

# M66515FP

## Laser Diode Driver/Controller

REJ03F0084-0100Z

Rev.1.0

Sep.22.2003

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### Description

The M66515 is a laser diode driver/controller that performs drive and controls the laser power control of a type of semiconductor laser diode the anode of which is connected, with the cathode of a photodiode for monitoring, to a stem in which the semiconductor laser diode anode and monitoring photo diode cathode are connected to the stem.

This IC has a sink-type laser driving current output pin, and can drive a laser diode with a bias current of up to a maximum 30 mA and with switched currents of up to 120 mA, switched at rates of up to 40 Mbps.

The IC incorporates a sample hold circuit, so that a self-APC (Automatic Power Control) system, which does not require external laser power control, can be realized.

### Features

- Internal sample-and-hold circuit for self-APC configuration
- High-speed switching (40 Mbps)
- High driving currents (150 mA max)
- Settable bias current (30 mA max)
- Single 5 V power supply

### Applications

- Equipment employing semiconductor laser diodes

### Function Overview

The M66515 is a laser diode driver/controller which drives and controls the laser power of a semiconductor laser diode (LD) the anode of which is connected, with the cathode of a photodiode (PD) for monitoring, to a stem (among Mitsubishi lasers, N type models).

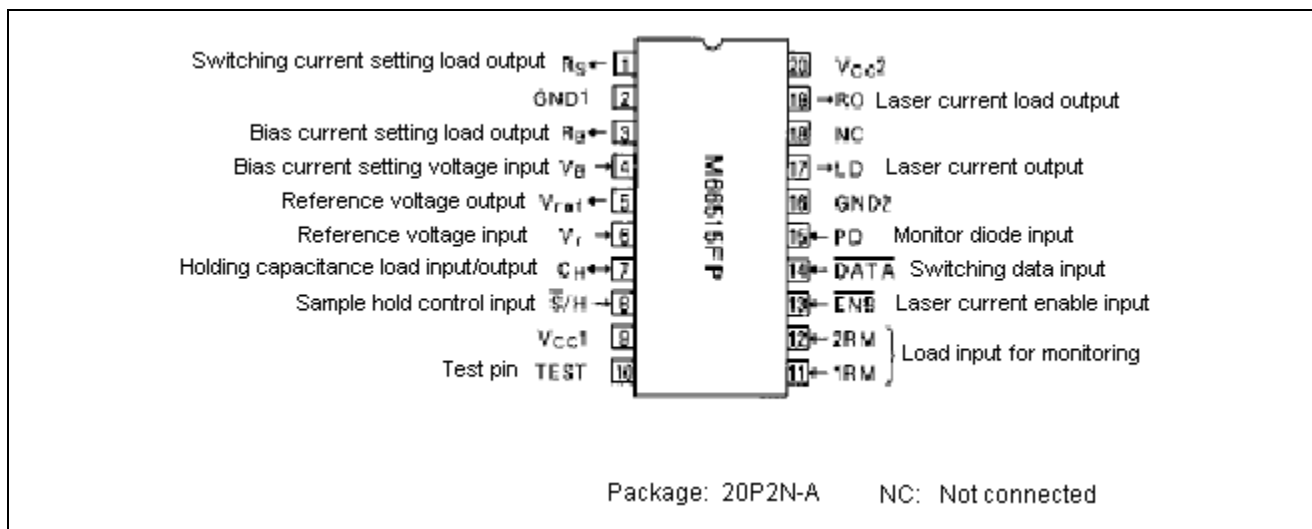
LD driving and laser power control are executed by connecting an external capacitance to the  $C_H$  pin and applying a reference voltage to the  $V_r$  pin.

The PD current occurring when a LD emits light flows through a resistance connected across 1RM and 2RM, resulting in a potential difference ( $V_M$ ). This  $V_M$  is compared with the voltage applied to the  $V_r$  pin, and when  $V_M < V_r$ , a constant current source from the  $C_H$  pin flows to charge the external capacitor. When  $V_M > V_r$ , a constant current sink from the  $C_H$  pin causes the charge on the external capacitor to be discharged.

This operation is performed when the  $\overline{S}/H$  input is "L" (sample); when the  $\overline{S}/H$  input is in the "H" state, the  $C_H$  pin is in the high-impedance state (hold), regardless of  $V_M$ ,  $V_r$  and the  $\overline{DATA}$  input state.

The LD driving current consists of a switched current  $I_{SW}$ , which is controlled by the  $\overline{DATA}$  input, and  $I_B$ , a LD bias current which is independent of the  $\overline{DATA}$  input state.

