DESCRIPTION

The M66515 is a semiconductor laser-diode driver/controller. Its functions are the driving and laser power control of a specific type (Mitsubishi's N type laser) of semiconductor laser diode, in which the anode of a semiconductor laser diode is connected in stem structure to the cathode of a monitoring photodiode.

The IC has a laser drive current output pin of sink type and is capable of driving a laser diode on a maximum bias current of 30mA and a maximum switching current of 120mA, which is switched at a rate of 40Mbit/s.

Since the M66515 has a built in sample-hold circuit, it is possible to realize an internal APC* system that requires no external device for laser power control.
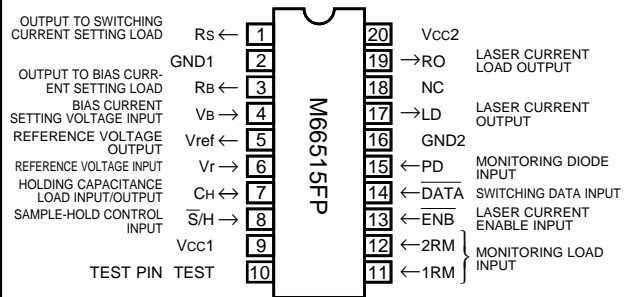
*: Automatic Power Control

FEATURES

• Built-in sample-hold circuit for internal APC function
• High speed switching (40Mbps)
• Large drive current (150mA max.)
• Capable of setting bias current (30mA max.)
• 5V single power supply

APPLICATION
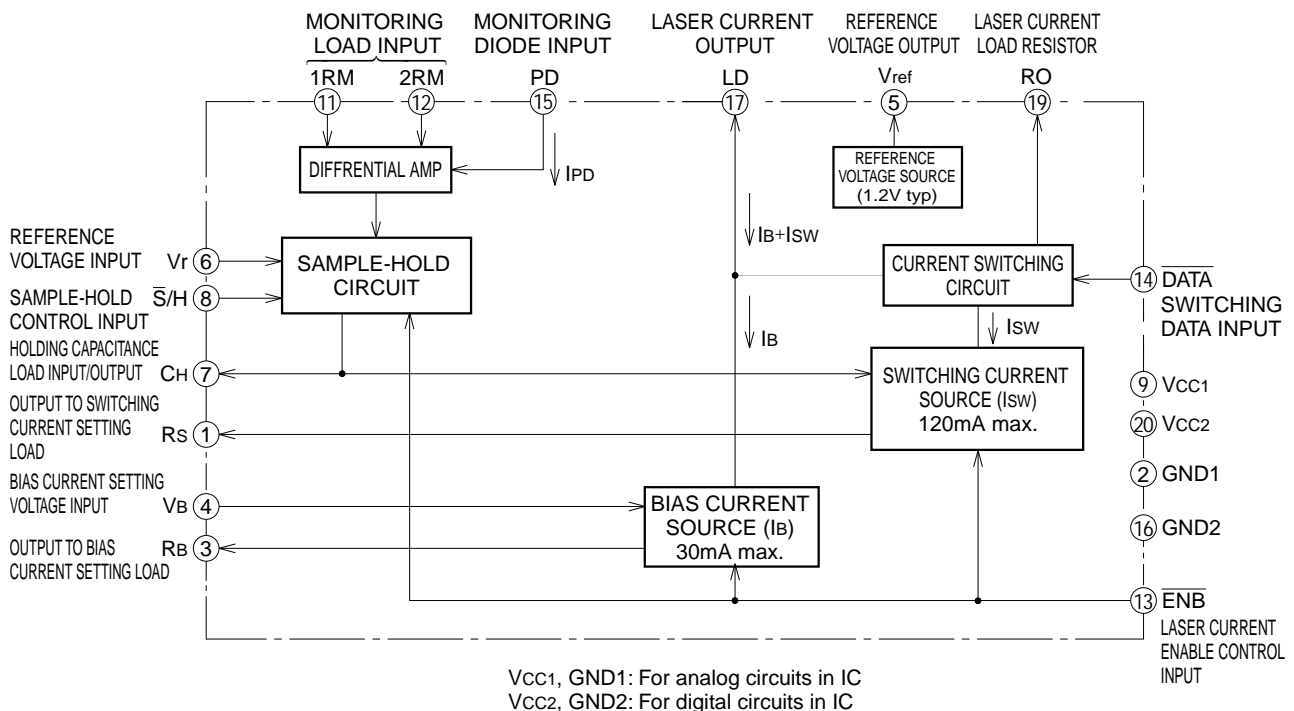
Semiconductor laser-diode applied equipment

