18-30GHz Low Noise Amplifier

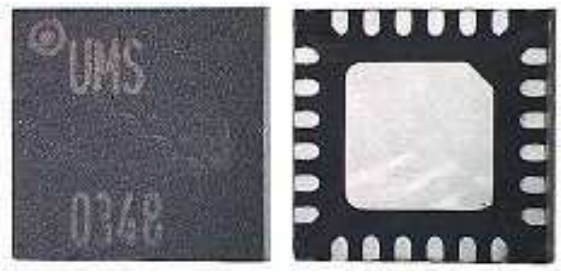
GaAs Monolithic Microwave IC in SMD leadless package

Description

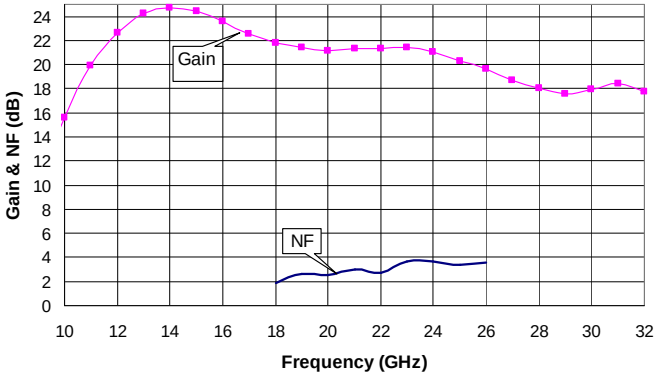
The CHA2069-QDG is a three-stage self-biased wide band monolithic low noise amplifier. Typical applications range from telecommunication (point to point, point to multi-point, VSAT) to ISM and military markets.

The circuit is manufactured with a standard pHEMT process: 0.25µm gate length, via holes through the substrate, air bridges and electron beam gate lithography.

It is supplied in lead-free SMD package.



Gain and NF @ high current config. (BCF grounded)



Main Features

- Broadband performance 18-30GHz
- 3dB noise figure
- 20dB gain
- 65 mA Low DC power consumption.
- 20dBm 3rd order intercept point (high current configuration).
- 24L-QFN4x4 SMD package

Main Characteristics

Tamb = +25°C, Vd = +4,5V Pads: VgB, VgC, VgF=GND (H igh current configuration)

Symbol	Parameter	Min	Typ	Max	Unit
NF	Noise figure, 18-26GHz		3	4	dB
G	Gain	17	20		dB
IP3	3rd order intercept point (Pout/tone=-5dBm) 18-26 GHz	18	20		dBm

ESD Protections: Electrostatic discharge sensitive device observe handling precautions!

United Monolithic Semiconductors S.A.S.
Route Départementale 128 - BP46 - 91401 Orsay Cedex France
Tel.: +33 (0) 1 69 33 03 08 - Fax: +33 (0) 1 69 33 03 09

Electrical Characteristics (low current configuration)

Tamb = +25°C, Vd = +4.5V Pads: **VgB, VgD, VgE=GND**

Symbol	Parameter	Min	Typ	Max	Unit
Fop	Operating frequency range	18		30	GHz
G	Gain	16.5	19.5		dB
ΔG	Gain flatness		±2	±2.5	dB
NF	Noise figure (18 – 26.5GHz)		3	4	dB
IS11I	Input return loss (18 – 26.5GHz)		-5	-3	dB
IS22I	Ouput return loss (18 – 26.5GHz)		-7	-3	dB
IP3	3rd order intercept point (Pout/tone=-5dBm) 18-26GHz	16.5	18.5		dBm
P1dB	Output power at 1dB gain compression 18-26GHz	9.0	10.5		dBm
Id	Drain bias current		65		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).

Electrical Characteristics (high current configuration)

Tamb = +25°C, Vd = +4,5V Pads: **VgB, VgC, VgF=GND**

Symbol	Parameter	Min	Typ	Max	Unit
Fop	Operating frequency range	18		30	GHz
G	Gain	17	20		dB
ΔG	Gain flatness		±2	±2.5	dB
NF	Noise figure (18 – 26.5GHz)		3	4	dB
IS11I	Input return loss (18 – 26.5GHz)		-5	-3	dB
IS22I	Ouput return loss (18 – 26.5GHz)		-7	-3	dB
IP3	3rd order intercept point (Pout/tone=-5dBm) 18-26 GHz	18	20		dBm
P1dB	Output power at 1dB gain compression 18-26 GHz	12	13.5		dBm
Id	Drain bias current		85		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).

Route Départementale 128, BP46 - 91401 ORSAY Cedex - FRANCE
Tel.: +33 (0) 1 69 33 03 08 - Fax: +33 (0) 1 69 33 03 09

Absolute Maximum Ratings (1)

Tamb = +25°C

Symbol	Parameter (1)	Values	Unit
Vd	Drain bias voltage	5	V
Pin	Maximum input power overdrive	-7.0	dBm
Rth_BDE	Thermal Resistance channel to ground paddle (2)	130	°C/W
Rth_BCF	Thermal Resistance channel to ground paddle (2)	120	°C/W
Top	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 for Tamb. = +85°C and a Tj max = +175°C.

Route Départementale 128, BP46 - 91401 ORSAY Cedex - FRANCE
Tel.: +33 (0) 1 69 33 03 08 - Fax: +33 (0) 1 69 33 03 09

Typical Package Sij parameters for low current configuration

Tamb = +25℃, Vd = +4,5V Pads: B, D, E grounded.

