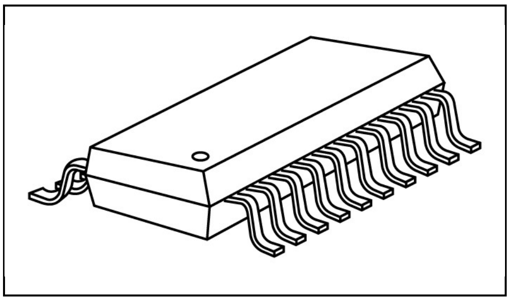
All-Ways-On™ Constant-Current LED Driver

Features

- 16 constant-current output channels
- Constant output current invariant to load voltage change
- Excellent output current accuracy:
  between channels: <±3% (max.), and
  between ICs: <±6% (max.)
- Output current adjusted through an external resistor
- Constant output current range: 5-60 mA
- Fast response of output current, $\overline{OE}$ (min.): 10 μs
- Schmitt trigger input
- 5V supply voltage
- Package Type: "Pb-free & Green" TSSOP20 with thermal pad



GT: TSSOP20-173-0.65

Current Accuracy		Conditions
Between Channels	Between ICs	
< ±3%	< ±6%	I_{OUT} = 10 ~ 60 mA

Product Description

MBI1816 is an instant On/Off LED driver for lighting applications and exploits PrecisionDrive™ technology to enhance its output characteristics. At MBI1816 output stage, sixteen regulated current ports are designed to provide uniform and constant current sinks for driving LEDs within a large range of V_F variations.

MBI1816 provides users 16-channel constant current ports to match LEDs with equal current. Users may adjust the output current from 5 mA to 60 mA through an external resistor, R_{ext}, which gives users flexibility in controlling the light intensity of LEDs. In addition, users can adjust device brightness via $\overline{OE}$ pin. The duty cycle of $\overline{OE}$ can decide the brightness intensity from 0% to 100%. MBI1816 guarantees to endure maximum 17V at the output ports.

Additionally, to ensure the system reliability, MBI1816 is built with TP (Thermal Protection) function and thermal pad. The TP function can protect IC from over temperature (165°C) and the thermal pad can enhance the power dissipation. As a result, a large amount of current can be handled safely in one package.

Applications

- Automotive Interior Lighting
- Channel Letter
- Decoration Lighting

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Typical Application Circuit

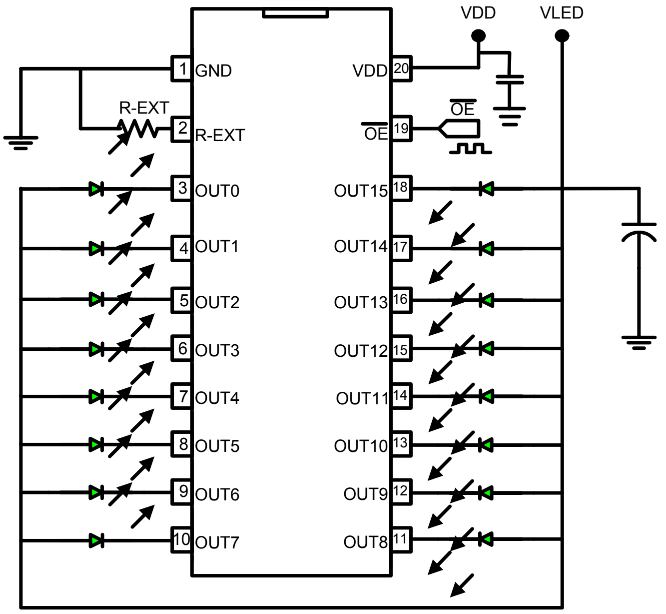
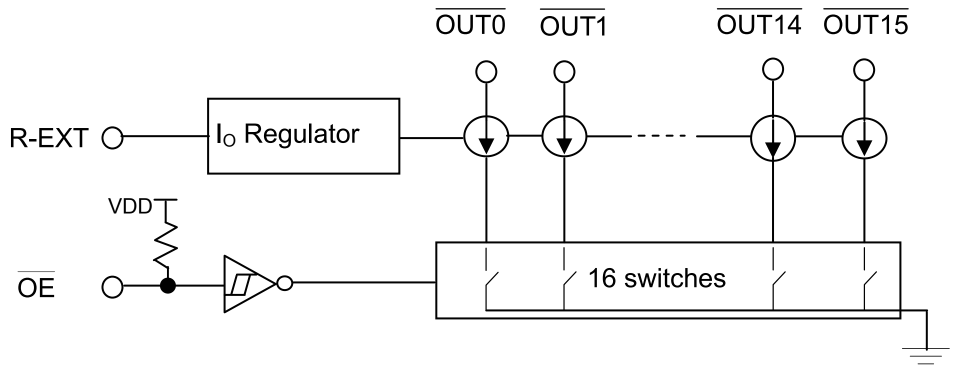


