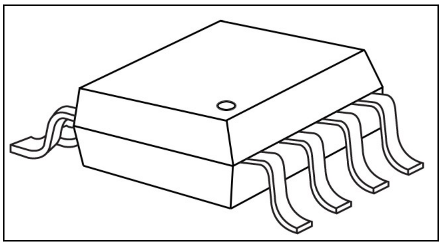
All-Ways-On™ High-Power LED Driver

Features



- 2 constant-current output channels
- Constant output current invariant to load voltage change
- Maximum output constant current: 360 mA
- Thermal protection and report
- Output current adjustment
- Schmitt trigger input
- 5V supply voltage
- Package type: SOP8 with thermal pad

Current Accuracy		Conditions
Between Channels	Between ICs	
< ±3%	< ±6%	I_{OUT} = 40mA ~ 360 mA @ 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 easily provides users with a consistent current source in their system design. 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 a quarter of the output current via enabling the QUAD pin as “High”.

Additionally, to ensure the system reliability, MBI1802 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

- High-Flux LED Lighting
- Automotive Interior Lighting

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Typical Application Circuit

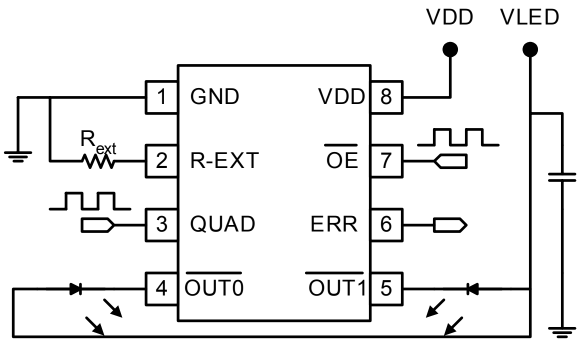
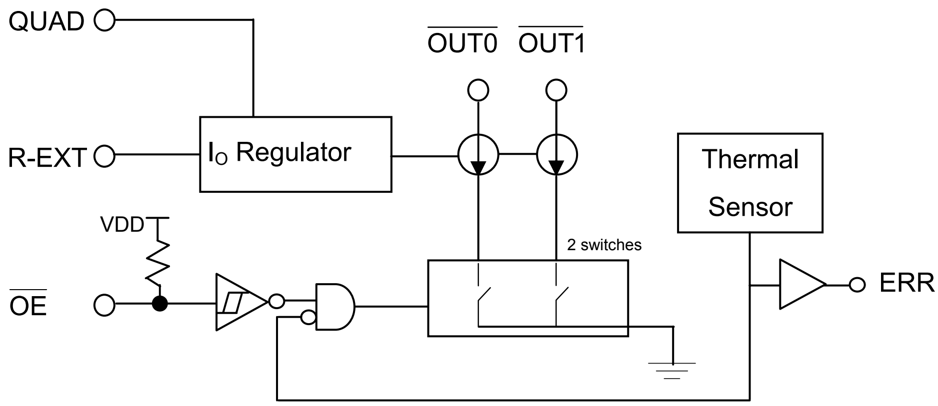
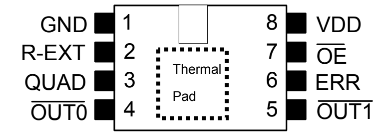


Figure 1

Block Diagram



Pin Configuration



MBI1802

Terminal 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	QUAD	Set all the output current to 25% of the pre-set current when QUAD is high.
4, 5	$\overline{OUT0}$ ~ $\overline{OUT1}$	Constant current output terminals
6	ERR	Thermal error flag, when junction temperature is over 165°C, ERR is going to high.*
7	$\overline{OE}$	Output enable terminal When $\overline{OE}$ (active) low, the output drivers are enabled; when $\overline{OE}$ high, all output drivers are turned OFF (blanked).
8	VDD	5V supply voltage terminal
-	Thermal Pad	Power dissipation terminals with ground connection*

*To eliminate the noise influence, the thermal pad should be connected to GND.

In addition, desired thermal conductivity will be better if the conduction area on PCB connecting to the thermal pad is large enough.

