Preliminary

MY-Semi

MY8103

65V 1A Common Anode Capable LED Driver With Internal Switch and Wide-Range Current Sense

General Description

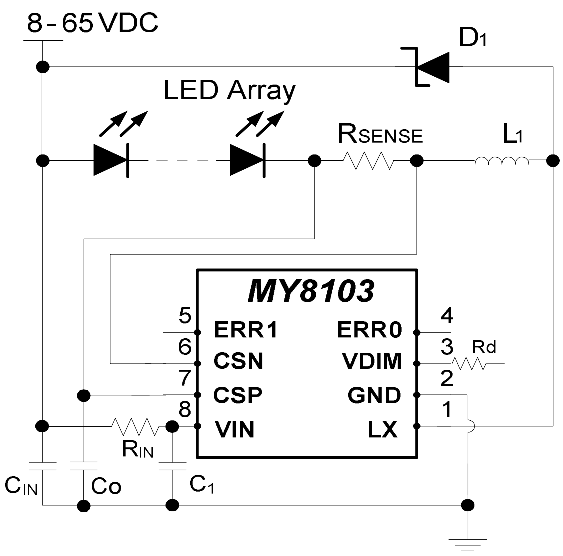
The MY8103 is a common anode capable step-down constant-current LED driver with internal MOSFET and wide-range current sense. The MY8103 provides a cost-effective design solution for architectural and ambient lighting, LED bulbs, and other LED applications.

The MY8103 operates from a +8V to +65V input voltage range and can provide an output current up to 1A. Output current of MY8103 is set by an external resistor connected between CSP and CSN pins. Dimming is controlled by an external control signal to the VDIM pin. The VDIM pin accepts either a DC voltage or a PWM signal, and applying a voltage of 0.4V or lower to the VDIM pin turns off the output current. The MY8103SE has two error outputs to indicate various fault conditions.

Applications

- ❑ Architectural, Industrial and Ambient Lighting
- ❑ Indicator and Emergency Lighting
- ❑ Decorative LED Lighting
- ❑ High Power LED Lighting
- ❑ Automotive Lighting
- ❑ Constant Current Source

Typical Application Circuit



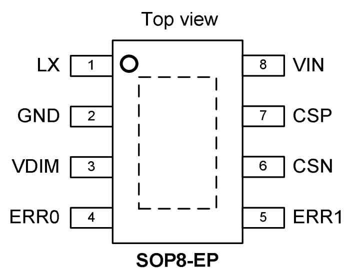
Features

- ✦ Support LED power up to 65W
- ✦ High-efficiency solution
- ✦ Internal 65V MOS switch
- ✦ Wide current sense common-mode range from 0 to 65V
- ✦ Hysteretic control
- ✦ Up to 1MHz switching frequency
- ✦ ±5% output current accuracy
- ✦ Single DC/PWM input pin for dimming control
- ✦ 100mV current-sense reference
- ✦ Resistor-programmable constant LED current
- ✦ Inherent open LED protection
- ✦ Short LED protection
- ✦ Thermal-shutdown protection
- ✦ Over current protection
- ✦ Fault indication for various fault conditions
- ✦ Soft-start