F (GHz)	S11	S11	S12	S12	S21	S21	S22	S22
	dB	/°	dB	/°	dB	/°	dB	/°
2	-0.1	-58.7	-95.2	-85.6	-57.5	-2.4	-0.6	-148.4
3	-0.1	-89.3	-68.8	63.3	-77.6	-24.4	-0.9	157.1
4	-0.1	-123.5	-63.2	93.4	-52.9	62.8	-0.9	112.4
5	-0.2	-160.8	-62.9	47.1	-37.4	145.3	-1.3	72.0
6	-0.4	156.1	-58.1	11.4	-18.1	93.6	-1.7	39.9
7	-0.6	107.6	-67.5	-59.7	-4.4	28.0	-2.0	8.4
8	-1.2	58.9	-68.1	93.7	4.4	-52.1	-3.0	-20.2
9	-1.8	13.5	-61.6	-9.2	9.6	-122.4	-3.9	-38.6
10	-2.8	-26.1	-60.0	-42.6	14.7	176.1	-4.4	-69.5
11	-4.0	-58.0	-55.1	171.8	19.0	109.4	-8.3	-92.5
12	-5.7	-89.1	-53.4	87.2	21.7	41.3	-13.4	-92.8
13	-8.8	-122.0	-49.6	14.1	23.3	-24.1	-17.0	-67.1
14	-15.8	-173.9	-50.5	-42.8	24.0	-86.8	-12.6	-36.0
15	-17.4	24.9	-48.2	-120.3	23.5	-146.2	-8.3	-46.7
16	-10.9	-20.6	-48.3	171.6	22.4	162.0	-6.3	-65.3
17	-8.5	-47.1	-49.6	133.4	21.5	116.9	-5.9	-85.2
18	-7.0	-65.5	-47.3	121.9	20.9	75.8	-5.9	-99.8
19	-6.2	-82.8	-44.9	92.5	20.8	34.2	-6.1	-116.0
20	-5.8	-98.4	-42.5	57.3	20.7	-6.5	-7.2	-130.1
21	-4.9	-110.8	-43.2	20.1	20.9	-48.3	-7.9	-137.3
22	-4.7	-125.9	-45.3	14.9	20.9	-90.8	-9.2	-142.4
23	-4.3	-138.7	-43.3	-0.5	20.9	-135.3	-8.7	-139.3
24	-3.9	-152.2	-43.7	-14.8	20.4	178.7	-7.6	-141.9
25	-3.8	-163.2	-44.2	-36.7	19.6	135.8	-6.3	-148.5
26	-3.3	-173.7	-45.4	-48.5	18.8	92.8	-4.4	-156.9
27	-3.0	175.5	-46.5	-43.8	17.8	52.7	-3.7	-169.0
28	-2.5	166.4	-43.7	-45.2	17.1	13.2	-3.0	-179.9
29	-2.5	155.4	-43.2	-59.5	16.8	-26.3	-2.7	171.2
30	-2.8	146.3	-42.0	-81.7	17.3	-69.6	-2.7	161.4
31	-3.9	144.4	-46.4	-112.7	18.0	-123.9	-2.6	156.1
32	-2.8	154.3	-47.9	-148.6	17.2	168.4	-2.5	150.5

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

Route Départementale 128, BP46 - 91401 ORSAY Cedex - FRANCE
Tel.: +33 (0) 1 69 33 03 08 - Fax: +33 (0) 1 69 33 03 09

united monolithic semiconductors

Typical Package Sij parameters for high current configuration

Tamb = +25°C, Vd = +4,5V Pads: B, C, F grounded.

F (GHz)	S11	S11	S12	S12	S21	S21	S22	S22
	dB	/°	dB	/°	dB	/°	dB	/°
2	-0.1	-58.5	-92.2	81.8	-57.9	0.4	-0.7	-146.6
3	-0.1	-88.9	-67.1	55.2	-69.1	-41.4	-1.1	159.3
4	-0.1	-122.6	-62.8	100.3	-51.5	77.3	-1.0	114.1
5	-0.2	-159.2	-63.0	51.4	-37.2	145.1	-1.5	73.0
6	-0.4	158.4	-56.6	15.4	-17.7	97.4	-1.9	40.1
7	-0.7	110.4	-64.5	-49.7	-3.8	31.4	-2.2	8.3
8	-1.3	60.8	-67.3	88.2	5.3	-49.4	-3.4	-21.8
9	-1.8	13.6	-61.5	-7.6	10.6	-120.9	-4.6	-40.0
10	-2.9	-27.8	-59.6	-45.7	15.6	177.2	-4.8	-68.3
11	-4.0	-60.9	-54.4	176.7	19.9	110.8	-8.5	-89.9
12	-5.6	-92.1	-53.9	99.3	22.7	43.0	-12.5	-90.4
13	-8.5	-123.1	-50.6	22.2	24.2	-22.2	-16.3	-76.8
14	-14.6	-169.0	-52.1	-32.8	25.1	-84.9	-13.8	-40.8
15	-19.5	26.2	-50.3	-120.6	24.8	-145.6	-8.9	-46.4
16	-11.3	-23.8	-49.4	165.3	23.6	161.3	-6.5	-65.0
17	-8.5	-49.1	-50.9	132.8	22.6	115.2	-6.0	-86.1
18	-6.9	-67.5	-46.9	122.6	21.8	73.8	-5.8	-101.6
19	-6.1	-83.9	-44.9	88.3	21.5	32.7	-6.1	-119.7
20	-5.6	-97.1	-43.0	53.7	21.2	-7.8	-7.0	-134.2
21	-4.6	-109.1	-44.1	21.4	21.3	-48.7	-7.6	-144.5
22	-4.4	-123.2	-45.4	19.8	21.3	-90.2	-9.0	-153.5
23	-4.1	-135.7	-43.9	7.2	21.4	-133.4	-9.4	-152.7
24	-3.7	-149.8	-43.4	-10.0	21.0	-178.9	-8.8	-151.9
25	-3.8	-162.0	-44.3	-34.6	20.3	138.4	-7.6	-155.6
26	-3.5	-173.4	-44.5	-42.2	19.7	94.7	-5.5	-161.7
27	-3.3	174.4	-47.4	-45.9	18.7	53.4	-4.5	-172.3
28	-3.0	164.8	-44.8	-39.0	18.0	12.8	-3.6	177.3
29	-2.9	153.8	-43.6	-43.1	17.6	-27.1	-3.0	168.4
30	-2.9	143.4	-41.7	-66.2	18.0	-70.8	-2.6	158.1
31	-3.8	138.2	-44.6	-91.4	18.4	-123.8	-2.6	150.7
32	-2.7	145.3	-49.9	-140.7	17.8	169.5	-2.6	144.6

