

M61880FP

Laser-diode driver / controller

DESCRIPTION

The M61880FP 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 40mA and a maximum switching current of 100 mA,which is switching at a rate of 200Mbps.

Since the M61880FP 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

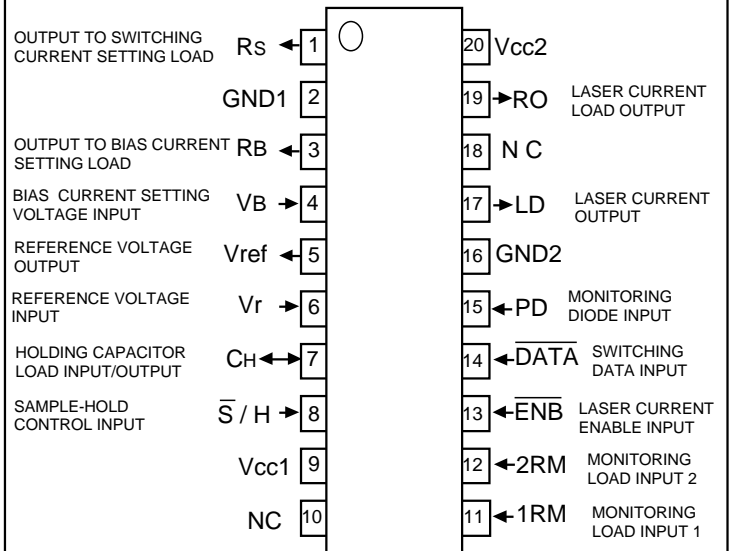
- Built-in sample-hold circuit for internal APC function
Hold error voltage is less than 1% for 1μs(C=0.047μF)
- High speed switching 200Mbps
- Large driving current 100mA (max)
- Capable of setting bias current (40mA max)
- 5V single power supply

APPLICATION

Semiconductor laser-diode applied equipment

- Laser beam printer(LBP)
- Plain Paper Copier(PPC)

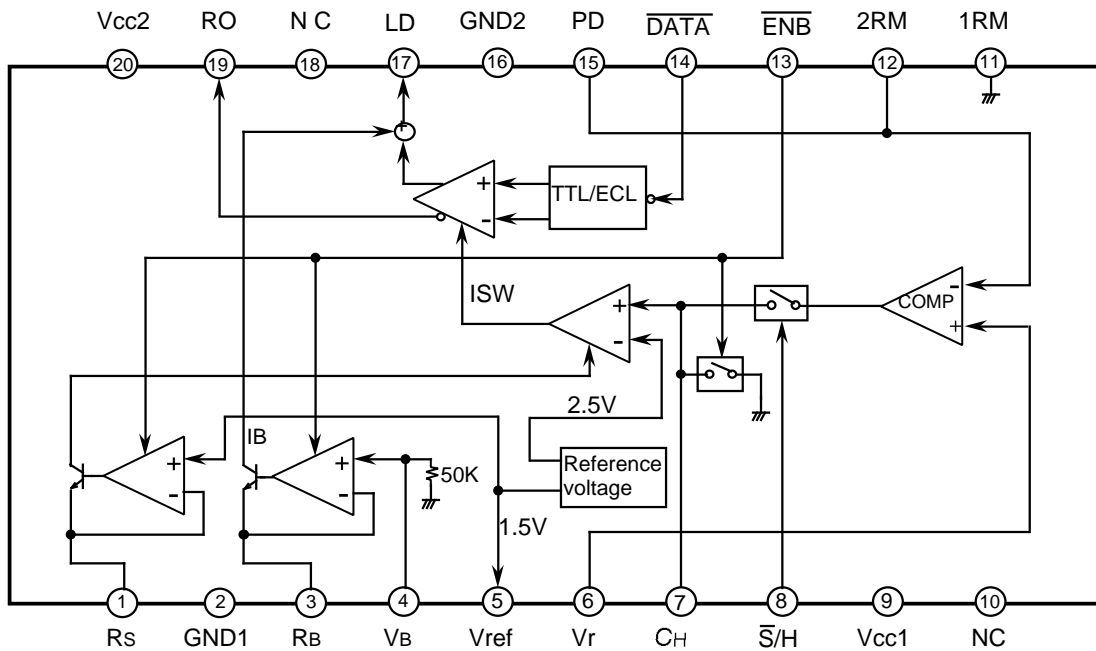
PIN CONFIGURATION (TOP VIEW)



NC : No connection

Outline 20P2N-A

BLOCK DIAGRAM



M61880FP

Laser-diode driver / controller

FUNCTIONS

The M61880 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 CH pin and applying a reference voltage to the Vr 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 Vr pin. If $V_m < V_r$, a constant current is sourced through the CH pin so that the external capacitor is charged. If $V_m > V_r$, a constant current sinks through the CH pin to discharge the external capacitor.

