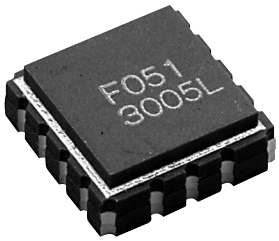
SUMITOMO ELECTRIC

01.08.28

F0513005L

3 Gb/s NRZ Data Rate

Laser Diode Driver



♦ *Features*

- Up to 3 Gb/s high speed operation
- Positive thermal coefficient of modulation current
- Differential ECL compatible interface
- -5.2 V single power supply
- Up to 50 mA p-p modulation current
- Up to 50 mA bias current
- Maximum bias current preset control
- Low-cost 18-terminal LCC package

♦ *Applications*

- Laser diode driver of an optical transmitter circuit up to 3 Gb/s

♦ *Functional Description*

The F0513005L is a high performance GaAs integrated laser diode driver for use in an optical transmitter circuit up to 3 Gb/s NRZ data rate. The F0513005L typically specifies rise time and fall time of 140 psec (10 % - 90 %). It features single -5.2 V supply operation, 1 to 50 mA presettable bias current and up to 50 mA modulation current while dissipating 650 mW is typical. A choice of three packages are available to match various application requirements: an 18-terminal leadless chip carrier (LCC) called F0513005L, an 18-lead metal-based flat package (MFP) called F0513005M, and a 20-lead plastic-molded QFP package called F0513005S.

♦ *Absolute Maximum Ratings*

T_a = 25 °C, unless specified

Parameter	Symbol	Value	Units
Supply Voltage	V_{SS}	- 7 to 0.5	V
Power Dissipation	Pdis	1	W
Input Voltage	V_{IN1}, V_{IN2}	-3 to 0.5	V
Output Voltage	V_{OUT1}, V_{OUT2}	-3 to 0.5	V
Modulation Current Control Voltage	V_M	V_{SS} to V_{SS}+1.3	V
Maximum Bias Current Setting Voltage	V_B	V_{SS} to V_{SS}+1	V
APC Voltage	V_{APC1},V_{APC2}	-3 to 0.5	V
Storage Temperature	Tstg	-55 to +125	° C
Ambient Operating Temperature	T_a	-0 to +70	° C

♦ *Recommended Operating Conditions*

T_a = 25 °C, V_{SS} = - 5.2 V, unless specified

Parameter	Symbol	Value			Units
		Min.	Typ.	Max.	
Supply Voltage	V_{SS}	-5.5	-5.2	-5.0	V
Output Voltage	V_{OUT1}, V_{OUT2}	-2.0	-1.0	0	V
Ambient Operating Temperature	Ta	0	25	70	° C

♦ *Electrical Characteristics*

T_a = 25 °C, V_{SS} = - 5.2 V, unless specified

Parameter	Symbol	Test Conditions	Value			Units
			Min.	Typ.	Max.	
Circuit Current (1)	I_{SS}	V_M =-5.2V, VB=-5.2V	-	75	110	mA
Input Voltage	V_{IH}	Differential Mode	-0.9	-	-0.7	V
	V_{IL}		-1.9	-	-1.7	V
Input Current	I_{IN1},I_{IN2}	V_{IN1},V_{IN2} =-1.9V	-150	-	150	μA
Modulation Current	I_{MMAX}	V_{IN1} =-1.7V, V_{IN2} =-0.9V V_{APC1} =-2.5 V, V_{APC2} =0V V_M =-3.9V, V_B =-5.2V	50	-	-	mA
	I_{MMIN}	V_{IN1} =-1.7V, V_{IN2} =-0.9V V_{APC1} =-2.5 V, V_{APC2} =0V V_M =-2.5V, V_B =-4.2V	-	-	1	mA
I_M Thermal Coefficient(2)	I_{MTC}	I_M =25 to 50mA (T_a= 25° C) T_a = 0 to 70° C	0	-	0.6	%/° C
Bias Current	I_{BMAX}	V_{IN1} =-0.9V, V_{IN2} =-1.7V V_{APC1} =0V, V_{APC2} =-2.5V V_M =-5.2V, V_B =-4.2V	50	-	-	mA
	I_{BMIN}	V_{IN1} =-0.9V, V_{IN2} =-1.7V V_{APC1} =-2.5V, V_{APC2} =-0V V_M =-5.2V, V_B =-5.2V	-	-	1	mA
Rise Time	tr	RL = 25Ω 10% - 90%	-	-	200	ps
Fall Time	tf	RL = 25Ω 10% - 90%	-	-	200	ps

