6-18GHz 4 bit Digital Variable Amplifier

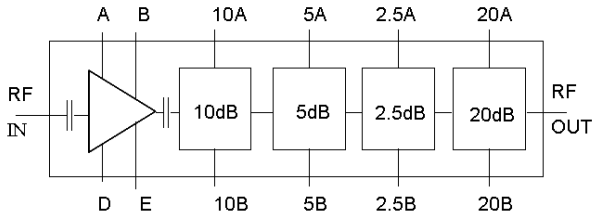
GaAs Monolithic Microwave IC

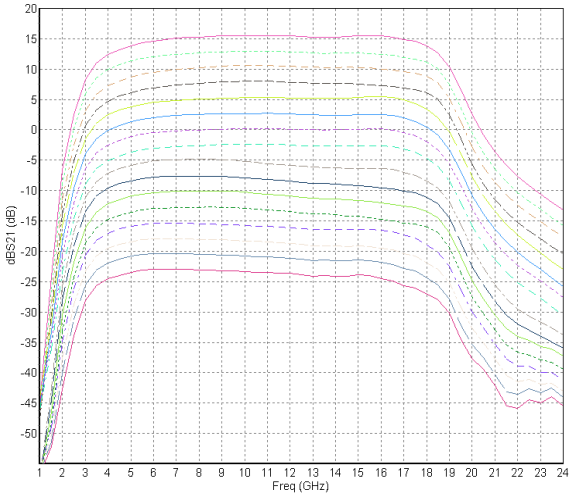
Description

The CHA3514 is composed by a two stage travelling wave amplifier followed by a four steps digital attenuator. It is designed for defense applications. The backside of the chip is both RF and DC grounded. This helps to simplify the assembly process.

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

It is available in chip form.





Typical on wafer Measurements
Gain versus attenuation states

Main Features

- Performances: 6-18GHz
- 19dBm saturated output power
- 13 dB gain
- 4bit attenuator for 39.5dB dynamic range
- DC power consumption, 190mA @ 4.5V
- Chip size: 5.54 x 2.30 x 0.1mm

Main Characteristics

Tamb. = 25℃

Symbol	Parameter	Min	Typ	Max	Unit
Fop	Operating frequency range	6		18	GHz
G	Small signal gain @ Attenuator state 0dB		13		dB
Psat	Saturated Output power @ Attenuator state 0dB		19		dBm
ATT dyn	Attenuator range with 4bit		39.5		dB

ESD Protection: Electrostatic discharge sensitive device. Observe handling precautions!

United Monolithic Semiconductors S.A.S.
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

Electrical Characteristics on wafer

Tamb = +25℃
Vd = Pads B, D = 4.5V, Vg = Pads A, E tuned for Id = 190mA

Symbol	Parameter	Min	Typ	Max	Unit
Fop	Operating frequency range (1)	6		18	GHz
G	Small signal gain @ Attenuator state 0dB (1)	11	13		dB
ATT bit	Attenuator bit: State 2.5dB	2	2.6	3.5	dB
	State 5dB	4	5	6	dB
	State 10 dB	9	10	11	dB
	State 20dB	19	22	23	dB
ATT dyn	Attenuator dynamic range with 4bit	35	39.5		dB
P1dB	Output power at 1dB compression @ Attenuator state 0dB (1)		18		dBm
Psat	Saturated Output power @ Attenuator state 0dB (1)		19		dBm
NF	Noise figure @ Attenuator state 0dB		7		dB
RL_IN	Input Return Loss all attenuator states		-13	-8	dB
RL_OUT	Output Return Loss all attenuator states		-15	-9	dB
Vd	Drain bias DC voltage (Pads B,D)		4.5		V
Id	Bias current @ small signal		190	250	mA
Vc	Control voltage for Attenuator bits	-5		0	V

(1) These values are representative for on-wafer measurements that are made without bonding wires at the RF ports.

