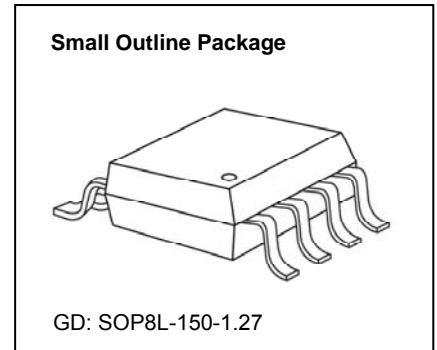




# All-Ways-On™ High-Power LED Driver

## Features

- 2 constant-current output channels
- Constant output current invariant to load voltage change
- Maximum output constant current per channel: 360 mA
- Thermal protection and flag
- Output current adjusted through an external resistor
- Schmitt trigger input
- 5V supply voltage
- Package type: “Pb-free & Green” package with thermal pad



| Current Accuracy |             | Conditions  |
|------------------|-------------|---|
| Between Channels | Between ICs |   |
| < ±3%            | < ±6%       | $I_{OUT} = 40mA \sim 360 mA$<br>@ $V_{DS} = 0.6V$ |

## Product Description

MBI1802 is an instant On/Off LED driver for high power LED applications and exploits PrecisionDrive™ and All-Ways-On™ technology to enhance its output characteristics.

With All-Ways-On™, MBI1802 provides users with 2-channel constant current ports. Users may adjust the output current up to 360 mA through an external resistor,  $R_{ext}$ , which gives users flexibility in controlling the light intensity of LEDs. Also, users can precisely adjust LED brightness from 0% to 100% via output control with Pulse Width Modulation. Alternatively, MBI1802 provides one-step current adjustment to make 25% of the output current via enabling the quarter pin ( $\overline{QT}$ ) as “Low”.

Additionally, to ensure the system reliability, MBI1802 is built with Thermal Protection (TP) function and thermal pad. The TP function protects IC from over temperature (165°C). Also, the thermal pad enhances the power dissipation. As a result, a large amount of current can be sunk safely in one package.

## Applications

- High-flux LED lighting
- Automotive interior lighting

Typical Application Circuit

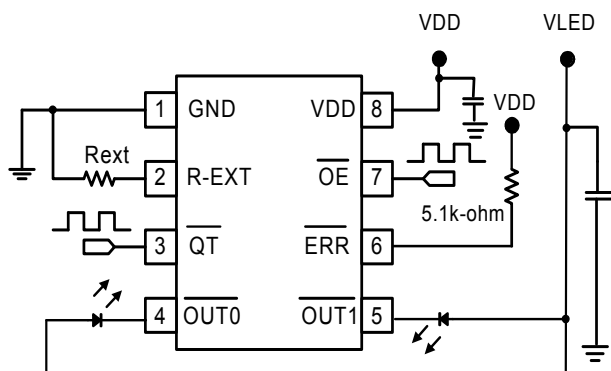
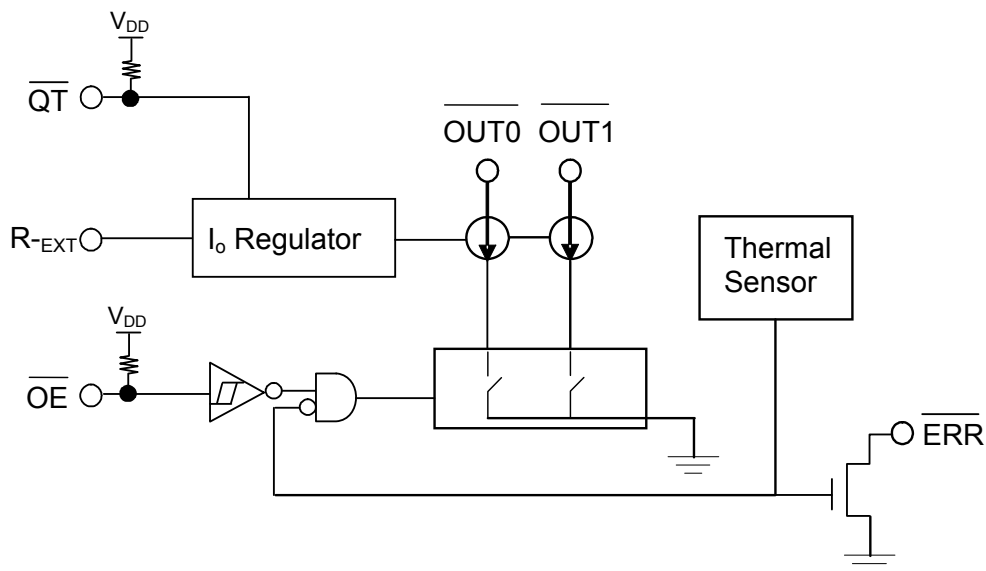
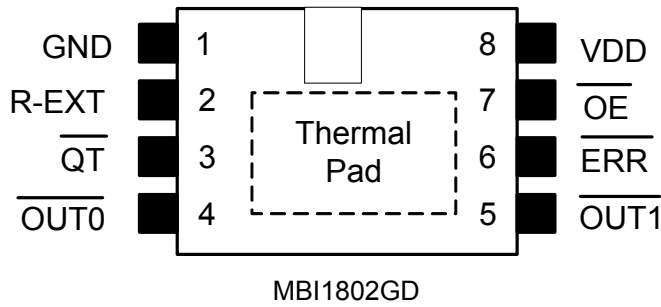