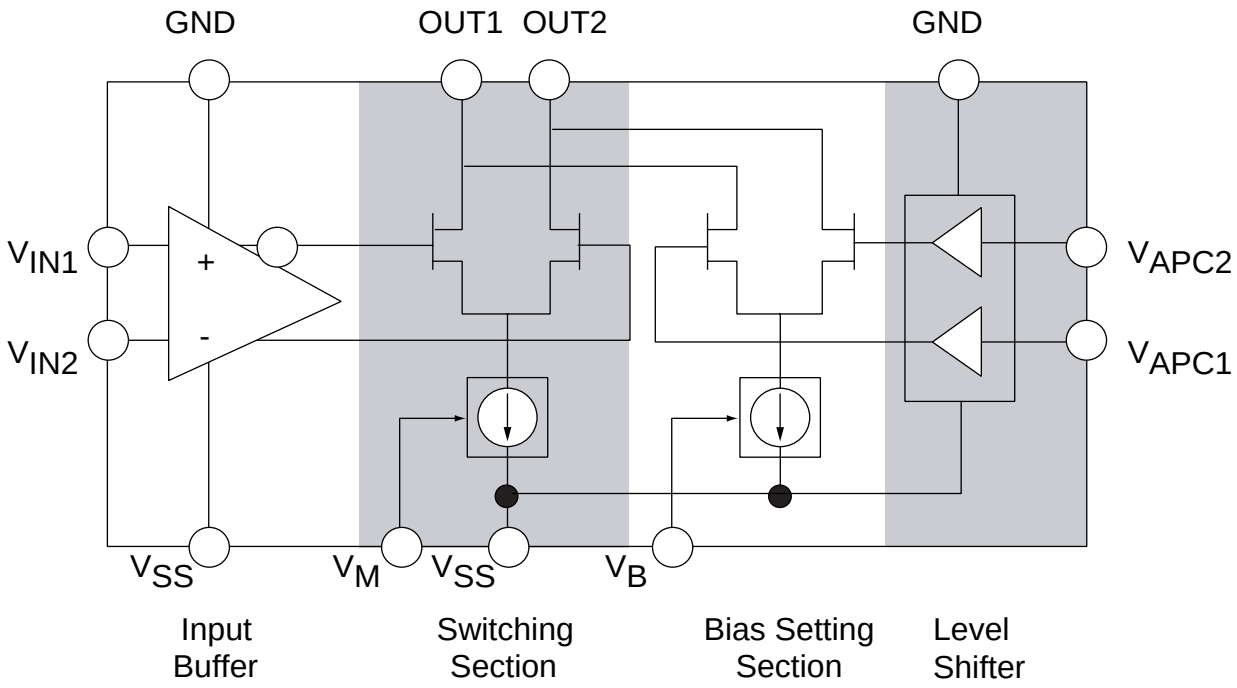
(1) except modulation current

(2) IMTC = 100× [I_M (T_a = 70 °C) - I_M (T_a = 0 °C)] / I_M (T_a = 25 °C) / 70

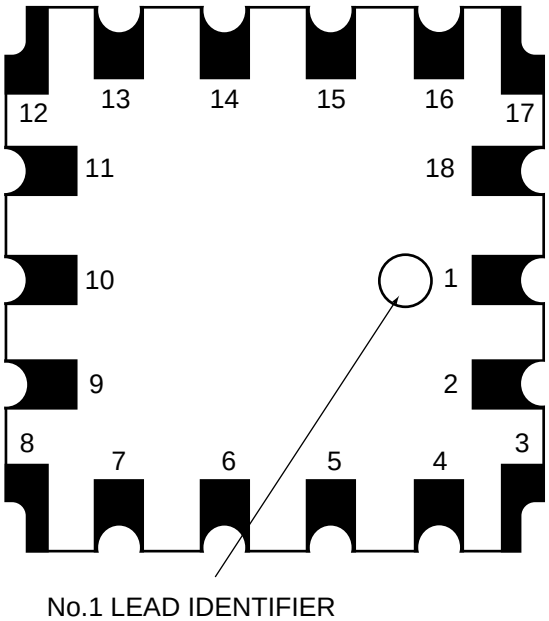
NOTES:

1. Modulation circuit on: V_{IN1} = - 1.7 V, V_{IN2} = - 0.9 V
2. Modulation circuit off: V_{IN1} = - 0.9 V, V_{IN2} = - 1.7 V
3. Bias circuit on: V_{APC1} = 0 V, V_{APC2} = - 2.5 V
4. Bias circuit off: V_{APC1} = - 2.5 V, V_{APC2} = 0 V