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

Absolute Maximum Ratings

Tamb. = 25℃ (1)

Symbol	Parameter	Values	Unit
Vd	Maximum Drain bias voltage (Pads B,D)	+5	V
Id	Drain bias current with Vd=4.5V	320	mA
Vg	Gate bias voltage (Pads A, E)	-2 to +0.4	V
Vc	Attenuator bits control voltage	-7 to +0.6	V
Pin	Maximum input power overdrive (2)	+20.0	dBm
Tch	Maximum channel temperature	+175	℃
Ta	Operating temperature range	-40 to +70	℃
Tstg	Storage temperature range	-55 to +125	℃

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

4bit VGA Control interface

The attenuator states are controlled by 8 voltages.

state	Theoretical attenuation dB	Voltage CONTROL PAD							
		10A (V)	10B (V)	5A (V)	5B (V)	2.5A (V)	2.5B (V)	20A (V)	20B (V)
0	0 référence	-5	0	-5	0	-5	0	-5	0
1	2.5	-5	0	-5	0	0	-5	-5	0
2	5	-5	0	0	-5	-5	0	-5	0
3	7.5	-5	0	0	-5	0	-5	-5	0
4	10	0	-5	-5	0	-5	0	-5	0
5	12.5	0	-5	-5	0	0	-5	-5	0
6	15	0	-5	0	-5	-5	0	-5	0
7	17.5	0	-5	0	-5	0	-5	-5	0
8	20	-5	0	-5	0	-5	0	0	-5
9	22.5	-5	0	-5	0	0	-5	0	-5
10	25	-5	0	0	-5	-5	0	0	-5
11	27.5	-5	0	0	-5	0	-5	0	-5
12	30	0	-5	-5	0	-5	0	0	-5
13	32.5	0	-5	-5	0	0	-5	0	-5
14	35	0	-5	0	-5	-5	0	0	-5
15	37.5	0	-5	0	-5	0	-5	0	-5

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 chip on wafer Sij parameters for reference state

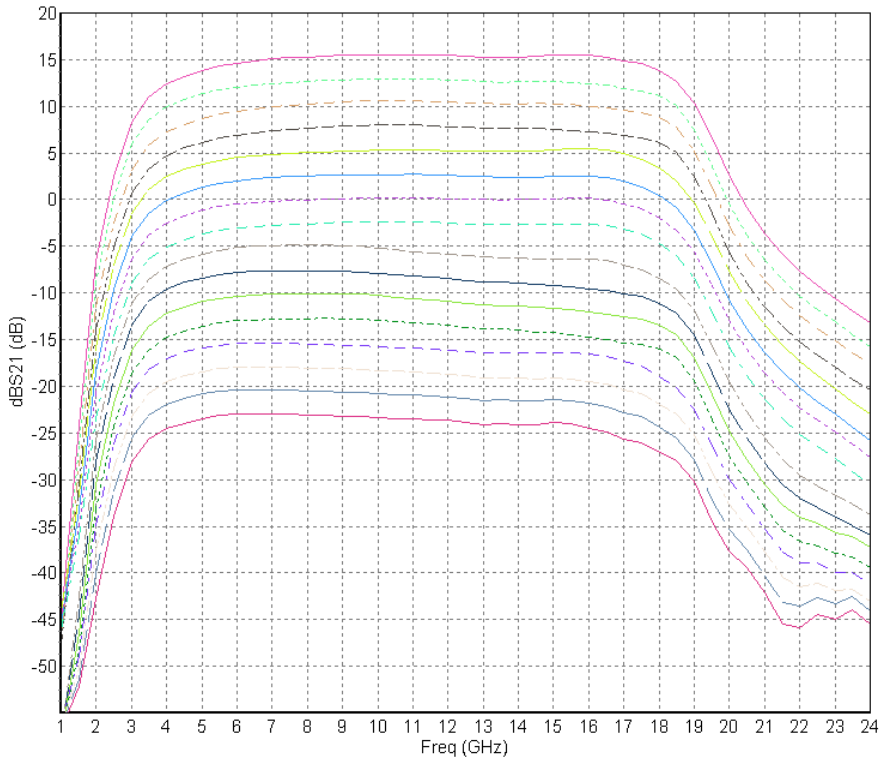
Tamb 25°C, B = D = 4.5V, Id = 190mA, 10A, 5A, 2.5A, 20A = -5V, 10B, 5B, 2.5B, 20B = 0V