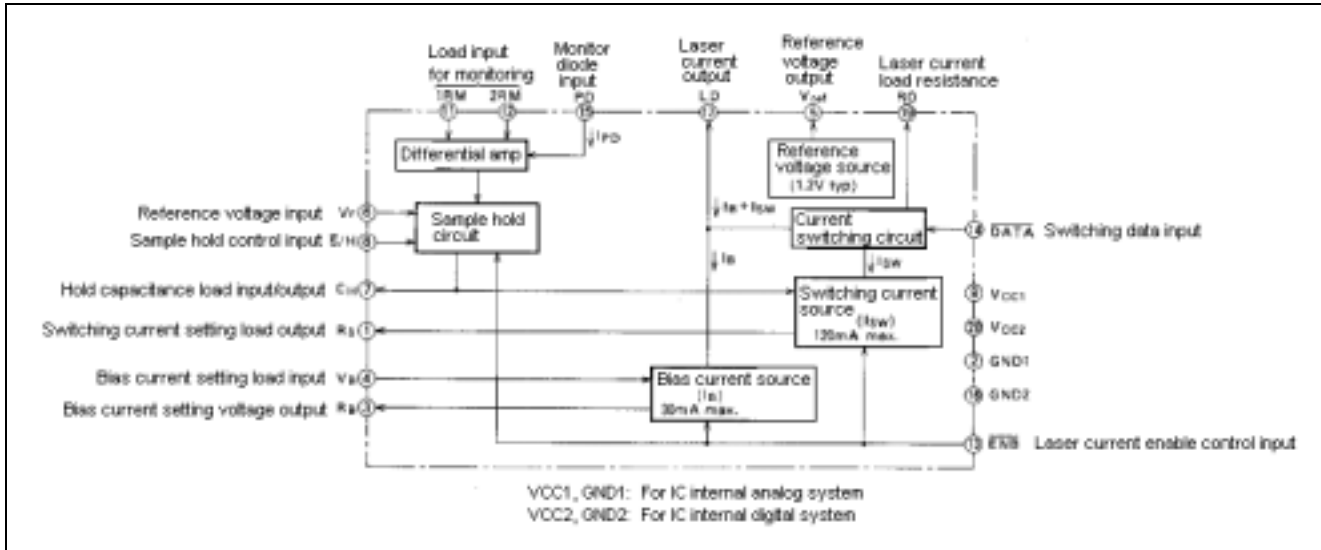
## Pin Configuration (top view)



## Description of Pin

Pin name	Name	Function
LD	Laser current output	Connected to the semiconductor LD cathode
PD	Monitor diode input	Connected to the monitor PD anode
RS	Switching current setting load output	Connects the load resistance to set the current for switching ( $I_{SW}$ ) to GND
RB	Bias current setting load output	Connects the load resistance to set the bias current ( $I_B$ ) to GND. If $I_B$ is not used, this pin should be left open.
VB	Bias current setting voltage input	The bias current value ( $I_B$ ) can be set by applying a voltage to this pin. If $I_B$ is not used, this pin should be left open.
DATA	Switching data input	At "L", the current $I_{SW}+I_B$ flows to the LD; at "H", the current to the LD is $I_B$
1RM, 2RM	Load input for monitoring	Connect a load resistance to convert the monitor PD current to a voltage across 1RM and 2RM
ENB	Laser current enable input	When "H", all current source circuits are turned off
RO	Laser current load output	Connect a laser current load resistance between this pin and $V_{CC}$
S/H	Sample hold control input	When "L", sample (APC) operation is performed; when "H", hold (switching) is performed
CH	Hold capacitor load input/output	Connect a hold capacitor between this pin and GND. This pin is connected within the M66515 to the sample hold circuit output and $I_{SW}$ current source input.
Vref	Reference voltage output	Output pin for the M66515 internal reference voltage (1.2 V typ)
Vr	Reference voltage input	A reference voltage is applied to cause operation of the comparator within the sample hold circuit. When using the reference voltage within the M66515, this pin should be connected to the $V_{ref}$ pin.
TEST	Test pin	Pin used for testing at time of shipment of the M66515; should be left open
Vcc1	Power supply pin 1	Power supply for the internal analog system; connect to a positive power supply (+5 V)
Vcc2	Power supply pin 2	Power supply for the internal digital system; connect to a positive power supply (+5 V)
GND1	GND pin 1	GND for internal analog system
GND2	GND pin 2	GND for internal digital system

## Block Diagram



## Explanation of operation

### 1. Laser driving current values

The values of the laser driving currents  $I_{SW}$  and  $I_B$  can be approximated as follows, if  $V_C$  is the voltage of the hold capacitor connected to the  $C_H$  pin.