Order information

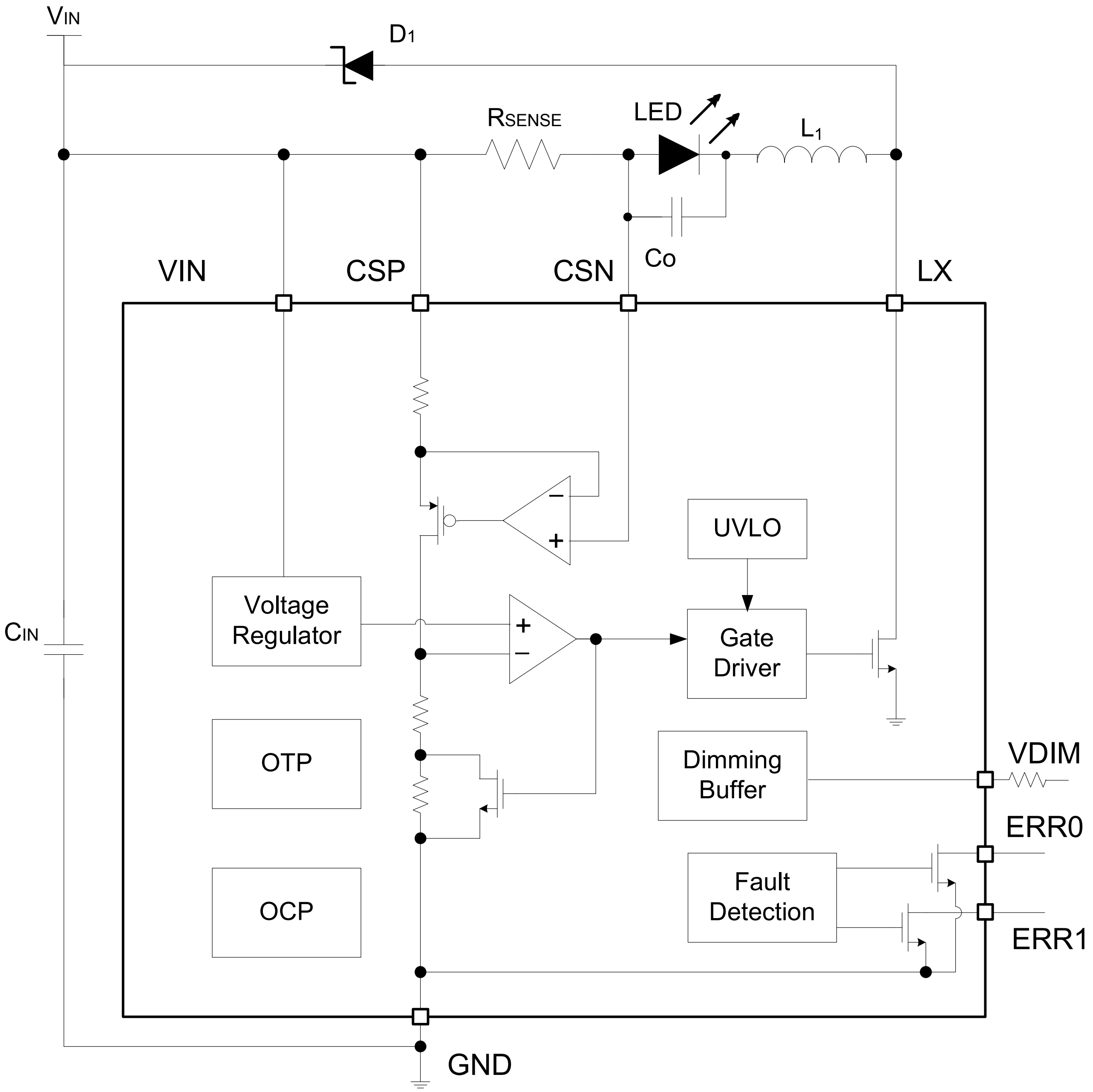
Part	Package Information	
MY8103SE	SOP8-EP	2500 pcs/Reel

Pin Configuration



For pricing, delivery, and ordering information, please contact MY-Semi Inc. at +886-3-560-1688, or email to INFO@MY-Semi.com.tw or visit MY-Semi's website at www.MY-Semi.com.tw

Block Diagram



Pin Description

<table>
<tr><th>PIN No.</th><th>PIN NAME</th><th>FUNCTION</th></tr>
<tr><td>1</td><td>LX</td><td>Switching pin</td></tr>
<tr><td>2</td><td>GND</td><td>Ground</td></tr>
<tr><td>3</td><td>VDIM</td><td>DC dimming and digital dimming input pin.
● Floating:
$I_{OUT} = 0.1/R_{SENSE}$
● $V_{DIM} < 0.4V$:
The output current is turned off.
● A DC voltage from 0.5V to 2.5V:
Adjust output current I_{OUT} from 20% to 100%
● Connect a capacitor on this pin to GND to provide additional soft-start delay.</td></tr>
<tr><td>7
6</td><td>CSP
CSN</td><td>Set normal output current pins. Connect a resistor between CSP and CSN to define the nominal average output current.</td></tr>
<tr><td>8</td><td>VIN</td><td>Supply voltage input pin. Bypass with a 4.7uF or higher value capacitor to GND.</td></tr>
<tr><td>4
5</td><td>ERR0
ERR1</td><td>ERR0 and ERR1 are fault indication pins. These two pins are open-drain outputs, which is normally high resistance. When fault conditions exist, ERR0 and/or ERR1 will be low resistance. For each pin, an external pull-up resistor should be connected to a suitable logic supply. The recommended value of pull-up resistor is 10KΩ. The fault conditions can be monitored by an external system. ERR0 and ERR1 can not be used as control signals to enable/disable MY8103 directly. Fault conditions and pin states are given in the following table:
<table>
<tr><th>Fault</th><th>ERR0</th><th>ERR1</th><th>Description</th></tr>
<tr><td>Normal</td><td>High</td><td>High</td><td>The ERR0 and ERR1 is pull-up to “High” level at normal operation.</td></tr>
<tr><td>Open</td><td>Low</td><td>High</td><td>The ERR0 goes “Low” when LED open.</td></tr>
<tr><td>OTP</td><td>Low</td><td>Low</td><td>The ERR0 and ERR1 are “Low” level and switching is off when over temperature.</td></tr>
<tr><td>OCP</td><td>High</td><td>Low</td><td>The ERR1 goes “Low” and switching is off when over current protection is occurred.</td></tr>
</table></td></tr>
<tr><td>-</td><td>Exposed PAD</td><td>Exposed Pad. Connect EP to a large-area ground plane for effective power dissipation. Do not use as the IC ground connection.</td></tr>
</table>

