PRODUCT DATASHEET

CGY2110UH/C1

10.0 Gb/s TransImpedance Amplifier

DESCRIPTION

The CGY2110UH is a 10.0 Gb/s TransImpedance Amplifier (TIA). Typical use is as a low noise preamplifier for lightwave receiver modules in optical fiber networks.
The device is intended to be used with a PIN or APD photodetector and is capable of amplifying input current up to 2 mA p.p. at BER of 10^{-12}.The circuit also exhibits exceptional sensitivity. A biasing circuit for PIN photodiode is integrated in the CGY2110UH.
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

- Digital fiber optic receiver for optical telecommunications (STM64 or OC192 systems)
- High sensitivity and high gain amplifier.

FEATURES

- Suitable for 10.0 Gb/s optical fiber links
- Single +5.7 V supply voltage
- 72 dBΩ differential transimpedance gain
- Differential output
- Low Power Consumption (400 mW)
- Tested, Inspected Known Good Die (KGD)
- Samples Available
- Demonstration Boards Available
- Space and MIL-STD Available

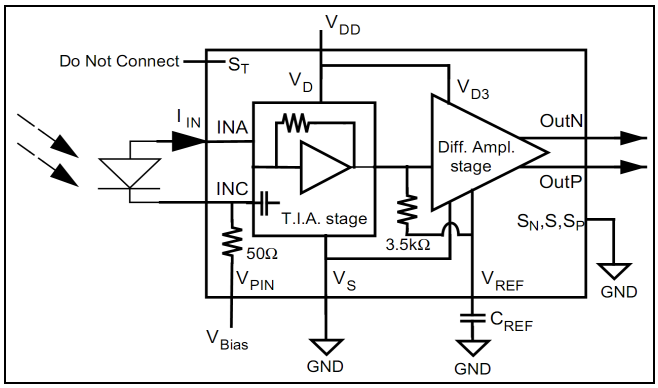

Fig. 1 : Block Diagram of the CGY2110UH/C1

RoHS Compliant

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LIMITING VALUES

T_{amb} = 25 °C unless otherwise noted

Symbol	Parameter	Conditions	MIN.	MAX.	UNIT
V_{DD}	Supply voltage (V_D, V_{D3})		- 0.5	+ 8	V
V_{BIAS}	Photodiode biasing voltage (See note 1)		- 15	+ 15	V
I_{IN}	Input photocurrent		- 1	6.0	mA pp
T_{stg}	Storage temperature		- 55	+ 150	° C
T_{ch}	Maximum operating channel temperature			+ 150	° C

OPERATING CONDITIONS

Symbol	Parameter	Conditions	MIN.	TYP.	MAX.	UNIT
V_{DD}	Supply voltage		5.4	5.7	6	V
T_{op}	Operating ambient temperature		- 10		+ 85	°C
Input interface	DC coupled					
Output interface	AC coupled via an external DC Block Capacitor					

DC CHARACTERISTICS

Minimum/Maximum values are defined at V_{DD} = 5.7 V ± 0.3 V, T_{amb} = -10°C to +85°C; Typical data is defined at T_{amb} = 25 °C, V_{DD} = 5.7 V ; unless otherwise noted.

Symbol	Parameter	Conditions	MIN.	TYP.	MAX.	UNIT
I_{DD}	Supply current		40	70	100	mA
V_{INDC}	DC input voltage (**INA** pad)			1.35		V
V_{OUTDC}	DC output voltage level			3.5		V
dV_{OUT}	Voltage offset between the two outputs		- 0.7		+ 0.7	V

NOTE

1. This specification is valid only if the photodiode is biased through the TIA chip.

AC CHARACTERISTICS

All measured data is at V_{DD} = 5.7 V; T_{amb} = 25 °C; R_L = 50 Ω and for recommended photodiode characteristics. The TIA is measured on-wafer using RF probes. AC characteristics are guaranteed for both OUTP and OUTN ; Unless otherwise stated.

Photodiode elements and parasitics :

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
C_P	Photodiode capacitance	Suggested value		0.22		pF
L_B	Photodiode bonding inductance	Suggested value		0.6		nH
R_S	Photodiode series resistance	Suggested value		8.0		Ohms

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
$\|Z_T\|_{LF}$	Low-Frequency Transimpedance gain	F= 100 MHz, single-ended	62	66	70	dBΩ
		F= 100 MHz, differential	–	72	–	dBΩ
$\Delta\|Z_T\|$	Transimpedance ripple (= $\|Z_T\| - \|Z_T\|_{LF}$)	F = 1 MHz to 3 GHz	-1.5	0	1.5	dB
		F = 3 GHz to 6 GHz	-1.5	1	3	dB
		F = 6 GHz to 10 GHz	–	–	3	dB
F_C	Transimpedance cut-off frequency	$\|Z_T\| = \|Z_T\|_{LF}$ - 3 dB	8	9		GHz
		$\|Z_T\| = \|Z_T\|_{LF}$ - 3 dB, C_P = 0.14 pF	–	10.1	–	GHz
$F_{c,Low}$	Low transimpedance cut-off frequency	AC coupled at the output (see note 1)	-	-	32	KHz
dT_G	Group delay, relative to 2.5GHz	F = 1 GHz to 3 GHz	-20	–	20	ps
		F = 4 GHz	-10	–	35	ps
		F = 5 GHz	0	–	50	ps
		F = 6.5 GHz to 9 GHz	15	–	75	ps
I_{PKMAX}	Maximum Peak Input Current before input overload		2.0	-	-	mA pp
$\|S_{22}\|$	Output reflection coefficient (see note 2)	F = 100 MHz to 10 GHz	–	-15	-10	dB
<Ieq>	Equivalent input noise current density	F = 1 GHz to 4 GHz	–	4.7	7	$pA/Hz^{1/2}$
		F = 7 GHz	–	6.5	10	$pA/Hz^{1/2}$
		F = 10 GHz, C_P = 0.14 pF	-	8	-	$pA/Hz^{1/2}$
I_N	Total integrated input RMS noise current	F = 10 MHz to 8 GHz	-	450	650	nA
		F = 10 MHz to 10 GHz, C_P = 0.14 pF	-	500	-	nA
R_L	Output load termination (Out_N, Out_P)		–	50	–	Ω

NOTE

1. The CGY2110UH is AC coupled at its outputs via an external capacitor, C. So the lower cut-off frequency is determined by the time constant RC, where R is the 50 Ohms load. Assuming that C is 100 nF, the lower cut-off frequency is given by : Fc_low = 1/(2*pi*R*C) = 32 kHz.

2. The |S22| specification given in this table is based on RF on-wafer measurements with low-inductance probes.

TEST AND APPLICATION INFORMATION

Typical application scheme

A typical receiver module, including a photodiode and a CGY2110UH Transimpedance Amplifier chip is shown in figure 3 and the electrical equivalent model of the module is shown in figure 4.

To ensure the best performance from the receiver module, the shortest possible connection between photodiode and CGY2110UH circuit must be used for both INA and INC circuits input pads. The same precaution applies to the output pads, OUT_N and OUT_P where the bonding wires should be as short as possible.

The V_S pad should also be connected to ground with the shortest possible bonding wire. The V_{REF} pad is decoupled directly to ground while the V_{D3} and V_D pads are decoupled and connected to the V_{DD} power supply. A high value resistor (R_{bias}) is put in series with the V_{PIN} circuit input to protect the photodiode against high currents in case of high illumination, the value of R_{bias} is determined by the photodiode characteristics.

The recommended decoupling scheme uses a High-Frequency ceramic capacitor (typically 50 pF) placed close to the chip and a low-frequency multilayer capacitor placed at greater distance. The value of C_{Ref} is determined by the required Low Frequency Cut Off, given by the time constant of the RC circuit C_{Ref} and a 3 500 Ohm on-chip resistor.

