CHA2069QDG

Recommended external matching network in the 21-24 GHz band

The following is an application note in order to improve the performances of the product for the dedicated 21-24GHZ frequency band using simple external matching networks.

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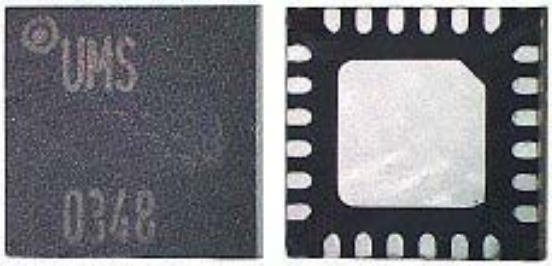
Description

The CHA2069QDG 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 P-HEMT process: 0.25µm gate length, via holes through the substrate, air bridges and electron beam lithography.
It is supplied in RoHS compliant SMD package.

Main Features

- Broadband performances : 18-30GHz
- 3dB noise figure
- 20dB gain
- 65mA low DC power consumption
- 20dBm 3rd order intercept point (high current configuration)
- Package type : 24 leads QFN4x4. :



External matching

The 24Leads QFN4x4 is an SMD type package. Therefore, a suitable motherboard environment is chosen. All tests and verifications are performed on Rogers RO4003 (or equivalent). This material exhibits a permittivity of 3.38 and is used with a thickness of 200µm (8 mils) and a 1/2oz or less copper cladding. The corresponding 50 Ohm transmission line has a strip width of about 460µm (approx. 18 mils).
When using this circuit in a reduced bandwidth, such as in the 21 to 24GHz frequency range, the performances of the circuit could be improved using external (on board) matching stubs and slugs. This board pattern is easily computed from the Sij of the package product as given in the data-sheet (and in the section below) with any CAD software, using the material defined above for the motherboard. The following give results obtained at UMS, based on the given motherboard layout.

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Typical Sij for low current configuration (without external matching)
Tamb = +25°C, 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

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Typical Sij for high current configuration (without external matching)

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

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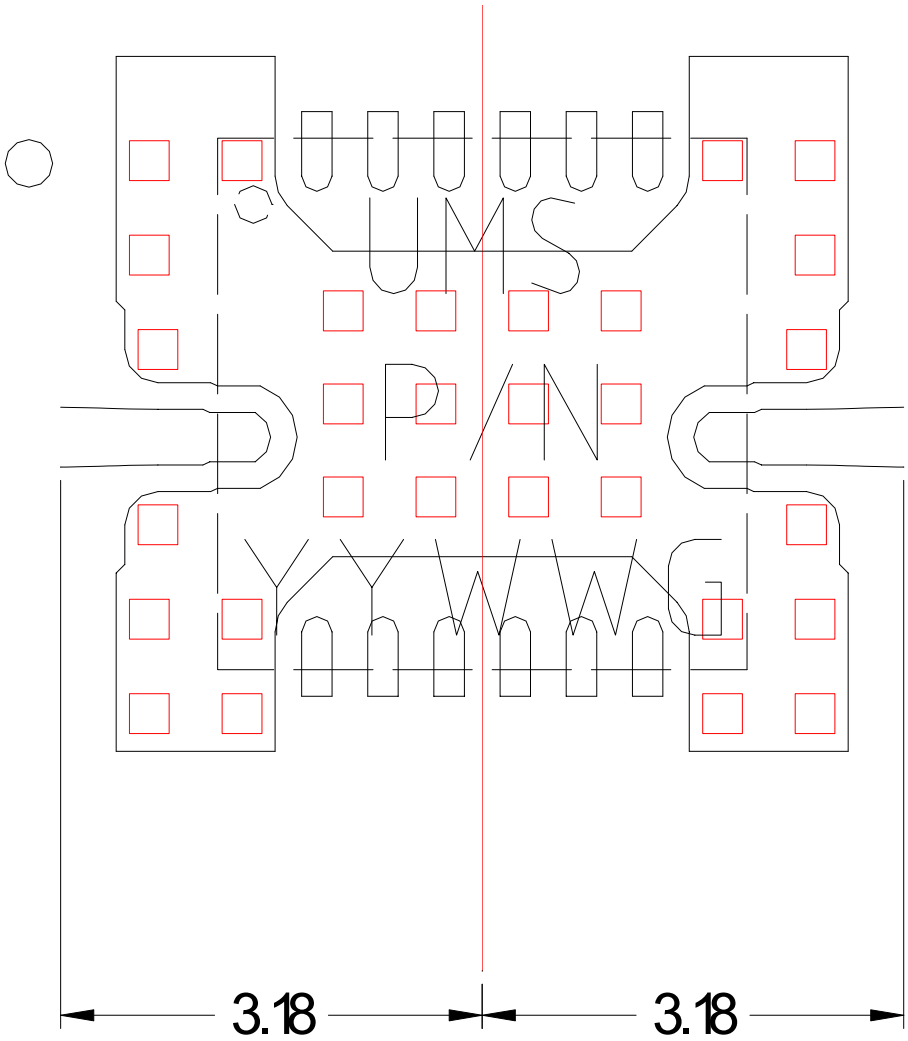
Definition of the Sij reference planes

