PRODUCT DATASHEET

CGY2144UH/C2

DC-54GHz, Medium Gain Broadband Amplifier

DESCRIPTION

The CGY2144UH/C2 is a broadband distributed amplifier designed especially for OC-768 (43 Gb/s) based fiber optic networks. The amplifier can be used as a Transimpedance Amplifier (TIA) or either as a driver amplifier for Electro-Absorption Modulator (EAM). The CGY2144UH/C2 can also be used as a flexible multi-purpose gain block.

The CGY2144UH/C2 features single ended RF input and output and operates with a power consumption of typically 500 mW. It requires only a single +5.0 V via on-chip bias network and a minimum number of external components.

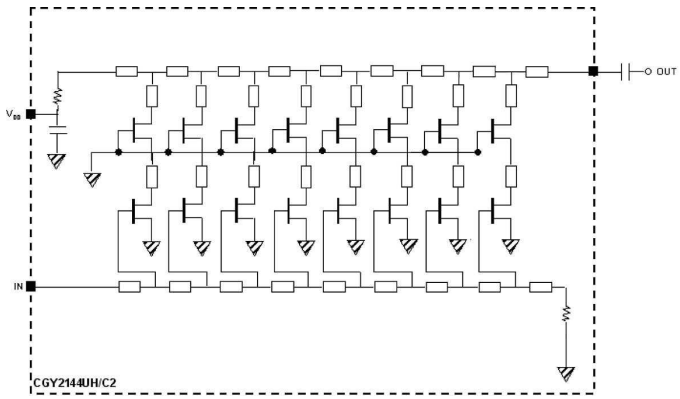
The MMIC is manufactured using OMMIC's qualified 0.13 µm PHEMT GaAs D01PH technology. The D01PH process is one of the European Space Agency (ESA) european preferred part list (EPPL) technologies.

APPLICATIONS

- 43 Gb/s OC-768 Receiver
- 43 Gb/s OC-768 EAM Driver
- Instrumentation, EW Systems
- General purpose wide band amplifier

FEATURES

- Wide frequency range : DC – 54 GHz
- Suitable for 43 Gb/s optical fibre links
- Gain S21 : 13 dB
- Fast rise/fall time < 10 ps
- Low noise figure: typical 2.5 dB @ 20 GHz
- Transimpedance gain : 280 Ω, (49 dBΩ)
- Input current density : 10 pA/Hz$^{1/2}$ @ 30 GHz
- Overload > 3.5 mApp
- Low group delay variation: ±7 ps @ 25 GHz
- Single positive supply voltage +5.0 V
- Chip size = 1490 x 2170 µm
- Tested, Inspected Known Good Die (KGD)
- Samples Available
- Space and MIL-STD Available



Block Diagram of the CGY2144UH Broadband Amplifier

RoHS Compliant

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LIMITING VALUES

Tamb = 25 °C unless otherwise noted

Symbol	Parameter	Conditions	MIN.	MAX.	UNIT
V_{DD}	Supply voltage		-0.5	+8	V
I_{DD}	Supply current			150	mA
T_{stg}	Storage temperature		-55	+150	° C
T_j	Junction temperature			+150	° C

THERMAL CHARACTERISTICS

Symbol	Parameter	Value	UNIT
$R_{th(j-a)}$	Thermal resistance from junction to ambient (T_a = 25 °C)	TBD	° C/W

OPERATING CONDITIONS

Symbol	Parameter	Conditions	MIN.	TYP.	MAX.	UNIT
V_{DD}	Supply voltage		+4.75	+5	+5.25	V
T_{op}	Operating ambient temperature		-10		+85	° C
Input interface	DC coupled in a TIA configuration ; All other cases : AC coupled via an external DC block					
Output interface	Must be AC coupled via an external DC block					

DC CHARACTERISTICS

T_{amb} = 25 °C, V_{DD} = 5 V, unless otherwise specified.

Symbol	Parameter	Conditions	MIN.	TYP.	MAX.	UNIT
I_{DD}	Total supply current			100	150	mA
P_{DC}	DC power consumption			500	750	mW
V_{INDC}	DC input voltage	see note 1		0		V
V_{OUTDC}	DC output voltage level	see note 2	+2.2	+2.8	+3.7	V

NOTE

1- V_{INDC} : DC voltage available at the input of the TIA.
2- V_{OUTDC} : DC voltage available at the output of the TIA.

