OMMIC Innovating with III-V's

PRODUCT DATASHEET

CGY2116UH/C1

10.7 Gb/s Low Noise TIA

DESCRIPTION

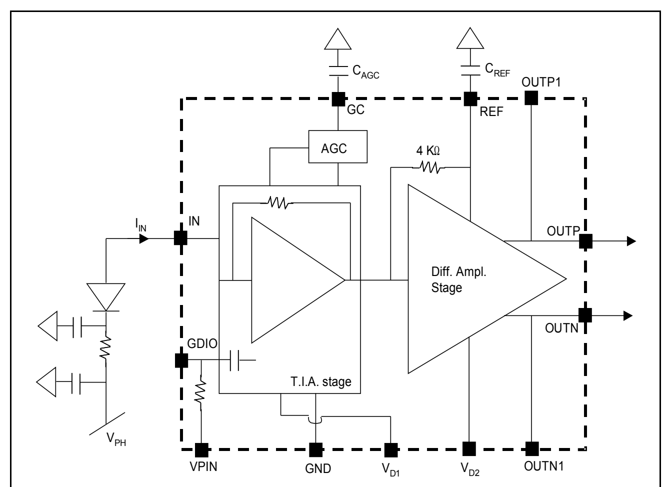
The CGY2116UH is a 10.7 Gb/s Low Noise TransImpedance Amplifier (TIA), designed for use in optical reception systems.
The device can be used with a PIN or APD photodetector. The built-in AGC function enables the device to achieve more than 2.5 mApp as input overload current. The CGY2116UH/C1 features differential outputs and operates using a single +5V supply voltage.
The die is manufactured using OMMIC's 0.18 µm gate length PHEMT Technology. The MMIC uses gold bonding pads and backside metallization and is fully protected with Silicon Nitride passivation to obtain the highest level of reliability. This technology has been evaluated for Space applications and is on the European Preferred Parts List of the European Space Agency.

APPLICATIONS

- 10 Gb/s Receivers Optical Sub Assemblies (ROSA)
- Optical Communications Network : SONET/SDH (OC-192/STM-64)
- Transponders modules : MSA300, XENPAK, XPAK, X2, XFP

FEATURES

- Suitable for 10.7 Gb/s optical fiber links
- Single +5 V supply voltage
- 2.6KΩ (68.5dBΩ) single-ended transimpedance
- Sensitivity : -22 dBm
- Built in AGC function
- 83 mA consumption current at +5 V
- Tested, Inspected Known Good Die (KGD)
- Samples Available
- Demonstration Boards Available
- Space and MIL-STD Available



Block Diagram of the CGY2116UH/C1

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LIMITING VALUES

T_{amb} = 25 °C unless otherwise noted

Symbol	Parameter	Conditions	MIN.	MAX.	UNIT
V_{DD}	Supply voltage		- 0.5	+ 8	V
V_{bias}	Photodiode biasing voltage	Photodiode cathode connected to supply voltage via GDIO and VPIN pads	- 15	+ 15	V
I_{IN}	Input photo-current	Average at V_{DD} = 5.0 V		50	mA
T_j	Junction temperature			+ 150	° C
T_{stg}	Storage temperature		- 55	+ 150	° C

OPERATING CONDITIONS

Symbol	Parameter	Conditions	MIN.	TYP.	MAX.	UNIT
V_{DD}	Positive Supply voltage		4.75	5.0	5.25	V
T_{op}	Operating ambient temperature		-10		+85	°C
Input interface	DC coupled					
Output interface	AC coupled					

DC CHARACTERISTICS

Typical data are defined at T_{amb} = 25 °C, V_{DD} = 5 V ; unless otherwise noted.

Symbol	Parameter	Conditions	MIN.	TYP.	MAX.	UNIT
I_{DD}	Supply current			83	110	mA
V_{INDC}	DC input voltage (see note 1)			1.3	1.4	V
I_{IN_LIM}	Input average current for AGC activation (see note 2)			100		µA
$\| dV_{OUT} \|$	Voltage offset between the two outputs in absolute value	At 8 µA DC input current		0	+0.8	V
V_{OUTDC}	DC voltage available at OUTP and OUTN pads			4.4	4.75	V

NOTE

1. V_{INDC} : DC voltage available at the RF input pad of the TIA.
2. For an input average current less than I_{IN_LIM}, the output voltage is proportional to the input current. Whereas for an input average current higher than I_{IN_LIM}, the AGC function is activated, leading to a linear decrease of the gain.

