter  | Min       | Typ  | Max       | Unit |
|----------------|--|-----------|------|-----------|------|
| Fop            | Operating frequency range                                | <b>20</b> |      | <b>25</b> | GHz  |
| G              | Gain   | 20        | 21   |           | dB   |
| ΔG             | Gain flatness  |           | ±1.5 | ±2        | dB   |
| I <sub>s</sub> | Reverse isolation  |           | 50   |           | dB   |
| S11            | Input return loss  |           | -7   | -5        | dB   |
| S22            | Output return loss                                       |           | -4   | -3        | dB   |
| IP3            | 3rd order intercept point (P <sub>in</sub> /tone=-10dBm) | 26.5      | 27.5 |           | dBm  |
| P1dB           | Output power at 1dB gain compression                     | 17        | 18   |           | dBm  |
| NF             | Noise Figure   |           | 8    | 10        | dB   |
| V <sub>d</sub> | Drain bias voltage (Lead D & D1)                         |           | 3.5  |           | V    |
| I <sub>d</sub> | Drain bias current (small signal)                        |           | 330  | 400       | mA   |

| Symbol         | Parameter  | Min       | Typ  | Max       | Unit |
|----------------|--|-----------|------|-----------|------|
| Fop            | Operating frequency range                                | <b>25</b> |      | <b>30</b> | GHz  |
| G              | Gain   | 18        | 20   |           | dB   |
| ΔG             | Gain flatness  |           | ±1.5 | ±2        | dB   |
| I <sub>s</sub> | Reverse isolation  |           | 45   |           | dB   |
| S11            | Input return loss  |           | -5   | -3        | dB   |
| S22            | Output return loss                                       |           | -4   | -3        | dB   |
| IP3            | 3rd order intercept point (P <sub>in</sub> /tone=-10dBm) | 26.5      | 27.5 |           | dBm  |
| P1dB           | Output power at 1dB gain compression                     | 17        | 18   |           | dBm  |
| NF             | Noise Figure   |           | 8    | 10        | dB   |
| V <sub>d</sub> | Drain bias voltage (Lead D & D1)                         |           | 3.5  |           | V    |
| I <sub>d</sub> | Drain bias current                                       |           | 330  | 400       | mA   |

\*These values are representative of onboard measurements as defined on the drawing 95541 (see below).

Performances can be optimized thanks to external matching (refer to the "Sub-band enhancement" section below).

**Absolute Maximum Ratings (1)**

Tamb = +25°C

| Symbol | Parameter (1)                      | Values      | Unit |
|--------|------------------------------------|-------------|------|
| Vd     | Drain bias voltage                 | 4           | V    |
| Ids    | Drain bias current_small signal    | 470         | mA   |
| Vgs    | Gate bias voltage                  | -2 to +0.4  | V    |
| Vds    | Drain Gate voltage (vds-Vgs)       | +5          | V    |
| Pin    | Maximum continous input power      | +4          | dBm  |
|        | Maximum peak input power overdrive | +15         |      |
| Tj     | Junction temperature (2)           | 175         | °C   |
| Ta     | Operating temperature range        | -40 to +85  | °C   |
| Tstg   | Storage temperature range          | -55 to +125 | °C   |

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

(2) Thermal Resistance channel to ground paddle= 82.4 °C/W for Tamb. = +85°C (Vd= 3.5V, Id=330mA)

## Typical Package Sij parameters

Tamb = +25°C, Vd= +3.5V Id=330mA (vg ≈-0.3V)