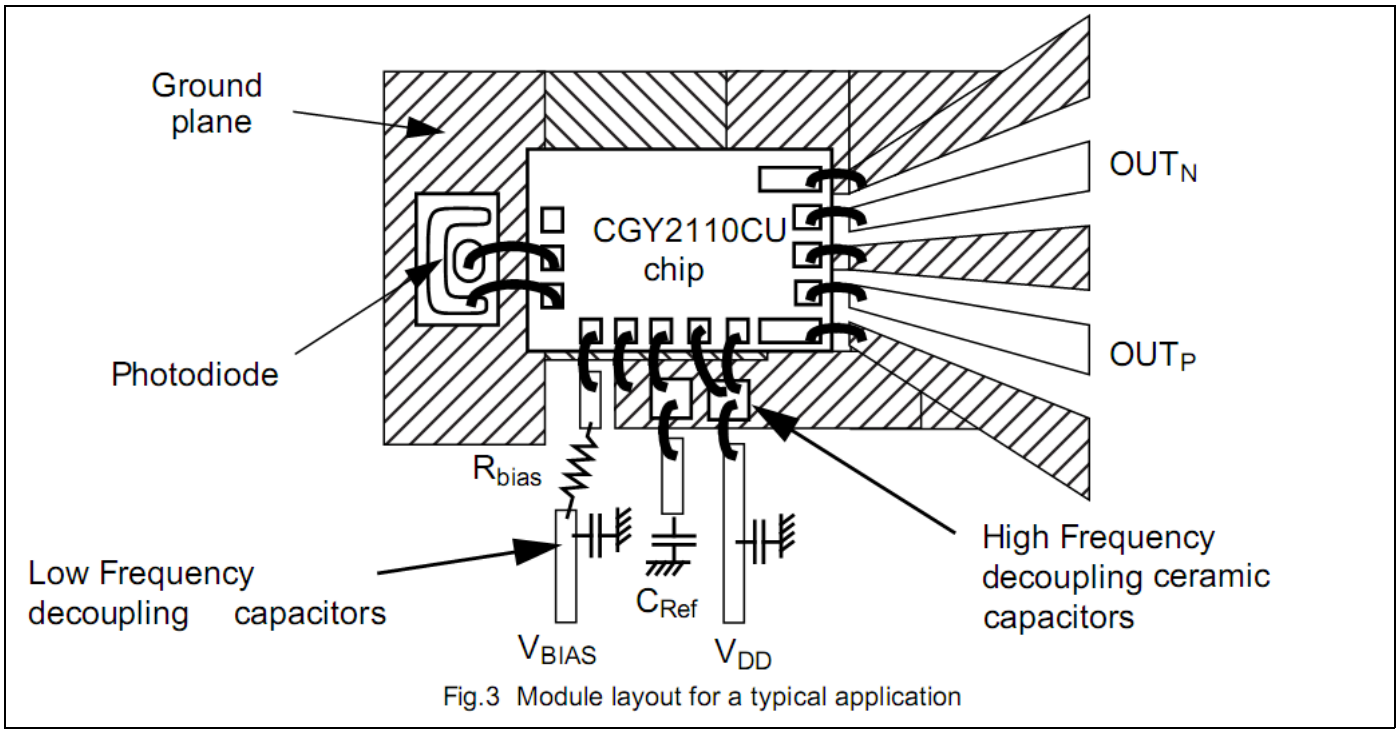


Fig.3 Module layout for a typical application

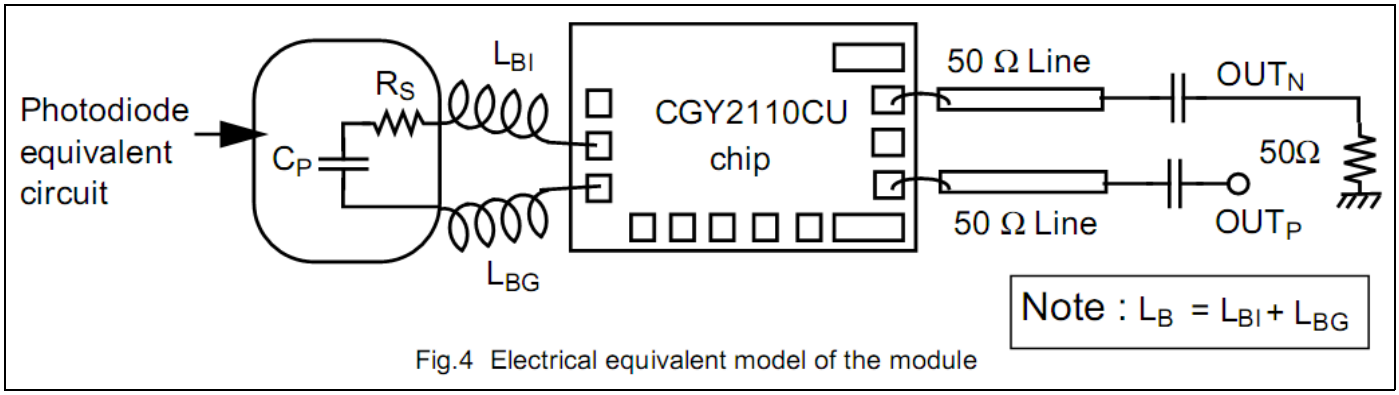


Fig.4 Electrical equivalent model of the module

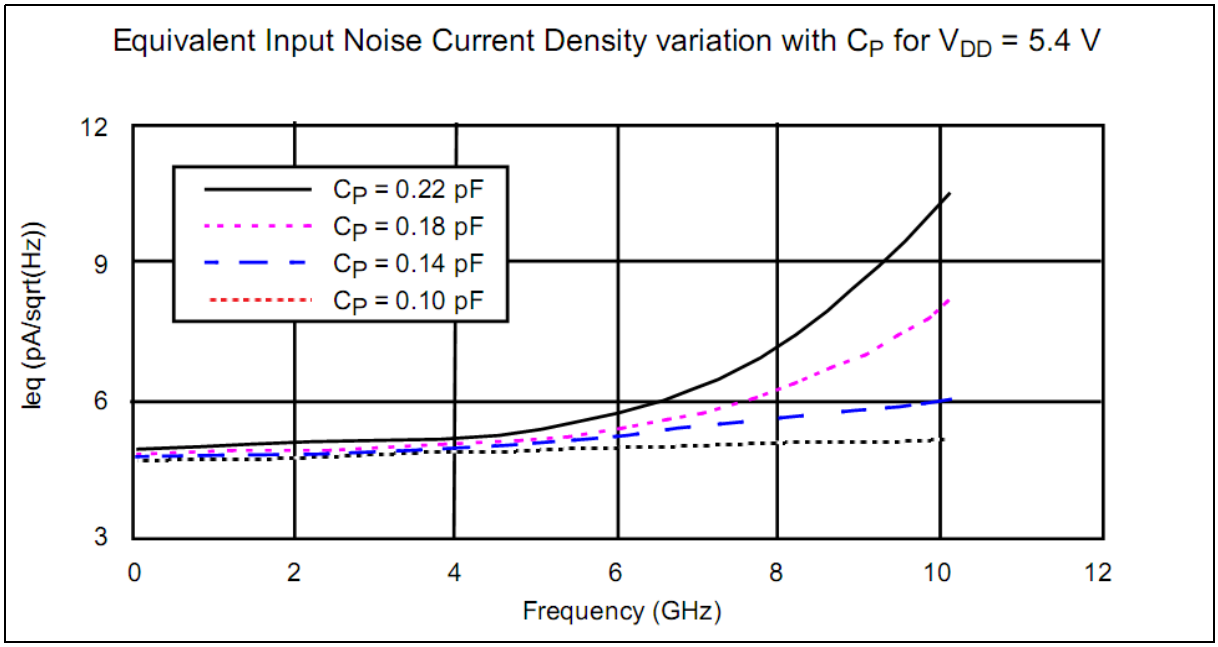
Typical results (Computed measurements)

The S-parameters of the CGY2110UH are measured on-wafer under nominal conditions, using 40 GHz bandwidth probes. These S-parameters may then be used with the photodiode parameters in order to simulate the complete 10 Gb/s receiver module (Photodiode + CGY2110UH) performance.

The transimpedance gain and the equivalent input noise current of receiver modules using the CGY2110UH are thus drawn for various photodiode parameter values in the figures below. The photodiode -3dB intrinsinc optical cut-off frequency is always assumed to be 15 GHz. The C_P, L_B and R_S parameters are defined as in figure 4.

From the following figures, it is clear that the lowest bonding inductance value (L_B) will lead to the flattest gain response, and that the lowest photodiode capacitance (C_P) will lead to the lowest noise. Recommended values are L_B < 0.6 nH and C_P < 0.25 pF.

These results are then followed by graphs showing the variation of the transimpedance gain, equivalent input noise, group delay and output matching as a function of temperature and supply voltage.