♦ *Block Diagram*



♦ *Pin Assignments (Bottom View)*

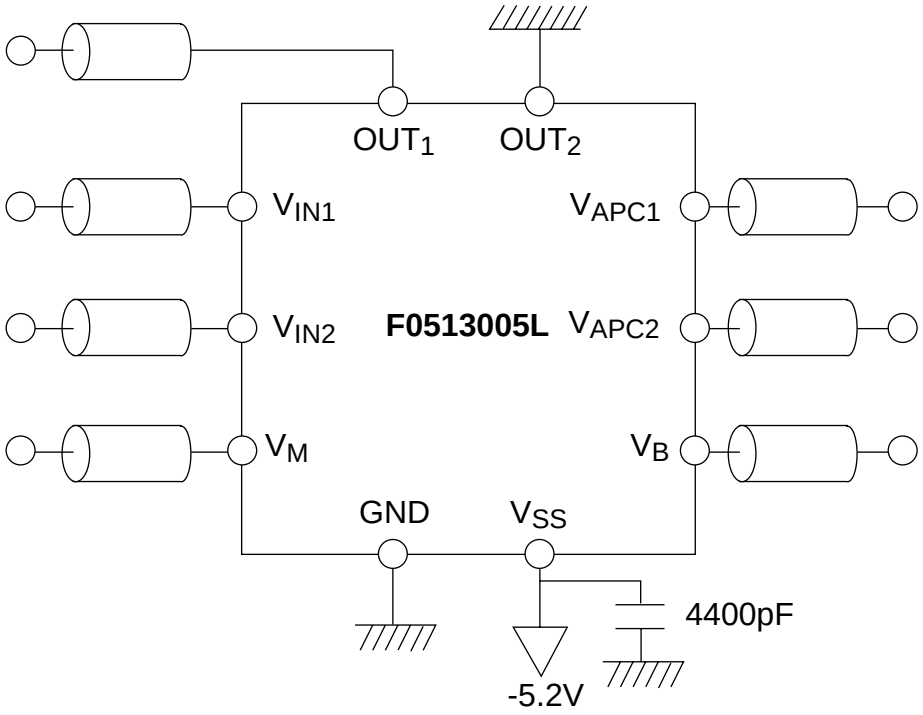


♦ *Pin Descriptions*

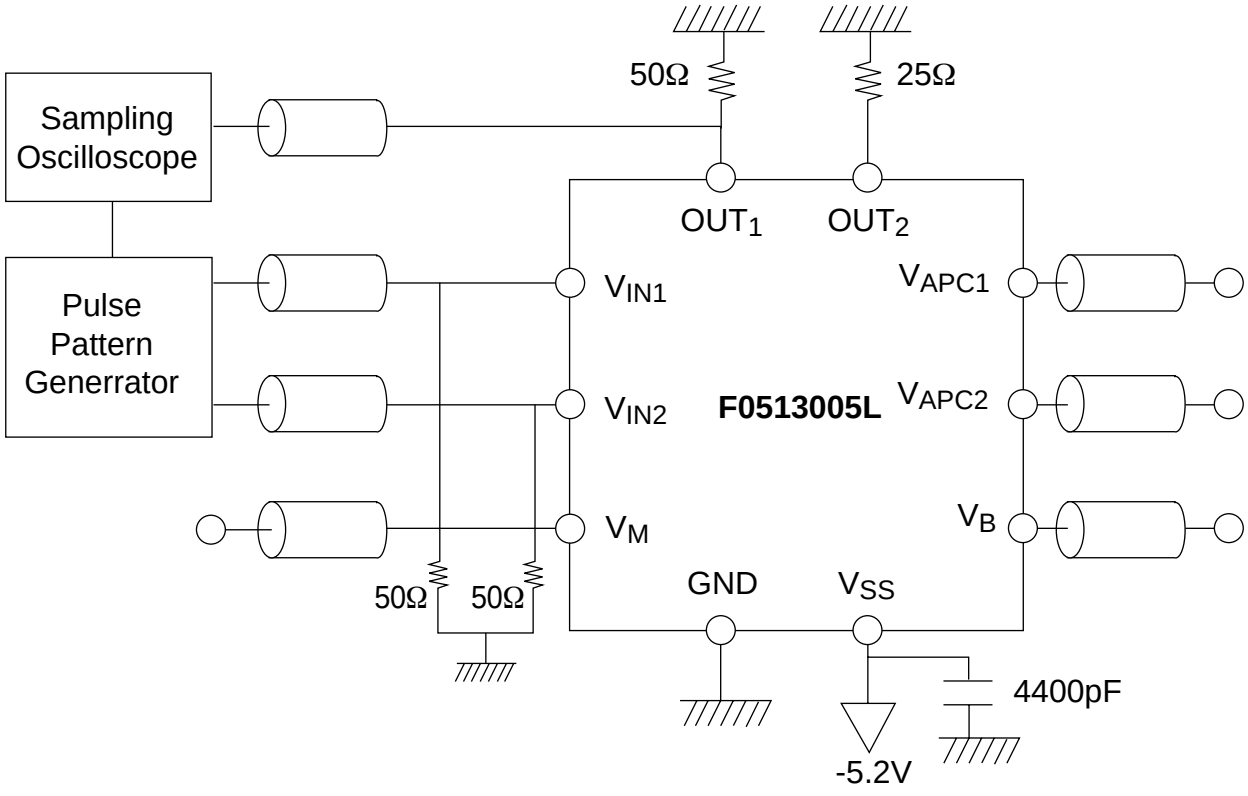
1	OUT1	Output
2	NC	No Connection
3	V_{APC1}	APC Signal Input
4	V_B	Maximum Bias Current (I_{BMAX})Setting Voltage
5	V_{SS}	Supply Voltage
6	GND	Supply Voltage
7	V_M	Modulation Current Control Voltage
8	V_{APC2}	APC Reference Voltage
9	NC	No Connection
10	OUT2	Output
11	NC	No Connection
12	V_{IN2}	Differential Mode Input
13	GND	Supply Voltage
14	NC	No Connection
15	NC	No Connection
16	V_{SS}	Supply Voltage
17	V_{IN1}	Differential Mode Input
18	GND	Supply Voltage

♦ *Test Circuits*

(1) DC Characteristics



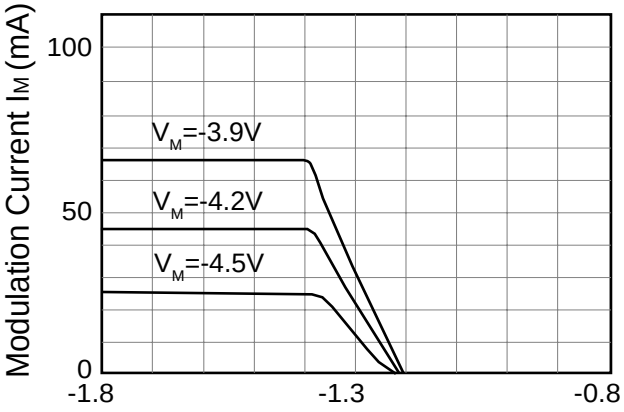
(2) AC Characteristics



♦ *Typical DC Characteristics*

(1) Switching characteristics

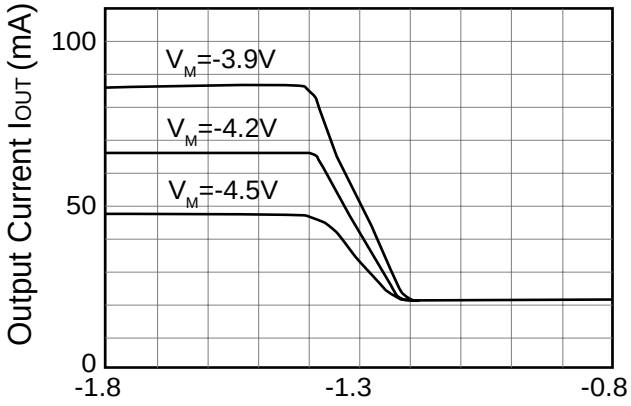
(a) Modulation Current Switching



Input Voltage V_{IN1}(V)