The above operation occurs when the $\overline{S/H}$ input is "L" and $\overline{DATA} = "L"$ (sample). When the $\overline{S/H}$ input is "H", the CH 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. |
| Rs | 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. (2RM pin connects to GND in the IC.) |
| \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. |
| $\overline{S/H}$ | Sample hold control input | If this pin is "L", sampling (APC) occurs, if "H", holding (switching). |
| CH | Holding capacitor load input/output | Connect a holding capacitor between this pin and GND. Inside the M61880 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 (1.5V _{typ.}) output pin of M61880. |
| 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 V _{ref} pin if the internal reference voltage of the M61880 is to be used. |
| Vcc1 | Power supply pin 1 | Power supply to internal analog circuits. Connect to a positive power source(+5V). |
| Vcc2 | Power supply pin 2 | Power supply to internal digital circuits. Connect to a positive power source(+5V). |
| GND1 | GND pin 1 | GND for internal analog circuits. |
| GND2 | GND pin 2 | GND for internal digital circuits. |

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OPERATION

1. Laser Drive Currents Setting Method

Laser Drive Current = I_{sw} (switching current) + I_B (bias current)
at switching mode

(1) I_{sw} (Switching Current)

First it is necessary to decide the center value (I_{sw0}) of maximum switching current $I_{sw(max)}$. I_{sw0} is depend on R_s (load for switching current setting) by the following equation.

$$(a) I_{sw0} [mA] = 30 \times \frac{V_{ref}(1.5V) [V]}{R_s [k \Omega]}$$

(b) When switching current is center value (I_{sw0}), it is necessary to set up R_m (load resistor for monitor of photodiode current) as follows:

V_m (voltage across resistor R_m) = V_r (reference voltage) at this condition CH pin voltage = 2.5V.

- When CH pin voltage < 2.5V, $I_{sw} < I_{sw0}$
 - When CH pin voltage > 2.5V, $I_{sw} > I_{sw0}$
- (CH pin voltage changes from 2V to 3V at APC mode)

(c) The usable range of I_{sw} at APC mode That is 20 ~180% of I_{sw0} accurately.

(2) I_B (Bias Current)

Bias current (I_B) is set by R_B (resistor for the setting of bias current) and V_B (voltage for the setting of bias current).

$$I_B [A] = 1 \times \frac{V_B [V]}{R_B [\Omega]}$$

$$1.2V \leq V_B \leq V_{CC} - 2.7V$$

$$I_B(max.) = 40mA$$

2. Switching Operation

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

3. ENB input

When the laser drive current is controlled by the \overline{DATA} input, the M61880'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 CH pin is compulsorily fixed to "L" in order to discharge the capacitor connected to the CH pin.

4. Internal Reset Function

The M61880 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 $V_{CC} < 3.5V$ (typ.), and the CH 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.

The load resistor is connected between the RO pin and V_{CC} 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 :

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

where $I_{sw(max.)}$ is the maximum of I_{sw} . If, for example, $V_{CC(min.)} = 4.75V$ and $I_{sw(max.)} = 100mA$, $RO(max.) = 22 \Omega$. Accordingly, if the resistance of R_S is selected so as to gain maximum I_{sw} of 100mA, RO should be 22 Ω at the maximum.

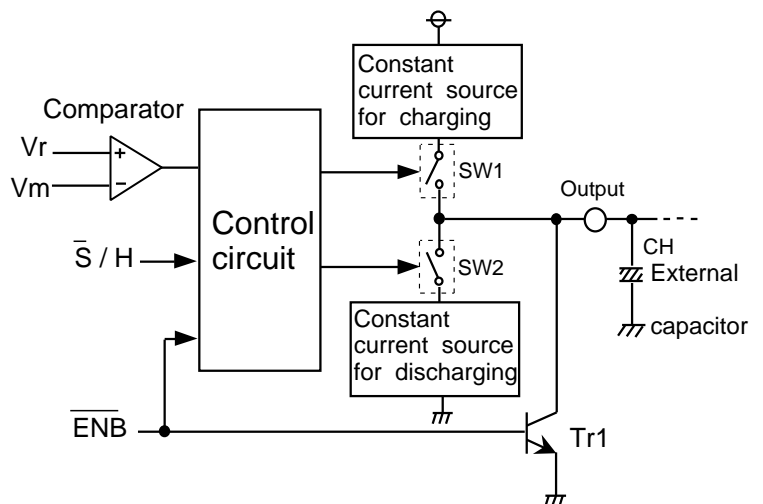
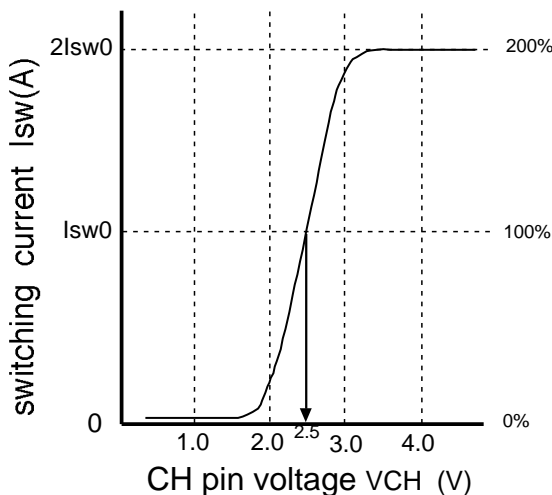
6. Sample-Hold Circuit

(1) Circuit Operation Overview

The following is an overview of the operation of the sample-hold circuit contained in the M61880.