Freq (GHz)	dB(S11)	P(S11) (°)	dB(S21)	P(S21) (°)	dB(S12)	P(S12) (°)	dB(S22)	P(S22) (°)
1.0	-0.8	-42.4	-44.8	-114.9	-69.9	-91.3	-3.3	-59.4
1.5	-1.5	-62.3	-24.1	-166.4	-69.2	-148.8	-4.6	-89.6
2.0	-2.1	-81.0	-6.6	156.9	-67.0	-165.4	-7.2	-122.7
2.5	-2.8	-99.6	2.5	94.4	-61.4	-179.5	-10.5	-160.5
3.0	-4.1	-116.9	8.3	37.6	-69.4	74.2	-14.8	147.5
3.5	-5.1	-133.6	11.0	-17.7	-86.1	97.0	-17.4	88.8
4.0	-6.3	-148.7	12.4	-65.1	-78.4	133.3	-16.9	43.1
4.5	-7.8	-162.3	13.3	-107.0	-72.8	112.9	-15.5	15.9
5.0	-9.3	-175.1	13.9	-145.1	-70.0	77.8	-14.4	-2.5
5.5	-10.7	174.7	14.3	178.9	-68.7	34.4	-13.5	-17.5
6.0	-12.2	167.3	14.6	144.5	-66.8	-5.4	-12.9	-30.6
6.5	-13.8	161.4	14.9	111.4	-64.9	-37.6	-12.4	-42.3
7.0	-15.0	157.0	15.1	79.3	-67.2	-61.6	-12.1	-54.0
7.5	-15.6	155.3	15.2	47.9	-62.7	-85.6	-12.0	-66.0
8.0	-16.2	156.1	15.3	16.9	-59.7	-109.9	-12.2	-78.5
8.5	-16.6	154.3	15.4	-13.7	-57.5	-138.0	-12.7	-90.1
9.0	-16.1	151.1	15.5	-44.0	-55.6	-167.3	-13.6	-102.2
9.5	-15.3	148.6	15.5	-73.9	-54.7	171.2	-15.1	-113.3
10.0	-14.6	145.0	15.5	-103.8	-53.2	136.4	-17.3	-123.0
10.5	-14.0	136.7	15.5	-133.5	-54.7	117.6	-20.4	-125.3
11.0	-13.0	127.2	15.5	-163.1	-56.0	96.6	-23.7	-113.1
11.5	-12.2	119.0	15.5	167.2	-56.4	74.2	-24.5	-88.9
12.0	-11.8	108.7	15.5	137.5	-59.8	43.6	-22.9	-73.3
12.5	-11.5	96.1	15.4	107.7	-76.5	22.9	-21.9	-66.9
13.0	-11.2	83.5	15.3	77.9	-65.0	178.8	-20.1	-59.5
13.5	-11.6	73.4	15.2	49.1	-60.2	148.9	-17.4	-59.3
14.0	-12.5	64.6	15.3	20.1	-59.5	146.9	-15.1	-68.1
14.5	-13.1	57.6	15.4	-10.6	-55.2	142.1	-13.5	-81.7
15.0	-13.2	52.4	15.5	-42.1	-49.9	141.5	-12.6	-99.9
15.5	-14.1	44.8	15.5	-74.7	-45.5	117.2	-12.6	-121.4
16.0	-15.7	40.2	15.4	-108.3	-43.7	87.3	-13.9	-146.5
16.5	-18.0	39.2	15.3	-143.1	-42.0	61.2	-16.6	-177.9
17.0	-19.7	66.0	14.9	-178.3	-41.7	36.3	-21.3	136.0
17.5	-16.8	97.0	14.5	144.9	-41.5	14.5	-22.3	46.6
18.0	-12.7	96.4	13.8	105.1	-41.0	-13.7	-17.6	-12.9
18.5	-9.9	89.2	12.7	64.1	-42.1	-42.4	-15.1	-51.6
19.0	-7.1	80.6	10.3	19.1	-45.0	-76.5	-15.6	-84.5
19.5	-5.3	68.5	6.6	-19.0	-50.6	-91.9	-20.1	-107.2
20.0	-4.1	54.4	2.6	-47.9	-54.4	-69.2	-29.1	-59.0
20.5	-3.3	41.5	-0.8	-70.2	-53.6	-67.9	-19.5	-18.0
21.0	-2.8	30.8	-3.6	-89.1	-54.2	-66.0	-14.7	-29.5
21.5	-2.6	21.1	-5.8	-107.0	-54.2	-73.1	-12.0	-43.1
22.0	-2.4	11.6	-7.7	-125.3	-55.5	-89.7	-10.4	-56.0
22.5	-2.2	3.5	-9.3	-143.8	-58.9	-95.4	-9.4	-69.1
23.0	-2.2	-3.3	-10.6	-162.9	-62.1	-90.4	-8.8	-81.5
23.5	-2.1	-10.1	-11.9	176.9	-65.9	-60.7	-8.6	-92.4
24.0	-2.1	-16.9	-13.2	156.5	-62.2	-32.7	-8.6	-102.8

