31-40GHz Variable Gain Amplifier

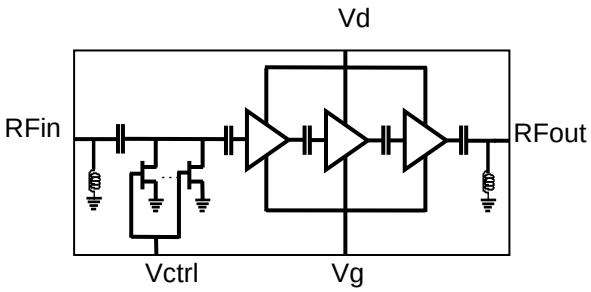
Preliminary

GaAs Monolithic Microwave IC

Description

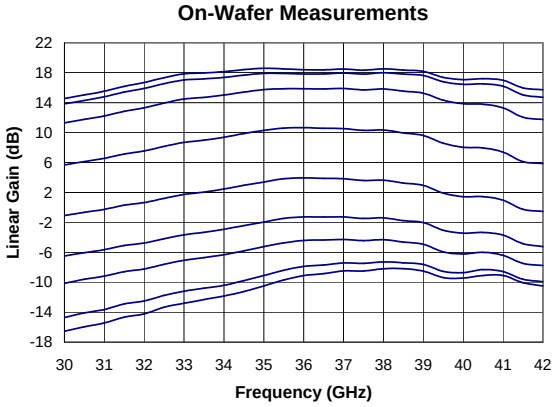
The CHA3694 is a variable gain broadband three-stage monolithic amplifier. It is designed for a wide range of applications, typically commercial communication systems.
The backside of the chip is both RF and DC grounded. This helps to simplify the assembly process.
The circuit is manufactured with a power pHEMT process, 0.15µm gate length, via holes through the substrate and air bridges.

It is supplied in chip form.



Main Features

- Broadband performance 31-40GHz
- 17dB gain
- 25dBm output IP3
- 26dB gain control range
- ESD protected (see page 11)
- DC power consumption: 3.5V, 160mA
- Chip size: 2.41 x 2.08 x 0.07mm



Main Characteristics

Tamb. = 25°C, Vd = 3.5V

Symbol	Parameter	Min	Typ	Max	Unit
Fop	Operating frequency range	31		40	GHz
G	Small signal gain		17		dB
Gc	Gain control range		26		dB
OIP3	3rd Output Intercept Point @ max. gain		25		dBm

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

Tamb. = 25°C. These values are representative of on-wafer measurements. *Preliminary*

Symbol	Parameter	Min	Typ	Max	Unit
Fop	Operating frequency range	31		40	GHz
G	Nominal gain @ max. gain (31-34GHz)		14.5		dB
	Nominal gain @ max. gain (37-40GHz)		17		dB
NF	Noise Figure @ nominal gain (31-34GHz)		10		dB
	Noise Figure @ nominal gain (37-40GHz)		8		dB
RLin	Input Return Loss (any attenuation) (31-34GHz)		-4		dB
	Input Return Loss (any attenuation) (37-40GHz)		-3		dB
RLout	Output Return Loss (any attenuation) (31-34GHz)		-11.5		dB
	Output Return Loss (any attenuation) (37-40GHz)		-7		dB
OIP3	3rd Output Intercept Point @ max. gain		25		dBm
P1dB	Output Power at 1dB gain compression @ nominal gain		17		dBm
Gc	Gain control range		26		dB
Vd	Drain bias voltage		3.5		V
Id	Drain bias current (*)		160		mA
Idc	Drain current at 1dB gain compression		180		mA
Vg	Gate bias voltage		-0.8		V
Vctrl	Variable gain control voltage	-1.5		+0,6	V

(*) Id not affected by Vctrl.

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

united monolithic semiconductors

Preliminary

Absolute Maximum Ratings (*)

Tamb = +25℃

Symbol	Parameter	Values	Unit
Vd	Drain bias voltage	4	V
Id	Power supply quiescent current	200	mA
Vg	Gate bias voltage	-2.0 to +0.4	V
Vctrl	Variable gain control voltage	-2.0 to +1.0	V
Pin	RF input power overdrive @ 3.5V	5	dBm
Tch	Maximum channel temperature	+175	℃
Ta	Operating temperature range	-40 to +85	℃
Tstg	Storage temperature range	-55 to +125	℃

(*) Operation of this device above anyone of these parameters may cause permanent damage.