PIN CONFIGURATION (TOP VIEW)

	Pin		Pin		
OUTPUT TO SWITCHING CURRENT SETTING LOAD	Rs ←	1	20	Vcc2	
	GND1	2	19	→RO	LASER CURRENT LOAD OUTPUT
OUTPUT TO BIAS CURRENT SETTING LOAD	RB ←	3	18	NC	
BIAS CURRENT SETTING VOLTAGE INPUT	VB →	4	17	→LD	LASER CURRENT OUTPUT
REFERENCE VOLTAGE OUTPUT	Vref ←	5	16	GND2	
REFERENCE VOLTAGE INPUT	Vr →	6	15	←PD	MONITORING DIODE INPUT
HOLDING CAPACITANCE LOAD INPUT/OUTPUT	CH ↔	7	14	←DATA	SWITCHING DATA INPUT
SAMPLE-HOLD CONTROL INPUT	S̅/H →	8	13	←ENB	LASER CURRENT ENABLE INPUT
	Vcc1	9	12	←2RM	MONITORING LOAD INPUT
TEST PIN	TEST	10	11	←1RM	

M66515FP

Outline 20P2N-A

NC: No Connection

BLOCK DIAGRAM

MONITORING LOAD INPUT 1RM (11) 2RM (12)
MONITORING DIODE INPUT PD (15)
LASER CURRENT OUTPUT LD (17)
REFERENCE VOLTAGE OUTPUT Vref (5)
LASER CURRENT LOAD RESISTOR RO (19)

DIFFRENTIAL AMP

REFERENCE VOLTAGE SOURCE (1.2V typ)

I_{PD}

REFERENCE VOLTAGE INPUT Vr (6)
SAMPLE-HOLD CONTROL INPUT S̅/H (8)
SAMPLE-HOLD CIRCUIT

$I_B + I_{SW}$

CURRENT SWITCHING CIRCUIT

(14) DATA SWITCHING DATA INPUT

I_{SW}

HOLDING CAPACITANCE LOAD INPUT/OUTPUT CH (7)
OUTPUT TO SWITCHING CURRENT SETTING LOAD Rs (1)

I_B

SWITCHING CURRENT SOURCE (I_{SW}) 120mA max.

(9) Vcc1
(20) Vcc2
(2) GND1
(16) GND2

BIAS CURRENT SETTING VOLTAGE INPUT VB (4)
OUTPUT TO BIAS CURRENT SETTING LOAD RB (3)
BIAS CURRENT SOURCE (I_B) 30mA max.

(13) ENB LASER CURRENT ENABLE CONTROL INPUT

Vcc1, GND1: For analog circuits in IC
Vcc2, GND2: For digital circuits in IC

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LASER-DIODE DRIVER/CONTROLLER

FUNCTIONS

The M66515 is a semiconductor laser-diode driver/controller. Its functions are the driving and laser power control of a specific type (Mitsubishi's N type laser) of semiconductor laser diode, in which the anode of a semiconductor laser diode (LD) is connected in stem structure to the cathode of a monitoring photodiode (PD).

The functions to drive LD and to control laser power are carried out by connecting an external capacitor to the C_H pin and applying a reference voltage to the V_r pin.

The PD current generated by LD illumination flows through the resistor connected between 1RM and 2RM, thereby gen-erating a potential difference (V_M). V_M is compared with the voltage applied to the V_r pin. If $V_M < V_r$, a constant current is sourced through the C_H pin so that the external capacitor is charged. If $V_M > V_r$, a constant current sinks through the C_H pin to discharge the external capacitor.