Caution : This device is a high performance RF component and can be damaged by inappropriate handling. Standard ESD precautions should be followed. OMMIC document “OM-CI-MV/ 001/ PG” contains more information on the precautions to take.

AC CHARACTERISTICS

T_{amb} = 25 °C, V_{DD} = 5 V, R_L = 50 Ω. The S-parameters of the amplifier are measured on-wafer using RF probes. When the amplifier is treated as a TIA, the following parameters are assumed : Photodiode and input parasitics capacitance C_{PH} = 50 fF, total photodiode bonding inductance L_{PH} = 0.3 nH, R_{PH} = 15Ω; unless otherwise stated.

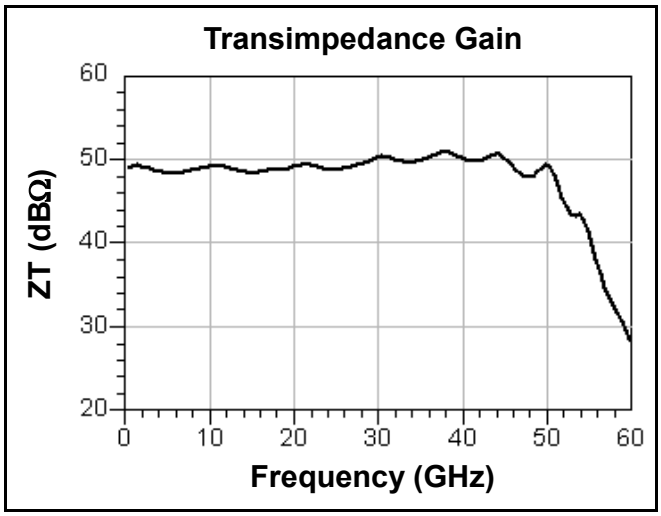
Symbol	Parameter	Conditions	MIN.	TYP.	MAX.	UNIT
Rate	Data rate	NRZ	43			Gb/s
S21	Reference Gain	F = 500 MHz - See note 1	11	13		dB
F_C	High frequency cut-off	$S21_{500MHz}$ – 3dB	45	54		GHz
Gain ripple		F = 500 MHz to 35 GHz		±0.5	±1	dB
		F = 35 GHz to F_C	-3	1	3	dB
NF	Noise Figure	F = 10 GHz		3		dB
		F = 20 GHz		2.5		dB
		F = 30 GHz		4		dB
S11	Input return loss	F = 500 MHz to 45 GHz		-13	-10	dB
		F = 45 GHz to 50 GHz		-11	-7	dB
S22	Output return loss	F = 500 MHz to 35 GHz		-13	-10	dB
		F = 35 GHz to 50 GHz		-12	-7	dB
S22	Output return loss (input loading : C_{PH}=50 fF, L_{PH}=0.3 nH, R_{PH}=15Ω)	F = 500 MHz to 35 GHz		-13	-10	dB
		F = 35 GHz to 50 GHz		-11	-7	dB
J	Jitter	See note 2			1.0	ps-rms
t_R/t_F	Rise/Fall time	20%-80% - See note 2			10	ps
F_{C_low}	Low frequency cut-off	AC coupled - See note 3			50	KHz
$\|Z_T\|_{LF}$	Low frequency transimpedance gain	F = 500 MHz - See note 1	45	49		dBΩ
F_{C_ZT}	Transimpedance high frequency cut-off	$\|Z_T\|_{LF}$ -3 dB	45	50		GHz
$\Delta\|Z_T\|$	Transimpedance ripple	F = 500 MHz to 35 GHz		±1	±1.5	dBΩ
		F = 35 GHz to F_{C_ZT}	-3	1	3	dBΩ
F_{C_low}	Low frequency cut-off	AC coupled - See note 3			50	KHz
dT_G	Group delay, relative to Z_T	F = 3 GHz to 33 GHz		±7	±9	ps
		F = 33 GHz to 40 GHz	-6		+25	ps
I_{PKMAX}	Maximum peak input current before input overload		3.5			mAp-p
I_{eq}	Equivalent input noise current	F = 3 GHz to 36 GHz		$6 \le I_{eq} \le 15$		$pA/Hz^{1/2}$
K	Microwave stability factor. T_{amb} = -10°C to +85°C	All passive source and loads	1.1			

