SUMITOMO ELECTRIC

Preliminary

02.05.21

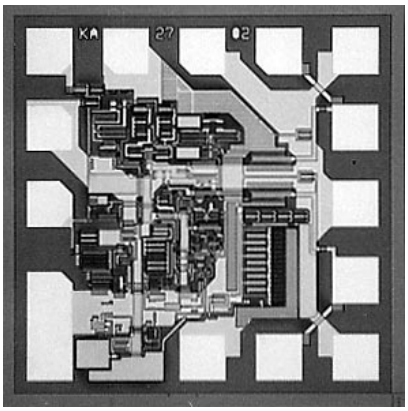
F0100505B

3.3 V /5V 2.5 Gb/s NRZ Receiver

Transimpedance Amplifier

♦ *Features*

- 1.5kΩ high transimpedance
- 28 dB gain
- Low noise (typ.8.2 pA/√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



♦ *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 avaiable) 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 kΩ (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 Ta=25 °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 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	Iinpeak	4	mA	-
Ambient Operating Temperature	Ta	-40 to +90	°C	-
Storage Temperature	Tstg	-50 to 125	°C	-

♦ *Recommended Operating Conditions*

V_{SS}=0 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	Ta	0	25	85	°C	
Input Capacitance	Cpd	-	0.25	-	pF	at Vb=-2 V*

* Vb 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 Zt(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].

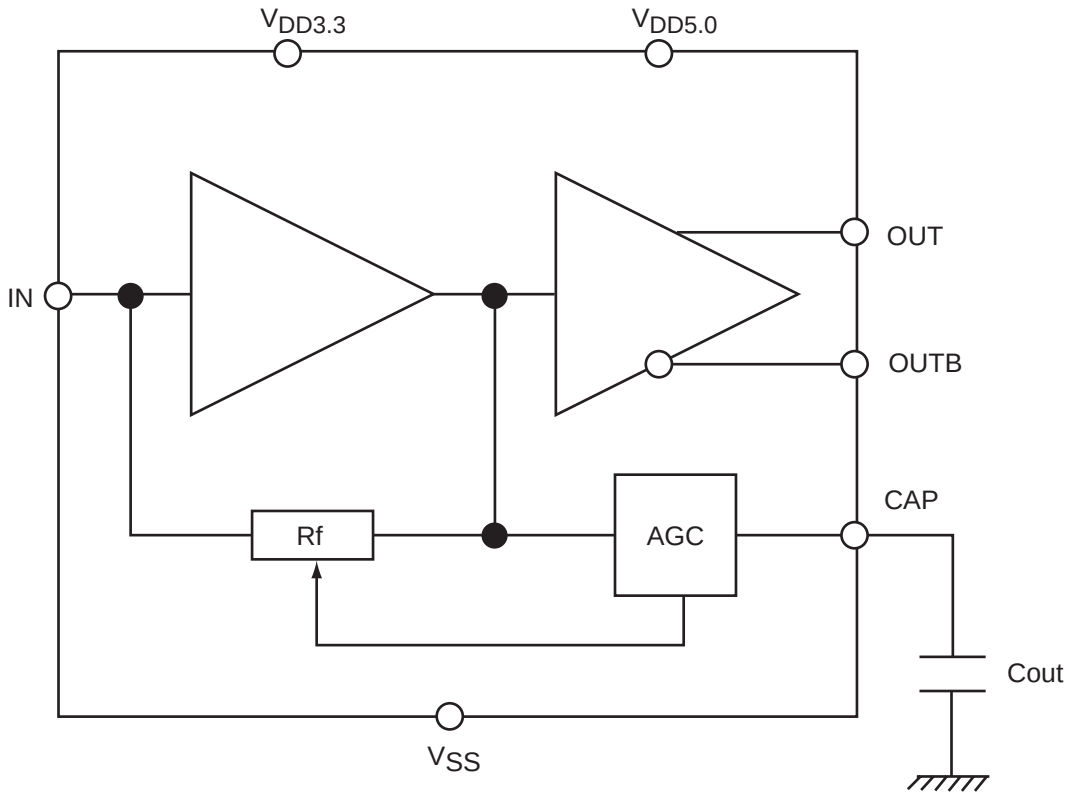
Ta=25 °C, $V_{DD3.3}$=3.3 V, V_{SS}=0 V, unless specified

