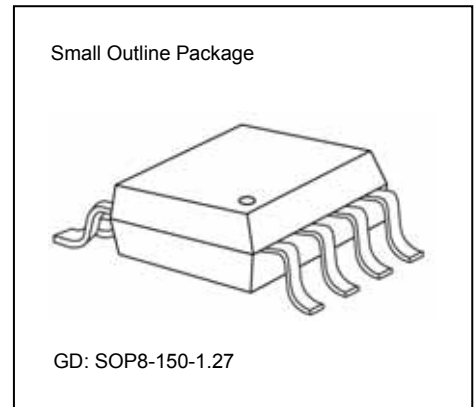




All-Ways-On™ High-Power LED Driver

Features

- 12V supply voltage
- 2 constant-current output channels
- Constant output current invariant to load voltage change
- Maximum output constant current per channel: 360 mA
- Thermal protection
- Individual output current adjusted through external resistors
- 25% and 50% of pre-set current adjustment via \overline{OEn} level setting
- Package type: "Pb-free & Green" package with thermal pad



Current Accuracy		Conditions
Between Channels	Between ICs	
< ±5%	< ±6%	$I_{OUTn} = 40mA \sim 360 mA$ @ $V_{DS} = 1V$

Product Description

MBI1812 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™, MBI1812 provides users with 2-channel constant current ports. Users may adjust the individual output current up to 360 mA through external resistors, R_{ext0} and R_{ext1} , which give 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, MBI1812 provides additional two-step current adjustment to make 25% and 50% of the output current via controlling pins, $\overline{OE0}$ and $\overline{OE1}$, to appropriate level.

Additionally, to ensure the system reliability, MBI1812 is built with thermal protection function and thermal pad. When junction temperature reaches 160°C, the output ports will be disabled to protect IC from thermal damage. The output will be activated again once the junction temperature cools down to 130°C. Also, the thermal pad enhances the power dissipation and a large amount of current can be sunk safely with the package.

Applications

- High-flux LED lighting

Typical Application Circuit

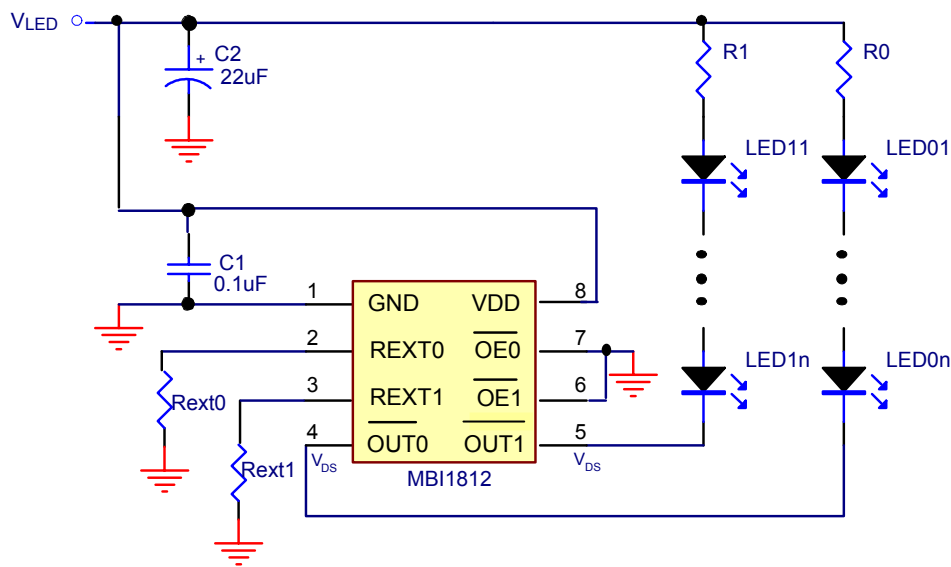
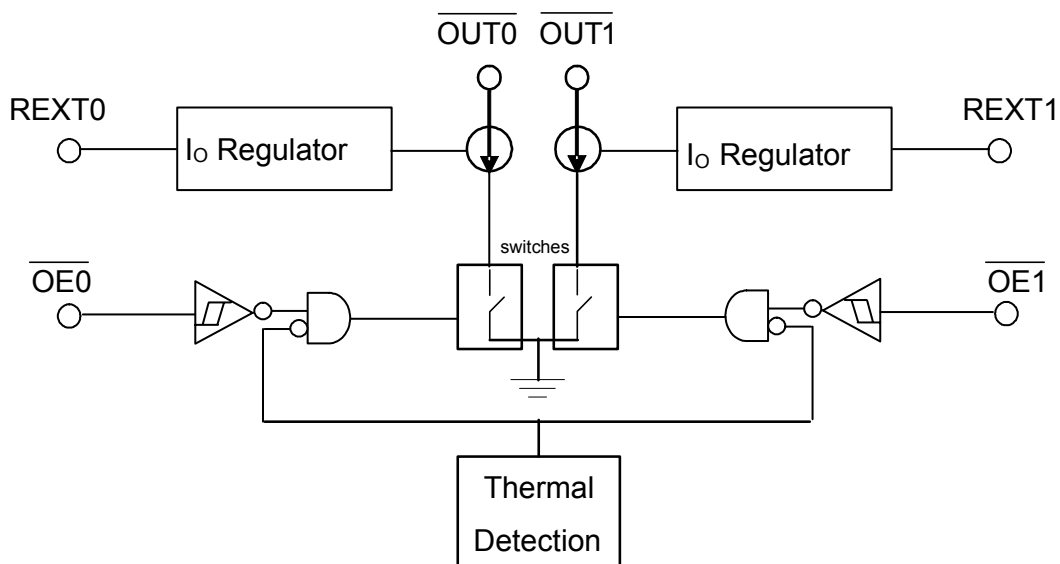
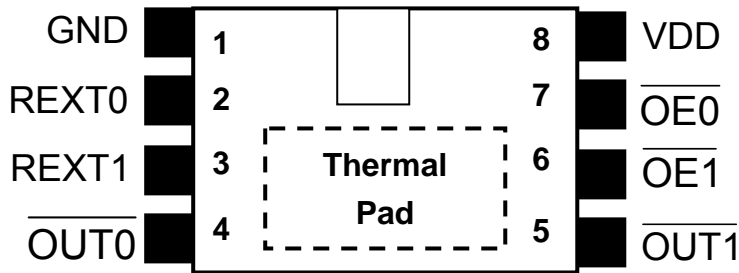