Maximum Ratings (Ta=25°C, Tj(max) = 150°C)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Supply Voltage	VIN	-0.3 ~ 72	V
LX Voltage	V_{LX}	-0.3 ~ 72	V
VDIM Input Voltage	V_{DIM}	-0.3 ~ 6	V
ERR0, ERR1 Voltage		-0.3 ~ 6	V
CSP, CSN Voltage		-0.3 ~ 72	V
Switching Current	I_{LX}	1.25	A
Thermal Resistance (On PCB)	Rth(j-a)	60 (SOP8-EP)	°C/W
Operating Junction Temperature	$T_{j.max}$	150	°C
Operating Temperature	Top	-40 ~ 125	°C
Storage Temperature	Tstg	-55 ~ 150	°C

(1) Stresses above these ratings may cause permanent damage. Exposure to absolute maximum conditions for extended periods may degrade device reliability. These are stress ratings only and functional operation of the device at these or any other condition beyond those specified is not supported.

(2) All voltage values are with respect to ground terminal.

Electrical Characteristics (VIN = 24V, Ta = 25°C unless otherwise noted)

CHARACTERISTIC	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNIT
Supply Voltage	VIN		8		65	V
Internal Supply Voltage	V_{CC}	Measured on VDIM pin with VDIM pin floating		5		V
Quiescent Current	I_{IN_off}	V_{DIM}<0.4V		310		μA
Switching Frequency*	F_{SW}				1	MHz
Current Sense						
Sense Voltage	V_{SENSE}	$V_{SENSE} = V_{CSP} - V_{CSN}$, V_{CSP}=24V	95	100	105	mV
		$V_{SENSE} = V_{CSP} - V_{CSN}$, V_{CSP}=2V	95	100	105	mV
Internal MOSFET						
Drain-to-Source Resistance	R_{DSON}	I_{LX}=1A		0.4		Ω
LX Leakage Current	I_{LX_Leak}	V_{DIM}=0V, V_{LX}=65V			1	μA
Under Voltage Lockout (UVLO)						
Under Voltage Lockout	UVLO	On VIN rising edge, V_{DIM} pin floating		7.5		
		On VIN falling edge, V_{DIM} pin floating		7		V
UVLO Hysteresis				0.5		
VDIM Input						
External Control Voltage Range for DC Dimming	V_{DIM}		0.5		2.5	
DC Voltage Level on VDIM Pin to Turn Off Output	V_{DIM_off}	On V_{DIM} falling edge	0.4			V
DC Voltage Level on VDIM Pin to Turn On Output	V_{DIM_on}	On V_{DIM} rising edge			0.5	
VDIM Pin Input Resistance	R_{VDIM}	To internal supply		200		KΩ
Over Current Protection (OCP)						
Over Current Threshold	I_{OCP}			1.5		A
Over Temperature Protection (OTP)						
Thermal Shutdown Threshold*	T_{SD}			+150		°C
Thermal Shutdown Hysteresis*	T_{SDH}			30		°C
Fault Indication						
Output Low Voltage	$V_{ERRn.L}$	V_{pu} = 5V, R_{pu} = 10 KΩ		100		mV
Leakage Current	$I_{ERRn.Leak}$	V_{pu} = 5V, R_{pu} = 10 KΩ			1	μA

(*) Parameters are guaranteed by design, characterization and process control.

