M66516FP

LASER-DIODE DRIVER/CONTROLLER

DESCRIPTION

The M66516 is a semiconductor laser-diode driver/controller. Its functions are the driving and laser power control of a specific type (Mitsubishi's R type laser) of semiconductor laser diode, in which the cathode of a semiconductor laser diode is connected in stem structure to the anode of a monitoring photodiode.

The IC has a laser drive current output pin of source type and is capable of driving a laser diode on a maximum bias current of 30mA and a maximum switching current of 120 mA, which is switched at a rate of 20Mbits/sec.

Since the M66516 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

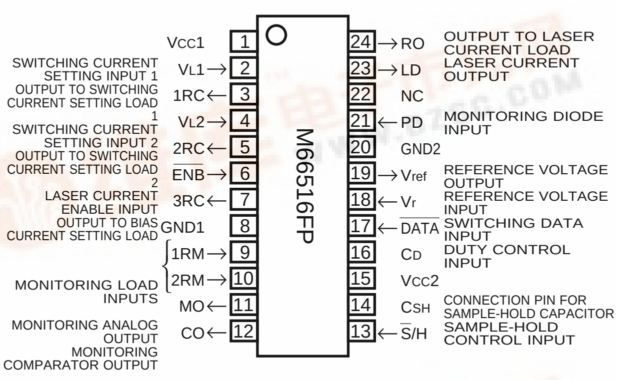
FEATURES

- Built-in sample-hold circuit for APC function
- High speed switching (20Mbps)
- Large drive current (150mA max.)
- Capable of setting bias current (30mA max.)
- 5V single power supply

APPLICATION

Semiconductor laser-diode applied equipment

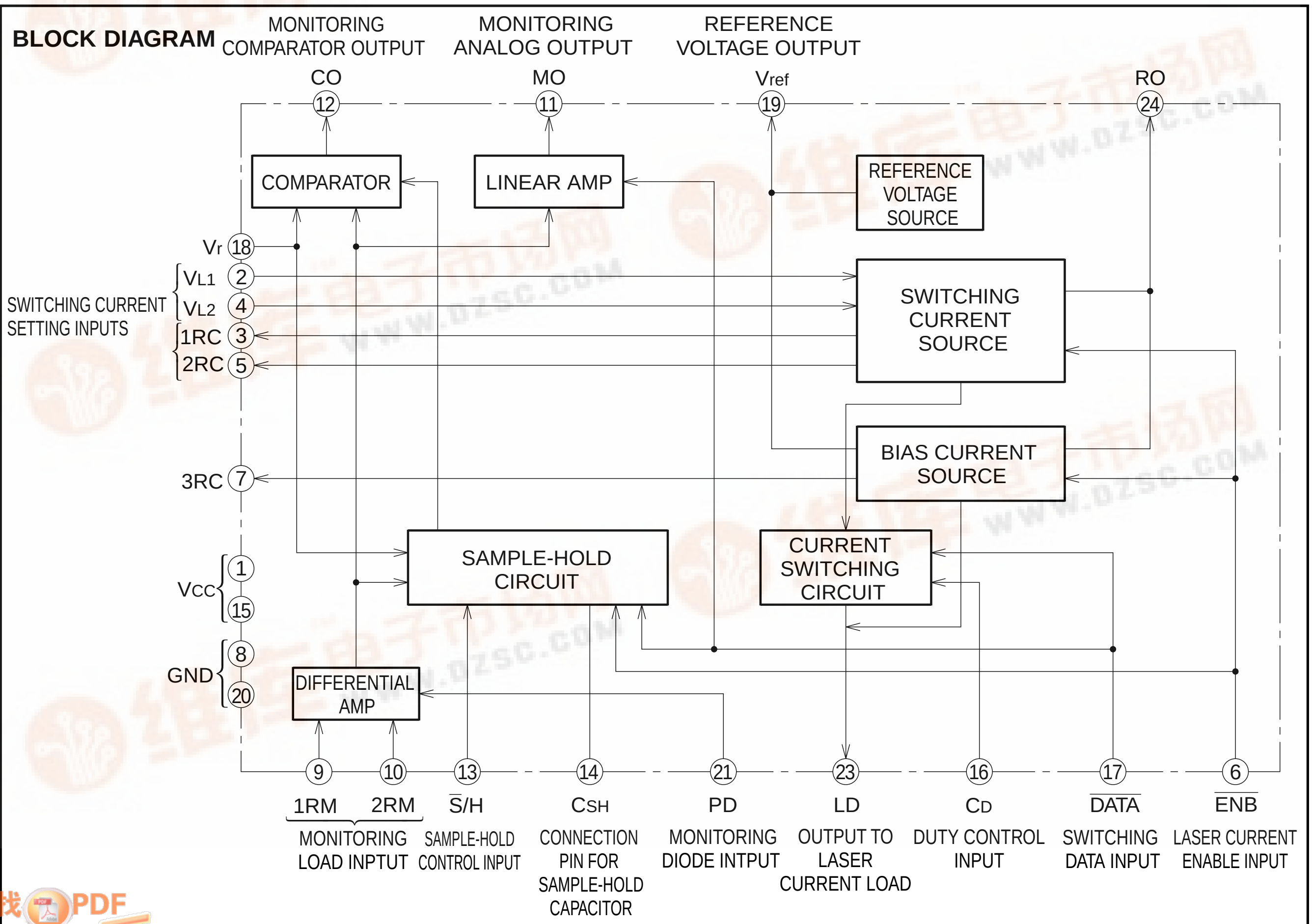
PIN CONFIGURATION (TOP VIEW)



