RENESAS

M66515FP

Laser Diode Driver/Controller

REJ03F0084-0100Z
Rev.1.0
Sep.22.2003

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).

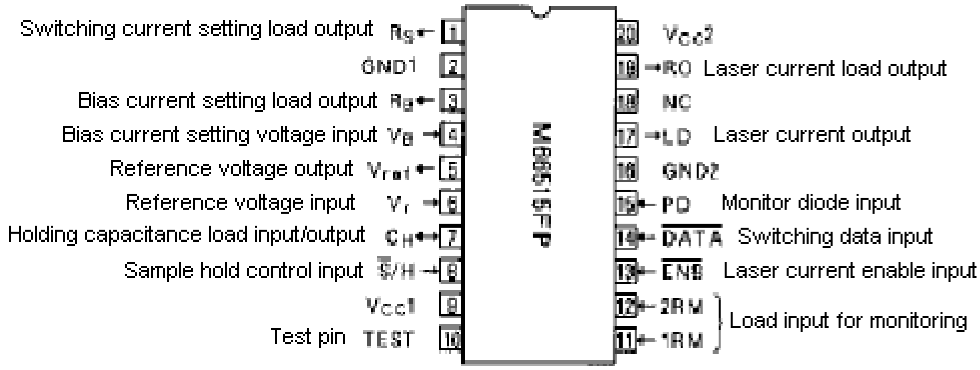
LD driving and laser power control are executed by connecting an external capacitance to the C_H pin and applying a reference voltage to the V_r pin.

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)

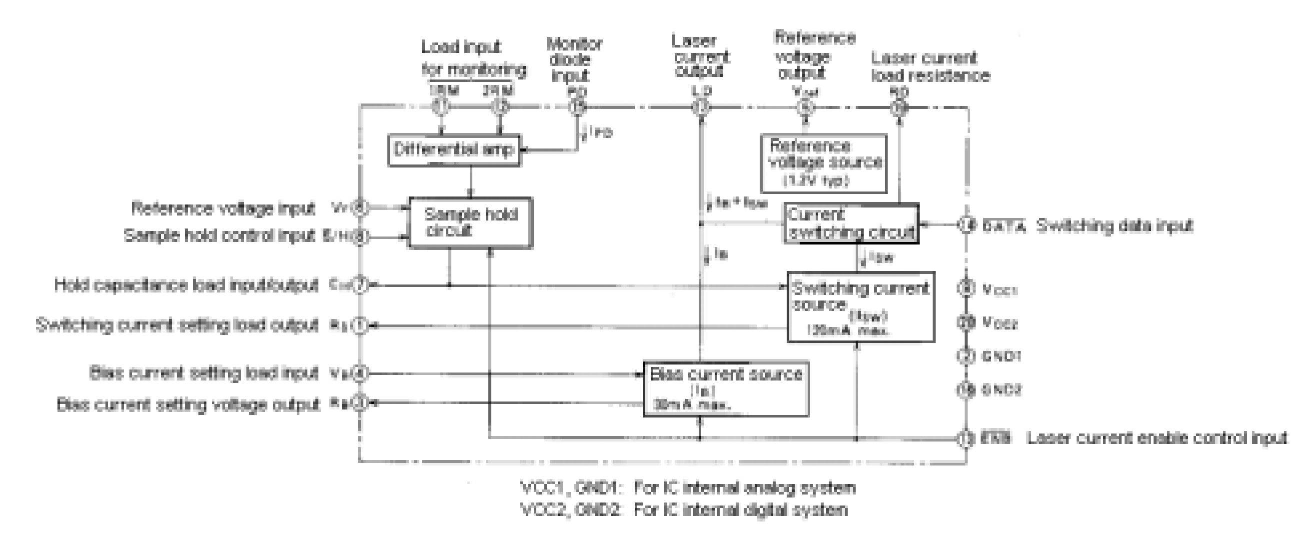


Package: 20P2N-A NC: Not connected

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
R_S	Switching current setting load output	Connects the load resistance to set the current for switching (I_{SW}) to GND
R_B	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.
V_B	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.
$\overline{DATA}$	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
$\overline{ENB}$	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}
$\overline{S}$/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
$V_{CC}1$	Power supply pin 1	Power supply for the internal analog system; connect to a positive power supply (+5 V)
$V_{CC}2$	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)

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

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

(2) I_B (bias current)

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

Here $0 \le V_B \le V_{CC}$-2.7 V, I_B (max) =30 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 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 Ω. 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 Ω or lower.