Figure 1

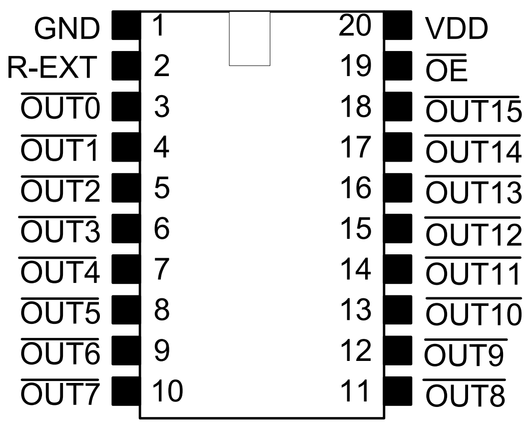
Block Diagram



Terminal Description

Pin Name	Function
GND	Ground terminal for control logic and current sink
$\overline{\text{OUT0}}$ ~ $\overline{\text{OUT15}}$	Constant current output terminals
$\overline{\text{OE}}$	Output enable terminal When $\overline{\text{OE}}$ (active) low, the output drivers are enabled; when $\overline{\text{OE}}$ high, all output drivers are turned OFF (blanked).
R-EXT	Terminal used to connect an external resistor (R_{ext}) for setting up output current for all output channels
VDD	5V supply voltage terminal

Pin Configuration



MBI1816GT

Maximum Ratings

<table>
<tr><th colspan="2">Characteristic</th><th>Symbol</th><th>Rating</th><th>Unit</th></tr>
<tr><td colspan="2">Supply Voltage</td><td>V_{DD}</td><td>0~7.0</td><td>V</td></tr>
<tr><td colspan="2">Input Voltage</td><td>V_{IN}</td><td>-0.4~V_{DD} + 0.4</td><td>V</td></tr>
<tr><td colspan="2">Output Current</td><td>I_{OUT}</td><td>90</td><td>mA</td></tr>
<tr><td colspan="2">Output Voltage</td><td>V_{DS}</td><td>-0.5~+17.0</td><td>V</td></tr>
<tr><td colspan="2">GND Terminal Current</td><td>I_{GND}</td><td>1000</td><td>mA</td></tr>
<tr><td>Power Dissipation*
(On PCB, Ta=25°C)</td><td rowspan="3">TSSOP20</td><td>P_D</td><td>0.85</td><td>W</td></tr>
<tr><td>Thermal Resistance*
(Under good thermal system)</td><td rowspan="2">$R_{th(j-a)}$</td><td>31.99**</td><td rowspan="2">°C/W</td></tr>
<tr><td>Thermal Resistance*
(On PCB, Ta=25°C)</td><td>117</td></tr>
<tr><td colspan="2">Operating Temperature</td><td>T_{opr}</td><td>-40~+85</td><td>°C</td></tr>
<tr><td colspan="2">Storage Temperature</td><td>T_{stg}</td><td>-55~+150</td><td>°C</td></tr>
</table>

*Users must notice that the power dissipation (almost equaling to I_{OUT} x V_{DS}) should be within the Safe Operation Area shown in Figure 6.