Outline 24P2N-B

NC: No Connection

BLOCK DIAGRAM



PIN DESCRIPTIONS

Pin	Name	Description
LD	Laser current output	Connect to anode on semiconductor laser diode.
PD	Monitoring diode input	Connect to cathode on monitoring photodiode.
V_{L1}	Switching current setting input 1	Voltage input to set output current (I_{L1}) of current source 1.
1RC	Output to switching current setting load 1	Connect load resistor between this pin and GND for I_{L1} setting.
V_{L2}	Switching current setting input 2	Voltage input to set output current (I_{L2}) of current source 2.
2RC	Output to switching current setting load 2	Connect a load resistor between this pin and GND for I_{L2} setting.
3RC	Output to bias current setting load	Connect a load resistor between this pin and GND for setting I_B (bias current). Leave this pin open if I_B is not used.
$\overline{DATA}$	Switching data input	If this pin is “L,” a current of $I_{L1} + I_{L2} + I_B$ flows through laser diode; if “H,” current I_B flows.
1RM, 2RM	Monitoring load input	Connect a load resistor between pins 1RM and 2RM for conversion of current generated by monitoring photodiode into changes in voltage.
MO	Monitoring analog output	If $\overline{DATA}$ = “L” the potential difference generated on monitoring load resistor from photodiode monitoring current is output as a voltage referenced to GND. If $\overline{DATA}$ = “H” the output at this pin is fixed at “H” saturation level.
CO	Monitoring comparator output	The potential difference generated on monitoring load resistor from photodiode monitoring current is compared with the voltage on pin Vr. The result of the comparison is output in TTL level. This pin acts as comparator output pin only when $\overline{S}$/H = “H” and $\overline{DATA}$ = “L.” In other states, this output pin is fixed to “H.”
$\overline{ENB}$	Laser current enable input	If this pin is “H,” all current supply circuits are turned off.
RO	Laser current load output	Connect a laser current load resistor between this pin and Vcc.
C_D	Duty control input	Connect a capacitor between this pin and GND for duty correction of light intensity switching waveforms. If duty correction is not required, leave this pin open.
$\overline{S}$/H	Sample-hold control input	In internal APC mode, if this pin is “L,” sampling (APC) occurs, if “H,” holding (switching). In external APC mode, connect this pin to Vcc.
C_{SH}	Connection pin for sample-hold capacitor	Connect a capacitor for sample-hold function between this pin and GND.
V_{ref}	Reference voltage output	Internal reference voltage (1.2V typ.) output pin of M66516
V_r	Reference voltage input	A reference voltage is applied to this pin to operate the comparator and the sample-hold circuit. Connect this pin to the Vref pin if the internal reference voltage of the M66516 is used.
V_{CC1}		Power supply for internal analog circuits. Connect to a positive power source (+5V).
V_{CC2}		Power supply for internal digital circuits. Connect to a positive power source (+5V).
GND1		GND for internal analog circuits.
GND2		GND for internal digital circuits.

OPERATION

1. Settings for Laser Drive Currents

The M66516 has built-in current sources for switching, I_{L1} and I_{L2}, and a bias current source, I_B. Each output current can be controlled independently.

Approximate equations used for determining the current output from each of these current sources are as follows.

(1) I_{L1}

I_{L1} is determined by the voltage on the V_{L1} pin and the resistor (RC 1) connected between the 1RC pin and GND.

