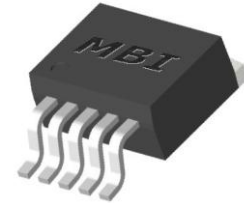


**All-Ways-On™ High-Power LED Driver****Features**

- Constant output current invariant to supply and load voltage change
- Maximum output constant current: 1.2A
- Output current adjusted through an external resistor
- Built-in thermal protection
- 5V supply voltage
- RoHS-compliant package

**Surface Mount Device**

GSD: TO-265-5L

**Product Description**

MBI1801 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. At MBI1801 output stage, one regulated current port is designed to provide a uniform and constant current sink for driving LEDs within a large range of  $V_F$  variations.

With All-Ways-On™, MBI1801 easily provides users a consistent current source. Users may adjust the output current from 50 mA up to 1.2A through an external resistor,  $R_{ext}$ , which gives users flexibility in controlling the light intensity of LEDs. In addition, users can precisely adjust LED brightness from 0% to 100% via output enable ( $\overline{OE}$ ) with Pulse Width Modulation. MBI1801 also guarantees that LEDs can be cascaded to maximum 17V at the output port.

Additionally, to ensure the system reliability, MBI1801 is built with Thermal Protection (TP) function. The TP function protects IC from over temperature (165°C). Also, the TO package enhances the power dissipation. As a result, a large amount of current can be sunk safely in one package.

**Applications**

- High-flux LED lighting

**Function Block Diagram**

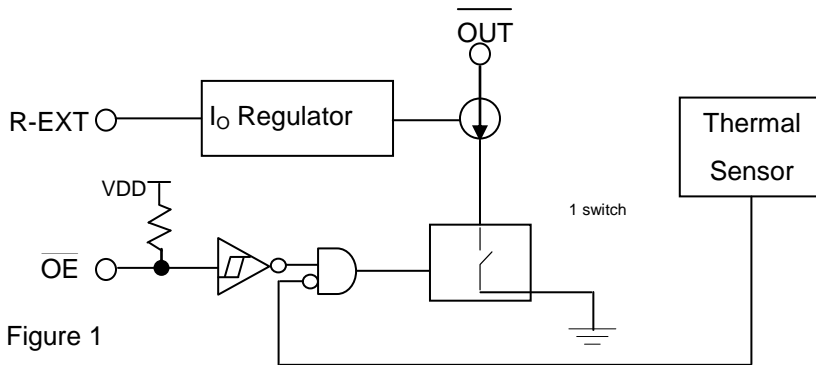
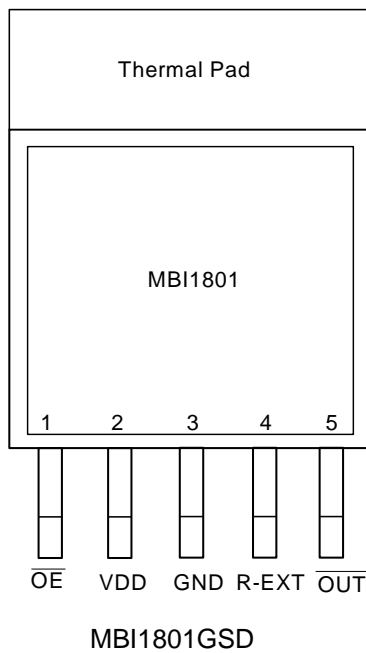


Figure 1

**Pin Configuration**

**Pin Description**



	Pin Name	Function
1	$\overline{OE}$	Output enable terminal When $\overline{OE}$ is active (low), the output is enabled; when $\overline{OE}$ is inactive (high), the output is turned OFF (blanked).
2	VDD	5V supply voltage terminal
3	GND	Ground terminal for control logic and current sink
4	R-EXT	Terminal used to connect an external resistor ( $R_{ext}$ ) for setting up output current for the output channel
5	$\overline{OUT}$	Constant current output terminal
-	Thermal Pad	Power dissipation terminal 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 device is screwed with thermal pad.