The above operation occurs when the $\overline{S}/H$ input is "L" (sample). When the $\overline{S}/H$ input is "H," the C_H pin is maintained at high impedance state (hold), irrespective of the state of V_M, V_r, and $\overline{DATA}$ input.

The LD drive current is made up of the switching current, I_{SW}, which is controlled by the $\overline{DATA}$ input, and I_B, which is the bias current to LD independent of the state of the $\overline{DATA}$ input.

PIN DESCRIPTIONS

Pin	Name	Description
LD	Laser current output	Connect to cathode on semiconductor laser diode.
PD	Monitoring diode input	Connect to anode on monitoring photodiode.
R_S	Switching current Set load output	Connect a load resistor between this pin and GND for the setting of current (I_{SW}) to be switched.
R_B	Bias current Set load output	Connect a load resistor between this pin and GND for the setting of bias current (I_B). Leave this pin open if I_B is not used.
V_B	Bias current setting voltage input	Bias current (I_B) is set by applying a voltage at this pin. Leave this pin open if I_B is not used.
$\overline{DATA}$	Switching data input	If this pin is "L," a current of $I_{SW} + I_B$ flows through laser diode; if "H," current I_B flows.
1RM, 2RM	For monitoring Load input	A load resistor is connected between pins 1RM and 2RM for conversion of current generated by monitoring photodiode into changes in voltage.
$\overline{ENB}$	Laser current enable input	If this pin is "H" all current source circuits are turned off.
RO	Laser current load output	Connect a laser current load resistor between this pin and Vcc.
S/H	Sample hold control input	If this pin is "L," sampling (APC) occurs, if "H," holding (switching).
C_H	Holding capacitor load input/output	Connect a holding capacitor between this pin and GND. Inside the M66515 this pin connects to the output of the sample-hold circuit and the current source input for I_{SW}.
V_{ref}	Reference voltage output	Internal reference voltage (1.2 V typ.) output pin of M66515
V_r	Reference voltage input	A reference voltage is applied to this pin to operate the comparator in the sample-hold circuit. Connect this pin to the Vref pin if the internal reference voltage of the M66515 is to be used.
TEST	Test pin	This pin is used to test the M66515 when shipped. Leave open.
V_{CC1}	Power supply pin 1	Power supply to internal analog circuits. Connect to a positive power source (+5 V).
V_{CC2}	Power supply pin 2	Power supply to internal digital circuits. connect to a positive power source (+5 V).
GND1	GND pin 1	GND for internal analog circuits.
GND2	GND pin 2	GND for internal digital circuits.

OPERATION

1. Laser Drive Currents

The approximate values of laser drive currents, I_{SW} and I_B, are obtained by the following equation, in which V_C is the voltage of holding capacitor connected to the C_H pin.

(1) I_{SW} (switching current)

$$I_{SW} \text{ [mA]} = 12 \times \frac{V_C \text{ [V]}}{R_S \text{ [k}\Omega\text{]}}$$

provided that $0 \leq V_C \leq V_{CC} - 1.8V$ and I_{SW} (max.) =120mA where R_S is the resistance of the resistor connected between the R_S pin and GND.

(2) I_B (bias current)

$$I_B \text{ [mA]} = 10 \times \frac{V_B \text{ [V]}}{R_B \text{ [k}\Omega\text{]}}$$

provided that $0 \leq V_B \leq V_{CC} - 2.7V$ and I_B (max.) = 30mA where R_B is the resistance of the resistor connected between the R_B pin and GND.

2. Switching Operation

If $\overline{DATA}$ = "L," the LD drive current is $I_{SW} + I_B$; if $\overline{DATA}$ = "H," I_B.

3. $\overline{ENB}$ Input

When the laser drive current is controlled by the $\overline{DATA}$ input, the M66515's internal current source is maintained turned on. In contrast, the control by $\overline{ENB}$ is turning on and off at the current source. If $\overline{ENB}$ = "L" the current source turns on; if $\overline{ENB}$ = "H" off.