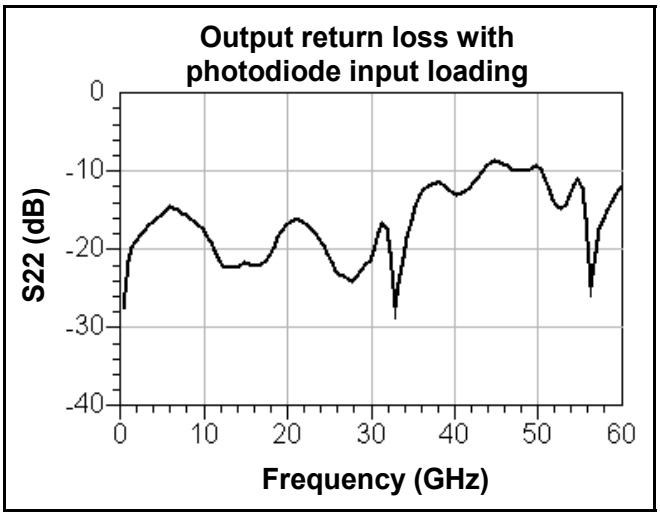
NOTE

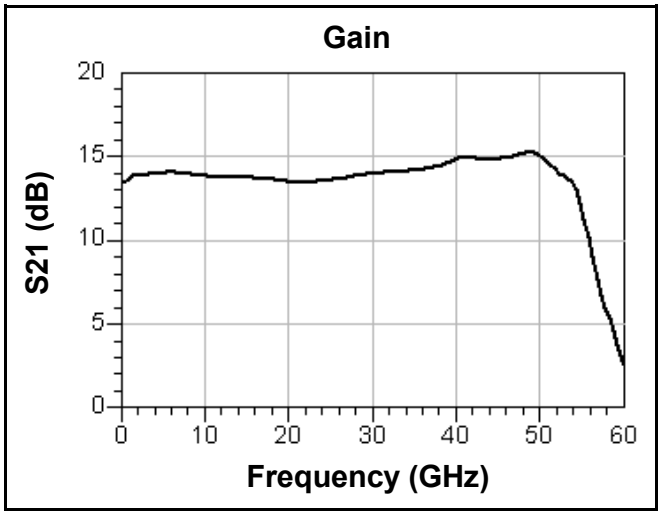
1- Measurement is guaranteed down to the lower frequency cut-off. 500 MHz is specified as a reference for convenience of measurement.
2- Measurement impacted by input signal, cable losses, probes and connectors.
3- The low frequency cut-off is set by the choice of the input/output blocking capacitor.