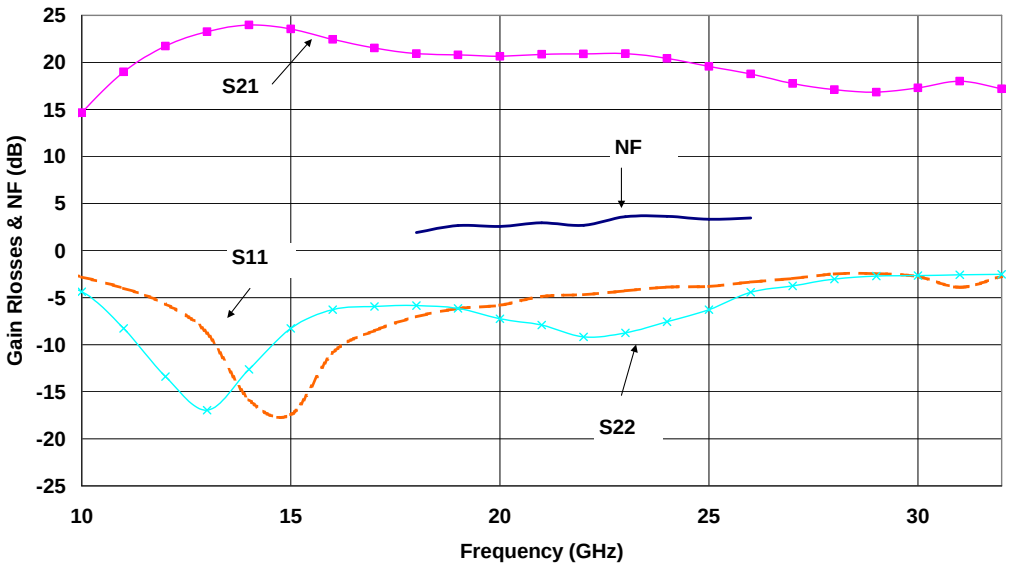
Refer to the “definition of the Sij reference planes” section below.

Route Départementale 128, BP46 - 91401 ORSAY Cedex - FRANCE
Tel.: +33 (0) 1 69 33 03 08 - Fax: +33 (0) 1 69 33 03 09

Typical PCB Measured Performance

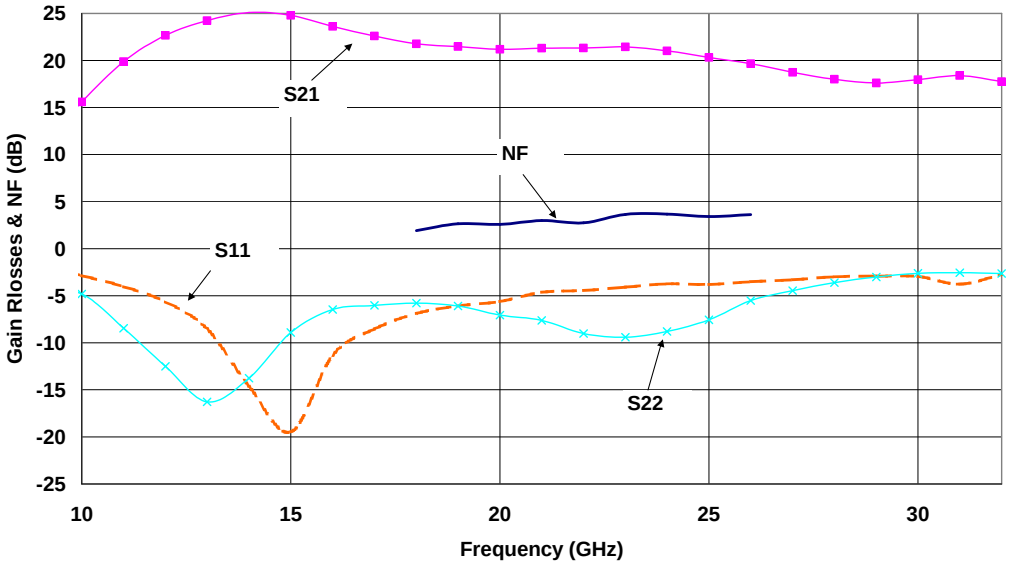
Tamb = +25℃, Vd = +4,5V

Gain / Return losses and NF @ low current config. (BDE grounded)



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

Gain / Return losses and NF @ high current config. (BCF grounded)



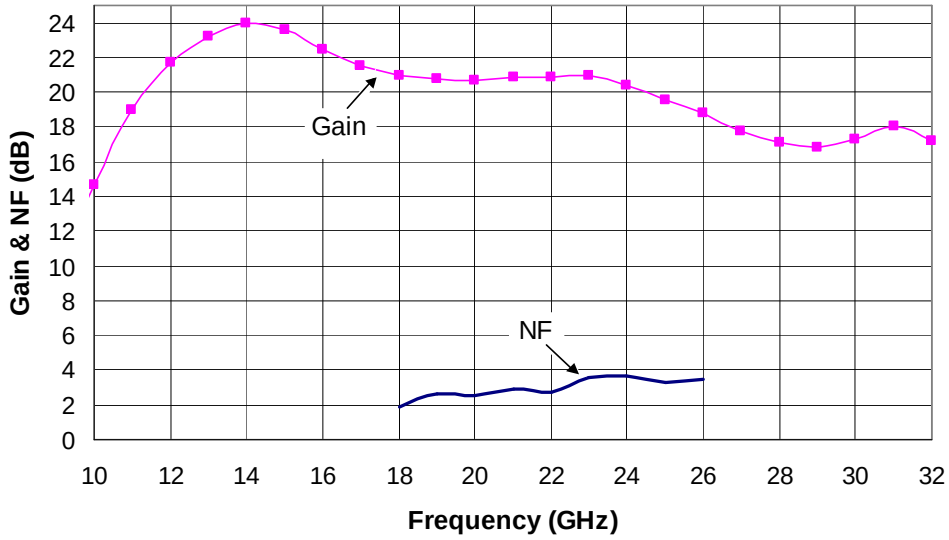
NF Gain and Rlosses in the package access planes, using the proposed land pattern & board 95541

Route Départementale 128, BP46 - 91401 ORSAY Cedex - FRANCE
Tel.: +33 (0) 1 69 33 03 08 - Fax: +33 (0) 1 69 33 03 09