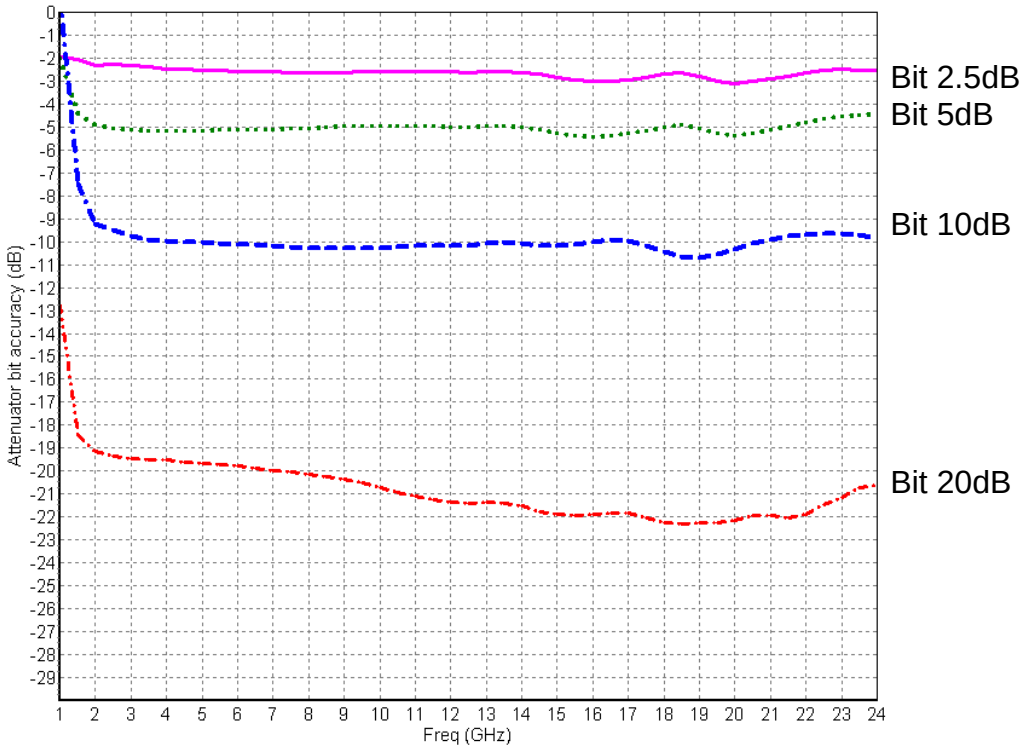
Route Départementale 128 , B.P.46 - 91401 ORSAY Cedex - FRANCE
Tel.: +33 (0)1 69 33 03 08 - Fax : +33 (0)1 69 33 03 09