Typical Characteristics (VIN = 24V, C_{IN}=15uF, L=47uH, LED V_F=4V @ I_{LED}=1A, Ta = 25°C unless otherwise noted)

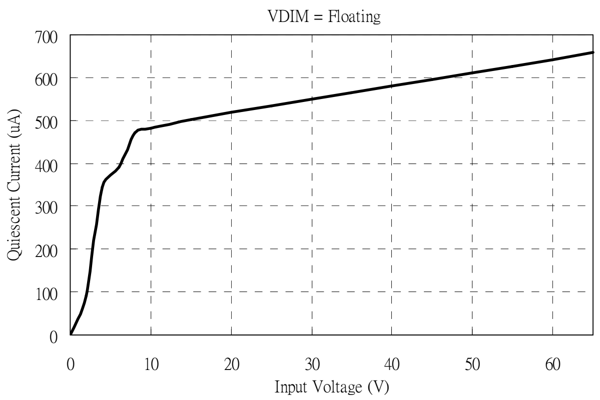


Figure 1. Supply Current (not switching) vs. Input Voltage

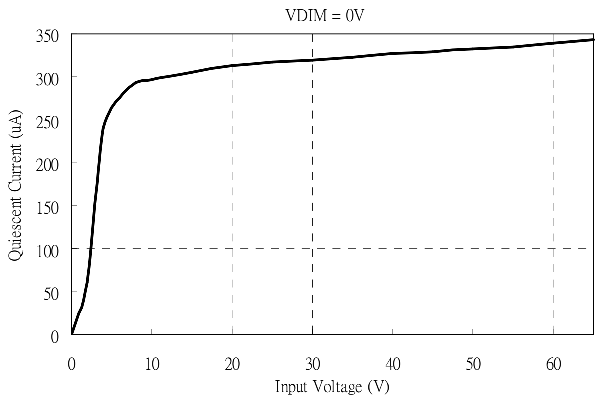


Figure 2. Supply Current (not switching) vs. Input Voltage

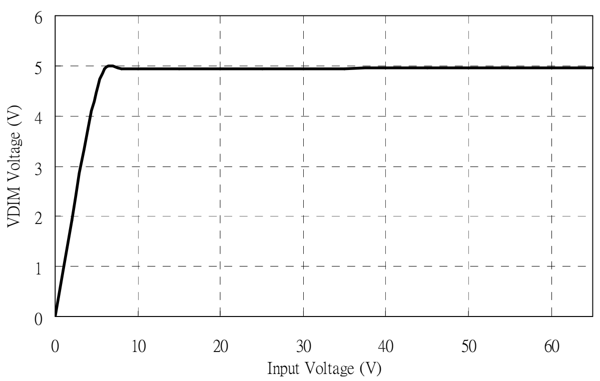


Figure 3. VDIM voltage vs. Input Voltage

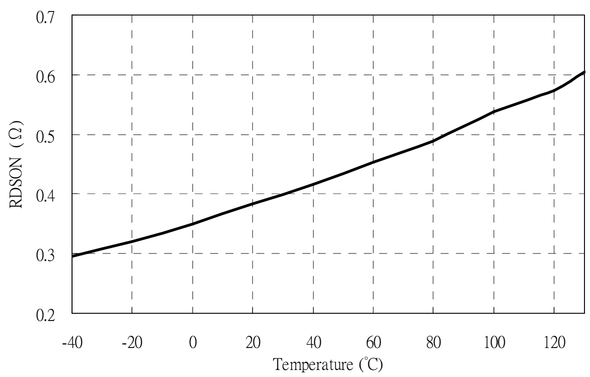


Figure 4. RDSON vs. Temperature

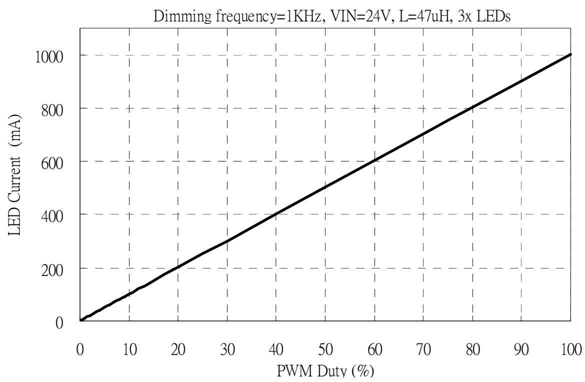


Figure 5. LED Current vs. PWM Duty

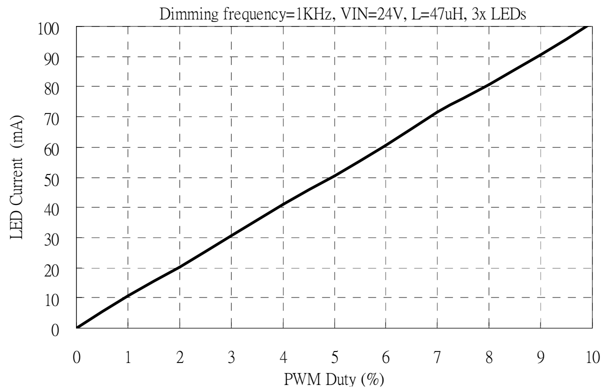


Figure 6. LED Current vs. PWM Duty=1%~10%

Typical Characteristics (VIN = 24V, C_{IN}=15uF, L=47uH, LED V_F=4V @ I_{LED}=1A, Ta = 25°C unless otherwise noted)