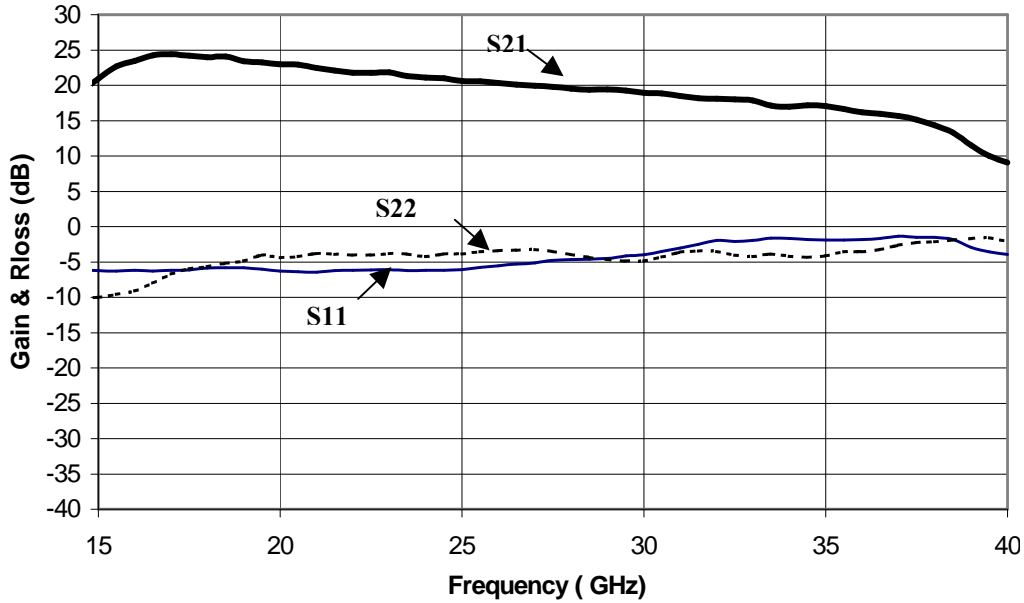
| F(GHz) | S11<br>dB | S11<br>/° | S12<br>dB | S12<br>/° | S21<br>dB | S21<br>/° | S22<br>dB | S22<br>/° |
|--------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|
| 2      | -8,83     | -88,13    | -69,83    | -126,88   | -40,54    | 8,83      | -0,11     | -36,92    |
| 4      | -8,83     | -0,68     | -73,27    | 68,20     | -40,72    | -39,81    | -0,28     | -73,87    |
| 6      | -8,64     | 91,54     | -64,31    | 37,06     | -34,09    | -107,22   | -0,34     | -111,83   |
| 8      | -7,72     | -157,53   | -55,69    | 6,81      | -30,27    | -166,33   | -0,40     | -156,81   |
| 10     | -7,30     | -68,95    | -68,59    | 20,62     | -22,09    | -142,85   | -1,42     | 147,70    |
| 12     | -6,49     | 37,98     | -63,63    | -32,07    | 2,12      | 127,18    | -4,84     | 82,30     |
| 14     | -5,95     | 143,74    | -73,37    | 100,59    | 15,68     | -16,16    | -9,02     | 46,38     |
| 16     | -5,95     | -106,60   | -52,40    | 93,68     | 22,74     | -163,39   | -8,61     | 19,87     |
| 18     | -5,99     | 3,79      | -62,93    | -178,84   | 23,87     | 61,71     | -5,02     | -25,84    |
| 20     | -6,36     | 108,06    | -55,89    | 59,05     | 22,93     | -47,72    | -4,18     | -66,46    |
| 21     | -6,74     | 166,91    | -46,87    | 45,01     | 22,66     | -99,88    | -3,86     | -87,22    |
| 22     | -6,27     | -139,16   | -51,98    | 46,66     | 21,92     | -145,39   | -3,97     | -103,46   |
| 23     | -6,16     | -80,70    | -48,96    | 16,37     | 21,92     | 169,12    | -3,79     | -116,84   |
| 24     | -6,34     | -23,12    | -46,99    | 7,56      | 21,31     | 124,36    | -4,24     | -132,57   |
| 25     | -6,40     | 36,28     | -48,16    | 13,94     | 20,87     | 81,78     | -4,09     | -141,94   |
| 26     | -5,93     | 96,58     | -43,73    | -4,41     | 20,66     | 37,50     | -3,49     | -154,57   |
| 27     | -5,36     | 153,39    | -42,94    | -26,86    | 20,13     | -2,95     | -3,24     | -168,83   |
| 28     | -4,98     | -148,47   | -44,76    | -35,38    | 19,78     | -45,91    | -3,76     | 177,81    |
| 29     | -4,86     | -86,47    | -41,29    | -37,25    | 19,78     | -86,23    | -4,50     | 167,74    |
| 30     | -4,36     | -27,89    | -41,52    | -61,53    | 19,32     | -129,26   | -4,80     | 163,72    |
| 31     | -3,36     | 32,62     | -38,66    | -77,90    | 18,76     | -173,86   | -4,09     | 156,85    |
| 32     | -2,64     | 92,69     | -41,19    | -158,77   | 18,17     | 149,82    | -3,28     | 145,38    |
| 33     | -2,24     | 145,64    | -47,12    | 164,10    | 18,29     | 101,76    | -4,01     | 136,30    |
| 34     | -1,89     | -155,52   | -47,97    | 121,51    | 17,46     | 62,12     | -4,02     | 125,27    |
| 35     | -2,14     | -101,63   | -46,70    | -44,11    | 16,98     | 16,48     | -4,72     | 127,84    |
| 36     | -2,36     | -44,96    | -42,01    | -104,03   | 16,39     | -29,52    | -3,21     | 120,85    |
| 37     | -2,03     | 14,77     | -42,49    | -123,02   | 15,72     | -77,36    | -2,78     | 113,07    |
| 38     | -2,62     | 69,17     | -40,73    | -160,86   | 14,25     | -128,68   | -2,22     | 103,43    |
| 39     | -4,20     | 121,07    | -46,80    | -168,39   | 11,71     | 179,68    | -1,61     | 89,83     |
| 40     | -5,39     | -164,92   | -50,85    | -73,02    | 9,73      | 131,26    | -2,18     | 72,52     |