(V_B=-5.2V, V_{APC1}=-2.0V,V_{APC2}=-0V)

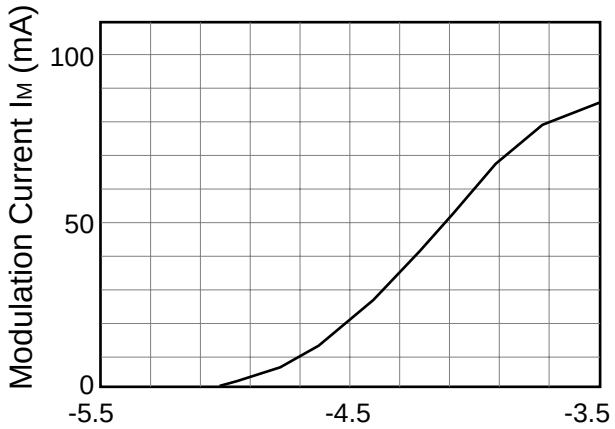
(b) Output Current Switching



Input Voltage V_{IN1}(V)

(V_B=-5V, V_{APC1}=-1.3V,V_{APC2}=-1.3V)

(a) Modulation Current vs V_M

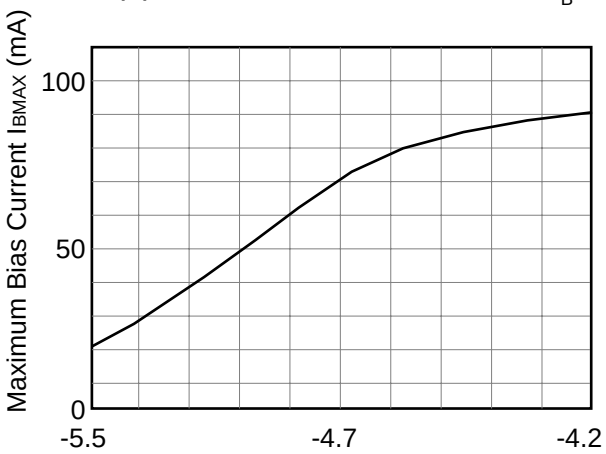


Control Voltage V_M (V)

(V_B=-5.2V, V_{APC1}=-2.0V, V_{APC2}=0V)

(V_{IN1}=-1.8V, V_{IN2}=-0.8V)

(b) Maximum Bias Current ns V_B



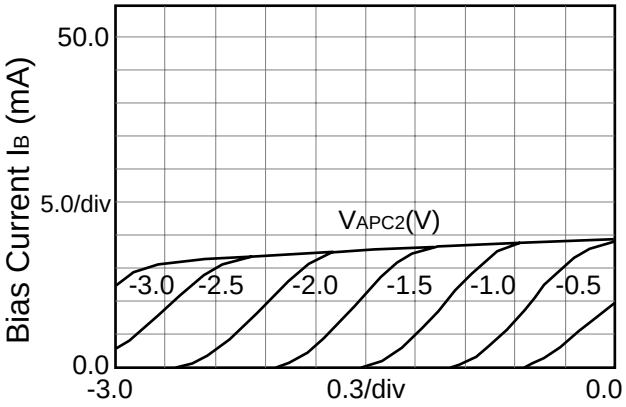
Control Voltage V_B (V)

(V_M=-5.2V, V_{APC1}=0V, V_{APC2}=-2.0V)

(V_{IN1}=-0.8V, V_{IN2}=-1.8V)