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>360*</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>720</td><td>mA</td></tr>
<tr><td>Power Dissipation*
(On PCB, Ta=25°C)</td><td rowspan="3">SOP8</td><td>P_D</td><td>0.8</td><td>W</td></tr>
<tr><td>Thermal Resistance*
(Under good thermal system)</td><td rowspan="2">$R_{th(j-a)}$</td><td>33.39**</td><td rowspan="2">°C/W</td></tr>
<tr><td>Thermal Resistance*
(On PCB, Ta=25°C)</td><td>125</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 MBI1802 within the defined temperature limits ($R_{th(j-a)}$= 33.39°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}	$\overline{\text{OUT0}}$ ~ $\overline{\text{OUT1}}$	-	-	17.0	V
Output Current	I_{OUT}	DC Test Circuit	40	-	360	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	-	204	-	mA
Current Skew	dI_{OUT1}	I_{OL}= 204mA, V_{DS}= 0.6V; R_{ext}= 720 Ω	-	±1	±3	%
Output Current 2	I_{OUT2}	V_{DS}= 0.5V; R_{ext}= 1440 Ω	-	102	-	mA
Current Skew	dI_{OUT2}	I_{OL}= 102mA, V_{DS}= 0.5V; R_{ext}= 1440 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)	$\overline{\text{OE}}$	250	500	800	KΩ
Thermal Protection Temperature	Tj	Junction Temperature	-	165	-	°C
Supply Current “OFF”	I_{DD}(off) 1	R_{ext}=Open, $\overline{\text{OUT0}}$ ~ $\overline{\text{OUT1}}$ = Off	-	1.6	3.6	mA
	I_{DD}(off) 2	R_{ext}=720 Ω, $\overline{\text{OUT0}}$ ~ $\overline{\text{OUT1}}$ = Off	-	4.5	7.5	
	I_{DD}(off) 3	R_{ext}=1440 Ω, $\overline{\text{OUT0}}$ ~ $\overline{\text{OUT1}}$ = Off	-	3.2	6.2	
Supply Current “ON”	I_{DD}(on) 1	R_{ext}=720 Ω, $\overline{\text{OUT0}}$ ~ $\overline{\text{OUT1}}$ = On	-	4.5	7.5	
	I_{DD}(on) 2	R_{ext}=1440 Ω, $\overline{\text{OUT0}}$ ~ $\overline{\text{OUT1}}$ = On	-	3.2	6.2	

Test Circuit for Electrical Characteristics

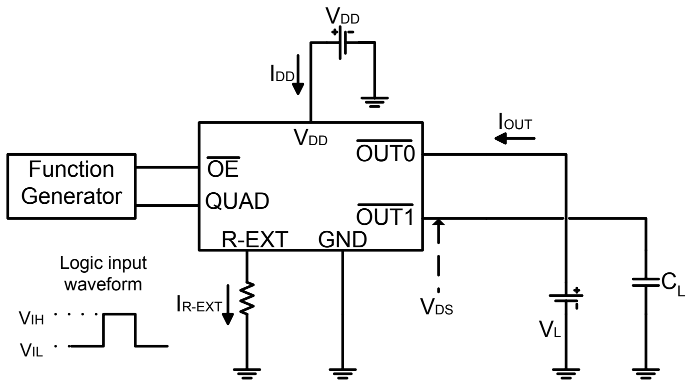


Figure 2

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}= 1-1.6V V_{IH}= V_{DD} V_{IL}= GND R_{ext}= 600 Ω V_L= 4.0 V R_L= 10 Ω C_L= 10 pF	1	2	3	μs
Propagation Delay Time ("H" to "L")	$\overline{OE}$ - $\overline{OUTn}$	t_{pHL}		1	2	3	μs
Pulse Width	$\overline{OE}$	$t_{w(OE)}$		10	-	-	μs
Output Rise Time of Vout (turn off)		t_{or}		1	1.7	3	μs
Output Fall Time of Vout (turn on)		t_{of}		1	1.7	3	μs