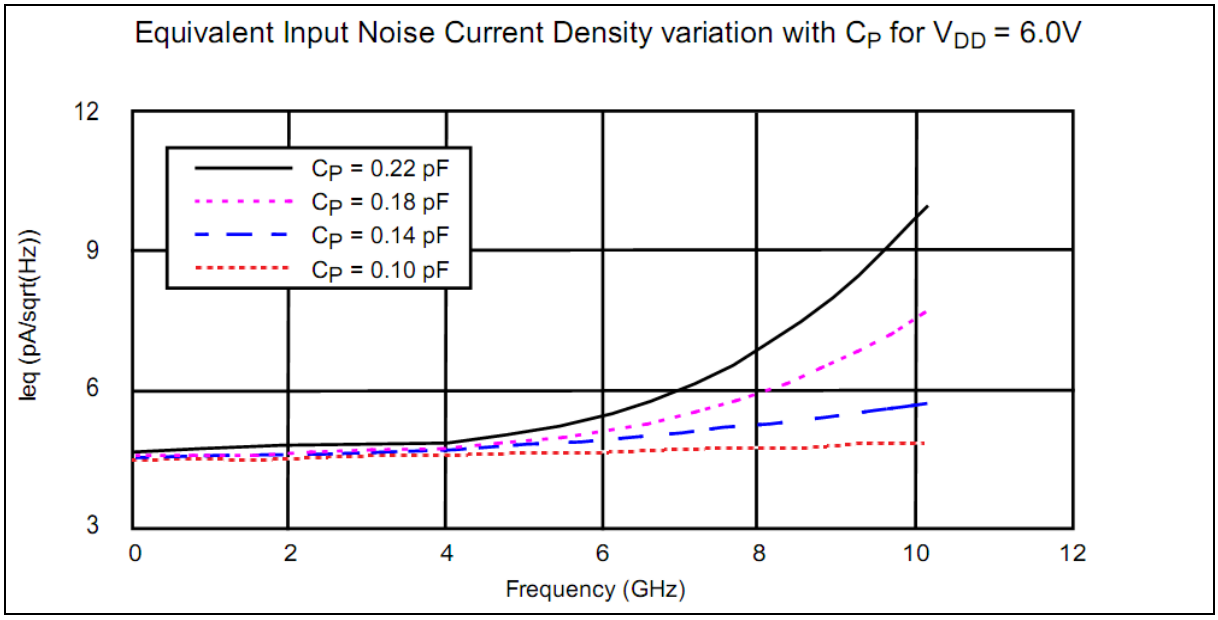
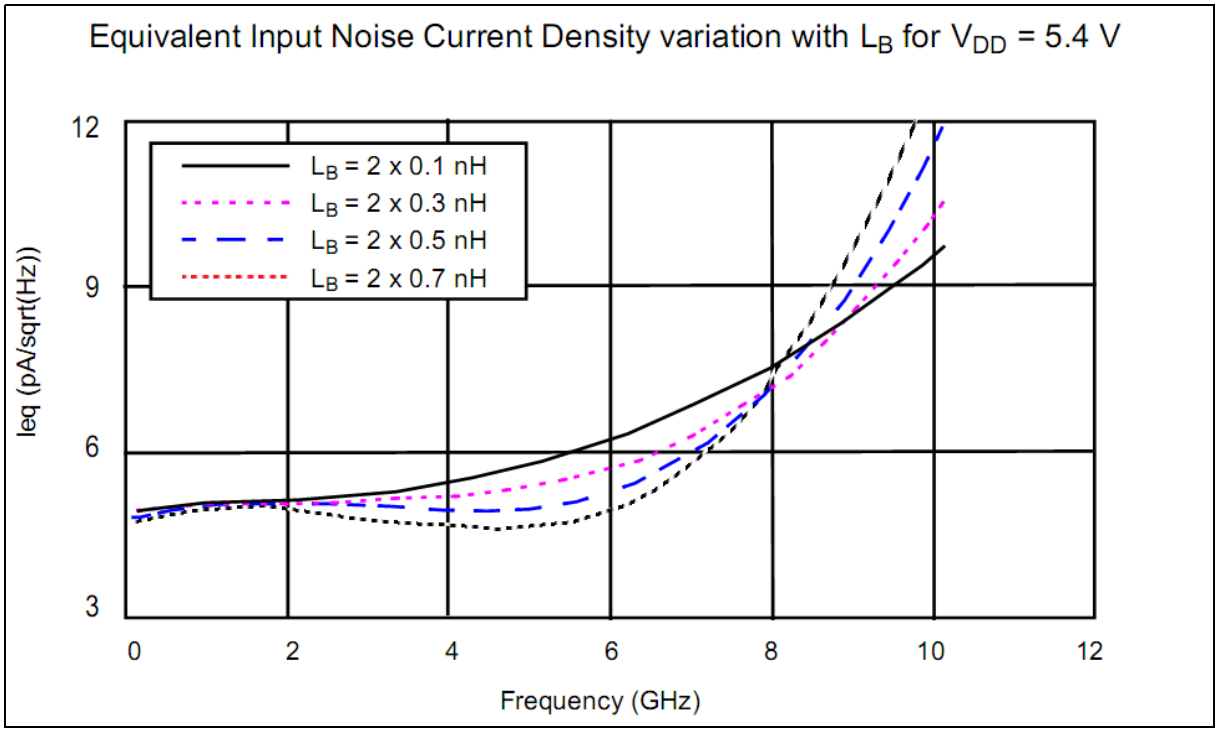


Fig. 5 : Equivalent Input Noise current of the CGY2110UH with different internal capacitance (C_P) values for the photodiode (Photodiode characteristics: R_S = 8 Ω, L_B = 0.6 nH)



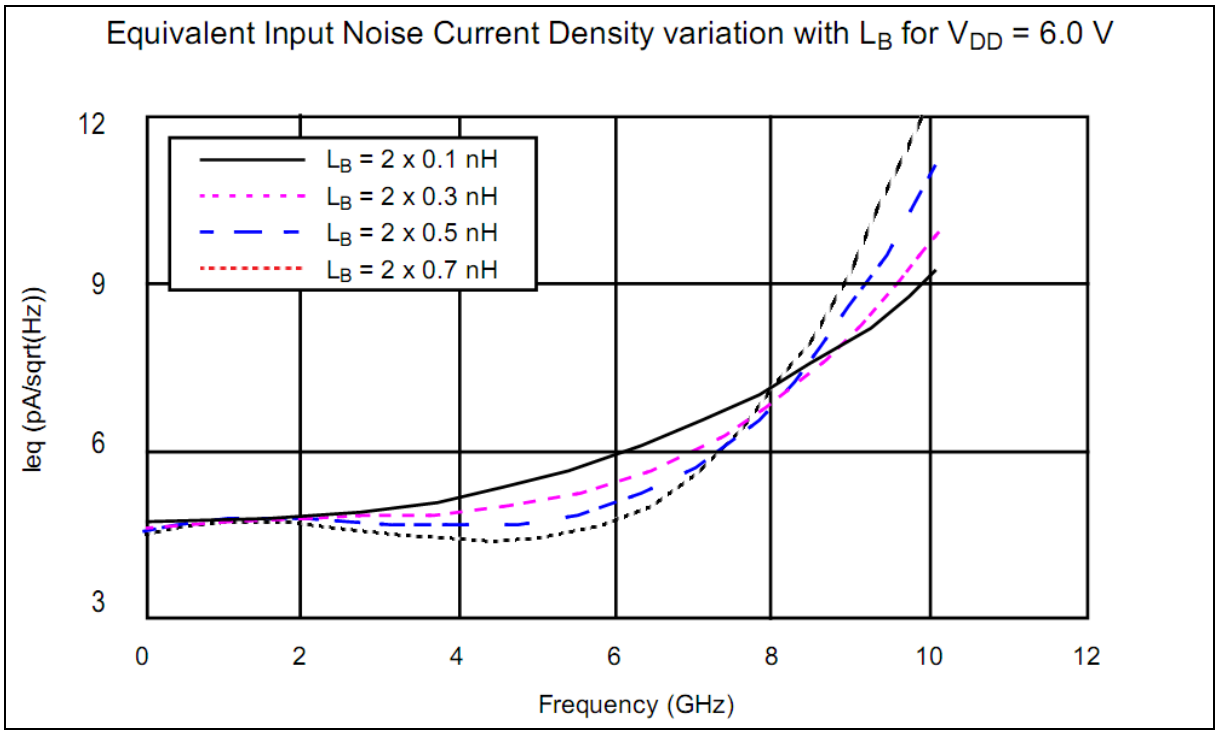
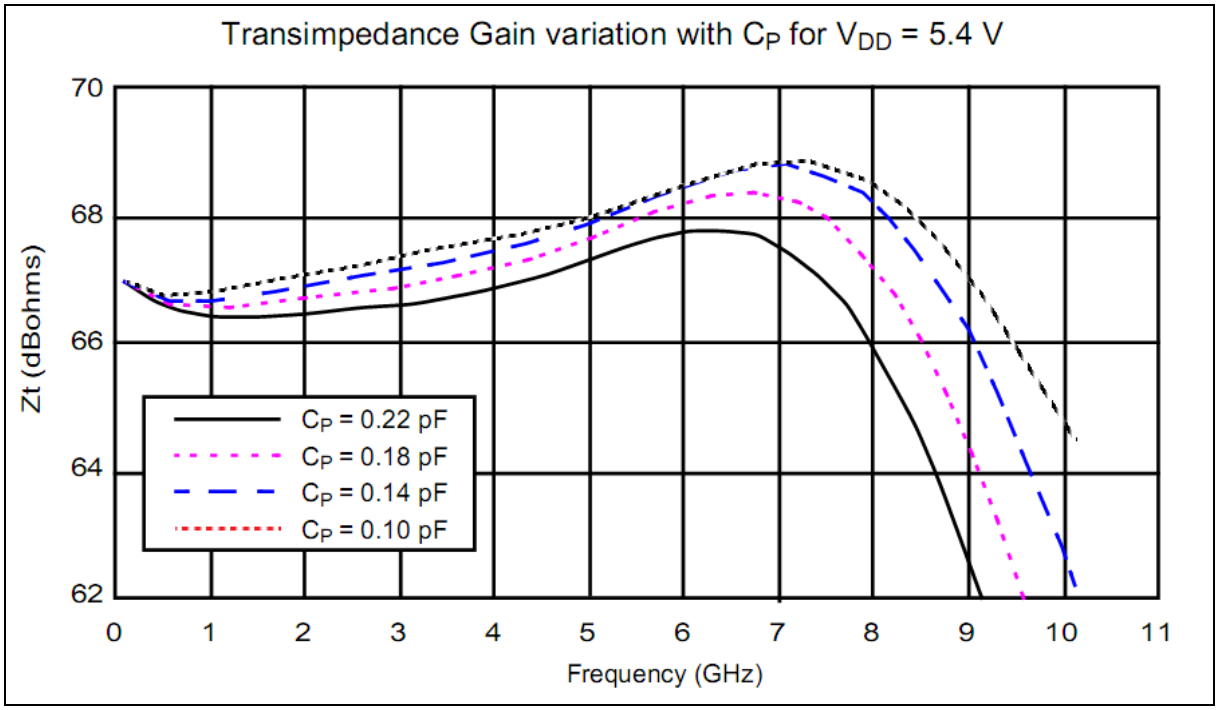