The reference planes are defined from the footprint of the recommended characterization board 95541 (see data-sheet).
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.



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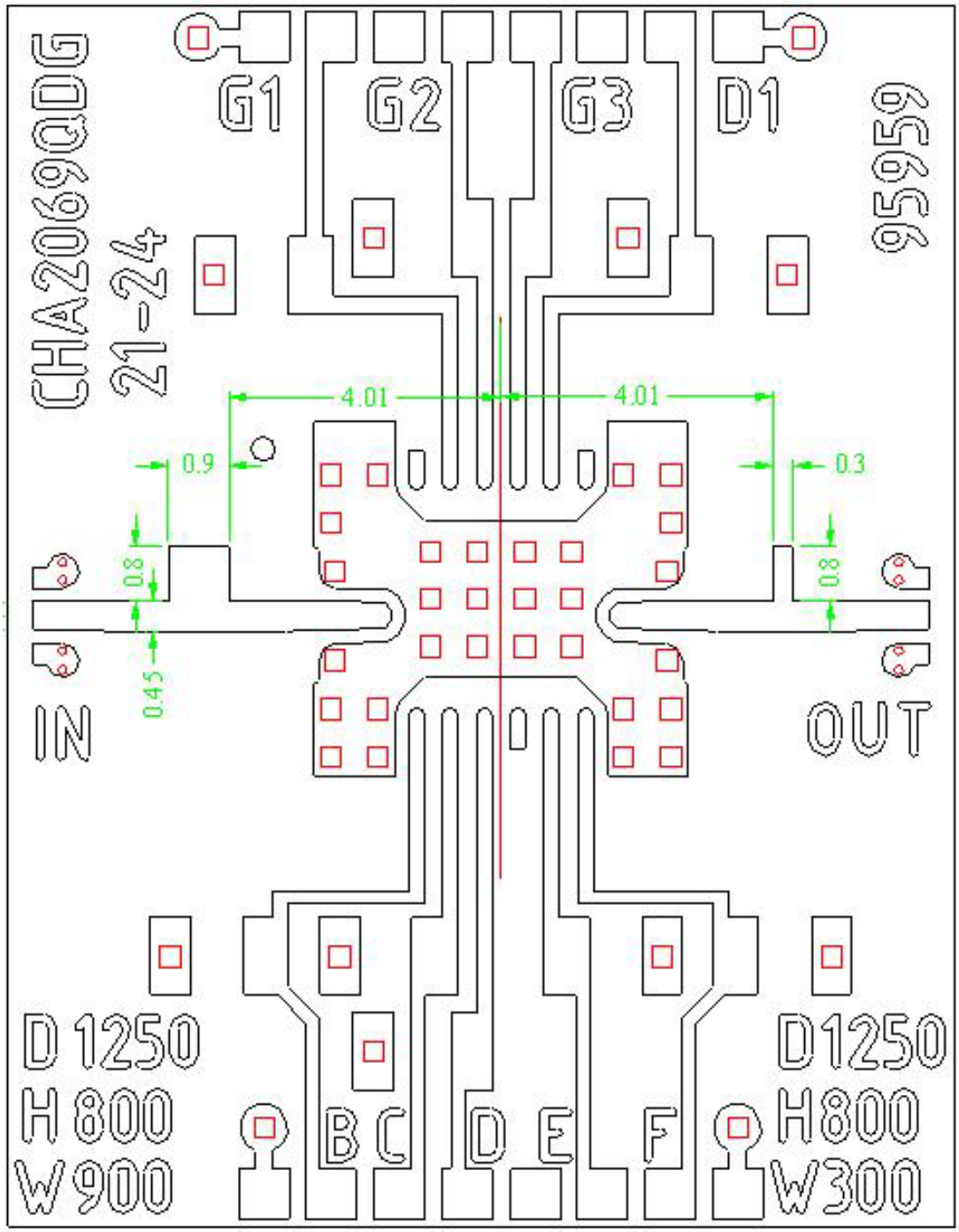
Proposed Assembly board “95959” for the 21-24GHz operation