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

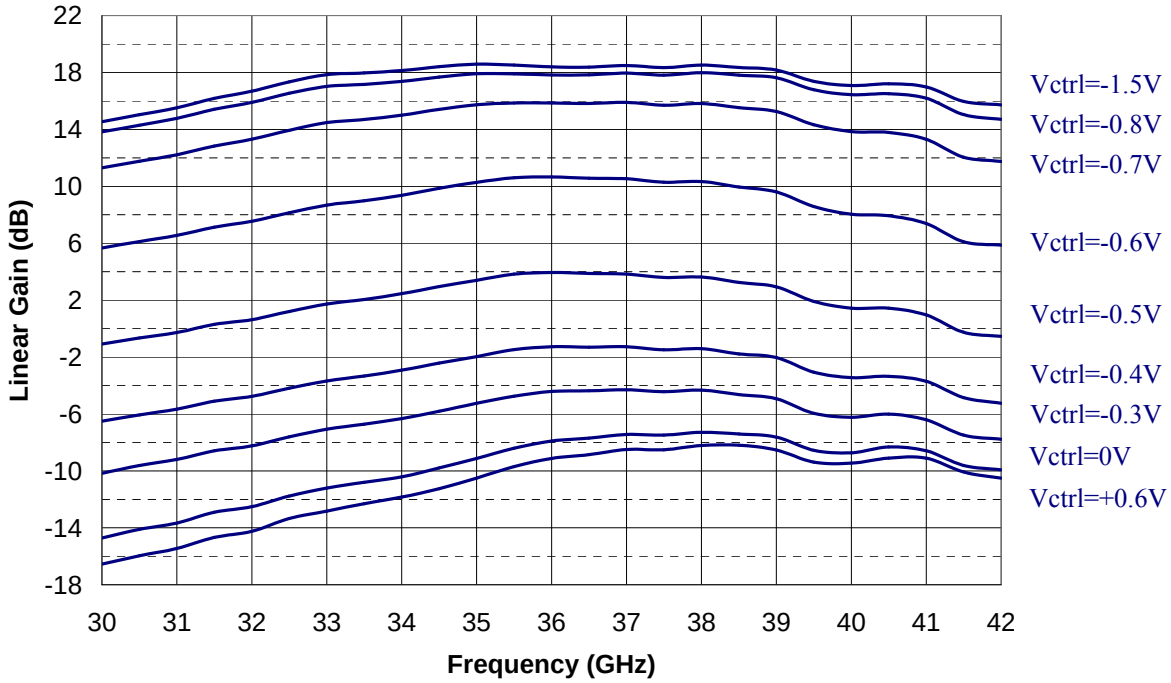
united monolithic semiconductors

Typical On-Wafer Measured Performance

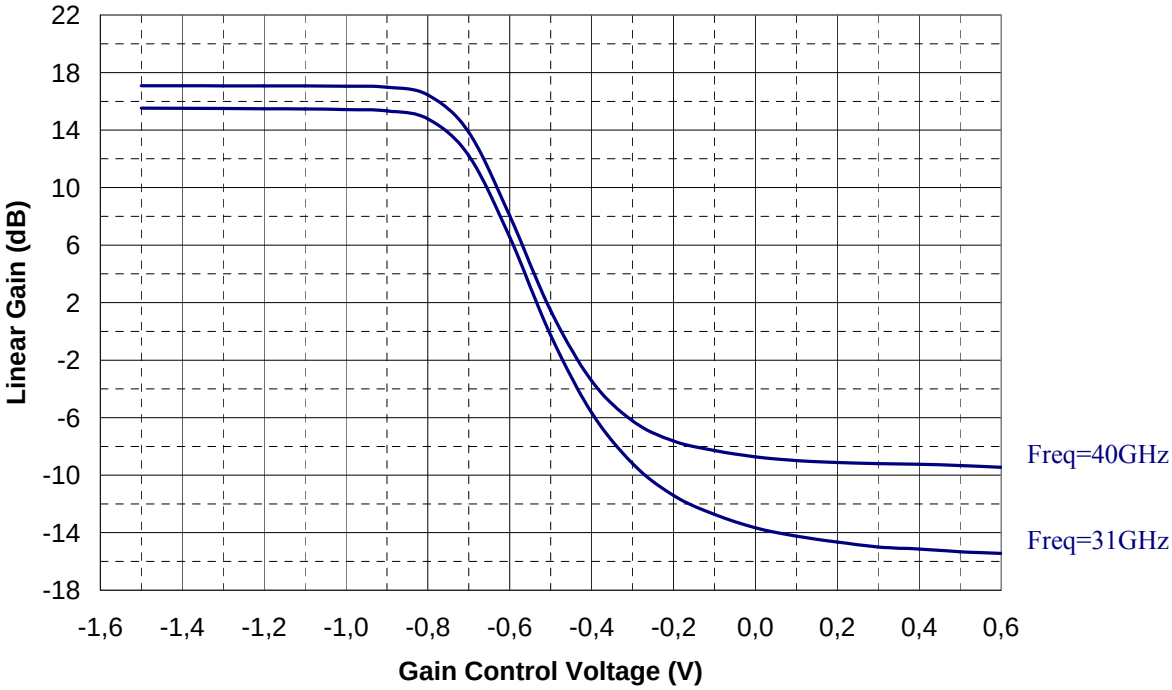
Preliminary

Tamb. = +25℃, Vd = +3.5V, Vg tuned for Id = 160mA

Linear Gain versus Frequency



Linear Gain versus Gain Control Voltage