Test Circuit for Switching Characteristics

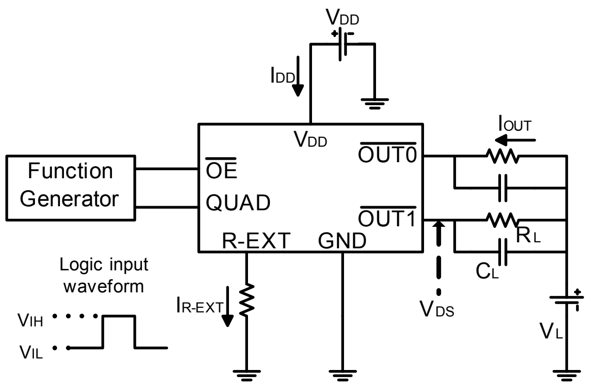


Figure 3

Application Information

Constant Current

In LED lighting applications, MBI1802 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.

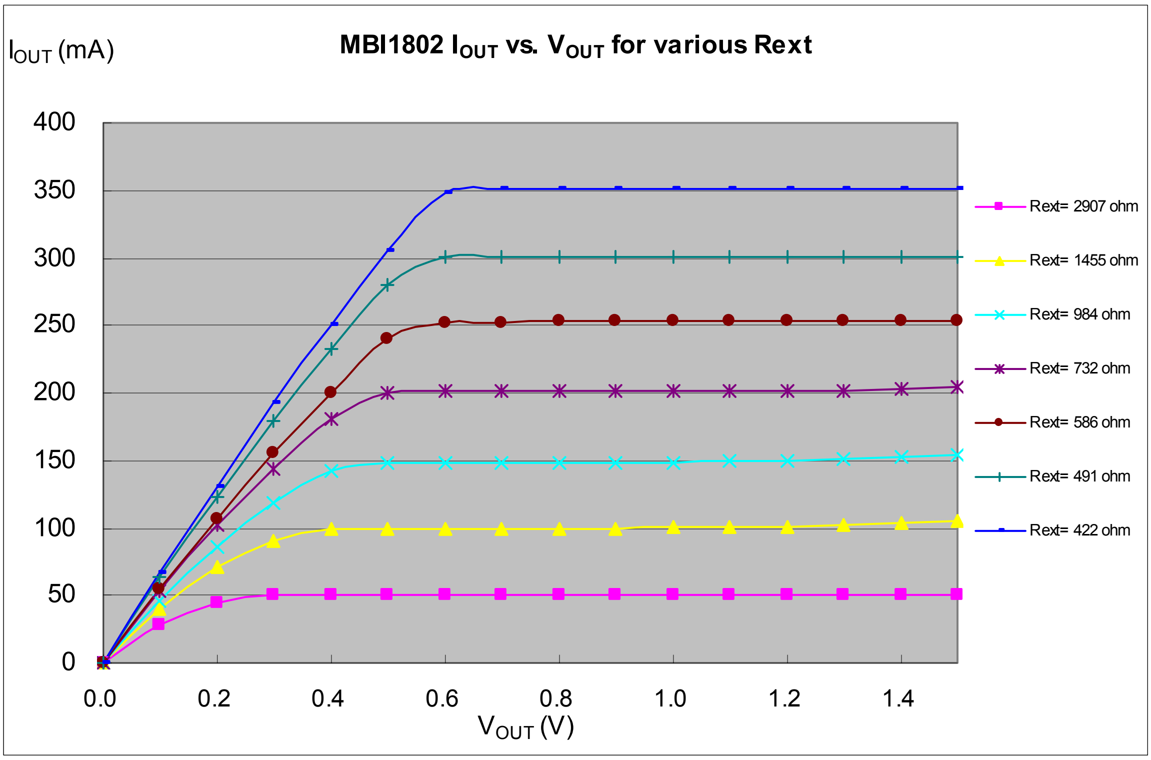


Figure 4

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.