Parameter	Symbol	Test Conditions	Value			Units
			Min.	Typ.	Max.	
Transimpedance	Ztm	RL=50 Ω, Single-ended f=100 MHz,*3	-	1.4	-	kΩ
O/E High Cut-off Frequency	Fcoeh	Ztm-3dB,*3	-	2400	-	MHz
O/E Low Cut-off Frequency	Fcoel	Cout=470pF	-	17	-	kHz
Equivalent Input Noise	Inoise	f=100 MHz	-	8.2	-	pA/√Hz
Sensitivity	Pin-min	2.66606 Gb/s, PRBS2^23-1, BER=1E-10,*4	-	-23	-	dBm
Overload	Pin-max		+2	-	-	dBm
Output Impedance	Routm	No input, f=1 MHz, *3	-	TBD	-	Ω

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

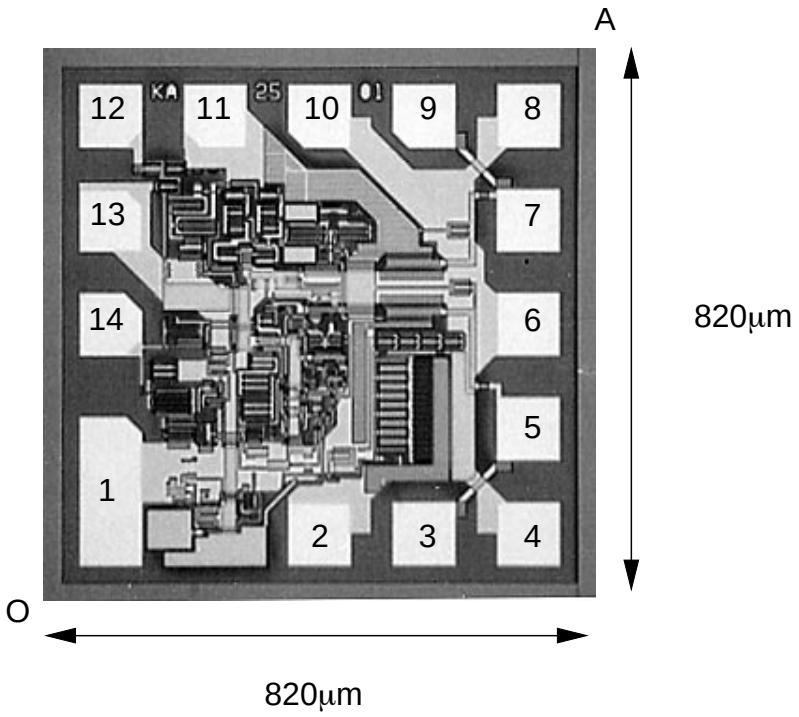
* 4 Shown [Test Circuits/4] Sensitivity Characteristics].