- Compatible with the proposed foot print (see datasheet).
- 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.



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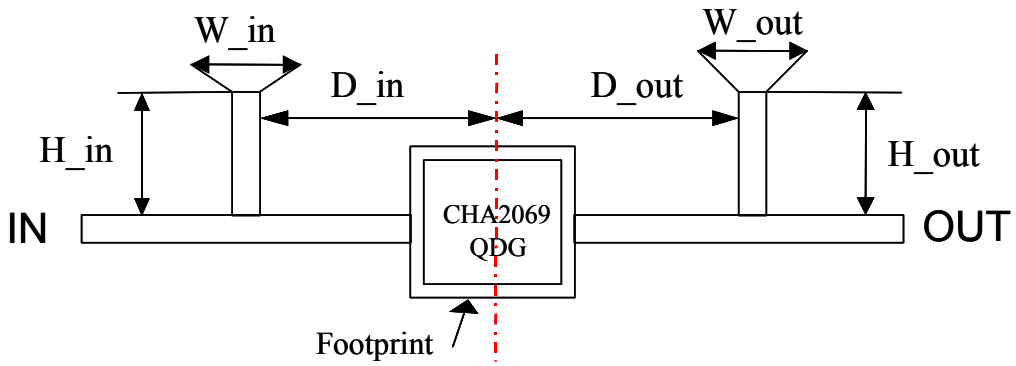
Dimension table for assembly board “95959”.



	D_in (µm)	W_in (µm)	H_in (µm)	D_out (µm)	W_out (µm)	H_out (µm)
21-24GHz	4010	900	800	4010	300	800

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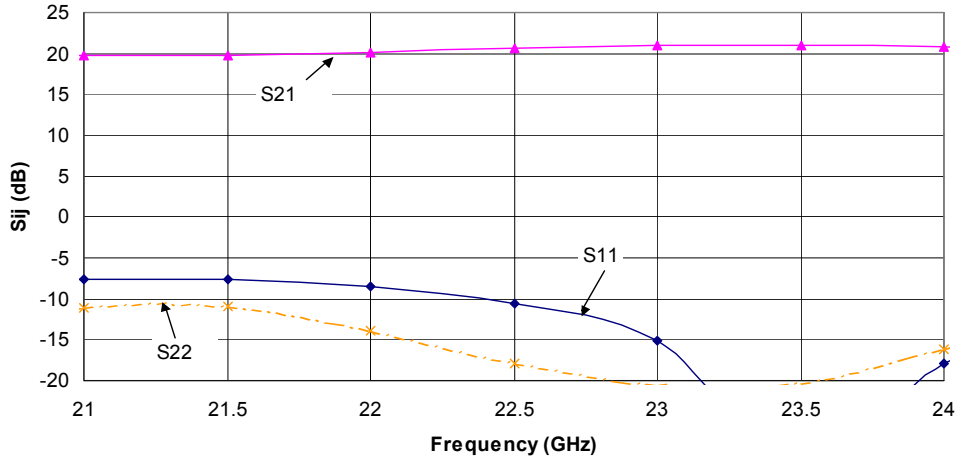
Typical results