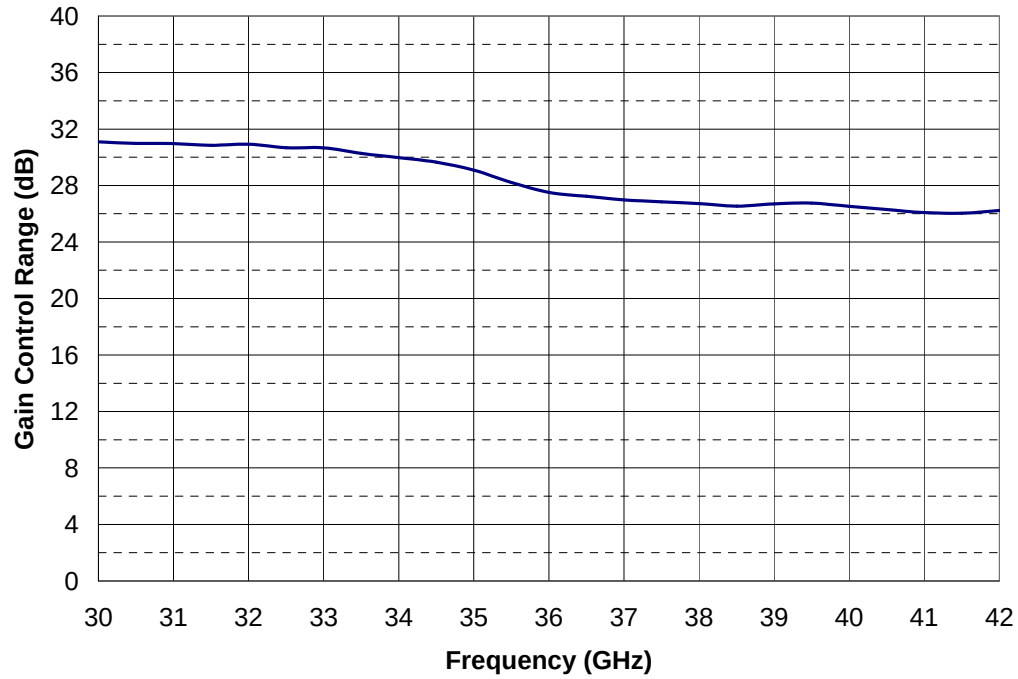


Route Départementale 128, B.P.46 - 91401 ORSAY Cedex - FRANCE
Tel.: +33 (0) 1 69 33 03 08 - Fax: +33 (0) 1 69 33 03 09

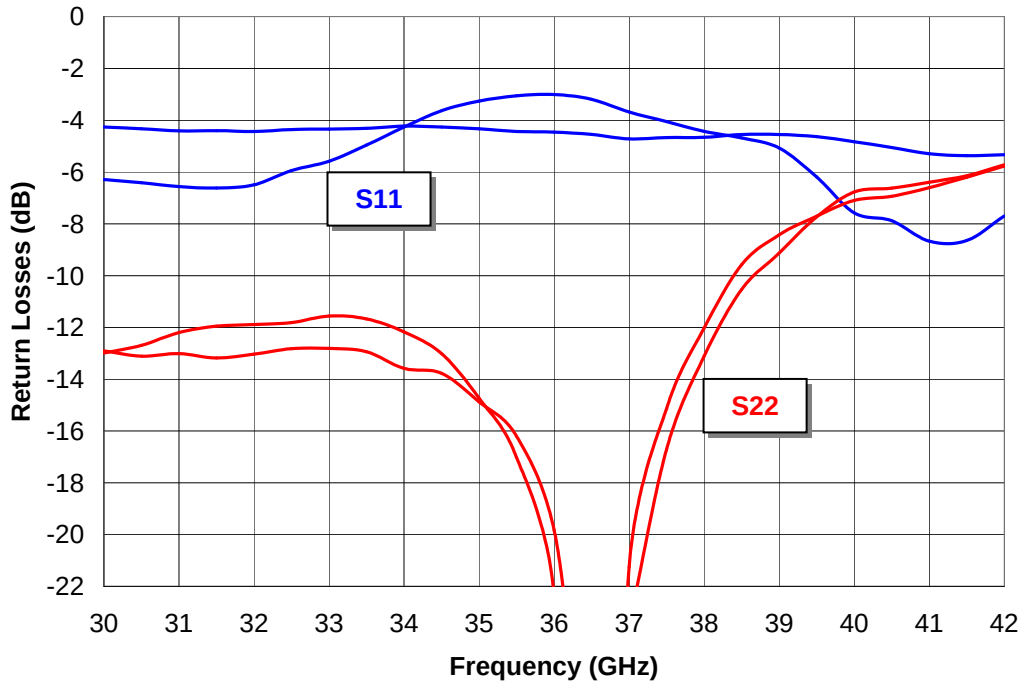
united monolithic semiconductors

Preliminary

Gain Control Range versus Frequency



Return Losses versus Frequency and Gain Control Voltage (-1,5V & +0,6V)