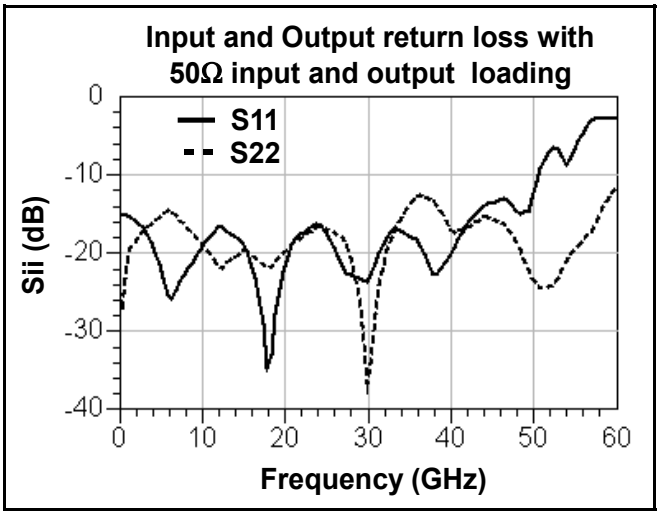
MEASURED PERFORMANCE

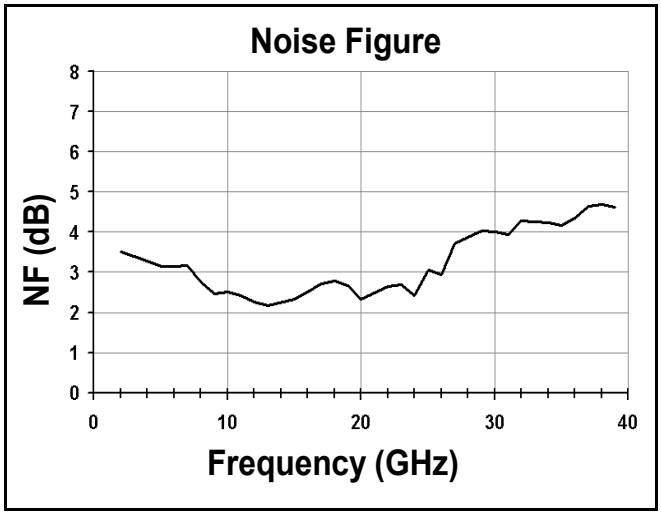
T_{amb} = 25 °C, V_{DD} = 5 V, on wafer measurement.











Measured transimpedance gain and output return loss for an input loading conditions : photodiode elements :
C_{PH} = 50 fF, L_{PH} = 0.3 nH, R_{PH} = 15 Ω.

Measured gain (S21) and input/output return loss for an input/output loading conditions : 50Ω.

CGY2144UH/C2 TYPICAL SCATTERING PARAMETERS

T_{amb} = 25°C, Vdd = +5.0 V, R_L = 50 Ω.

Frequency (GHz)	Mag S11	Ang S11 (°)	Mag S21	Ang S21 (°)	Mag S12	Ang S12 (°)	Mag (S22)	Ang S22 (°)
0.3	0.175	-4.1	4.688	175.7	0.0007	178.7	0.044	129.5
0.5	0.177	-6.1	4.715	173.4	0.0003	-119.3	0.060	106.8
0.7	0.173	-8.5	4.764	170.5	0.0000	54.7	0.078	90.9
0.9	0.174	-12.1	4.853	167.6	0.0004	93.4	0.094	75.1
1	0.174	-12.9	4.898	166	0.0006	97.9	0.102	69.2
3	0.143	-38.3	4.955	129.2	0.0011	60.8	0.142	36.4
6	0.047	-54.8	5.047	76.1	0.0022	16.8	0.188	-7.1
9	0.090	16.3	4.943	23.3	0.0031	-24.1	0.131	-39.4
12	0.149	-19.7	4.853	-28.2	0.0038	-61.4	0.078	-20.3
15	0.113	-63.8	4.864	-80.4	0.0045	-88.9	0.104	-20.8
18	0.012	-23.6	4.809	-133.8	0.0077	-130	0.079	-20.1
21	0.121	2.3	4.688	173.3	0.0105	-175.5	0.115	-9.6
24	0.158	-48.6	4.737	121.3	0.0142	138	0.148	-30.3
27	0.077	-106.5	4.870	67.6	0.0181	92.3	0.124	-67.8
30	0.064	22.1	5.006	11.1	0.0227	44.7	0.007	-123.8
33	0.145	-40.8	5.047	-46.2	0.0294	-13.3	0.136	15.9
36	0.120	-120.8	5.129	-102.5	0.0316	-74.2	0.237	-45.7
38	0.068	137.9	5.254	-143.2	0.0305	-106.4	0.213	-101.4
40	0.1	20.9	5.559	174.4	0.0399	-138	0.134	171.1
42	0.157	-62.7	5.546	128.8	0.0507	175.5	0.145	57.4
44	0.202	-145.9	5.496	84.8	0.0553	133.1	0.172	-12.0
46.5	0.226	113.3	5.591	28.7	0.0648	87	0.151	-76.8
48	0.179	36.7	5.748	-7.2	0.08	54.5	0.113	-121.3
49.5	0.186	-88.5	5.748	-48.4	0.0891	12.4	0.073	-158.8
51	0.370	177.5	5.395	-90.7	0.0865	-25.4	0.058	162.3
52.5	0.487	114.6	4.955	-131.5	0.0842	-62.6	0.064	120.9
54	0.353	33.0	4.710	179.7	0.0915	-110.9	0.092	54.4
57	0.731	107.5	2.240	90.0	0.0511	171.7	0.138	-133.4
60	0.715	86.7	1.316	57.4	0.0466	137.2	0.269	161

APPLICATION INFORMATION

Typical application scheme

Two module layouts are proposed. Figure 1 illustrates a module with the CGY2144UH/C2 used in a photo receiver application while in figure 2 is pictured the general purpose application module. In both cases, RF accesses are built with microstrip transmission lines. Coplanar transmission lines can be used and will give the same performance. All path lengths and physical sizes of the components should be minimized.