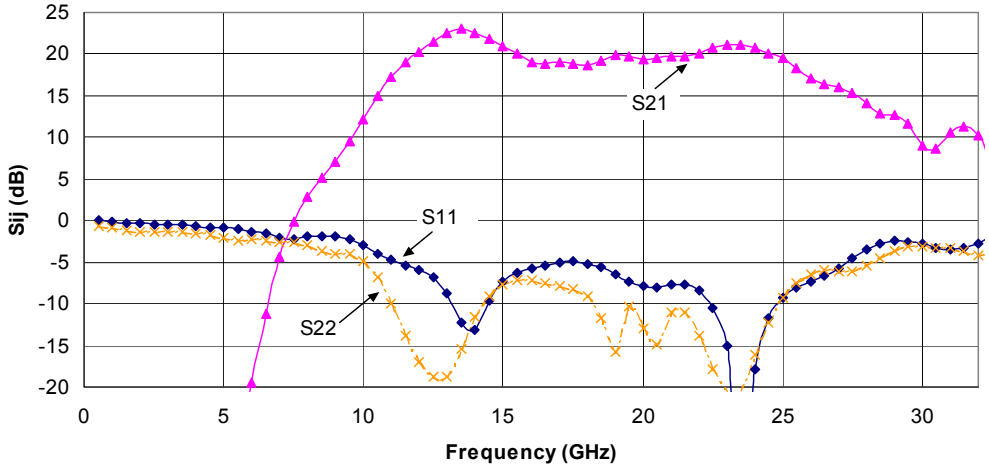
Tamb = +25°C, Vd = +4,5V

Typical S parameters with matching network for the 21-24GHz band
Config. Low current (BDE grounded)
Narrow frequency band



Sij using the proposed land pattern and board 95959 with SSMA connectors.
Sij in the package access plan

Typical S parameters with matching network for the 21-24GHz band
Config. Low current (BDE grounded)
Wide frequency range



Sij using the proposed land pattern and board 95959 with SSMA connectors.
Sij in the package access plan

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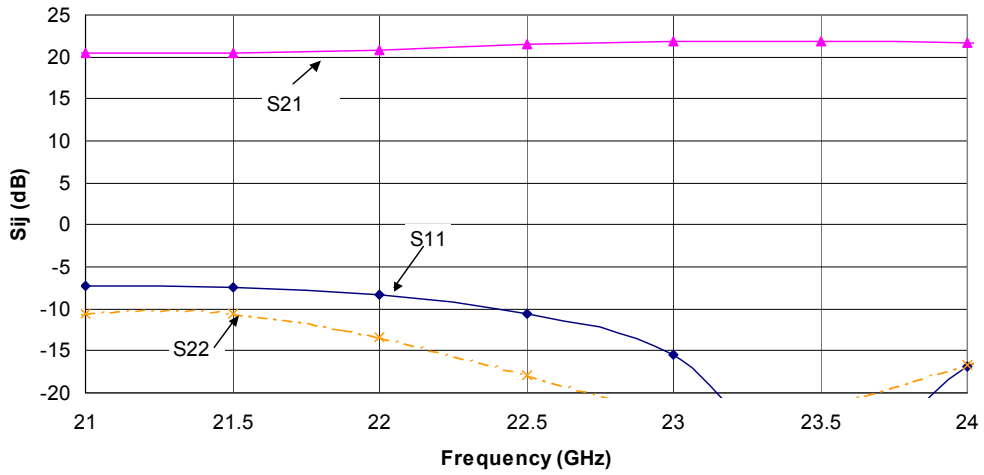
Typical PCB Measured Performance