Fig. 6 : Equivalent Input Noise current of the CGY2110UH as a function of the Bonding Inductances (L_B) to the Photodiode (Photodiode characteristics : R_S = 8 Ω, L_B = 0.6 nH)



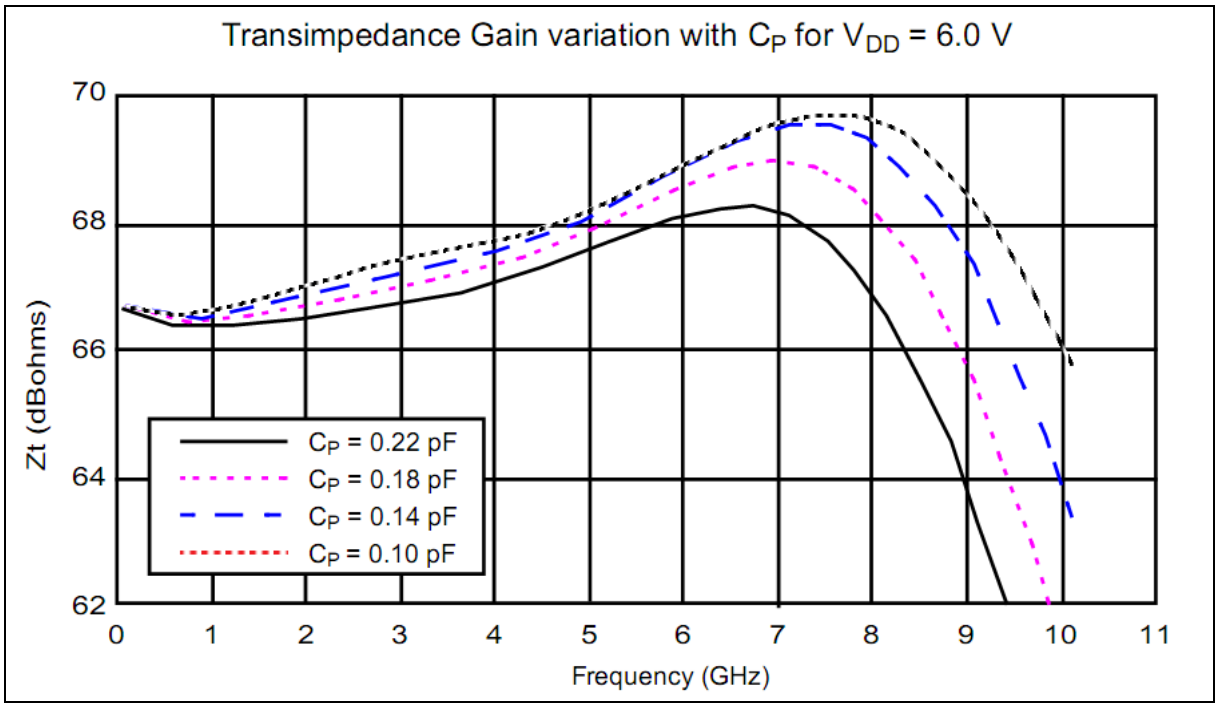
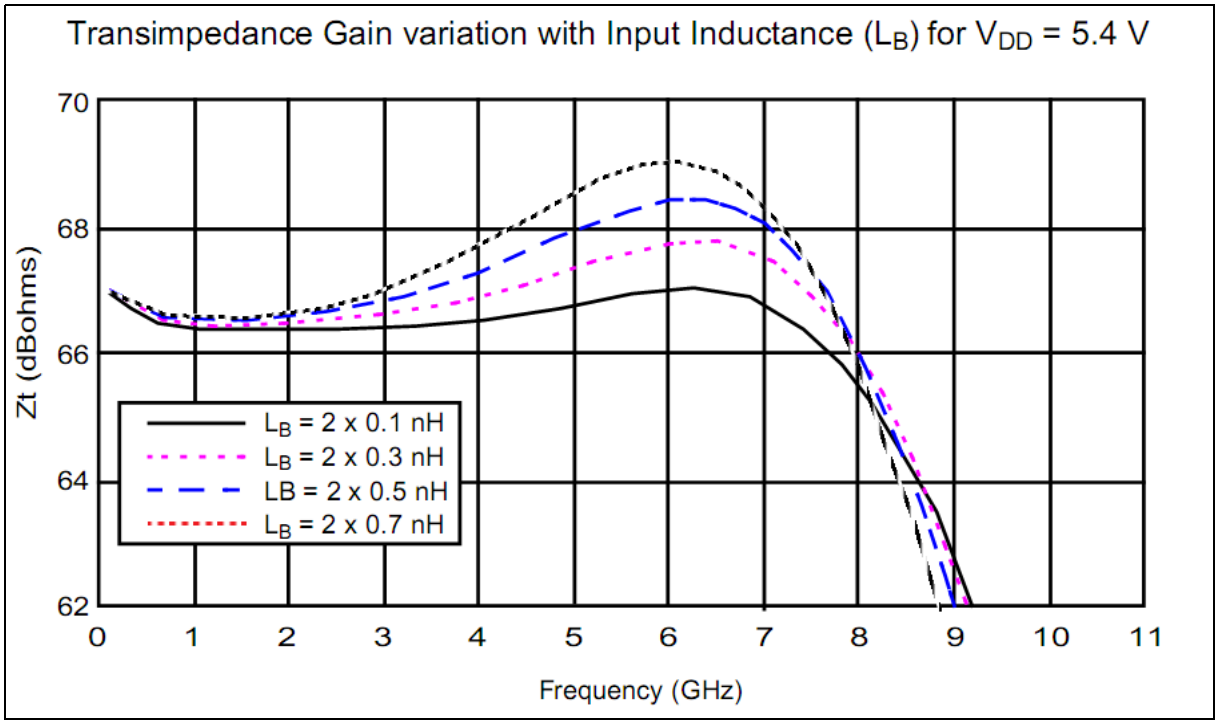