For photo receiver applications, the photodiode capacitance C_{PH} should be lower than 75 fF. A total input inductance value of 0.3 nH is recommended while 0.4 nH should be considered as a maximum value along with a low photodiode series resistance.

For general purpose applications, all RF input and output bonding inductances should be minimized to obtain the best performance from the module. Two gold wires are recommended with maximum separation between the wires. Overall wire length should be kept less than 0.4 mm to keep lead inductance to less than 0.2 nH.

Wedge-Wedge bonding or ribbon bonding is recommended to reduce the bonding wire inductances. The use of too large inductances will lead to degradation in the gain and matching.

In figure 1 and figure 2, C1, C2 and C3 capacitors are used to improve the power supply rejection.

The chip itself has via holes connecting the front side to the backside of the chip. A good RF grounding connection should be maintained between the backside of the chip and the ground of the system. It is extremely important to use an uninterrupted ground plane. AuSn or silver conductive epoxy material can be used for die attachment.

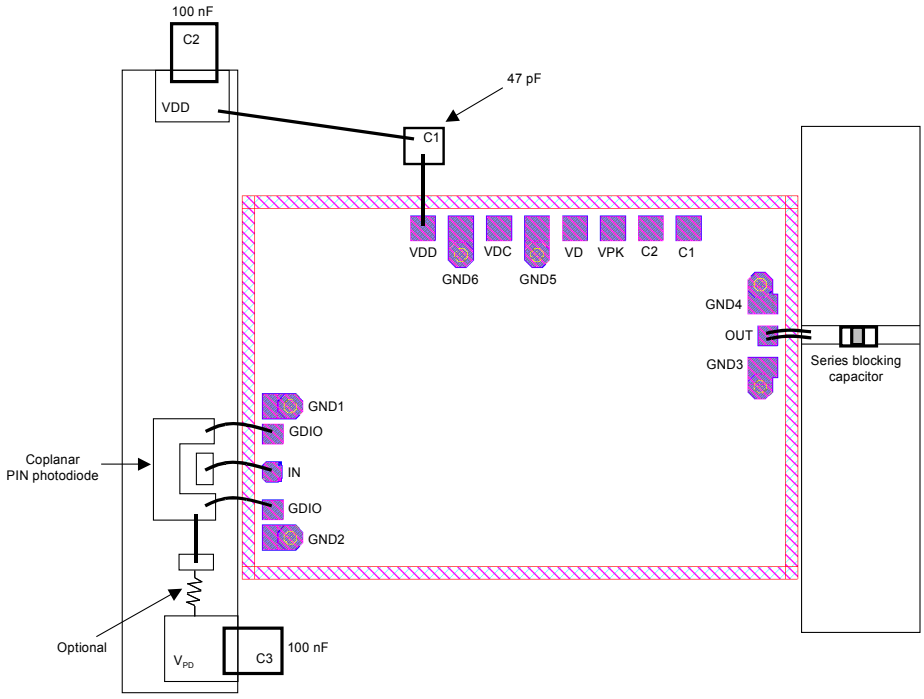


Figure 1: *CGY2144UH/C2 module layout : photo receiver application*

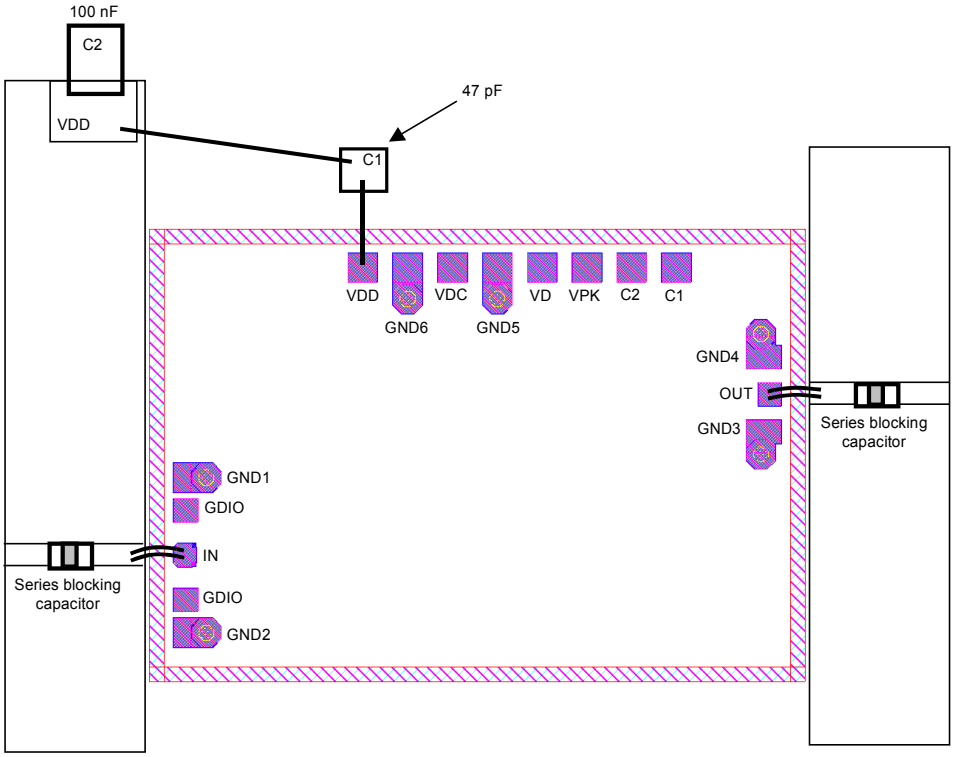


***Figure 2**: CGY2144UH/C2 module layout : other applications cases*

OPERATING AND HANDLING INSTRUCTIONS

The CGY2144UH/C2 is a very high performance GaAs device and as such, care must be taken at all times to avoid damage due to inappropriate handling, mounting, packaging and biasing conditions.

1- Power Supply Sequence

The following power supply sequence is recommended.

a) Photo receiver application

V_{PD} : Photodiode bias
V_{DD} : TIA bias

i) Always turn on the photodiode bias V_{PIN} first or simultaneously with V_{DD}. Since the photodiode is direct coupled to the TIA input, powering V_{DD} first can damage the photodiode through forward bias and excess current.
ii) Apply the input optical signal.

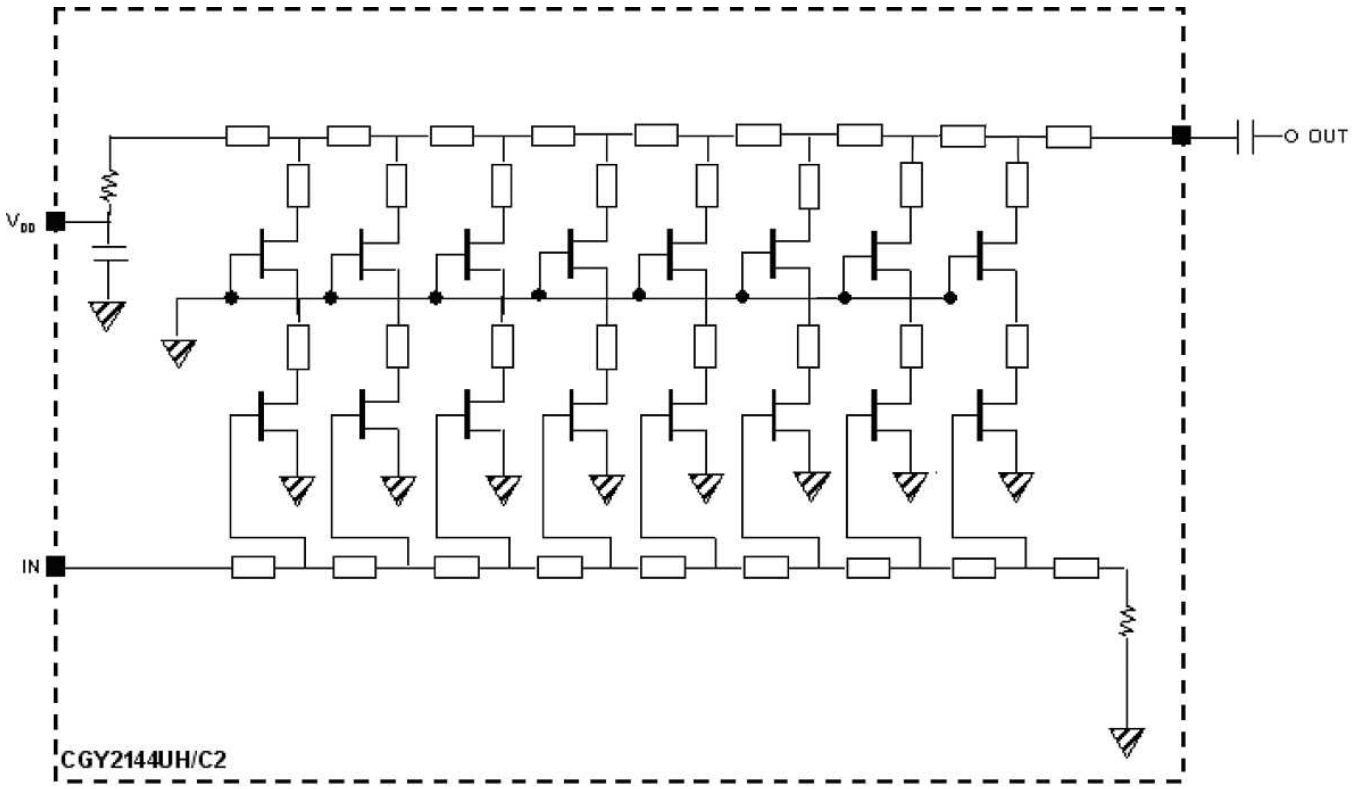
b) General purpose amplifier application