Figure 1

Functional Diagram



Pin Configuration



Pin Description

| Pin No. | Pin Name                               | Function  |
|---------|--|---|
| 1       | GND                                    | Ground terminal for control logic and current sink  |
| 2       | R-EXT                                  | Terminal used to connect an external resistor ( $R_{ext}$ ) for setting up output current for all output channels   |
| 3       | $\overline{QT}$                        | Set all the output current to 25% of the pre-set current when $\overline{QT}$ is low. Default value is high.  |
| 4, 5    | $\overline{OUT0} \sim \overline{OUT1}$ | Constant current output terminals   |
| 6       | $\overline{ERR}$                       | Open drain thermal error flag, when junction temperature is over 165°C, ERR is going to low.  |
| 7       | $\overline{OE}$                        | Output enable terminal<br>When $\overline{OE}$ is active (low), the output pins are enabled; when $\overline{OE}$ is inactive (high), all output pins are turned OFF (blanked). |
| 8       | VDD                                    | 5V supply voltage terminal  |
| -       | Thermal Pad                            | Power dissipation terminals connected to GND*   |

\*To eliminate the noise influence, the thermal pad is suggested to be connected to GND on PCB.

In addition, desired thermal conductivity will be improved, if a heat-conducting copper foil on PCB is soldered with thermal pad.

Maximum Ratings

| Characteristic                                      |         | Symbol        | Rating               | Unit          |
|---|---------|---------------|----------------------|---------------|
| Supply Voltage                                      |         | $V_{DD}$      | 0~7.0                | V             |
| Input Voltage                                       |         | $V_{IN}$      | -0.4~ $V_{DD} + 0.4$ | V             |
| Output Current                                      |         | $I_{OUT}$     | 360                  | mA            |
| Sustaining Voltage                                  |         | $V_{DS}$      | -0.5~+17.0           | V             |
| GND Terminal Current                                |         | $I_{GND}$     | 720                  | mA            |
| Power Dissipation*<br>(On PCB, $T_a=25^{\circ}C$ )  | GD-type | $P_D$         | 3.74                 | W             |
| Thermal Resistance<br>(On PCB, $T_a=25^{\circ}C$ )* |         | $R_{th(j-a)}$ | 33.39                | $^{\circ}C/W$ |
| Junction Temperature                                |         | $T_{j,max}$   | 150**                | $^{\circ}C$   |
| Operating Ambient Temperature                       |         | $T_{opr}$     | -40~+85              | $^{\circ}C$   |
| Storage Temperature                                 |         | $T_{stg}$     | -55~+150             | $^{\circ}C$   |

\*The PCB size is 76.2mm\*114.3mm in simulation. Please refer to JEDEC JESD51.

\*\* Operation at the maximum rating for extended periods may reduce the device reliability; therefore, the suggested junction temperature of the device is under 125 $^{\circ}C$ .

Note: The performance of thermal dissipation is strongly related to the size of thermal pad, thickness and layer numbers of the PCB. The empirical thermal resistance may be different from simulative value. Users should plan for expected thermal dissipation performance by selecting package and arranging layout of the PCB to maximize the capability.

Electrical Characteristics

| Characteristic                                      |           | Symbol             | Condition  | Min.                | Typ.      | Max.                | Unit       |
|---|-----------|--------------------|--|---------------------|-----------|---------------------|------------|
| Supply Voltage                                      |           | $V_{DD}$           | -  | 4.5                 | 5.0       | 5.5                 | V          |
| Sustaining Voltage at $\overline{OE}$ =High         |           | $V_{DS}$           | $\overline{OUT0} \sim \overline{OUT1}$                             | -                   | -         | 17.0                | V          |
| Output Current                                      |           | $I_{OUT}$          | DC Test Circuit  | 40                  | -         | 360                 | mA         |
| Input Voltage for $\overline{OE}, \overline{QT}$    | “H” level | $V_{IH}$           | $T_a = -40 \sim 85^\circ C$  | $0.7 \times V_{DD}$ | -         | $V_{DD}$            | V          |
|   | “L” level | $V_{IL}$           | $T_a = -40 \sim 85^\circ C$  | GND                 | -         | $0.3 \times V_{DD}$ | V          |
| Output Leakage Current                              |           | $I_{OH}$           | $V_{DS} = 17V, \overline{OE} = High$                               | -                   | -         | 1.0                 | $\mu A$    |
| $\overline{ERR}$ Output Voltage                     |           | $V_{OL}$           | $I_{OL} = +1.0mA$  | -                   | -         | 0.5                 | V          |
| $\overline{ERR}$ Turn On Impedance                  |           | $R_{DS,(ON),ERR}$  | Refer to the “Test Circuit for Electrical Characteristics”         | 200                 | 300       | 500                 | $\Omega$   |
| Output Current                                      |           | $I_{OUT}$          | $V_{DS} = 0.6V$ $R_{ext} = 2.4k\Omega$                             | -                   | 243       | -                   | mA         |
| Current Skew (channel)                              |           | $dI_{OUT}/I_{OUT}$ | $I_{OL} = 243mA$<br>$V_{DS} = 0.6V$ $R_{ext} = 2.4k\Omega$         | -                   | $\pm 1$   | $\pm 3$             | %          |
| Current Skew (IC)                                   |           | $dI_{OUT}/I_{OUT}$ | $I_{OL} = 243mA$<br>$V_{DS} = 0.6V$ $R_{ext} = 2.4k\Omega$         | -                   | $\pm 3$   | $\pm 6$             | %          |
| Regulation of Output Current vs. Sustaining Voltage |           | $\%/dV_{DS}$       | $V_{DS}$ within 1.0V and 3.0V                                      | -                   | $\pm 1.1$ | -                   | % / V      |
| Regulation of Output Current vs. Supply Voltage     |           | $\%/dV_{DD}$       | $V_{DD}$ within 4.5V and 5.5V                                      | -                   | $\pm 1.0$ | -                   | % / V      |
| $\overline{OE}$ Pull-up Resistor                    |           | $R_{IN(up)}$       | $\overline{OE}, \overline{QT}$                                     | 250                 | 500       | 800                 | K $\Omega$ |
| Threshold Junction Temperature of Thermal Shutdown  |           | $T_x$              | When $T_j$ approaches $T_x$ and $\overline{OUT}$ is shut off.      | -                   | 165       | -                   | $^\circ C$ |
| Supply Current                                      | “OFF”     | $I_{DD(off) 1}$    | $R_{ext} = Open, \overline{OUT0} \sim \overline{OUT1} = Off$       | -                   | 3         | 6                   | mA         |
|   |           | $I_{DD(off) 2}$    | $R_{ext} = 5.6k\Omega, \overline{OUT0} \sim \overline{OUT1} = Off$ | -                   | 4         | 7                   |            |
|   |           | $I_{DD(off) 3}$    | $R_{ext} = 1.4k\Omega, \overline{OUT0} \sim \overline{OUT1} = Off$ | -                   | 5         | 8                   |            |
|   | “ON”      | $I_{DD(on) 1}$     | $R_{ext} = 5.6k\Omega, \overline{OUT0} \sim \overline{OUT1} = On$  | -                   | 4         | 7                   |            |
|   |           | $I_{DD(on) 2}$     | $R_{ext} = 1.4k\Omega, \overline{OUT0} \sim \overline{OUT1} = On$  | -                   | 5         | 8                   |            |

