

DESCRIPTION

The M66512 is a semiconductor laser-diode driver for driving a specific type* of semiconductor laser, in which the anode of a semiconductor laser diode is connected in stem structure to the cathode of a monitoring photodiode.

The amplitude of laser drive current is set by applying a voltage from an external source. the M66512 is capable of driving laser diodes on a maximum current of 120 mA. It operates on a 5-V single power supply and switches laser drive current at a rate of 40 Mbit/s.

*: The N type of Mitsubishi's semiconductor lasers.

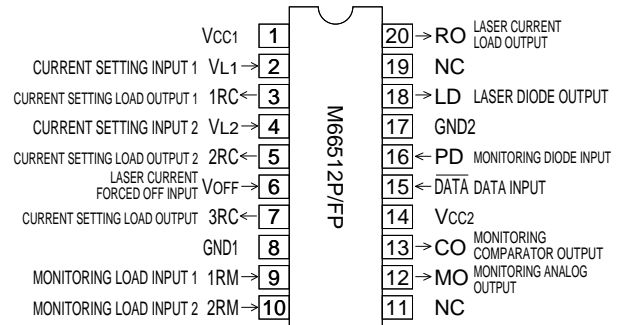
FEATURES

- Two kinds of outputs for monitoring laser power built in. (comparator output and analog output)
- Pin provided for forced OFF of current circuit.
- High speed switching (40 Mbit/s)
- Large drive current (120mA max.)
- 5V single power supply

APPLICATION

Laser beam printers

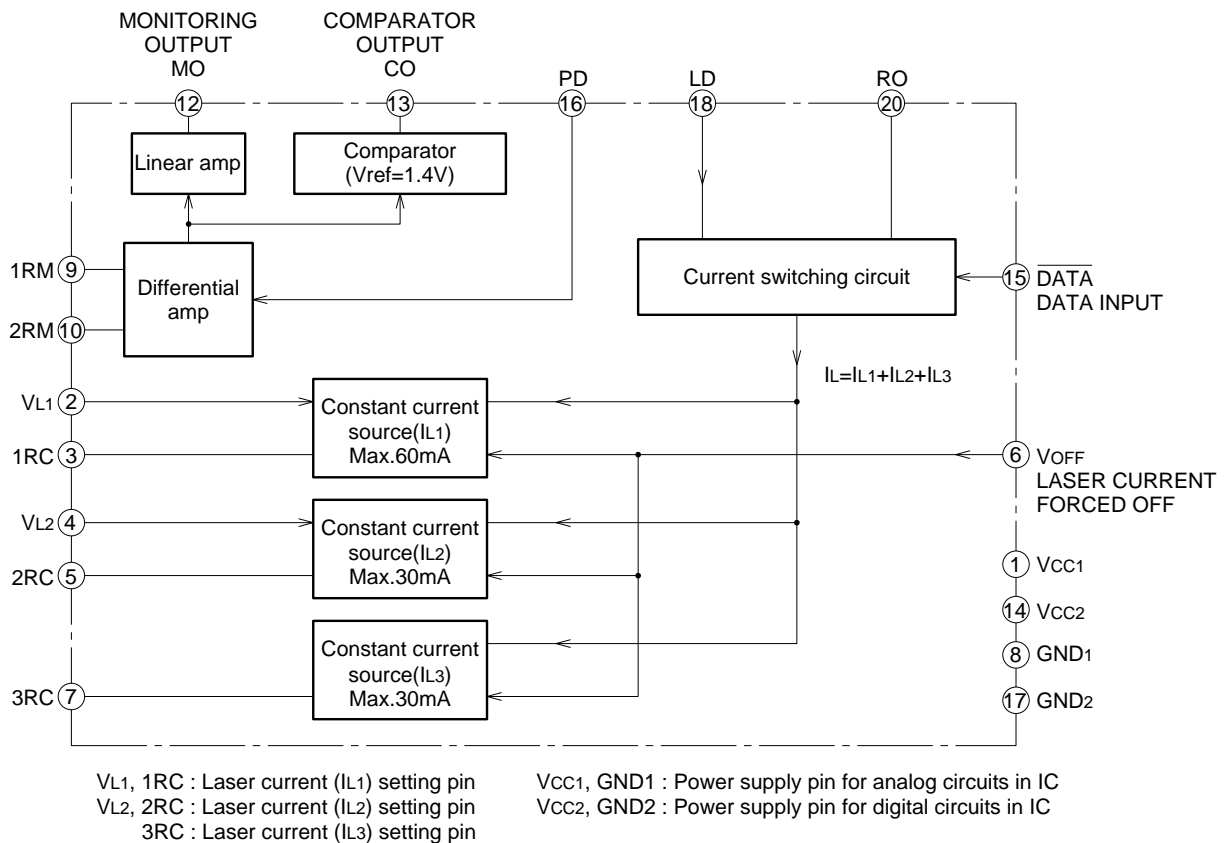
PIN CONFIGURATION (TOP VIEW)



Outline 20P4
20P2N-A

NC: No Connection

BLOCK DIAGRAM



FUNCTION

The M66512 is a semiconductor laser-diode driver for driving a specific type (Mitsubishi's N type) of laser, in which the anode of a semiconductor laser diode is connected in stem structure to the cathode of a monitoring photodiode. The amplitude of laser drive current is set by applying a constant voltage from an external source. For that purpose, the M66512 has two voltage applying pins, which they are independent each other. This mechanism makes it possible to set a drive current with great accuracy.