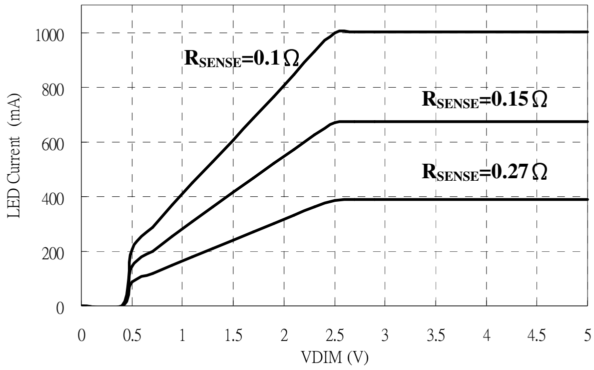


Figure 7. LED Current vs. VDIM

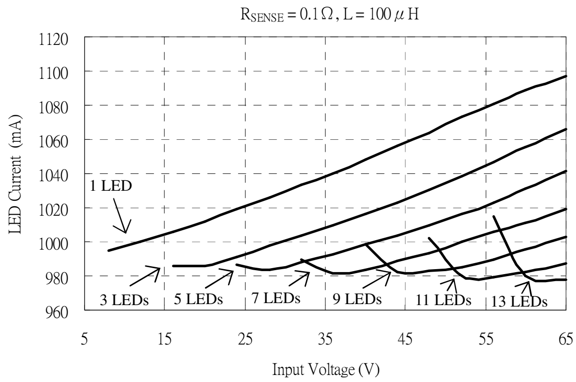


Figure 8. LED Current vs. Input Voltage

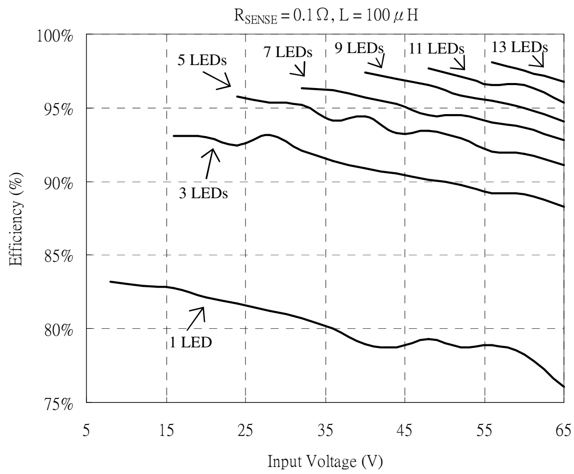


Figure 9. Efficiency vs. Input Voltage

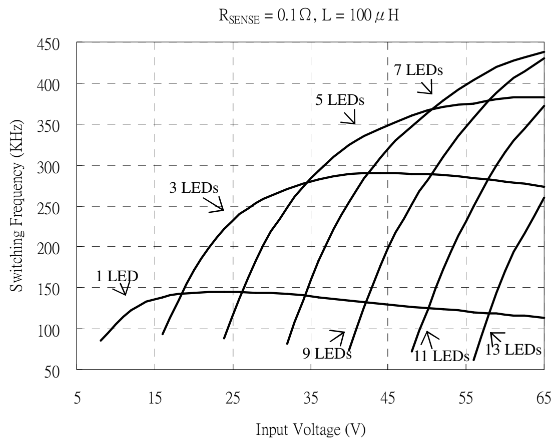


Figure 10. Switching Frequency vs. Input Voltage

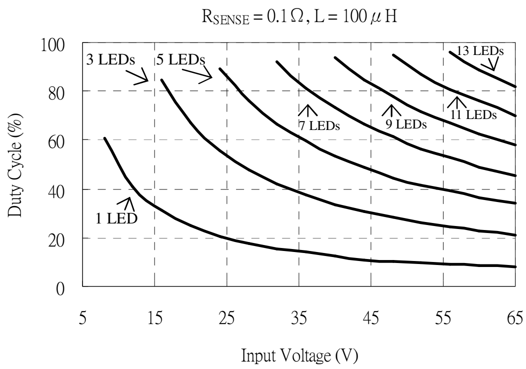


Figure 11. Duty Cycle vs. Input Voltage

Typical Characteristics (VIN = 24V, C_{IN}=15uF, L=47uH, LED V_F=4V @ I_{LED}=1A, Ta = 25°C unless otherwise noted)