Test Circuit for Electrical Characteristics

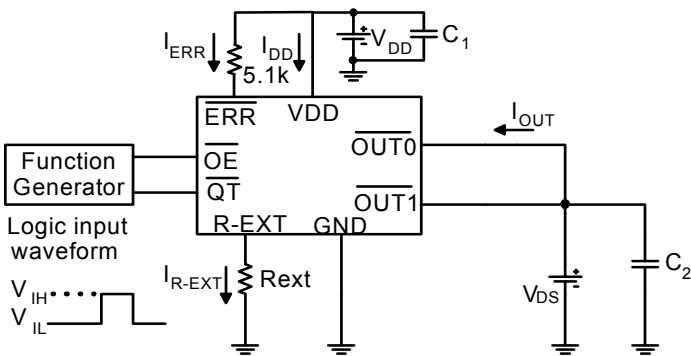


Figure 2

Switching Characteristics

| Characteristic                                  |                                   | Symbol      | Condition  | Min. | Typ. | Max. | Unit          |
|---|-----------------------------------|-------------|--|------|------|------|---------------|
| Propagation Delay Time ("L" to "H")             | $\overline{OE} - \overline{OUTn}$ | $t_{pLH}$   | $V_{DD} = 5.0\text{ V}$<br>$V_{DS} = 1.0\text{ V}$       | 0.3  | 0.5  | 1    | $\mu\text{s}$ |
| Propagation Delay Time ("H" to "L")             | $\overline{OE} - \overline{OUTn}$ | $t_{pHL}$   | $V_{IH} = V_{DD}$<br>$V_{IL} = \text{GND}$               | 0.3  | 0.5  | 1    | $\mu\text{s}$ |
| Pulse Width                                     | $\overline{OE}$                   | $t_{w(OE)}$ | $R_{ext} = 1630\Omega$<br>( $I_{OUTn} = 360\text{ mA}$ ) | 1.5  | -    | -    | $\mu\text{s}$ |
| Output Rise Time of $\overline{OUT}$ (turn off) |                                   | $t_{or}$    | $V_L = 4.0\text{ V}$<br>$R_L = 8.684\Omega$              | 0.3  | 0.5  | 1    | $\mu\text{s}$ |
| Output Fall Time of $\overline{OUT}$ (turn on)  |                                   | $t_{of}$    | $C_L = 10\text{ pF}$                                     | 0.3  | 0.5  | 1    | $\mu\text{s}$ |