Typical PCB Measured Performance

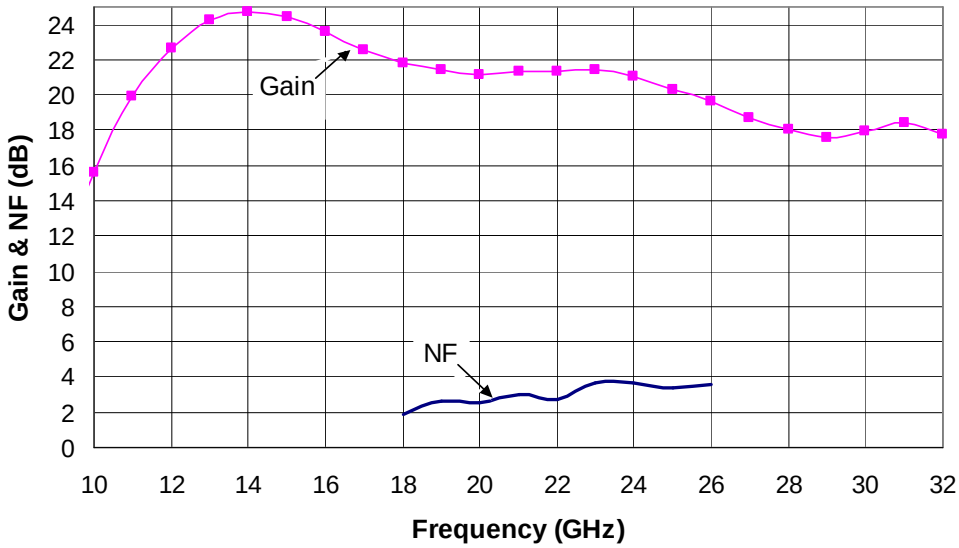
Tamb = +25°C, Vd = +4,5V

Gain and NF @ low current config. (BDE grounded)



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

Gain and NF @ high current config. (BCF grounded)



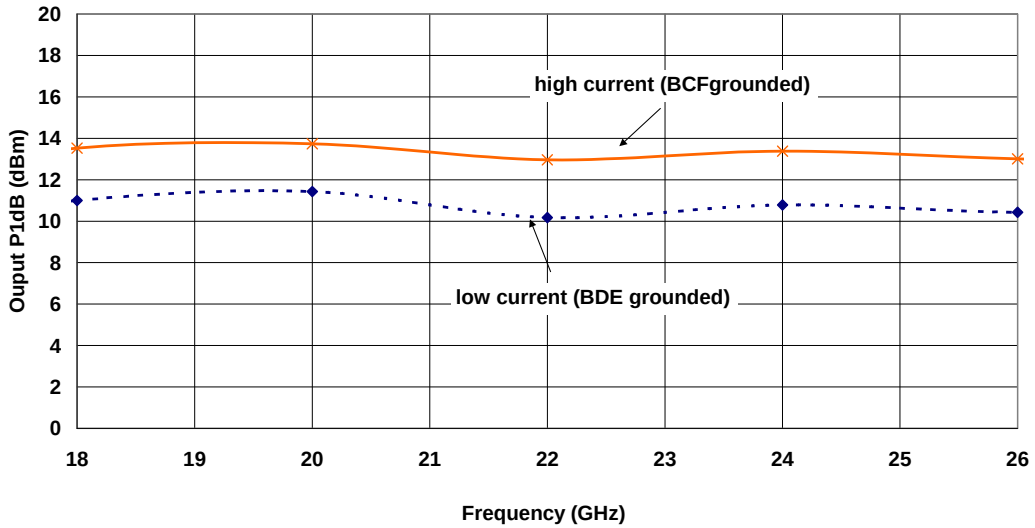
NF and Gain in the package access planes, using the proposed land pattern & board 95541

Route Départementale 128, BP46 - 91401 ORSAY Cedex - FRANCE
Tel.: +33 (0) 1 69 33 03 08 - Fax: +33 (0) 1 69 33 03 09

Typical PCB Measured Performance

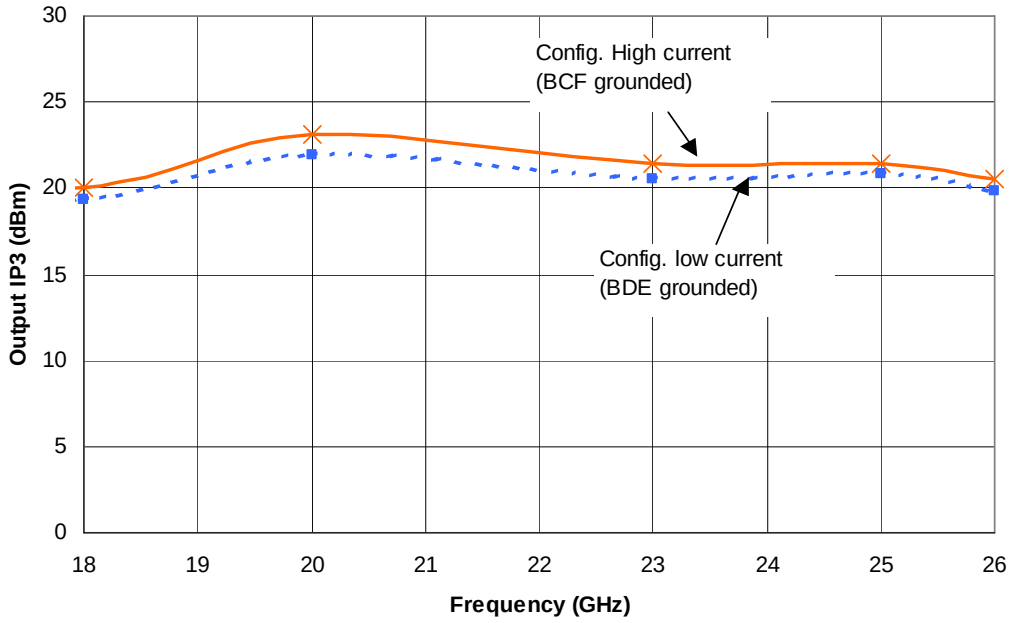
Tamb = +25°C, Vd = +4,5V

Typical Output 1 dB compression



Typical Pout –1dB in the package, using the proposed land pattern & board 95541.