(1)  $I_{SW}$  (switched current)

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

Here  $0 \leq V_C \leq V_{CC} - 1.8 \text{ V}$ ,  $I_{SW} (\text{max}) = 120 \text{ mA}$ , and  $R_S$  is the value of the resistance connected between the  $R_S$  pin and GND

(2)  $I_B$  (bias current)

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

Here  $0 \leq V_B \leq V_{CC} - 2.7 \text{ V}$ ,  $I_B (\text{max}) = 30 \text{ mA}$ , and  $R_B$  is the value of the resistance connected between the  $R_B$  pin and GND

### 2. Switching operation

When  $\overline{\text{DATA}} = "L"$ , the LD driving current is  $I_{SW} + I_B$ ; when  $\overline{\text{DATA}} = "H"$ , the LD driving current is  $I_B$ .

### 3. $\overline{\text{ENB}}$ input

Whereas the laser driving current is controlled by  $\overline{\text{DATA}}$  input by controlling the driving current applied to the laser with the current source in the M66515 turned on, control by  $\overline{\text{ENB}}$  turns the current source operation on and off.

When  $\overline{\text{ENB}} = "L"$  the current source is turned on, and when  $\overline{\text{ENB}} = "H"$  the current source is turned off.

When  $\overline{\text{ENB}} = "H"$ , the  $C_H$  pin is forced to "L" level, and the charge on the capacitor connected to the  $C_H$  pin is forcibly discharged.

### 4. Internal reset operation

The M66515 incorporates a reset circuit to prevent the flow of excessive current to the laser when power is turned on; when  $V_{CC} < 3.5 \text{ V}$  (typ), the internal current source is turned off and the  $C_H$  pin is forced to "L" level.

5. RO pin

The RO pin is connected to the laser driving current load resistance; current essentially equal to  $I_{SW}$  flows from this pin. The load resistance is connected between this pin and  $V_{CC}$ ; by this means the Power dissipation within the IC is reduced.

However, the circuit operation requires that the voltage at this pin be 2.5 V or above. Hence if the maximum value of  $I_{SW}$  is  $I_{SW(max)}$ , then the maximum value  $RO(max)$  of the load resistance RO is as follows.

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

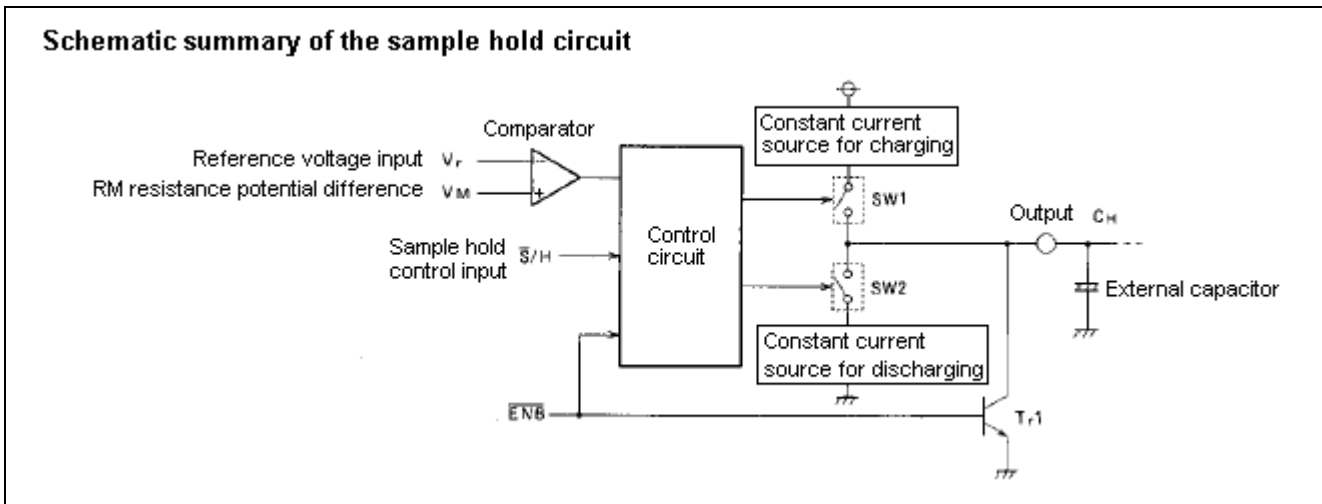
For example, if  $V_{CC(min)}=4.75$  V and  $I_{SW(max)}=120$  mA, then  $RO(max)=18.8 \Omega$ . In other words, when setting the resistance  $R_S$  such that the maximum value of  $I_{SW}$  is 120 mA, RO should be 18.8  $\Omega$  or lower.

6. Sample-and-hold circuit

(1) Summary of circuit operation

The following is a summary of operation of the sample hold circuit within the M66515.

