



SUMITOMO ELECTRIC

Preliminary

02.05.21

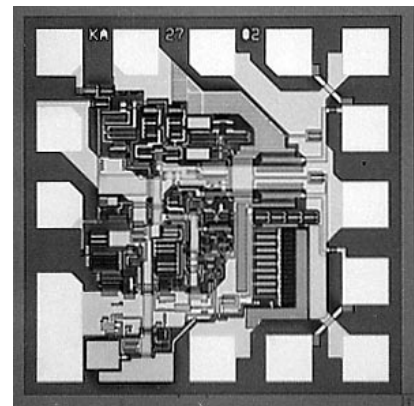
◆ Features

- 1.5k Ω high transimpedance
- 28 dB gain
- Low noise (typ.8.2 pA/ $\sqrt{\text{Hz}}$ @100 MHz)
- Typical 2400 MHz O/E bandwidth
- Over 25 dB wide dynamic range
- 3.3 V or 5.0 V single voltage supply operation
- Differential output

F0100505B

3.3 V /5V 2.5 Gb/s NRZ Receiver

Transimpedance Amplifier



◆ Applications

- Preamplifier of an optical receiver circuit for OC-48/STM-16 (2.7 Gb/s (FEC available))

◆ Functional Description

The F0100505B is stable GaAs integrated transimpedance amplifier. Typical Applications are for 2.7 Gb/s (FEC available) optical receiver circuit, for example, OC-48/STM-16, instrumentation, and measurement applications. The integrated feedback loop design provides broad bandwidth and stable operation. The F0100505B typically specifies a high transimpedance of 1.5 k Ω (RL=50 Ω) at a typical 2400 MHz O/E bandwidth (-3 dB-cutoff frequency) with a dynamic range of over 25 dB. It also provides a large optical input overload of more than +1 dBm. Furthermore, it can operate with a low supply voltage of single +3.3 V. It features a typical dissipation current of 45 mA.

Only chip-shipment is available for all product lineups of GaAs transimpedance amplifiers, because the packaged preamplifier cannot operate with the maximum performance owing to parasitic element of the package.

◆ Absolute Maximum Ratings

All published data at $T_a=25\text{ }^{\circ}\text{C}$ unless otherwise indicated. This device isn't guaranteed opto-electric characteristics in these ranges. At least, this device isn't broken in these ranges.

$V_{SS}=0\text{ V}$

Parameter	Symbol	Value	Units	Attentions
Supply Voltage	$V_{DD3.3}$	-0.3 to +4.0 V	V	at 3.3 V operation
Supply Voltage	$I_{DD5.0}$	-0.3 to +7.0 V	mA	at 5.0 V operation
Input Current	I_{inpeak}	4	mA	-
Ambient Operating Temperature	T_a	-40 to +90	$^{\circ}\text{C}$	-
Storage Temperature	T_{stg}	-50 to 125	$^{\circ}\text{C}$	-

◆ Recommended Operating Conditions

$V_{SS}=0\text{ V}$, unless specified

Parameter	Symbol	Value			Units	Attentions
		Min.	Typ.	Max.		
Supply Voltage	$V_{DD3.3}$	3.10	3.30	3.60	V	at 3.3 V operation
Supply Voltage	$I_{DD5.0}$	4.75	5.00	5.25	V	at 5.0 V operation
Ambient Operating Temperature	T_a	0	25	85	$^{\circ}\text{C}$	
Input Capacitance	C_{pd}	-	0.25	-	pF	at $V_b=-2\text{ V}^*$

* V_b is the bias between IN and VPD. Show [Test Circuits / 2] Block Diagram of F0832483T]

◆ Electrical Characteristics

Ta=25 °C, V_{DD3.3}=3.3 V, V_{SS}=0, unless specified

Parameter	Symbol	Test Conditions	Value			Units
			Min.	Typ.	Max.	
Supply Current	I _{DD}	DC	-	50	-	mA
Input Voltage	V _i	*1	-	0.96	-	V
Output Voltage(positive)	V _{op}	*1	-	2.13	-	V
Output Voltage(negative)	V _{on}	*1	-	2.04	-	V
Gain(positive)	S _{21p}	Single-ended, f=1 MHz *1	-	27.6	-	dB
Gain(negative)	S _{21n}	Single-ended, f=1 MHz *1	-	27.4	-	dB
-3dB High Frequency Cut-off (positive)	F _{cp}	S _{21p} -3dB	-	1130	-	MHz
-3dB High Frequency Cut-off (negative)	F _{cn}	S _{21p} -3dB	-	1010	-	MHz
Input Impedance	R _i	f=1 MHz, *1	-	67	-	Ω
Output Impedance(positive)	R _{out}	f=1 MHz, *1	-	59	-	Ω
Output Impedance(negative)	R _{out}	f=1 MHz, *1	-	55	-	Ω
Transimpedance(positive)	Z _{tp}	RL=-50 Ω, Single-ended, *2	-	1.5	-	kΩ
Transimpedance(negative)	Z _{tn}	RL=-50 Ω, Single-ended, *2	-	1.5	-	kΩ
AGC time constant	tagc	Cout=470 pF	-	10	-	μsec