When $\overline{ENB}$ = "H" the C_H pin is compulsorily fixed to "L" in order to discharge the capacitor connected to the C_H pin.

4. Internal Reset Function

The M66515 has a reset circuit built in for the protection of laser from an excessive current flowing at the moment of power on. The internal current source goes off in the range Vcc < 3.5V (typ.), and the C_H pin is compulsorily fixed to "L" at the same time.

5. RO Pin

A load resistor for laser drive current is connected to the RO pin, through which a current almost equal to I_{SW} flows in (when $\overline{DATA}$ = "H"). The load resistor is connected between the RO pin and Vcc to reduce power dissipated in the IC.

Due to reasons related to the operation of circuits, the voltage at this pin should be 2.5V or higher.

Consequently, the maximum resistance, RO(max.), of load resistor RO is:

$$RO_{(max.)} \text{ [}\Omega\text{]} = \frac{V_{CC(min.)} - 2.5 \text{ [V]}}{I_{SW(max.)} \text{ [A]}}$$

where $I_{SW(max.)}$ is the maximum of I_{SW}. If, for example, $V_{CC(min.)}$ = 4.75V and $I_{SW(max.)}$ =120mA, RO(max.) =18.8Ω.

Accordingly, if the resistance of R_S is selected so as to gain maximum I_{SW} of 120mA, RO should be 18.8Ω at the maximum.

6. Sample-Hold Circuit

(1) Circuit Operation Overview

The following is an overview of the operation of the sample-hold circuit contained in the M66515.

The PD current generated by LD illumination flows through the resistor connected between 1RM and 2RM, thereby generating a potential difference (V_M). V_M is compared with the voltage applied to the Vr pin. If $V_M < V_r$, a constant current is sourced through the C_H pin so that the external capacitor is charged. If $V_M > V_r$, a constant current sinks through the C_H pin to discharge the external capacitor. This operation occurs when the $\overline{S}$/H input is "L" (sample). When the $\overline{S}$/H input is "H," the C_H pin is maintained at high impedance state (hold), irrespective of the state of V_M, V_r, and $\overline{DATA}$ input.
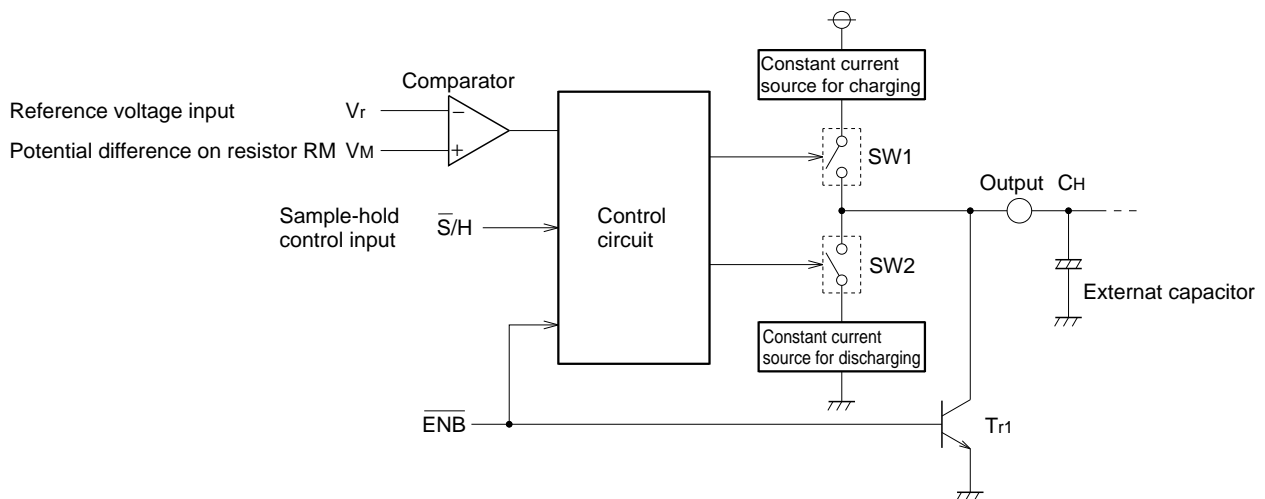