A PD current arising upon LD light emission flows through the resistance connected between 1RM and 2RM, giving rise to a potential difference ( $V_M$ ). This  $V_M$  is compared with the voltage applied to the pin  $V_r$ , and if  $V_M < V_r$ , pin  $C_H$  is a constant current source which charges the external capacitor. If  $V_M > V_r$ , pin  $C_H$  is a constant current sink which discharges the external capacitor. This operation is performed when the  $\overline{S/H}$  input is "L" (sample); when the  $\overline{S/H}$  input is "H", the  $C_H$  pin is kept in the high-impedance state (hold), regardless of  $V_M$ ,  $V_r$ , and the  $\overline{DATA}$  input state.



Function table

Input		Vm, Vr	Switched state		Tr1	Output
$\overline{ENB}$	$\overline{S/H}$		SW1	SW2		
H	X	X	OFF	OFF	ON	Fixed at "L"
L	H	X	OFF	OFF	OFF	High-impedance state (hold)
L	L	$V_M < V_r$	ON	OFF	OFF	Constant current source (sample)
		$V_M > V_r$	OFF	ON	OFF	Constant current sink (sample)

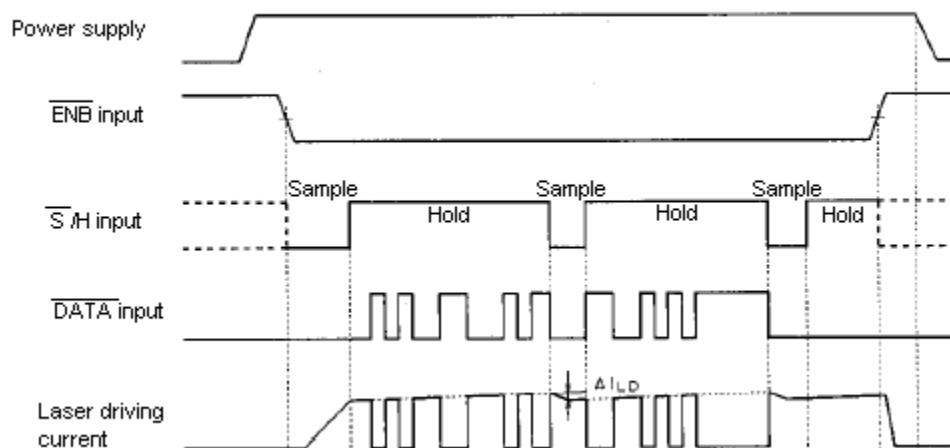
X: arbitrary

(2) APC operation timing chart

An example of an APC operation timing chart for a given sample hold control signal is shown below.

In this example, a case is shown in which it is assumed that the direction of the leakage current of the  $C_H$  pin in the hold state is the direction flowing out from the M66515 (the negative direction).

### Example of an APC operation



## 7. V<sub>CC</sub> and GND pins

The V<sub>CC1</sub> and V<sub>CC2</sub> pins and the GND1 and GND2 pins are related to the power supply. The internal circuitry connected to these pins is as follows.

V<sub>CC1</sub>, GND1: Connected to analog circuitry

V<sub>CC2</sub>, GND2: Connected to digital circuitry

The following should be taken into account in designing the actual wiring.

- (1) Wiring widths should be as broad as possible, and drawn-out lengths of wiring should be avoided.
- (2) The electrolytic capacitor for voltage stability should be positioned close to V<sub>CC1</sub> and GND1.
- (3) The bypass capacitor should be positioned close to V<sub>CC2</sub> and GND2.

### Important Information Regarding Peripheral Element Wiring

Peripheral elements necessary for M66515 operation should be positioned as close to the M66515 as possible.

### Method of Calculating Power dissipation

The M66515 Power dissipation P is essentially given by the following formula.

$$P = I_{CC} \times V_{CC} + I_{(RO)} \times V_{(RO)} + I_{(LD)} \times V_{(LD)}$$

Here V<sub>(RO)</sub> is the RO pin voltage, V<sub>(LD)</sub> is the LD pin voltage, I<sub>(RO)</sub> is the RO pin load current, and I<sub>(LD)</sub> is the LD pin load current.

For example, when V<sub>CC</sub> = 5.25 V, V<sub>(RO)</sub> = V<sub>(LD)</sub> = 2.5 V, and I<sub>(RO)</sub> = I<sub>(LD)</sub> = 150 mA, the Power dissipation when the laser is turned on and off is as follows.