♦ *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

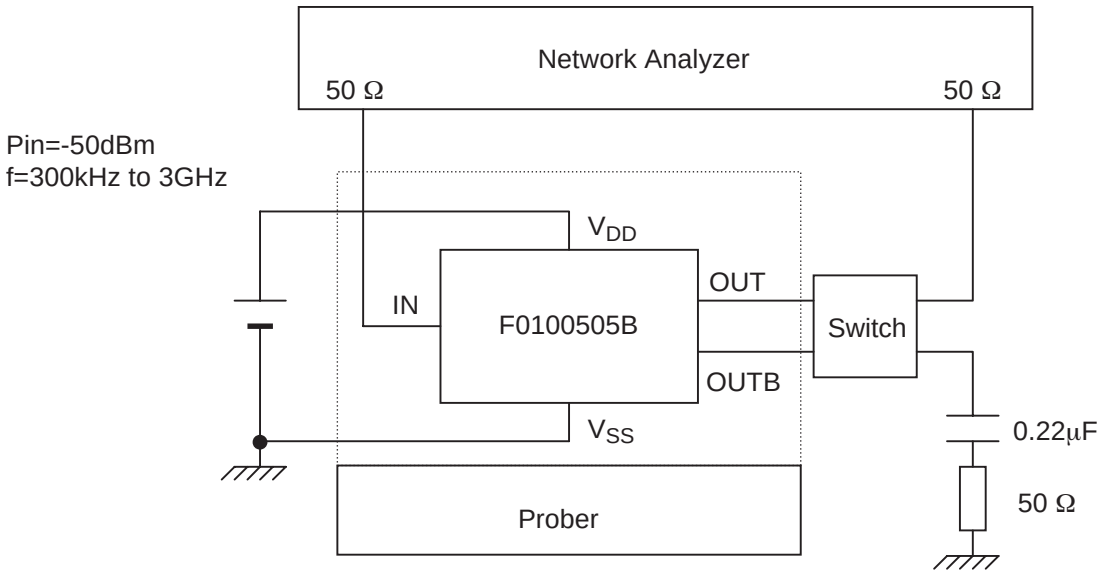
♦ *Die Pad Assignments*



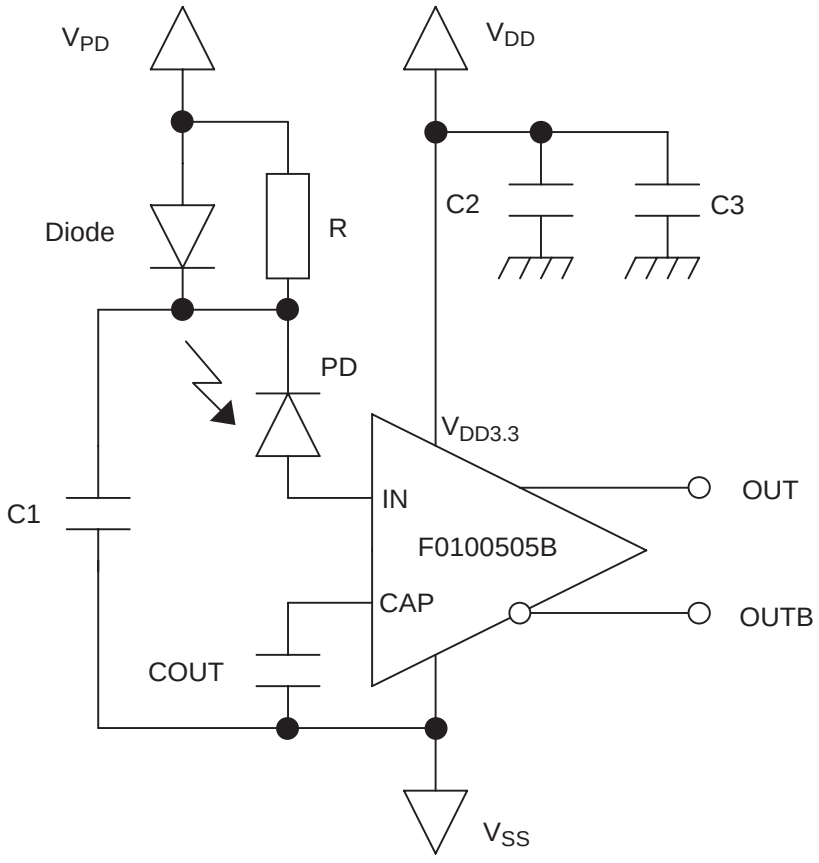
No.	Symbol	Center Coordinates (μm)	No.	Symbol	Center Coordinates (μm)
1	$V_{DD3.3}$	(75,140)	10	V_{SS}	(395,715)
2	$V_{DD5.0}$	(395,75)	11	$V_{DD3.3}$	(235,715)
3	OUTB	(555,75)	12	CAP	(75,715)
4	V_{SS}	(715,75)	13	V_{SS}	(75,555)
5	OUTB	(715,235)	14	IN	(75,395)
6	V_{SS}	(715,395)			
7	OUT	(715,555)	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