The following equation is used for approximation.

$$I_{L1}\ [\text{mA}] = 12 \times \frac{V_{L1}\ [\text{V}]}{\text{RC1}\ [\text{k}\Omega]}$$

(2) I_{L2}

I_{L2} is determined by the voltage on the V_{L2} pin and the resistor (RC 2) connected between the 2RC pin and GND.

The following equation is used for approximation.

$$I_{L2}\ [\text{mA}] = 12 \times \frac{V_{L2}\ [\text{V}]}{\text{RC2}\ [\text{k}\Omega]}$$

(3) I_B

I_B is determined by the internal reference voltage (Vref) and the resistor (RC 3) connected between the 3RC pin and GND.

The following equation is used for approximation.

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

2. Laser Drive Current Switching Operation

If $\overline{\text{DATA}}$ = “L,” laser drive current is $I_{L1} + I_{L2} + I_B$; if $\overline{\text{DATA}}$ = “H,” I_B.

3. Laser Power Monitoring Operation

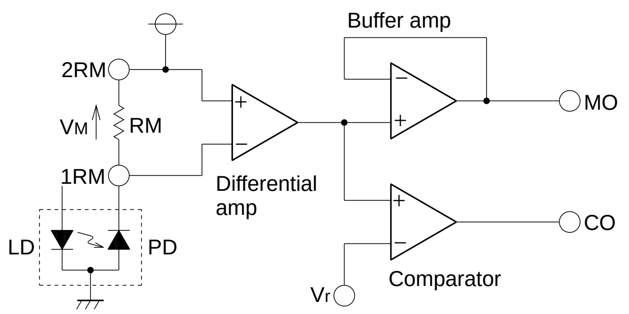
At the MO and CO pins, the M66516 outputs data obtained by the monitoring photodiode (PD) contained in laser, in the sequence explained below.

(1) A current equal to the PD current generated from laser light flows through the resistor (RM) inserted between 1RM and 2RM. Thence a potential difference (V_M) occurring on RM is converted by the internal differential amp. to a level from GND.

(2) V_M is output at the MO pin as an analog signal through a buffer amp. At the same time, the comparator compares V_M with the voltage applied to the Vr pin, then the result of the comparison is output at the CO pin in TTL level.

If V_M < Vr, CO output = “L”; and if V_M > Vr, CO output = “H.”

As the condition of the above operation, both the MO and CO output circuits should be in monitoring operation. See the table below.



A Schematic Diagram of Monitor Circuits

Monitor Function Table

Input		Output	
$\overline{\text{S}}$/H	$\overline{\text{DATA}}$	MO output	CO output
L	L	Analog output	Fixed to “H”
L	H	“H” saturation	Fixed to “H”
H	L	Analog output	Comparator output
H	H	“H” saturation	Fixed to “H”

4. RO Pin

A load resistor for laser drive current is connected to the RO pin, through which a current almost equal to laser drive current flows in(when $\overline{DATA}$ = "H"). A 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 3.5V or higher.

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

$$RO_{(max.)}\ (\Omega) = \frac{Vcc_{(min.)} - 3.5\ [V]}{I_{LD\ (max.)}\ [A]}$$

where ILD (max.) is the maximum of laser drive current. If, for example, Vcc (min.) = 4.75 V and ILD(max.) = 150 mA, RO (max.) = 8.3 Ω. Accordingly, if the resistances of RC 1 to RC 3 is selected so as to gain a maximum laser drive current of 150mA, RO should be 8.3Ω at the maximum.