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 V_r pin. If $V_m < V_r$, a constant current is sourced through the CH pin so that the external capacitor is charged. If $V_m > V_r$, a constant current sinks through the CH pin to discharge the external capacitor. This operation occurs when the S/H input is "L" and $\overline{DATA} = "L"$ (sample).

When the S/H input is "H", the CH 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

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FUNCTION TABLE

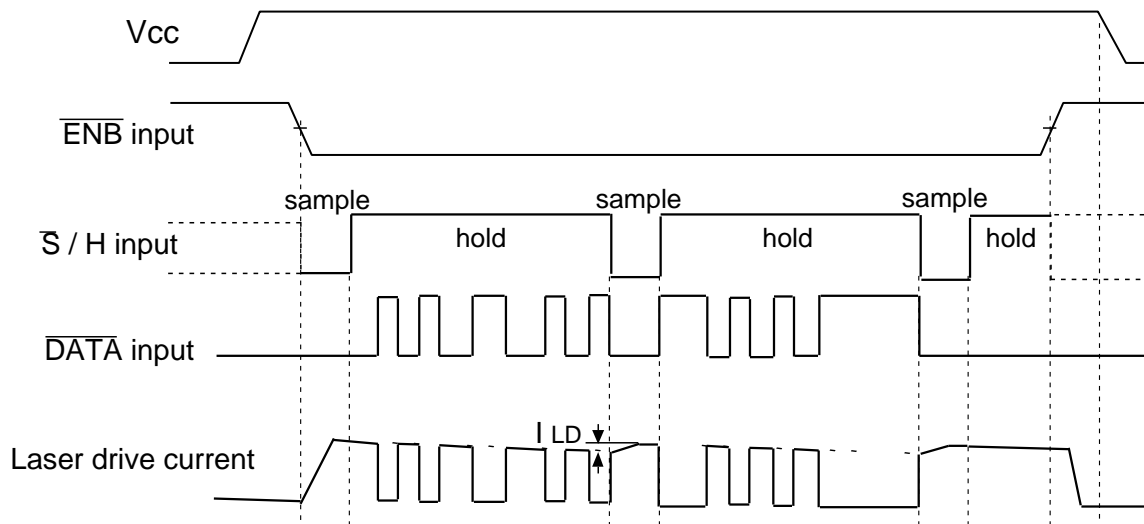
| Input | | | | Switch condition | | Tr1 | Output |
|-------|-----|------|---------|------------------|-----|-----|------------------------------------|
| ENB | S/H | DATA | Vm,Vr | SW1 | SW2 | | |
| H | X | X | X | OFF | OFF | ON | Fixed to "L" |
| L | H | X | X | OFF | OFF | OFF | High impedance state (hold) |
| L | L | H | X | OFF | OFF | OFF | High impedance state (hold) |
| | | L | Vm < Vr | ON | OFF | OFF | Constant current sourcing (sample) |
| | | | Vm > Vr | OFF | ON | OFF | Constant current sinking (sample) |

X : 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 into the M61880 (in the positive direction).



An example of APC Timing Chart

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 M61880 to operate in closest possible proximity to the M61880.

Calculation Method for Power Dissipation

The approximate power dissipation, P, of the M61880FP is determined by the following equation.

$$P = I_{cc} \times V_{cc} + I(RO) \times V(RO) + I(LD) \times V(LD) \text{ where}$$

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) = 100mA, power dissipation at times of turning laser on and off will be as follows.

(1) Laser ON (DATA = "L" and I_{cc} = 55mA)

$$PON = 55 \times 5.25 + 0 + 100 \times 2.5 = 538.8(\text{mW})$$

(2) Laser OFF (DATA = "H" and I_{cc} = 55mA)

$$POFF = 55 \times 5.25 + 0 + 100 \times 2.5 = 538.8(\text{mW})$$

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

| Symbol | Parameter | Conditions | Ratings | Unit |
|--------|---------------------|---|-------------|------|
| Vcc | Supply voltage | | -0.3 ~ +5.5 | V |
| Vi | Input voltage | CH, Vr | -0.3 ~ +Vcc | V |
| | | DATA, ENB, S/H | -0.3 ~ +Vcc | V |
| Vo | Output voltage | RO | -0.3 ~ +Vcc | V |
| Isw | Switching current | | 120 | mA |
| Ib | Bias current | | 50 | mA |
| Pd | Power dissipation | Measured being mounted Ta = 25°C(Note) | 980 | mW |
| Tstg | Storage temperature | | -60 ~ +150 | °C |

Note: For operation above 25°C, derating of 9.8mW/°C is necessary.