Typical Output IP3 vs Frequency @ Pout/tone=-5 dBm

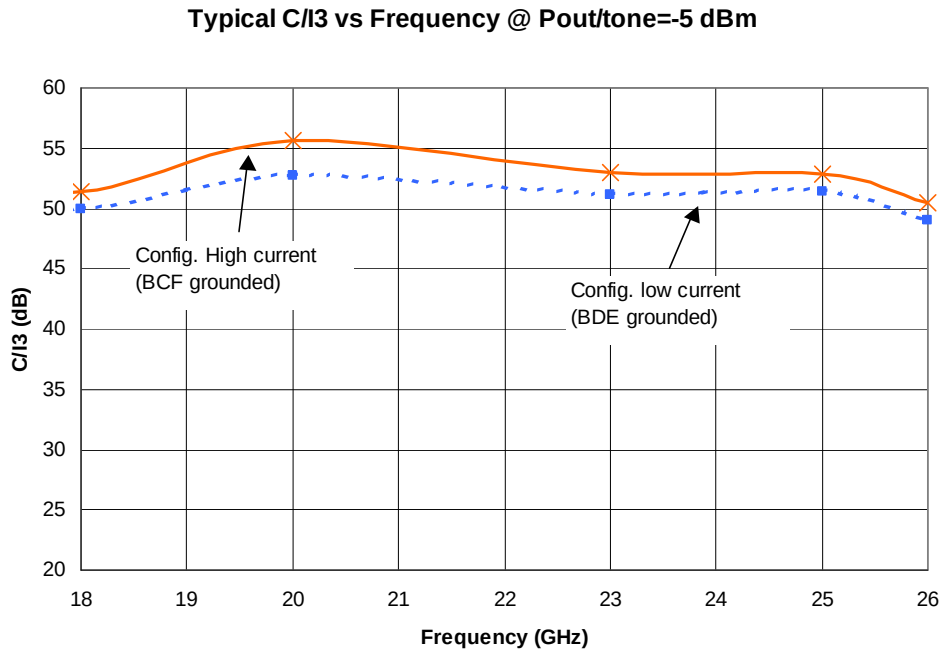


Typical Output IP3 in the package, using the proposed land pattern & board 95541.

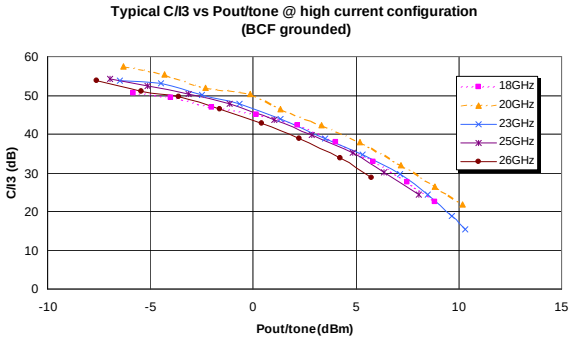
Route Départementale 128, BP46 - 91401 ORSAY Cedex - FRANCE
Tel.: +33 (0) 1 69 33 03 08 - Fax: +33 (0) 1 69 33 03 09

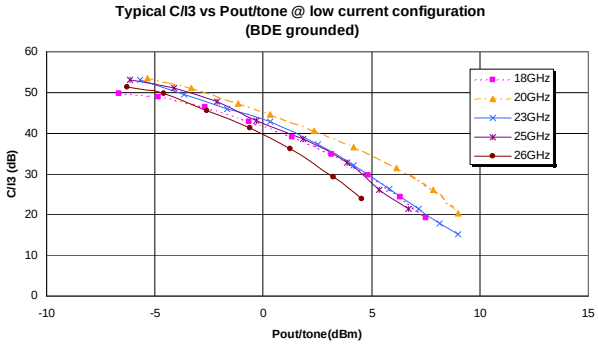
Typical PCB Measured Performance

Tamb = +25°C, Vd = +4,5V



Typical C/I3 versus frequency, using the proposed land pattern & board 95541.

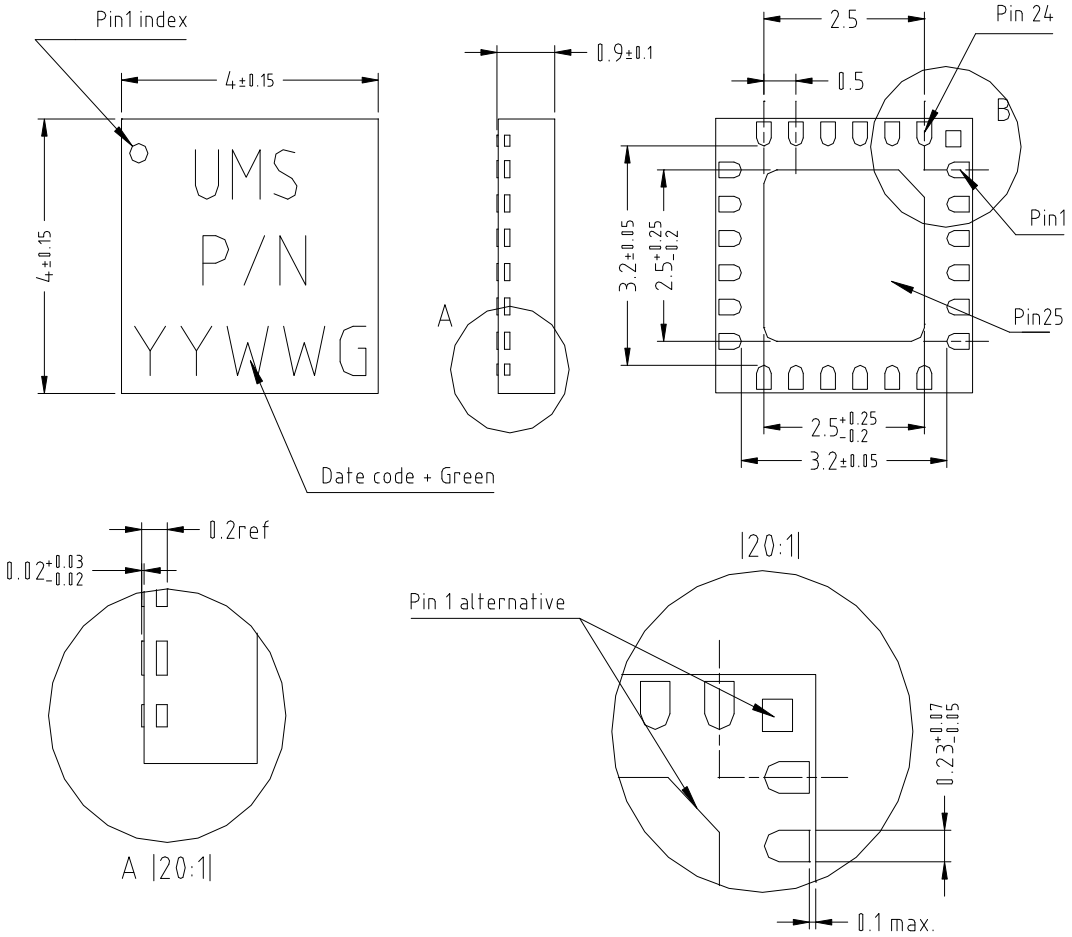




Typical C/I3 versus output power, using the proposed land pattern & board 95541.