Figure 1

Functional Diagram



Pin Configuration



MBI1812GD

Pin Description

Pin No.	Pin Name	Function
1	GND	Ground terminal for control logic and current sink
2	REXT0	The terminal used to connect an external resistor for setting up output current for output channel $\overline{OUT0}$
3	REXT1	The terminal used to connect an external resistor for setting up output current for output channel $\overline{OUT1}$
4, 5	$\overline{OUT0}$ 、 $\overline{OUT1}$	Constant current output terminals
6	$\overline{OE0}$	$\overline{OE0}$ enable and analog dimming terminal* <ul style="list-style-type: none"> ■ $\overline{OE0} > 3V$, $\overline{OUT0}$ port is disabled ■ $2V < \overline{OE0} < 3V$, set the output current to 25% of the pre-set current ■ $1V < \overline{OE0} < 2V$, set the output current to 50% of the pre-set current ■ $\overline{OE0} < 1V$, $\overline{OUT0}$ is enabled and the output current is the pre-set current.
7	$\overline{OE1}$	$\overline{OE1}$ enable and analog dimming terminal* <ul style="list-style-type: none"> ■ $\overline{OE1} > 3V$, $\overline{OUT1}$ port is disabled ■ $2V < \overline{OE1} < 3V$, set the output current to 25% of the pre-set current ■ $1V < \overline{OE1} < 2V$, set the output current to 50% of the pre-set current ■ $\overline{OE1} < 1V$, $\overline{OUT1}$ is enabled and the output current is the pre-set current.
8	VDD	12V supply voltage terminal
-	Thermal Pad	Power dissipation terminals connect to GND**

*There is 200mV input voltage hysteresis in each transition point.

**To eliminate the noise influence, thermal pad is suggested to connect to GND on PCB. In addition, the desired thermal conductivity will be improved on condition that a heat-conducting copper foil on PCB is soldered with thermal pad.

Maximum Ratings

Characteristic		Symbol	Rating	Unit
Supply Voltage		V_{DD}	0~15.0	V
\overline{OEn}^* Input Voltage		V_{IN}	-0.4~ $V_{DD} + 0.4$	V
Output Current		I_{OUTn}^*	360	mA
Sustaining Voltage		V_{DSn}^*	-0.5~+17.0	V
GND Terminal Current		I_{GND}	720	mA
Power Dissipation** (On PCB, $T_a=25^\circ\text{C}$)	SOP8	P_D	0.8	W
Thermal Resistance*** (By simulation)		$R_{th(j-a)}$	33.39	$^\circ\text{C/W}$
Empirical Thermal Resistance** (On PCB, $T_a=25^\circ\text{C}$)			125	
Operating Junction Temperature		$T_{j,max}$	125	$^\circ\text{C}$
Operating Ambient Temperature		T_{opr}	-40~+85	$^\circ\text{C}$
Storage Temperature		T_{stg}	-55~+150	$^\circ\text{C}$

*n=0 or 1.

**Users must notice that the power dissipation (almost equaling to $I_{OUTn} \times V_{DSn}$) should be within the Safe Operation Area shown in Figure 11.

*** Provided by package house.

Electrical Characteristics

VDD=12V, GND =0V, Ta=25°C, unless otherwise specified.

Characteristic	Symbol	Condition	Min.	Typ.	Max.	Unit
Supply Voltage	V _{DD}	-	9.6	12	14.4	V
Output Current	I _{OUTn}	DC Test Circuit	40	-	360	mA
OEn Input Voltage Threshold* (high-to-low)	V _{IH}	V _{IH1,Min.} The minimum threshold voltage is to set original 0% to 25% of output current setting.	2.8	2.86		V
		V _{IH2,Min.} The minimum threshold voltage is to set original 25% to 50% of output current setting.	1.8	1.86		V
		V _{IH3,Min.} The minimum threshold voltage is to set original 50% to 100% of output current setting.	0.8	0.88		V
OEn Input Voltage Threshold* (low-to-high)	V _{IL}	V _{IL1,Max.} The maximum threshold voltage is to set original 100% to 50% of output current setting.		1.15	1.2	V
		V _{IL2,Max.} The maximum threshold voltage is to set original 50% to 25% of output current setting.		2.14	2.2	V
		V _{IL3,Max.} The maximum threshold voltage is to set original 25% to 0% of output current setting.		3.12	3.2	V
Output Leakage Current	I _{OH}	V _{DS} =17V, OEn=VDD		-	0.5	µA
Current Bit Skew	dI _{OUT} /I _{OUT}	V _{DS} = 0.7V, R _{extn} = 2.4kΩ I _{OL} = 360mA		±3	±5	%
Current Chip Skew				-	±6	%
Regulation of Output Current vs. Sustaining Voltage	%/dV _{DS}	V _{DS} within 1.0V and 3.0V		±0.65	±1.2	% / V
Regulation of Output Current vs. Supply Voltage	%/dV _{DD}	V _{DD} within 9.6V and 14.4V		±0.02	±0.1	% / V
Junction Temperature Threshold of Thermal Shutdown	T _x	When T _j approaches T _x and OUTn is shut off.		160		°C
Hysteresis of Thermal Shutdown				30		°C
Supply Current	"OFF"	I _{DD(off) 1} R _{extn} =Open, OEn=VDD		1.2	5	mA
		I _{DD(off) 2} R _{extn} =21.4kΩ, OEn=VDD, I _{OUTn} =0mA		2	6	
		I _{DD(off) 3} R _{extn} =2.4kΩ, OEn=VDD, I _{OUTn} =0mA		8.4	12	
	"ON"	I _{DD(on) 1} R _{extn} =21.4kΩ, OEn=GND, I _{OUTn} =40mA		2.3	6	
		I _{DD(on) 2} R _{extn} =2.4kΩ, OEn=GND, I _{OUTn} =360mA		8.5	12	

* Please refer to Figure 8 Adjustable Dimming Control on P.10 for details.

Note: OEn, OUTn, R_{extn} and I_{OUTn}, n=0 or 1.