♦ *Test Circuits*

1) AC Characteristics

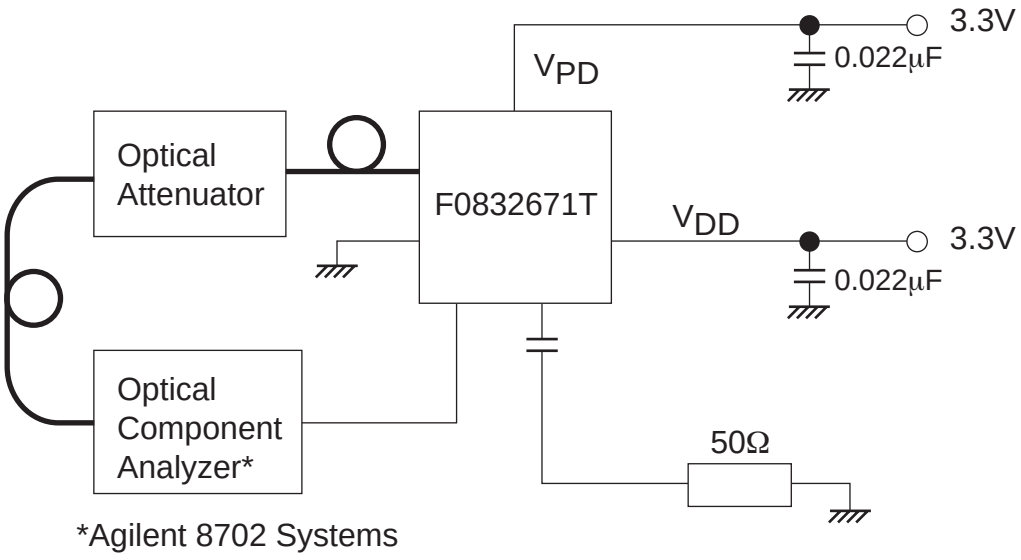


2) Block Diagram of F0832483T



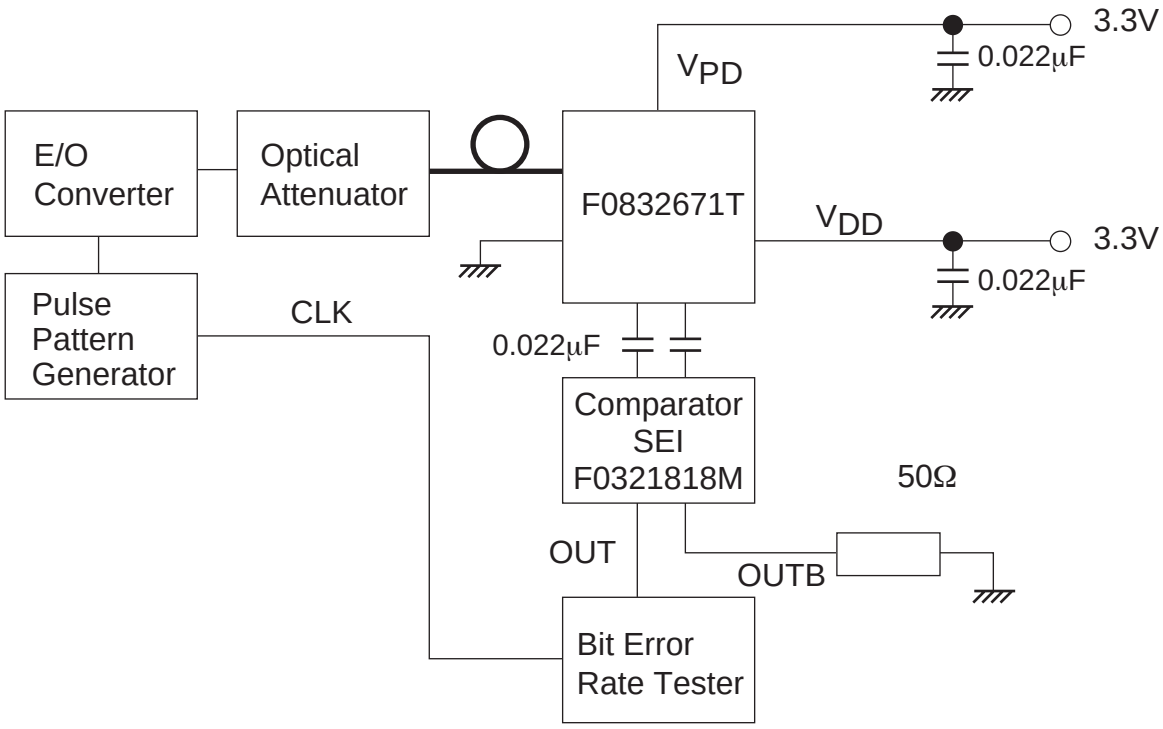
R=3 kΩ
C1=200 pF
C2=100 pF
C3=2200 pF
Cout=470 pF
C_{PD}=0.25 pF (typical value)