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

All measured data are at V_{DD} = 5V; T_{amb} = 25 °C; R_L = 50 Ω. The TIA is measured on-wafer using RF probes without any light beam on the top of the IC (see note 1). Unless otherwise stated.

Photodiode elements and parasitics :

Symbol	Parameter	Conditions	MIN.	TYP.	MAX.	UNIT
C_{PH}	Photodiode capacitance	Suggested value		0.2		pF
L_{PH}	Photodiode bonding inductance	Suggested value		0.5		nH
R_{PH}	Photodiode series resistance	Suggested value		8.0		Ohms
F_{c_PH}	Photodiode 3 dB O/E cut-off frequency	Suggested value		15		GHz
$L_{BOND,OTHER}$	Inductance on each of all other bond pads on the TIA	Suggested value		0.5		nH

Symbol	Parameter	Conditions	MIN.	TYP.	MAX.	UNIT
	Data rate		10.7			Gb/s
$\|ZT\|_{LF}$	Low-Frequency Transimpedance gain	F=0.2 GHz, single-ended (note 1)	65	68.5	71	dBΩ
$\Delta\|ZT\|_{LF}$	Transimpedance ripple (=$\|ZT\| - \|ZT\|_{LF}$)	F = 0.2 MHz to 2.5 GHz	-1.5	-0.7	+1	dB
		F = 2.5 GHz to 4 GHz	-1.5	-1	+1	dB
		F = 4 GHz to 7.5 GHz	-1.5	±1	+4	dB
		F = 7.5 GHz to Fc	-3		+3	dB
F_c	Transimpedance cut-off frequency	$\|ZT\| = \|ZT\|_{LF}$ – 3 dB	8.5	9.6		GHz
$F_{c,Low}$	Low Frequency cut-off (note 2)	AC coupled at the outputs (via 100 nF capacitor)			25	KHz
I_{PKMAX}	Maximum peak input current before input overload (note 3)		2.5			mApp
T_G	Group delay	F = 0.2 MHz to Fc		±23	±35	ps
V_{OUT}	Output swing, single-ended			380		mVpp
S_{22}	Output reflection coefficient (input loading : C_{PH} = 0.2 pF, L_{PH} = 0.5 nH, R_{PH} = 8 Ω) (note 4)	F = 0.2 GHz to 5.5 GHz		-8.5	-7	dB
		F = 5.5 GHz to 10 GHz		-11.5	-7	dB
I_{NOISE}	Total integrated input RMS noise	F = 0.1 GHz to F_c		800		nA
S	Optical input sensitivity (note 5)	ρ = 0.95 A/W, r_e = 12 dB, BER = 10^{-12}		-21.7		dBm
K	Microwave Stability Factor	All passive source and load	1.1			
R_L	Output load termination (OUTP, OUTPN)			50		Ω

NOTE

1) The gain specification is guaranteed down to the lower cut-off frequency. 0.2 GHz is specified as a reference for convenience of measurement.

2) The CGY2116UH is AC coupled at its outputs via an external capacitor, C. So the low frequency cut-off is determined by the time constant RC, where R is the total output resistance (on-chip output series 50 Ohms impedance of the TIA circuit plus the external 50 Ohms load) equivalent to 100 Ohms. Assuming that C is 100 nF, the low frequency cut-off is given by : F_{c_low} = 1/(2*pi*R*C) = 16 KHz.

3) This characteristic is guaranteed by design and verified by measurement (using evaluation boards with $2^{31} - 1$ PRBS, BER of 10^{-12}).

4) With typical output bond wire inductances L_{OUTP}, L_{OUTN} = 0.5 nH, the Output reflection coefficient is improved.