As the IC is equipped with a pin to provide a forced OFF of current circuit, it is possible to prevent a large current flowing through laser diodes at the moment of power ON.

Regarding the detection of laser power, a monitor current generated by a monitoring photodiode, which is incorporated in laser unit, is drawn and converted into changes in voltage by means of an external resistor, in order to output as an analog signal. Simultaneously, the converted voltage is compared with the internal reference voltage, thence the result is output in TTL level as logic information.

PIN DESCRIPTIONS

Pin	Name	Functions
LD	Laser connection pin	Connect to cathode on semiconductor laser diode.
PD	Monitoring diode connection pin	Connect to cathode on monitoring photodiode.
VL1	Voltage input pin for IL1 setting	Voltage input to set output current (IL1) of current source 1.
1RC	Load resistor connection pin for IL1 setting	Connect load resistor between this pin and GND for IL1 setting.
VL2	Voltage input pin for IL2 setting	Voltage input to set output current (IL2) of current source 2.
2RC	Load resistor connection pin for IL2 setting	Connect load resistor between this pin and GND for IL2 setting.
3RC	Load resistor connection pin for IL3 setting	Connect load resistor between this pin and GND for IL3 setting. Leave this pin open if IL3 is not used.
DATA	Switching data input pin	Laser turns on and off by "L" and "H", respectively.
1RM, 2RM	Load resistor connection pins for monitoring function	Connect resistor between pins 1RM and 2RM for conversion of current generated by monitoring photodiode into changes in voltage.
MO	Analog output pin for monitoring function	Analog output for monitoring laser power
CO	Comparator output pin for monitoring function	Comparator output for monitoring laser power
VOFF	Laser current forced OFF input pin	If this is "L", all current supply circuits are turned off.
RO	Load resistor connection pin for laser current	Connect load resistor between RO and VCC for laser current.
VCC1	Power supply pin 1	Power supply for internal analog circuits. Connect to positive power source (+5V)
VCC2	Power supply pin 2	Power supply for internal digital circuits. Connect to positive power source (+5V)
GND1	GND pin 1	GND for internal analog circuits
GND2	GND pin 2	GND for internal digital circuits

OPERATION

1. Setting for Laser Drive Current

The M66512 has 3 built-in constant current sources, IL1, IL2, and IL3. Each output current can be controlled independently. The following (1) to (3) describe the method for how to set IL1, IL2, and IL3.

(1) IL1 setting method

The value of IL1 is determined by the voltage on the VL1 pin and the resistor (RC1) connected between the 1RC pin and GND. The following equation is used for approximation.

$$IL1 [mA] = 12 \times \frac{VL1[V]}{RC1 [k\Omega]}$$

provided that $0 \leq VL1 \leq VCC - 1.8V$ and $IL1(max.) = 60mA$

(2) IL2 setting method

The value of IL2 is determined by the voltage on the VL2 pin and the resistor (RC2) connected between the 2RC pin and GND. The following equation is used for approximation.

$$IL2[mA] = 6 \times \frac{VL2[V]}{RC2 [k\Omega]}$$

provided that $0 \leq VL2 \leq VCC - 1.8V$ and $IL2(max.) = 30mA$

(3) IL3 setting method

The value of IL3 is determined by the internal reference voltage (Vref) and the resistor (RC3) connected between the 3RC pin and GND. The following equation is used for approximation.

$$IL3[mA] = 10 \times \frac{Vref[V]}{RC3 [k\Omega]}$$

provided that $Vref = 1.4V$ (typ.) and $IL3(max.) = 30mA$

Note: Each of the above equations is a typical on for obtaining IL1–IL3. In practice values vary by a few percent due to some reasons such as differences of ICs from lot to lot and variations in operation temperatures.

2. Switching Operation

The laser turns on if $\overline{DATA} = "L"$. The laser drive current at that moment is $IL1 + IL2 + IL3$.

If $\overline{DATA} = "H"$ the laser is turned off, and the laser drive current is almost zero irrespective of the values of IL1 to IL3.