Typical on wafer Measurements @ 25°C

Bias conditions: Vd = 4.5V, Vg tuned for Id = 190mA

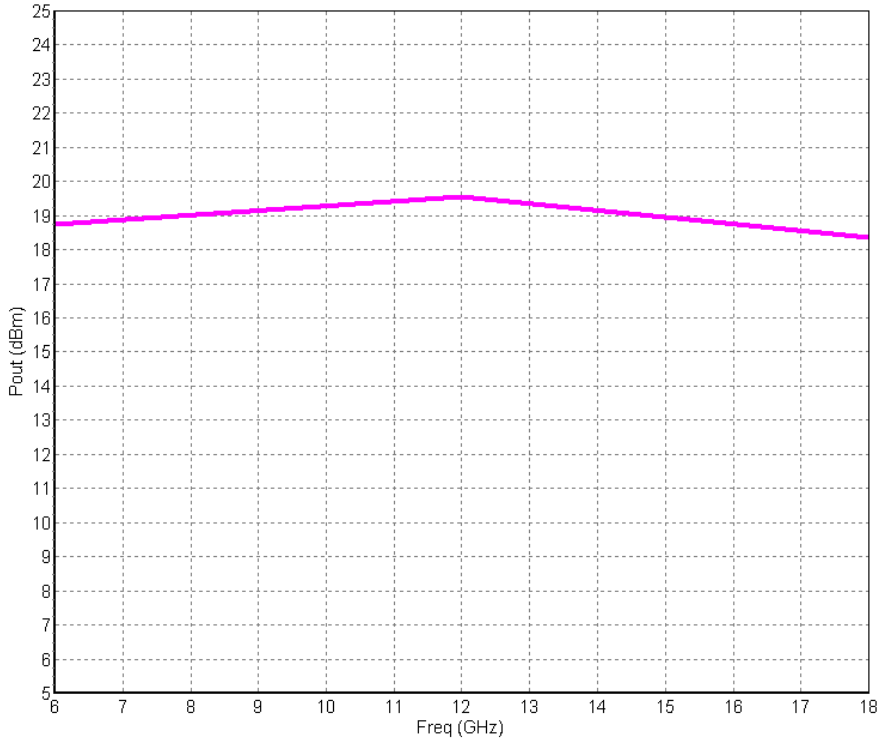


Linear Gain versus attenuator states

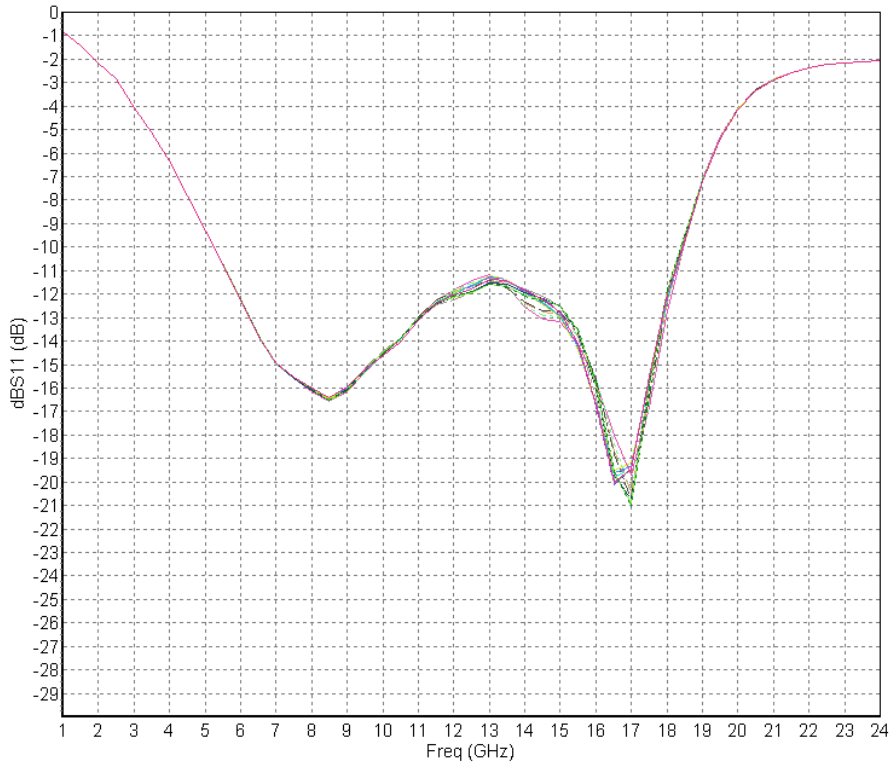


Attenuator bit values vs frequency for main states