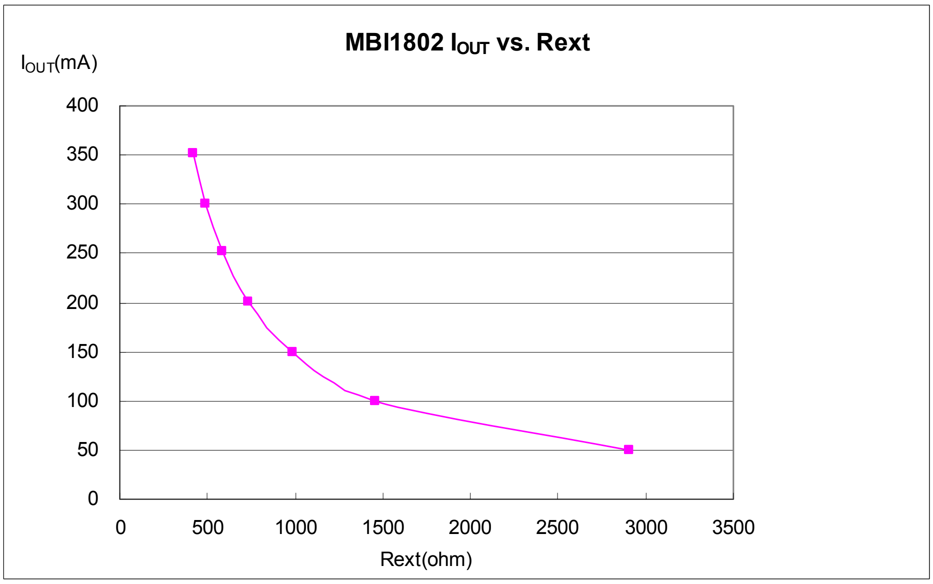


Figure 5

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

$V_{R\text{-}EXT}$ = 1.28V ; R_{ext}= ($V_{R\text{-}EXT}$ / I_{OUT}) x 115= (1.28V / I_{OUT}) x 115

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 102 mA at 1440Ω and 204 mA at 720Ω.

TP Function (Thermal Protection)

When the junction temperature exceeds the limit (165°C), TP starts to function and turn off the output current and the thermal error flag, ERR, goes high simultaneously. 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.

Package Power Dissipation (P_D)