3. Use of the VOFF Input

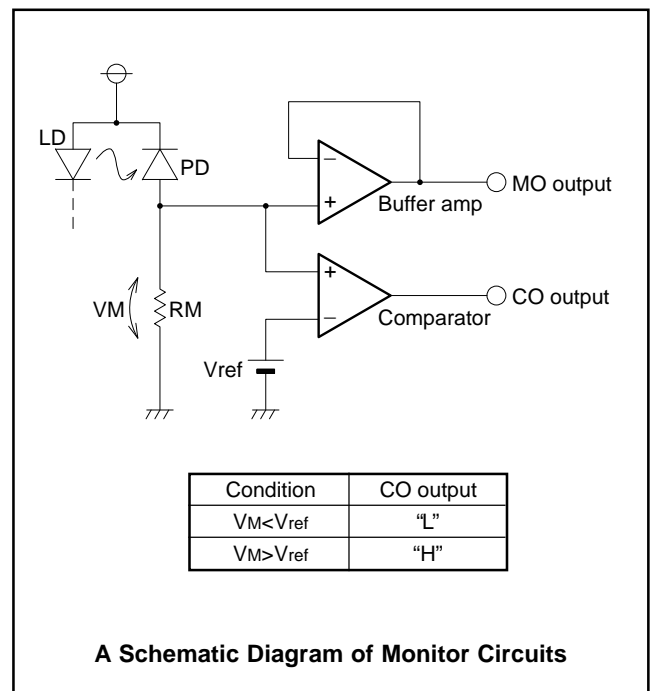
When $\overline{DATA} = "H"$ the current flowing through the laser is zero so the laser is turned off, but the internal current sources are in operation.

When $VOFF = "L"$ in contrast, the internal current sources are turned off. Accordingly, it is possible to prevent an excessive current from flowing through the laser by, for example, fixing the VOFF input to "L" until VCC, after turned on, reaches 3.5V(typ.). (See the section dealing with internal reset.)

4. Laser Power Monitoring Operation

At the MO and CO pins, the M66512 outputs data obtained by the monitoring photodiode (PD) contained in the laser, in the sequence explained below.

- (1) A current equal to the PD current generated by laser light flows through the resistor (RM) connected between 1RM and 2RM. Then, a potential difference (VM) proportional to the output of laser light occurs at RM.
- (2) The VM is output at the MO pin as an analog signal through a buffer amp. At the same time, VM is compared with the internal reference voltage Vref(1.4V typ.) by the comparator, thence the result of the comparison is output at the CO pin in TTL level.



5. RO Pin

The RO pin is used to connect a load resistor (RO) for the current sources (IL1, IL2, and IL3). The load resistor is connected between the RO pin and VCC in order to reduce the power dissipated in the IC.

The resistance of the load resistor should be such that does not generate a voltage equal to or lower than 2.5V at the RO pin. Accordingly, a value that satisfies the following equation should be chosen.

$$RO(\Omega) \leq \frac{V_{CC} - 2.5[V]}{\text{maximum load current flowing through RO [A]}}$$

Example: If VCC = 5V and the maximum load current is 120 mA, RO is 20Ω or under.

6. Internal Reset Function

The M66512 has a reset circuit for the protection of laser from an excessive current flowing at the moment of power on. The reset circuit functions in the range VCC < 3.5V(typ.), letting all current sources turn off.

7. Vcc and GND Pins

Pins related to the power supply function are VCC1, VCC2, GND1, and GND2. The role of these pins in terms of the internal circuits are as follows.

VCC1, GND1 : connected to analog circuits

VCC2, GND2 : connected to digital circuits

In practical wiring, the following should be noted.

- (1) Secure as much a width as possible for conductors and avoid lengthy wiring.
- (2) Allocate electrolytic capacitors for stable voltage near VCC1 and GND1.
- (3) Allocate by-pass capacitors near VCC2 and GND2.

Notes on the Wiring for peripheral Components

Lay out peripheral components necessary for the M66512 to operate in closest possible proximity to the M66512.

Calculation Method for Power Dissipation

The M66512's approximated power dissipation, P, is determined by the following equation.

$$P = I_{CC} \times V_{CC} + I(RO) \times V(RO) + I(LD) \times V(LD) + IOL(CO) \times VOL(CO)$$

Where V(RO) : voltage at RO pin

V(LD) : voltage at LD pin

I(RO) : load current at RO pin

I(LD) : load current at LD pin

VOL(CO) : "L" output voltage at CO pin

IOL(CO) : "L" output voltage at CO pin

If, for example, VCC = 5.25V, V(RO) = V(LD) = 2.75V, I(RO) = I(LD) = 120mA, IOL(CO) = 8mA, and VOL(CO) = 0.5V, power dissipation at times of turning on and off of laser will be as follows.