** Good thermal system design can ensure that the heat management of the total system (storage temperature and operating temperature) maintains MBI1816 within the defined temperature limits ($R_{th(j-a)}$= 31.99°C/W).

Electrical Characteristics

Characteristic	Symbol	Condition	Min.	Typ.	Max.	Unit
Supply Voltage	V_{DD}	-	4.5	5.0	5.5	V
Output Voltage	V_{DS}	$\overline{OUT0}$ ~ $\overline{OUT15}$	-	-	17.0	V
Output Current	I_{OUT}	DC Test Circuit	5	-	60*	mA
Input Voltage, "H" level	V_{IH}	Ta= -40~85ºC	0.7*V_{DD}	-	V_{DD}	V
Input Voltage, "L" level	V_{IL}	Ta= -40~85ºC	GND	-	0.3*V_{DD}	V
Output Leakage Current	I_{OH}	V_{OH}= 17.0V	-	-	0.5	μA
Output Current 1	I_{OUT1}	V_{DS}= 0.6V, R_{ext}= 720 Ω	-	25	-	mA
Current Skew	dI_{OUT1}	I_{OL}= 25mA, V_{DS}= 0.6V, R_{ext}= 720 Ω	-	±1	±3	%
Output Current 2	I_{OUT2}	V_{DS}= 0.8V, R_{ext}= 360 Ω	-	50	-	mA
Current Skew	dI_{OUT2}	I_{OL}= 50mA, V_{DS}= 0.8V, R_{ext}= 360 Ω	-	±1	±3	%
Output Current vs. Output Voltage Regulation	$\%/dV_{DS}$	V_{DS} within 1.0V and 3.0V	-	±0.1	-	% / V
Output Current vs. Supply Voltage Regulation	$\%/dV_{DD}$	V_{DD} within 4.5V and 5.5V	-	±1	-	% / V
Pull-up Resistor	R_{IN}(up)	$\overline{OE}$	250	500	800	KΩ
Supply Current "OFF"	I_{DD}(off) 1	R_{ext}= Open, $\overline{OUT0}$ ~ $\overline{OUT15}$ = Off	-	6	8	mA
Supply Current "OFF"	I_{DD}(off) 2	R_{ext}= 720 Ω, $\overline{OUT0}$ ~ $\overline{OUT15}$ = Off	-	9	11	mA
Supply Current "OFF"	I_{DD}(off) 3	R_{ext}= 360 Ω, $\overline{OUT0}$ ~ $\overline{OUT15}$ = Off	-	12	14	mA
Supply Current "ON"	I_{DD}(on) 1	R_{ext}= 720 Ω, $\overline{OUT0}$ ~ $\overline{OUT15}$ = On	-	5	7	mA
Supply Current "ON"	I_{DD}(on) 2	R_{ext}= 360 Ω, $\overline{OUT0}$ ~ $\overline{OUT15}$ = On	-	8	10	mA

* Each output current, I_{OUT}, can be driven up to 90mA if the total output current is smaller than 1A.