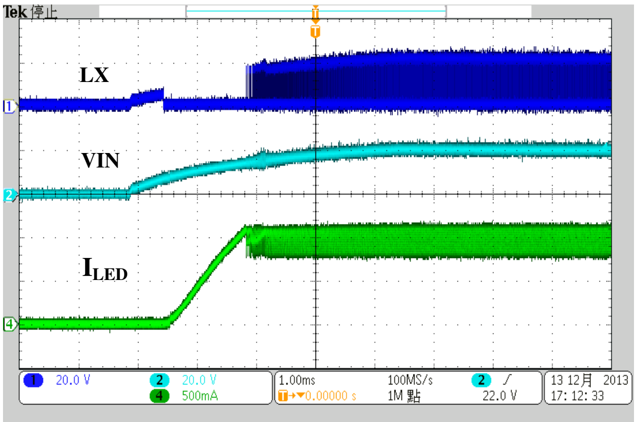


Figure 12. Power ON Waveform

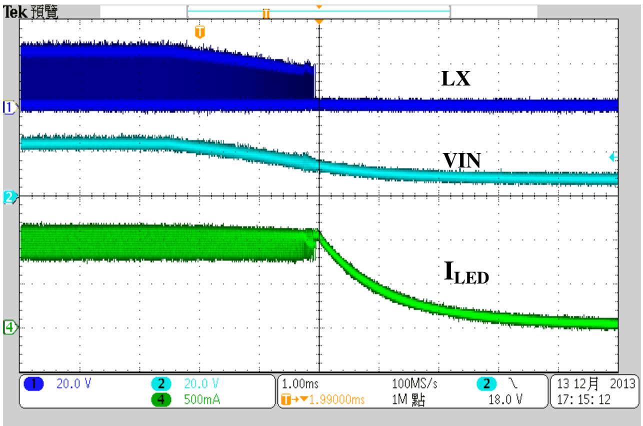


Figure 13. Power OFF Waveform

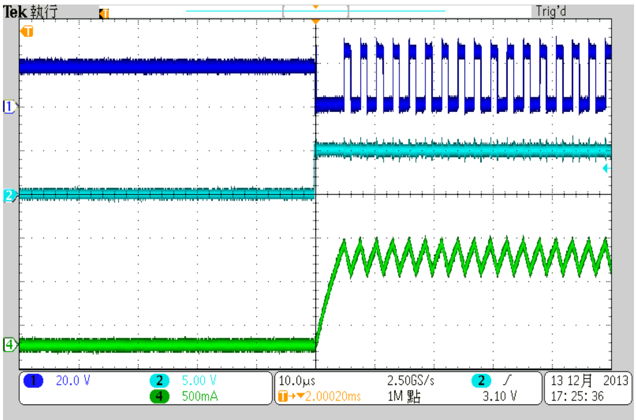


Figure 14. VDIM ON

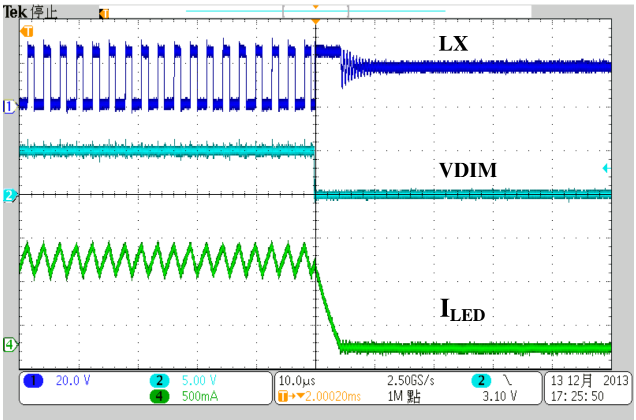


Figure 15. VDIM OFF

Application Information

MY8103 can be configured to operate in common anode or high-side current sense configurations by suitable connection of the external components as shown in the following schematics.