Fig. 7 : Transimpedance gain of the CGY2110UH connected to a photodiode with different internal capacitance (C_P) (Photodiode characteristics: R_S = 8 Ω, L_B = 0.6 nH)



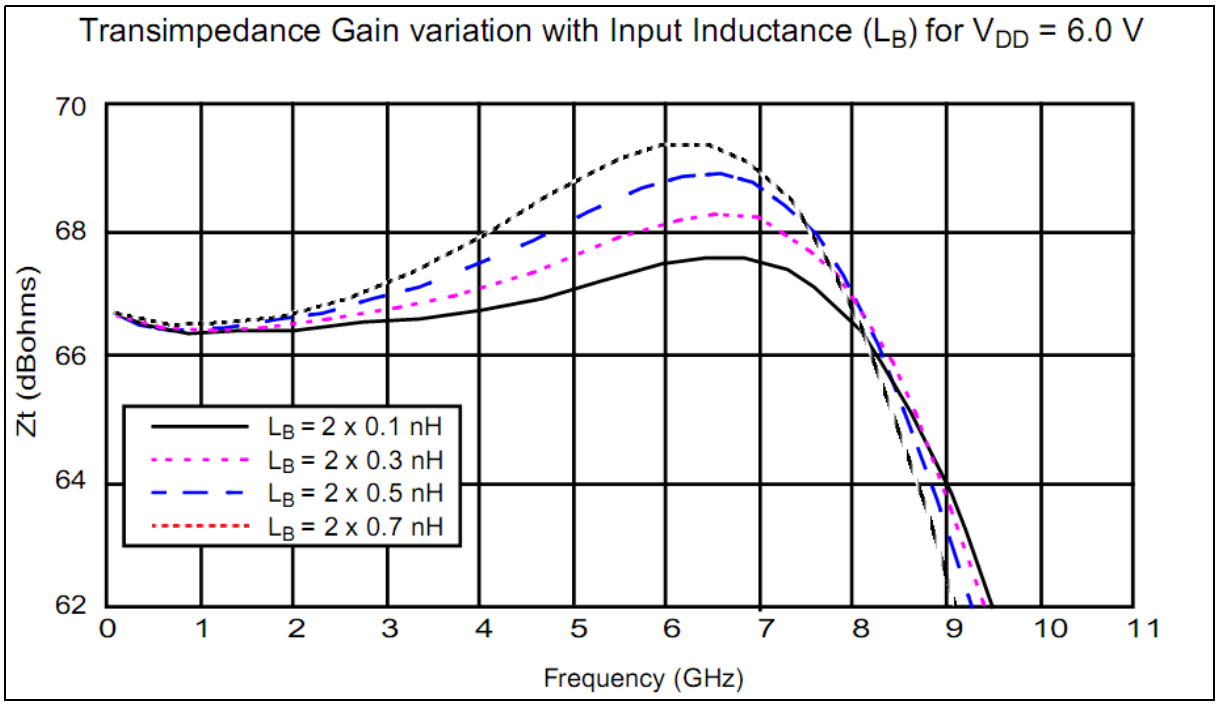
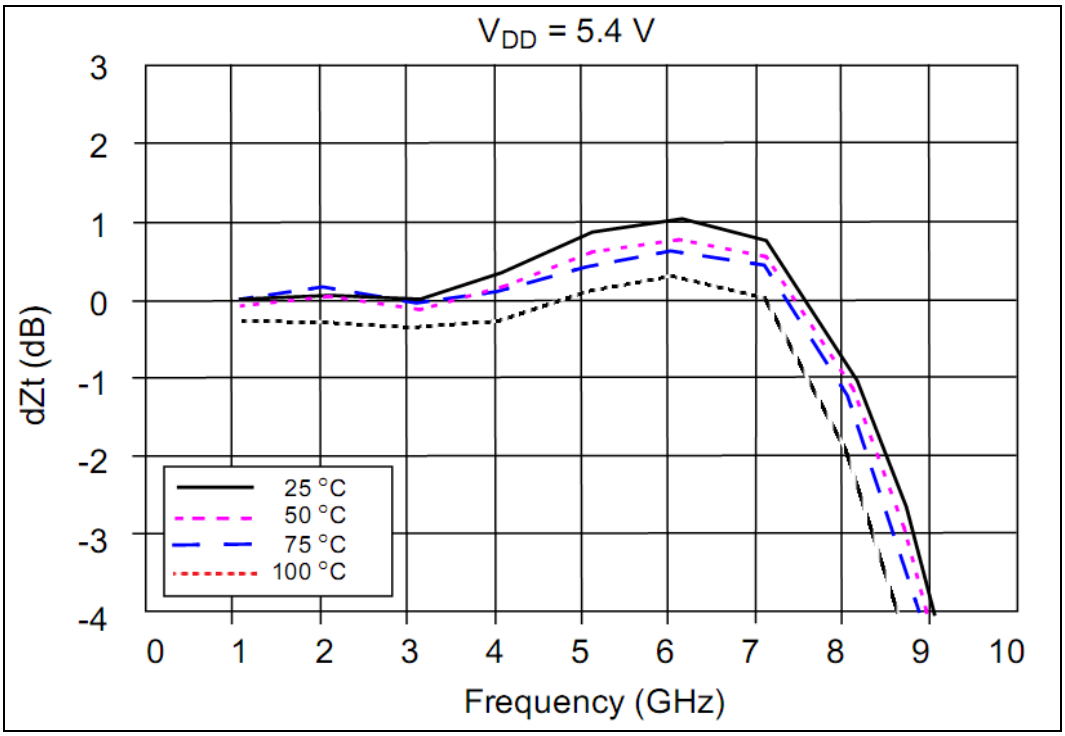


Fig. 8 : Transimpedance gain of the CGY2110UH connected to a photodiode with different Bond Wire Inductances (L_B) (Photodiode characteristics : C_P = 0.22 pF, R_S = 8 Ω)



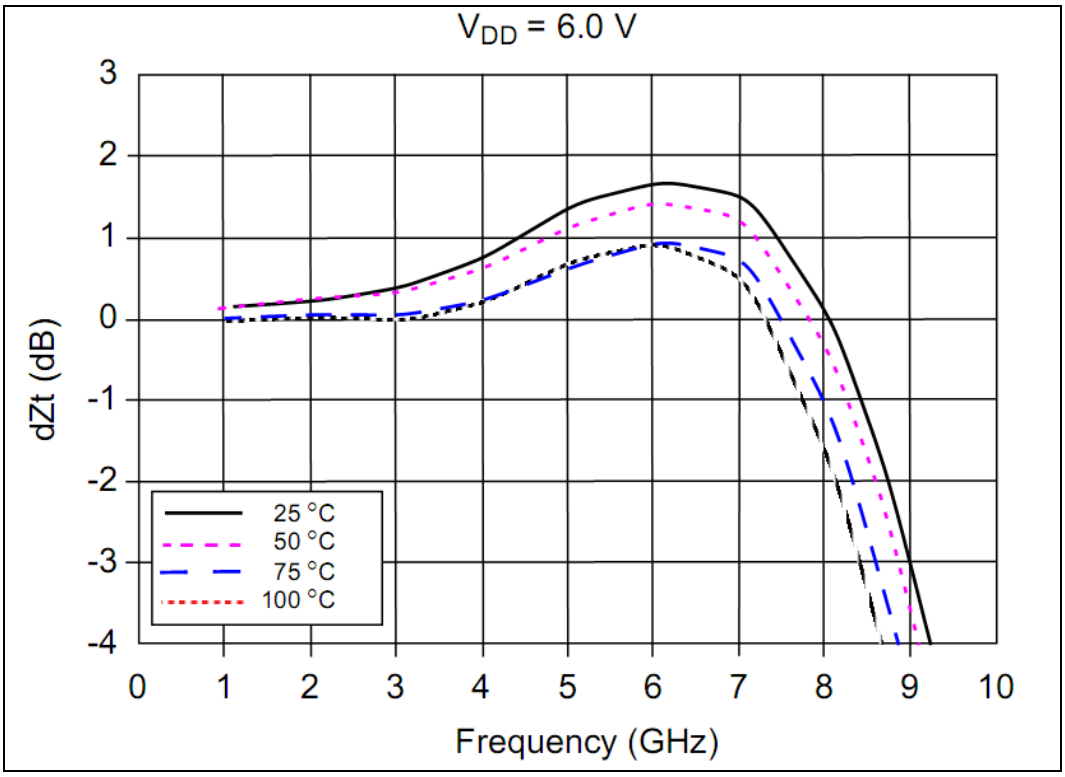


Fig. 9 : Transimpedance gain of the TIA versus temperature and supply voltage
(Photodiode characteristics used for transformation: C_P = 0.22 pF, R_S = 8 Ω, L_B = 0.6 nH)