Conceptual Diagram : Sample-Hold circuit

LASER-DIODE DRIVER/CONTROLLER

FUNCTION TABLE

Input			Switch condition		Tr1	Output
$\overline{ENB}$	$\overline{S}$/H	VM, Vr	SW1	SW2		
H	×	×	OFF	OFF	ON	Fixed to "L"
L	H	×	OFF	OFF	OFF	High impedance state (hold)
L	L	VM < Vr	ON	OFF	OFF	Constant current sourcing (sample)
		VM > Vr	OFF	ON	OFF	Constant current sinking (sample)

×: Don't care

(2) APC Timing Chart
The following diagram is an APC timing chart, operation of which is based on sample hold control signals.

Note that in the example it is assumed that the leak current occurring at the CH pin under hold condition flows out from the M66515 (in the negative direction).
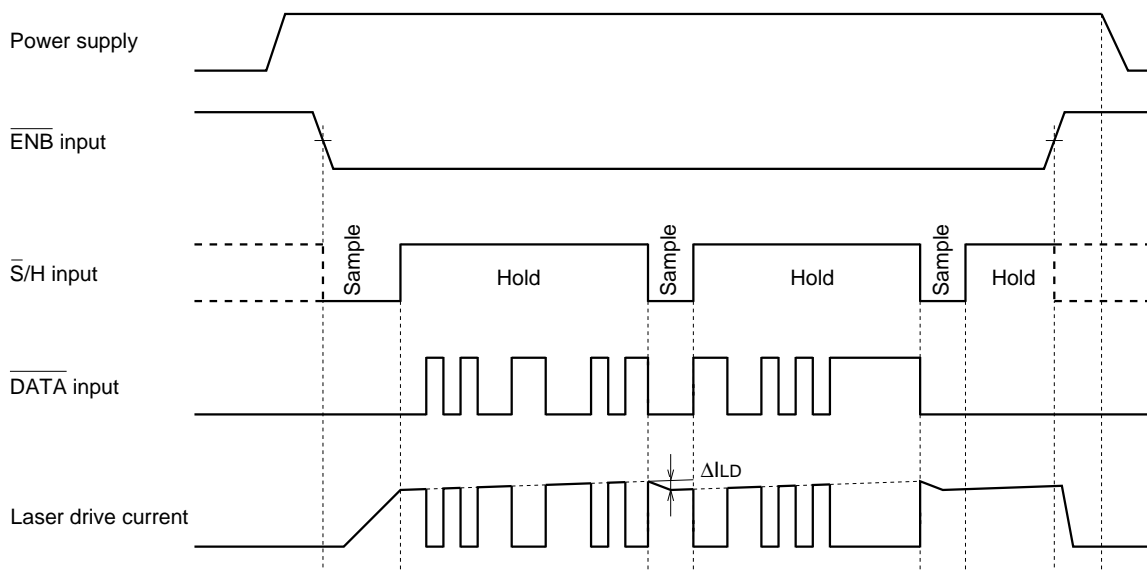
APC Timing Chart

7. Vcc and GND Pins
Pins related to the power supply function are Vcc 1, Vcc 2, GND 1, and GND 2. The role of these pins in terms of the internal circuits are as follows.
Vcc 1, GND 1: connected to analog circuits
Vcc 2, GND 2: 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 GND 1.
(3) Allocate by-pass capacitors near Vcc2 and GND 2.

Notes on the Wiring for Peripheral Components
Lay out peripheral components necessary for the M66515 to operate in closest possible proximity to the M66515.