**Maximum Ratings**

Characteristics		Symbol	Rating	Unit
Supply Voltage		$V_{DD}$	0~7.0	V
Input Voltage		$V_{IN}$	-0.4~ $V_{DD} + 0.4$	V
Output Current		$I_{OUT}$	1440	mA
Sustaining Voltage		$V_{DS}$	-0.5~+17.0	V
GND Terminal Current		$I_{GND}$	1440	mA
Power Dissipation ( $T_a=25^{\circ}C$ )	GSD Type	$P_D$	1.6	W
Thermal Resistance* (On PCB, by simulation)		$R_{th(j-a)}$	21.99	$^{\circ}C/W$
Empirical Thermal Resistance ( $T_a=25^{\circ}C$ )			60	$^{\circ}C/W$
Operating Ambient Temperature		$T_{opr}$	-40~+85	$^{\circ}C$
Junction Temperature		$T_{j,max}$	150**	$^{\circ}C$
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**

Characteristics		Symbol	Condition	Min.	Typ.	Max.	Unit
Supply Voltage		$V_{DD}$	-	4.5	5.0	5.5	V
Sustaining Voltage at $\overline{OE}$ =High		$V_{DS}$	$\overline{OUT}$ when $\overline{OE} = 5V = V_{DD}$	-	-	17.0	V
Output Current		$I_{OUT}$	DC Test Circuit	50	-	1200*	mA
Input Voltage	“H” level	$V_{IH,OE}$	$T_a = -40\sim 85^\circ C$	$0.7V_{DD}$	-	$V_{DD}$	V
	“L” level	$V_{IL,OE}$	$T_a = -40\sim 85^\circ C$	GND	-	$0.3V_{DD}$	V
Output Leakage Current		$I_{OH}$	$V_{DS} = 17V, \overline{OE} = High$	-	-	2.0	$\mu A$
Output Current 1		$I_{OUT}$	$V_{DS} = 0.6V$ $R_{ext} = 2.4k\Omega$	-	488	-	mA
Chip Skew 1		$dI_{OUT}/I_{OUT}$	$I_{OUT} = 488mA$ $V_{DS} = 0.6V$ $R_{ext} = 2.4k\Omega$	-	-	$\pm 6$	%
Output Current 2		$I_{OUT}$	$V_{DS} = 0.8V$ $R_{ext} = 1.2k\Omega$	-	976	-	mA
Chip Skew 2		$dI_{OUT}/I_{OUT}$	$I_{OUT} = 976mA$ $V_{DS} = 0.8V$ $R_{ext} = 1.2k\Omega$	-	-	$\pm 6$	%
Regulation of Output Current vs. Sustaining Voltage		$\%/dV_{DS}$	$V_{DS}$ within 1.0V and 3.0V	-	$\pm 0.1$	-	% / V
Regulation of Output Current vs. Supply Voltage		$\%/dV_{DD}$	$V_{DD}$ within 4.5V and 5.5V	-	$\pm 1$	-	% / V
$\overline{OE}$ Pull-up Resistor		$R_{IN(up)}$	$\overline{OE}$	200	500	800	k $\Omega$
Supply Current	“OFF”	$I_{DD(off) 1}$	$R_{ext} = Open, \overline{OUT} = Off$	-	5	8	mA
		$I_{DD(off) 2}$	$R_{ext} = 2.4k\Omega, \overline{OUT} = Off$	-	6	8	
		$I_{DD(off) 3}$	$R_{ext} = 1.2k\Omega, \overline{OUT} = Off$	-	8	11	
	“ON”	$I_{DD(on) 1}$	$R_{ext} = 2.4k\Omega, \overline{OUT} = On$	-	6	8	
		$I_{DD(on) 2}$	$R_{ext} = 1.2k\Omega, \overline{OUT} = On$	-	7	10	
Threshold Junction Temperature of Thermal Shutdown		$T_x$	When $T_j$ approaches $T_x$ and $\overline{OUT}$ is shut off.	-	165	-	$^\circ C$

\* The output current,  $I_{OUT}$ , can be driven up to 1440mA, if a heat-conducting device is applied.