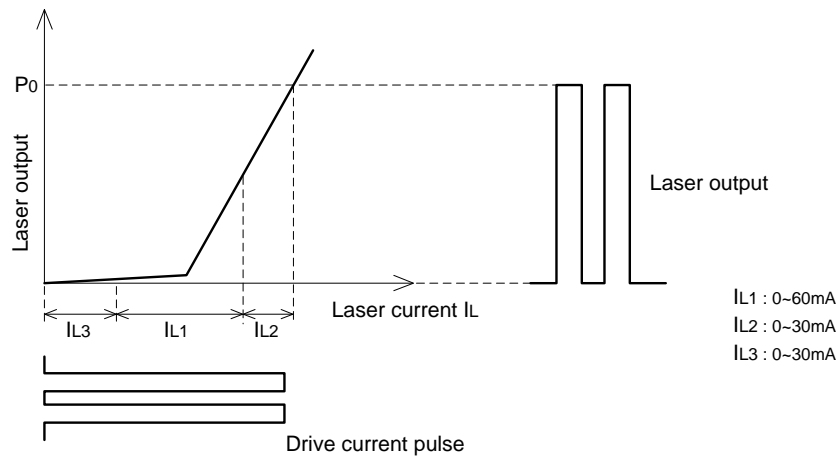
(1) Laser ON (DATA = "L" and ICC = 75mA)

$$P_{ON} = 75 \times 5.25 + 0 + 120 \times 2.75 + 8 \times 0.5 = 727.8(\text{mW})$$

(2) Laser OFF (DATA = "H" and ICC = 74mA)

$$P_{OFF} = 74 \times 5.25 + 120 \times 2.75 + 0 = 718.5(\text{mW})$$

OPERATING WAVEFORMS



ABSOLUTE MAXIMUM RATINGS

Symbol	Parameter		Conditions	Ratings	Unit
V_{CC}	Supply voltage			-0.5 ~ +7.0	V
V_I	Input voltage	V_{L1}, V_{L2}		-0.3 ~ V_{CC}	V
		DATA, V_{OFF}		-0.3 ~ +7	
V_O	Output voltage	CO	Output: "H"	-0.3 ~ +5.5	V
		RO		-0.3 ~ +7	
I_{L1}	Output current 1			90	mA
I_{L2}	Output current 2			45	mA
I_{L3}	Output current 3			45	mA
P_d	Power dissipation	DIP	For single integrated circuit; $T_a=25^{\circ}\text{C}$ (Note 1)	1300	mW
		SOP	IC Measured being mounted; $T_a=25^{\circ}\text{C}$ (Note 2)	1200	
T_{stg}	Storage temperature			-65 ~ 150	$^{\circ}\text{C}$

Note 1: For operation above 25°C free-air temperature, derating of 10.4mW/°C is necessary.

Note 2: For operation above 25°C free-air temperature, derating of 9.6mW/°C is necessary.

RECOMMENDED OPERATIONAL CONDITIONS

Symbol	Parameter	Conditions	Limits			Unit
			Min.	Typ.	Max.	
V_{CC}	Supply voltage		4.75	5	5.25	V
I_{L1}	Output current 1				60	mA
I_{L2}	Output current 2				30	mA
I_{L3}	Output current 3				30	mA
T_{opr}	Operational ambient temperature		-20		75	$^{\circ}\text{C}$

ELECTRICAL CHARACTERISTICS (VCC = 5V ± 5%, Ta = -20 ~ 75°C unless otherwise noted))

Symbol	Parameter		Test conditions	Limits			Unit
				Min.	Typ.*	Max.	
VIH	"H" input voltage	DATA, VOFF		2			V
VIL	"L" input voltage	DATA, VOFF				0.8	V
VI	Maximum effective input voltage	VL1, VL2		VCC-1.8	VCC-1.4		V
VOH	"H" output voltage	CO	IOH=-400μA	2.7			V
VOL	"L" output voltage	CO	IOH=4mA			0.4	V
			IOH=8mA			0.5	
VLD	Operating voltage range	LD		VCC-2.5		VCC	V
VOS	Output offset voltage	MO	IMO=±20μA, IPD=0mA (Note 3)		30		mV
ΔVM	Output voltage fluctuation	MO	IPD=0.2~2.0mA, IMO=±20μA RM=1kΩ (Note 4)		20		mV
		Temperature coefficient	RM=1kΩ, IPD=1.2mA		0.05		mV/°C
II	Input current	DATA, VOFF	VI=2.7V			20	μA
			VI=0.4V			-0.2	mA
		VL1, VL2	VI=0~VCC			±1	μA
Vref	Reference voltage	Temperature coefficient			1.4		V
			Ta=-20~25°C		-0.8		mV/°C
			Ta=25~75°C		-0.5		
IL1	Output current 1 (Note 5)	LD	VL1=3V, RC1=560Ω, VLD=2V		61		mA
		Temperature coefficient			0.111		mA/°C
IL2	Output current 2 (Note 5)	LD	VL2=3V, RC2=560Ω, VLD=2V		31		mA
		Temperature coefficient			0.050		mA/°C
IL3	Output current 3 (Note 5)	LD	RC3=360Ω, VLD=2V		34		mA
IOFF	OFF state output current	LD	VOFF=DATA=2V		0.03	50	μA
			VOFF=DATA=0.8V		0.01	50	μA
ICC	Supply current		VCC=5.25V, VOFF=4.5V, VL1=VL2=3.0V, RC1=RC2=560Ω, RC3=360Ω, RO=LD=5.0V	DATA=0V	60	75	mA
				DATA=4.5V	59	74	