- (1) When the laser is on ( $\overline{DATA} = \text{"L"}\text{"}$ , I<sub>CC</sub> = 75 mA):

$$P_{ON} = 75 \times 5.25 + 0 + 150 \times 2.5 = 768.8 \text{ (mW)}$$

- (2) When the laser is off ( $\overline{DATA} = \text{"H"}\text{"}$ , I<sub>CC</sub> = 74 mA):

$$P_{OFF} = 74 \times 5.25 + 0 + 150 \times 2.5 = 763.5 \text{ (mW)}$$

## Absolute Maximum Ratings

(Unless otherwise noted, Ta = -20 to 70°C)

Symbol	Parameter	Conditions	Value	Unit
V <sub>CC</sub>	Power supply voltage		-0.5 to +7.0	V
V <sub>I</sub>	Input voltage	CH, Vr	-0.3 to V <sub>CC</sub>	V
		$\overline{\text{DATA}}$ , $\overline{\text{ENB}}$ , $\overline{\text{S/H}}$	-0.3 to +7.0	V
V <sub>O</sub>	Output voltage	RO	-0.5 to +7.0	V
I <sub>sw</sub>	Switching current		150	mA
I <sub>B</sub>	Bias current		45	mA
P <sub>d</sub>	Power dissipation	Mounted on board, with Ta=25°C (see note)	1200	mW
T <sub>stg</sub>	Storage temperature		-60 to +150	°C

Note: When Ta ≥ 25°C, derating at 9.6 mW/°C should be performed.

## Recommended Operating Conditions

(Unless otherwise noted, Ta = -20 to 70°C)

Symbol	Parameter	Limits			Unit
		Min	Typ	Max	
V <sub>CC</sub>	Power supply voltage	4.75	5.0	5.25	V
I <sub>sw</sub>	Switching current			120	mA
I <sub>B</sub>	Bias current			30	mA
Topr	Operating ambient temperature	-20	—	70	°C

## Electrical Characteristics

(Unless otherwise noted,  $V_{CC} = 5\text{ V} \pm 5\%$ ,  $T_a = -20\text{ to }70^\circ\text{C}$ )

Sym- bol	Parameter	Measurement conditions	Limits			Unit	Mea- sure- ment cir- cuit	
			Min	Typ	Max			
$V_{IH}$	"H" input voltage	$\overline{\text{DATA}}, \overline{\text{ENB}}, \text{S/H}$	2.0			V		
$V_{IL}$	"L" input voltage	$\overline{\text{DATA}}, \overline{\text{ENB}}, \text{S/H}$			0.8	V		
$V_r$	Reference voltage input	$V_r$	0.4		2.0	V		
$V_{ref}$	Reference voltage output	$V_{ref}$	$I_O = -10\ \mu\text{A}$	1.2		V	1	
		Temperature coefficient	$T_a = -20\text{ to }25^\circ\text{C}$ $T_a = 25\text{ to }70^\circ\text{C}$	-0.9 -0.9		mV/ $^\circ\text{C}$		
$V_{LD}$	Operating voltage range	LD	2.5		$V_{CC}$	V		
$V_I$	Effective voltage upper limit	$C_H$	$V_{CC}-1.8$	$V_{CC}-1.4$		V		
$V_{OH}$	"H" output voltage	$C_H$	$\overline{\text{ENB}} = 0.8\text{ V}, I_{OH} = -2\text{ mA}$	4.0		V	1	
$V_{OL}$	"L" output voltage	$C_H$	$\overline{\text{ENB}} = 0.8\text{ V}, I_{OL} = 2\text{ mA}$		0.6	V	1	
$I_L$	Input current	$\overline{\text{DATA}}, \overline{\text{ENB}}$	$V_I = 2.7\text{ V}$		20	$\mu\text{A}$		
			$V_I = 0.4\text{ V}$		-0.2	mA		
		$C_H$	$V_I = 0\text{ to }V_{CC}$		$\pm 1$	$\mu\text{A}$		
$I_{SW}$	Switching current (see note)	LD	$C_H = 3.0\text{ V}, R_S = 360\ \Omega, V_{LD} = 2\text{ V}$		120	mA	2	
		Temperature coefficient	$T_a = 20\text{ to }70^\circ\text{C}$		0.11	mA/ $^\circ\text{C}$		
$I_B$	Bias current (see note)	LD	$V_B = 1.2\text{ V}, R_B = 360\ \Omega, V_{LD} = 2\text{ V}$		30	mA	2	
$I_{cg}$	Load charging current	$C_H$	$\overline{\text{ENB}} = 0.8\text{ V}, V_O = 0.6\text{ to }4.0\text{ V}$	-0.66	-2.0	mA	3	
$I_{dg}$	Load discharge current	$C_H$	$\overline{\text{ENB}} = 0.8\text{ V}, V_O = 0.6\text{ to }4.0\text{ V}$	0.66	2.0	mA	3	
$I_{oz}$	Output current in off state	$C_H$	$V_O = 0\text{ to }V_{CC}, \text{ Hold state}$		$\pm 5$	$\mu\text{A}$	3	
$I_{OFF}$	Output current when off	LD	$\overline{\text{ENB}} = 0.8\text{ V}, \overline{\text{DATA}} = 2.0\text{ V}$	0.33	50	$\mu\text{A}$	2	
			$\overline{\text{ENB}} = 2.0\text{ V}, \overline{\text{DATA}} = 0.8\text{ V}$	0.01	50			
$I_{CC}$	Power supply current		$V_{CC} = 5.25\text{ V}, \overline{\text{ENB}} = 0\text{ V}, \overline{\text{DATA}} = 0\text{ V}$ $C_H = 3.0\text{ V}, V_B = 1.2\text{ V}, R_S = 300\ \Omega, R_B = 360\ \Omega, R_O = LD = 5.0\text{ V}$		54 52	75 74	mA	4

\*Typical values are for  $T_a = 25^\circ\text{C}$ ,  $V_{CC} = 5\text{ V}$ .Note: These quantities indicate the input voltage-output current conversion characteristic;  $I_{SW}$  and  $I_B$  should be used within the range of the rated values under recommended operating conditions.