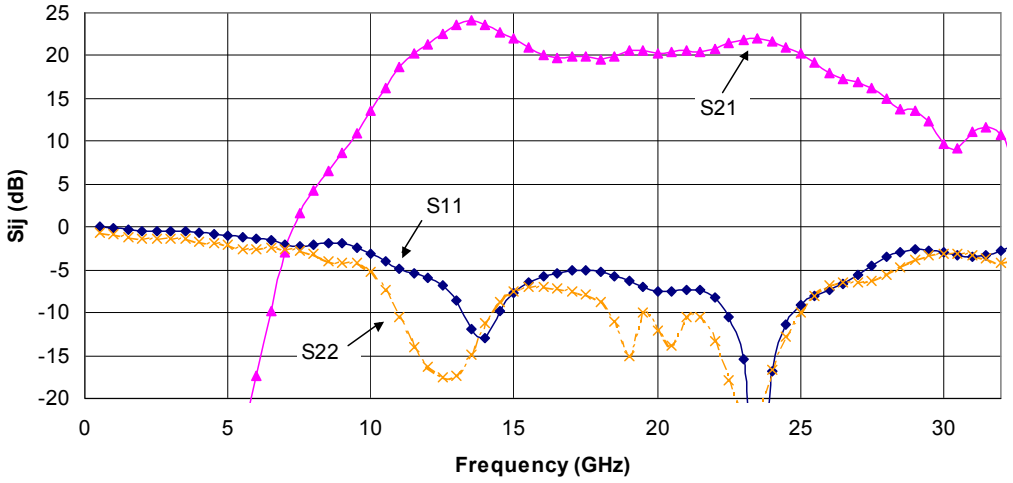
Tamb = +25°C, Vd = +4,5V

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



Sij using the proposed land pattern and board 95959 with SSMA connectors.
Sij in the package access plan

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



Sij using the proposed land pattern and board 95959 with SSMA connectors.
Sij in the package access plan

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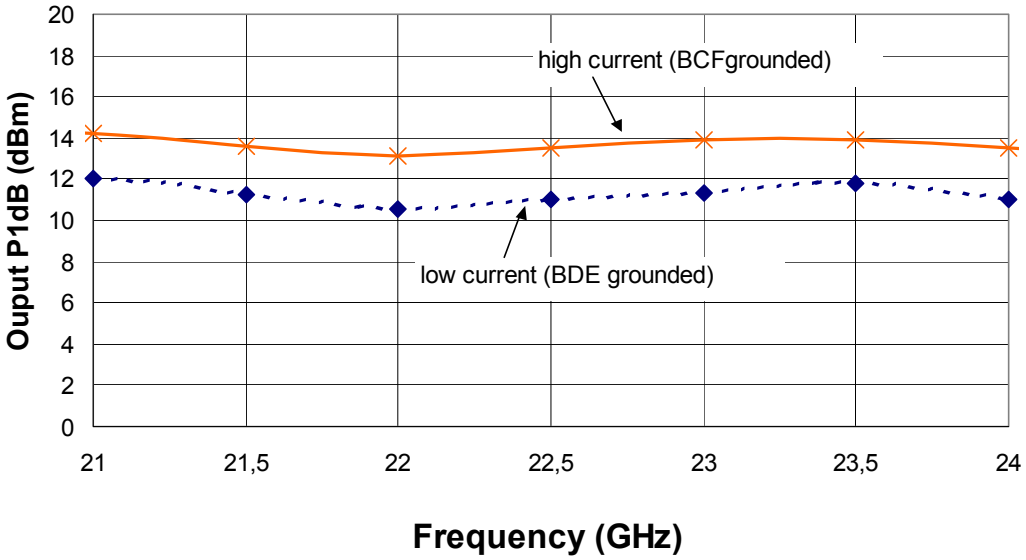
Typical PCB Measured Performance