i) Apply V_{DD} at 5.0 V
ii) Apply the RF input signal

2- Mounting and ESD handling precautions

For high performance Integrated Circuits, such as the CGY2144UH/C2, care must be taken when mounting GaAs MMICs so as to correctly mount, bond and subsequently seal the packages and hence obtain the most reliable long-term operation. The temperature, duration, material and sealing techniques compatible with GaAs MMICs and the precautions to be taken are described in OMMIC's document "OMCI-MV/001/PG", entitled, "Precautions for III-V users".

BLOCK DIAGRAM AND PAD CONFIGURATION



Block Diagram of the CGY2144UH/C2

PAD POSITION

SYMBOL	PAD	COORDINATES (1)		DESCRIPTION
		Y	X	
GND1	1	2063	670	Connected to ground with on-chip via holes
GDIO	2	2063	560	Case 1 : amplifier used as TIA : to be connected to photodiode cathode pad (see figure 1) Case 2 : all others cases, do not bond (see figure 2)
IN	3	2063	410	RF input
GDIO	4	2063	260	Case 1 : amplifier used as TIA : to be connected to photodiode cathode pad (see figure 1) Case 2 : all others cases, do not bond (see figure 2)
GND2	5	2063	150	Connected to ground with on-chip via holes
GND3	6	115	824	Connected to ground with on-chip via holes
OUT	7	115	950	RF output
GND4	8	115	1076	Connected to ground with on-chip via holes
C1	9	418	1375	Do not bond
C2	10	568	1375	Do not bond
VPK	11	718	1375	Do not bond
VD	12	868	1375	Do not bond
GND5	13	1018	1375	Connected to ground with on-chip via holes
VDC	14	1168	1375	DC output voltage monitor
GND6	15	1318	1375	Connected to ground with on-chip via holes
VDD	16	1468	1375	Drain supply voltage, must be decoupled to ground using external capacitor (s)

NOTE

1- All x and y coordinates in µm represent the position of the centre of the pad with respect to the lower left corner of the chip layout (see the bonding pattern).

MECHANICAL INFORMATION

PARAMETER		VALUE
Size		2170 x 1490 µm (Tolerance : +/- 15 µm)
Thickness		100 µm
Backside material		TiAu
Bonding pad dimensions	C1, C2, VPK, VD, GND5, VDC, GND6, VDD	100 x 100 µm
	GND1, GND2	100 x 87 µm
	GDIO	85 x 80 µm
	IN, OUT	80 x 80 µm
	GND3, GND4	120 x 80 µm