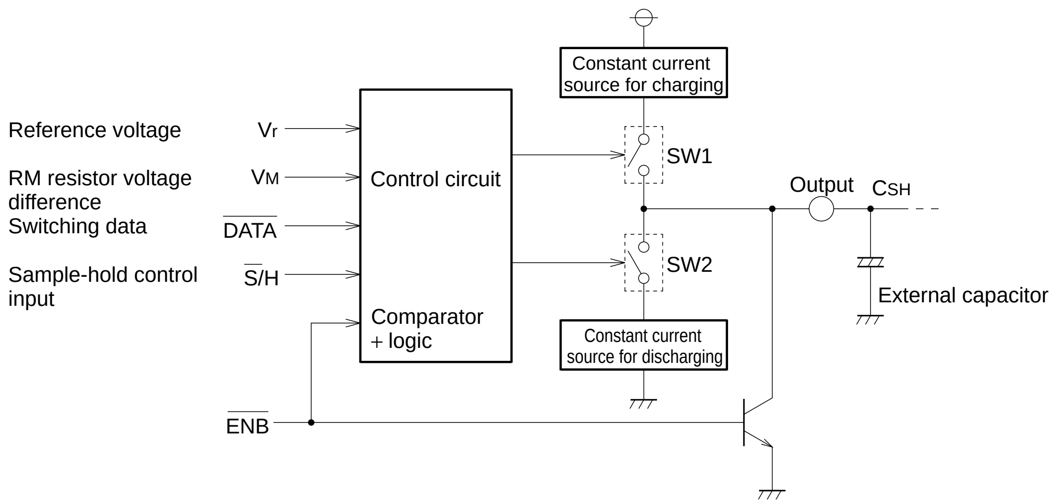
5. $\overline{ENB}$ Input

If laser current is controlled by the $\overline{DATA}$ input, the current source circuit is in operation even with zero laser current. If $\overline{ENB}$ input = "H", all current source circuits go off including the bias current source.

6. APC Operation

(1) Sample-hold circuit

The following are a conceptual diagram and function table of the sample-hold circuit contained in the M66516.