**Test Circuit for Electrical Characteristics**

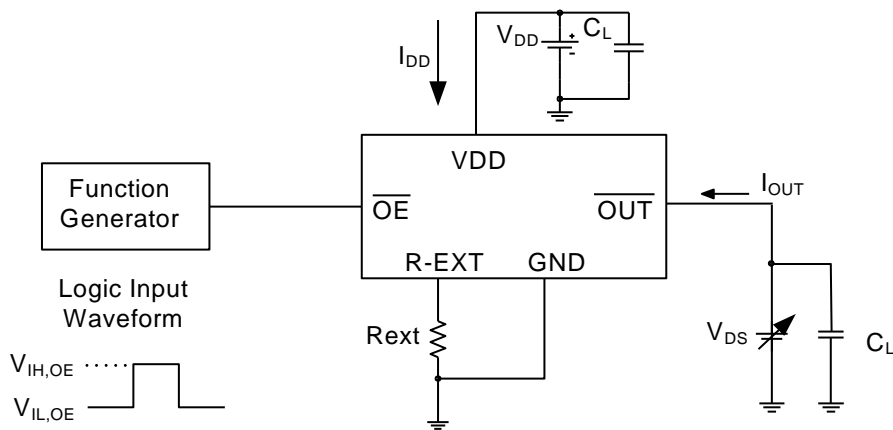


Figure 2

**Switching Characteristics**

Characteristic	Symbol	Condition	Min.	Typ.	Max.	Unit	
Propagation Delay Time ("L" to "H")	$\overline{OE} - \overline{OUT}$	$t_{pLH}$	$V_{DD} = 5.0\text{ V}$ $V_{DS} = 1\text{ V}$ $V_{IH,OE} = V_{DD}$ $V_{IL,OE} = \text{GND}$ $R_{ext} = 1200\Omega$ $(I_{OUT} = 976\text{mA})$	0.3	0.5	1	$\mu\text{s}$
Propagation Delay Time ("H" to "L")	$\overline{OE} - \overline{OUT}$	$t_{pHL}$		0.3	0.5	1	$\mu\text{s}$
Pulse Width	$\overline{OE}$	$t_{w(OE)}$		1			$\mu\text{s}$
Output Rise Time of $\overline{OUT}$ (turn off)		$t_{or}$		0.3	0.5	1	$\mu\text{s}$
Output Fall Time of $\overline{OUT}$ (turn on)		$t_{of}$		0.3	0.5	1	$\mu\text{s}$