3) Optical & Electrical Characteristics



*Agilent 8702 Systems

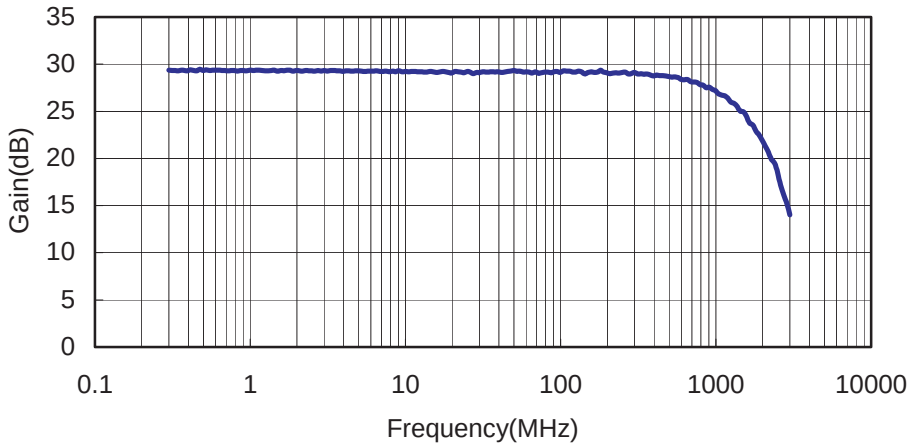
4) Sensitivity Characteristics



♦ *Examples of AC Characteristics*

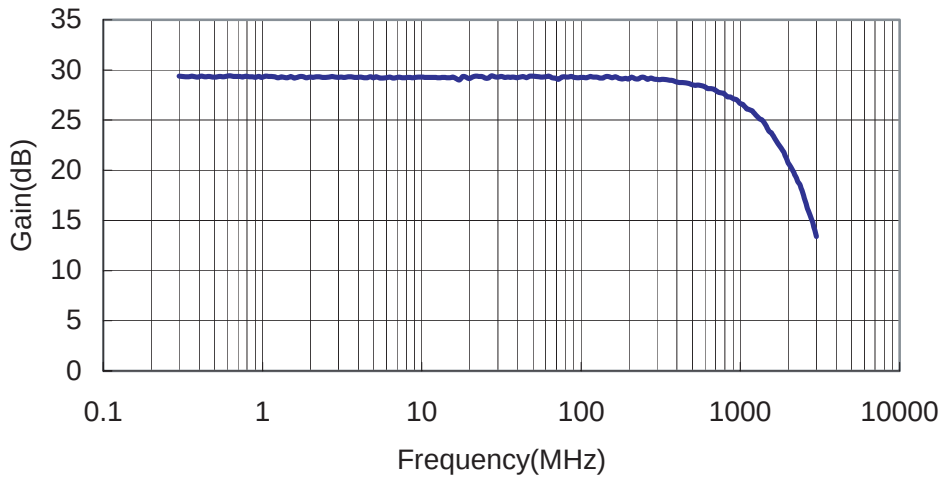
1) Gain (S21p)

Ta=25 °C, V_{DD}=3.30 V, V_{SS}=0 V, Pin=-50 dBm, RL=50 Ω, 300 kHz to 3 GHz



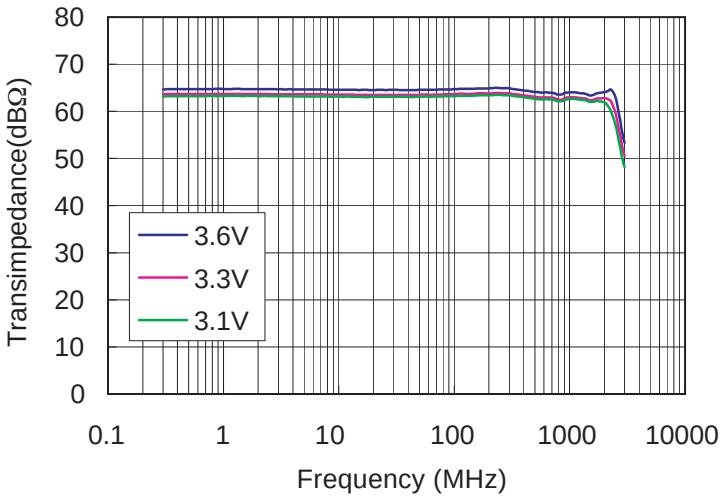
2) Gain (S21n)