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

| Symbol | Parameter | Limits | | | Unit |
|--------|-------------------------------|--------|------|------|------|
| | | Min. | Typ. | Max. | |
| Vcc | Supply voltage | 4.75 | 5.0 | 5.25 | V |
| Isw | Switching current | | | 100 | mA |
| Ib | Bias current | | | 40 | mA |
| Topr | Operating ambient temperature | -20 | | 70 | °C |

Note: Isw + Ib 100mA

ELECTRICAL CHARACTERISTICS (Ta = -20 ~ 70°C, Vcc = 5V±5% unless otherwise noted)

| Symbol | Parameter | Test conditions | Limits | | | Unit | |
|------------------|------------------------------------|-------------------------|---|---------|-------|------|-------|
| | | | Min. | Typ. | Max. | | |
| V _{IH} | "H" Input voltage | DATA, ENB, S/H | 2.0 | | | V | |
| V _{IL} | "L" Input voltage | DATA, ENB, S/H | | | 0.8 | V | |
| V _r | Reference voltage input | V _r | 0.35 | | 2.0 | V | |
| V _{ref} | Reference voltage output | V _{ref} | I _o = ±10μA | 1.4 | 1.5 | 1.6 | V |
| | | Temperature coefficient | Ta = -20 ~ 25°C | | 0.1 | | mV/°C |
| | | | Ta = 25 ~ 70°C | | -0.1 | | |
| V _{LD} | Operating voltage range | LD | 2.5 | | Vcc | V | |
| V _i | Maximum effective voltage | CH | 2.7 | 3.0 | | V | |
| V _{OH} | "H" output voltage | CH | ENB = "L", I _{oL} = (-0.6mA) | Vcc-1.6 | | V | |
| V _{OL} | "L" output voltage | CH | ENB = "L", I _{oH} = (0.6mA) | | 0.6 | V | |
| I _i | Input current | DATA, ENB | V _i = 2.7V | | 20 | μA | |
| | | | V _i = 0.4V | -0.2 | | mA | |
| I _{sw} | Switching current | LD | CH=3.5V, R _s =1.2k, V _{LD} =3V | | 75 | mA | |
| I _b | Bias current (Note) | LD | V _B =1.5V, R _B =70, V _{LD} =3V | | 20 | mA | |
| I _{cg} | Load charging current | CH | ENB = "L", V _o = (0.6 ~ Vcc-1.6V) | -1.0 | -0.66 | mA | |
| I _{dg} | Load discharge current | CH | ENB = "L", V _o = (0.6 ~ Vcc-1.6V) | 0.66 | 1.0 | mA | |
| I _{oz} | Output current under off condition | CH | V _o =2.0 ~ 3.0V, Hold condition | -0.5 | +0.5 | μA | |
| I _{OFF} | Output current under off condition | LD | ENB = "L", DATA = "H", I _{sw} =50mA | | 50 | μA | |
| | | | ENB = "H", DATA = "L", I _{sw} =50mA | | 50 | μA | |
| I _{cc} | Supply current | | Vcc=5.25V, ENB=0V, CH=3.5V, V _B =1.4V, I _{sw} =75mA, I _B =25mA, RO=LD=5.0v | DATA=0V | 43 | 63 | mA |
| | | | DATA=4.5V | 43 | 63 | | |

*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.

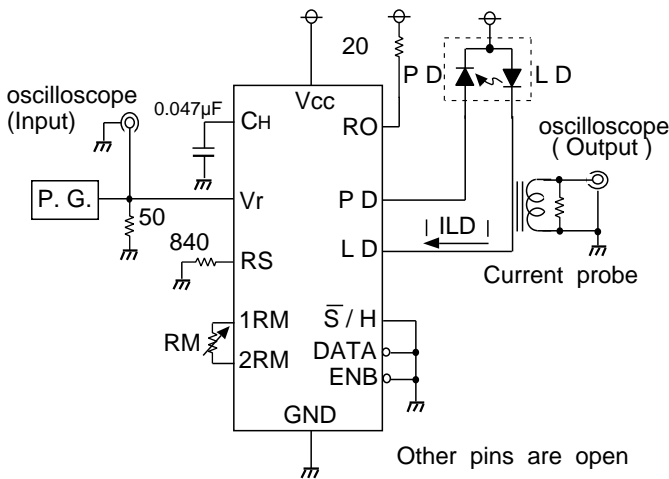
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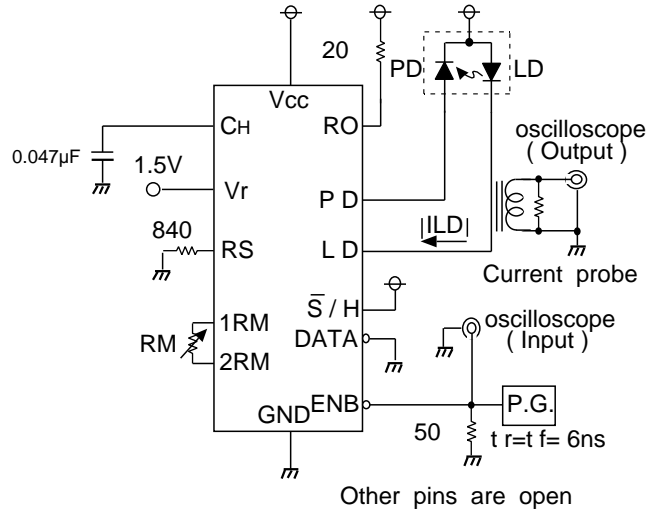
SWITCHING CHARACTERISTICS (Ta=25°C, Vcc=5V)