Calculation Method for Power Dissipation
The approximate power dissipation, P, of the M66515FP is determined by the following equation.
$P = Icc \times Vcc + I_{(RO)} \times V_{(RO)} + I_{(LD)} \times V_{(LD)}$ 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
If, for example, Vcc = 5.25V, $V_{(RO)} = V_{(LD)} = 2.5V$, and $I_{(RO)} = I_{(LD)} = 150mA$, power dissipation at times of turning laser on and off will be as follows.
(1) Laser ON ($\overline{DATA}$ = "L" and Icc = 75mA)
$P_{ON} = 75 \times 5.25 + 0 + 150 \times 2.5 = 768.8$ (mW)
(2) Laser OFF ($\overline{DATA}$ = "H" and Icc = 74mA)
$P_{OFF} = 74 \times 5.25 + 150 \times 2.5 + 0 = 763.5$ (mW)

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LASER-DIODE DRIVER/CONTROLLER

ABSOLUTE MAXIMUM RATINGS (Ta = −20 ~ 70°C unless otherwise noted)

Symbol	Parameter		Conditions	Ratings	Unit
V_{CC}	Supply voltage			−0.5 ~ +7.0	V
V_I	Input voltage	C_H, V_r		−0.3 ~ V_{CC}	V
		$\overline{DATE}$, $\overline{ENB}$, $\overline{S/H}$		−0.3 ~ +7.0	
V_O	Output voltage	RO		−0.3 ~ +7.0	V
I_{SW}	Switching current			150	mA
I_B	Bias current			45	mA
P_d	Power dissipation		Measured being mounted Ta = 25°C	1200	mW
T_{stg}	Storage temperature			−65 ~ 150	°C

RECOMMENDED OPERATIONAL CONDITIONS (Ta = −20 ~ 70°C unless otherwise noted)

Symbol	Parameter	Limits			Unit
		Min.	Typ.	Max.	
V_{CC}	Supply voltage	4.75	5.0	5.25	V
I_{SW}	Switing current			120	mA
I_B	Bias current			30	mA
T_{opr}	Operating ambient temperature	−20		70	°C

ELECTRICAL CHARACTERISTICS (Ta = −20 ~ 70°C, V_{CC} = 5V±5% unless otherwise noted)

| Symbol	Parameter		Test conditions		Limits			Unit	Test circuit
					Min.	Typ.*	Max.		
V_{IH}	"H" Input voltage	$\overline{DATA}$, $\overline{ENB}$, $\overline{S/H}$			2.0			V	
V_{IL}	"L" Input voltage	$\overline{DATA}$, $\overline{ENB}$, $\overline{S/H}$					0.8	V	
V_r	Reference voltage input	V_r			0.4		2.0	V	
V_{ref}	Reference voltage output	V_{ref}	$I_O = -10\mu A$			1.2		V	1
		Temprature coefficient	Ta = −20 ~ 25°C			−0.9		mV/°C	
			Ta = 20 ~ 70°C			−0.9			
V_{LD}	Operating voltage range	LD			2.5		V_{CC}	V	
V_I	Maximum effective voltage	C_H			V_{CC} − 1.8	V_{CC} − 1.4		V	
V_{OH}	"H" output voltage	C_H	$\overline{ENB}$ = 0.8V, $I_{OH} = -2mA$		4.0			V	1
V_{OL}	"L" output voltage	C_H	$\overline{ENB}$ = 0.8V, $I_{OL} = 2mA$				0.6	V	1
I_I	Input current	$\overline{DATA}$, $\overline{ENB}$	V_I = 2.7V				20	μA	
			V_I = 0.4V				−0.2	mA	
		C_H	V_I = 0 ~ V_{CC}				±1	μA	
I_{SW}	Switching current (Note)	LD	C_H = 3.0V, R_S = 300Ω, V_{LD} = 2V			120		mA	2
			Temprature coefficient	Ta = 20 ~ 70°C		0.11		mA/°C	
I_B	Bias current (Note)	LD	V_B = 1.2V, R_B = 360Ω, V_{LD} = 2V			30		mA	2
I_{cg}	Load charging current	C_H	$\overline{ENB}$ = 0.8V, V_O = 0.6 ~ 4.0V		−0.66		−2.0	mA	3
I_{dg}	Load discharging current	C_H	$\overline{ENB}$ = 0.8V, V_O = 0.6 ~ 4.0V		0.66		2.0	mA	3
I_{oz}	Output current under off condition	C_H	V_O = 0 ~ V_{CC}, Hold condition				±5	μA	3
I_{OFF}	Output current under off condition	LD	$\overline{ENB}$ = 0.8V, $\overline{DATA}$ = 2.0V			0.03	50	μA	2
			$\overline{ENB}$ = 2.0V, $\overline{DATA}$ = 0.8V			0.01	50		
I_{CC}	Supply current		V_{CC} = 5.25V, $\overline{ENB}$ = 0V, C_H = 3.0V, V_B = 1.2V, R_S = 300Ω, R_B = 360Ω, RO = LD = 5.0V	$\overline{DATA}$ = 0V		54	75	mA	4
				$\overline{DATA}$ = 4.5V		52	74		