Refer to the “definition of the Sij reference planes” section below.

Typical PCB Measured Performance

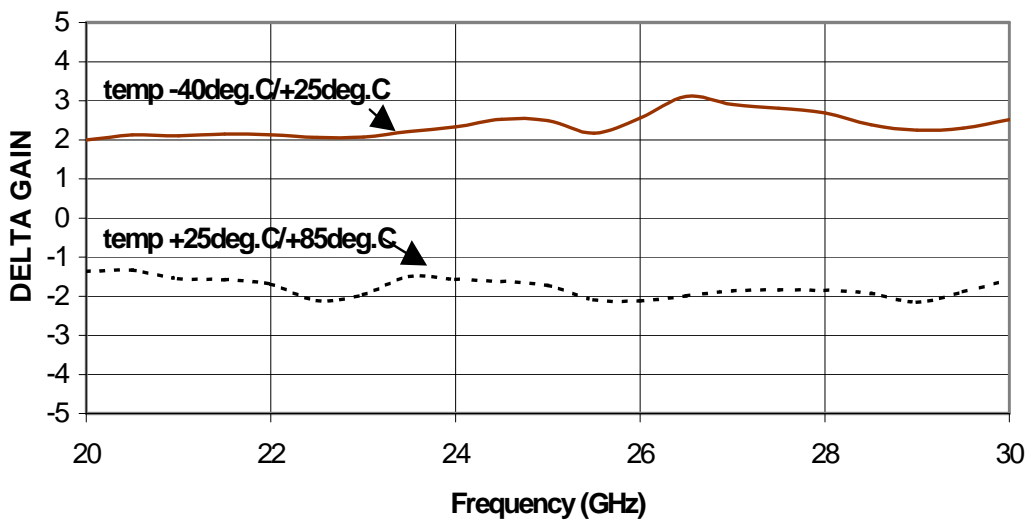
Tamb = +25°C, Vd= +3.5V Id=330mA

Sij parameters