* 1 Test circuit is shown [Test Circuits / 1] AC Characteristics].

* 2 Z_{t(p,n)}=10^{^(S21(p,n)/20×(Ri+50)/2)}

◆ Optical and Electrical Characteristics

This table values are specified by F0832671T. F0832671T is 2.7 Gb/s (FEC available) NRZ PIN-PD preamplifier module using F0100505B. Test circuits of F0832671T are shown in [Test Circuits].

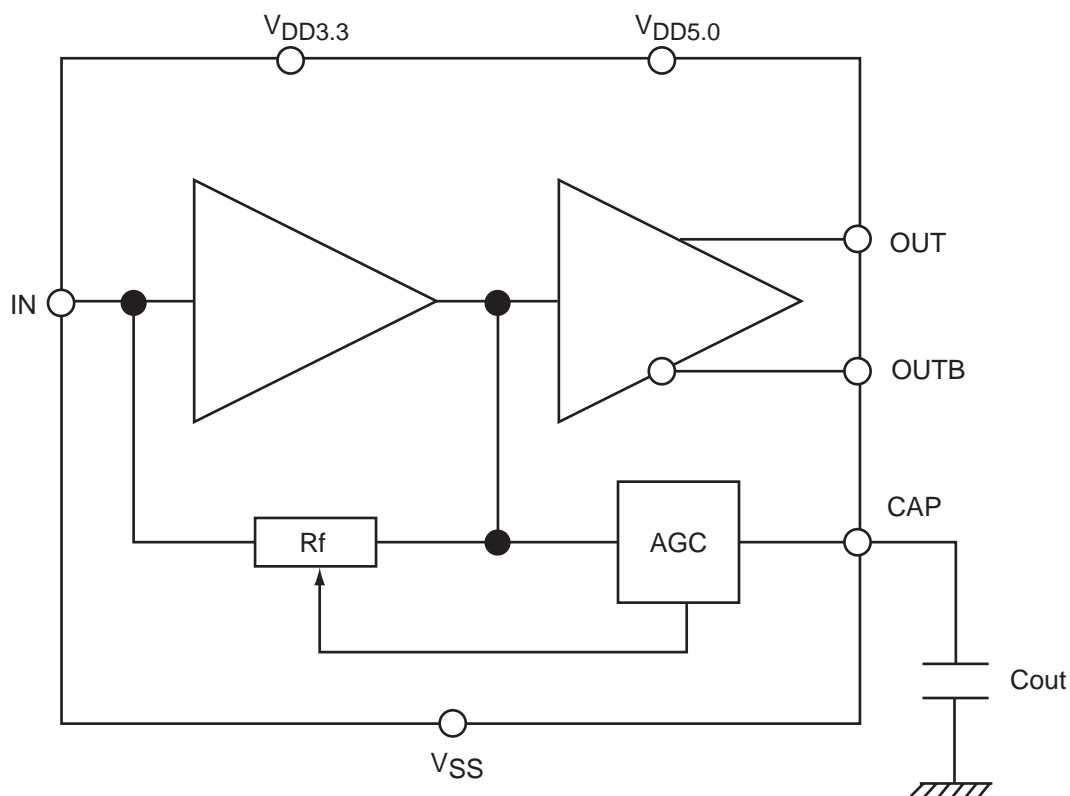
Ta=25 °C, V_{DD3.3}=3.3 V, V_{SS}=0 V, unless specified

Parameter	Symbol	Test Conditions	Value			Units
			Min.	Typ.	Max.	
Transimpedance	Z _{tm}	RL=50 Ω, Single-ended f=100 MHz,*3	-	1.4	-	kΩ
O/E High Cut-off Frequency	F _{coeh}	Z _{tm} -3dB,*3	-	2400	-	MHz
O/E Low Cut-off Frequency	F _{coel}	Cout=470pF	-	17	-	kHz
Equivalent Input Noise	I _{noise}	f=100 MHz	-	8.2	-	pA/√Hz
Sensitivity	Pin-min	2.66606 Gb/s, PRBS2 ²³ -1,	-	-23	-	dBm
Overload	Pin-max	BER=1E-10,*4	+2	-	-	dBm
Output Impedance	R _{outm}	No input, f=1 MHz, *3	-	TBD	-	Ω

* 3 Shown [Test Circuits/3] Optical & Electrical Characteristics].