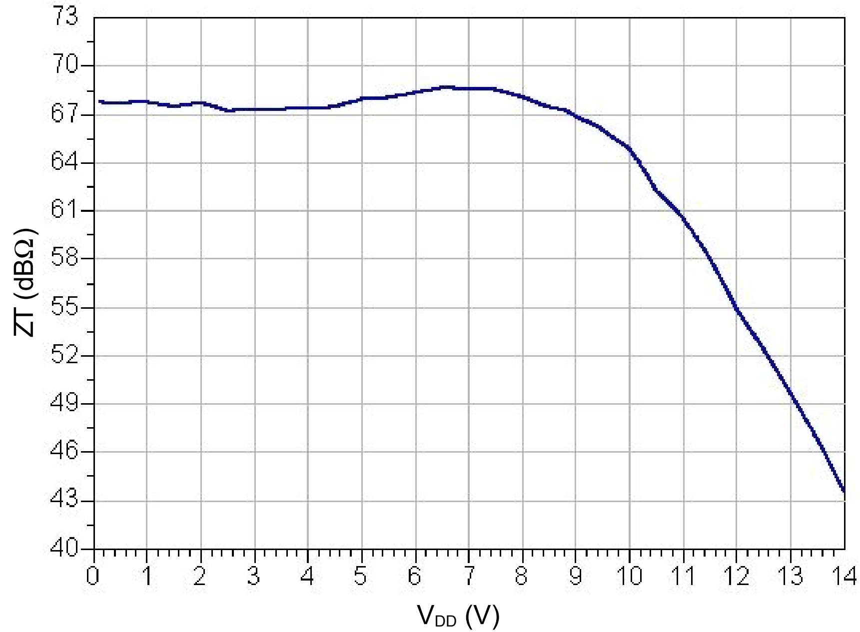
5) The sensitivity is computed from the total integrated input RMS noise. To obtain a system bit-error rate of 10^{-12}, the signal-to-noise ratio must be 14.1 or better. The input sensitivity, expressed in average power, is calculated as :

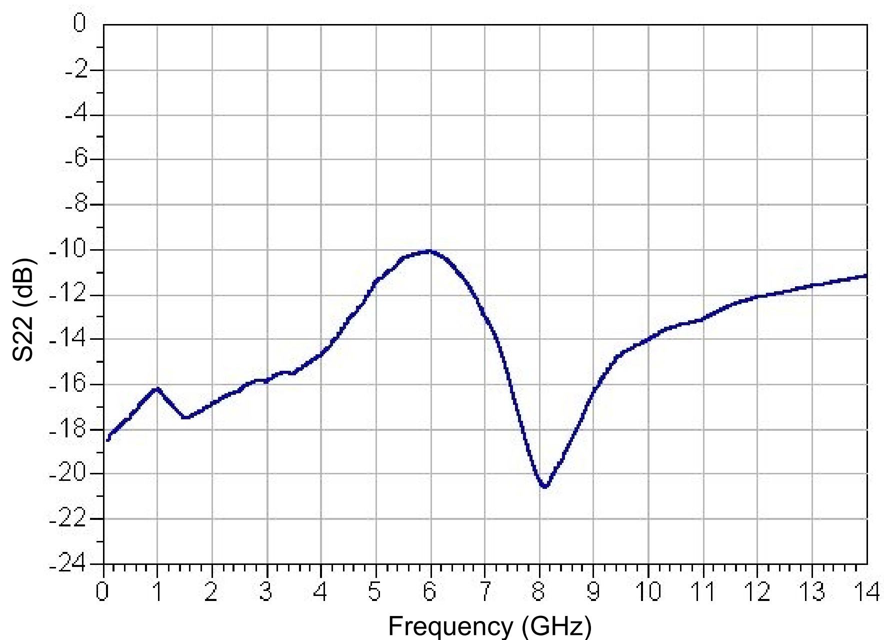
$$Sensitivity = 10\log\left(\frac{14.1\times I_{NOISE}\times(r_e+1)}{2\times\rho\times(r_e-1)}\times 1000\right) \text{ dBm}$$

where ρ and r_e are respectively, the photodiode responsivity in A/W and the extinction ratio. I_{NOISE} is measured in amperes.