Note 3. IMO: Output current at MO pin. IPD: Input current at PD pin

4. RM: Resistor connected between 1RM and 2RM pins

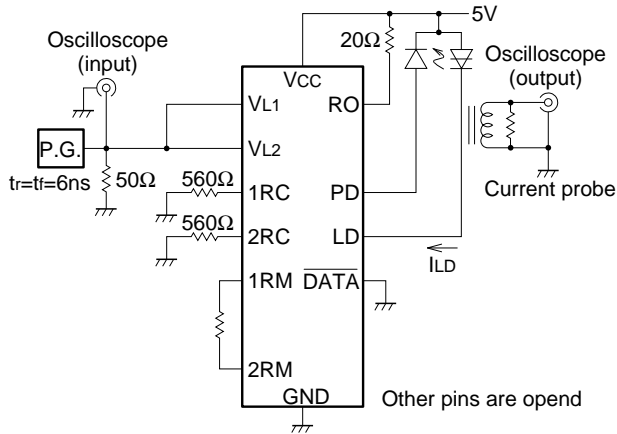
5. These parameters indicate the conversion characteristics of the input voltage and output current. In actual use, IL1 – IL3 shall be within the range specified as limits in the recommended operating conditions.

* Typical values are gained under conditions of VCC =5V and Ta =25°C. Regarding parameters that Ta is specified as test condition, however, typical values are gained under the condition VCC = 5V.

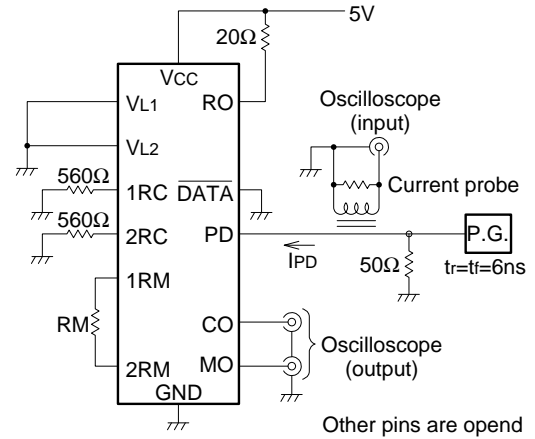
SWITCHING CHARACTERISTICS (VCC = 5V, Ta = -25°C)

Symbol	Parameter	Test pin		Test conditions	Limits			Unit
		Input	Output		Min.	Typ.	Max.	
fOP	Operating frequency					40		Mbps
tRP1	Circuit response time 1	VL1, VL2 Voltage	LD Current	ILD(L)=0mA, ILD(H)=60mA (Note 6)		4.5	7	μs
				ILD(L)=55mA, ILD(H)=65mA (Note 6)		0.5	2	
tRP2	Circuit response time 2	PD Current	MO Voltage	IPD(L)=0mA, IPD(H)=2mA, RM=1kΩ (Note 7)		7	10	μs
				ΔIPD =0.2mA, RM=1kΩ (Note 7)		1	3	
tRP3	Circuit response time 3	PD Current	CO Voltage	ΔIPD =1mA (Note 7)		7	10	μs
				ΔIPD =0.2mA (Note 7)		0.5	2	
tON	Circuit ON time	VOFF Voltage	LD Current	ILD(H)=60mA, ILD(L)=0mA (Note 8)		3	5	μs
tOFF	Circuit OFF time	VOFF Voltage	LD Current	ILD(H)=60mA, ILD(L)=0mA (Note 8)		0.5	2	μs