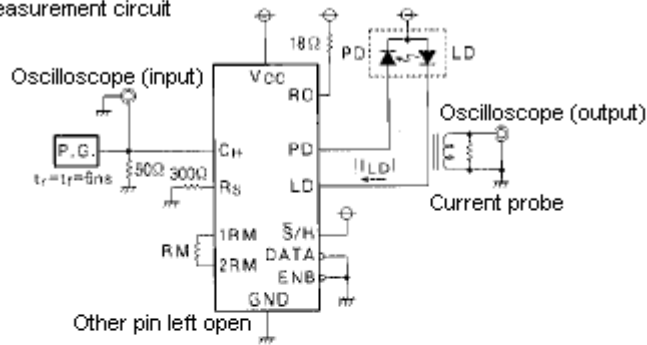
Switching Characteristics

(Ta = 25°C, V<sub>CC</sub> = 5 V)

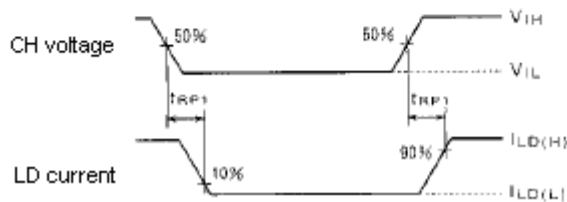
Symbol	Item	Measurement pin		Measurement conditions	Limits			Unit
		Input	Output		Min.	Typ.	Max.	
f <sub>OP</sub>	Operating frequency					40		Mbps
t <sub>RP1</sub>	Circuit response time 1	C <sub>H</sub> voltage	LD current	I <sub>LD(L)</sub> = 0 mA		7	μs	
				I <sub>LD(H)</sub> = 60 mA (Note 1)				
				I <sub>LD(L)</sub> = 55 mA		2	μs	
t <sub>RP2</sub>	Circuit response time 2	PD current	C <sub>H</sub> voltage	I <sub>PD(L)</sub> = 0 mA		15	μs	
				I <sub>PD(H)</sub> = 2 mA				
				RM = 1 kΩ (Note 2)				
t <sub>RP3</sub>	Circuit response time 3	S/H voltage	C <sub>H</sub> voltage	I <sub>PD</sub> = 0 mA, 2 mA		1	μs	
				RM = 1 kΩ, Vr = 1.2 V				
				(Note 3)				
t <sub>ON</sub>	Circuit turn-on time	ENB voltage	LD current	I <sub>LD(H)</sub> = 60 mA (Note 4)		5	μs	
t <sub>OFF</sub>	Circuit turn-off time	ENB voltage	LD current	I <sub>LD(H)</sub> = 60 mA (Note 4)		2	μs	