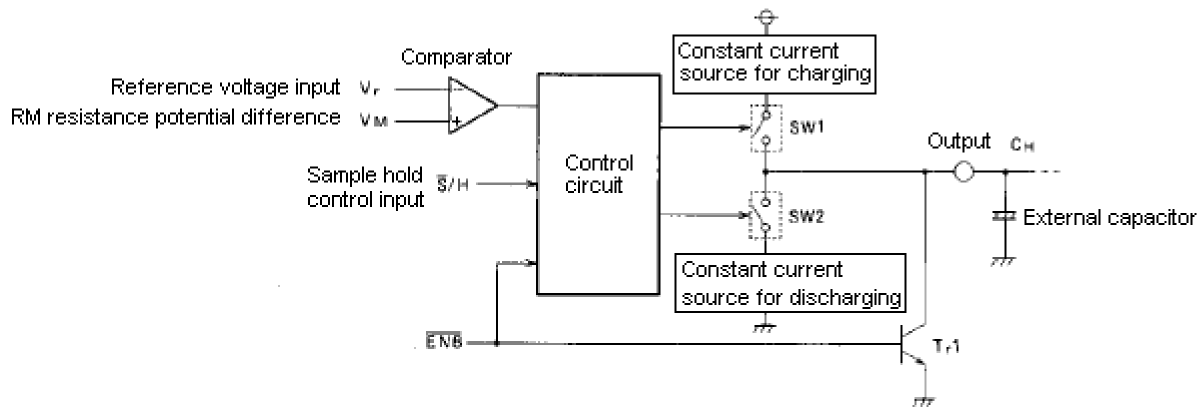
6. Sample-and-hold circuit

(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.

Schematic summary of the sample hold circuit



Function table

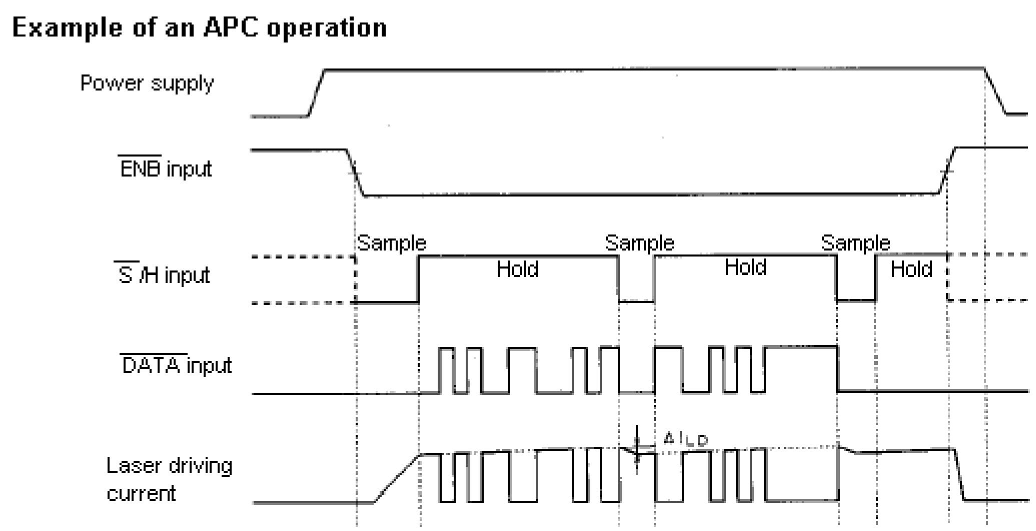
Input			Switched state		Tr1	Output
$\overline{ENB}$	$\overline{S}$/H	Vm, Vr	SW1	SW2		
H	X	X	OFF	OFF	ON	Fixed at "L"
L	H	X	OFF	OFF	OFF	High-impedance state (hold)
L	L	V_M < Vr	ON	OFF	OFF	Constant current source (sample)
		V_M > Vr	OFF	ON	OFF	Constant current sink (sample)

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).