**Test Circuit for Switching Characteristics**

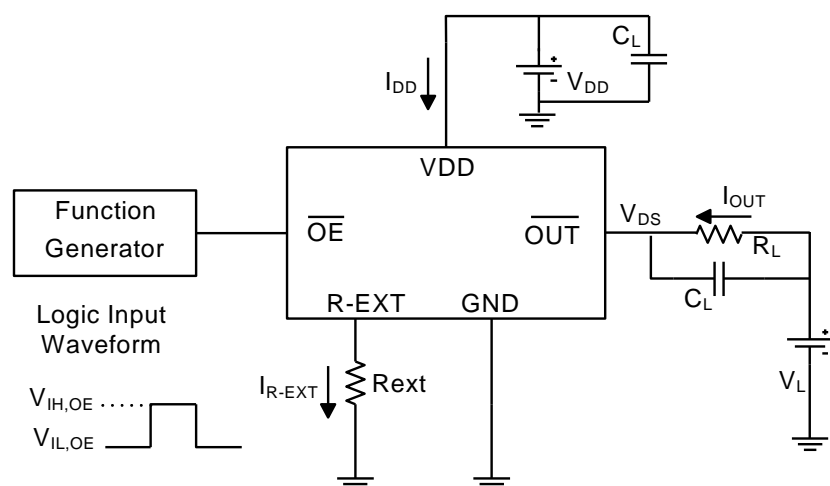


Figure 3

**Application Information**

**Typical Application Circuits**

MBI1801 application circuit

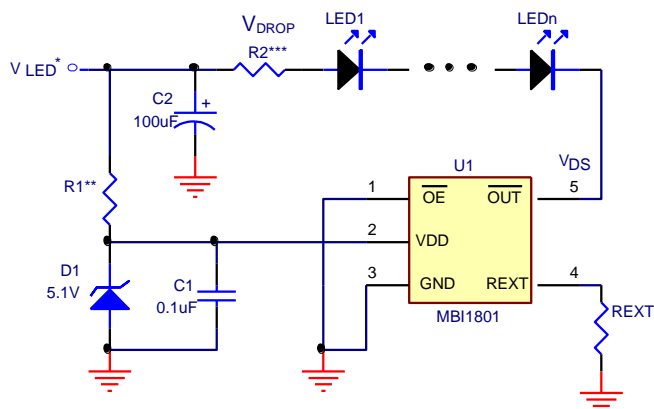


Figure 4

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

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

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

MBI1801 application circuit with brightness control by PWM signal

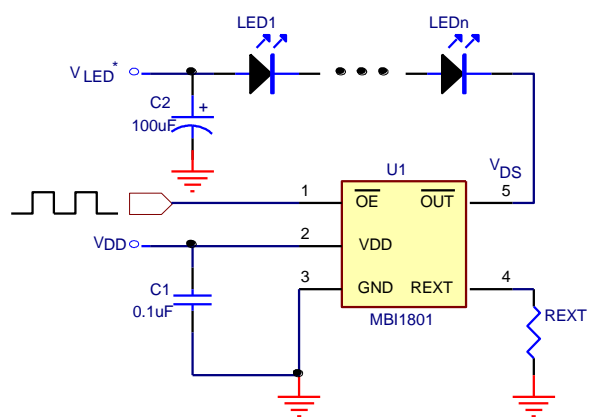


Figure 5

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

**Constant Current**

In LED lighting applications, MBI1801 provides nearly no variation in current from IC to IC. This can be achieved by:

- 1) The maximum current variation 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.