Note 1. Measurement circuit and Timing chart

Measurement circuit

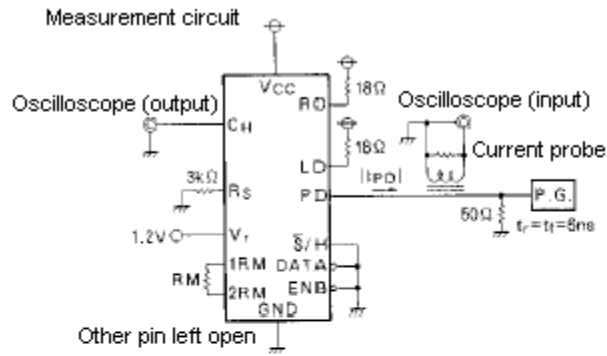


Timing chart

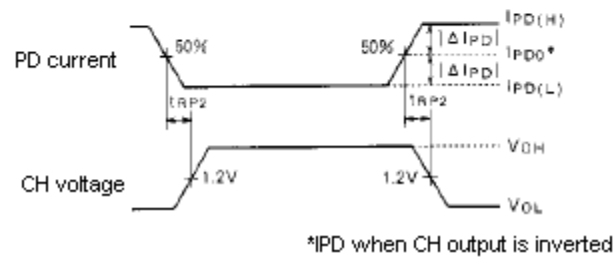




Note 2. Measurement circuit and Timing chart

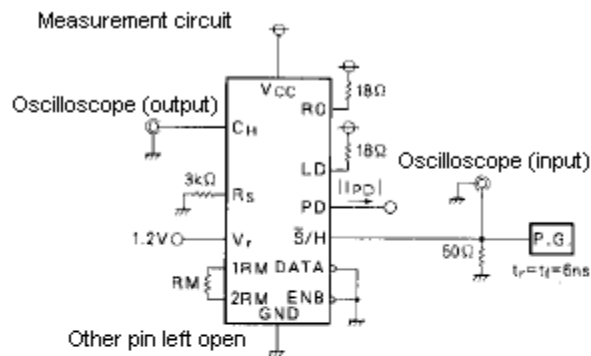


Timing chart

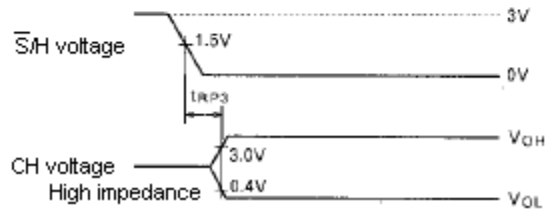


\*IPD when CH output is inverted

Note 3. Measurement circuit and Timing chart

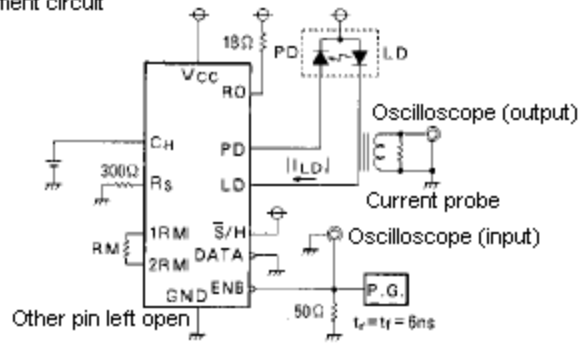


Timing chart

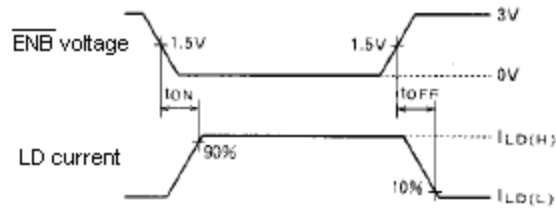


Note 4. Measurement circuit and Timing chart

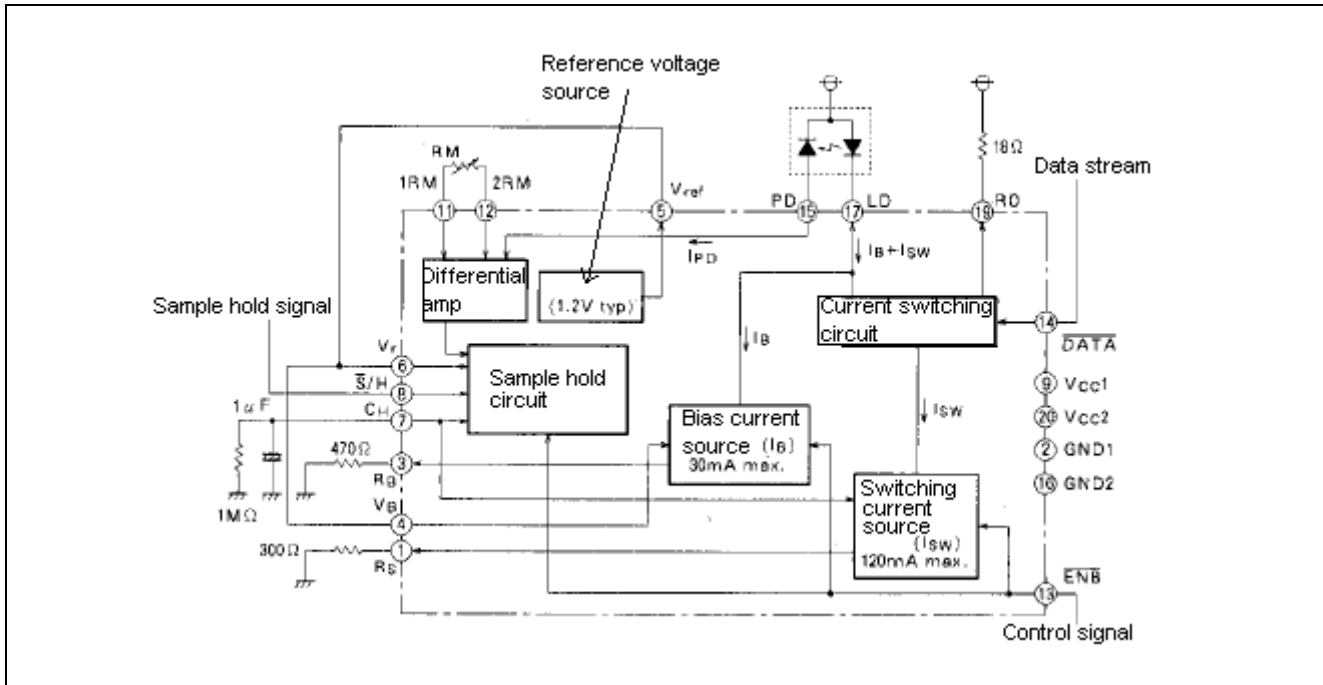
Measurement circuit



Timing chart



Application example



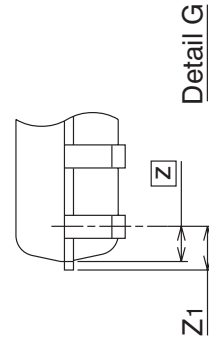
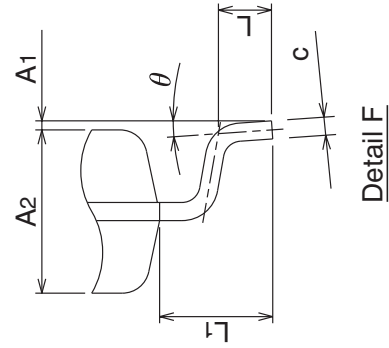