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

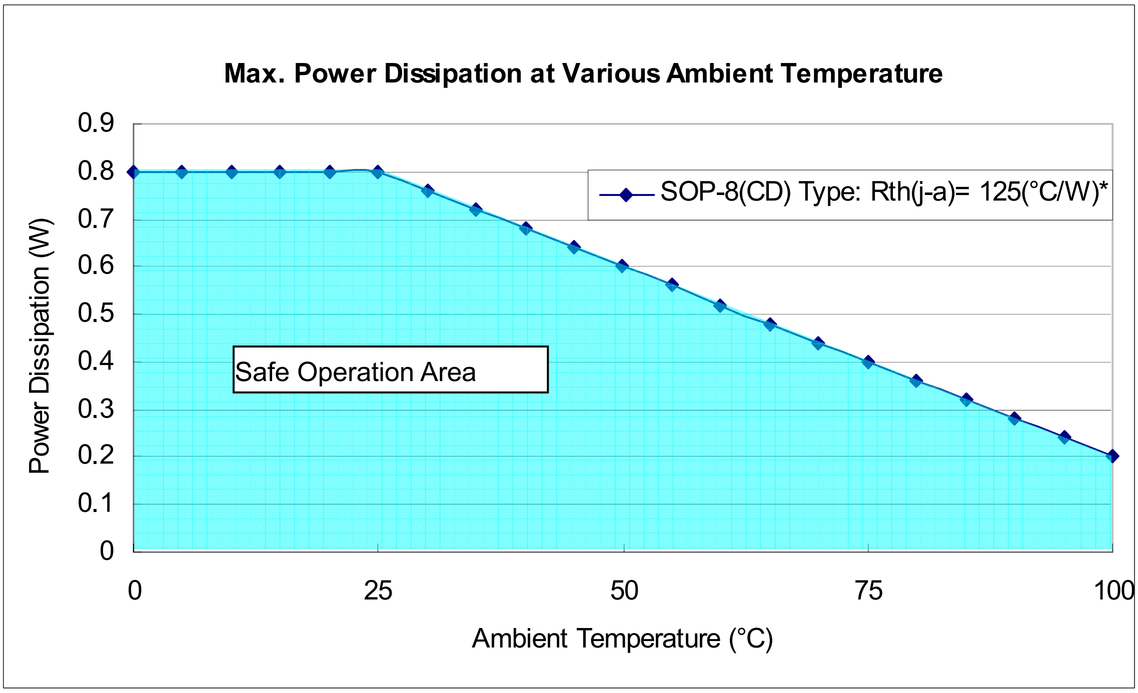


Figure 6

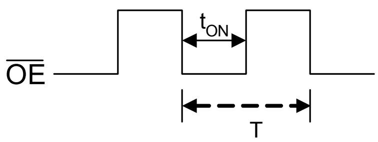
The maximum allowable package power dissipation is determined as $P_D(max) = (Tj – Ta) / R_{th(j-a)}$. When 2 output channels are turned on simultaneously, the actual package power dissipation is $P_D(act) = (I_{DD} \times V_{DD}) + (I_{OUT} \times Duty \times V_{DS} \times 2)$. Therefore, to keep $P_D(act) \leq P_D(max)$, the allowable maximum output current as a function of duty cycle is:

$I_{OUT} = \{ [(Tj – Ta) / R_{th(j-a)}] – (I_{DD} \times V_{DD}) \} / V_{DS} / Duty / 2$,

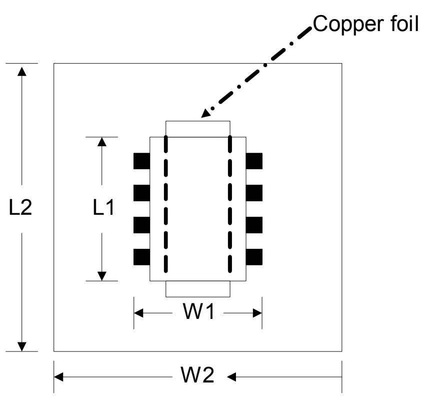
where Tj = 125°C;

Duty= t_{ON} / T;

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



*Note1: The thermal resistor $R_{th(j-a)}$ =125 °C/W is based on the following structure.



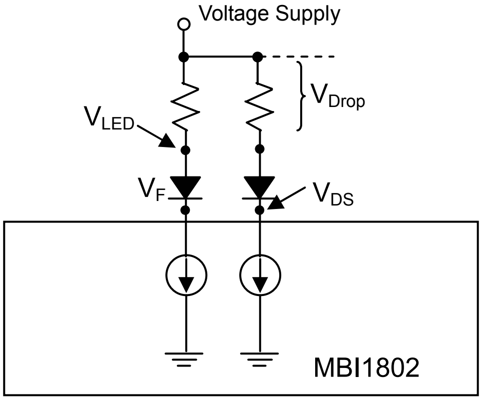
The PCB area L2xW2 is 4 times to the IC's area L1xW1.
The thickness of the PCB is 1.6mm, copper foil 1 Oz. The thermal pad on the IC's bottom has to be mounted on the copper foil.

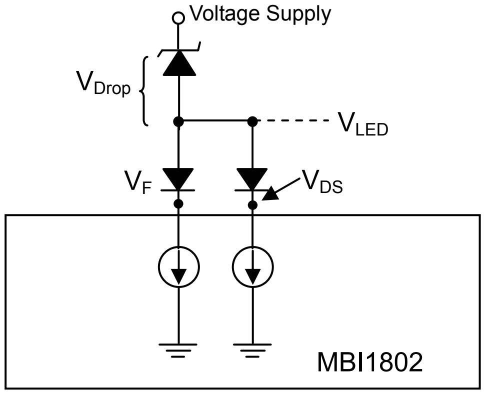
Load Supply Voltage (V_{LED})

MBI1802 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}.