Test Circuit for Switching Characteristics

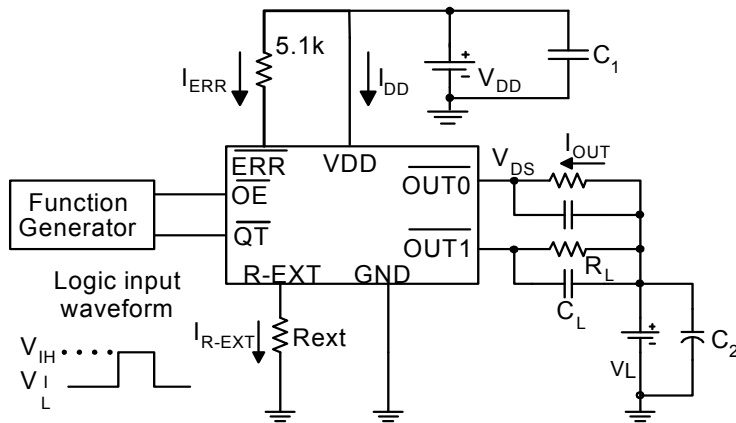
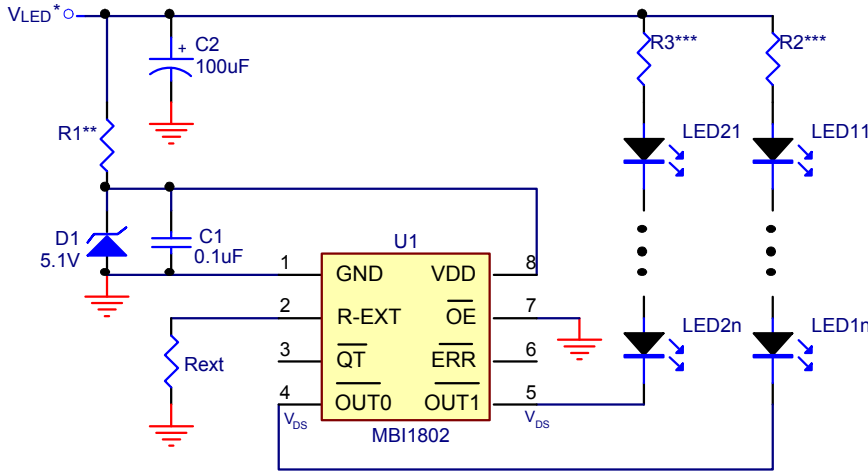


Figure 3

Application Information

Application Circuits

(a) MBI1802 application circuit, where  $V_{LED}$  and  $V_{DD}$  share a single voltage source.

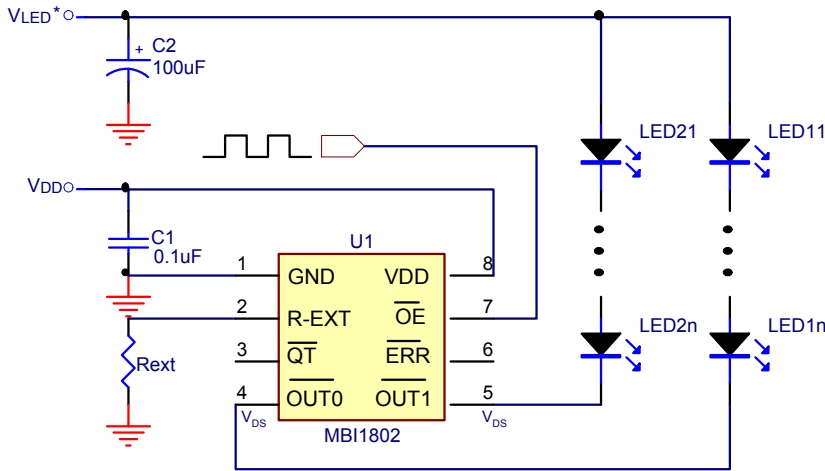


\*  $V_{LED} > V_{DS} + V_{F,LED} \times n$ ;  $V_{F,LED}$ : Forward voltage of LED; n: LED count

\*\*  $R1 = (V_{LED} - 5.1V) / I_{DD}$ ; refer to Electrical Characteristics for  $I_{DD}$

\*\*\*  $R2 = R3 = [V_{LED} - V_{DS} - (V_{F,LED} \times n)] / I_{LED}$

(b) MBI1802 Application Circuit with dimming control by PWM signal, where  $V_{LED}$  and  $V_{DD}$  use voltage sources separately.



\*  $V_{LED} = V_{DS} + V_{F,LED} \times n$ ;  $V_{F,LED}$ : Forward voltage of LED; n: LED count

Figure 4

### Constant Current

In LED lighting applications, MBI1802 provides nearly no variation in current from channel to channel and from IC to IC. This can be achieved by:

- 1) The maximum current variation between channels is less than  $\pm 3\%$ , and that between ICs is less than  $\pm 6\%$ .
- 2) In addition, the current characteristic of output stage is flat and users can refer to the figure as shown below. The output current can be kept constant regardless of the variations of LED forward voltages ( $V_F$ ). This guarantees LED to be performed on the same brightness as user's specification.