Route Départementale 128, BP46 - 91401 ORSAY Cedex - FRANCE
Tel.: +33 (0) 1 69 33 03 08 - Fax: +33 (0) 1 69 33 03 09

Package outline:



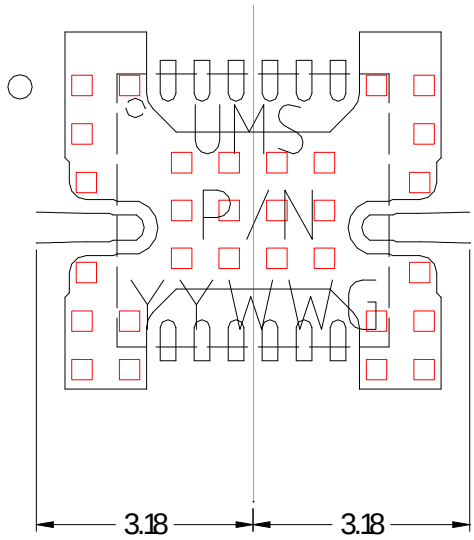
Matt tin, Lead Free	(Green)
Units	mm
From the standard	JEDEC MO-220

1-	NC	9-	D	17-	NC
2-	NC	10-	NC	18-	NC
3-	GND	11-	E	19-	Vd1,2,3
4-	RF in	12-	F	20-	Vd1,2,3
5-	GND	13-	NC	21-	Vg3
6-	NC	14-	GND	22-	Vg2
7-	B	15-	RF out	23-	Vg1
8-	C	16-	GND	24-	NC
25-	GND				

Route Départementale 128, BP46 - 91401 ORSAY Cedex - FRANCE
Tel.: +33 (0) 1 69 33 03 08 - Fax: +33 (0) 1 69 33 03 09

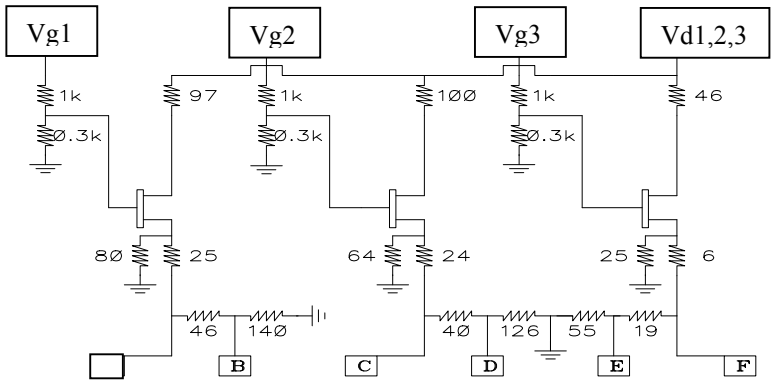
Definition of the Sij reference planes

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.



Circuit Biasing options

This circuit is self-biased, and flexibility is provided by the access to number of pads. the internal DC electrical schematic is given in order to use these pads in a safe way.



The two requirements are:
N°1: Not exceed Vds = 3.5Volt (internal Drain to S ource voltage).
N°2: Not biased in such a way that Vgs becomes posi tive. (Internal Gate to Source voltage)

We propose two standard biasing:
Low Noise and low consumption: Vd = 4.5V and B, D, E grounded.
All the other pads non connected (NC).
Idd = 65mA & Pout-1dB = 10.5dBm Typical.
(Equivalent to B, C, D, E, F: non connected and Vd=4.5V; Vg1=Vg2=Vg3=+1.V).
Low Noise and higher output power Vd = 4.5V and B, C, F grounded.
All the other pads non connected (NC).
Idd = 85mA & Pout-1dB = 13.5dBm Typical..

Route Départementale 128, BP46 - 91401 ORSAY Cedex - FRANCE
Tel.: +33 (0) 1 69 33 03 08 - Fax: +33 (0) 1 69 33 03 09

Application note

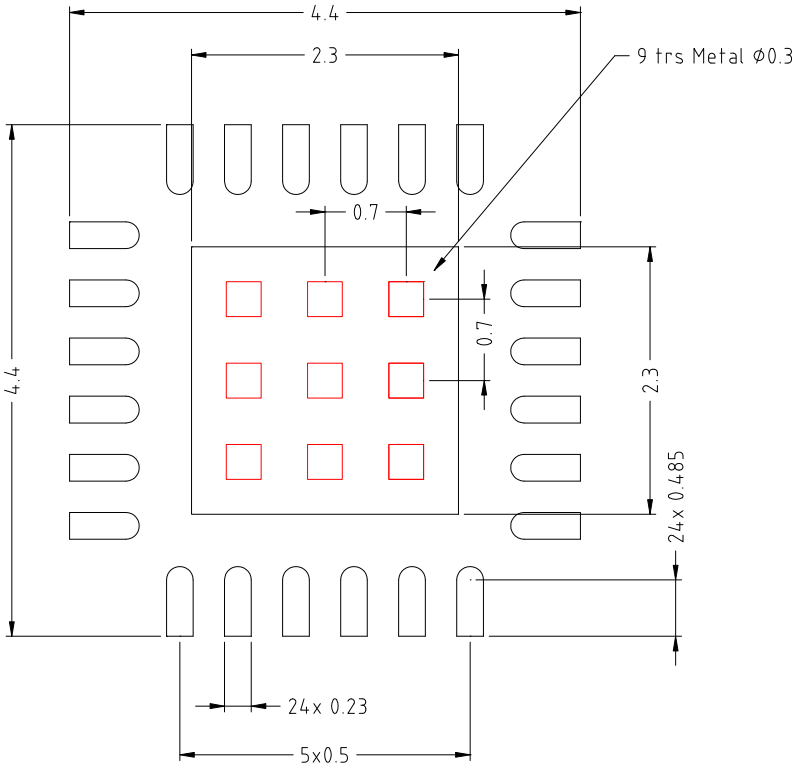
The design of the motherboard has a strong impact on the over all performance since the transition from the motherboard to the package is comparably large. In case of the SMD type packages of United Monolithic Semiconductors the motherboard should be designed according to the information given in the following to achieve good performance. Other configurations are also possible but can lead to different results. If you need advise please contact United Monolithic Semiconductors for further information.