Conceptual Diagram: Sample-Hold Circuit

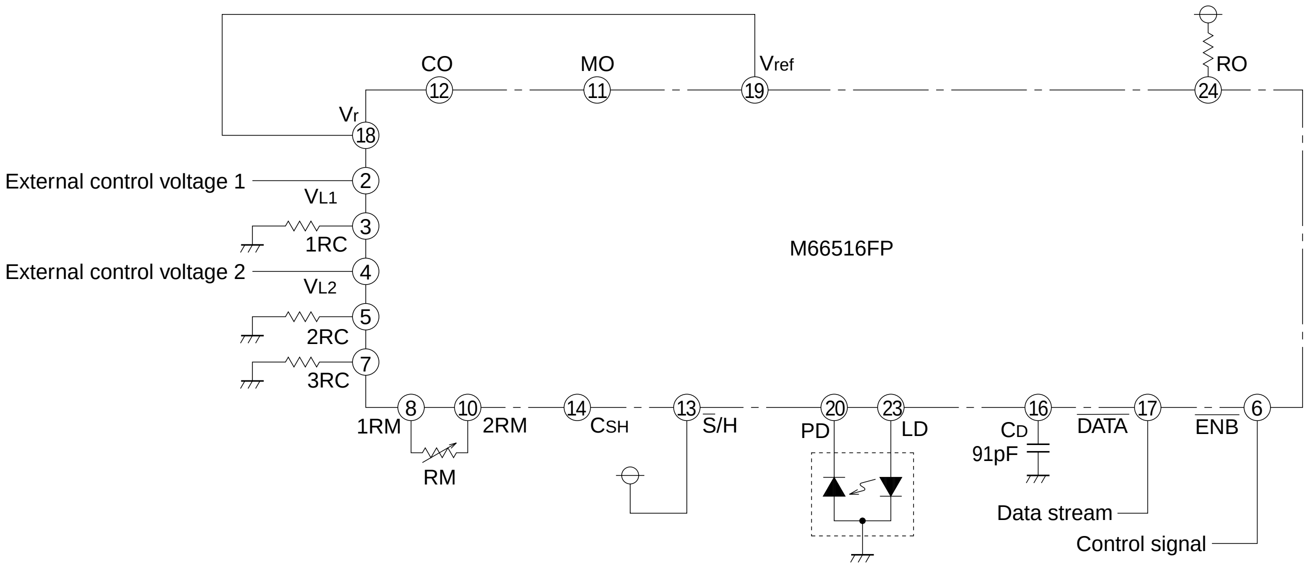
Function Table

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

×: Don't care

(2) External voltage-applied APC circuit

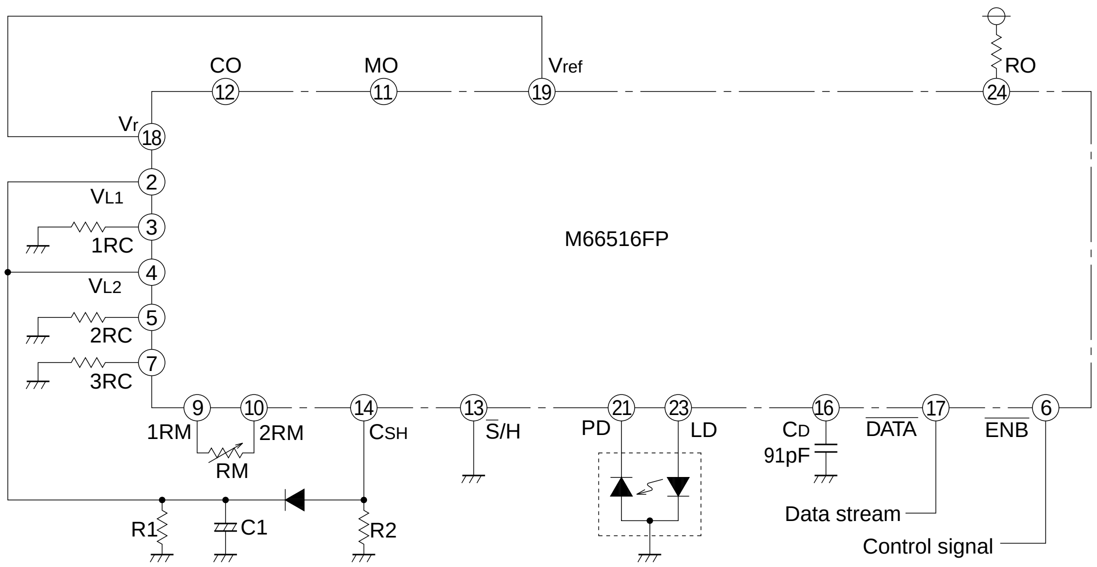
The following figure is an example of APC circuit configuration, in which voltages are applied from external sources to the V_{L1} and V_{L2} input pins of the M66516. In this example, the $\overline{S}$/H input pin is connected to Vcc and the C_{SH} pin is open. The CO or MO output is used to monitor laser power for adjustment of external control voltage.



(3) Peak-holding internal APC circuit

The following figure is a configuration example of peak-holding internal APC circuit. In this example, the $\overline{S}$/H input pin is connected to GND.

If laser power is lower than preset value, C1 is charged with the current from the C_{SH} output pin through D1. The charge stored in C1 is discharged through R1 thereafter.



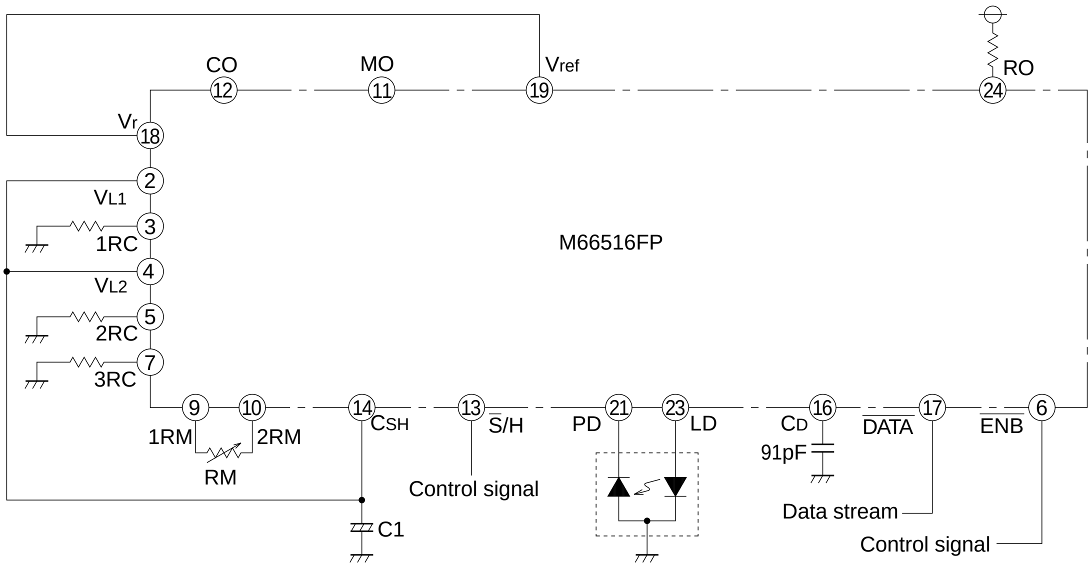
C1, R1: Time constant components
R2: Pull–down resistor
(Used for establishing C_{SH} line voltage in case that C_{SH} is in high impedance condition.)

(4) Sample-hold type internal APC circuit

The following figure is a configuration example of sample-hold type internal APC circuit. In this example, a sample-hold control signal is applied to the $\overline{S}$/H input pin.