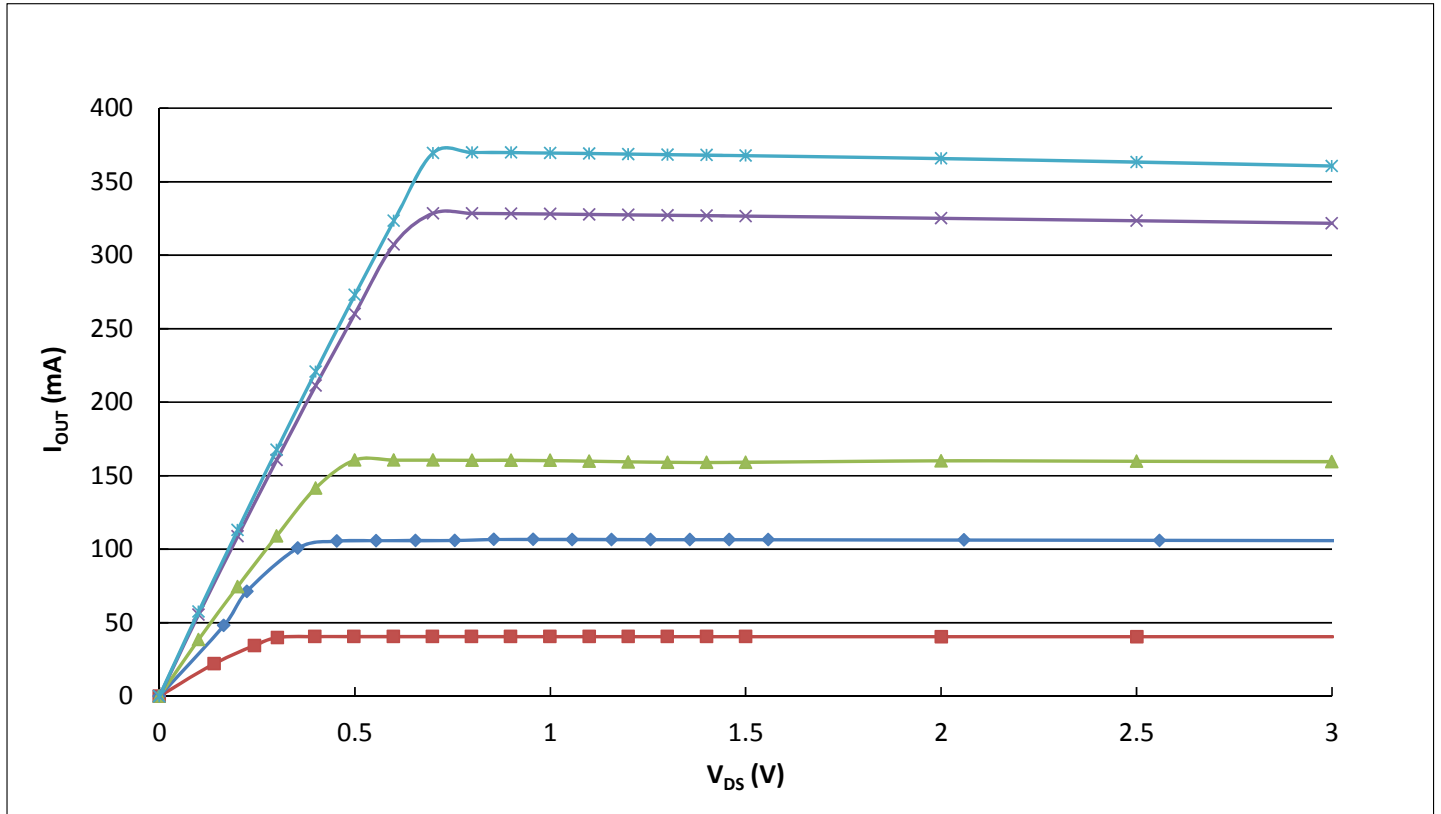


Figure 5



## Setting Output Current

The output current of each channel ( $I_{OUT}$ ) is set by an external resistor,  $R_{ext}$ . The relationship between  $I_{OUT}$  and  $R_{ext}$  is shown in the following figure.

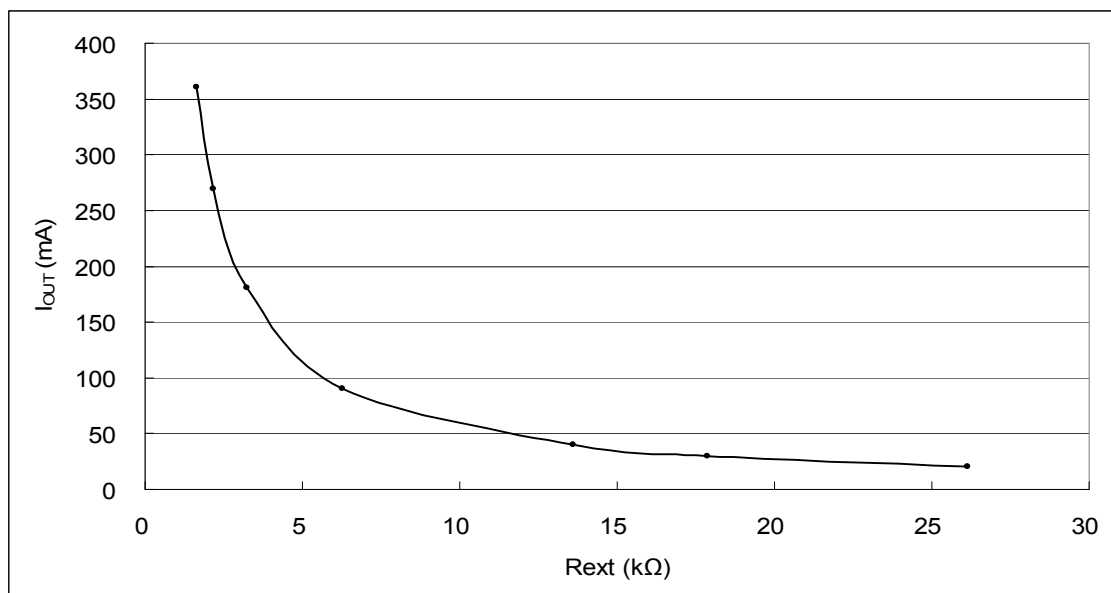


Figure 6

Also, the output current can be calculated from the equation:

$$V_{R-EXT} = 1.24V ;$$

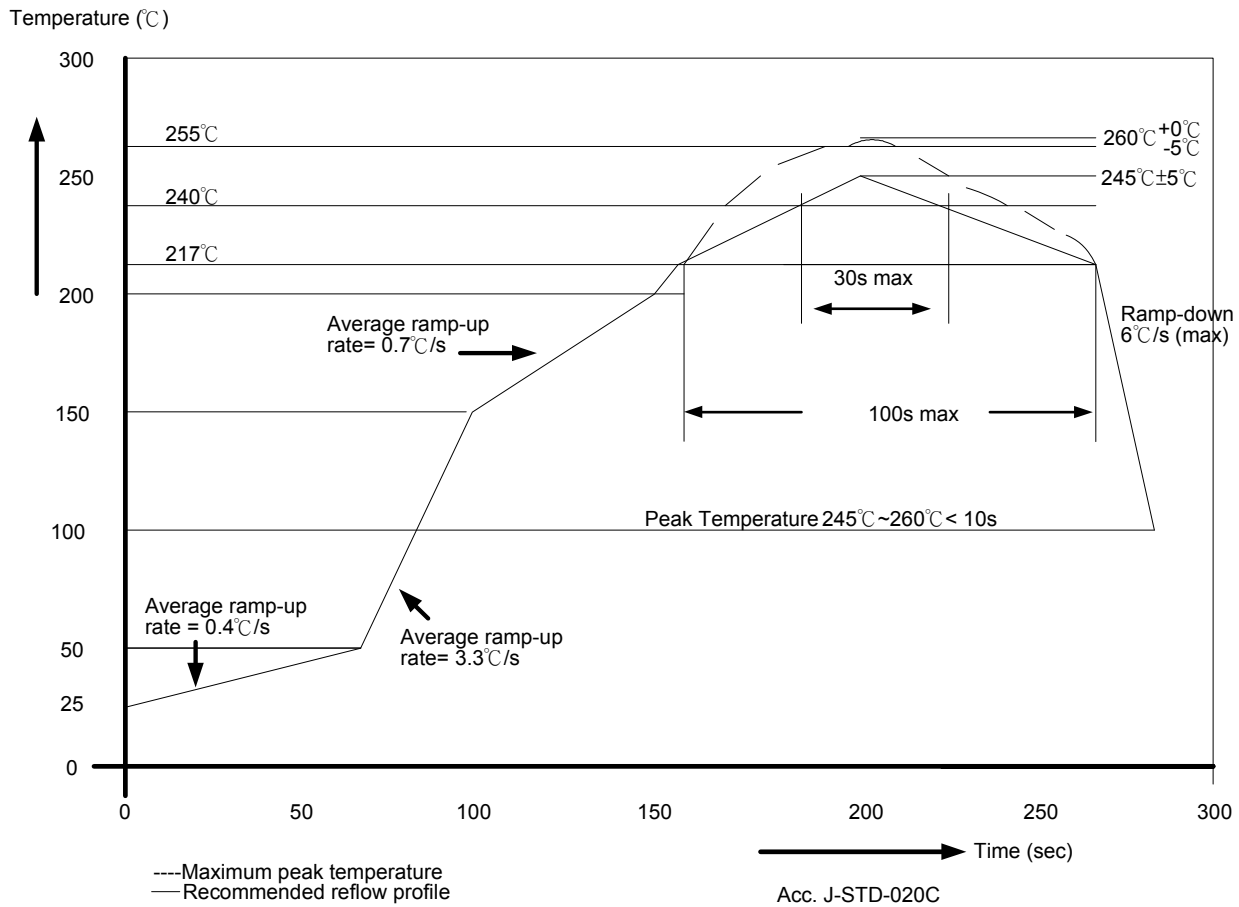
$$R_{ext} = (V_{R-EXT} / I_{OUT}) \times 471 = (1.24V / I_{OUT}) \times 471,$$

$$I_{OUT} = (V_{R-EXT} / R_{ext}) \times 471 = (1.24V / R_{ext}) \times 471 \text{ within } \pm 6\% \text{ chip skew}$$

where  $R_{ext}$  is the resistance of the external resistor connected to R-EXT terminal and  $V_{R-EXT}$  is the voltage of R-EXT terminal. The magnitude of current (as a function of  $R_{ext}$ ) is around 243mA at 2.4k $\Omega$  and 324mA at 1.8k $\Omega$ .

Soldering Process of "Pb-free & Green" Package Plating\*

Macroblock has defined "Pb-Free & Green" to mean semiconductor products that are compatible with the current RoHS requirements and selected **100% pure tin (Sn)** to provide forward and backward compatibility with both the current industry-standard SnPb-based soldering processes and higher-temperature Pb-free processes. Pure tin is widely accepted by customers and suppliers of electronic devices in Europe, Asia and the US as the lead-free surface finish of choice to replace tin-lead. Also, it is backward compatible to standard 215°C to 240°C reflow processes which adopt tin/lead (SnPb) solder paste. However, in the whole Pb-free soldering processes and materials, 100% pure tin (Sn) will all require up to 260°C for proper soldering on boards, referring to J-STD-020C as shown below.



\*For details, please refer to Macroblock's "Policy on Pb-free & Green Package".

Package Power Dissipation ( $P_D$ )

The maximum power dissipation,  $P_D(\text{max}) = (T_{j,\text{max}} - T_a) / R_{\text{th}(j-a)}$ , decreases as the ambient temperature increases.