Test Circuit for Electrical Characteristics

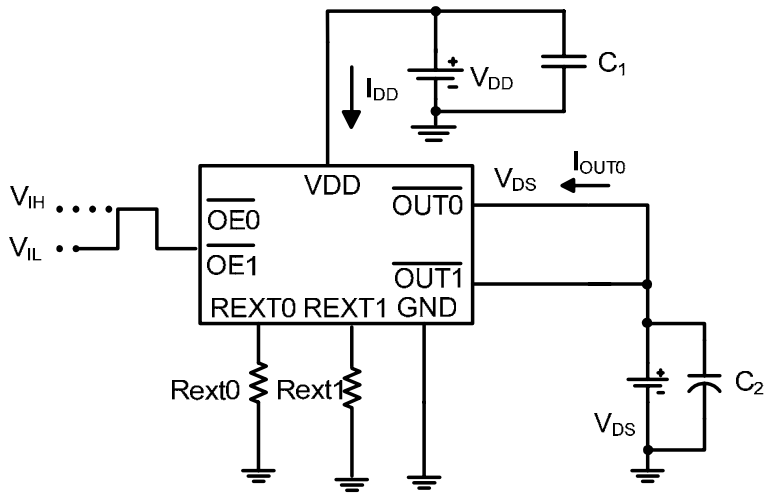


Figure 2

Switching Characteristics

$I_{OUTn}=40mA$

Characteristic		Symbol	Condition	Min.	Typ.	Max.	Unit
Propagation Delay Time ("L" to "H")	$\overline{OEn} - \overline{OUTn}$	t_{pLH}	$V_{DD}= 12.0 V$ $V_{DS}= 1.0V$ $V_{IH}= V_{DD}$ $V_{IL}= GND$ $R_{ext}= 22.4K\Omega$ ($I_{OUTn}=40mA$) $V_L= 4.0V$ $R_L= 100\Omega$ $C_L= 10 pF$	-	0.36	1	μs
Propagation Delay Time ("H" to "L")	$\overline{OEn} - \overline{OUTn}$	t_{pHL}		-	0.95	1	μs
Pulse Width	\overline{OEn}	$t_{w(OE)}$		1.5	-	-	μs
Output Rise Time of \overline{OUTn} (turn off)		t_{or}		-	0.55	1	μs
Output Fall Time of \overline{OUTn} (turn on)		t_{of}		-	0.42	1	μs

Note: n =0 or 1

$I_{OUTn}=360mA$

Characteristic		Symbol	Condition	Min.	Typ.	Max.	Unit
Propagation Delay Time ("L" to "H")	$\overline{OEn} - \overline{OUTn}$	t_{pLH}	$V_{DD}= 12.0 V$ $V_{DS}= 1.0V$ $V_{IH}= V_{DD}$ $V_{IL}= GND$ $R_{ext}= 2.4K\Omega$ ($I_{OUTn}=360mA$) $V_L= 4.0V$ $R_L= 11\Omega$ $C_L= 10 pF$	-	2	3	μs
Propagation Delay Time ("H" to "L")	$\overline{OEn} - \overline{OUTn}$	t_{pHL}		-	1.7	3	μs
Pulse Width	\overline{OEn}	$t_{w(OE)}$		2.5	-	-	μs
Output Rise Time of \overline{OUTn} (turn off)		t_{or}		-	1.4	3	μs
Output Fall Time of \overline{OUTn} (turn on)		t_{of}		-	1	3	μs

Note: n =0 or 1

Test Circuit for Switching Characteristics

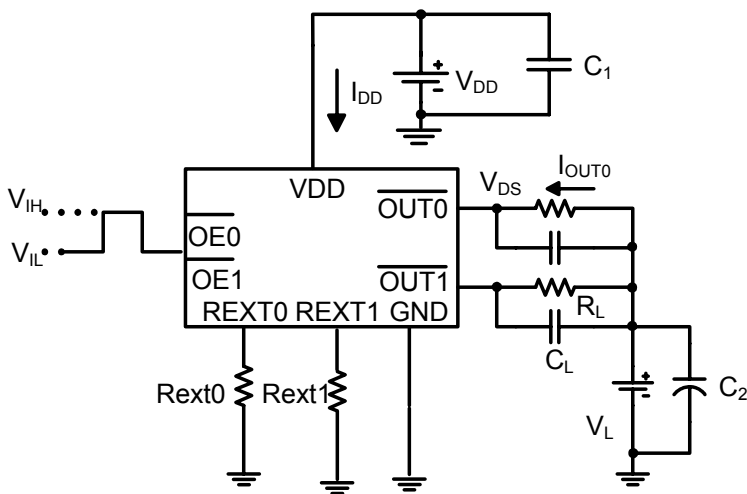


Figure 3

Application Information

Application Circuits

(a) MBI1812 application circuit, where V_{LED} and V_{DD} share a single voltage source.

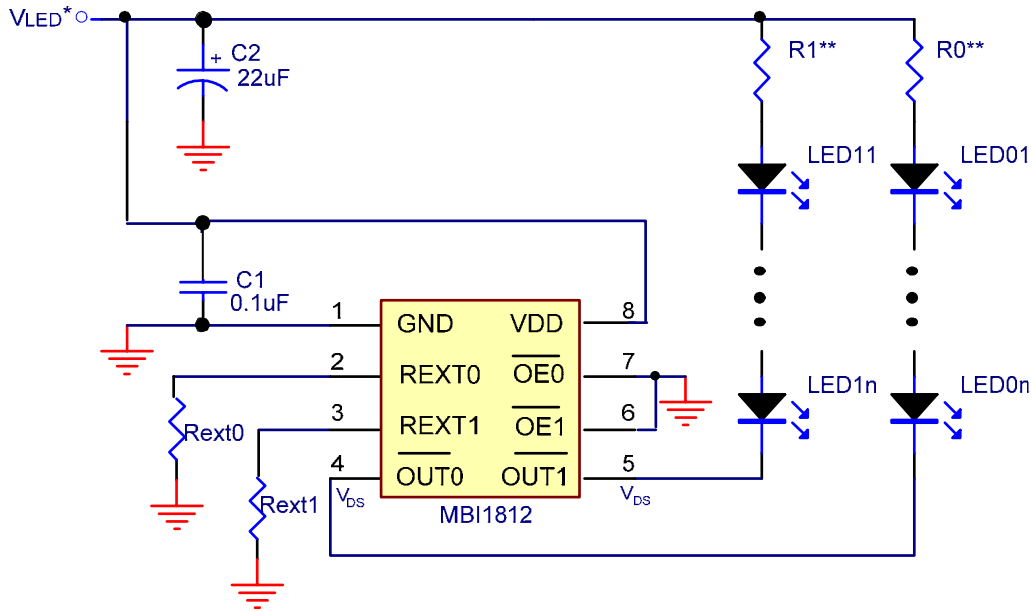


Figure 4

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

** $R_0 = R_1 = [V_{LED} - V_{DS} - (V_{F,LED} \times n)] / I_{LED}$;

Here in application circuits (a) and following (b), (c), (d), “n” refers to LED count.

(b) Dimming control by DC level to individual channels. MBI1812 exhibits capability of 4 level analog dimming to preset current by adjustment of \overline{OEn} DC level*.