In a sampling state, if laser power is lower than preset value, C1 is charged by current from the C_{SH} output pin, while if it is higher than preset value, C1 is discharged.

In a holding state, the C_{SH} output is in high-impedance condition.



C1: Capacitor for sample–hold function

ABSOLUTE MAXIMUM RATINGS (T_a = –20 ~ 75°C, unless otherwise noted)

Symbol	Parameter		Conditions	Ratings	Unit
V_{CC}	Supply voltage			–0.5 ~ +7.0	V
V_I	Input voltage	V_{L1}, V_{L2}, V_r		–0.3 ~ V_{CC}	V
		$\overline{DATE}$, $\overline{ENB}$, $\overline{S}$/H		–0.3 ~ +7.0	
V_O	Output voltage	CO	"H" Output	–0.3 ~ +5.5	V
		RO	"H" Output	–0.3 ~ +7.0	
I_{L1}	Output current 1			–90	mA
I_{L2}	Output current 2			–90	mA
I_B	Bias current			–45	mA
P_d	Power dissipation		Measured being mounted Ta = 25°C (Note 1)	890	mW
T_{stg}	Storage temperature			–60 ~ 150	°C

SWITCHING CHARACTERISTICS (T_a = –20 ~ 75°C, unless otherwise noted)

Symbol	Parameter	Conditions	Limits			Unit
			Min.	Typ.	Max.	
V_{CC}	Supply voltage		4.75	5.0	5.25	V
I_{L1}	Output current 1				–60	mA
I_{L2}	Output current 2				–60	mA
I_B	Bias current				–30	mA
T_{opr}	Operational ambient temperature		–20		75	°C

Note 1: When Ta ≥ 25°C, derate by 7.1mW/°C

ELECTRICAL CHARACTERISTICS (T_a = –20 ~ 75°C, V_{CC} = 5V±5%, unless otherwise noted)

Symbol	Parameter		Test conditions	Limits Min.	Typ.(2)	Max.	Unit
V_{IH}	“H” Input voltage	$\overline{\text{DATA}}$, $\overline{\text{ENB}}$, $\overline{\text{S}}$/H		2.0			V
V_{IL}	“L” Input voltage	$\overline{\text{DATA}}$, $\overline{\text{ENB}}$, $\overline{\text{S}}$/H				0.8	V
V_I	Maximum effective Input voltage	V_{L1}, V_{L2}		V_{CC} – 1.8	V_{CC} – 1.4		V
V_{OH}	“H” Output voltage	CO	I_{OH} = –400µA	2.7			V
V_{OL}	“L” Output voltage	CO	I_{OL} = 4mA			0.4	V
			I_{OL} = 8mA			0.5	
V_{OH}	“H” Output voltage	C_{SH}	$\overline{\text{ENB}}$ = 0.8V, I_{OH} = –2mA	4.0			V
V_{OL}	“L” Output voltage	C_{SH}	$\overline{\text{ENB}}$ = 0.8V, I_{OH} = 2mA			0.6	V
V_{LD}	Ambient tempererature	LD				2.5	V
V_{OS}	Output offset voltage	MO	I_{MO} = ±20µA (3)		30		mV
ΔV_M	Output voltage fluctua-tion	MO	I_{PD} = –0.2 ~ 2.0mA I_{MO} = ±20µA, RM = 1kΩ (4)		20		mV
		Temperature coefficient	I_{PD} = –1.2mA		0.05		mV/°C
I_I	Input current	$\overline{\text{DATA}}$, $\overline{\text{ENB}}$	V_I = 2.7V			20	µA
			V_I = 0.4V			–0.2	mA
		V_{L1}, V_{L2}, V_r	V_I = 0 ~ V_{CC}			±1	µA
V_{ref}	Reference voltage output		I_O = –10µA		1.2		V
		Temperature coefficient	Ta = –20 ~ 25°C		–1.5		mV/°C
			Ta = 25 ~ 75°C		–0.7		
V_r	Reference voltage input			0.4		2.0	V
I_{L1}	Output current 1 (5)	LD	V_{L1} = 3V, V_{L2} = 0V, V_{LD} = 2V, RC1 = RC2 = 560Ω, RC3 open		–62		mA
		LD Temperature coefficient			0.037		mA/°C
I_{L2}	Output current 2 (5)	LD	V_{L1} = 0V, V_{L2} = 3V, V_{LD} = 2V, RC1 = RC2 = 560Ω, RC3 open		–62		mA
		LD Temperature coefficient			0.037		mA/°C
I_B	Bias current (5)	LD	RC3 = 360Ω, V_{LD} = 2V		–31		mA
I_{OFF}	OFF state output current	LD	$\overline{\text{ENB}}$ = 0.8V, $\overline{\text{DATA}}$ = 2V			–1	mA
			$\overline{\text{ENB}}$ = 2V, $\overline{\text{DATA}}$ = 0.8V			–20	µA
I_{cg}	Charge current	C_{SH}	V_O = 0.6 ~ 4.0V	–0.66		–2.0	mA
I_{dg}	Discharge current	C_{SH}	V_O = 0.6 ~ 4.0V	0.66		2.0	mA
I_{oz}	Output leak current	C_{SH}	V_O = 0 ~ V_{CC}, Hold condition			±8	µA
I_{CC}	Supply current	$\overline{\text{DATA}}$ = 0V	V_{CC} = 5.25V, $\overline{\text{ENB}}$ = 0V, V_{L1} = V_{L2} = 3V, RC1 = RC2 = 560Ω, RC3 = 360Ω output open			36	mA
		$\overline{\text{DATA}}$ = 4.5V				54	