| Symbol | Parameter | Test pin | | Test condition | Limits | | | Unit |
|--------|------------------------|-------------|------------|--|--------|------|------|------|
| | | Input | Output | | Min. | Typ. | Max. | |
| fop | Operating frequency | | | | | 100 | | Mbps |
| trp1 | Circuit response time1 | Vr voltage | LD current | ILD=50mA, Rs=840 , CH=0.047μF APC adjustment; RM=adjustment(CH=2.5V) Vr=1.5V± 0.5% (Note1) | | 1 | | μS |
| trp2 | Circuit response time2 | Vr voltage | LD current | ILD=50mA, Rs=840 , CH=0.047μF APC adjustment; RM=adjustment(CH=2.5V) Vr=1.5V± 2.5% (Note1) | | 3 | | μS |
| ton | Circuit ON time | ENB voltage | LD current | ILD(H)=50mA (Note2) | | | 350 | μS |
| toff | Circuit OFF time | ENB voltage | LD current | ILD(H)=50mA (Note2) | | | 5 | μS |

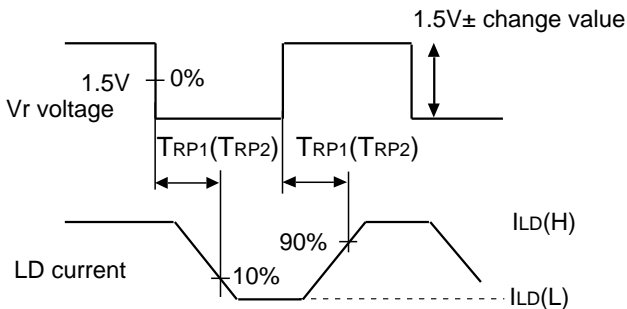
NOTE1:TEST CIRCUIT



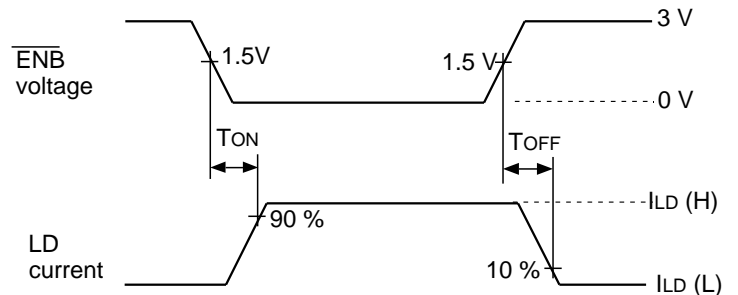
NOTE2:TEST CIRCUIT



TIMING CHARTS



TIMING CHARTS

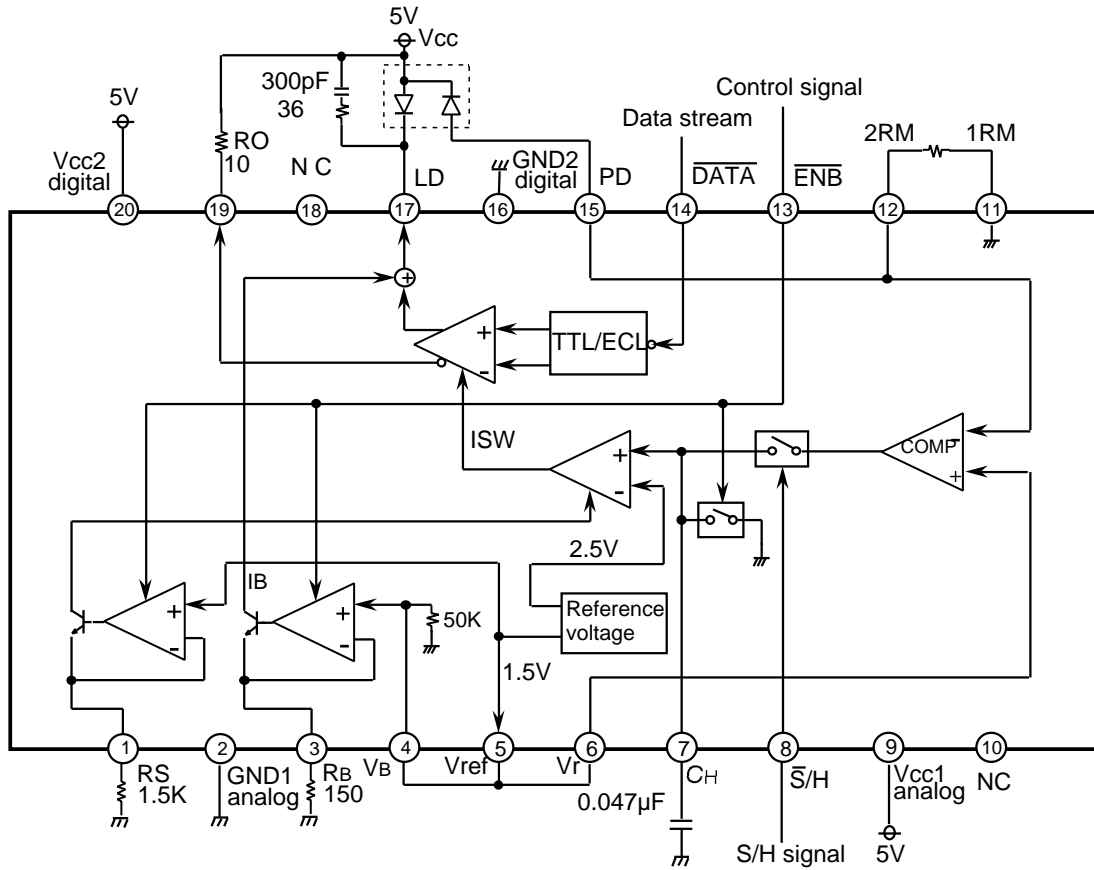


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APPLICATION EXAMPLE