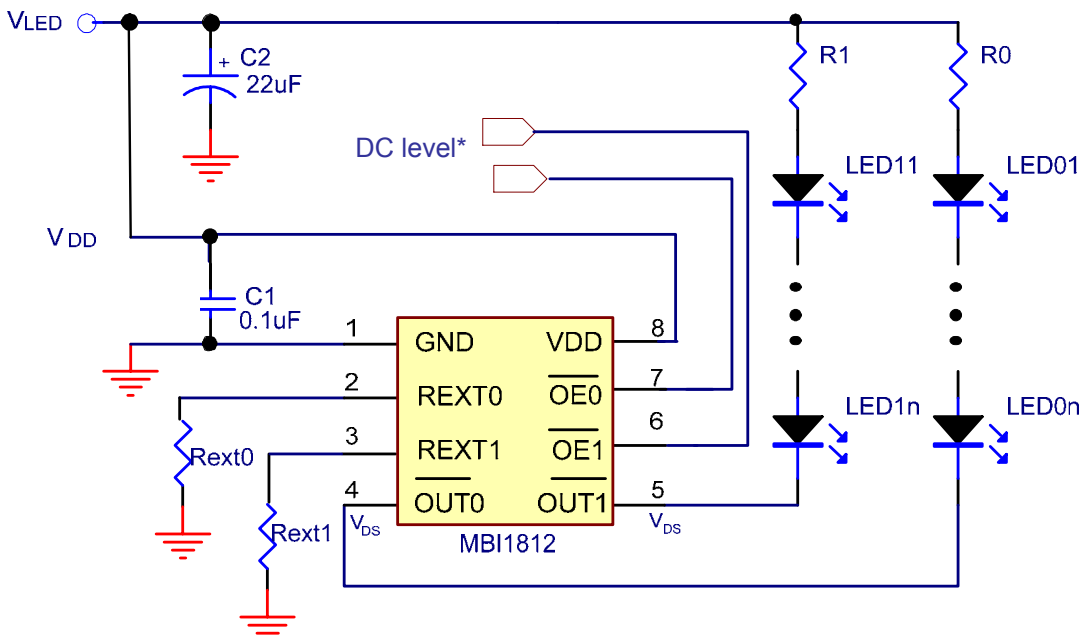


Figure 5

* Please refer to P.10 Adjustable Dimming Control for details.

(c) Dimming control by PWM signals to individual channels.

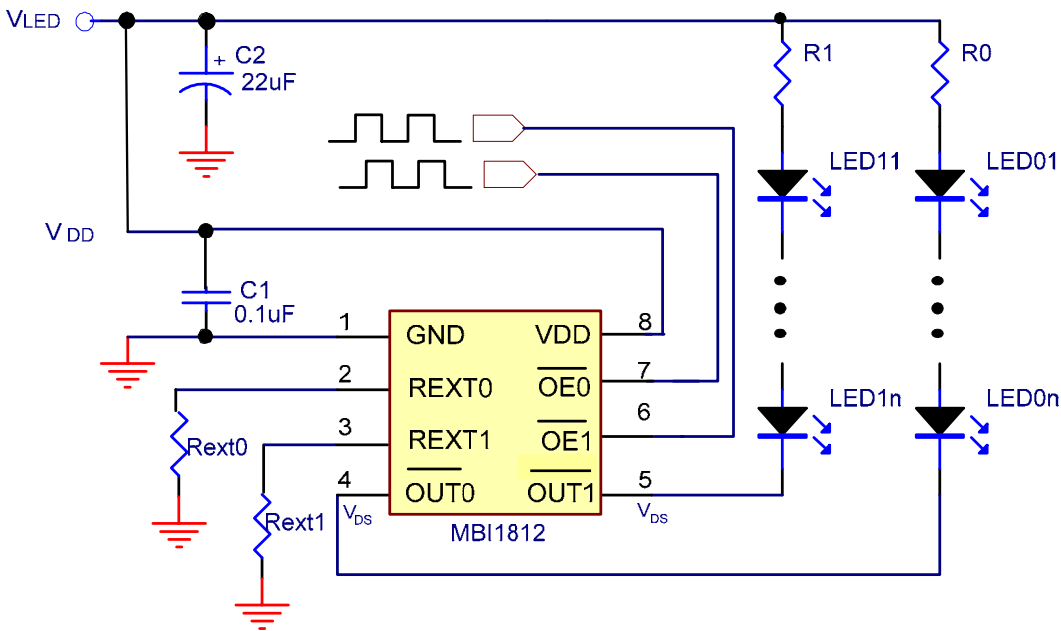


Figure 6

(d) For the case of using single channel, it is a must to well disable the non-used \overline{OUTn} . It is suggested that \overline{OEn} should tie to VDD through an external pull-up resistor, R_{UP} . The R_{UP} should be around 510 kohm.