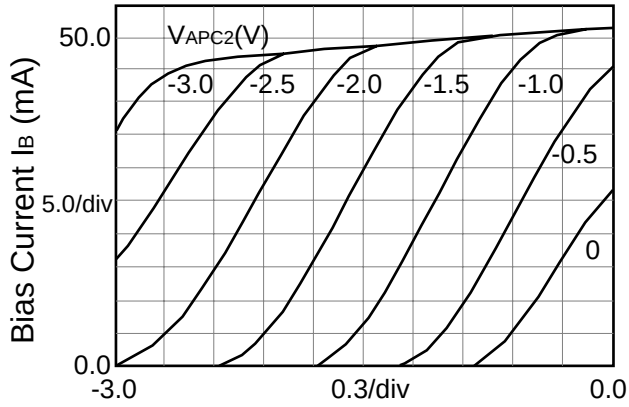
(2) Bias control by APC voltage

(a) I_{BMAX}=20mA



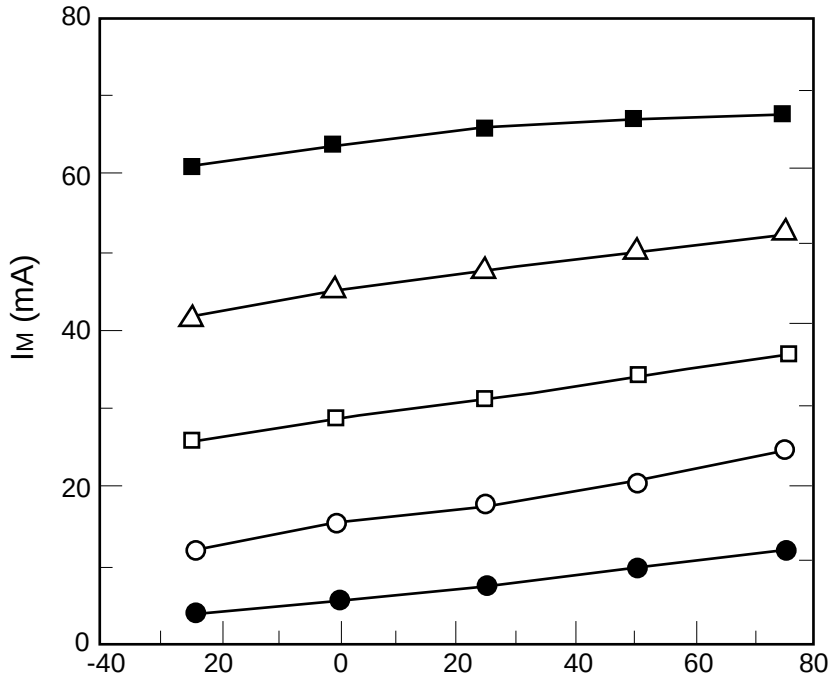
APC Voltage V_{APC1} (V)
(V_M=-5.2V, V_B=-5.2V)
(V_{APC2}=-3.0V to 0V, step 0.5V)

(b) I_{BMAX}=50mA



APC Voltage V_{APC1} (V)
(V_M=-5.2V, V_B=-5.2V)
(V_{APC2}=-3.0V to 0V, step 0.5V)

(3) Dependence on modulation current on the ambient temperature



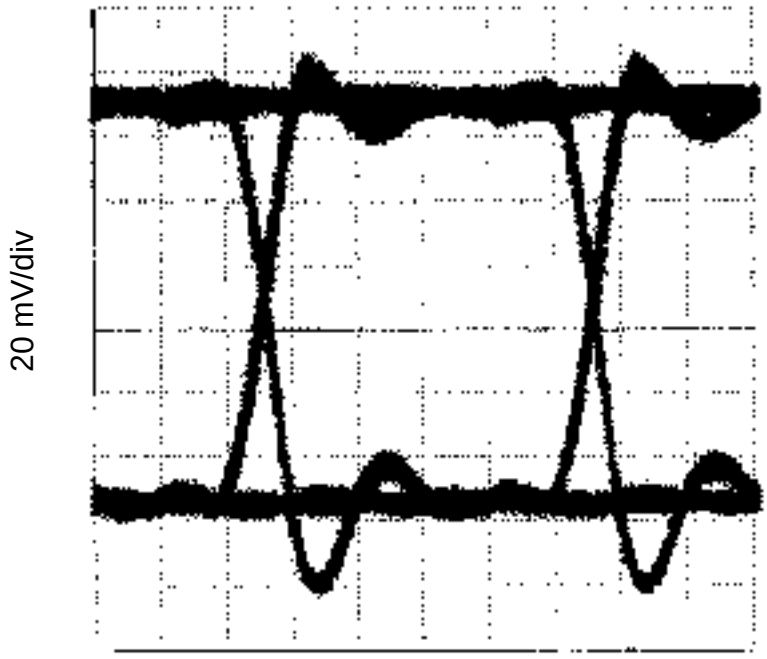
Temperature (°C)
(V_{IN1}=-1.8V, V_{IN2}=-0.8V)
(V_B=-5.2V, V_{APC1}=-2.0V, V_{APC2}=0V)

♦ *Typical AC Characteristics*

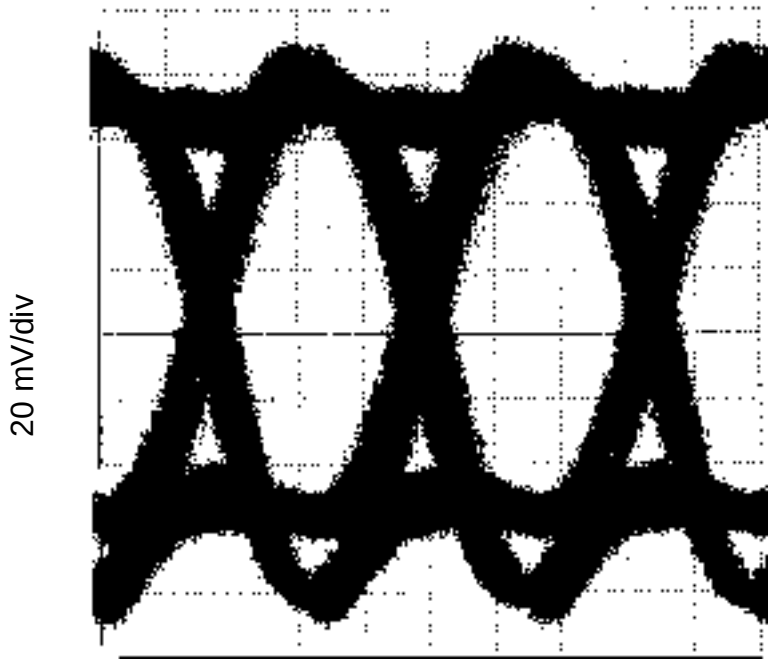
(1) Eye diagrams for pseudo-random data response of electrical output

T_a = 25 °C, V_{SS} = - 5.2 V, V_{IN} = 0.8 Vp-p, RL = 25 Ω

(a) 1 Gb/s NRZ (PRBS 2^{23}-1)