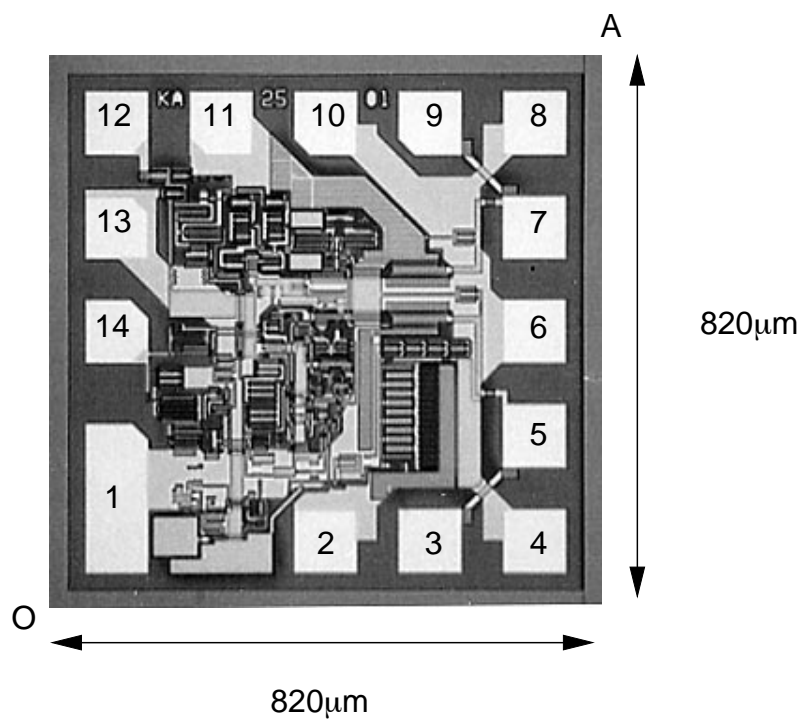
* 4 Shown [Test Circuits/4] Sensitivity Characteristics].

◆ Block Diagram



Symbol	Description
$V_{DD3.3}$	Supply Voltage for 3.3 V operation, it is not required for 5.0 V operation.
$V_{DD5.0}$	Supply Voltage for 5.0 V operation, For 3.3 V operation, $V_{DD3.0}$ must be opened.
V_{SS}	Supply Voltage Generally V_{SS} is connected to GND.
IN	Input
OUT	Non-inverted data output, must be AC coupled.
OUTB	Inverted data output, must be AC coupled.
CAP	Connected to outer capacitance