7. V_{CC} and GND pins

The $V_{CC}1$ and $V_{CC}2$ pins and the GND1 and GND2 pins are related to the power supply. The internal circuitry connected to these pins is as follows.

$V_{CC}1$, GND1: Connected to analog circuitry

$V_{CC}2$, 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 $V_{CC}1$ and GND1.
(3) The bypass capacitor should be positioned close to $V_{CC}2$ 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.

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

Here $V_{(RO)}$ is the RO pin voltage, $V_{(LD)}$ is the LD pin voltage, $I_{(RO)}$ is the RO pin load current, and $I_{(LD)}$ is the LD pin load current.

For example, when $V_{CC} = 5.25$ V, $V_{(RO)} = V_{(LD)} = 2.5$ V, and $I_{(RO)} = I_{(LD)} = 150$ mA, the Power dissipation when the laser is turned on and off is as follows.

(1) When the laser is on ($\overline{DATA}$ = “L”, I_{CC} = 75 mA):

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

(2) When the laser is off ($\overline{DATA}$ = “H”, I_{CC} = 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_{CC}	Power supply voltage			–0.5 to +7.0	V
V_I	Input voltage	CH, Vr		–0.3 to V_{CC}	V
		$\overline{DATA}$, $\overline{ENB}$, $\overline{S}$/H		–0.3 to +7.0	V
V_O	Output voltage	RO		–0.5 to +7.0	V
I_{SW}	Switching current			150	mA
I_B	Bias current			45	mA
Pd	Power dissipation		Mounted on board, with Ta=25°C (see note)	1200	mW
Tstg	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_{CC}	Power supply voltage	4.75	5.0	5.25	V
I_{SW}	Switching current			120	mA
I_B	Bias current			30	mA
Topr	Operating ambient temperature	–20	—	70	°C

Electrical Characteristics

(Unless otherwise noted, V_{CC} = 5 V ±5%, Ta = –20 to 70°C)

Symbol	Parameter		Measurement conditions	Limits Min	Typ	Max	Unit	Measurement circuit
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	
Vr	Reference voltage input	Vr		0.4		2.0	V	
Vref	Reference voltage output	Vref	I_O = –10 µA		1.2		V	1
		Temperature coefficient	Ta = –20 to 25°C		–0.9		mV/°C	
			Ta = 25 to 70°C		–0.9			
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 V, I_{OH} = –2 mA	4.0			V	1
V_{OL}	"L" output voltage	C_H	$\overline{\text{ENB}}$ = 0.8 V, I_{OL} = 2 mA			0.6	V	1
I_L	Input current	$\overline{\text{DATA}}$, $\overline{\text{ENB}}$	V_I = 2.7 V			20	µA	
			V_I = 0.4 V			–0.2	mA	
		C_H	V_I = 0 to V_{CC}			±1	µA	
I_{SW}	Switching current (see note)	LD	CH = 3.0 V, Rs = 360 Ω, V_{LD} = 2 V		120		mA	2
		Temperature coefficient	Ta = 20 to 70°C		0.11		mA/°C	
I_B	Bias current (see note)	LD	VB = 1.2 V, RB = 360 Ω, V_{LD} = 2 V		30		mA	2
Icg	Load charging current	C_H	$\overline{\text{ENB}}$ = 0.8 V, V_O = 0.6 to 4.0 V	–0.66		–2.0	mA	3
Idg	Load discharge current	C_H	$\overline{\text{ENB}}$ = 0.8 V, V_O = 0.6 to 4.0 V	0.66		2.0	mA	3
Ioz	Output current in off state	C_H	V_O = 0 to V_{CC}, Hold state			±5	µA	3
I_{OFF}	Output current when off	LD	$\overline{\text{ENB}}$ = 0.8 V, $\overline{\text{DATA}}$ = 2.0 V		0.33	50	µA	2
			$\overline{\text{ENB}}$ = 2.0 V, $\overline{\text{DATA}}$ = 0.8 V		0.01	50		
I_{CC}	Power supply current		V_{CC} = 5.25 V, $\overline{\text{ENB}}$ = 0 V, C_H = 3.0 V, V_B = 1.2 V, R_S = 300 Ω, R_B = 360 Ω, R_O = LD = 5.0 V; $\overline{\text{DATA}}$ = 0 V		54	75	mA	4
			$\overline{\text{DATA}}$ = 4.5 V		52	74		