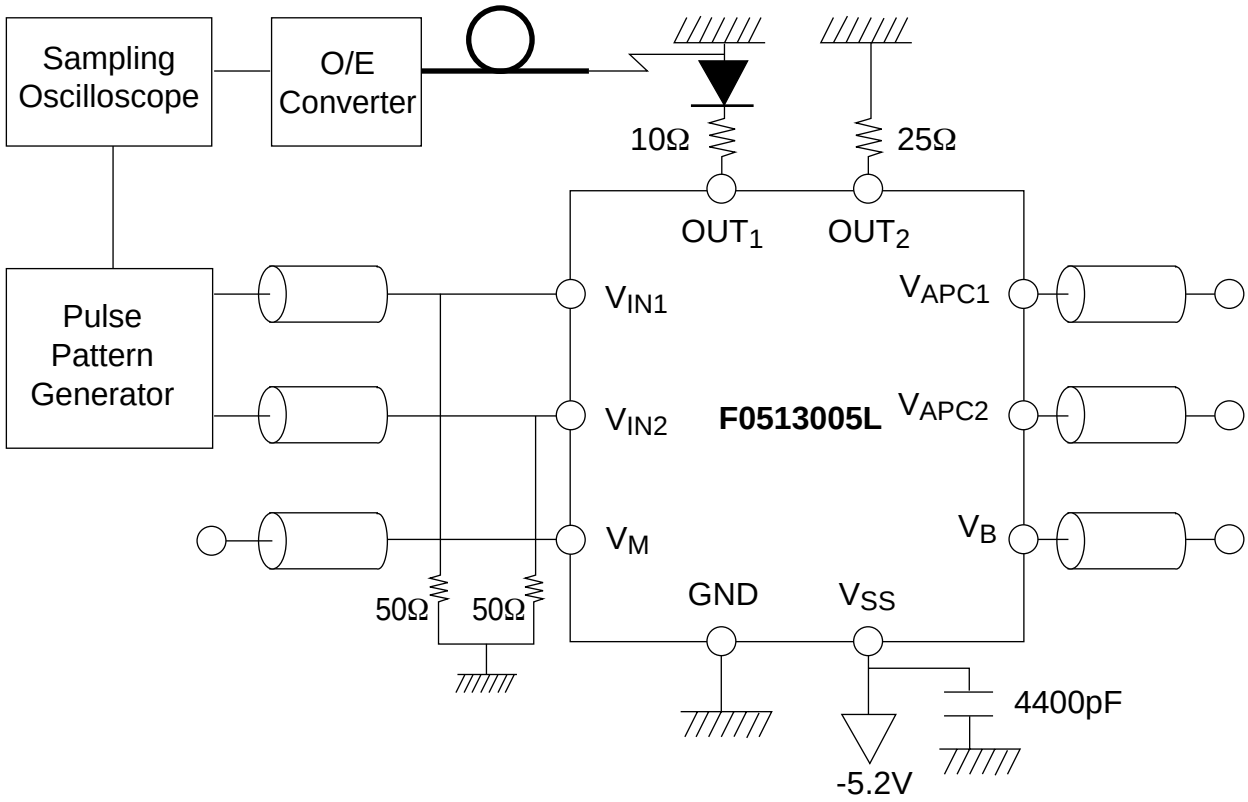


(b) 3 Gb/s NRZ (PRBS 2^{23}-1)



♦ *Application Notes*

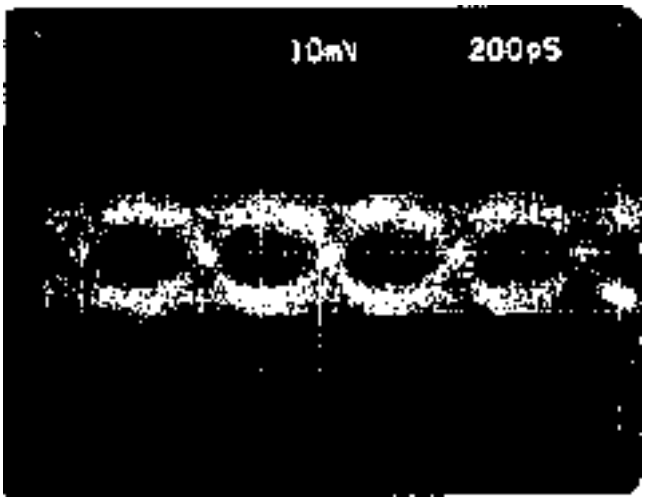
(1) Example of circuit block diagram to drive laser diode



NOTE : The 10Ω and 25Ω resistors in series with OUT1 and OUT2 respectively are damping resistors. Their values are selected to minimize ringing caused by the impedance mismatch to the laser diode. These values may change depending upon the type of laser diode used.