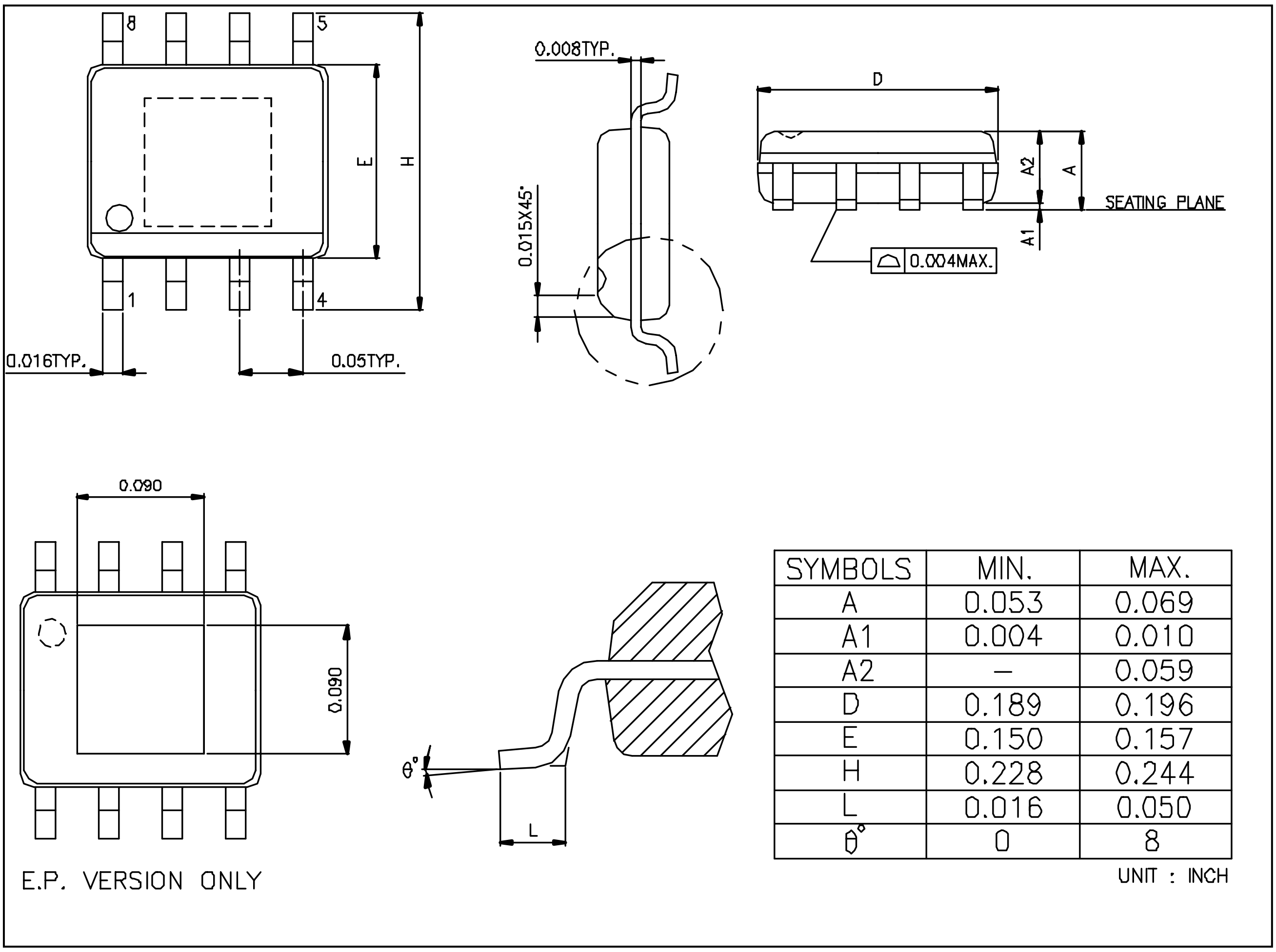
A voltage reducer lets $V_{DS} = (V_{LED} - V_F) - V_{DROP}$.

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





Outline Drawing



SYMBOLS	MIN.	MAX.
A	0.053	0.069
A1	0.004	0.010
A2	–	0.059
D	0.189	0.196
E	0.150	0.157
H	0.228	0.244
L	0.016	0.050
θ°	0	8

UNIT : INCH