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

united monolithic semiconductors

Typical On-Wafer Sij parameters for Vctrl = -1.5V

Preliminary

Tamb. = +25°C, Vd = +3.5V, Id = 160mA

Freq (GHz)	dB(S11)	Ph(S11) (°)	dB(S12)	Ph(S12) (°)	dB(S2 1)	Ph(S21) (°)	dB(S22)	Ph(S22) (°)
1,0	0,0	174	-72,4	103	-48,9	-50	-0,8	163
2,0	-0,1	167	-70,1	91	-50,9	-173	-4,5	146
3,0	0,1	161	-69,9	-127	-45,2	38	-5,7	178
4,0	-0,1	154	-68,1	-164	-48,5	-41	-0,9	163
5,0	-0,3	146	-77,5	-160	-51,3	-178	-0,9	141
6,0	-1,5	134	-63,5	-162	-45,3	131	-2,0	127
7,0	-0,8	143	-68,2	102	-36,1	30	-3,2	118
8,0	-0,6	133	-69,1	15	-31,6	1	-4,3	110
9,0	-0,7	124	-68,1	107	-24,4	-32	-5,8	104
10,0	-0,7	116	-63,2	167	-17,2	-84	-7,4	106
11,0	-0,9	108	-55,7	152	-12,5	-140	-7,1	113
12,0	-1,1	98	-49,7	137	-9,0	166	-6,0	109
13,0	-1,4	87	-48,2	114	-6,5	117	-5,1	102
14,0	-1,9	74	-47,7	67	-4,3	70	-4,5	92
15,0	-3,0	57	-51,4	23	-2,9	24	-4,1	81
16,0	-4,9	36	-57,1	1	-1,5	-19	-3,7	68
17,0	-9,6	11	-61,5	-25	-0,5	-60	-3,3	54
18,0	-23,3	-24	-62,5	56	0,4	-98	-3,2	39
19,0	-16,3	151	-64,1	110	1,7	-132	-3,3	21
20,0	-10,5	129	-64,4	133	3,1	-168	-3,5	4
21,0	-8,0	113	-54,4	149	5,0	155	-4,0	-14
22,0	-7,0	99	-50,1	122	6,5	117	-4,7	-31
23,0	-6,6	87	-48,4	130	8,6	81	-5,7	-49
24,0	-6,8	76	-46,4	95	10,4	37	-6,7	-67
25,0	-7,0	70	-46,3	70	11,7	-8	-8,1	-85
26,0	-7,2	64	-47,0	63	12,4	-52	-9,9	-101
27,0	-7,2	59	-45,8	64	12,9	-93	-11,9	-118
28,0	-7,1	52	-47,6	55	13,5	-134	-14,4	-137
29,0	-6,8	47	-44,3	52	13,9	-176	-18,4	-172
30,0	-7,2	43	-47,1	39	14,6	145	-20,5	152
31,0	**-7,2**	**39**	**-46,9**	**49**	**15,5**	**106**	**-21,5**	**88**
31,5	**-7,3**	**38**	**-45,9**	**44**	**16,2**	**85**	**-20,6**	**56**
32,0	**-7,2**	**38**	**-46,0**	**45**	**16,7**	**62**	**-19,6**	**49**
32,5	**-6,9**	**39**	**-43,8**	**37**	**17,3**	**40**	**-18,4**	**27**
33,0	**-6,1**	**39**	**-44,8**	**31**	**17,9**	**14**	**-17,9**	**24**
33,5	**-5,2**	**37**	**-44,3**	**21**	**18,0**	**-10**	**-16,2**	**8**
34,0	**-4,4**	**32**	**-46,2**	**19**	**18,1**	**-33**	**-15,6**	**-6**
34,5	**-3,9**	**26**	**-45,4**	**28**	**18,4**	**-57**	**-15,2**	**-18**
35,0	**-3,4**	**20**	**-44,7**	**26**	**18,6**	**-83**	**-16,4**	**-29**
35,5	**-3,0**	**13**	**-42,8**	**26**	**18,5**	**-108**	**-17,7**	**-28**
36,0	**-2,7**	**6**	**-42,0**	**14**	**18,4**	**-133**	**-17,7**	**-33**
36,5	**-2,8**	**-2**	**-41,1**	**0**	**18,4**	**-156**	**-19,8**	**-51**
37,0	**-3,0**	**-9**	**-41,2**	**-18**	**18,5**	**178**	**-23,6**	**-69**
37,5	**-3,5**	**-14**	**-42,5**	**-30**	**18,3**	**153**	**-50,8**	**-127**
38,0	**-3,7**	**-19**	**-44,6**	**-34**	**18,5**	**127**	**-26,4**	**96**
38,5	**-4,3**	**-24**	**-44,4**	**-40**	**18,4**	**99**	**-16,9**	**85**
39,0	**-4,9**	**-28**	**-45,0**	**-54**	**18,2**	**70**	**-12,7**	**66**
39,5	**-5,5**	**-31**	**-46,4**	**-64**	**17,4**	**42**	**-9,9**	**55**
40,0	**-6,4**	**-34**	**-48,0**	**-63**	**17,1**	**16**	**-8,3**	**38**
41,0	-7,6	-29	-51,7	-118	17,0	-45	-6,9	18
42,0	-7,3	-16	-63,0	-162	15,7	-111	-6,3	5
43,0	-4,8	-17	-59,6	-73	13,2	180	-5,6	-8
44,0	-3,6	-28	-54,8	-89	11,2	100	-6,7	-17
45,0	-2,9	-40	-59,2	-179	2,5	-4	-4,3	-7
46,0	-3,0	-50	-53,9	146	-10,9	-70	-3,2	-26
47,0	-3,2	-61	-47,4	165	-24,5	-107	-3,5	-36
48,0	-3,9	-73	-41,4	111	-47,2	142	-3,4	-42
49,0	-4,6	-87	-39,6	89	-43,7	171	-3,0	-50
50,0	-6,8	-102	-37,2	53	-29,1	96	-3,7	-57

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

united monolithic semiconductors

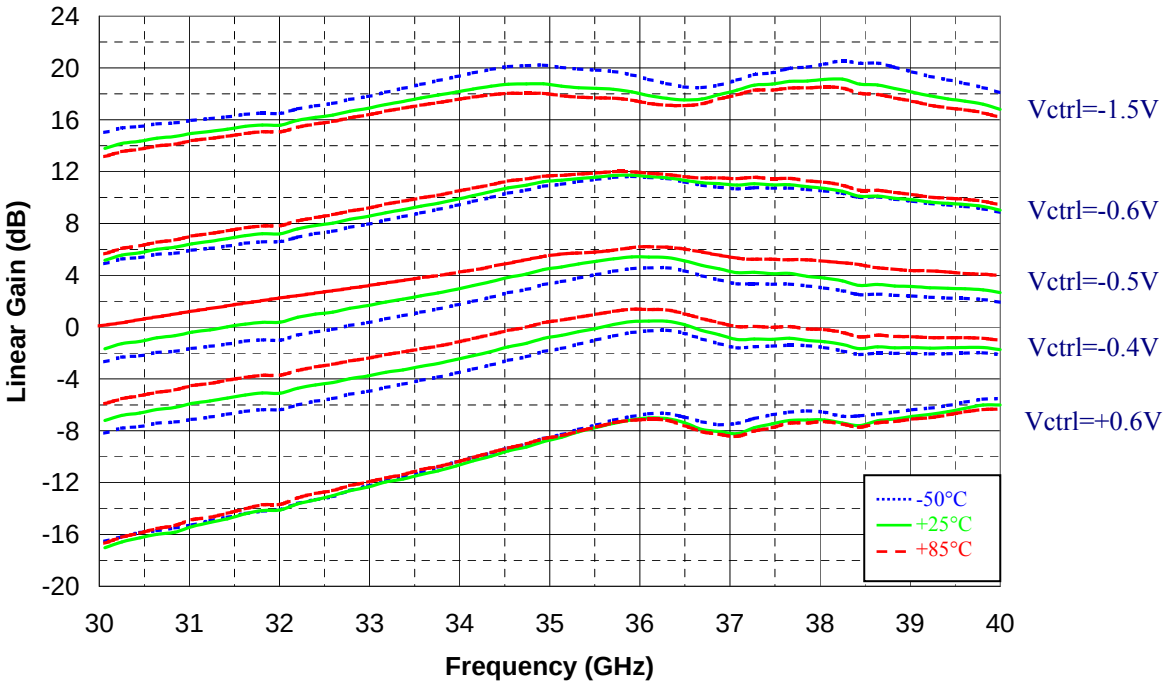
Typical Measured Performance in Test Fixture