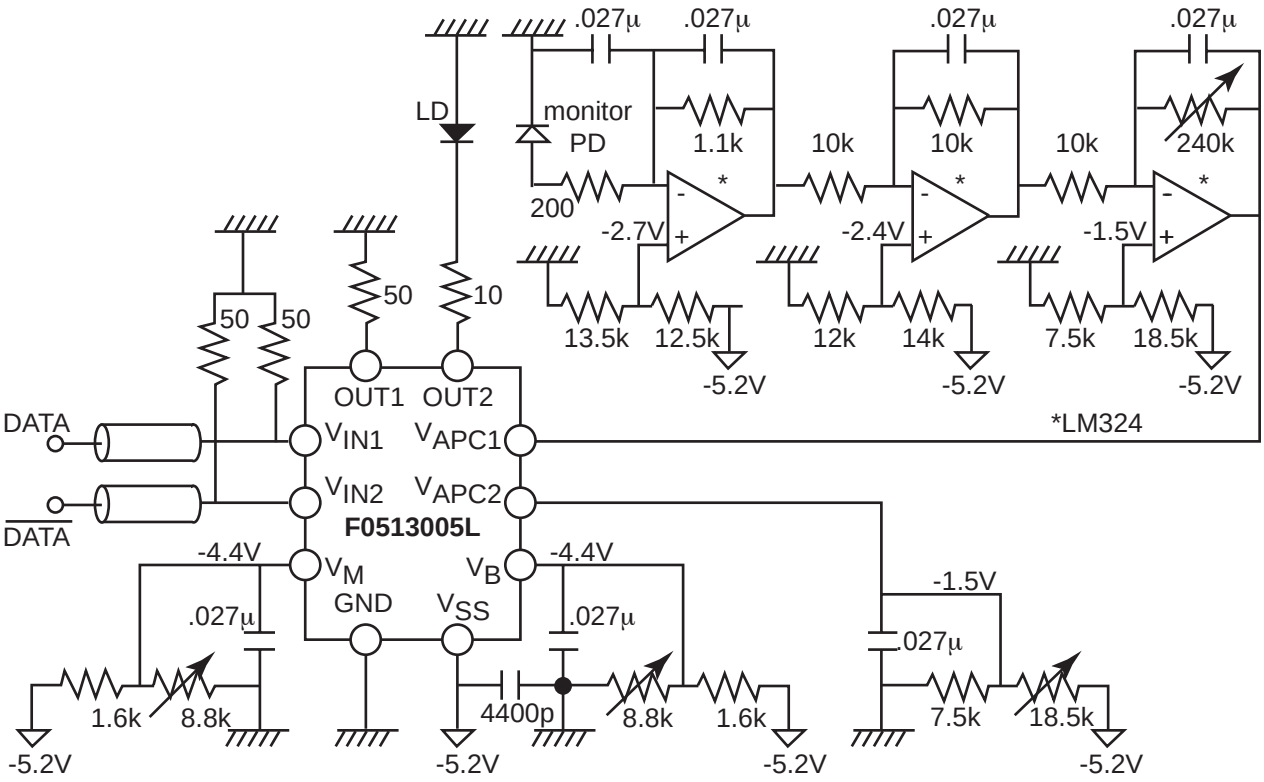
(2) Eye diagrams for 2.4 Gb/s NRZ pseudo-random data response of optical output

PRBS 2^{23}-1, T_a = 25 °C, V_{SS} = - 5.2 V, Vin = 0.8 Vp-p, RL = 25 Ω

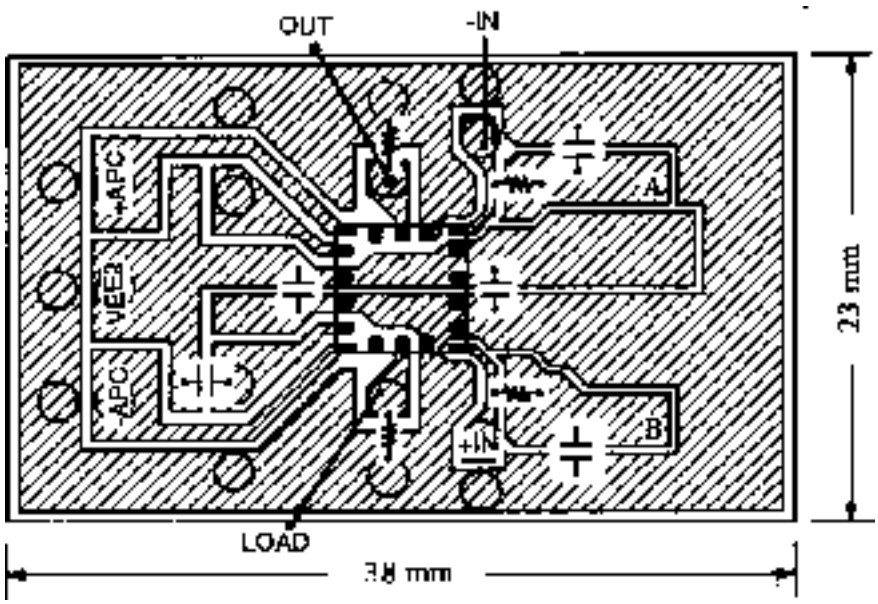


*Laser Diode: Mitsubishi FU-63SDF

(3) Example of APC circuit



(4) Example of evaluation board



NOTE: The open circles indicate soldering positions for coaxial cables. Islands A and B are termination resistors bias points. When driven from Picologic, they should be connected to -2 V. Otherwise, they may be connected to ground.

♦ *General Description*

Bias current and modulation current are very important electrical characteristics in a laser diode. A center value of the driving current of a laser diode is bias current, which is designed to be presettable ranging from 1 to 50 mA by a controlled voltage of V_B terminal according to the threshold current of an employed laser diode and the application. An optical output power is proportional to an amplitude of the driving current of a laser diode called modulation current which can be controlled from 1 to 50 mA by a voltage of V_M terminal. Protection against laser thermal runaway is provided by auto power control. V_{APC} terminal is used to control the bias current setting negative feedback, monitoring the optical output power by PIN photo diode.

♦ *Positive Temperature Characteristics*

The most remarkable feature of the F0513005L, which can not be found in other IC's, is the positive temperature characteristics of the modulation current designed to be +0.5 %/°C. Emission efficiency in typical laser diodes exhibits negative temperature characteristics; their optical output decreases with increasing ambient temperature. In the case of multi-quantum well (MQW) laser diodes, which is the focus of keen interest, the temperature coefficient of -0.5 %/°C is reported. The F0513005L can successfully compensate the temperature fluctuation of the optical output power, providing a stable extinction ratio. If a driver circuit does not have a positive temperature characteristic in the modulation current, the bias current increases above the threshold current at higher temperature, resulting in degradation of the extinction ratio. It is not impossible to achieve this kind of compensation by external circuits; it is, however, unrealistic owing to inevitably troublesome tuning.