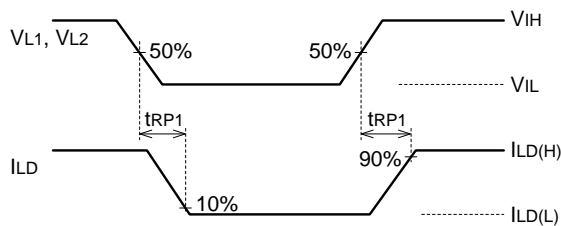
NOTE 6: MEASURING CIRCUIT



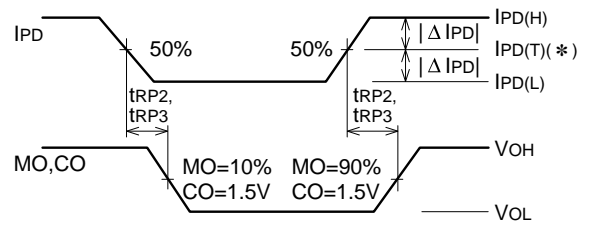
NOTE 7: MEASURING CIRCUIT



TIMING CHART

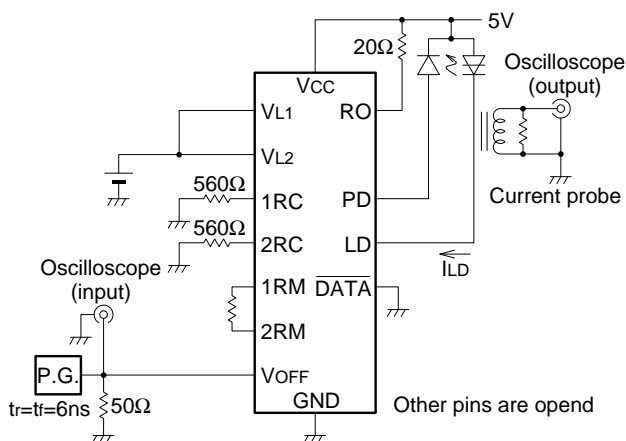


TIMING CHART

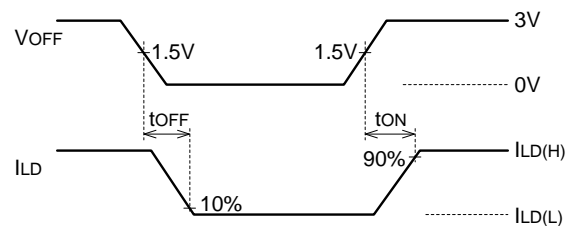


(*) : IPD gained at the moment CO output is inverted.