Note 2: 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.

3: I_{MO}: Output current at MO pin; I_{PD}: Input current at PD pin

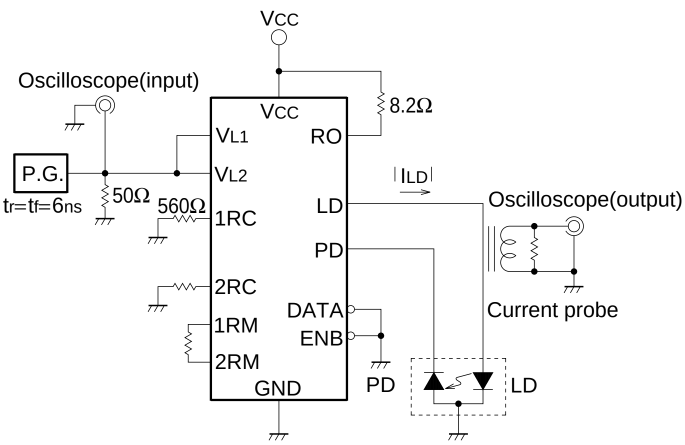
4: RM: Resistor inserted between 1RM and 2RM.

5: These parameters indicate the conversion characteristics of the input voltage and output current. In actual use, I_{L1}, I_{L2}, and I_B shall be within the range specified as limits in the recommended operating conditions.

SWITCHING CHARACTERISTICS (T_a = –25°C, V_{CC} = 5V)

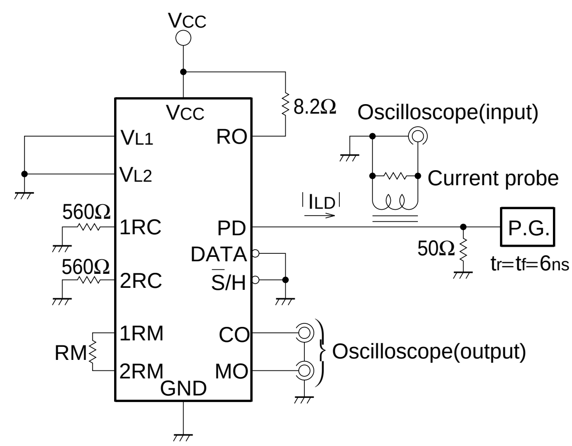
Symbol	Parameter	Test pin		Test condition	Limits			Unit
		Input	Output		Min.	Typ.	Max.	
f_{op}	Operating frequency					20		Mbps
t_{RP1}	Circuit response time 1	V_{L1}, V_{L2} voltage	LD current	$I_{LD(L)}$ = 0mA $I_{LD(H)}$ = –60mA (Note 6)			7	µs
				$I_{LD(L)}$ = –55mA $I_{LD(H)}$ = –65mA (Note 6)			2	µs
t_{RP2}	Circuit response time 2	PD current	MO voltage	$I_{PD(L)}$ = 0mA $I_{PD(H)}$ = –2mA RM = 1kΩ (Note 7)			10	µs
				$\lvert\Delta I_{PD}\rvert$ = 0.2mA RM = 1kΩ (Note 7)			3	µs
t_{RP3}	Circuit response time 3	PD current	CO voltage	$\lvert\Delta I_{PD}\rvert$ = 1mA (Note 7)			10	µs
				$\lvert\Delta I_{PD}\rvert$ = 0.2mA (Note 7)			2	
t_{RP4}	Circuit response time 4	$\overline{DATA}$ voltage	C_{SH} voltage	I_{PD} = 0mA, –2mA, RM = 1kΩ, V_r = 1.2V (Note 8)			8	µs
t_{ON}	Circuit ON time	$\overline{ENB}$ voltage	LD current	$I_{LD(H)}$ = –60mA (Note 9)			5	µs
t_{OFF}	Circuit OFF time	$\overline{ENB}$ voltage	LD current	$I_{LD(H)}$ = –60mA (Note 9)			2	µs