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

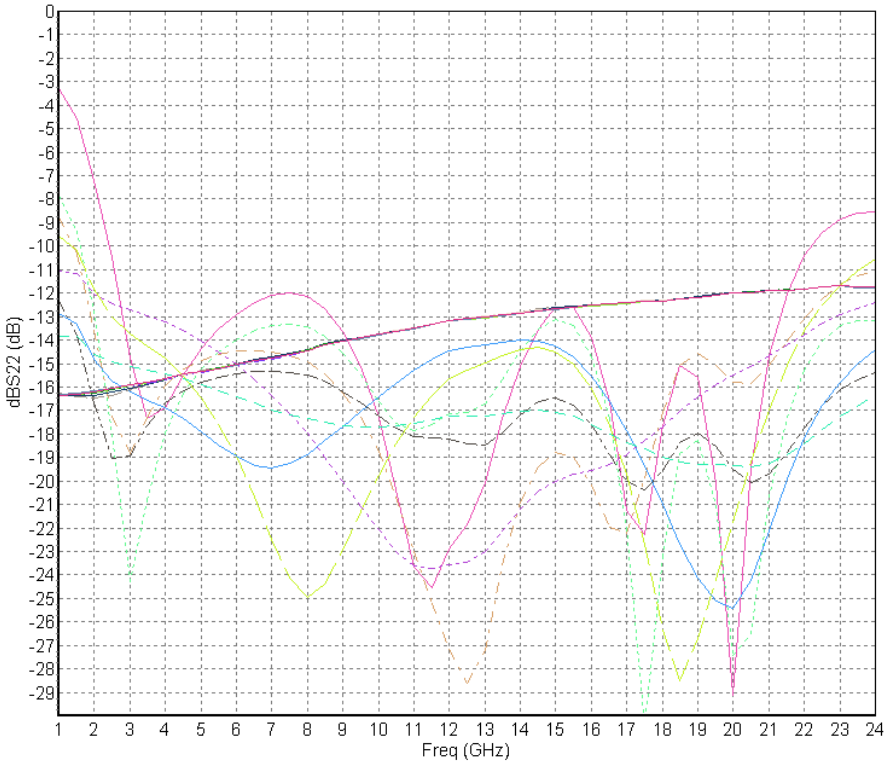


Saturated output power @ nominal state

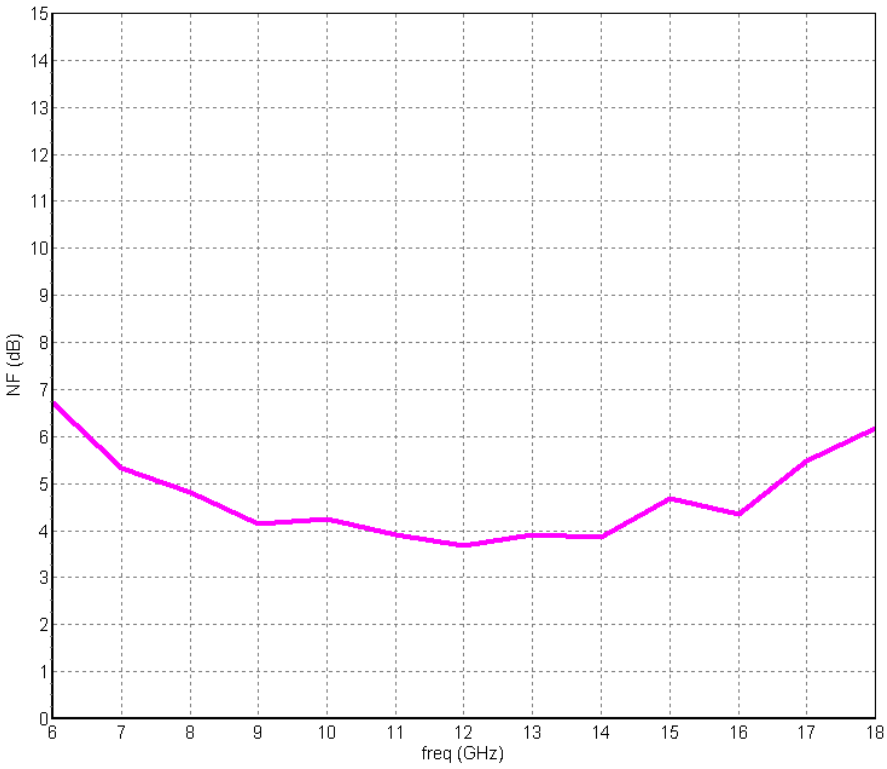


dB(S11) versus frequency for all states

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