LD driver M61880FP



Explanation for setting Laser switching current

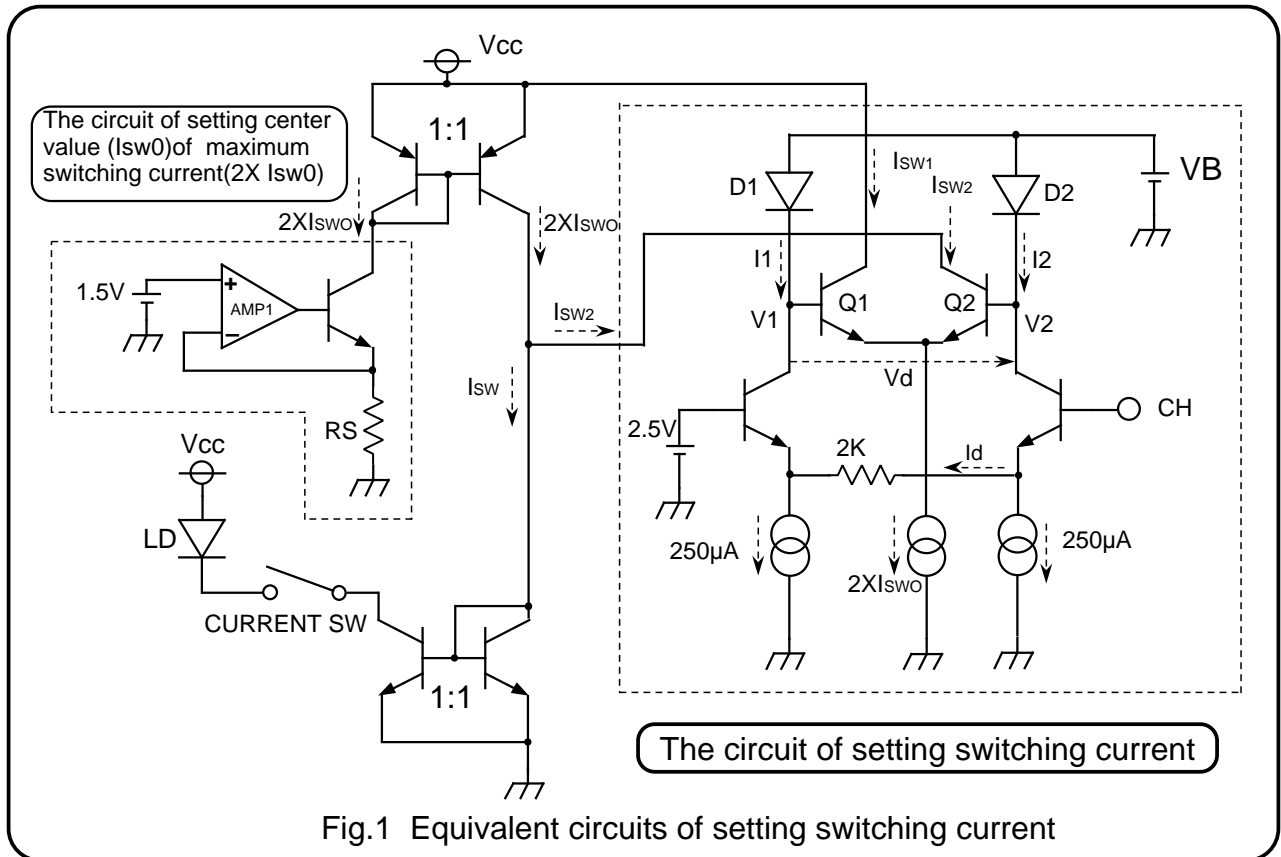


Fig.1 Equivalent circuits of setting switching current

1. The circuit of setting center value(Isw0) of maximum switching current

The setting center value(Isw0) of maximum switching current, 2 X Isw0, set up Rs (load for switching current setting). Isw0 (the value that is initialized) is

$$Isw0[mA]=30 \times \frac{Vref(1.5V)[V]}{RS[k]} \quad (1)$$

2. The circuit of setting switching current

When V is a difference voltage of between CHpin and 2.5V, Id is

$$Id = \frac{V}{2K} \quad (2)$$

So I1 and I2 is as follows

$$\begin{cases} I1=250\mu A-Id \\ I2=250\mu A+Id \end{cases} \quad (3)$$

D1,D2,Q1 and Q2 construct a Gilbert circuit. The relation of I1,I2,Isw1, Isw2 and Isw0 is

$$\frac{I1}{I2} = \frac{Isw2}{Isw1} \quad (4)$$

$$Isw1+Isw2=2 \cdot Isw0 \quad (5)$$

So Isw2 is

$$Isw2=2 \cdot Isw0 \times \frac{I1}{I1+I2} \quad (6)$$

Isw is as follows

$$Isw=2 \cdot Isw0-Isw2 \quad (7)$$

Next the relation between Isw and V would be introduced .