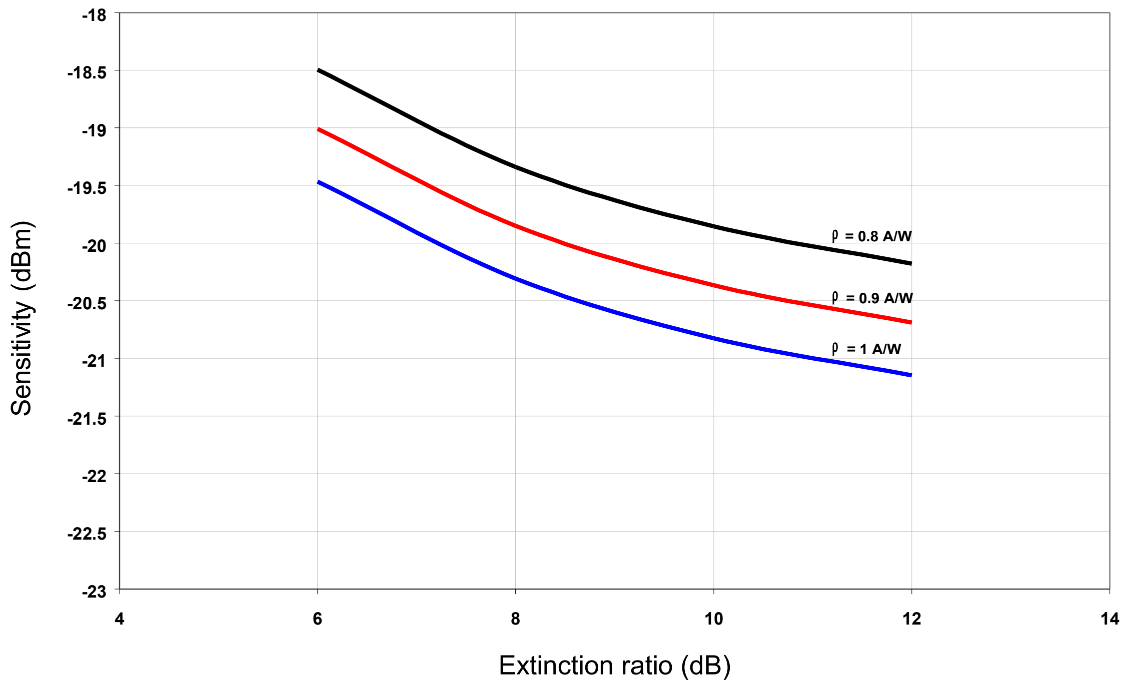
MEASURED PERFORMANCE CHARACTERISTICS

Operating Temperature of 25°C. V_{DD} = +5 V. Results are from electrical demo-board using RF probes for on chip measurements.

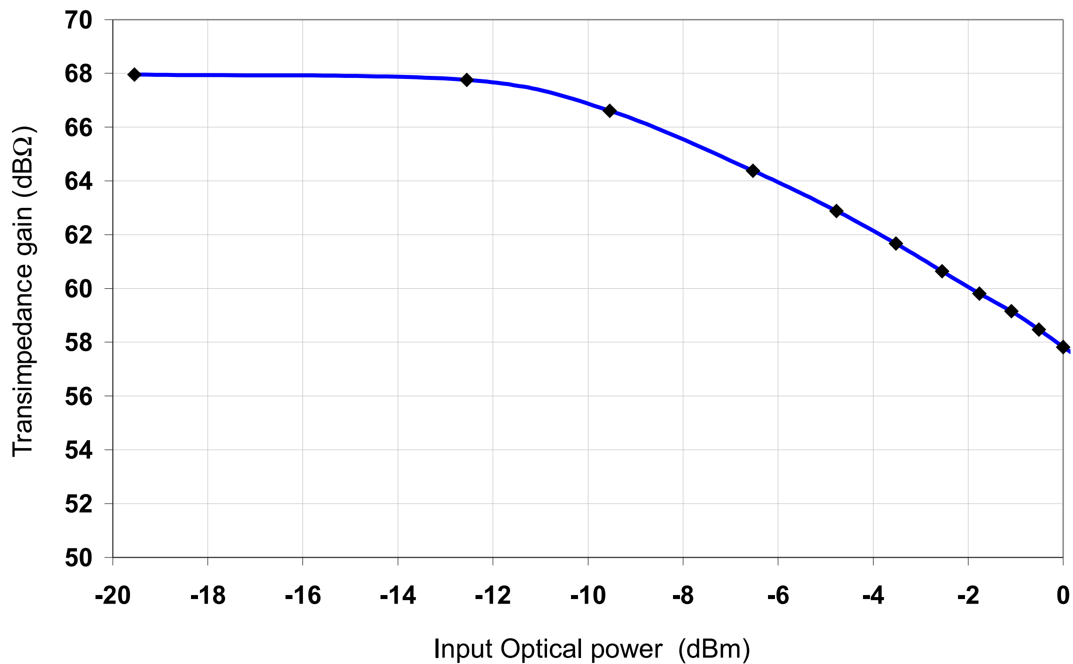




Transimpedance gain vs. V_{DD} and Output Return Loss vs. Frequency
Input Loading Conditions : C_{PH} = 0.2 pF, L_{PH} = 0.5 nH, R_{PH} = 8 Ω.