Test Circuit for Electrical Characteristics

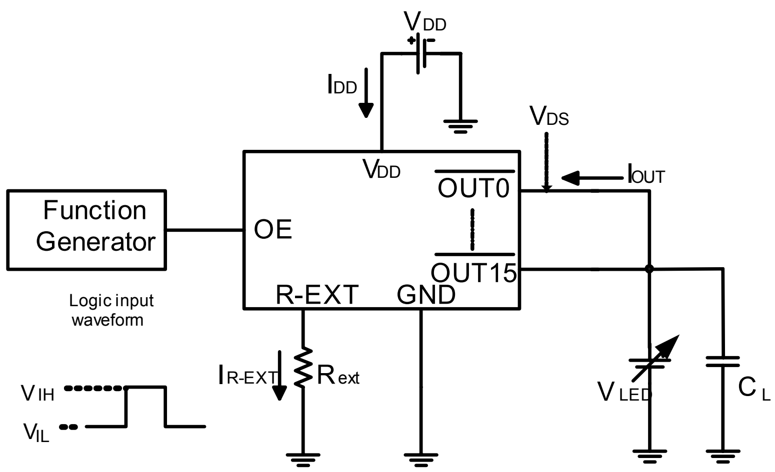


Figure 2

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 V V_{DS}= 0.8 V- 1.0V V_{IH}= V_{DD} V_{IL}= GND R_{ext}= 300 Ω V_L= 4.0 V R_L= 52 Ω C_L= 10 pF	0.08	-	8.2	μs
Propagation Delay Time ("H" to "L")	$\overline{OE}$ - $\overline{OUTn}$	t_{pHL}		0.08	-	8.2	μs
Pulse Width	$\overline{OE}$	$t_{w(OE)}$		10	-	-	μs
Output Rise Time of Vout (turn off)		t_{or}		-	190	250	ns
Output Fall Time of Vout (turn on)		t_{of}		-	50	150	ns

Test Circuit for Switching Characteristics

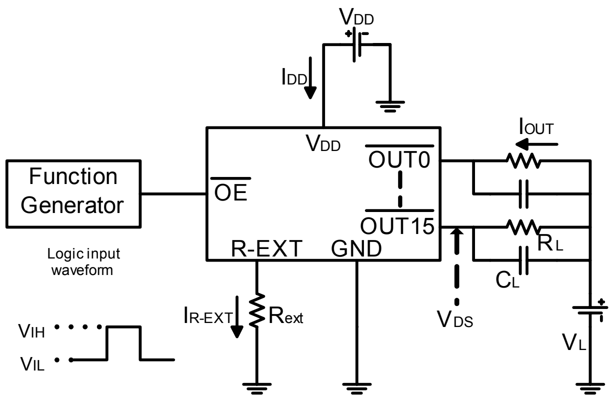


Figure 3

Application Information

Constant Current

In LED lighting applications, MBI1816 provides nearly no variations 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 ±3%, and that between ICs is less than ±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 performs as a perfection of load regulation.

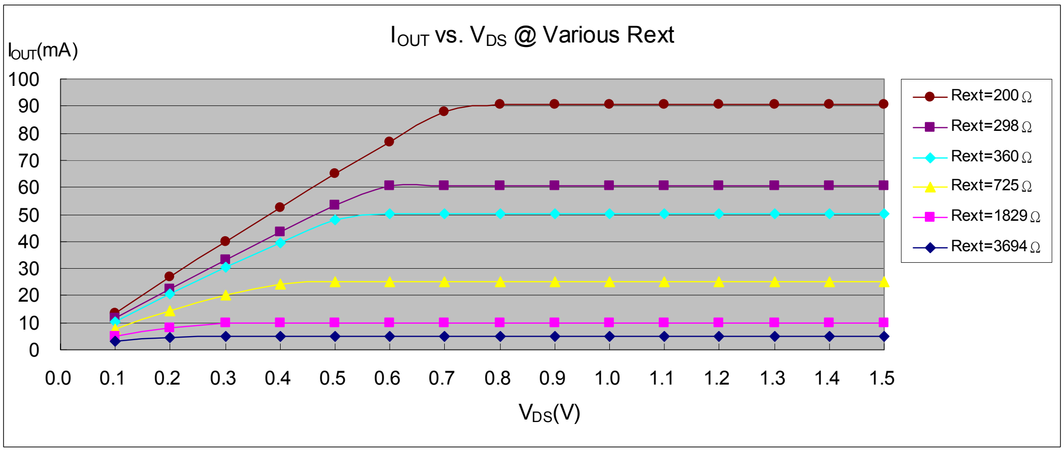


Figure 4

Adjusting 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.