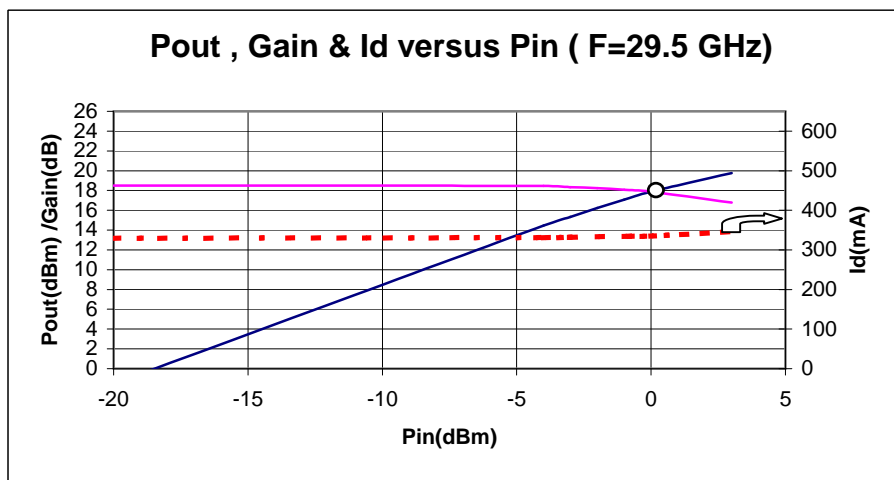
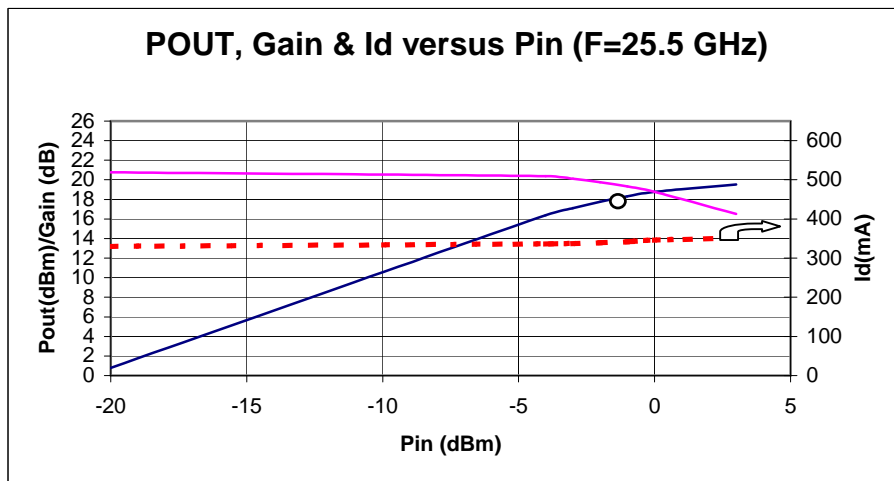
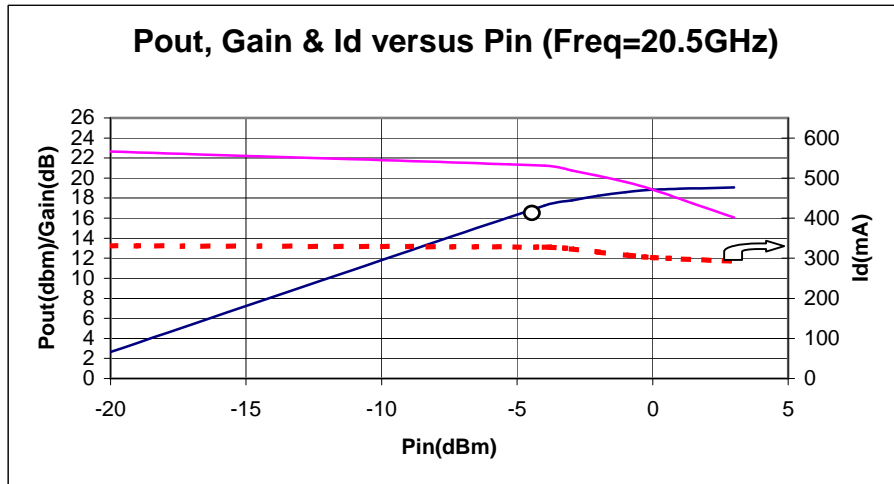


Gain and Losses in the package access planes, using the proposed land pattern & board 95541.