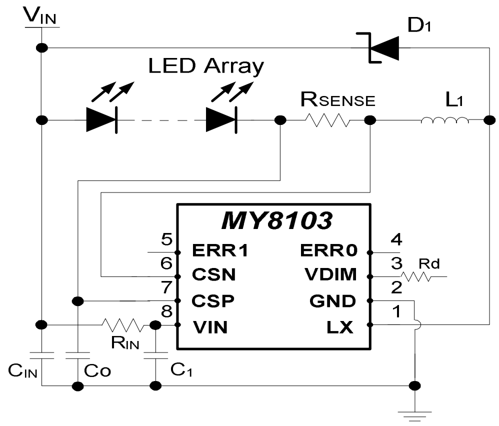


Figure 16. Common Anode

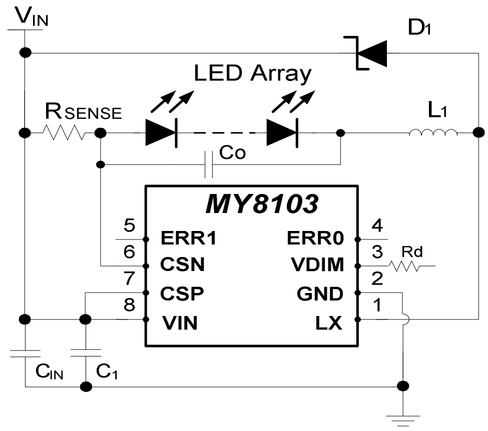


Figure 17. High-Side Current Sense

LED Current Setting

The LED current is programmed by the resistor R_{SENSE} connected between CSP and CSN. The following equation defines the value of LED current (if the V_{DIM} is higher than 2.5V or leave VDIM pin floating):

$$I_{LED} = \frac{V_{SENSE}}{R_{SENSE}}$$

The above equation defines the nominal I_{LED}. Drive a DC voltage to VDIM pin to adjust the current level from 100% to 0% of I_{LED}.

The following equation calculates the value of R_{SENSE}:

$$R_{SENSE} = \frac{V_{SENSE}}{I_{LED}}$$

For example, if desired I_{LED} is 500mA and VDIM pin is floating, then the value of R_{SENSE} is:

$$R_{SENSE} = \frac{0.1}{500m} = 0.2\,\Omega$$

Dimming Control

LED current can be adjusted by applying an external control signal to VDIM pin. The VDIM pin can accept a DC voltage or a PWM signal to perform analog dimming or PWM dimming. In order to protect this pin from voltage surges, adding a series resistor (Rd=47~100Ω) on VDIM pin is recommended.

Analog Dimming

Drive a DC voltage to VDIM pin to adjust the LED current below the maximum value set by R_{SENSE}. The following equation defines the value of I_{LED} when $0.5V \le V_{DIM} \le 2.5V$:

$$I_{LED} = \frac{V_{DIM}}{2.5}\frac{V_{SENSE}}{R_{SENSE}}$$

PWM Dimming

Drive a PWM signal to VDIM pin to adjust the LED current digitally. The average output current is proportional to the duty cycle of PWM signal. To achieve high resolution of PWM dimming the PWM frequency must be lower than 500Hz. MY8103 provides the 10-bit dimming resolution with a low frequency PWM signal at 100Hz.

Turn-Off Output Current

A voltage level below 0.4V at VDIM turns off the LED current. To turn the LED current on, the voltage level at VDIM must be greater than 0.5V. The Figure 7 shows the related output current in different R_{SENSE} values.

Over Current Protection

MY8103 has built-in over-current protection to protect LX pin from abnormal excessive current flowing through. The output switching will be turned off when LED current exceeds 1.5A. When over-current protection is activated, it will not be removed until resetting the input power. When over-current occurs, the ERR1 pin is pulled low and ERR0 remains "high" (The ERR0/ERR1 pins have pull-up resistors to 5V). Figure 18 shows the waveform of over-current protection.