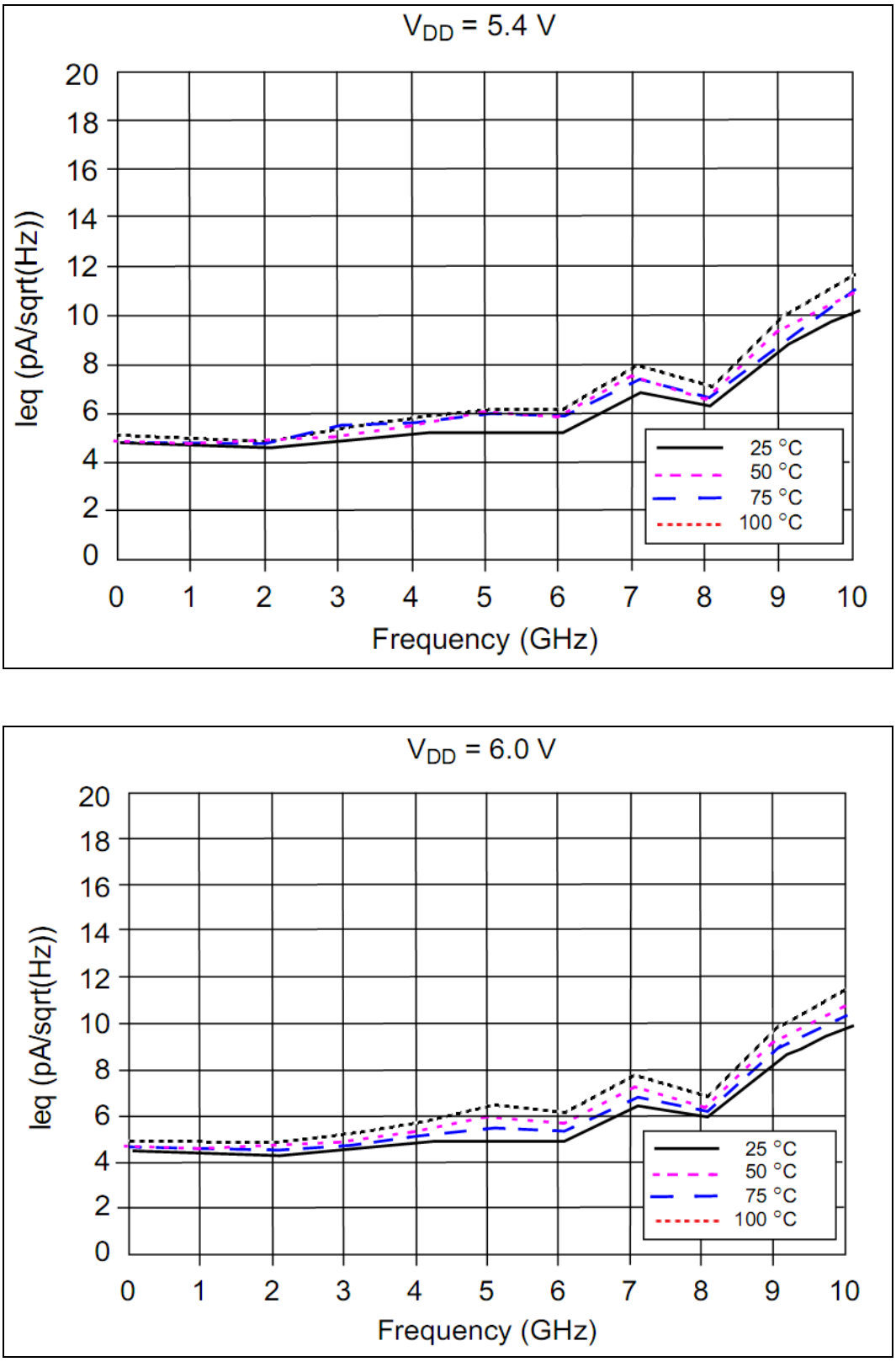


Fig. 10 : Equivalent input noise current of the TIA versus temperature and supply voltage
(Photodiode characteristics used for measurement transformation: C_P = 0.22 pF, R_S = 8 Ω, L_B = 0.6 nH)

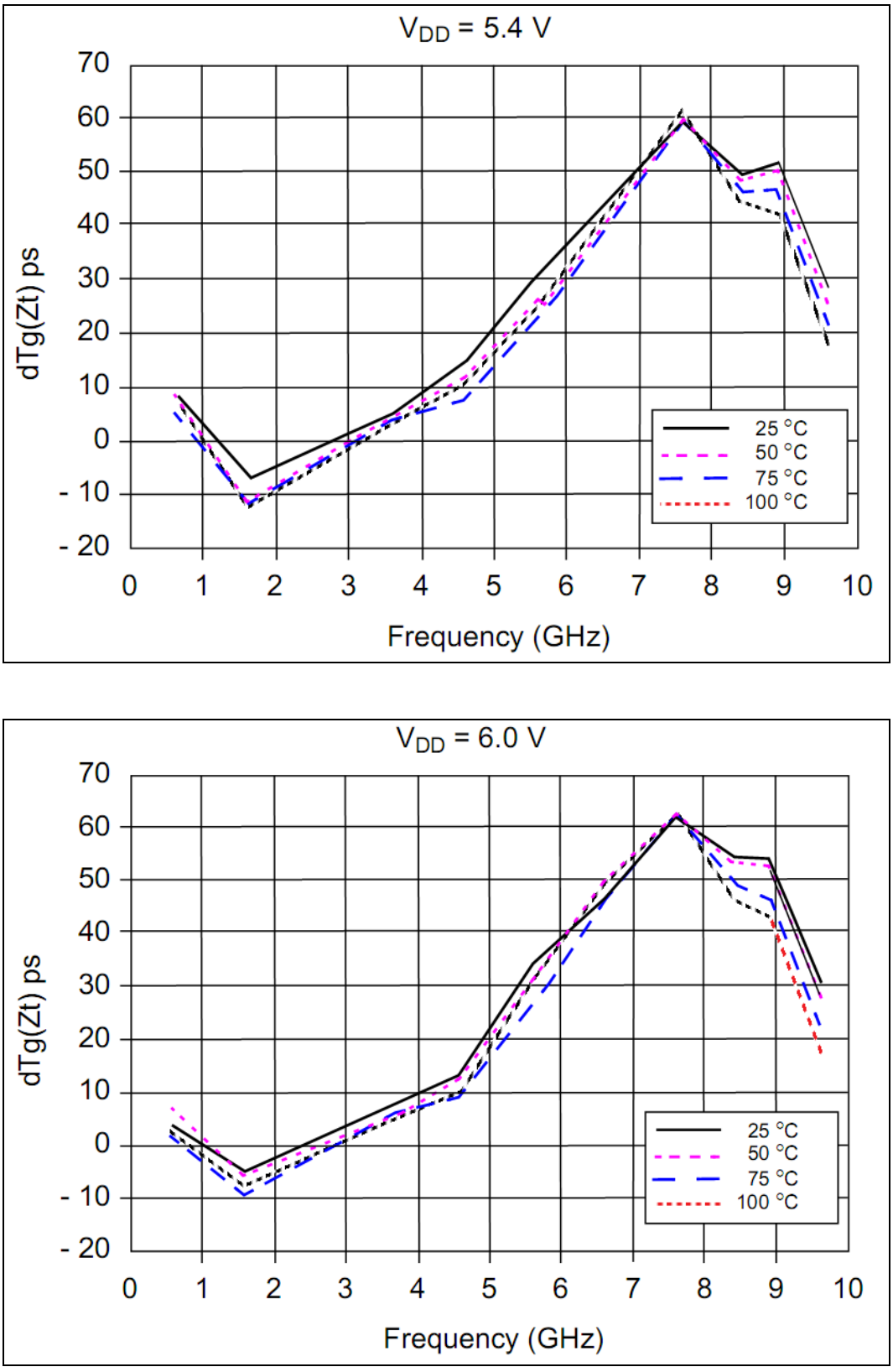
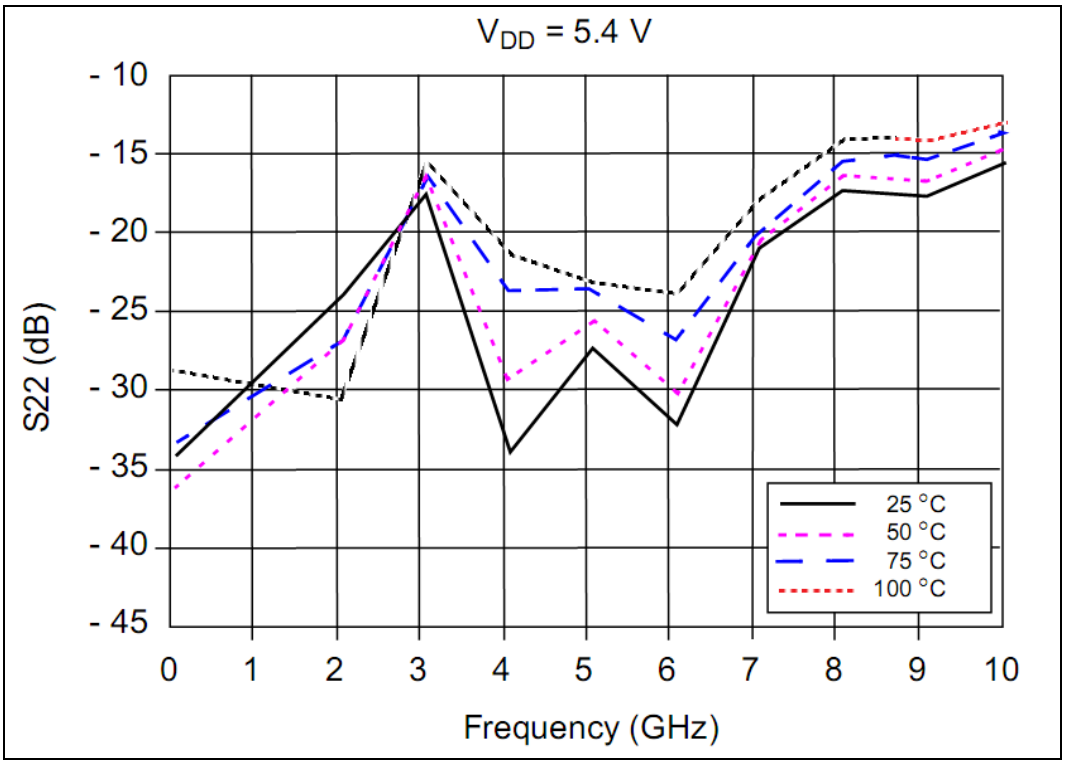