Ta=25 °C, V_{DD}=3.30 V, V_{SS}=0 V, Pin=-50 dBm, RL=50 Ω, 300 kHz to 3 GHz



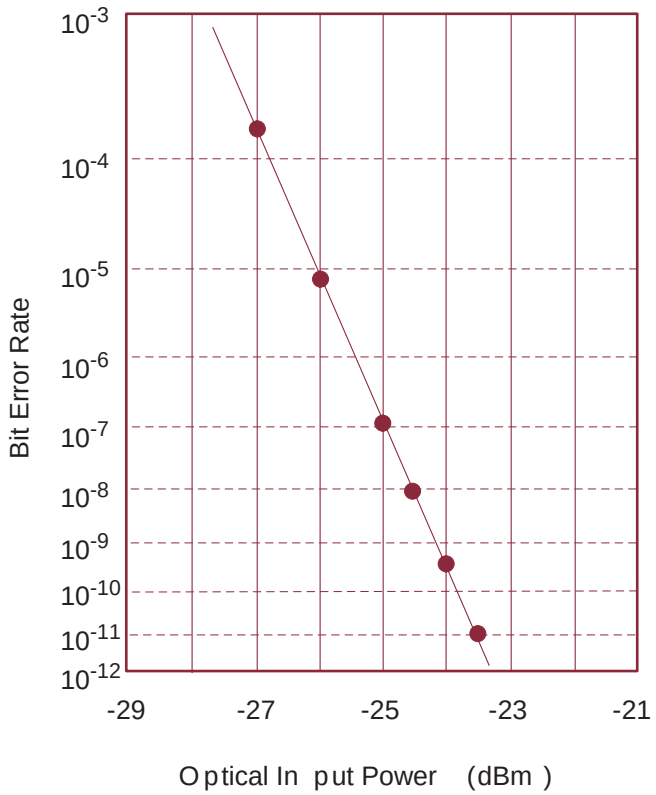
♦ *Examples of Optical & Electrical Characteristics*

1) Frequency response of Transimpedance (Ta=25 °C)



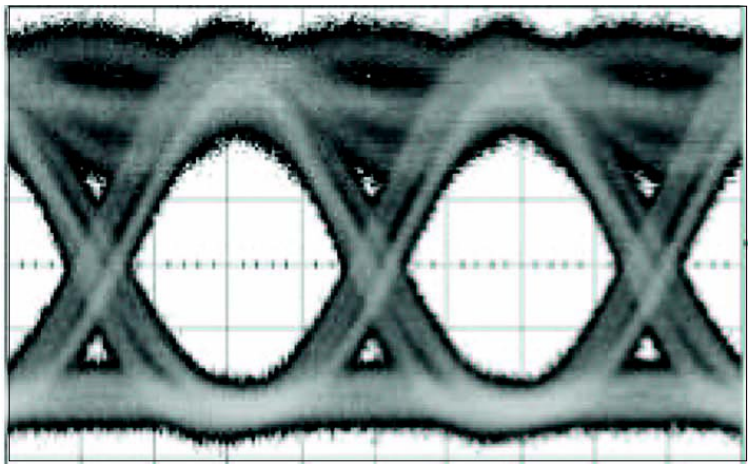
2) Typical Bit Error Rate

Date rate : 2.666,6Gb/s, PRBS2^23-1, Ta=25°C, V_{DD}=3.3V, V_{SS}=0V, RL=50Ω



3) Eye Diagram (Ta=25 °C, V_{DD}=3.3 V, RL=50 Ω road single-end)
Average input Optical Power -20 dBm (λ=1310nm, 2.66606 Gb/s, NRZ, PRBS2^23-1)

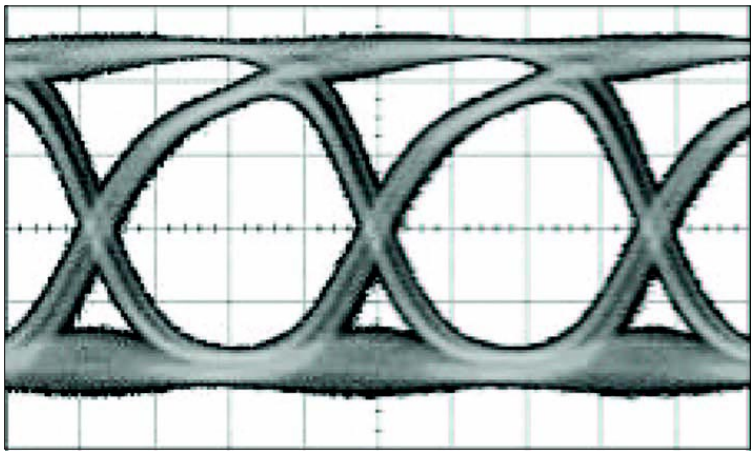
5 mV/div



100 ps/div

Average input Optical Power +2 dBm (λ=1310nm, 2.66606 Gb/s, NRZ, PRBS2^23-1)

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 μm ± 20 μm with the available pad size uncovered by a passivation film of 95 μm 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 °C gave satisfactory results for die-bonding with AuSn preforms. The heating and ultrasonic wire-bonding at the temperature of 150 °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.