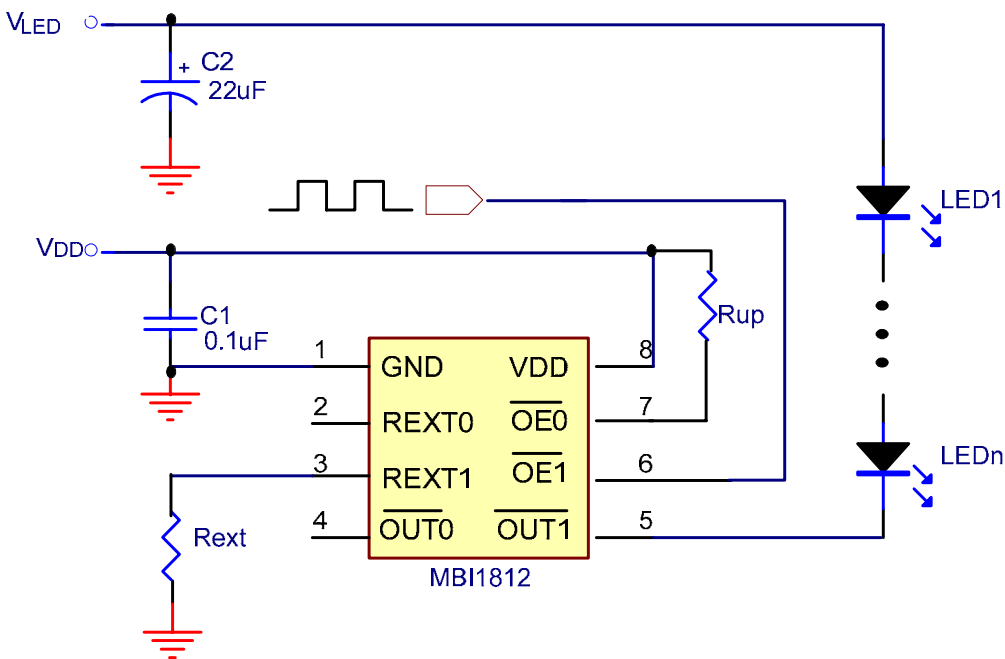


Figure 7

Adjustable Dimming Control

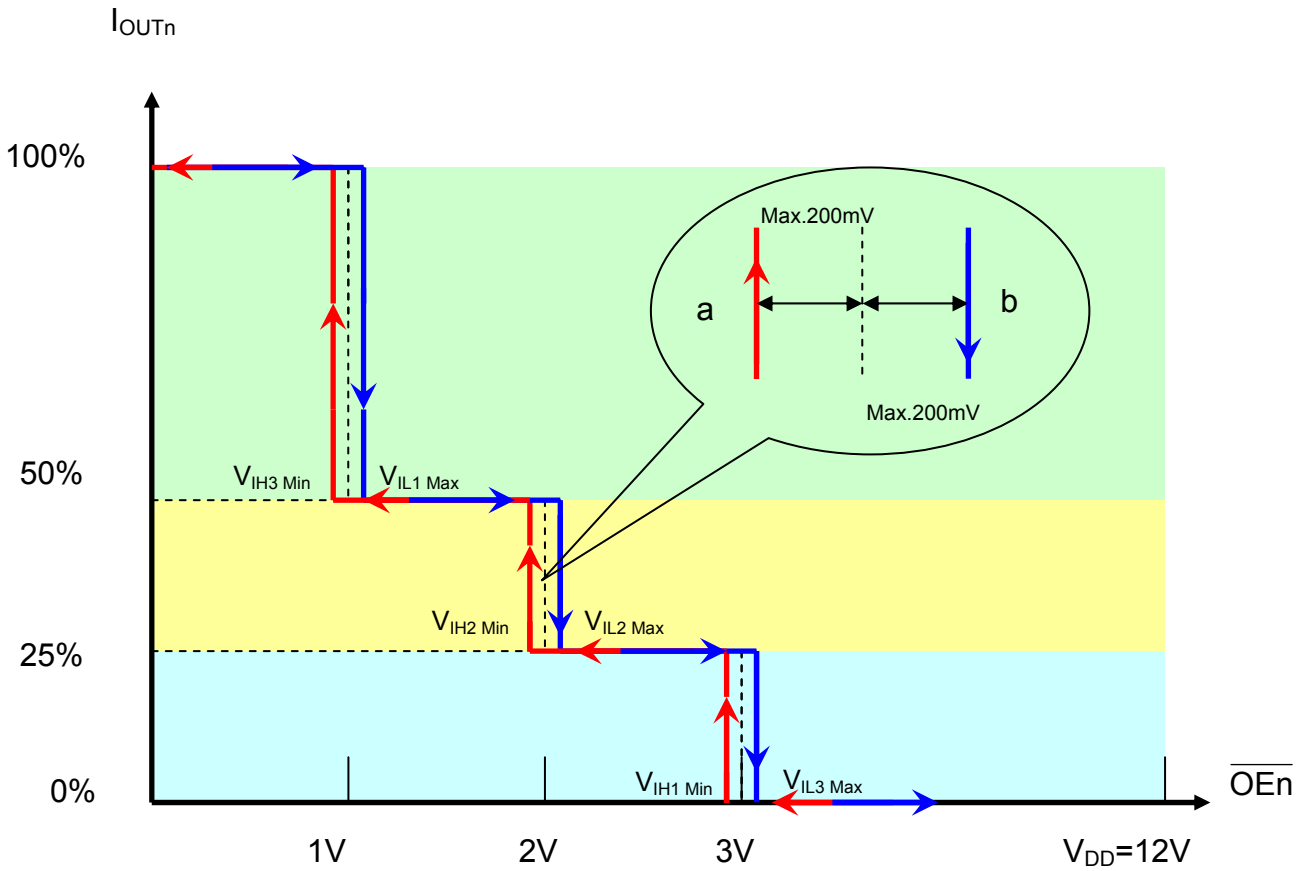


Figure 8

MBI1812 has analog dimming function for better application flexibility. MBI1812 provides two additional dimming level 25% and 50% of pre-set current which are controlled by \overline{OEn} , as shown in Figure 8 .

In general, when $\overline{OEn} > 3V$, the corresponding output pins are disabled. When $\overline{OEn} < 1V$, the output pins are fully enabled to the pre-set current. The additional two dimming levels are between $2V < \overline{OEn} < 3V$ and $1 < \overline{OEn} < 2 V$ when setting all the output current to 25% and 50% of the pre-set current.

Besides, there is hysteresis design in each transition point. The maximum value 200mV is to avoid output current from flickering when \overline{OEn} swaying between the nominal value of pre-set levels (1V, 2V and 3V). For example, when users increase the output current by controlling \overline{OEn} from high to low, the transition points are ahead of nominal values and reach to 2.86V, 1.86V and 0.88V individually as shown in the red line “a” of Figure 8.

On the other hand, when \overline{OEn} are from low to high, it means to dim the output current. Those transition points are behind nominal values and reach to 1.15V, 2.14V and 3.12V accordingly as shown in the blue line “b” of Figure 8.

Constant Current

In LED lighting applications, MBI1812 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 $\pm 5\%$, and that between ICs is less than $\pm 6\%$.
- 2) In addition, the current characteristic of output stage is flat as shown in Figure 9. The output current can be kept constant regardless of the variations of LED forward voltages (V_F). This guarantees LED to perform the same brightness as user's specification.