∗ Typical values are gained under conditions of Ta = 25°C and Vcc = 5V.
Note: This parameter indicates the conversion characteristics of the input voltage and output current. In actual use, I_{SW} and I_B shall be within the range specified as limits in the recommended operating conditions.

LASER-DIODE DRIVER/CONTROLLER

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

| Symbol	Parameter	Test pin		Test condition	Limits			Unit
		Input	Output		Min.	Typ.	Max.	
fop	Operating frequency					40		Mbps
tRP1	Circuit response time 1	CH voltage	LD current	$I_{LD(L)}$ = 0mA $I_{LD(H)}$ = 60mA (Note 1)			7	μs
				$I_{LD(L)}$ = 55mA $I_{LD(H)}$ = 65mA (Note 1)			2	
tRP2	Circuit response time 2	PD current	CH voltage	$I_{PD(L)}$ = 0mA $I_{PD(H)}$ = 2mA RM = 1kΩ (Note 2)			15	μs
				$|\Delta I_{PD}|$ = 0.2mA RM = 1kΩ (Note 2)			8	
tRP3	Circuit response time 3	$\overline{S}$/H voltage	CH voltage	I_{PD} = 0mA, 2mA, (Note 3) RM = 1kΩ, Vr = 1.2V			8	μs
tON	Circuit ON time	$\overline{ENB}$ voltage	LD current	$I_{LD(H)}$ = 60mA (Note 4)			5	μs
tOFF	Circuit OFF time	$\overline{ENB}$ voltage	LD current	$I_{LD(H)}$ = 60mA (Note 4)			2	μs

NOTE1: TEST CIRCUIT
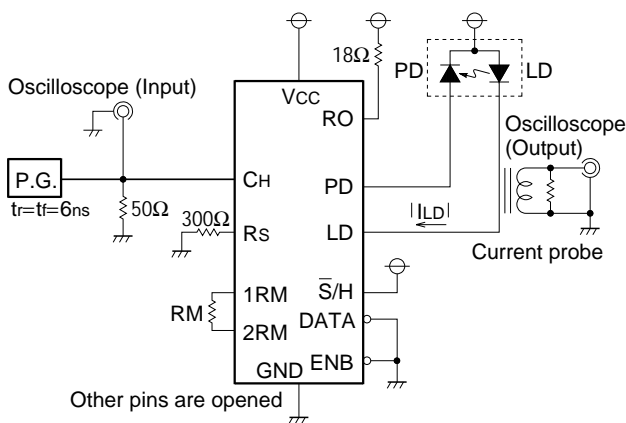
NOTE2: TEST CIRCUIT
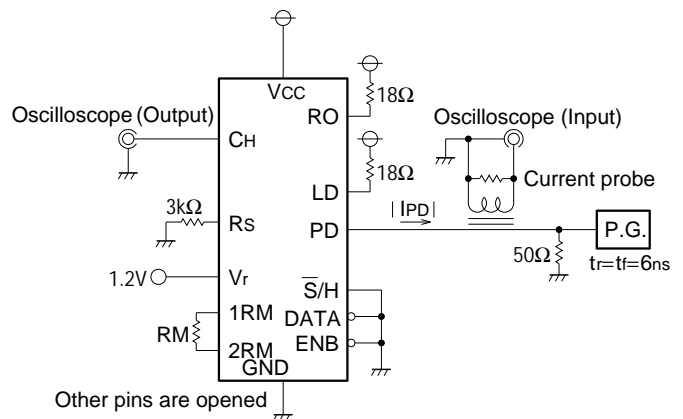
TIMING CHARTS
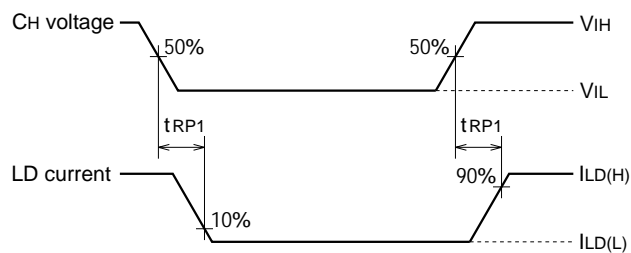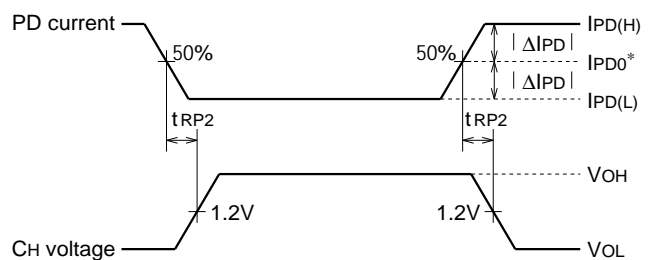
TIMING CHARTS