Fig. 11 : Group Delay (relative to 2.5 GHz) of the TIA versus temperature and supply voltage
(Photodiode characteristics used for measurement transformation: C_P = 0.22 pF, R_S = 8 Ω, L_B = 0.6 nH)



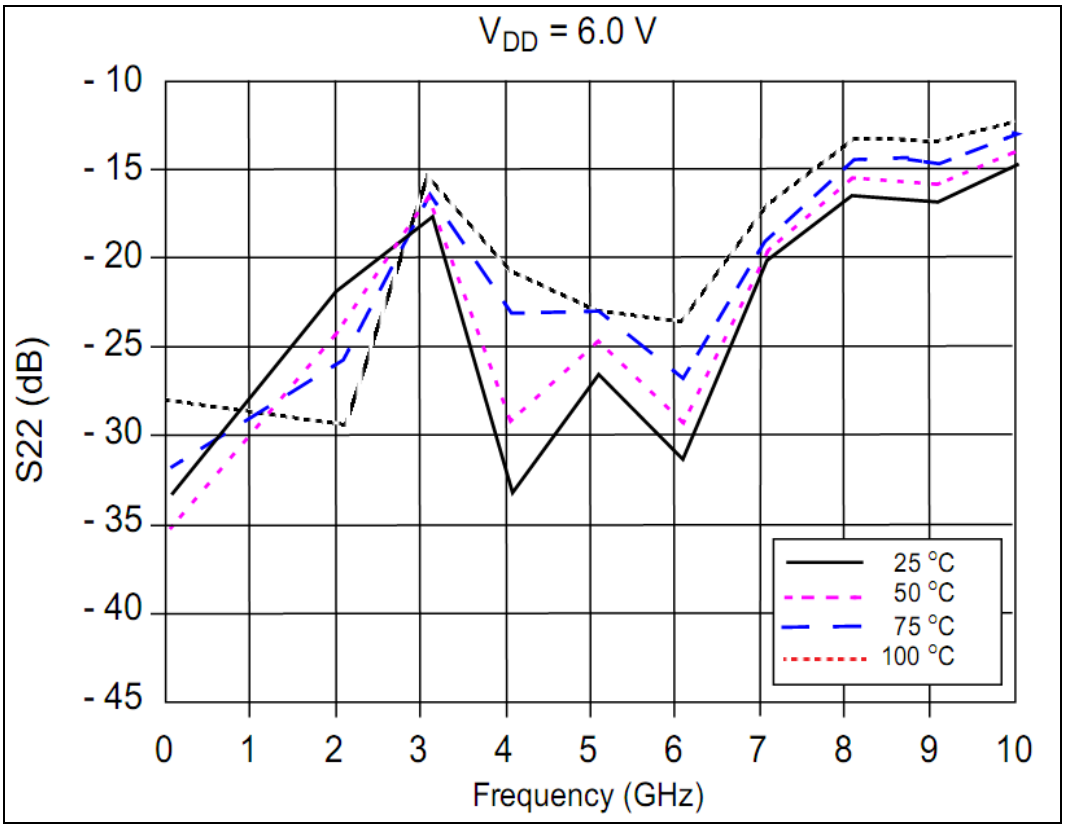


Fig. 12 : Output matching of the TIA versus temperature and supply voltage (Photodiode characteristics used for measurement transformation: C_P = 0.22 pF, R_S = 8 Ω, L_B = 0.6 nH)

S-PARAMETER DATA

The S-parameters of the CGY2110UH die are measured on wafer using 40 GHz bandwidth probes. Measurement data from a typical CGY2110UH chip are shown in the table below. Port 1 is the input (INA), while Port 2 is OUT_P. For these measurements, the OUT_N pad is connected to a 50 Ω load via a DC block capacitor.

Test conditions are : T_{amb} = 25 °C, V_{DD} = 5.4 V, R_L = 50 Ω. Magnitude is given in dB and Phase is given in degrees.

FREQ. (GH_Z)	$\|S_{11}\|$	ΦS_{11}	$\|S_{12}\|$	ΦS_{12}	$\|S_{21}\|$	ΦS_{21}	$\|S_{22}\|$	ΦS_{22}
0.1	- 5.04	- 1.17	- 72.3	- 3	25.87	- 1.5	- 53	+ 152
1.1	- 6.02	- 11.8	- 66.0	- 112	27.44	- 19.7	- 15.1	+ 47.2
2.1	- 7.38	- 15.9	- 69.2	+ 176	29.21	- 49.3	- 23.2	- 35.6
3.1	- 9.32	- 16.6	- 62.5	- 35	30.48	- 84.8	- 18.3	- 3.37
4.1	- 11.1	- 7.0	- 64.2	- 165	31.29	- 124	- 22.8	- 65
5.1	- 12	+ 9.0	- 71.4	+ 137	31.77	- 164	- 27.4	- 66.9
6.1	- 10.6	+ 24.7	- 82.5	- 115	31.65	+ 156	- 35.4	- 178
7.1	- 9.19	+ 31.9	- 68.1	- 129	31.32	+ 112	- 21.8	+ 136
8.1	- 7.7	+ 35.1	- 66.8	+ 179	30.14	+ 64.3	- 14.4	+ 72.1
8.7	- 6.86	+ 35.7	- 67.0	- 158	28.84	+ 37.6	- 14.7	+ 44.0
9.1	- 6.45	+ 35.0	- 62.8	- 162	27.58	+ 20.2	- 17.0	+ 31.4
10.1	- 5.08	+ 34.5	- 59.4	- 173	24.52	- 15.4	- 13.4	+ 40.3

Test conditions are : T_{amb} = 25 °C, V_{DD} = 6.0 V, R_L = 50 Ω. Magnitude is given in dB and Phase is given in degrees.