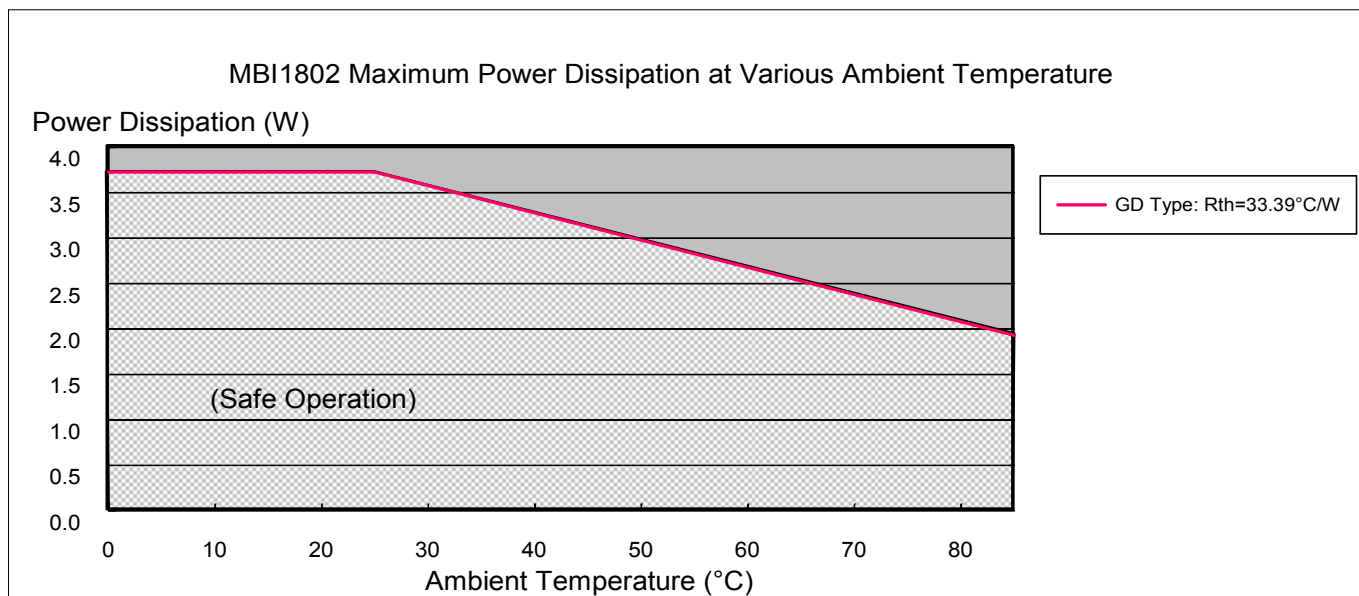


Figure 7

**TP Function (Thermal Protection)**

When the junction temperature exceeds the threshold,  $T_x$  (165°C), TP function turns off the output current and the thermal error flag,  $\overline{ERR}$ , goes low simultaneously. As soon as the temperature is below 165°C, the output current will be turned on again. The on-state and off-state switch at a high frequency; thus, the blinking is imperceptible. However, the average output current is limited, and therefore, the driver is protected from being overheated.

**Load Supply Voltage ( $V_{LED}$ )**

MBI1802 is designed to operate with adequate  $V_{DS}$  to achieve constant current.  $V_{DS}$  together with  $I_{OUT}$  should not exceed the package power dissipation limit,  $P_{D(max)}$ .

As in Figure 8,  $V_{DS} = V_{LED} - V_F$ , and  $V_{LED}$  is the load supply voltage.  $P_{D(act)}$  will be greater than  $P_{D(max)}$ , if  $V_{DS}$  drops too much voltage on the driver. In this case, it is recommended to use the lowest possible supply voltage or to set an external voltage reducer,  $V_{DROP}$ .

A voltage reducer lets  $V_{DS} = (V_{LED} - V_F) - V_{DROP}$ .

Resistors can be used in the applications as shown in Figure 8.