*Typical values are for Ta = 25°C, V_{CC} = 5 V.

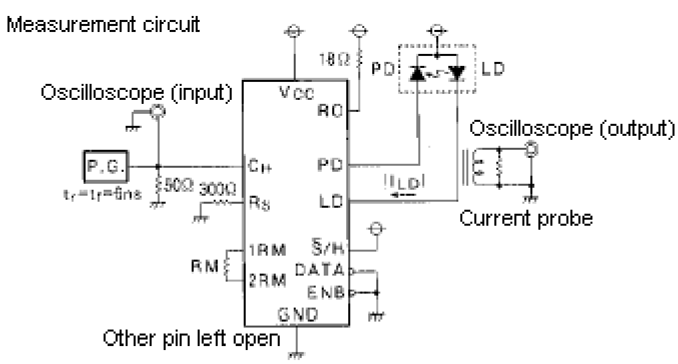
Note: These quantities indicate the input voltage-output current conversion characteristic; I_{SW} and I_B should be used within the range of the rated values under recommended operating conditions.

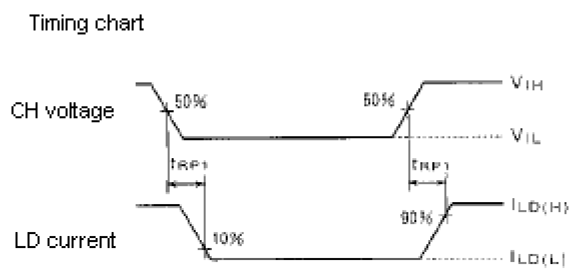
Switching Characteristics

(Ta = 25°C, V_{CC} = 5 V)

Symbol	Item	Measurement pin		Measurement conditions	Limits			Unit
		Input	Output		Min.	Typ.	Max.	
f_{OP}	Operating frequency					40		Mbps
t_{RP1}	Circuit response time 1	C_H voltage	LD current	$I_{LD(L)}$ = 0 mA $I_{LD(H)}$ = 60 mA (Note 1)			7	µs
				$I_{LD(L)}$ = 55 mA $I_{LD(H)}$ = 65 mA (Note 1)			2	µs
t_{RP2}	Circuit response time 2	PD current	C_H voltage	$I_{PD(L)}$ = 0 mA $I_{PD(H)}$ = 2 mA RM = 1 kΩ (Note 2)			15	µs
				$\lvert\Delta I_{PD}\rvert$ = 0.2 mA RM = 1 kΩ (Note 2)			8	µs
t_{RP3}	Circuit response time 3	$\overline{S}$/H voltage	C_H voltage	I_{PD} = 0 mA, 2 mA RM = 1 kΩ, Vr = 1.2 V (Note 3)			1	µs
t_{ON}	Circuit turn-on time	$\overline{ENB}$ voltage	LD current	$I_{LD(H)}$ = 60 mA (Note 4)			5	µs
t_{OFF}	Circuit turn-off time	$\overline{ENB}$ voltage	LD current	$I_{LD(H)}$ = 60 mA (Note 4)			2	µs