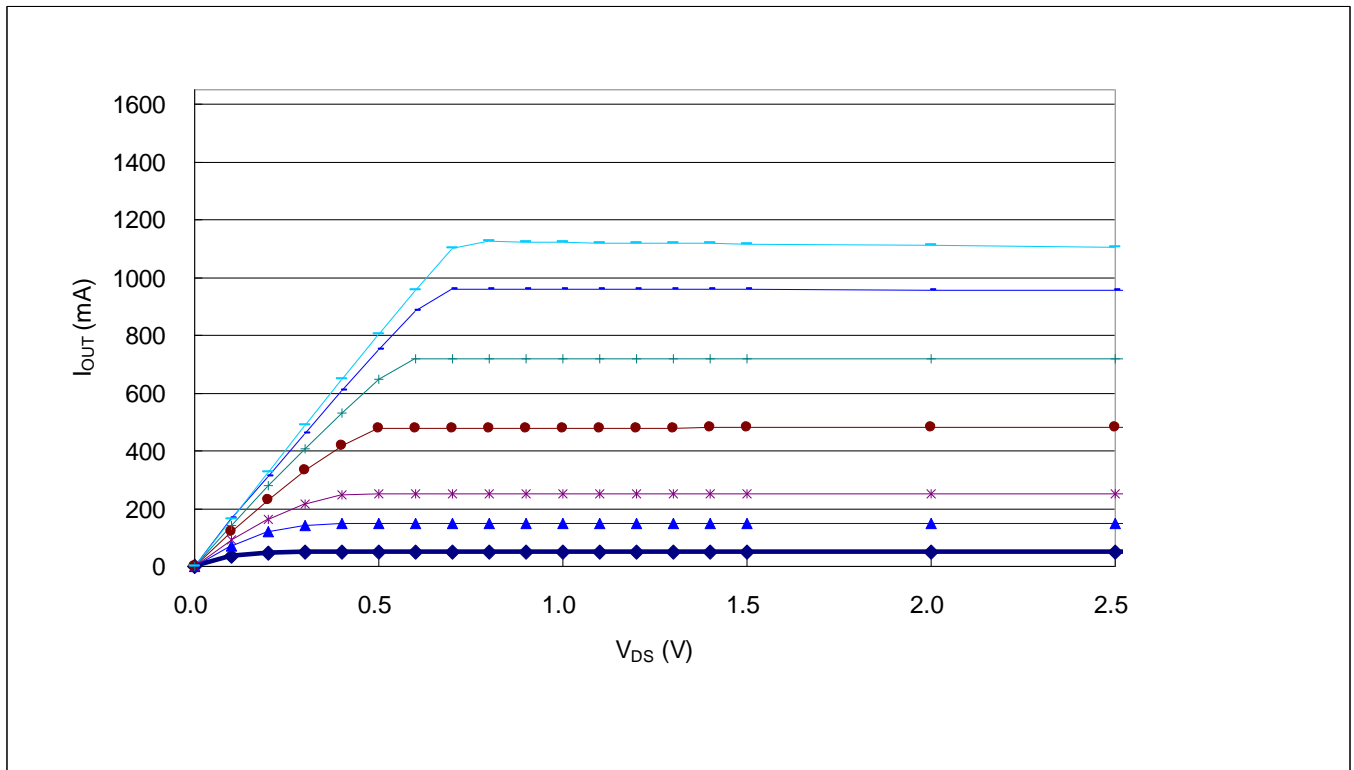


Figure 6

**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.

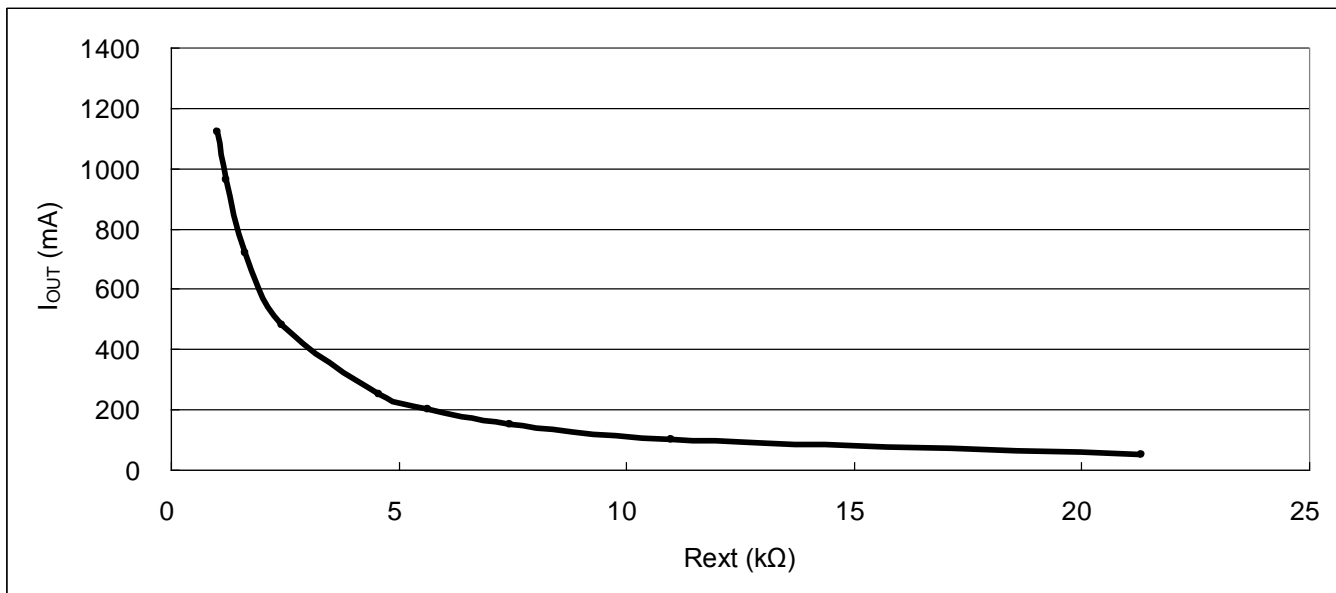


Figure 7

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

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

$$R_{ext} = (V_{R-EXT} / I_{OUT}) \times 945 = (1.24V / I_{OUT}) \times 945,$$

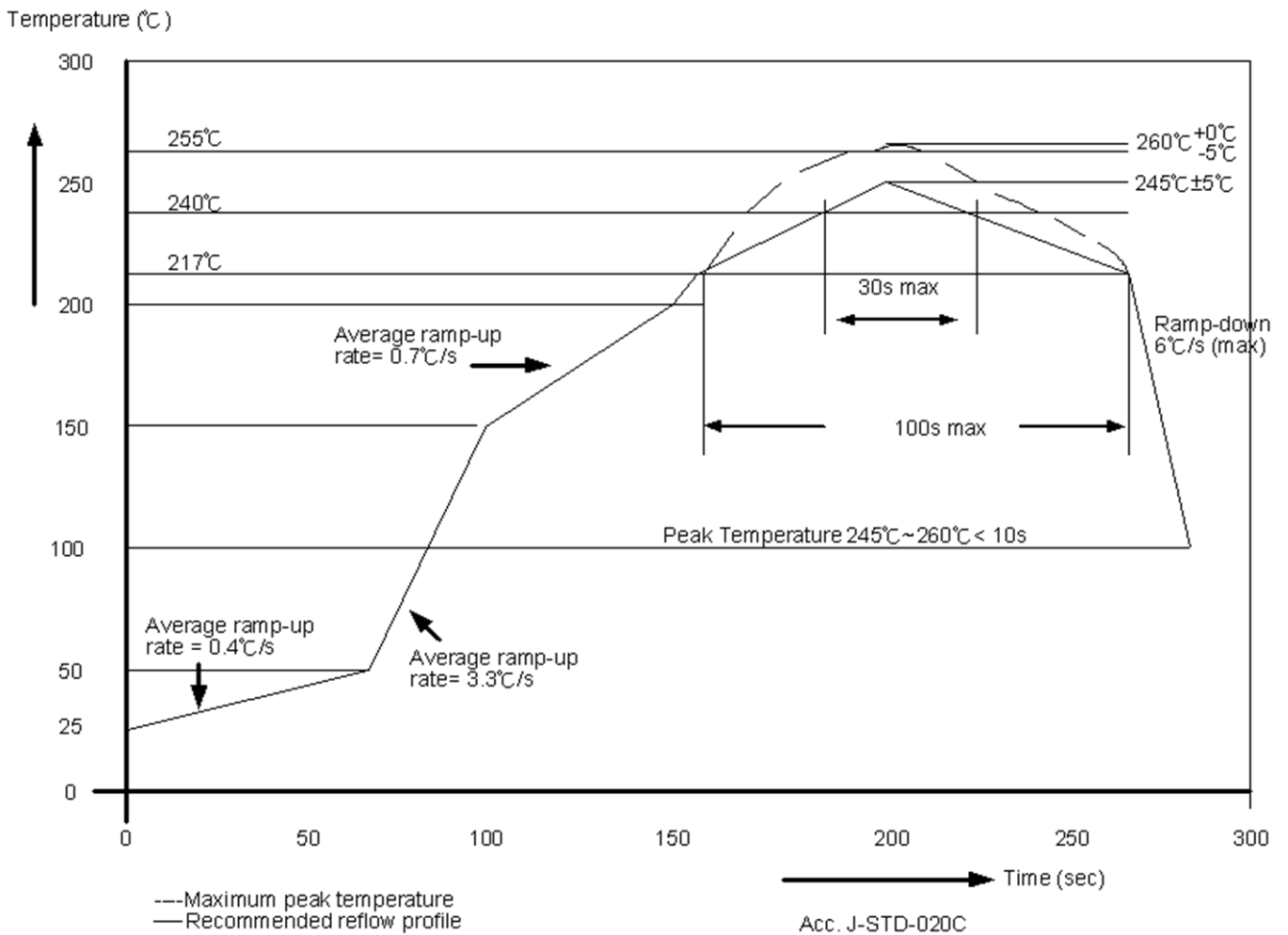
$$I_{OUT} = (V_{R-EXT} / R_{ext}) \times 945 = (1.24V / R_{ext}) \times 945 \text{ within } \pm 6\% \text{ chip skew}$$

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 976mA at 1200Ω and 488mA at 2400Ω.



**Soldering Process of “Pb-free” 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 adopts tin/lead (SnPb) solder paste, and please refer to the JEDEC J-STD-020C for the temperature of solder bath. However, in the whole Pbfree soldering processes and materials, 100% pure tin (Sn) will all require from 245 oC to 260oC for proper soldering on boards, referring to JEDEC J-STD-020C as shown below.



Package Thickness	Volume mm <sup>3</sup> <350	Volume mm <sup>3</sup> 350-2000	Volume mm <sup>3</sup> ≥ 2000
<1.6mm	260 +0 °C	260 +0 °C	260 +0 °C
1.6mm – 2.5mm	260 +0 °C	250 +0 °C	245 +0 °C
≥ 2.5mm	250 +0 °C	245 +0 °C	245 +0 °C

\*Note: For details, please refer to Macroblock’s “Policy on Pb-free & Green Package”.