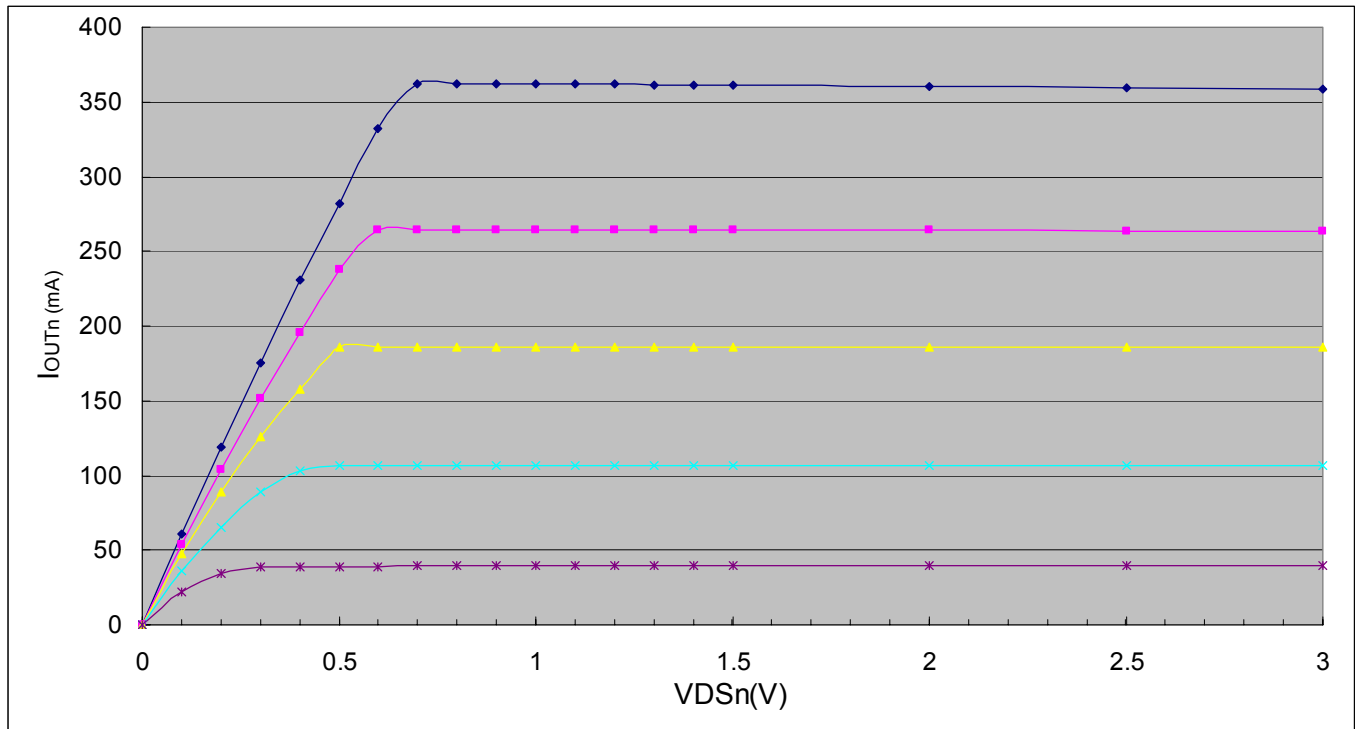


Figure 9

Setting Output Current

The output current of each channel (I_{OUTn}) is set by an external resistor, R_{extn} . The relationship between I_{OUTn} and R_{extn} is shown in Figure 10.