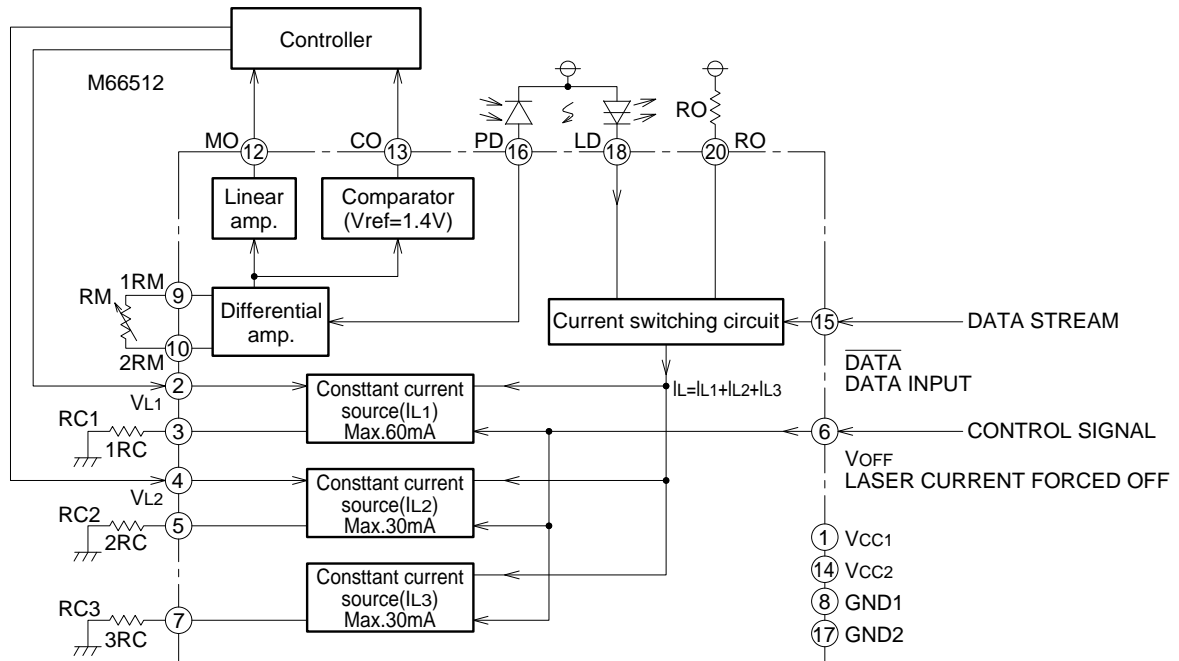
NOTE 8: MEASURING CIRCUIT



TIMING CHART

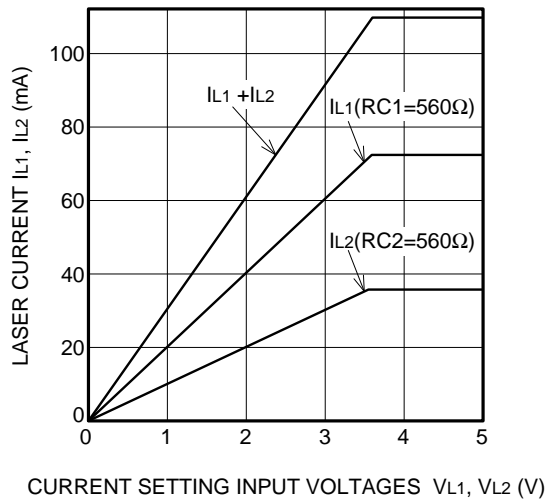


APPLICATION EXAMPLE

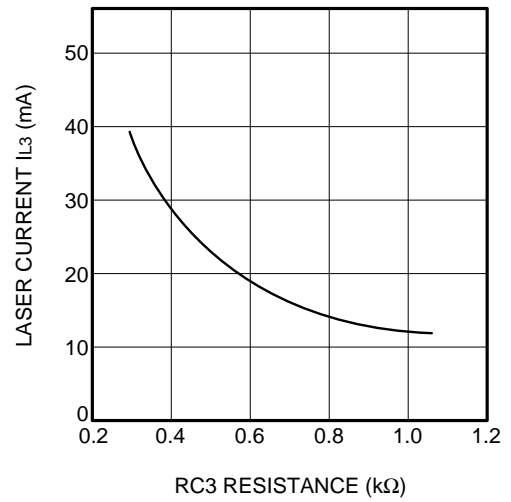


TYPICAL CHARACTERISTICS ($V_{CC}=5V$, $T_a=25^{\circ}C$)

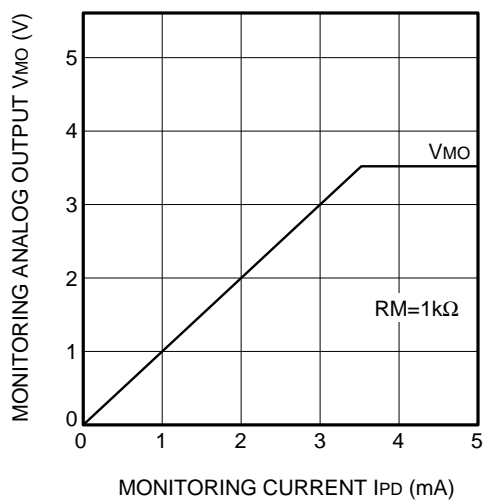
LASER CURRENT VS. CURRENT SETTING VOLTAGE