**Package Power Dissipation (P<sub>D</sub>)**

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.

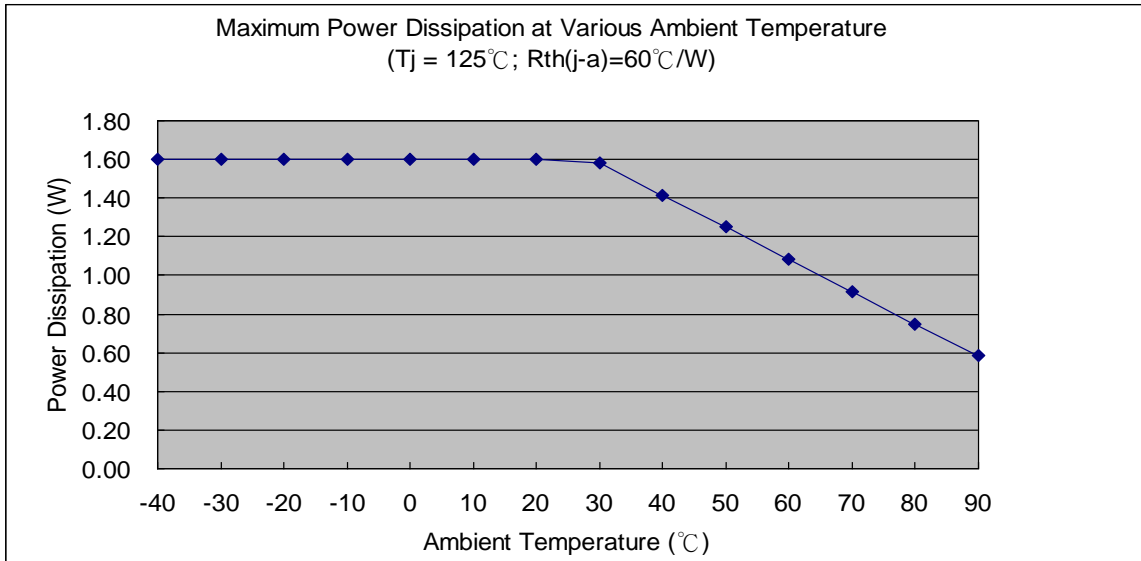


Figure 8

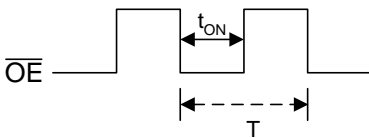
The maximum allowable package power dissipation is determined as  $P_D(\text{max}) = (T_{j,\text{max}} - T_a) / R_{\text{th}(j-a)}$ . When  $\overline{\text{O}}\overline{\text{U}}\overline{\text{T}}$  is turned on, the actual package power dissipation is  $P_D(\text{act}) = (I_{\text{DD}} \times V_{\text{DD}}) + (I_{\text{OUT}} \times \text{Duty} \times V_{\text{DS}})$ . Therefore, to keep  $P_D(\text{act}) \leq P_D(\text{max})$ , the allowable maximum output current as a function of duty cycle is:

$$I_{\text{OUT}} = \{ [(T_j - T_a) / R_{\text{th}(j-a)}] - (I_{\text{DD}} \times V_{\text{DD}}) \} / V_{\text{DS}} / \text{Duty},$$

where  $T_j = 125^\circ\text{C}$ ;

$$\text{Duty} = t_{\text{ON}} / T;$$

$t_{\text{ON}}$ : the time of LEDs turning on;  $T$ :  $\overline{\text{O}}\overline{\text{E}}$  signal period



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

MBI1801 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 4,  $V_{DS} = V_{LED} - V_F$ , 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,  $V_{DROP}$ .