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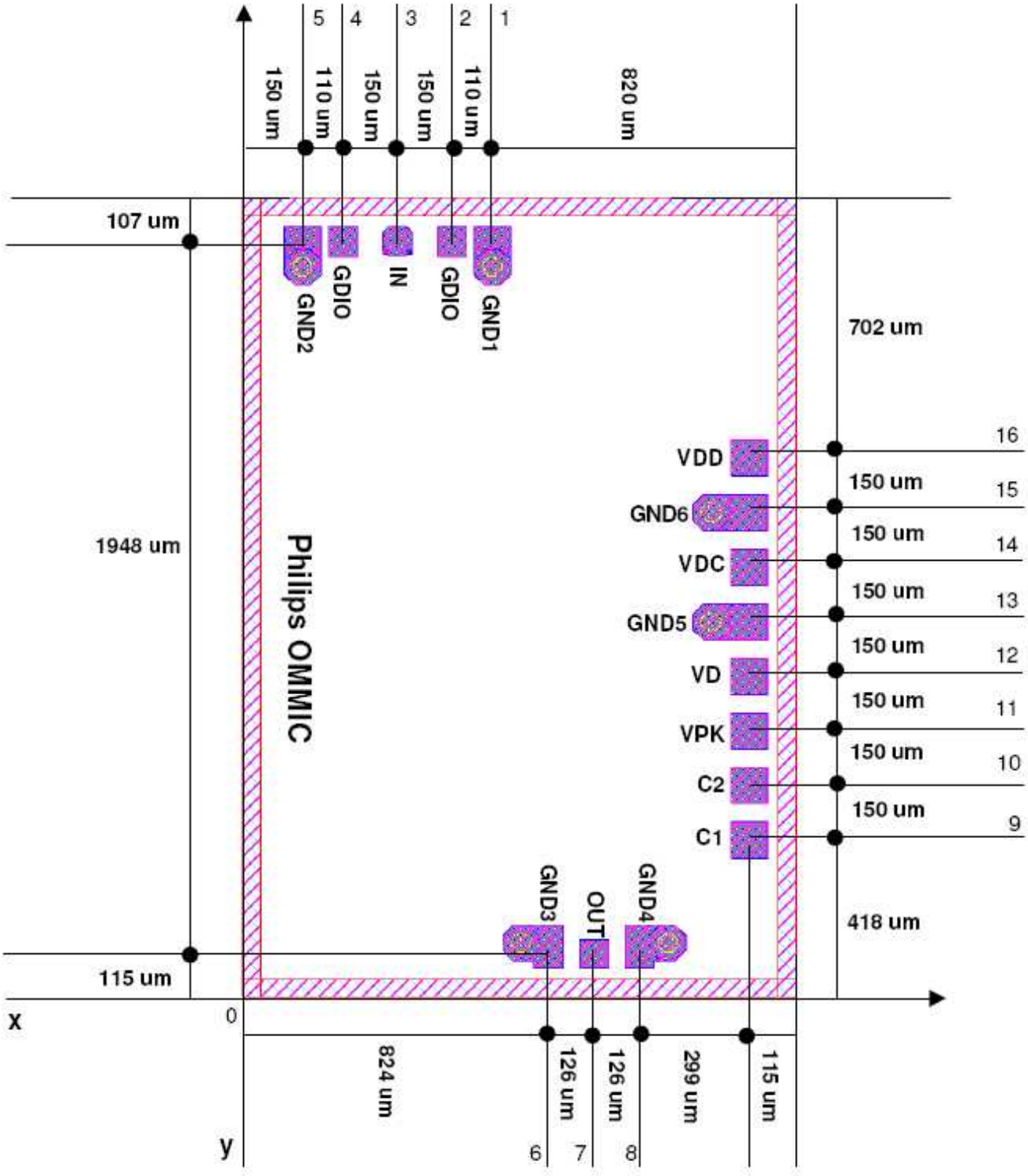
BONDING PADS



CGY2144UH/C2 bonding pattern

DEFINITIONS

Limiting values definition
Limiting values given are in accordance with the Absolute Maximum Rating System (IEC 60134). Stress above one or more of the limiting values may cause permanent damage to the device. These are stress ratings only and operation of the device at these or at any other conditions above those given in the Characteristics sections of the specification is not implied. Exposure to limiting values for extended periods may affect device reliability.

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ORDERING INFORMATION

Generic type	Package type	Version	Description
CGY2144UH	Bare Die	C2	InGaAs Semi-conductor die. External dimensions : 2170 x 1490 µm (Tolerance : ±15 µm). Die thickness: 0.1 mm. Backside material: TiAu

RoHS Compliant

Document History : Version 1.2, Last Update 19/04/2010

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