Preliminary

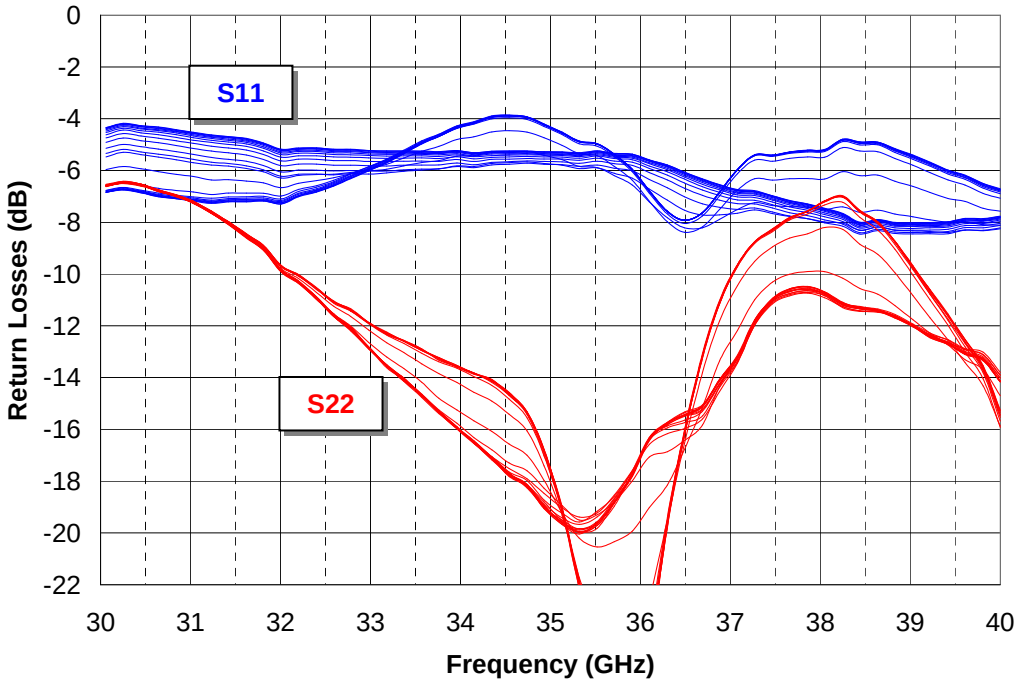
Vd = +3.5V, Vg tuned for Id = 160mA

Measurements in test fixture, using the proposed chip assembly, as defined page 10.

Linear Gain versus Frequency and Temperature



Return Losses versus Frequency and Gain Control Voltage (-1,5V to +0,6V)

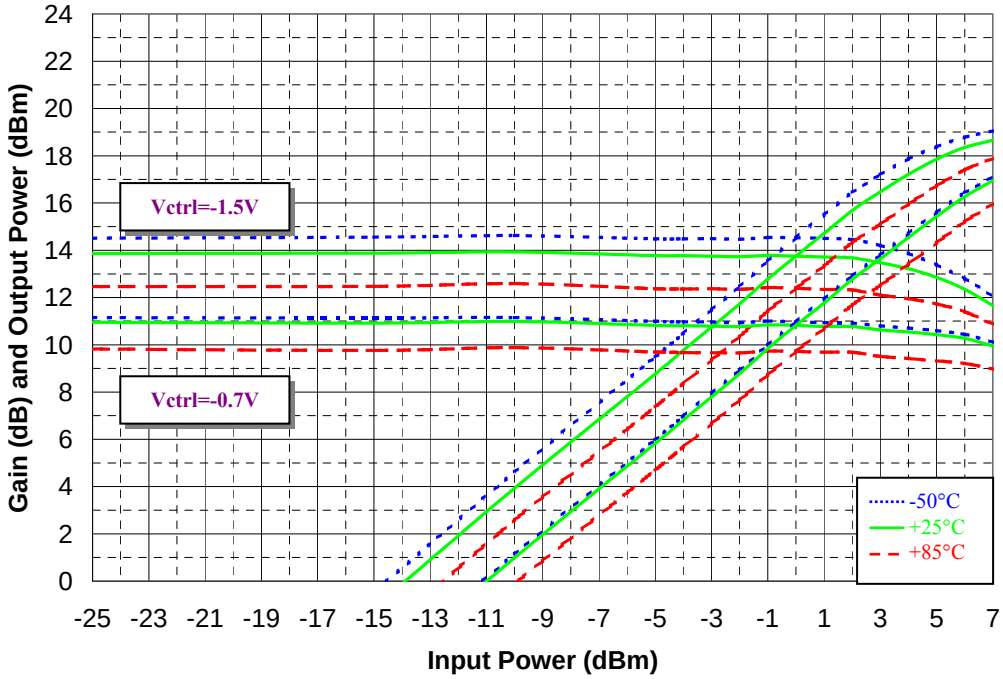


Route Départementale 128, B.P.46 - 91401 ORSAY Cedex - FRANCE
Tel.: +33 (0) 1 69 33 03 08 - Fax: +33 (0) 1 69 33 03 09