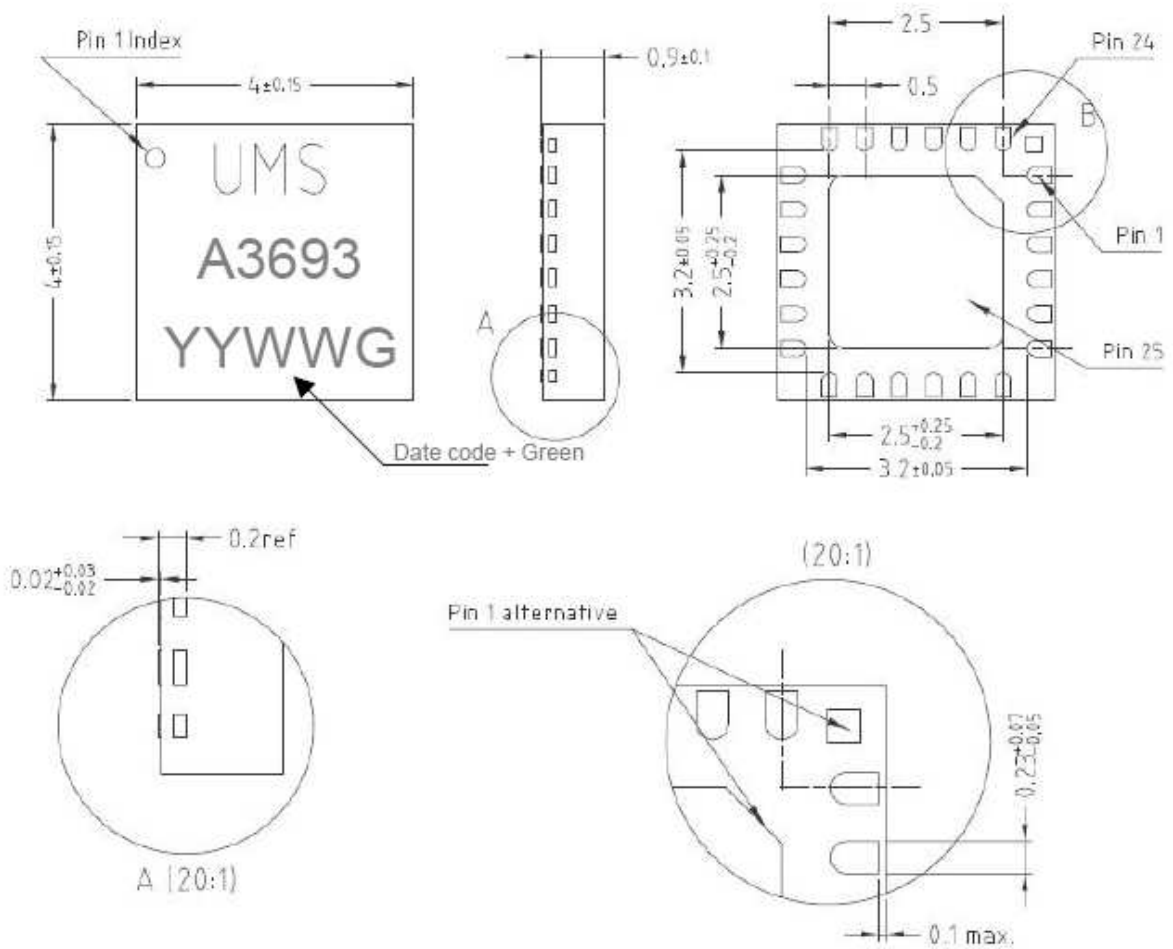
S21 Variation in Temperature



CW Power Measurements



**Package outline:**



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

|          |            |           |
|----------|------------|-----------|
| 1- Nc    | 11- DR *   | 21- Nc    |
| 2- Gnd   | 12- Nc     | 22- Gnd   |
| 3- Gnd   | 13- Gnd    | 23- D1 ** |
| 4- RF IN | 14- Gnd    | 24- Nc    |
| 5- Gnd   | 15- RF OUT | 25- Gnd   |
| 6- Gnd   | 16- Gnd    |           |
| 7- G1    | 17- Gnd    |           |
| 8- G2    | 18- Nc     |           |
| 9- G3    | 19- Nc     |           |
| 10- G4   | 20- C **   |           |

\* DR pad is provided for monitoring the output power. This access, when connected to an external resistor of 10kOhm (typical value) provides a DC voltage, which follows the output power level.