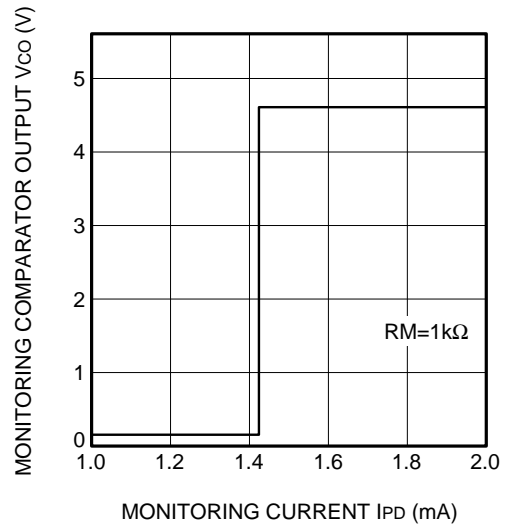
LASER CURRENT VS. RC3 RESISTANCE



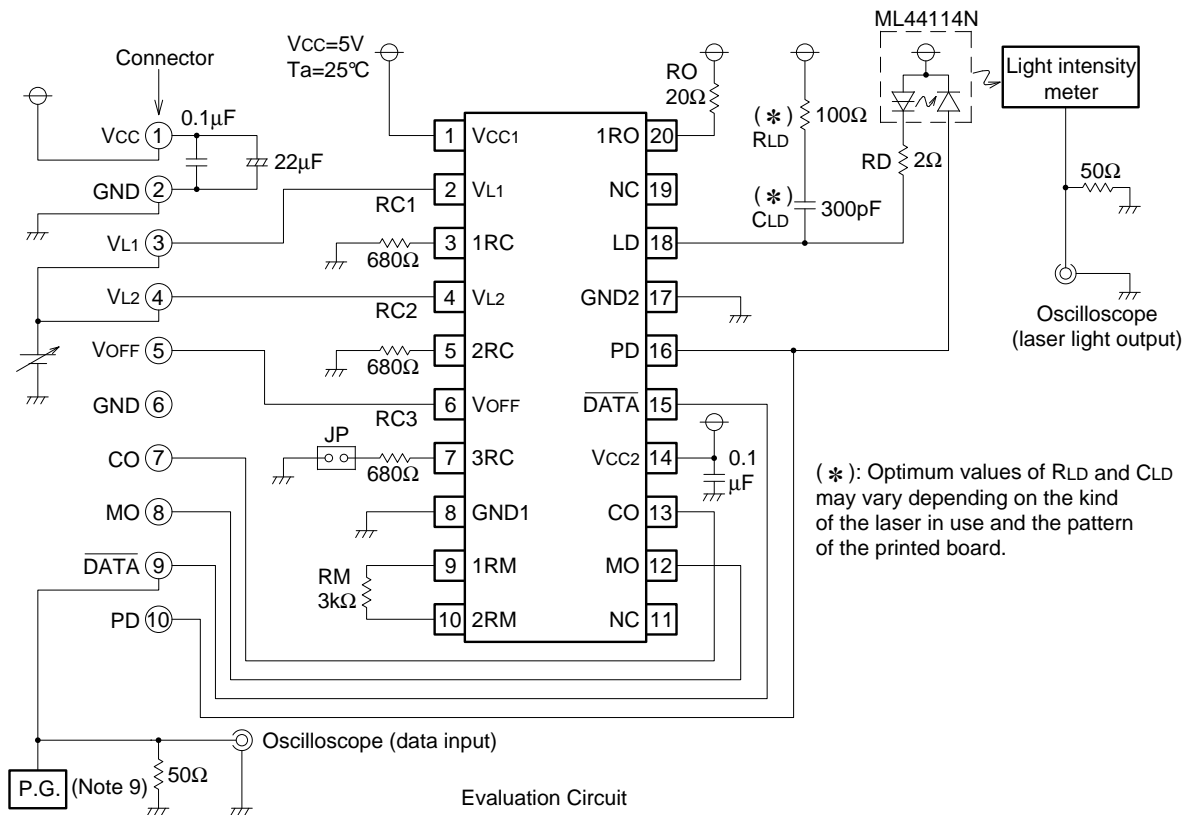
MO OUTPUT VS. MONITORING CURRENT



CO OUTPUT VS. MONITORING CURRENT

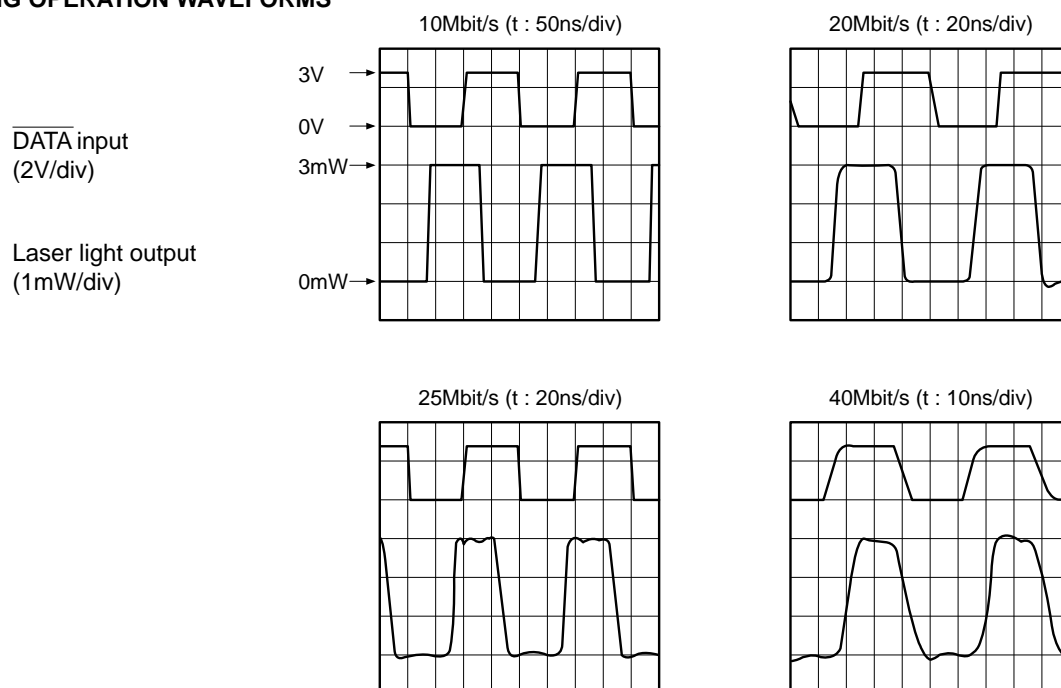


EVALUATION OF SWITCHING OPERATION WAVEFORMS



Note 9. $t_r=t_f=6\text{ns}$, $V_O=3\text{VP-P}$, duty=50%

SWITCHING OPERATION WAVEFORMS



Note: The delay from the DATA input to the laser light output contains the delay occurring in measuring systems.