Sensitivity vs. Extinction ratio at various photodiode sensitivity, ρ.

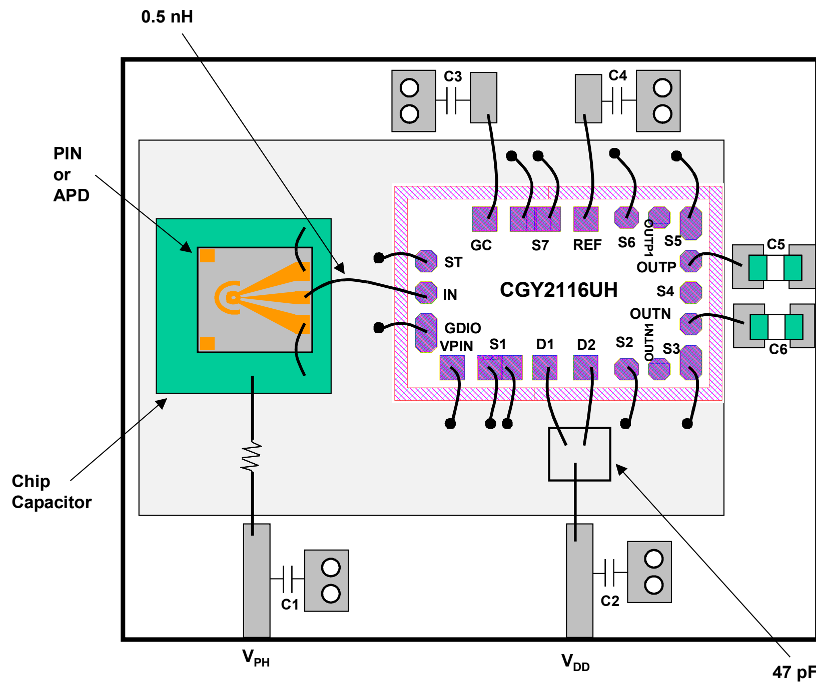


Single Ended Transimpedance gain at F = 200 MHz vs. input optical power

APPLICATION INFORMATION

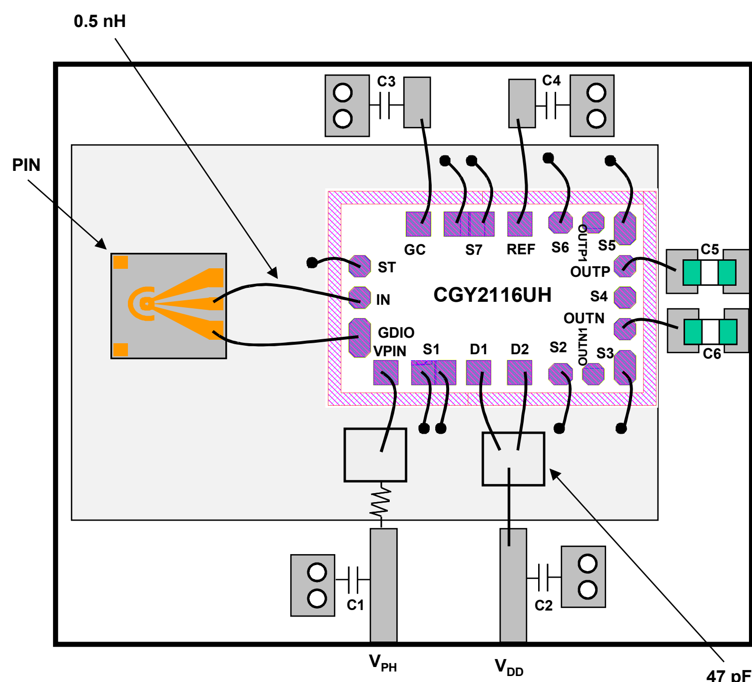
The performance of the photo-receiver module is dependent both on the photodiode capacitance and on the interconnection inductance between the photodiode and the CGY2116UH/C1. The circuit was optimized for a photodiode capacitance C_{PH} lower than 0.2 pF with a low photodiode series resistance (R_{PH}) to give the best noise performance from the receiver module.