\*\* D1pad corresponds to the 1<sup>st</sup> stage drain, D pad corresponds to the 2<sup>nd</sup>, 3<sup>rd</sup>, and 4<sup>th</sup> stage drains

The RF ports are DC blocked on chip. The DC connections do not include any decoupling capacitor in package, therefore it is mandatory to provide a good external DC decoupling on the PCB, as close as possible to the package.

## SMD mounting procedure

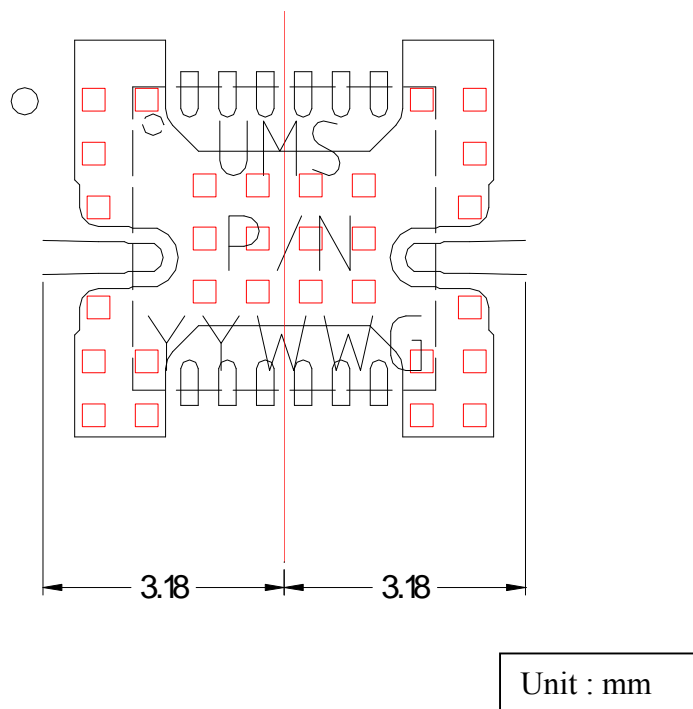
The SMD leadless package has been designed for high volume surface mount PCB assembly process. The dimensions and footprint required for the PCB (motherboard) are given in the drawings above.

For the mounting process standard techniques involving solder paste and a suitable reflow process can be used. For further details, see application note AN0017.

## Definition of the Sij reference planes

The reference planes are defined from the footprint of the recommended characterization board 95541 shown below.

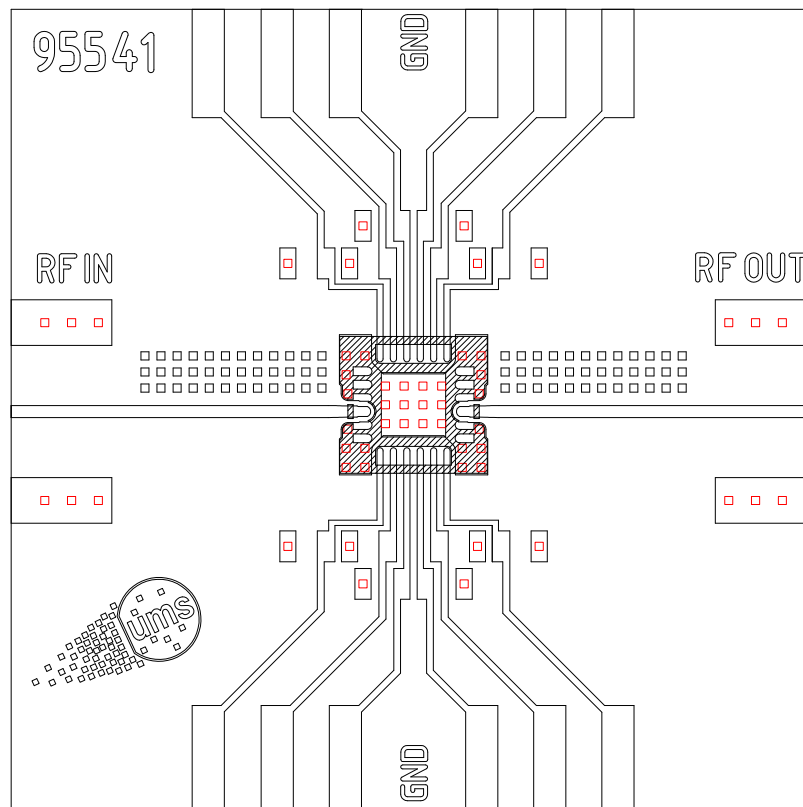
The reference is the symmetrical axis of the package. The input and output reference planes are located at 3.18mm offset (input wise and output wise respec.) from this axis. Then, the given Sij incorporates this land pattern.