Isw is able to solve with (6), (7),(3) and (2)equation.

$$Isw=2 \cdot Isw0 \left(\frac{I2}{I1+I2} \right) \quad (8)$$

$$Isw=Isw0 \left(1 + \frac{Id}{250\mu A} \right) \quad (9)$$

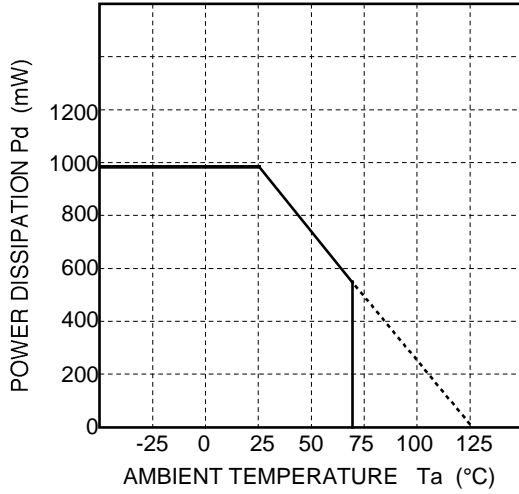
$$Isw=Isw0 \left(1 + \frac{V/2K}{250\mu A} \right) \quad (10)$$

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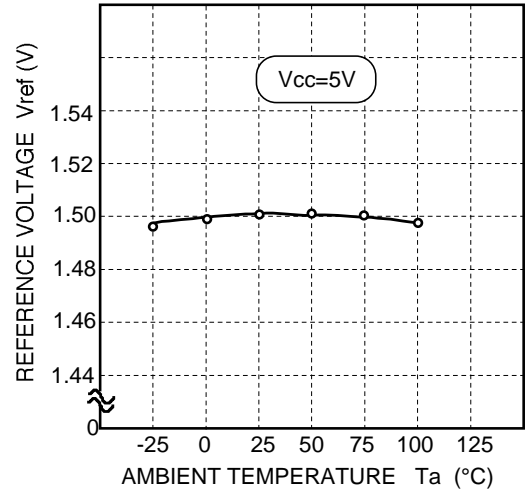
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TYPICAL CHARACTERISTICS

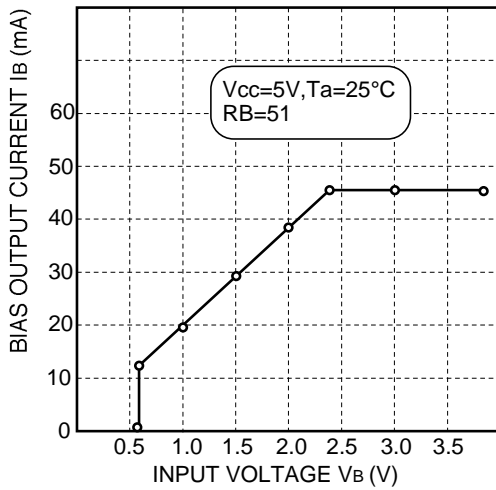
THERMAL DERATING



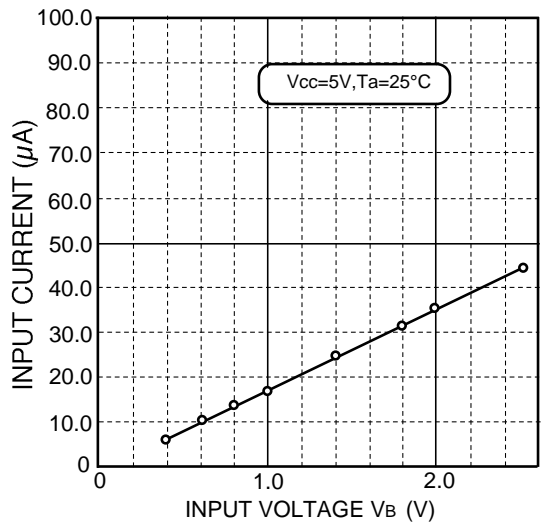
Reference Voltage - Ambient Temperature



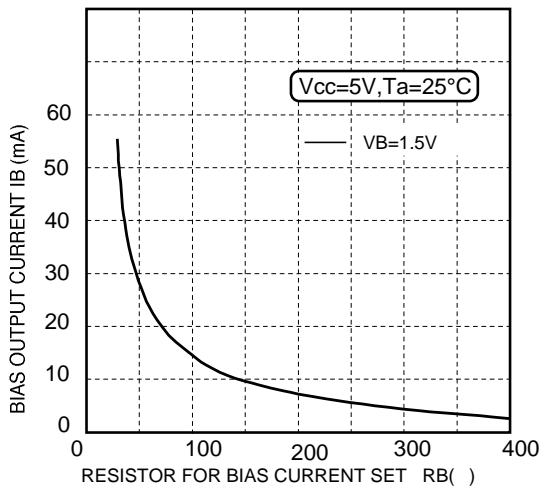
V_B PIN INPUT VOLTAGE • BIAS OUTPUT CURRENT