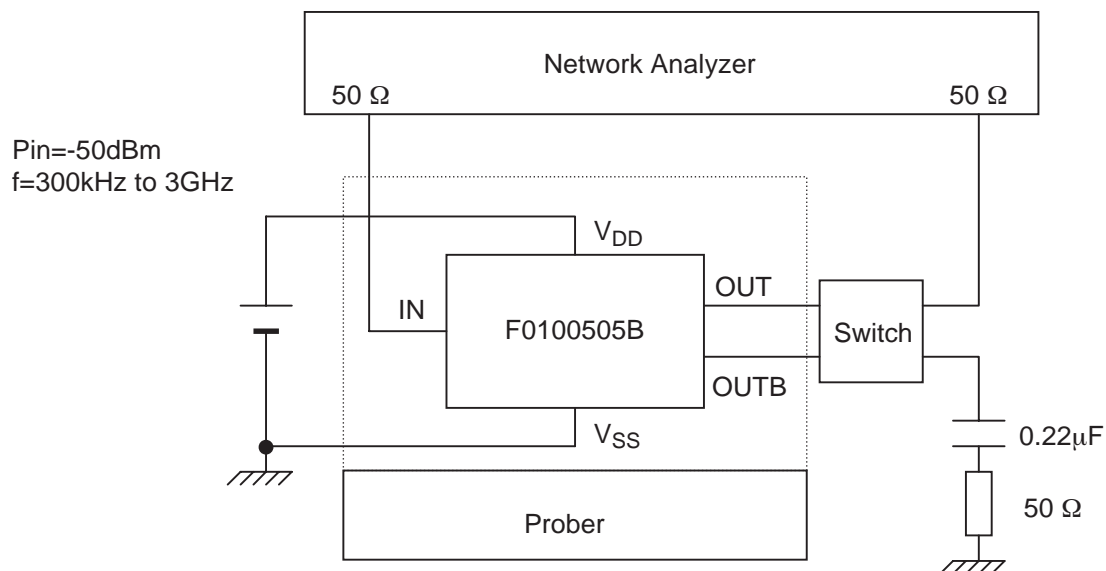
◆ Die Pad Assignments



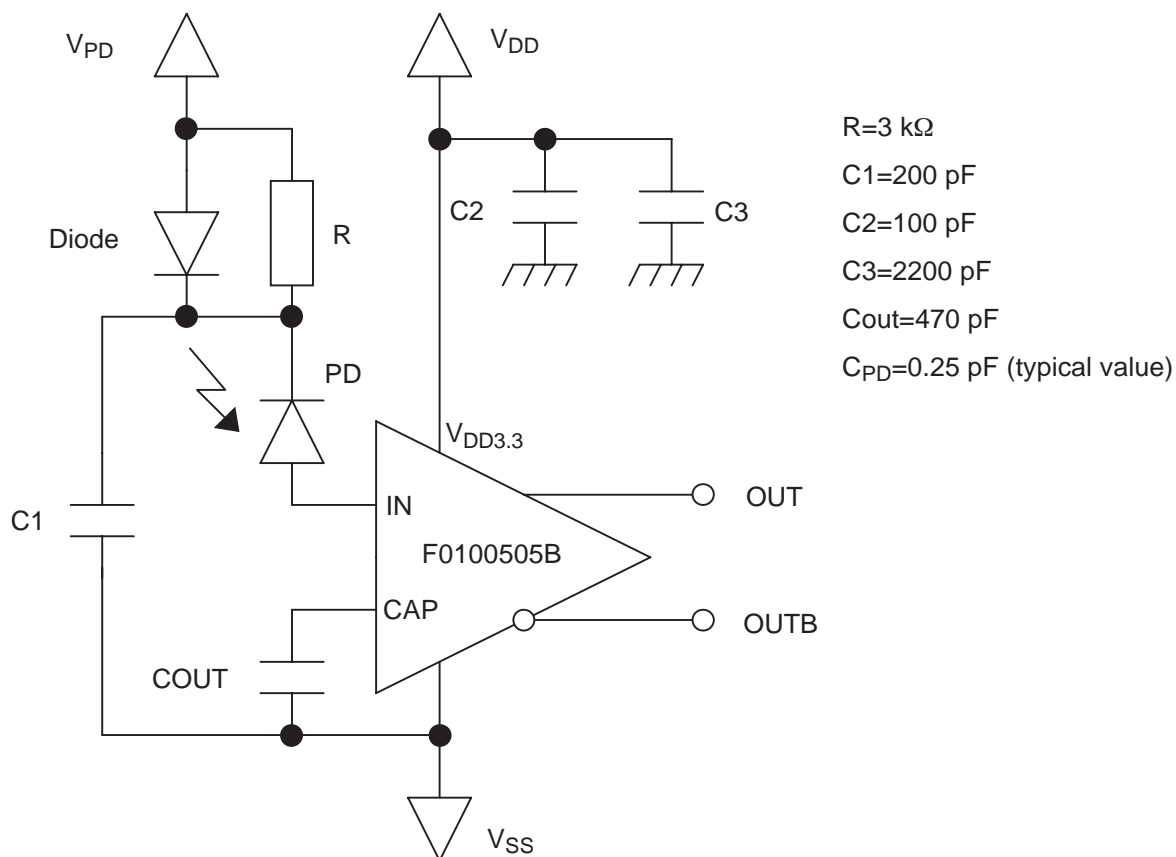
No.	Symbol	Center Coordinates (μm)	No.	Symbol	Center Coordinates (μm)
1	V _{DD3.3}	(75,140)	10	V _{SS}	(395,715)
2	V _{DD5.0}	(395,75)	11	V _{DD3.3}	(235,715)
3	OUTB	(555,75)	12	CAP	(75,715)
4	V _{SS}	(715,75)	13	V _{SS}	(75,555)
5	OUTB	(715,235)	14	IN	(75,395)
6	V _{SS}	(715,395)			
7	OUT	(715,555)			
8	V _{SS}	(715,715)	O		(0,0)
9	OUT	(555,715)	A		(790,790)