NOTE 6: TEST CRICUTS



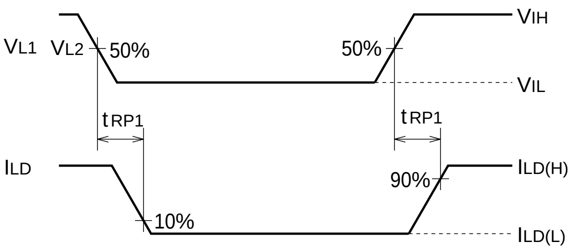
Other pins are opened

NOTE 7: TEST CRICUTS

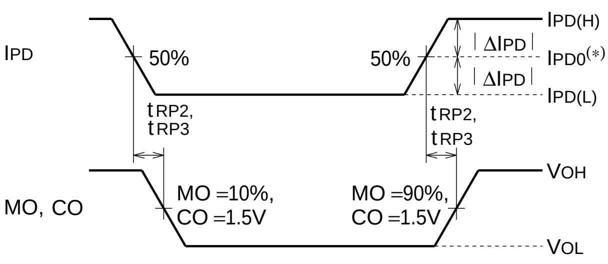


Other pins are opened

TIMING CHARTS

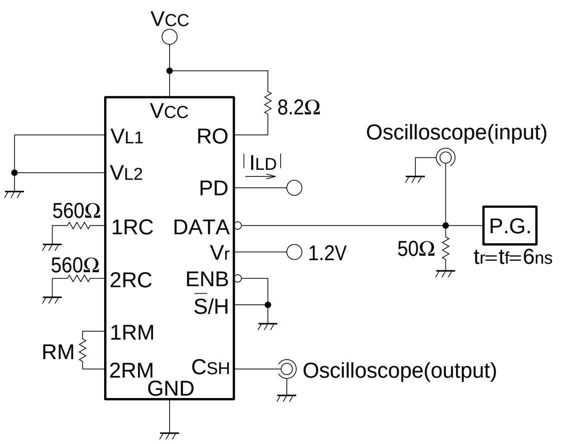


TIMING CHARTS



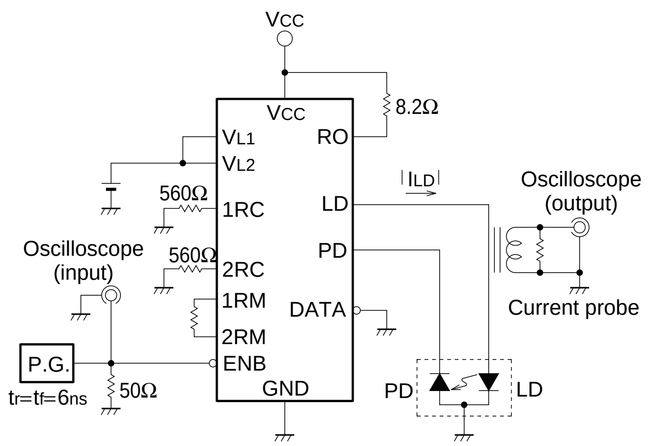
(*): I_{PD} gained at the moment C_H output is inverted.

NOTE 8: TEST CIRCUITS



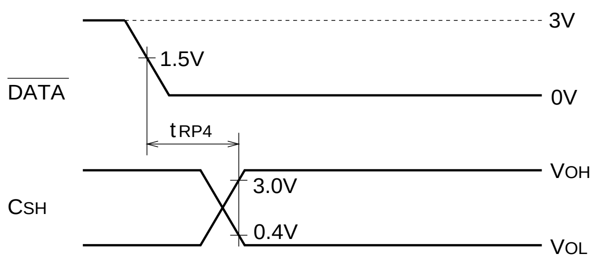
Other pins are opened

NOTE 9: TEST CIRCUITS



Other pins are opened

TIMING CHARTS



TIMING CHARTS