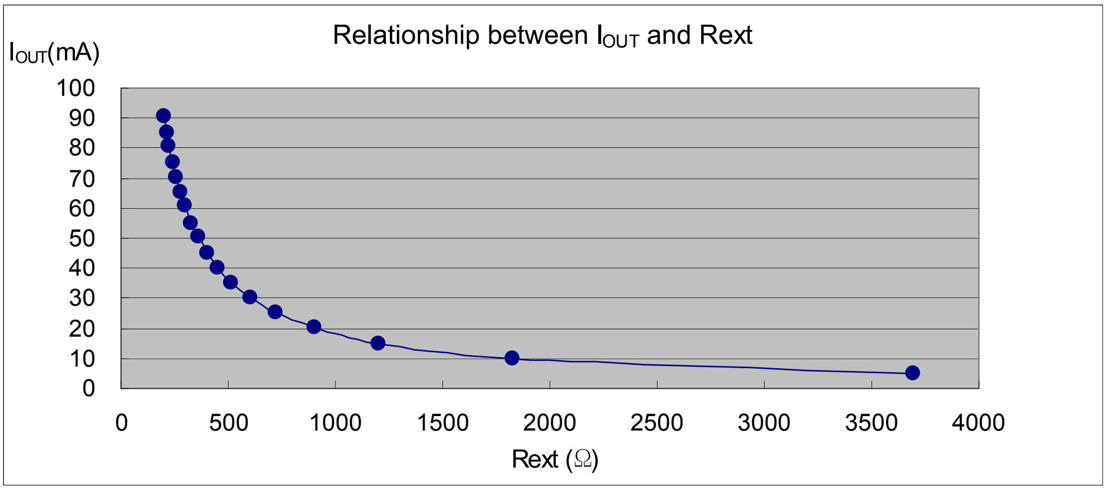


Figure 5

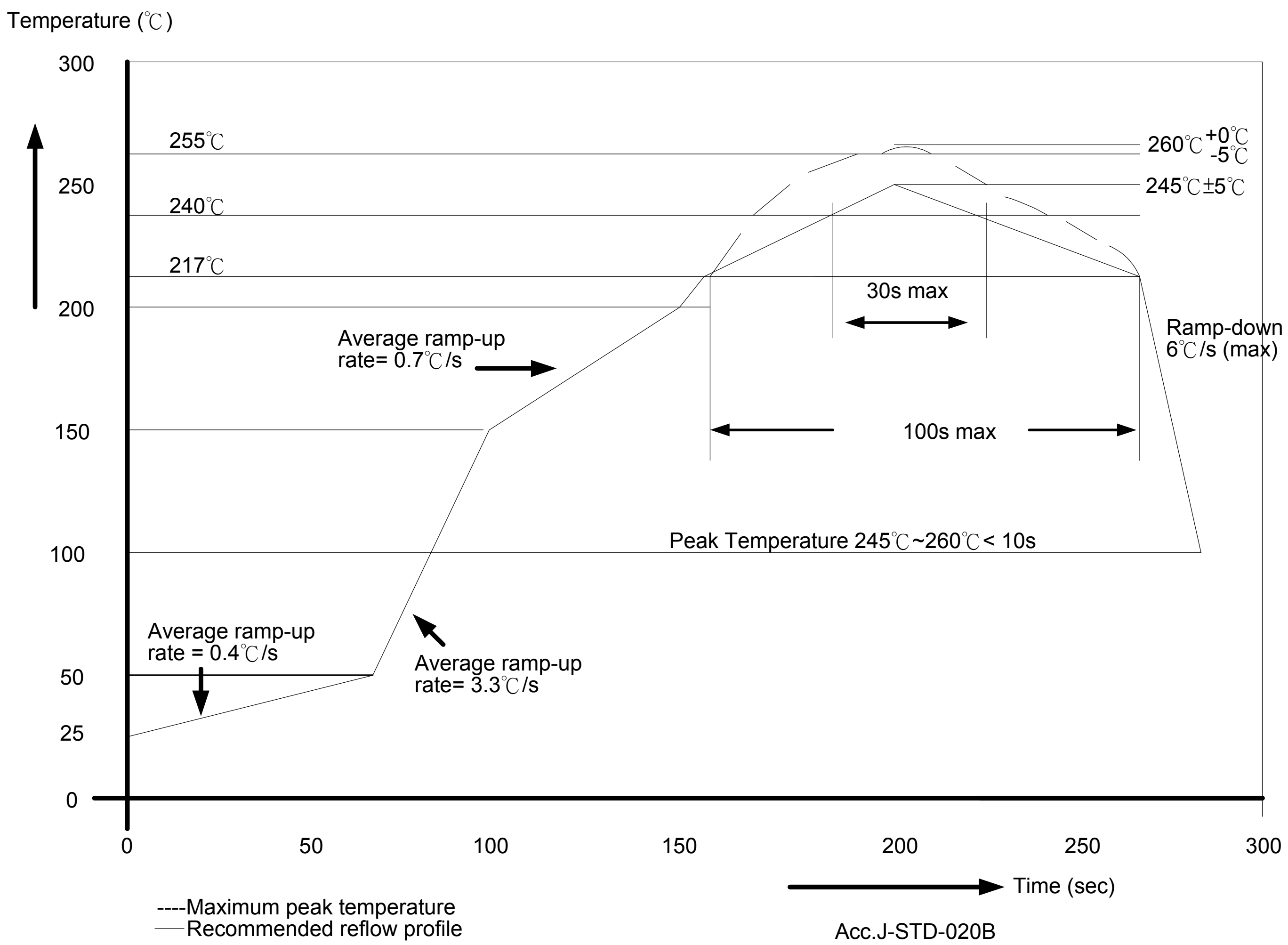
Also, the output current can be calculated from the equation:

$V_{R\text{-}EXT} = 1.25V$；$I_{OUT} = (V_{R\text{-}EXT} / R_{ext}) \times 14.4 = (1.25V / R_{ext}) \times 14.4$

where R_{ext} is the resistance of the external resistor connected to R-EXT terminal and $V_{R\text{-}EXT}$ is the voltage of R-EXT terminal. The magnitude of current (as a function of R_{ext}) is around 50mA at 360Ω and 25mA at 720Ω.

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

Macroblock has defines "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 215ºC to 240ºC 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-020B as shown below.



*Note1: For details, please refer to Macroblock's "Policy on Pb-free & Green Package".

Package Power Dissipation (P_D)

The maximum power dissipation, $P_D(max) = (Tj – Ta) / R_{th(j-a)}$, decreases as the ambient temperature increases.

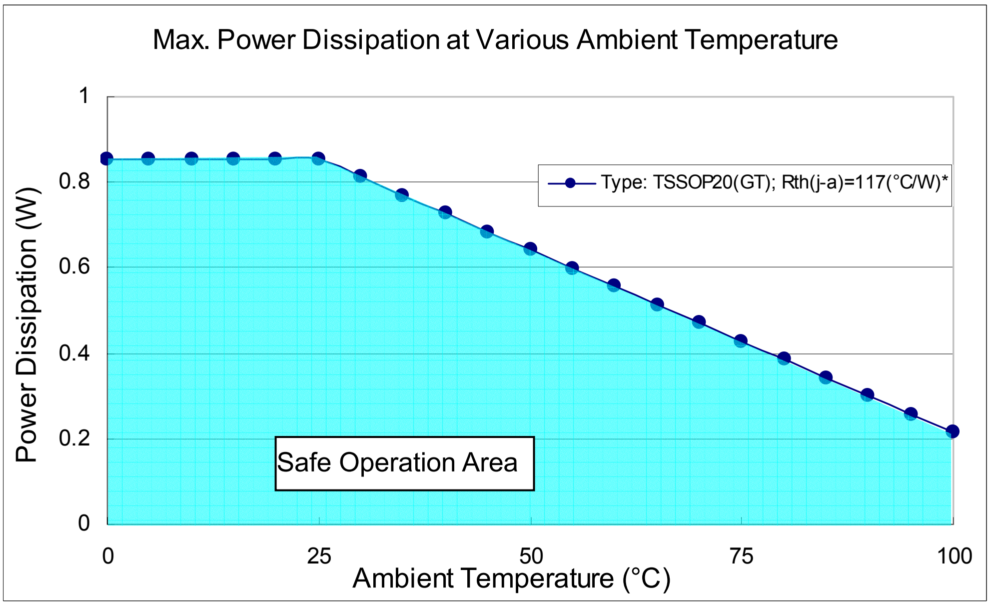


Figure 6

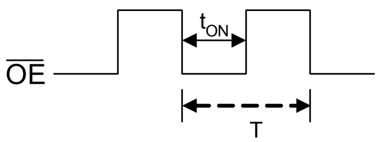
The maximum allowable package power dissipation is determined as $P_D(max) = (Tj – Ta) / R_{th(j-a)}$. When 16 output channels are turned on simultaneously, the actual package power dissipation is $P_D(act) = (I_{DD} \times V_{DD}) + (I_{OUT} \times Duty \times V_{DS} \times 16)$. Therefore, to keep $P_D(act) \le P_D(max)$, the allowable maximum output current as a function of duty cycle is:

$I_{OUT} = \{ [(Tj – Ta) / R_{th(j-a)}] – (I_{DD} \times V_{DD}) \} / V_{DS} / Duty / 16$,

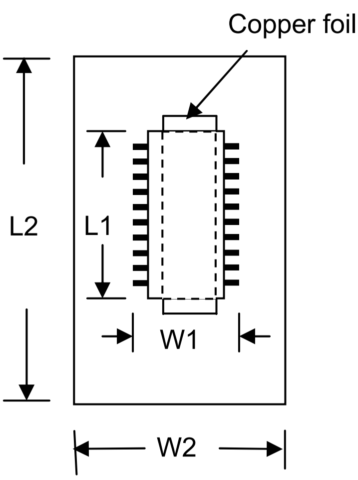
where Tj = 125°C;

Duty= t_{ON} / T;

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



*Note 1: The thermal resistor $R_{th(j-a)}$ =117 °C/W; it is based on the following structure.



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

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

TP Function (Thermal Protection)

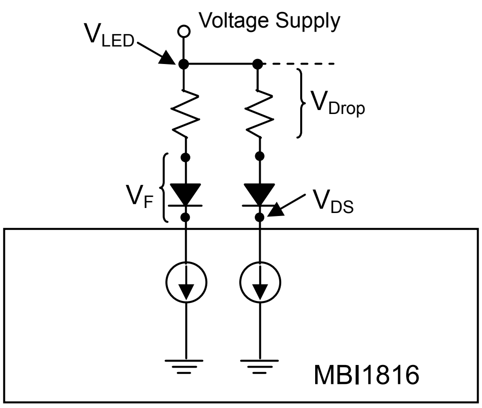
When the junction temperature exceeds the limit (165°C), TP starts to function and turn off the output current. As soon as the temperature is below 165°C, the output current will be on again. The switching runs at a high frequency, so the blinking is imperceptible. However, the DC output current is limited and thus the driver is protected from overheat.

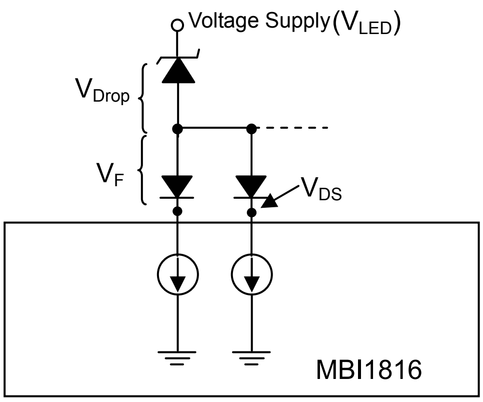
Load Supply Voltage (V_{LED})

MBI1816 are designed to operate with V_{DS} ranging from 0.4V to 1.0V considering the package power dissipating limits. V_{DS} may be higher enough to make $P_{D(act)} > P_{D(max)}$ when V_{LED} = 5V and $V_{DS} = V_{LED} – V_F$, in which V_{LED} is the load supply voltage. In this case, it is recommended to use the lowest possible supply voltage or to set an external voltage reducer, V_{DROP}.