∗ : I_{PD} gained at the moment CH output is inverted.

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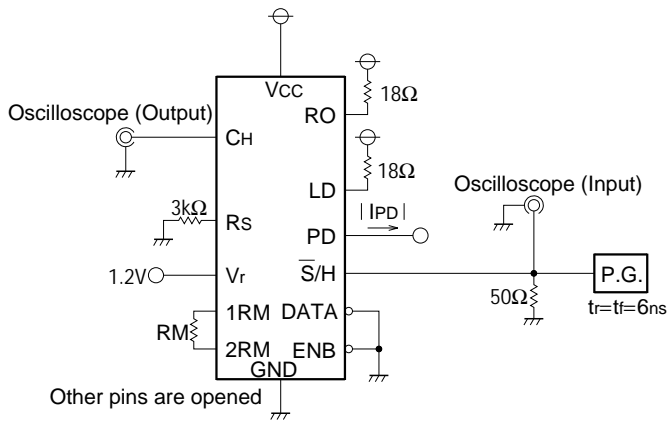
NOTE3: TEST CIRCUIT

NOTE4: TEST CIRCUIT
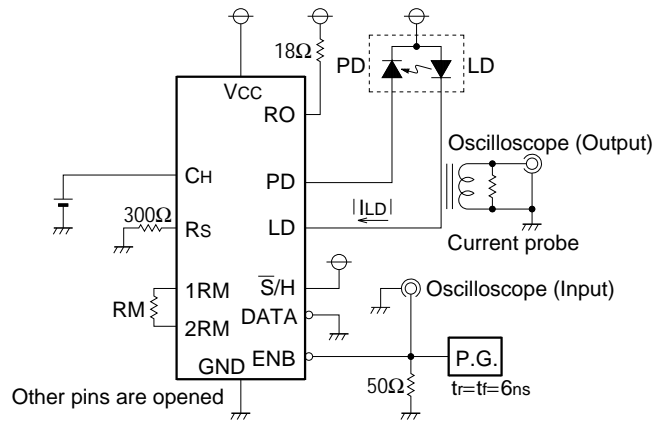
TIMING CHARTS
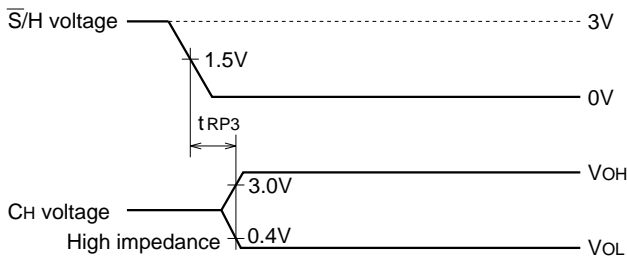
TIMING CHARTS

APPLICATION EXAMPLE

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