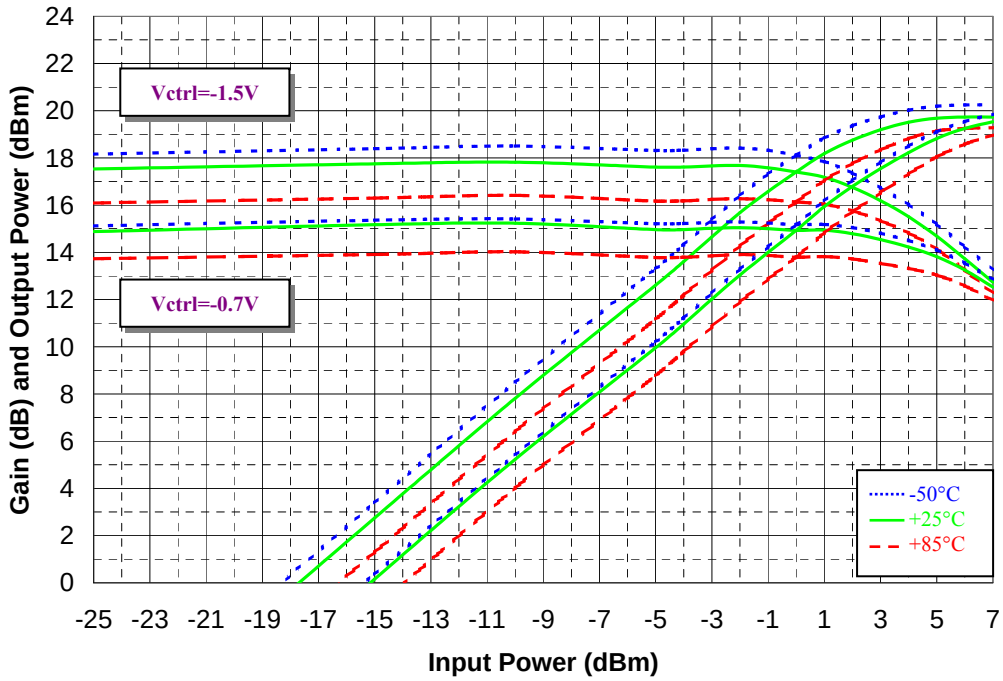
united monolithic semiconductors

Preliminary

Gain and Output Power versus Input Power and Temperature @ 31GHz



Gain and Output Power versus Input Power and Temperature @ 34GHz

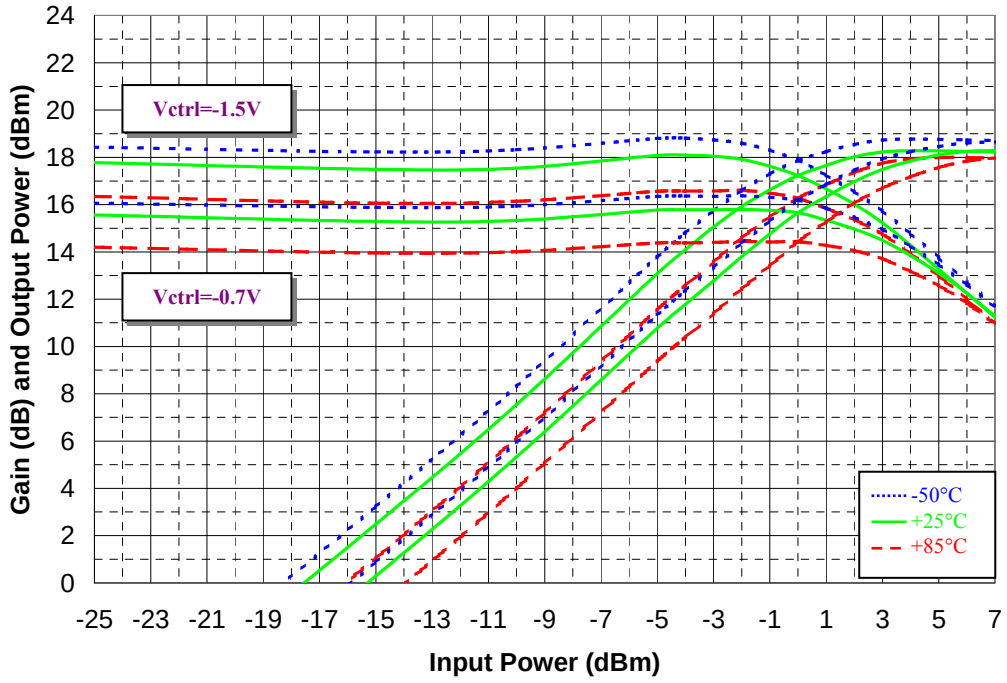


Route Départementale 128, B.P.46 - 91401 ORSAY Cedex - FRANCE
Tel.: +33 (0) 1 69 33 03 08 - Fax: +33 (0) 1 69 33 03 09