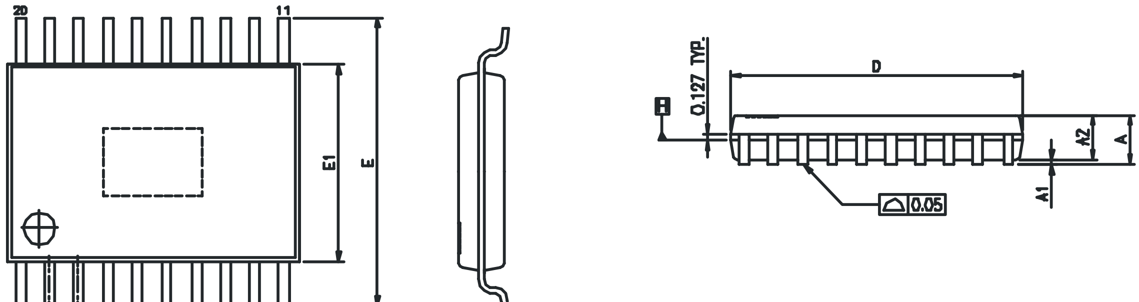
A voltage reducer lets $V_{DS} = (V_{LED} – V_F) – V_{DROP}$.

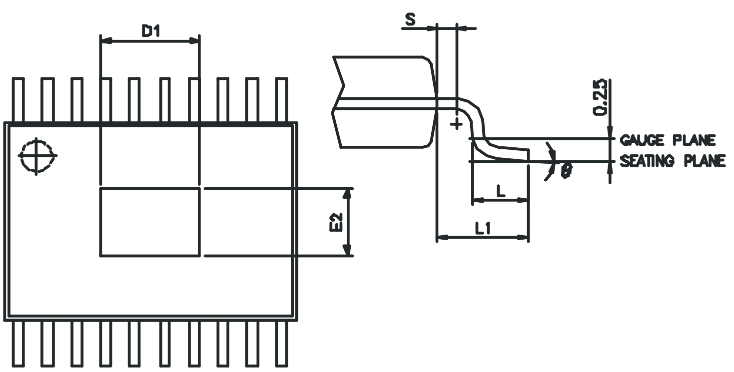
Resistors or Zener diode can be used in the applications as shown in the following figures.





Outline Drawing

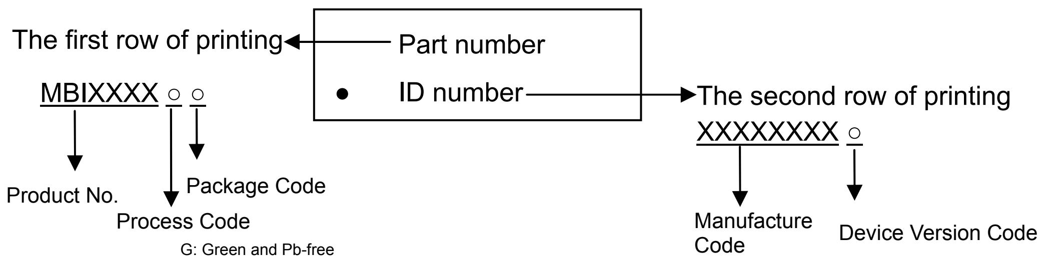




VARIATIONS (ALL DIMENSIONS SHOWN IN MM)

SYMBOLS	MIN.	NOM.	MAX.
A	–	–	1.20
A1	0.00	–	0.15
A2	0.80	1.00	1.05
b	0.19	–	0.30
D	6.40	6.50	6.60
D1	2.20	–	–
E2	1.50	–	–
E1	4.30	4.40	4.50
E		6.40 BSC	
e		0.65 BSC	
L1		1.00 REF	
L	0.45	0.60	0.75
S	0.20	–	–
θ	0°	–	8°

Product Top-mark Information



Product Revision History

Datasheet version	Device version code
V1.00	*Not defined*
V1.01	

Product Ordering Information

Part Number	Package Type	Weight (g)
MBI1816	TSSOP-173-0.65	0.065