FREQ. (GH_Z)	$\|S_{11}\|$	ΦS_{11}	$\|S_{12}\|$	ΦS_{12}	$\|S_{21}\|$	ΦS_{21}	$\|S_{22}\|$	ΦS_{22}
0.1	- 5.57	- 0.78	- 79.5	+ 103	27.17	- 1.5	- 61.2	+ 107
1.1	- 6.54	- 10.5	- 65.9	- 99	28.65	- 20.1	- 14.4	+ 48.3
2.1	- 7.84	- 14.1	- 69.6	+ 138	30.24	- 49.4	- 24.1	- 46.2
3.1	- 9.52	- 11.9	- 62.3	- 28	31.44	- 83.6	- 17.7	+ 1.8
4.1	- 11	- 3.46	- 63.8	- 167	32.27	- 121	- 22.1	- 62.7
5.1	- 11.7	+ 13	- 69.9	+ 145	32.89	- 160	- 25.6	- 65.2
6.1	- 10.2	+ 25.9	- 78.7	- 154	32.90	+ 161	- 32.9	- 163
7.1	- 8.85	+ 31.2	- 70.2	- 138	32.89	+ 119	- 20.9	+ 145
8.1	- 7.51	+ 33..8	- 68.5	- 173	32.23	+ 70.7	- 13.2	+ 80.3
8.7	- 6.77	+ 34.2	- 67.8	- 161	31.08	+ 42.4	- 13.5	+ 50.4
9.1	- 6.29	+ 34.1	- 61.8	- 165	29.82	+ 24.0	- 16.1	+ 36.7
10.1	- 5.01	+ 33.7	- 60.1	- 177	26.71	- 13.2	- 11.9	+ 46.2

OPERATING AND HANDLING INSTRUCTIONS

The CGY2110UH is a very high performance GaAs device and care must be taken at all times to avoid damage due to inappropriate handling, mounting and biasing conditions.

Power Supply Sequence :

The following power supply sequence is recommended.

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

a) Always turn on the photodiode bias V_{bias} 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.

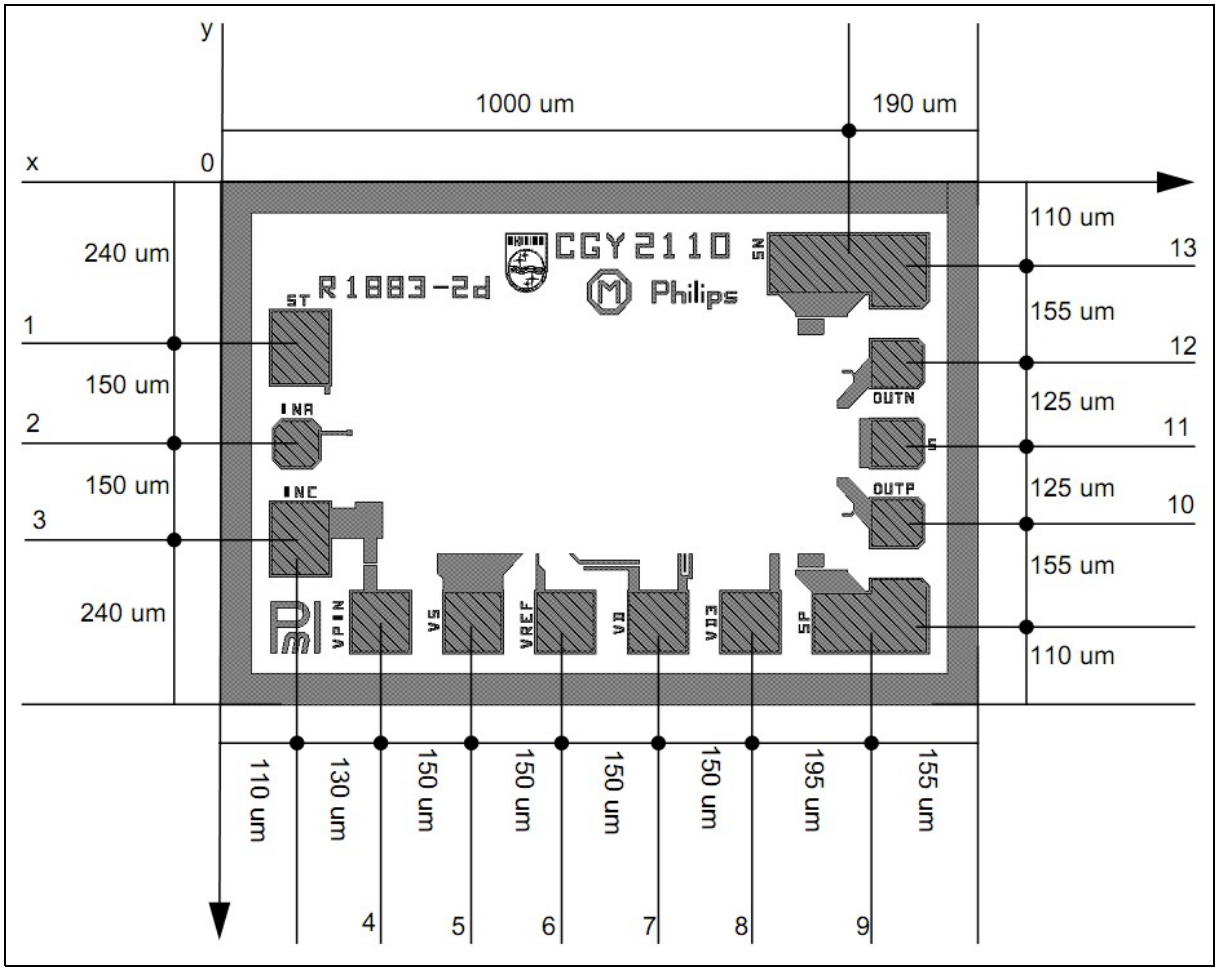
Handling Precautions :

- Use a conductive working desk connected to the ground (or, a conductive table top connected to the ground).
- Require all handling personal to wear a conductive bracelet or wrist-strap connected to the ground.
- Ground all test equipment and all soldering iron tops.
- 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 = 1190 x 780 µm (± 15 µm)
Chip Thickness = 200 µm



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PAD POSITION

PAD NAME	PAD NUMBER	COORDINATES		DESCRIPTION
		X	Y	
ST	1	240	110	Do Not Bond
INA	2	390	110	RF Input. To be connected to photodiode anode
INC	3	540	110	Photodiode biasing pad. To be connected to photodiode cathode (optional use)
VPIN	4	670	240	Photodiode DC biasing voltage (optional use)
VS	5	670	390	Bond to ground with lowest possible inductance
VREF	6	670	540	Reference input voltage, must be decoupled to ground using external capacitor(s)
VD	7	670	690	First stage DC supply voltage
VD3	8	670	840	Second stage DC supply voltage
SP	9	670	1035	Bond to ground
OUTP	10	515	1080	RF non-inverted output
S	11	390	1080	Bond to ground
OUTN	12	265	1080	RF inverted output
SN	13	110	1000	Bond to ground

All x and y coordinates (in µm) represent the position of the center of the pad with respect to the upper left corner of the chip layout
See Mechanical Information for more details.

Bonding Pad	Dimensions (µm)
VPIN, VS, VREF, VD, VD3	100 x 100 µm
OUTP, OUTN, S	90 x 80 µm
ST, INC	120 x 100 µm
INA	80 x 80 µm
SP	190 x 100 µm
SN	260 x 100 µm

PACKAGE

Type	Description	Terminals	Pitch (mm)	Die size (mm)
UH	Bare Die	-	-	1.19 x 0.78 mm ±15 µm 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.

DISCLAIMERS

Life support applications
These products are not designed for use in life support appliances, devices, or systems where malfunction of these products can reasonably be expected to result in personal injury. OMMIC's customers using or selling these products for use in such applications do so at their own risk and agree to fully indemnify OMMIC for any damages resulting from such application.

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ORDERING INFORMATION

Generic type	Package type	Version	Sort type	Description
CGY2110	UH	C1	-	10.0 Gb/s TransImpedance Amplifier

RoHS Compliant

Document History : Version 2.0, Last Update 22/6/2010