Note 1. Measurement circuit and Timing chart





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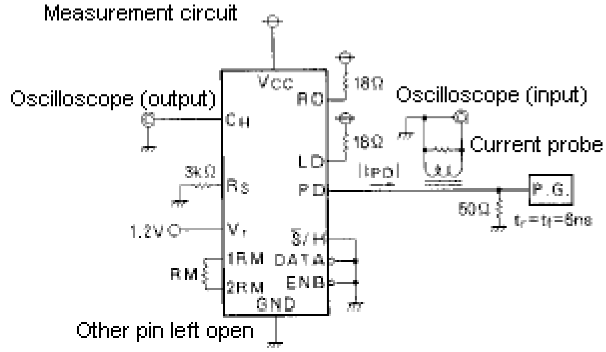
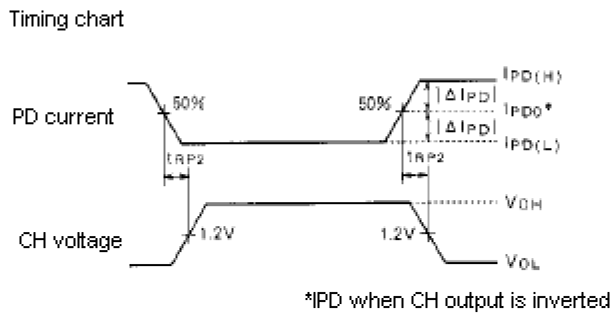
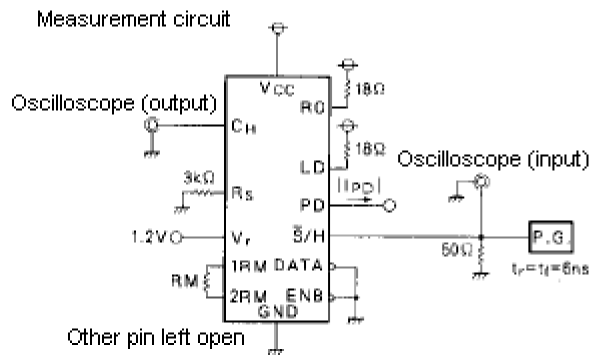
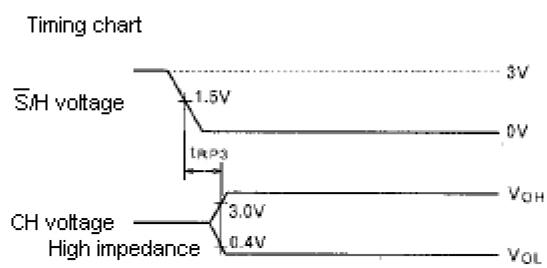
Note 2. Measurement circuit and Timing chart