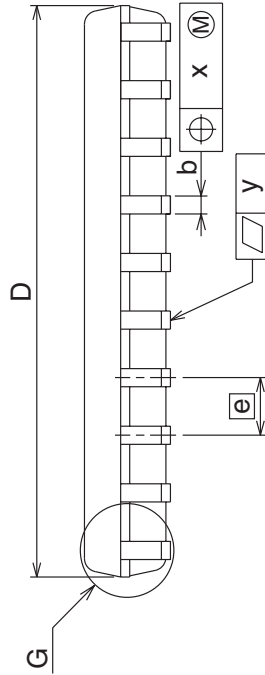
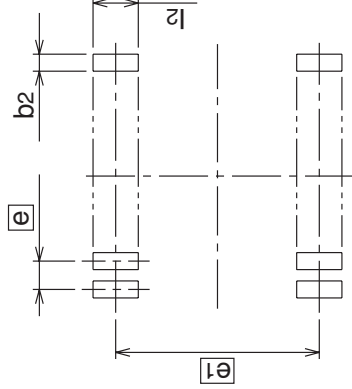
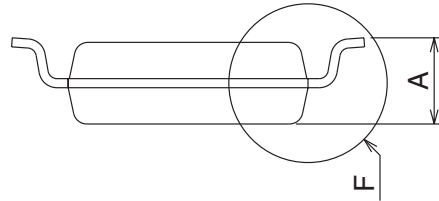
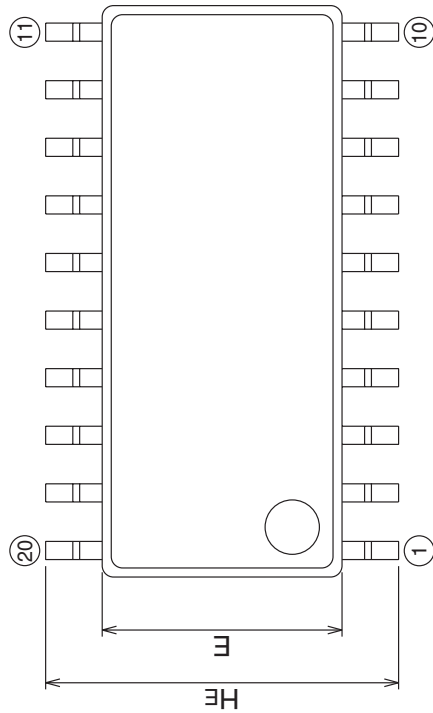
Package Dimensions

**20P2N-A**

(MMP)

**Plastic 20pin 300mil SOP**

EIAJ Package Code SOP20-P-300-1.27	JEDEC Code —	Weight(g) 0.26	Lead Material Cu Alloy
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Recommended Mount Pad

Symbol	Dimension in Millimeters		
	Min	Nom	Max
A	—	—	2.1
A1	0	0.1	0.2
A2	—	1.8	—
b	0.35	0.4	0.5
c	0.18	0.2	0.25
D	12.5	12.6	12.7
E	5.2	5.3	5.4
e	—	1.27	—
HE	7.5	7.8	8.1
L	0.4	0.6	0.8
L1	—	1.25	—
Z	—	0.585	—
Z1	—	—	0.735
x	—	—	0.25
y	—	—	0.1
$\theta$	0°	—	8°
b2	—	0.76	—
e1	—	7.62	—
l2	1.27	—	—

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