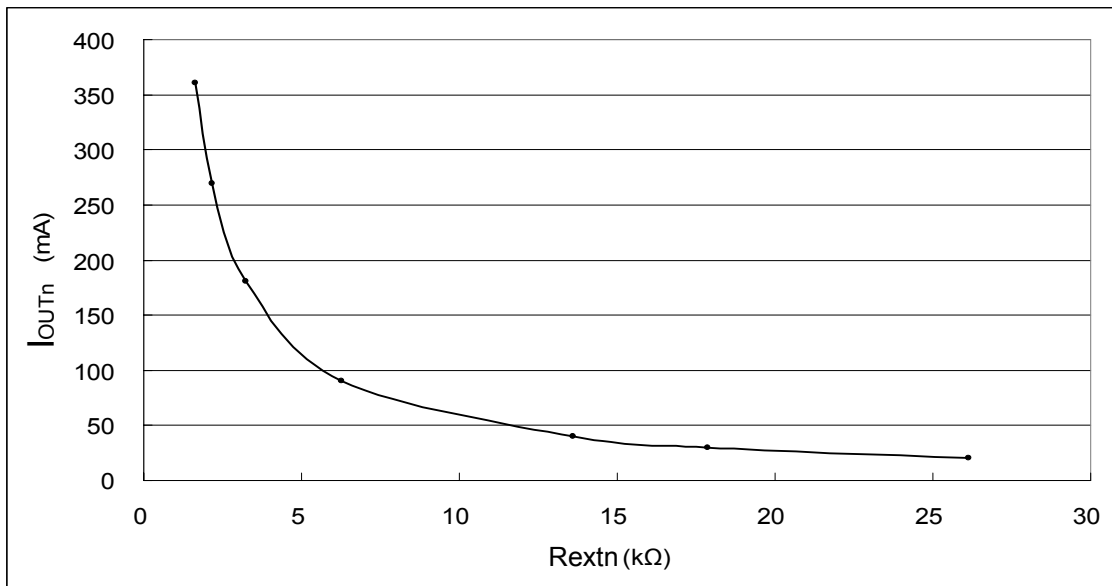


Figure 10

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

$$V_{R-EXTn} = 1.224V; n=0 \text{ or } 1.$$

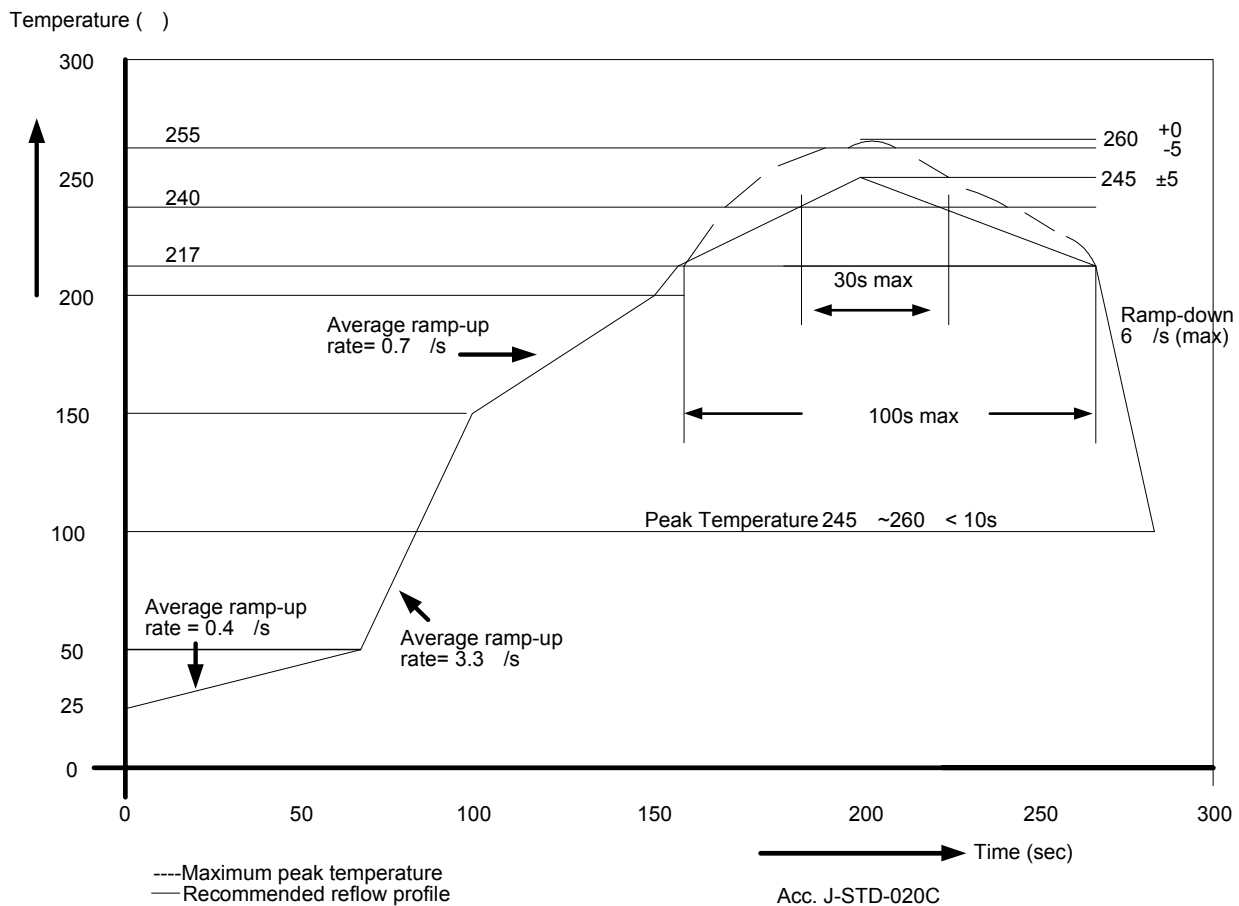
$$R_{extn} = (V_{R-EXTn} / I_{OUTn}) \times 720 = (1.224V / I_{OUTn}) \times 720;$$

$$I_{OUTn} = (V_{R-EXTn} / R_{extn}) \times 720 = (1.224V / R_{extn}) \times 720 \text{ within } \pm 6\% \text{ chip skew};$$

where R_{extn} is the resistance of the external resistor connecting to R-EXTn terminal and V_{R-EXTn} is the voltage of R-EXTn terminal. The magnitude of current (as a function of R_{extn}) is around 360mA at 2.45kΩ and 188mA at 4.7kΩ.

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. Please refer to J-STD-020C as shown below.



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

Package Power Dissipation (P_D)

The maximum power dissipation, P_{D(max)} = (T_{j,max} – T_a) / R_{th(j-a)}, decreases as the ambient temperature increases.

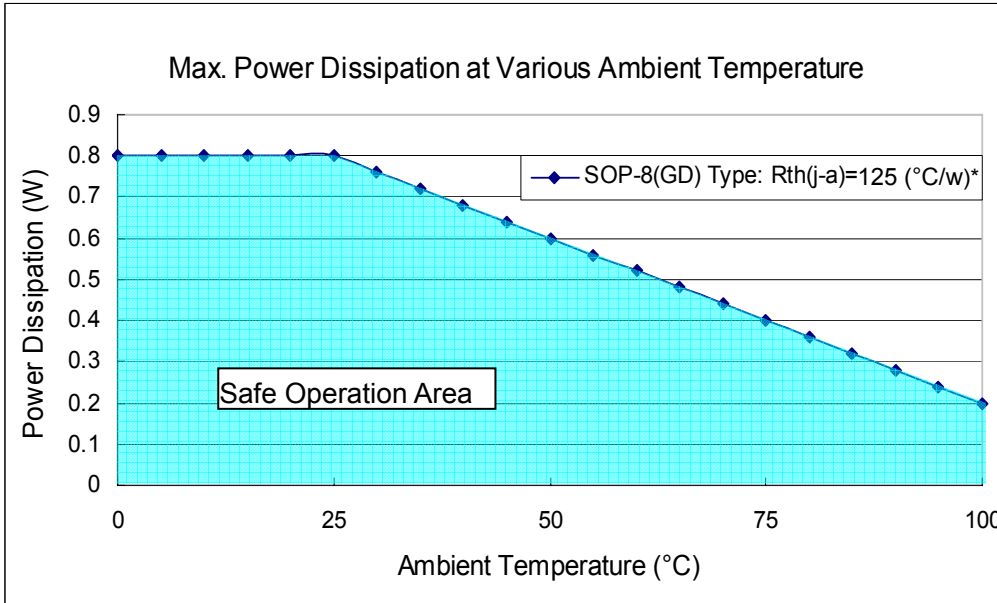


Figure 11

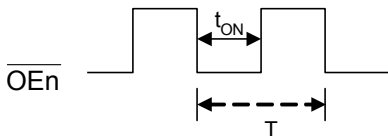
The maximum allowable package power dissipation is determined as P_{D(max)} = (T_{j,max} – T_a) / R_{th(j-a)}. If the output channels of these two channels are the same and turned on simultaneously, the actual package power dissipation is P_{D(act)} = (I_{DD} × V_{DD}) + (I_{OUTn} × Duty × V_{DS} × 2). Therefore, to keep P_{D(act)} ≤ P_{D(max)}, the allowable maximum output current as a function of duty cycle is:

$$I_{OUTn} = \{ [(T_j - T_a) / R_{th(j-a)}] - (I_{DD} \times V_{DD}) \} / V_{DS} / Duty / 2,$$

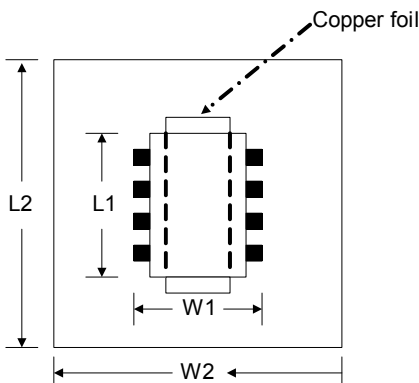
where T_j = 125°C;

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

t_{ON}: the time of LEDs turning on; T: \overline{OEn} signal period



*Note: The empirical thermal resistor R_{th(j-a)} = 125 °C/W is based on the following structure.



The PCB area L₂xW₂ is 4 times of the IC's area L₁xW₁.

The thickness of the PCB is 1.6mm, copper foil 1 Oz. The thermal pad on the IC's bottom has to be mounted on the copper foil.