SMD type packages of UMS should allow design and fabrication of micro- and mm-wave modules at low cost. Therefore, a suitable motherboard environment has been chosen. All tests and verifications have been performed on Rogers RO4003. This material exhibits a permittivity of 3.38 and has been used with a thickness of 200µm [8 mils] and a 1/2oz or less copper cladding. The corresponding 50Ohm transmission line has a strip width of about 460µm [approx. 18 mils].

The contact areas on the motherboard for the package connections should be designed according to the footprint given below. The proper via structure under the ground pad is very important in order to achieve a good RF and lifetime performance. All tests have been done by using a grid of plated through vias with a diameter of less than 300µm [12 mils] and a spacing of less than 700µm [28 mils] from the centres of two adjacent vias. The via grid should cover the whole space under the ground pad and the vias closest to the RF ports should be located near the edge of the pad to allow a good RF ground connection. Since the vias are important for heat transfer, a proper via filling should be guaranteed during the mounting procedure to get a low thermal resistance between package and heat sink. For power devices the use of heat slugs in the motherboard instead of a grid of via’s is recommended.

For the mounting process the SMD type package can be handled as a standard surface mount component. The use of either solder or conductive epoxy is possible. The solder thickness after reflow should be typical 50µm [2 mils] and the lateral alignment between the package and the motherboard should be within 50µm [2 mils]. Caution should be taken to obtain a good and reliable contact over the whole pad areas. Voids or other improper connections, in particular, between the ground pads of motherboard and package will lead to a deterioration of the RF performance and the heat dissipation. The latter effect can reduce drastically reliability and lifetime of the product.

Route Départementale 128, BP46 - 91401 ORSAY Cedex - FRANCE
Tel.: +33 (0) 1 69 33 03 08 - Fax: +33 (0) 1 69 33 03 09



(For production, design must be adapted with regard to PCB tolerances and assembly process)

Basic footprint for a 24L-QFN4x4 (all units mm)
(Please, refer to the UMS propose footprint for optimum operation in the following “Proposed Assembly board” section)

The RF ports are DC blocked on chip. The DC connection (Vd) does 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.

SMD mounting procedure

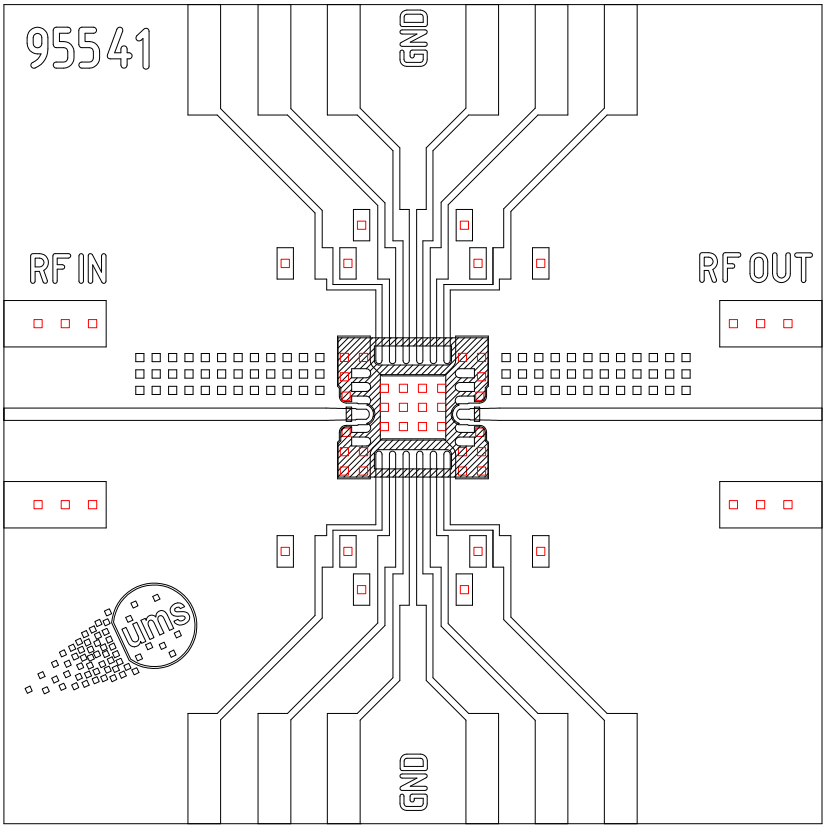
The SMD leadless package has been designed for high volume surface mount PCB assembly process. The dimensions and footprint required for the PCB (motherboard) are given in the drawings above.

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

Route Départementale 128, B.P.46 - 91401 ORSAY Cedex - FRANCE
Tel.: +33 (0) 1 69 33 03 08 - Fax: +33 (0) 1 69 33 03 09

Proposed Assembly board “95941” 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.



Route Départementale 128, BP46 - 91401 ORSAY Cedex - FRANCE
Tel.: +33 (0) 1 69 33 03 08 - Fax: +33 (0) 1 69 33 03 09

Sub-band enhancement

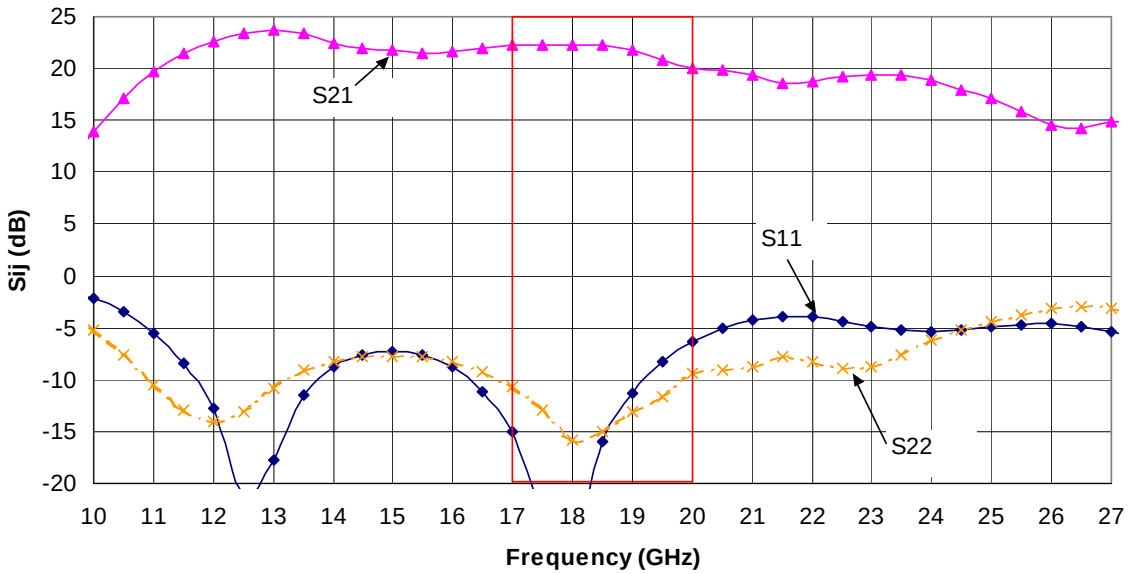
The performances of this product can be enhanced in sub-bands using external matching components such as very simple combination of micro-strip stubs.
For some sub-bands, matching networks have been implemented and some typical results are shown below. For further details see the application notes listed below.