Note 3. Measurement circuit and Timing chart





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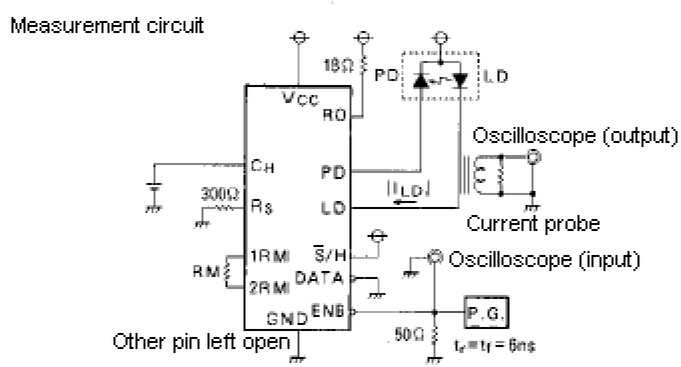
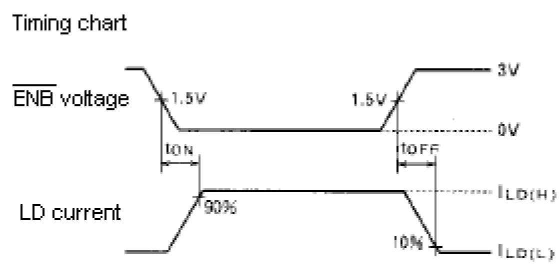
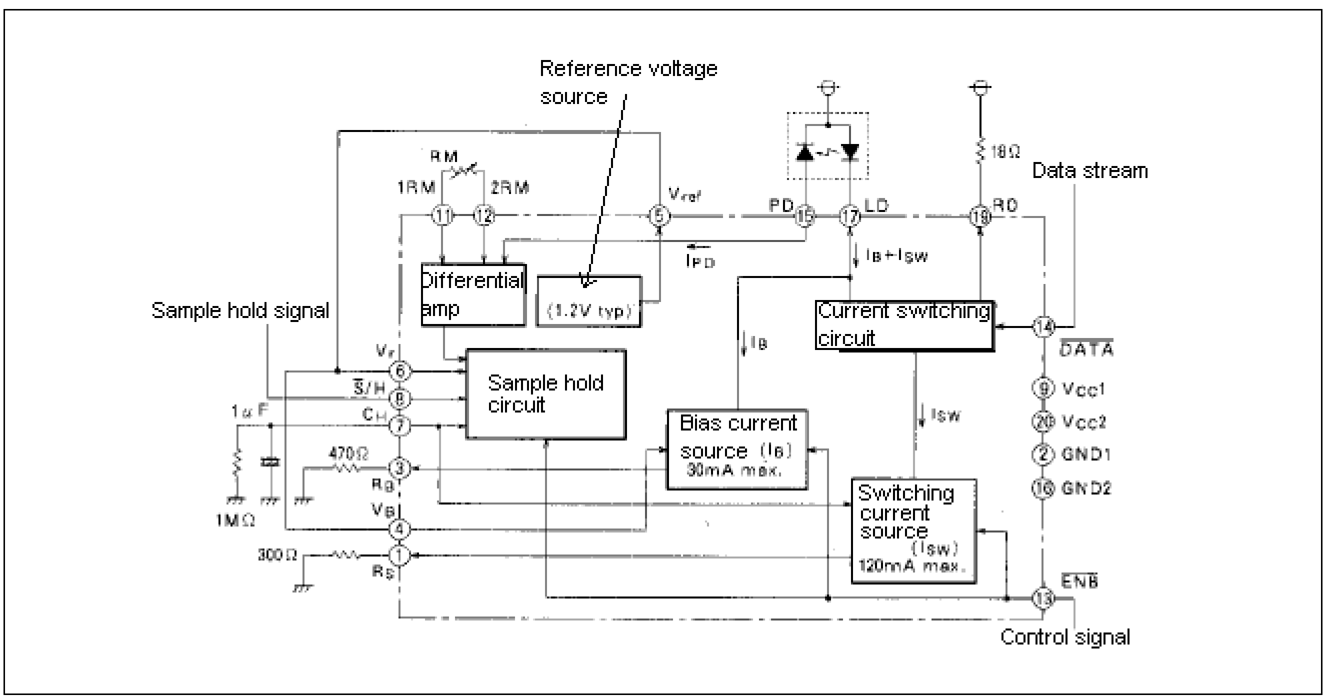
Note 4. Measurement circuit and Timing chart