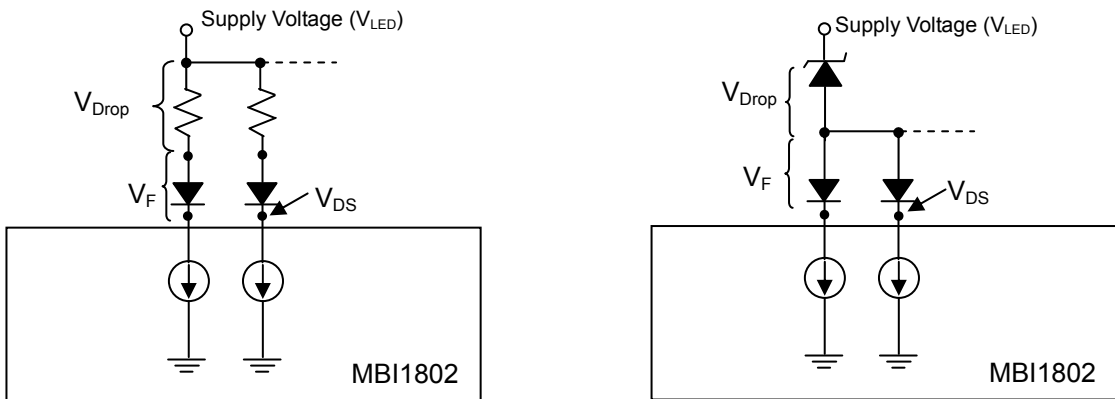
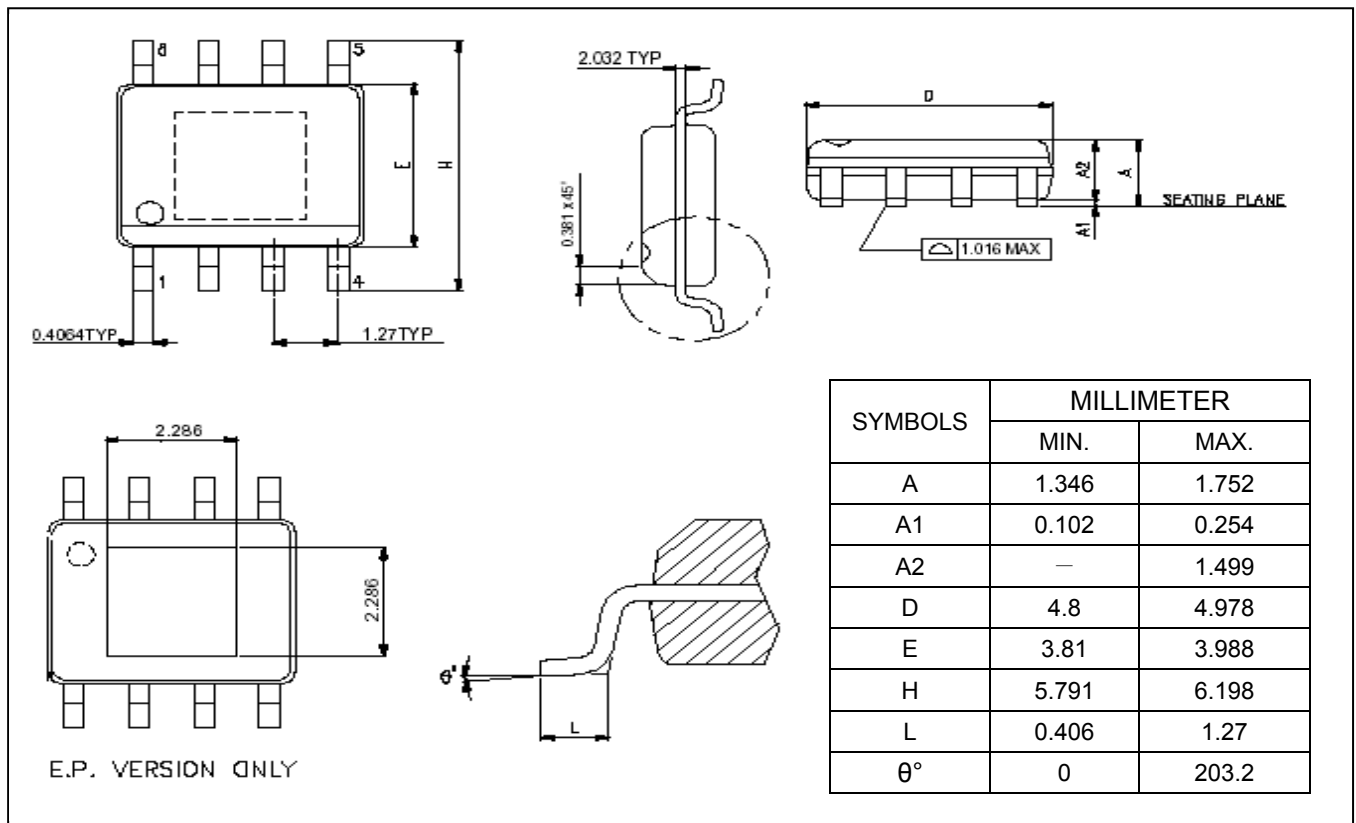


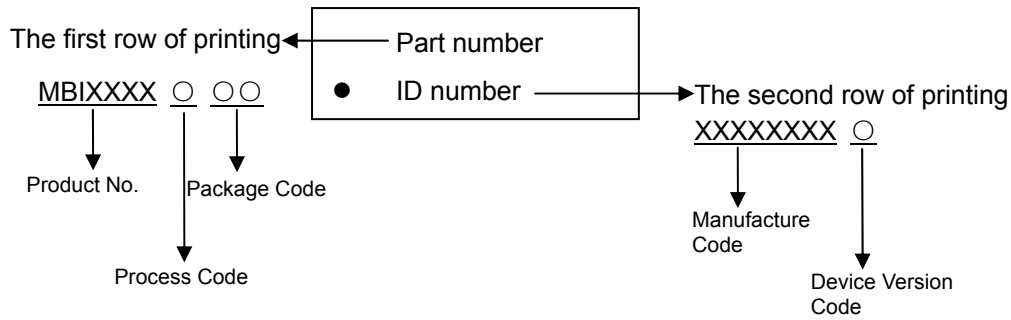
Figure 8

Outline Drawing



MBI1802GD Outline Drawing

Product Top-mark Information



Product Revision History

| Datasheet Version | Device Version Code |
|-------------------|---------------------|
| VA.00             | B                   |
| VB.00             | C                   |

Product Ordering Information

| Part Number | Package Type   | Weight (g) |
|-------------|----------------|------------|
| MBI1802GD-C | SOP8L-150-1.27 | 0.07       |

## Disclaimer

Macroblock reserves the right to make changes, corrections, modifications, and improvements to their products and documents or discontinue any product or service. Customers are advised to consult their sales representative for the latest product information before ordering. All products are sold subject to the terms and conditions supplied at the time of order acknowledgement, including those pertaining to warranty, patent infringement, and limitation of liability.

Macroblock's products are not designed to be used as components in device intended to support or sustain life or in military applications. Use of Macroblock's products in components intended for surgical implant into the body, or other applications in which failure of Macroblock's products could create a situation where personal death or injury may occur, is not authorized without the express written approval of the Managing Director of Macroblock. Macroblock will not be held liable for any damages or claims resulting from the use of its products in medical and military applications.

All text, images, logos and information contained on this document is the intellectual property of Macroblock. Unauthorized reproduction, duplication, extraction, use or disclosure of the above mentioned intellectual property will be deemed as infringement.