Matched Sub-band	Application note reference
17-20GHz	AN0010_CHA2069QDG_17-20
21-24GHz	AN0011_CHA2069QDG_21-24
24.5-26.5GHz	AN0012_CHA2069QDG_24_5-26_5

Of course, based on the Sij matrix given previously, more accurate, or dedicated frequency boards may be derived.

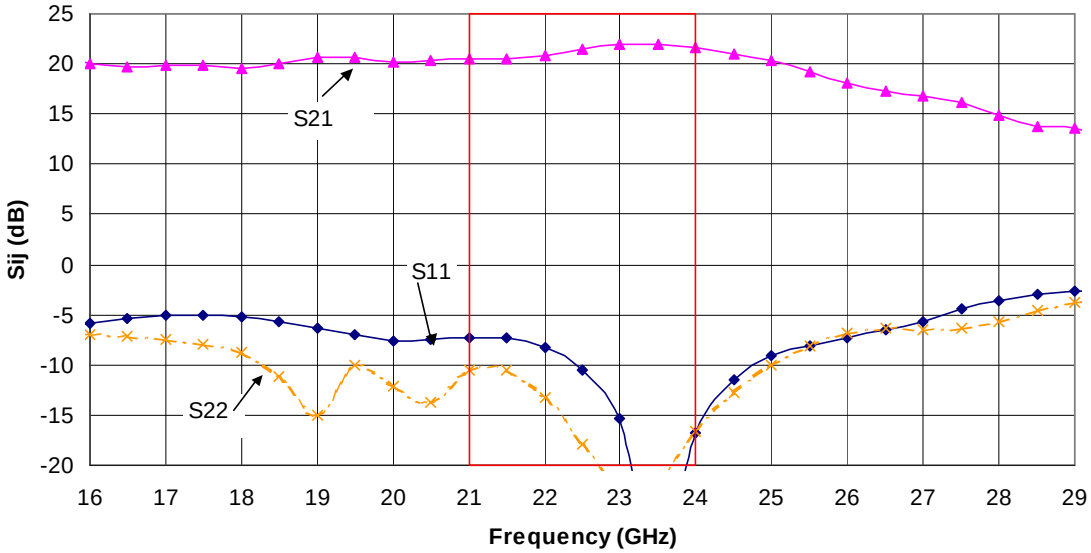
The following graphs show S parameters obtained thanks to the external matching networks described in the application notes quoted in the list above.

Typical S parameters with matching network for the 17-20GHz band
Config. High current (BCFgrounded)

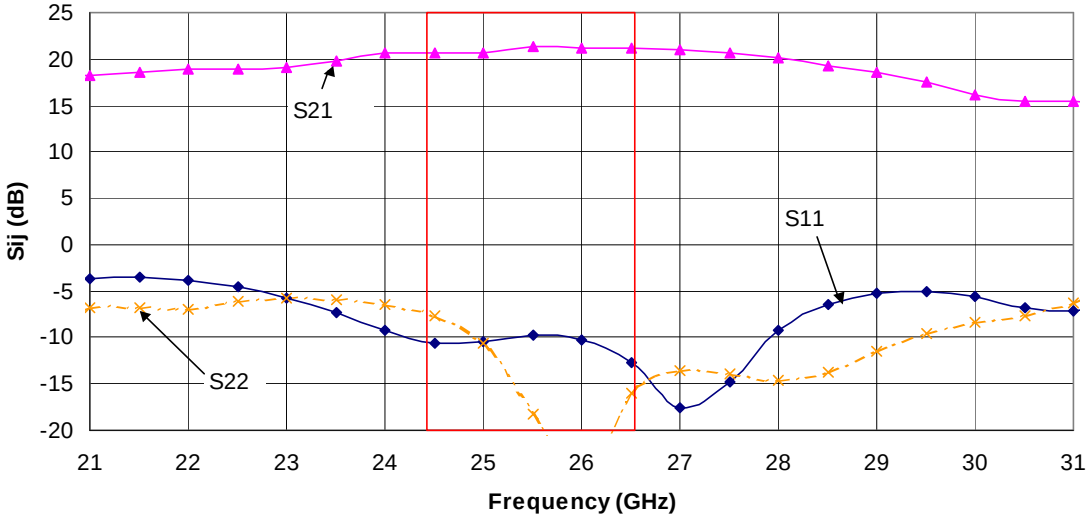


Route Départementale 128, B.P.46 - 91401 ORSAY Cedex - FRANCE
Tel.: +33 (0) 1 69 33 03 08 - Fax: +33 (0) 1 69 33 03 09

Typical S parameters with matching network for the 21-24GHz band
Config. High current (BCFgrounded)



Typical S parameters with matching network
for the 24.5-26.5GHz band
Config. High current (BCFgrounded)



Route Départementale 128, BP46 - 91401 ORSAY Cedex - FRANCE
Tel.: +33 (0) 1 69 33 03 08 - Fax: +33 (0) 1 69 33 03 09

Route Départementale 128, B.P.46 - 91401 ORSAY Cedex - FRANCE
Tel.: +33 (0) 1 69 33 03 08 - Fax: +33 (0) 1 69 33 03 09

Ordering Information

QFN 4x4 RoHS compliant package: CHA2069-QDG/XY
Stick: XY = 20 Tape & reel: XY = 21

Route Départementale 128, BP46 - 91401 ORSAY Cedex - FRANCE
Tel.: +33 (0) 1 69 33 03 08 - Fax: +33 (0) 1 69 33 03 09