In this application note, two modules layout are proposed, the difference occurs only at the receiver input :



The figure above shows a configuration which is suitable for both PIN and APD photodiodes.

The figure below shows a second configuration suitable only for a PIN photodiode :



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The CGY2116UH/C1 also offers an option to bias the photodiode through the VPIN pad. It is important to note that APD photodiodes cannot be mounted with this configuration (more than 15 V, DC supply voltage (required for APD) cannot be applied on this pad due to potential problems via the substrate).

It is recommended to use a total input equivalent bonding inductance value of typical 0.5 nH, while 1 nH should be considered as a maximum value. The length of the output bonding wire should be minimized.

To improve power supply rejection throughout the frequency band, 47 pF and 100 nF capacitors are required. The 47 pF capacitor provides a decoupling at frequencies above 1 GHz and should be positioned close to the chip. The 100 nF capacitor is for decoupling at lower frequencies and can be positioned further away from the chip.

A good RF grounding connection should be maintained between the ground pads of the chip and the ground of the system. The grounding of high gain amplifiers is critical for achieving the maximum microwave performance. Inductance due to bonding wires can cause unwanted feedback, performance degradation, resonances and possibly oscillations. To reduce the inductance effect, several bond wires can be used in parallel on each bond pad.

The CGY2116UH/C1 can be used in differential or single ended topology. In the case of single ended configuration, the unused output pad is connected to a 50Ω load via a 100 nF DC blocking capacitor.

Recommended Components :

Name	Value	Manufacturer part number
C1, C2, C3, C4, C5, C6	100 nF	0402 sub-mount capacitors
C1, C2, C3, C4	100 nF	GMA085F51A104ZD01T size : 0.8 x 0.8 x 0.5 mm or chip capacitors from Murata
C1, C2, C3, C4	100 nF	VL3030Y5V104Z16VH5 (size : 0.8 x 0.8 x 0.56 mm) or VL4080X7R104M16VH5 (size : 1.016 x 2.032 x 0.635 mm) or chip capacitors from Presidio

Power Supply Sequence :

The following power supply sequence is recommended (V_{PH} : Photodiode bias, V_{DD} : TIA bias)

a) Always turn on the photodiode bias V_{PH} 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.
b) Apply the input optical signal.

It is important to apply the DC voltage from ground, then increases them to their desired values.

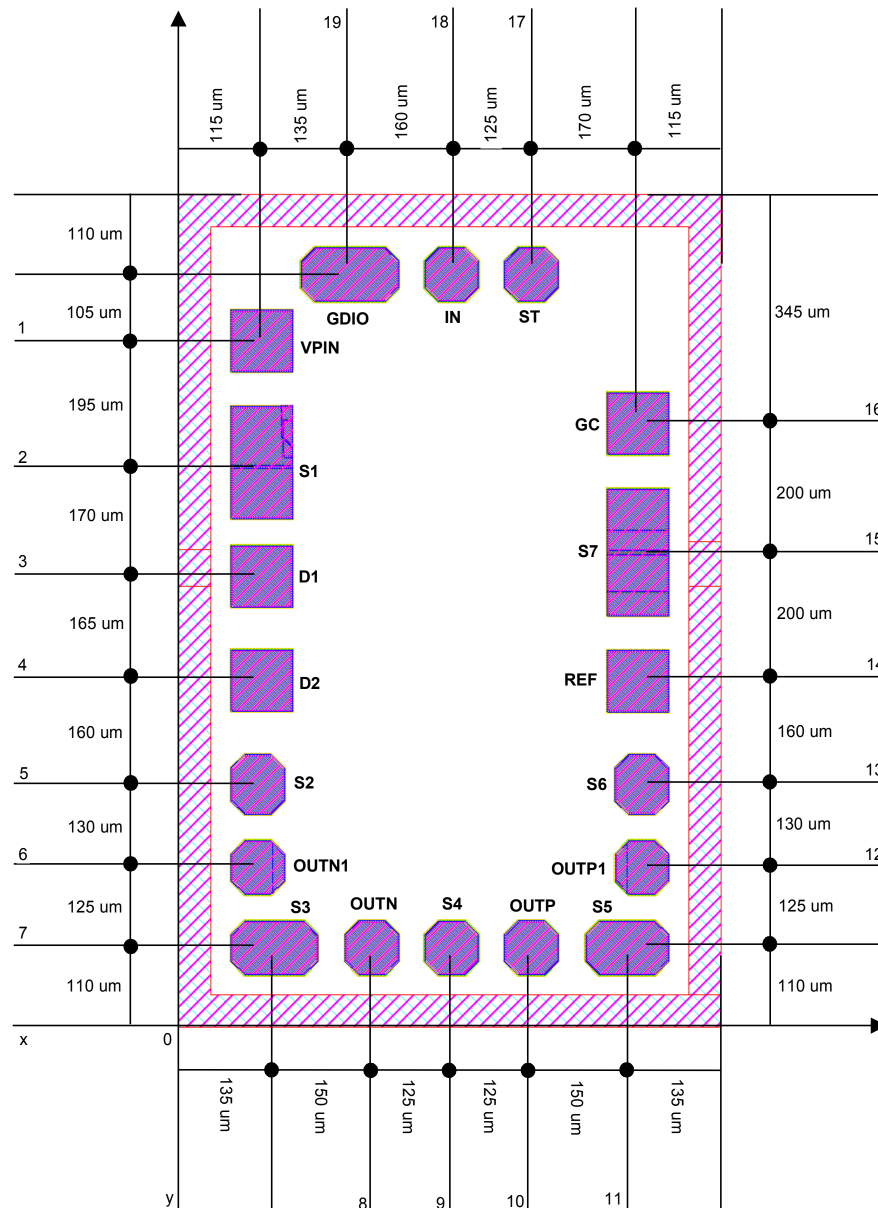
Handling Precautions :