◆ Test Circuits

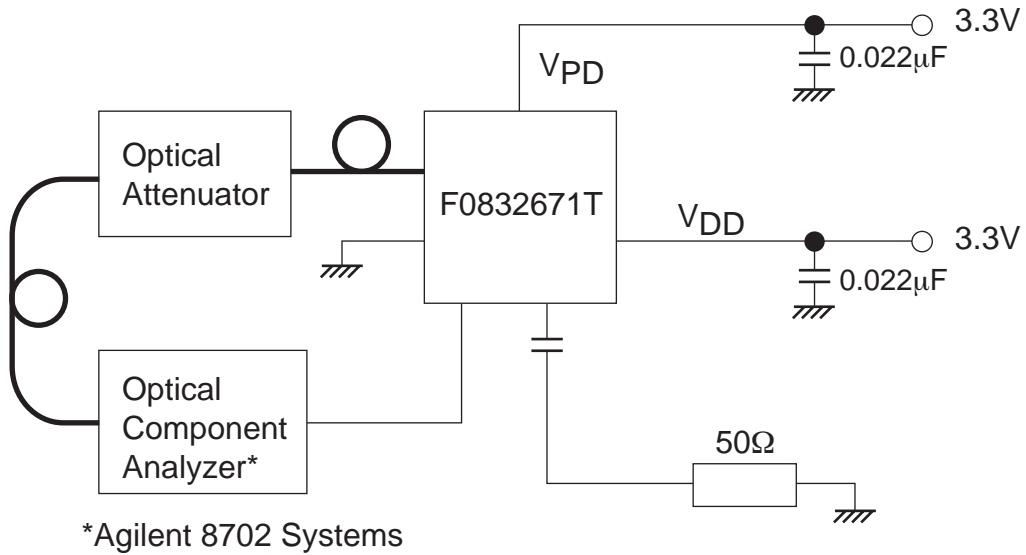
1) AC Characteristics



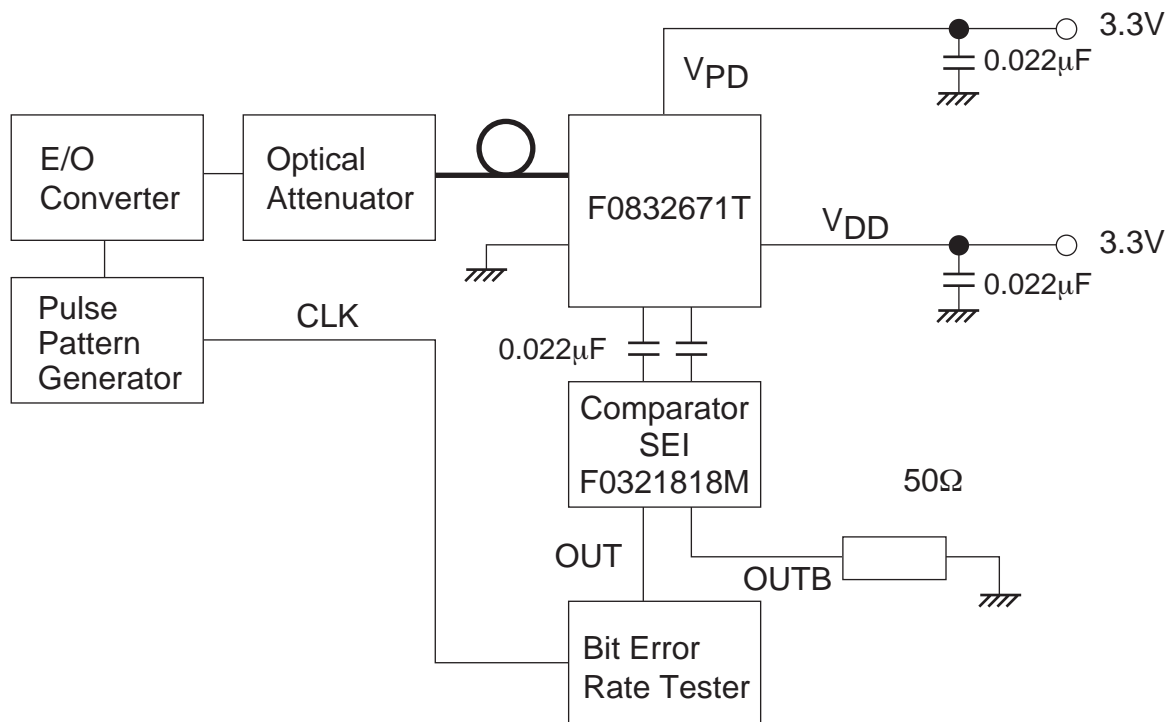
2) Block Diagram of F0832483T



3) Optical & Electrical Characteristics



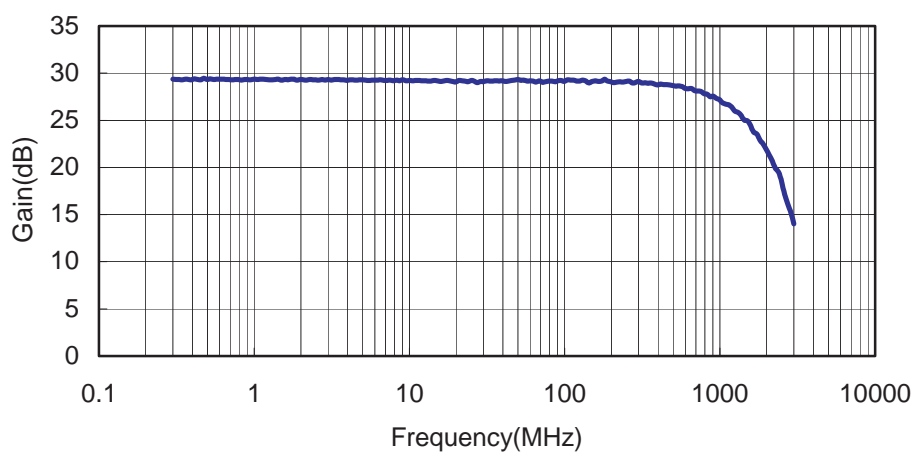
4) Sensitivity Characteristics