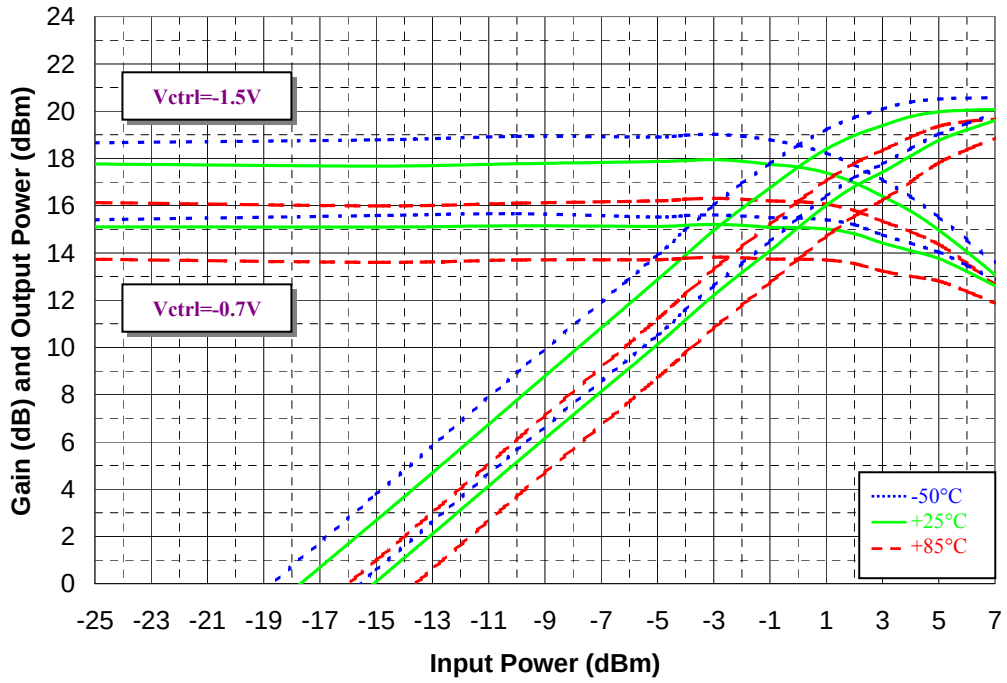
united monolithic semiconductors

Preliminary

Gain and Output Power versus Input Power and Temperature @ 37GHz



Gain and Output Power versus Input Power and Temperature @ 40GHz

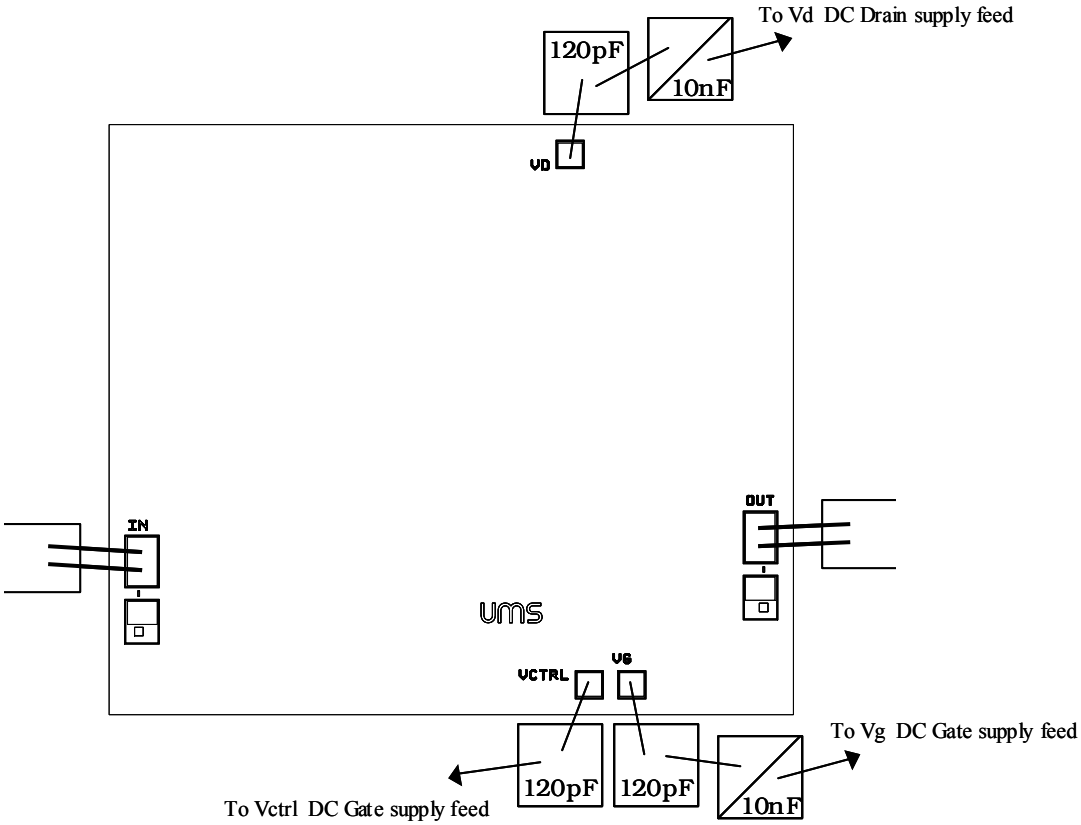


Route Départementale 128, B.P.46 - 91401 ORSAY Cedex - FRANCE
Tel.: +33 (0) 1 69 33 03 08 - Fax: +33 (0) 1 69 33 03 09