Thermal Protection (TP)

When the junction temperature exceeds the threshold, T_x (160°C), TP function turns off the output channels. As soon as the temperature is below 130°C, the output channels will be turned on again. The average output current is controlled by this function. As a result, the driver is protected from being overheated.

Load Supply Voltage (V_{LED})

MBI1812 is designed to operate with adequate V_{DS} to achieve constant current. V_{DSn} and I_{OUTn} should not exceed the package power dissipation limit, $P_{D(max)}$.

In Figure 10, $V_{DSn} = V_{LED} - V_{Fn}$. V_{LED} is the load supply voltage. If V_{DSn} drops too much voltage on the driver, $P_{D(act)}$ will be greater than $P_{D(max)}$. In this case, it is recommended to use the supply voltage as low as possible or to set an external voltage reducer, V_{DROPN} .

A voltage reducer allows $V_{DSn} = (V_{LED} - V_{Fn}) - V_{DROPN}$.

Resistors can be used in the applications as shown in Figure 12.

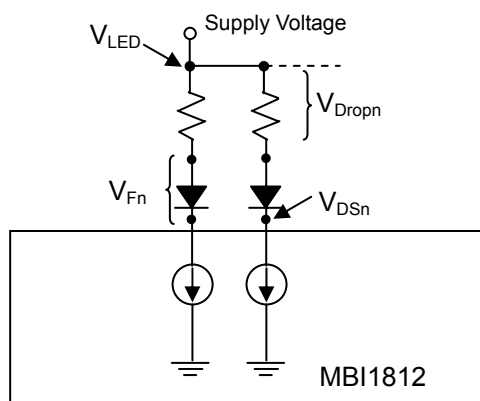
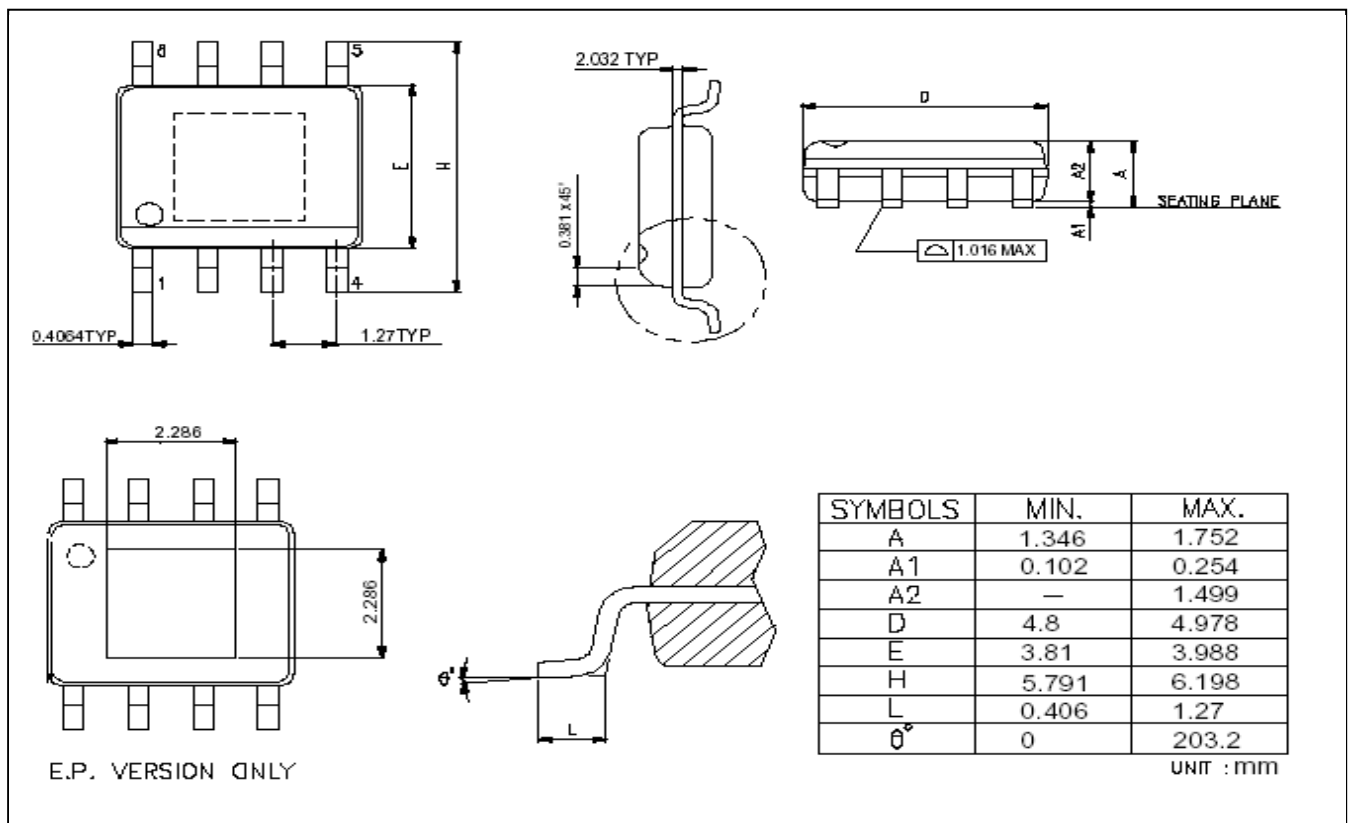


Figure 12

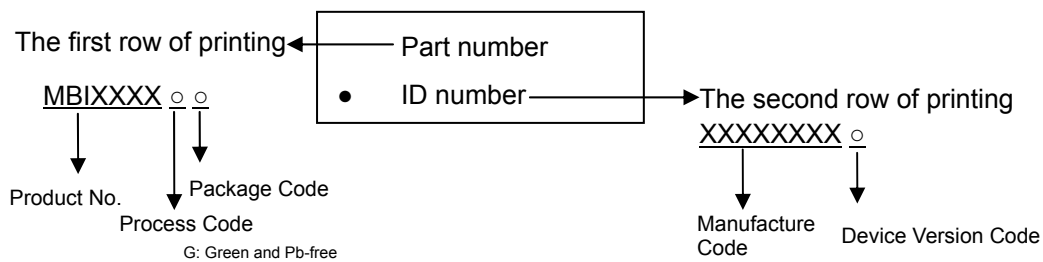
Outline Drawing



MBI1812GD Outline Drawing

Note: The unit for the outline drawing is mm.

Product Top-mark Information



Product Revision History

Datasheet Version	Device Version Code
V1.00	A

Product Ordering Information

Part Number	Package Type	Weight (g)
MBI1812GD	SOP8-150-1.27	0.079

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