◆ Examples of AC Characteristics

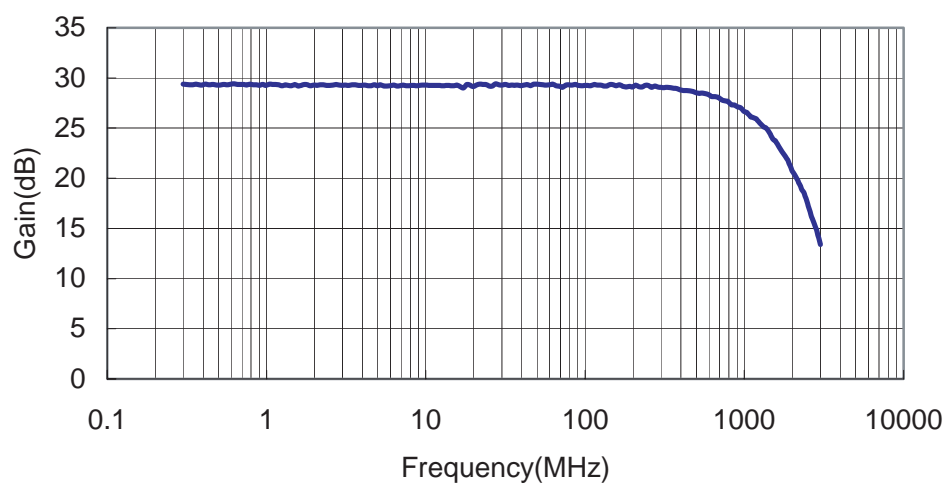
1) Gain (S21p)

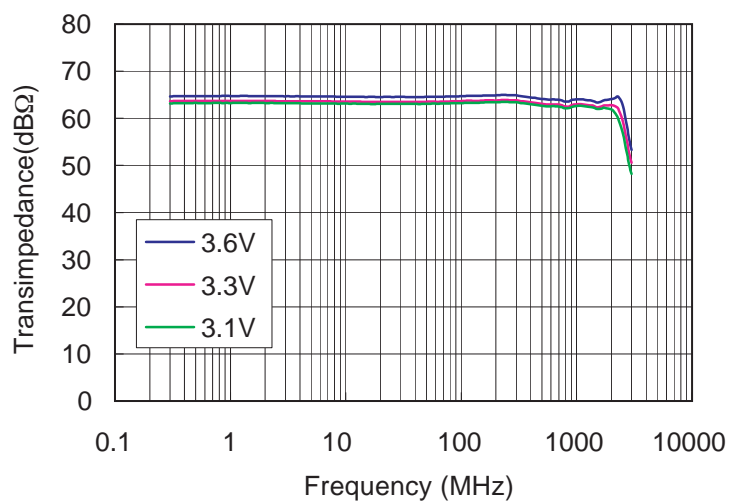
$T_a=25\text{ }^{\circ}\text{C}$, $V_{DD}=3.30\text{ V}$, $V_{SS}=0\text{ V}$, $\text{Pin}=-50\text{ dBm}$, $R_L=50\text{ }\Omega$, 300 kHz to 3 GHz