united monolithic semiconductors

Chip Assembly and Mechanical Data

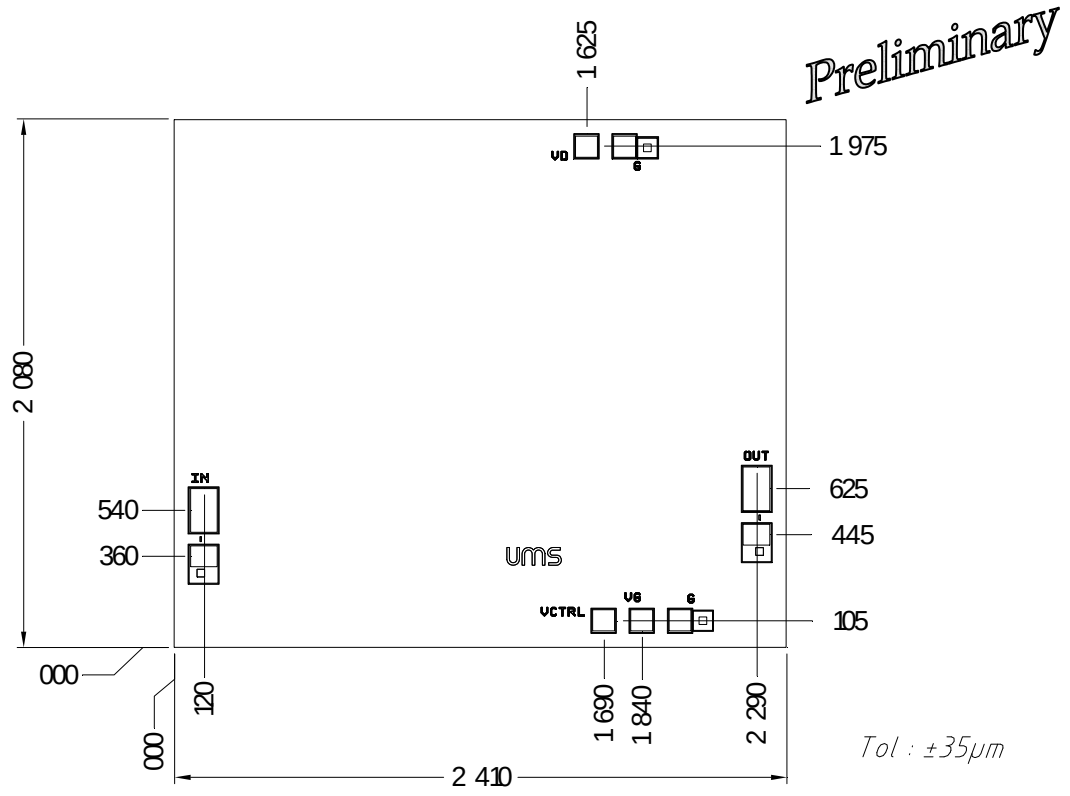
Preliminary



Note : Supply feed should be capacitively bypassed.
25µm diameter gold wire is recommended.
RF wire bondings should be as short as possible, lower than 0.35mm.
RF Pad size: 105/172µm
DC Pad size : 86/83µm

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

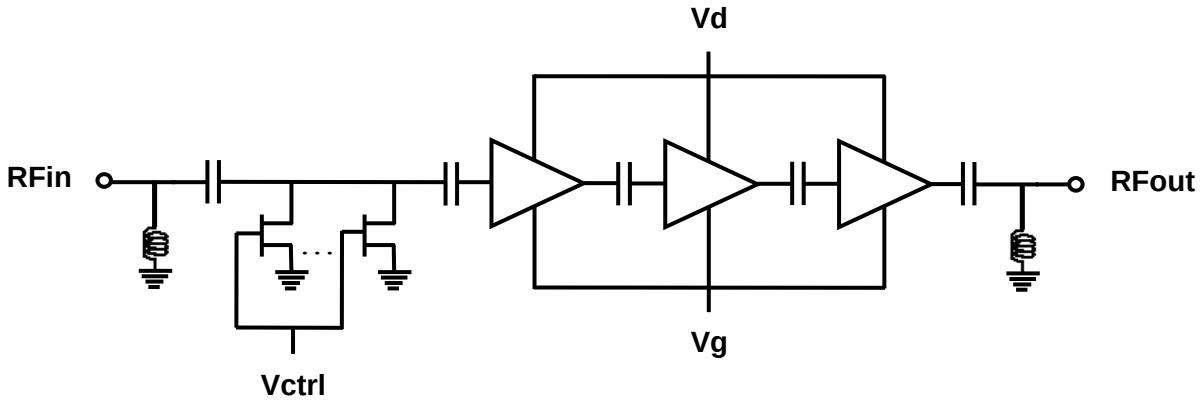
united monolithic semiconductors



Bonding pad positions
(Chip thickness : 70µm. All dimensions are in micrometers)

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.



ESD protections are also implemented on gate and control accesses.

- Due to BCB coating on the chip, qualification domain implies the chip must be glued.

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

united monolithic semiconductors

Preliminary

Ordering Information

Chip form: CHA3694-98F/00

Information furnished is believed to be accurate and reliable. However **United Monolithic Semiconductors S.A.S.** assumes no responsibility for the consequences of use of such information nor for any infringement of patents or other rights of third parties which may result from its use. No license is granted by implication or otherwise under any patent or patent rights of **United Monolithic Semiconductors S.A.S.**. Specifications mentioned in this publication are subject to change without notice. This publication supersedes and replaces all information previously supplied. **United Monolithic Semiconductors S.A.S.** products are not authorised for use as critical components in life support devices or systems without express written approval from **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