♦ *User-friendly Design*

The F0513005L features a user-friendly design for system designers, permitting a single +5 V power supply operation. A differential ECL compatible input for direct control from ECL or conventional GaAs logic IC's is provided. Two unique auto power controls (V_{APC1}, V_{APC2}) permit modulation of the bias current control setting as a mechanism to protect the laser diode against thermal runaway. The APC controls may be modulated at rates up to 100 MHz.

♦ *Packaging*

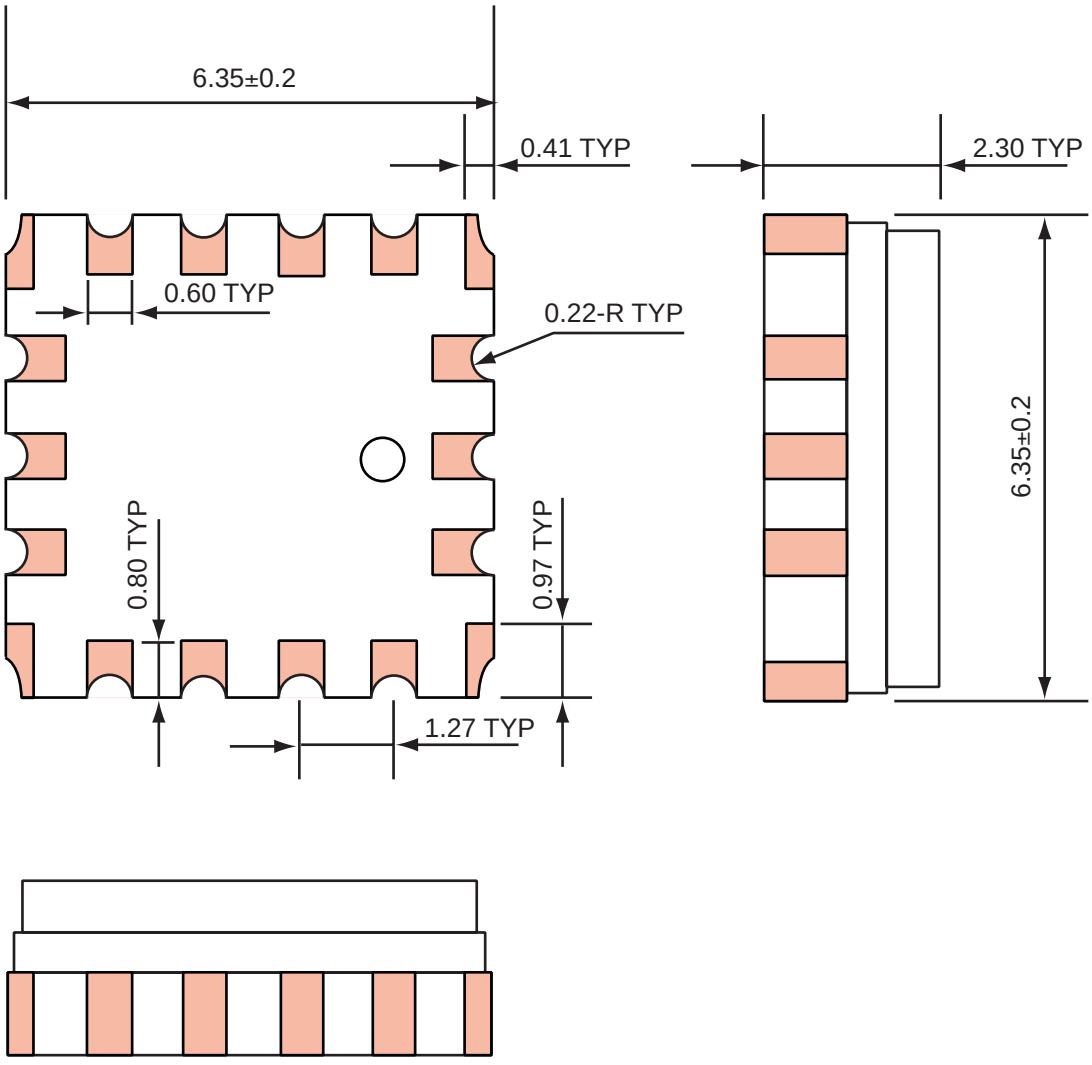
The F0513005L is in an 18-terminal ceramic LCC package about 300 mil square with the lead pitch of 50 mil, achieving miniaturization and low cost. It is convenient for designers to miniaturize the circuit area in the PCB owing to the leadless package with small dimension.

The F0513005M packaged in an 18-lead ceramic MFP about 300 mil square with the lead pitch of 40 mil is also available as another choice for this device, allowing to enhance the flexibility of assembling design. It was originally developed by SEI to improve RF performance and heat radiation. Compared with the LCC, the ground potential is stabler at microwave frequency range and the thermal resistivity is smaller due to the metal-based bottom structure made from CuW (an alloy of copper and tungsten) with a high thermal conductivity. The electrical characteristics of both IC's are almost equal but the system performance depends on the assembling design. The F0513005M is more suitable for application requiring very excellent eye pattern performance and severe thermal stability.

♦ *Precautions*

Owing to their small dimensions, the GaAs FET's from which the F0513005L 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.

♦ *Package Drawings*



Notes:

(1) All dimensions in millimeters.
(2) Package is made of ceramic.
(3) Leads are Ni and Au plated copper.
(4) Base metal is copper tungsten.