a) Use a conductive working desk connected to the ground (or, a conductive table top connected to the ground).
b) Require all handling personal to wear a conductive bracelet or wrist-strap connected to the ground.
c) Ground all test equipment and all soldering iron tops.
d) Store IC's and other devices such as chip capacitors in their conductive carriers until they are soldered.

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.

MECHANICAL INFORMATION

Chip size = 1270 x 820 µm (± 15 µm)
Chip Thickness = 200 µm



Bonding Pad	Dimensions (µm)
VPIN, D1, D2, GC, REF	100 x 100
IN, ST, OUTP, OUTP1, OUTN, OUTN1, S4	88 x 88
S2, S6	88 x 98
S3, S5	88 x 140
S1	100 x 180
S7	100 x 200
GDIO	88 x 157

PAD POSITION

PAD NAME	PAD NUMBER	COORDINATES		DESCRIPTION
		Y	X	
VPIN	1	1055	115	Photodiode DC supply voltage pad
S1	2	860	115	Bond to ground
D1	3	690	115	First stage DC supply voltage, must be decoupled to ground using external capacitor(s)
D2	4	525	115	Second stage DC supply voltage, must be decoupled to ground using external capacitor(s)
S2	5	365	115	Bond to ground
OUTN1	6	235	115	RF inverted output (recommended for TO-can package)
S3	7	110	135	Bond to ground
OUTN	8	110	285	RF inverted output
S4	9	110	410	Do not bond
OUTP	10	110	535	RF non-inverted output
S5	11	110	685	Bond to ground
OUTP1	12	235	705	RF non-inverted output (recommended for TO package)
S6	13	365	705	Bond to ground
REF	14	525	705	Reference input voltage, must be decoupled to ground using an external capacitor
S7	15	725	705	Bond to ground
GC	16	925	705	Gain control pad, must be decoupled to ground using an external capacitor
ST	17	1160	535	Bond to ground
IN	18	1160	410	RF input. Connected to the photodiode anode
GDIO	19	1160	250	Connected to the photodiode cathode

NOTE :

- All x and y coordinates (in µm) represent the position of the center of the pad with respect to the lower left corner of the chip layout.
- OUTN and OUTN1 must not be connected together to the RF output 50 Ohms transmission line. Only one is to be used.
- OUTP and OUTP1 must not be connected together to the RF output 50 Ohms transmission line. Only one is to be used.

PACKAGE

Type	Description	Terminals	Pitch (mm)	Die size (mm)
UH	Bare Die	-	-	1.27 x 0.82 mm ±15 um Die Thickness : 200 µm

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.

Application information

Applications that are described herein for any of these products are for illustrative purposes only. OMMIC makes no representation or warranty that such applications will be suitable for the specified use without further testing or modification.

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ORDERING INFORMATION

Generic type	Package type	Version	Sort type	Description
CGY2116	UH	C1	-	10.7 Gb/s Low Noise TransImpedance Amplifier

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