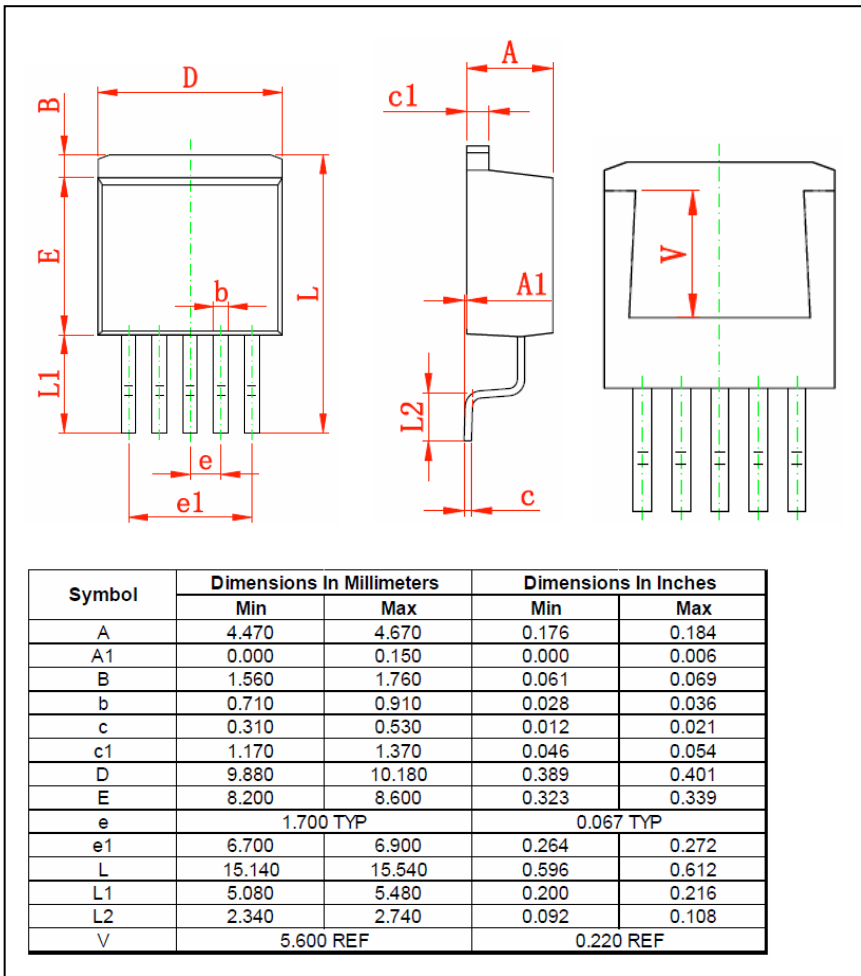
A voltage reducer lets  $V_{DS} = (V_{LED} - V_F) - V_{DROP}$ .

The resistor, R2, can be used in the applications as shown in Figure 4.

**TP Function (Thermal Protection)**

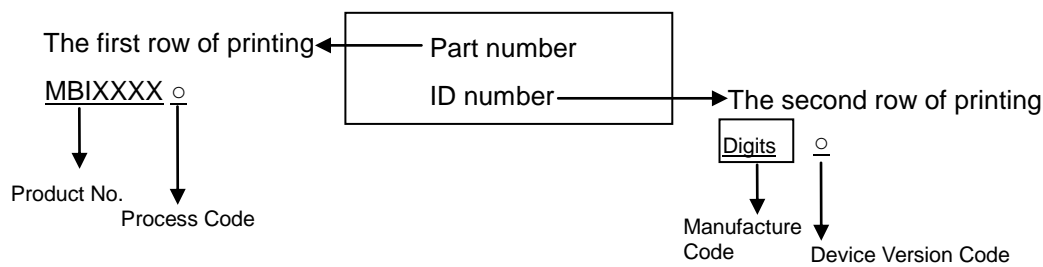
When the junction temperature exceeds the threshold,  $T_X$  (165°C), TP function turns off the output current. Thus, the junction temperature starts to decrease. As soon as the temperature is below 165°C, the output current will be turned on again. The on-state and off-state switch at a high frequency; thus, the blinking is imperceptible. However, the average output current is limited, and therefore, the driver is protected from being overheated.

**Outline Drawing**



MBI1801GSD

**Product Top-mark Information**



**Product Revision History**

Datasheet version	Device version code
VA.00	A
VA.01	A
VA.02	A

**Product Ordering Information**

Part Number	Package Type	Weight (g)
MBI1801GSD	TO-265-5L	1.534

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