dB(S22) versus frequency for all states

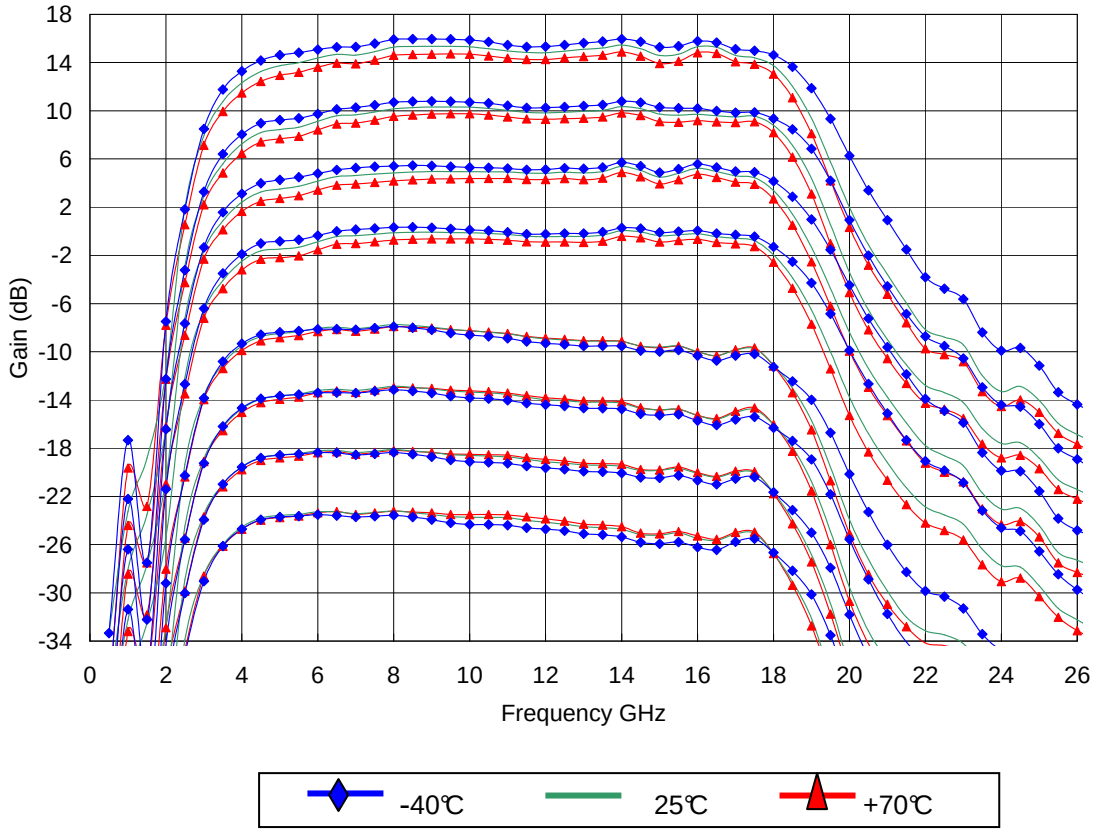


Noise Figure vs frequency @ nominal state

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 test fixture Measurements

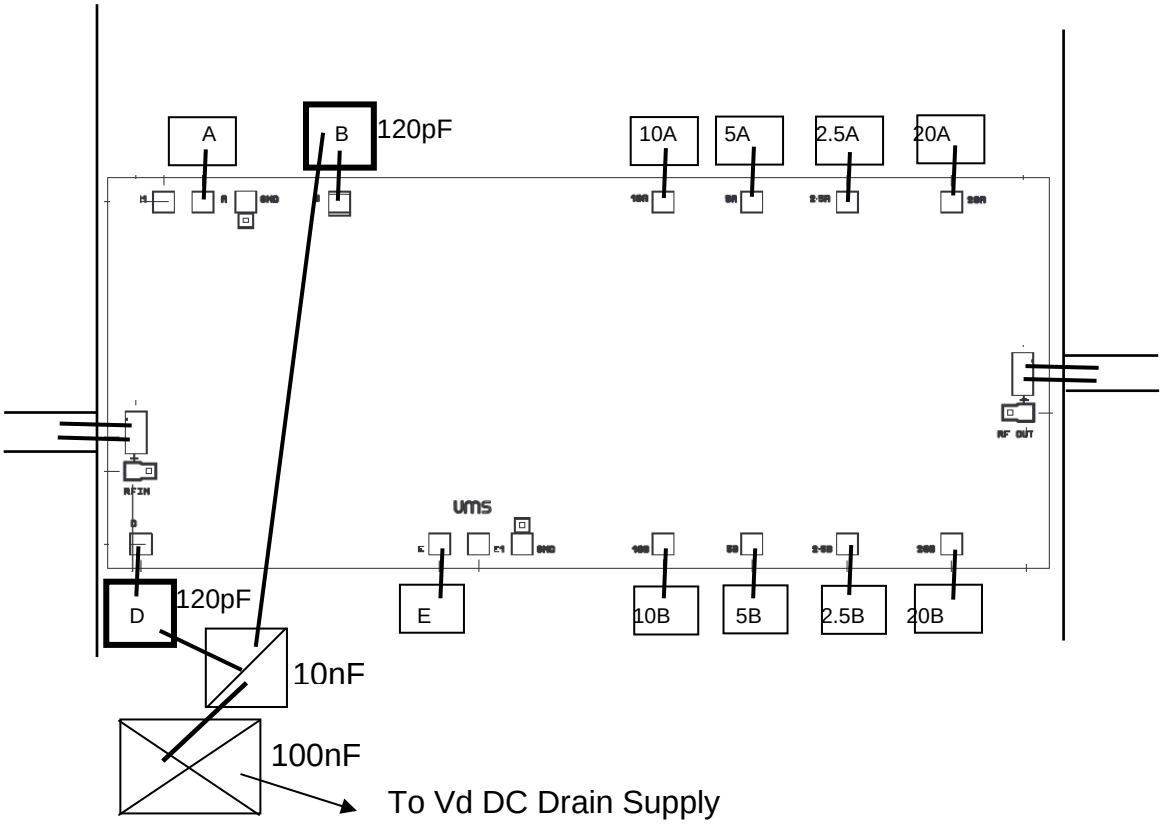
Bias conditions: Vd=4.5V, Vg tuned for Id = 190mA