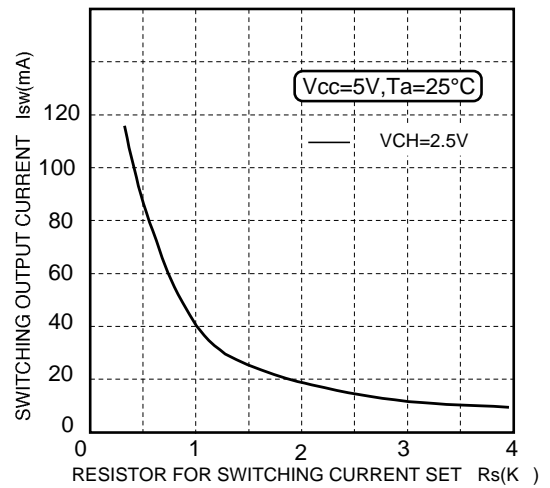
V_B PIN INPUT VOLTAGE-CURRENT



BIAS CURRENT SET RESISTOR- BIAS OUTPUT CURRENT



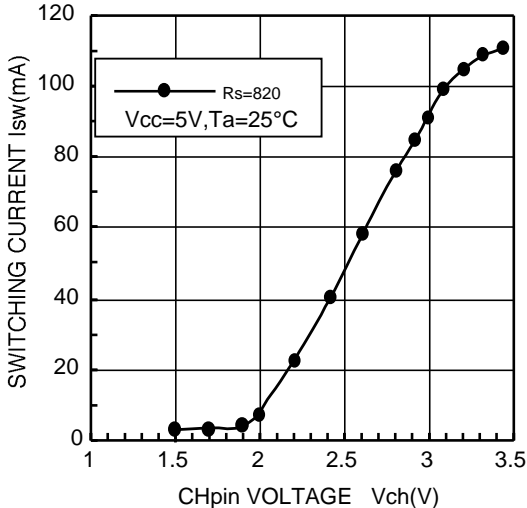
SWITCHING CURRENT SET RESISTOR- SWITCHING OUTPUT CURRENT



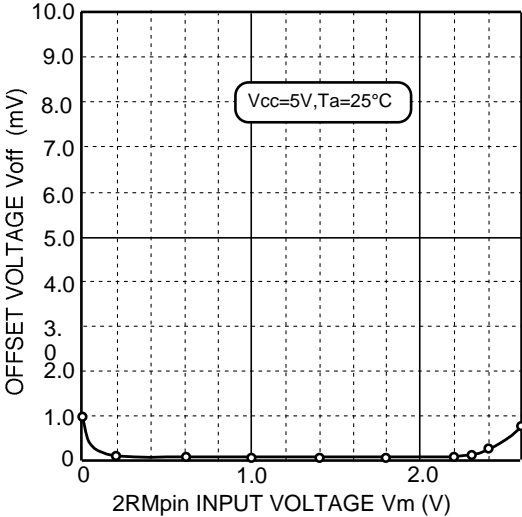
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CHpin VOLTAGE - SWITCHING CURRENT



APC COMPARATOR INPUT VOLTAGE-OFFSET VOLTAGE



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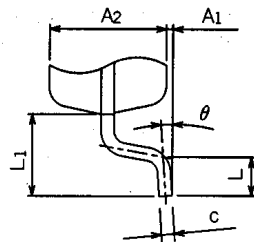
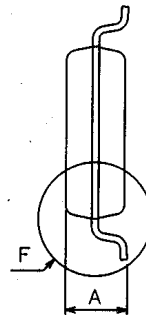
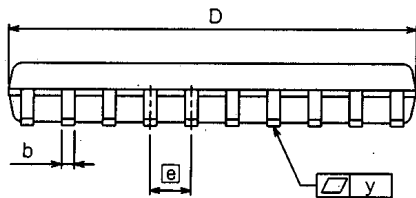
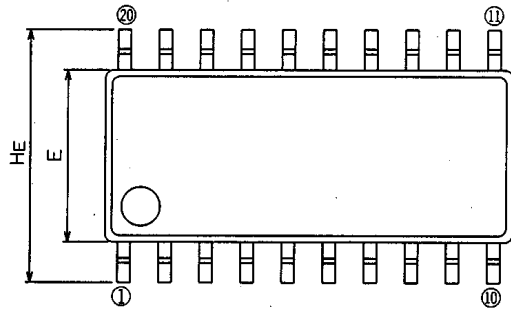
PACKAGE OUTLINE

20P2N-A

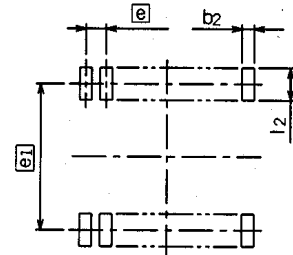
Plastic 20pin 300mil SOP

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

Scale : 4/1



Detail F



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 | — |
| y | — | — | 0.1 |
| θ | 0° | — | 8° |
| b2 | — | 0.76 | — |
| e1 | — | 7.62 | — |
| l2 | 1.27 | — | — |