Tamb = +25°C, Vd = +4,5V

Typical Output 1 dB compression with the Matching Network for the 21-24GHz Band



Output P1dB using the proposed land pattern and board 95959 with SSMA connectors

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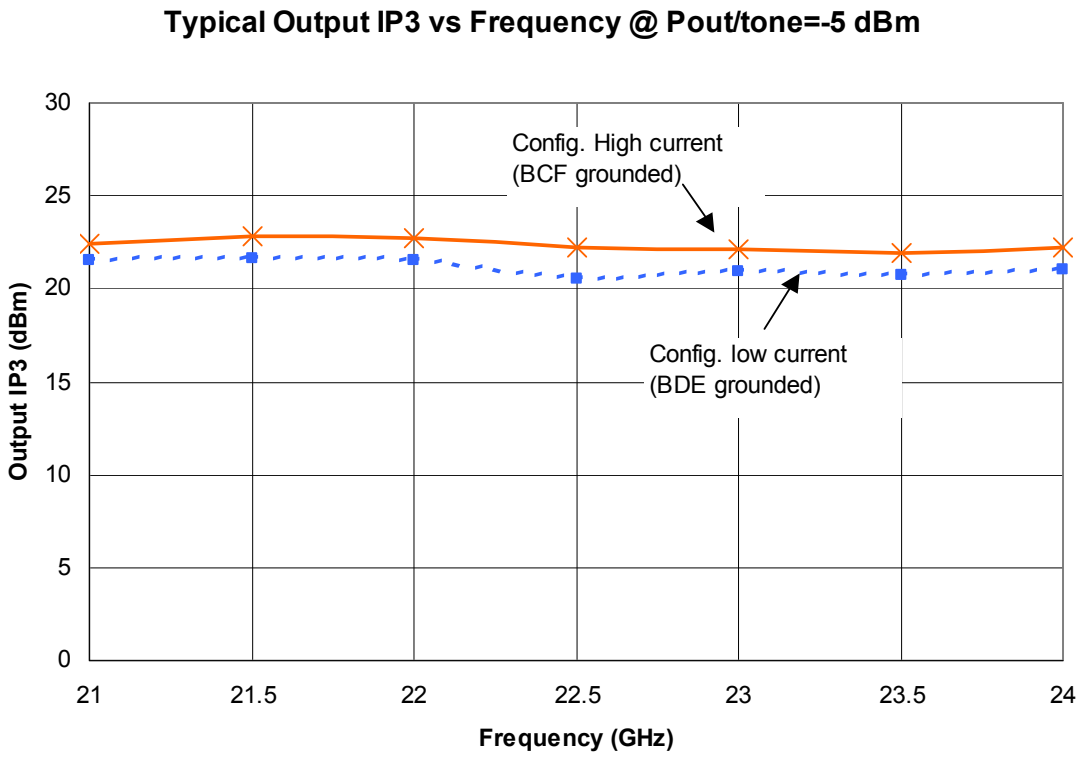
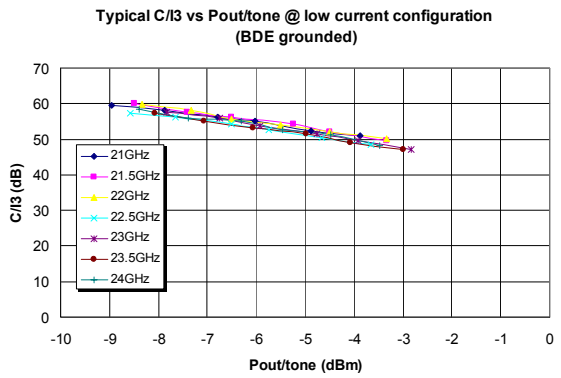
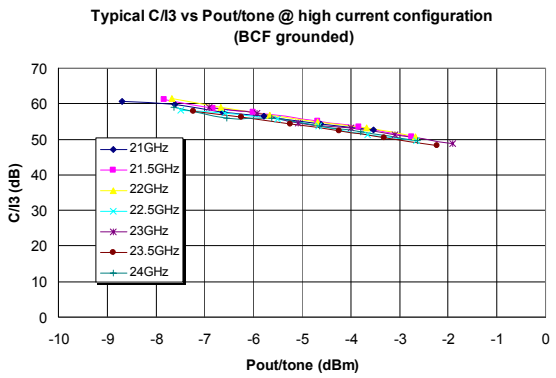
Typical PCB Measured Performance

Tamb = +25°C, Vd = +4,5V



Output IP3 using the proposed land pattern and board 95959 with SSMA connectors





C/I3 using the proposed land pattern and board 95959 with SSMA connectors

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Typical Electrical Characteristics summary :

Low current configuration

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

Symbol	Parameter		Unit
Fop	Operating frequency range	21-24	GHz
G	Gain	20.5	dB
ΔG	Gain flatness	±1	dB
NF	Noise figure	3.5	dB
IS11I	Input return loss	-10	dB
IS22I	Ouput return loss	-12	dB
IP3	3rd order intercept point (Pout/tone=-5dBm)	20	dBm
P1dB	Output power at 1dB gain compression	11	dBm
Id	Drain bias current	65	mA

High current configuration

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

Symbol	Parameter		Unit
Fop	Operating frequency range	21-24	GHz
G	Gain	21	dB
ΔG	Gain flatness	±1	dB
NF	Noise figure	3.5	dB
IS11I	Input return loss	-10	dB
IS22I	Ouput return loss	-15	dB
IP3	3rd order intercept point (Pout/tone=-5dBm)	22.5	dBm
P1dB	Output power at 1dB gain compression	13.5	dBm
Id	Drain bias current	85	mA

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