2) Gain (S21n)

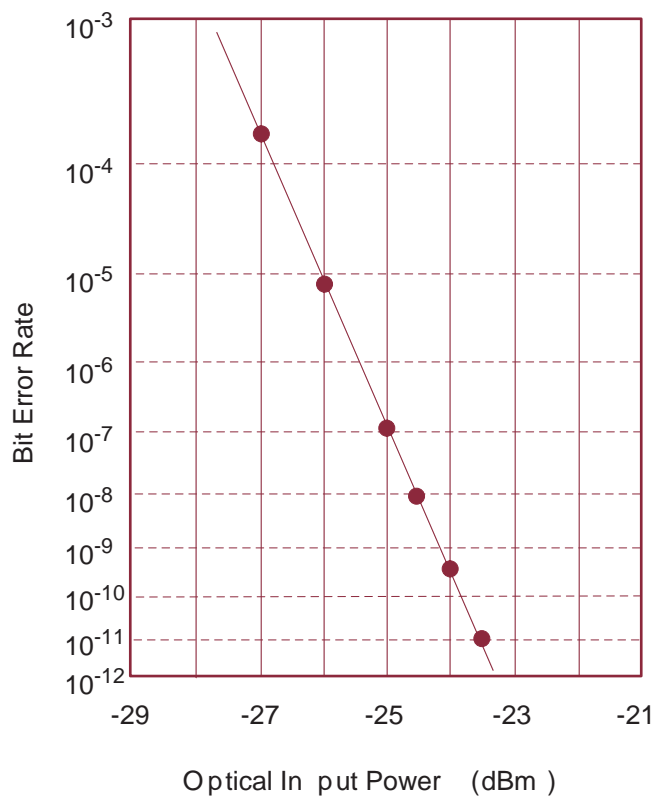
$T_a=25\text{ }^{\circ}\text{C}$, $V_{DD}=3.30\text{ V}$, $V_{SS}=0\text{ V}$, $\text{Pin}=-50\text{ dBm}$, $R_L=50\text{ }\Omega$, 300 kHz to 3 GHz



◆ Examples of Optical & Electrical Characteristics1) Frequency response of Transimpedance ($T_a=25\text{ }^{\circ}\text{C}$)

2) Typical Bit Error Rate

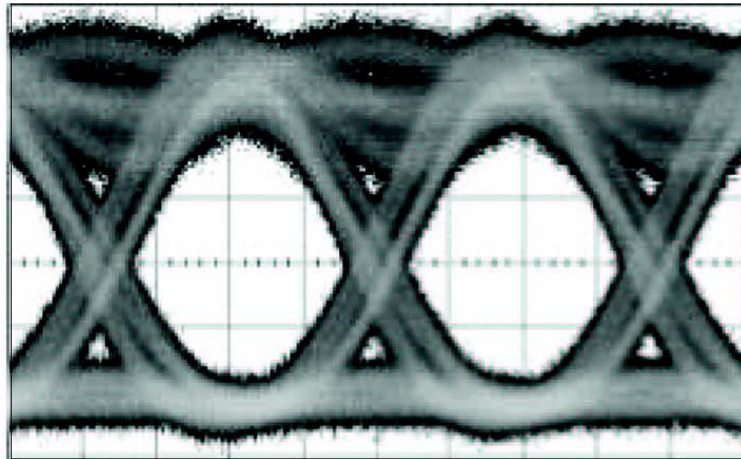
Date rate : 2.666,6Gb/s, PRBS2²³-1, $T_a=25^{\circ}\text{C}$, $V_{DD}=3.3\text{V}$, $V_{SS}=0\text{V}$, $R_L=50\Omega$



3) Eye Diagram ($T_a=25\text{ }^{\circ}\text{C}$, $V_{DD}=3.3\text{ V}$, $R_L=50\text{ }\Omega$ load single-end)

Average input Optical Power -20 dBm ($\lambda=1310\text{ nm}$, 2.66606 Gb/s, NRZ, PRBS2²³-1)