Application example



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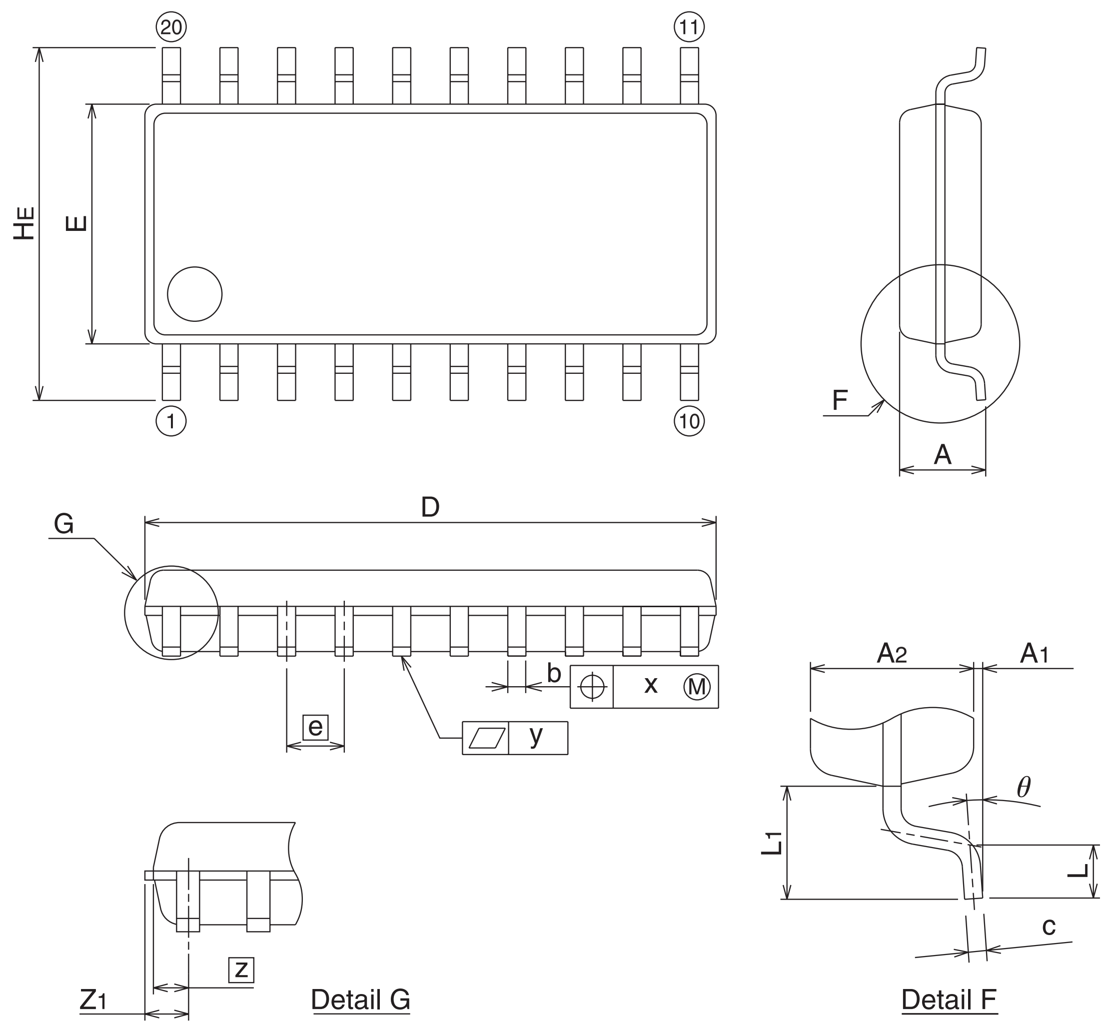
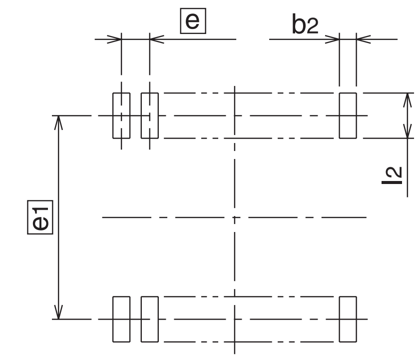
Package Dimensions

20P2N-A (MMP) **Plastic 20pin 300mil SOP**

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





Recommended Mount Pad

Symbol	Dimension in Millimeters		
	Min	Nom	Max
A	—	—	2.1
A_1	0	0.1	0.2
A_2	—	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	—
H_E	7.5	7.8	8.1
L	0.4	0.6	0.8
L_1	—	1.25	—
z	—	0.585	—
Z_1	—	—	0.735
x	—	—	0.25
y	—	—	0.1
θ	0°	—	8°
b_2	—	0.76	—
e_1	—	7.62	—
l_2	1.27	—	—

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