**Proposed Assembly board “95541” for the 24L-QFN4x4 products characterization.**

- Compatible with the proposed footprint.
- Based on typically Ro4003 / 8mils or equivalent.
- Using a microstrip to coplanar transition to access the package.
- Recommended for the implementation of this product on a module board.



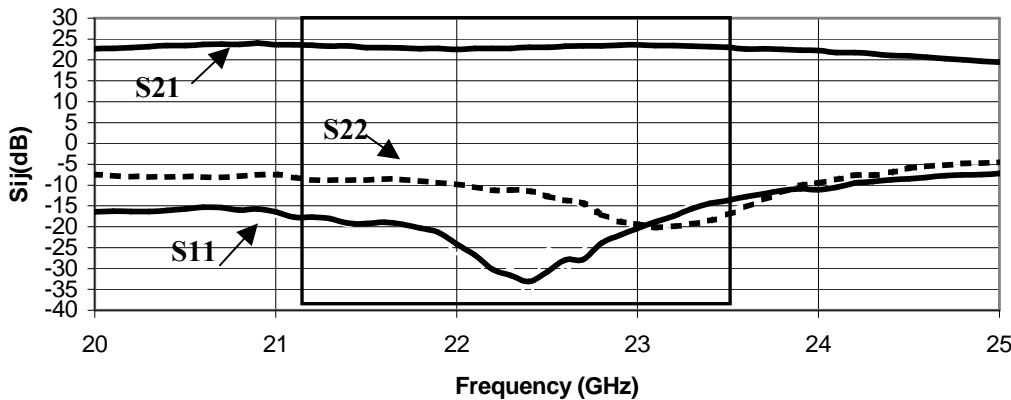
Sub-band enhancement

Based on the  $S_{ij}$  matrix given previously, the performances of this product can be enhanced in sub-bands using external matching components such as very simple combination of micro-strip stubs.

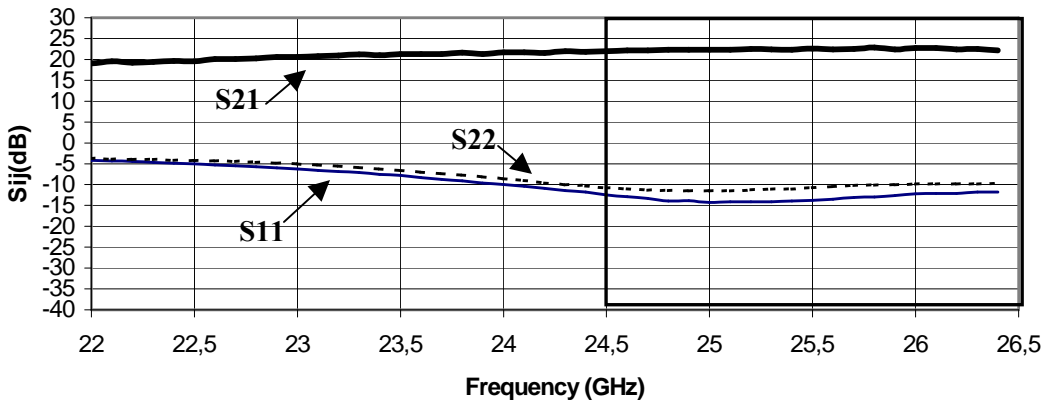
For some sub-bands, matching networks have been implemented and some typical results are shown below.

The following graphs show S parameters obtained thanks to external matching networks.

Typical S parameters with matching networks for the 21.2-23.6 GHz band



Typical S parameters with matching networks for the 24.5-26.5 GHz band



Ordering Information

QFN 4x4 RoHS compliant package: CHA3693-QDG/XY  
 Stick: XY = 20      Tape & reel: XY = 21

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