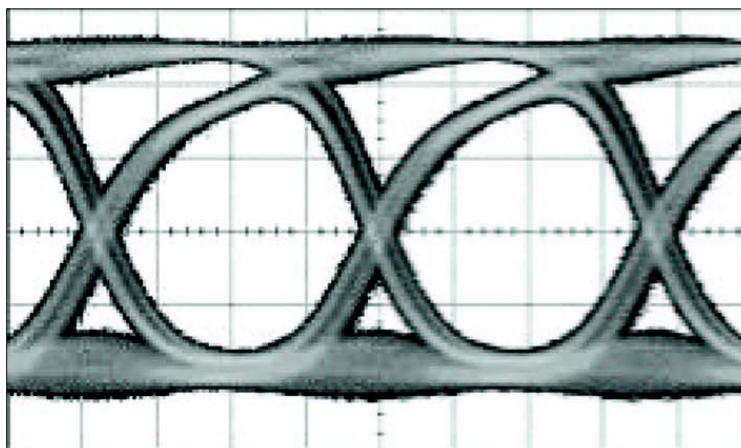
5 mV/div



100 ps/div

Average input Optical Power +2 dBm ($\lambda=1310\text{ nm}$, 2.66606 Gb/s, NRZ, PRBS2²³-1)

100 mV/div



100 ps/div

◆ **General Description**

A transimpedance amplifier is applied as a pre-amplifier which is an amplifier for a faint photo-current from a PIN photo diode (PD). The performance in terms of sensitivity, bandwidth, and so on, obtained by this transimpedance amplifier strongly depend on the capacitance brought at the input terminal; therefore, “typical”, “minimum”, or “maximum” parameter descriptions can not always be achieved according to the employed PD and package, the assembling design, and other technical experts. This is the major reason that there is no product lineup of packaged transimpedance amplifiers.

Thus, for optimum performance of the transimpedance amplifier, it is essential for customers to design the input capacitance carefully.

Hardness to electro-magnetic interference and fluctuation of a power supply voltage is also an important point of the design, because very faint photo-current flows into the transimpedance amplifier. Therefore, in the assembly design of the interconnection between a PD and a transimpedance, noise should be taken into consideration.

◆ **Recommendation**

SEI basically recommends the F08 series PINAMP modules for customers of the transimpedance amplifiers. In this module, a transimpedance amplifier, a PD, and a noise filter circuit are mounted on a TO-18-can package hermetically sealed by a lens cap, having typically a fiber pigtail. The F08 series lineups are the best choice for customers to using the F01 series transimpedance amplifiers. SEI's F08 series allows the customers to resolve troublesome design issues and to shorten the development lead time.

◆ **Noise Performance**

The F0100505B based on GaAs FET's shows excellent low-noise characteristics compared with IC's based on the silicon bipolar process. Many transmission systems often demand superior signal-to-noise ratio, that is, high sensitivity; the F0100505B is the best choice for such applications.

The differential circuit configuration in the output enable a complete differential operation to reduce common mode noise: simple single ended output operation is also available.

◆ Die-Chip Description

The F0100505B is shipped like the die-chip described above. The die thickness is typically $280\text{ }\mu\text{m} \pm 20\text{ }\mu\text{m}$ with the available pad size uncovered by a passivation film of $95\text{ }\mu\text{m}$ square. The material of the pads is TiW/Pt/Au and the backside is metalized by Ti/Au.

◆ Assembling Condition

SEI recommends the assembling process as shown below and affirms sufficient wire-pull and die-shear strength. The heating time of one minute at the temperature of $310\text{ }^{\circ}\text{C}$ gave satisfactory results for die-bonding with AuSn preforms. The heating and ultrasonic wire-bonding at the temperature of $150\text{ }^{\circ}\text{C}$ by a ball-bonding machine is effective.

◆ Quality Assurance

For the F01 series products, there is only one technically inevitable drawback in terms of quality assurance which is to be impossible of the burn-in test for screening owing to die-shipment. SEI will not ship them if customers do not agree on this point. On the other hand, the lot assurance test is performed completely without any problems according to SEI's authorized rules. A microscope inspection is conducted in conformance with the MIL-STD-883C Method 2010.7.

◆ Precautions

Owing to their small dimensions, the GaAs FET's from which the F0100505B is designed are easily damaged or destroyed if subjected to large transient voltages. Such transients can be generated by power supplies when switched on if not properly decoupled. It is also possible to induce spikes from static-electricity-charged operations or ungrounded equipment.