Linear Gain versus attenuation states & temperature

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

Chip Assembly and Mechanical Data



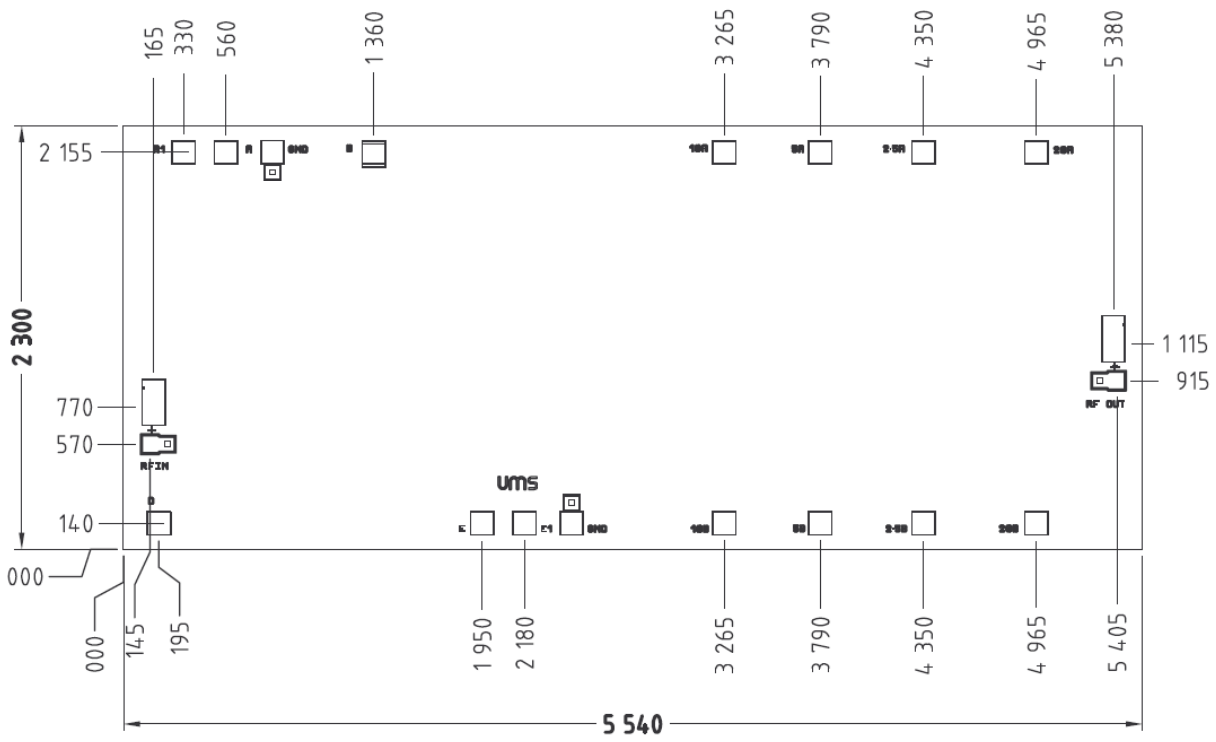
Note : Supply feed should be capacitively bypassed. 25µm diameter gold wire is to be prefered.

Recommended circuit bonding table

Label	Type	Decoupling	Comment
10A, 10B	Vc	*Not required*	10dB pad control
5A, 5B	Vc	*Not required*	5dB pad control
2.5A, 2.5B	Vc	*Not required*	2.5dB pad control
20A, 20B	Vc	*Not required*	20dB pad control
B	**Vd**	**120pF / 10nF**	**Drain Supply**
D	**Vd**	**120pF / 10nF**	**Drain Supply**
A	Vg	*Not required*	Gate Supply
E	Vg	*Not required*	Gate Supply

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

Bonding pad positions



UNITS : µm
Tol : ±35µm

Chip thickness: 100µm

Ordering Information

Chip form : CHA3514-99F/00

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