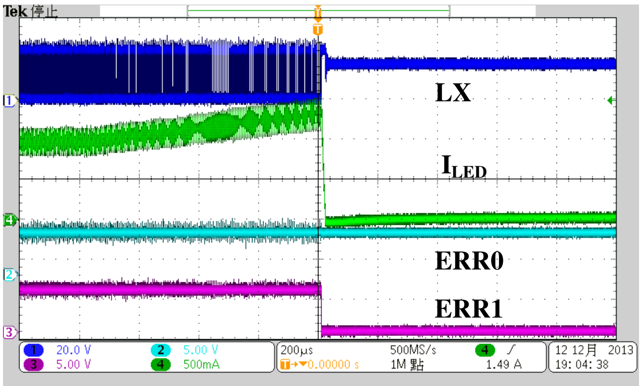


Figure 18. Over Current Protection

LED Open Protection

MY8103 has built-in open-circuit protection for LED string. The switching is stopped when any LED is open. The switching is restarted when the open situation is removed. When open-circuit is occurred, the ERR0 pin is pulled low and ERR1 remains "high" (The ERR0/ERR1 pins have pull-up resistors to 5V). Figure 19 shows the waveform of open-circuit protection.

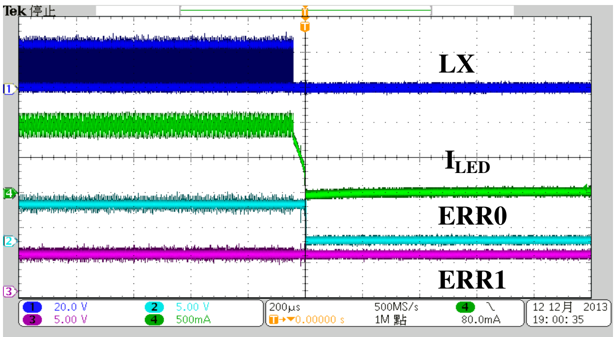


Figure 19. Open Protection

Thermal Shutdown

The MY8103 thermal shutdown function turns off the output current when the junction temperature exceeds +150℃. The output current turns back on when the junction temperature drops 30℃ below the shutdown temperature threshold. When over-temperature is occurred, the ERR0 and ERR1 pins are pulled low(The ERR0/ERR1 pins have pull-up resistors to 5V). Figure 20 shows the waveform of over- temperature protection.

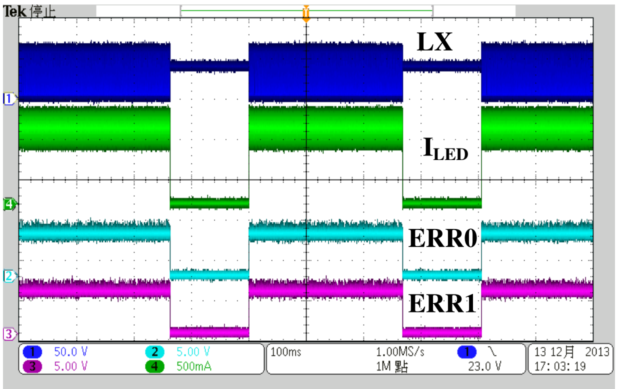


Figure 20. Over Temperature Protection

LED Short Protection

MY8103 is switching and remains in constant current regulation when there is one or several LEDs in short circuit. Figure 21 shows the waveform of LED short protection.

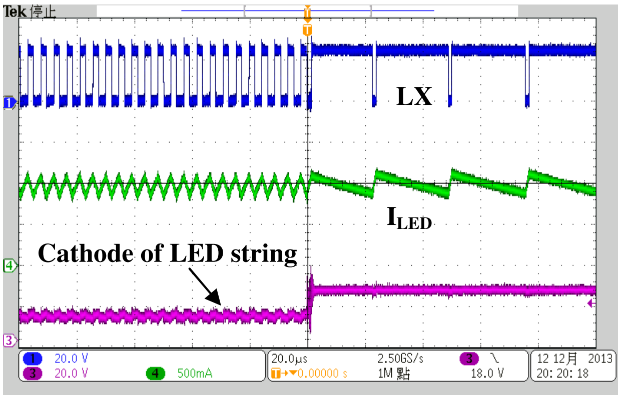


Figure 21. LED Short Protection

Input Capacitor/Resistor Selection

C_{IN}=10uF or greater capacitor and C_1=0.1~1uF ceramic capacitor are recommended. The C1 bypass capacitor should be placed as close to VIN pin as possible. If a constant capacitance over wider temperature and voltage is needed, X5R or X7R dielectric capacitors are recommended.

For common anode configuration, to avoid high voltage transients into MY8103, adding a R_{IN}=100Ω resistor between C_{IN} and C_1, and selecting a greater C_{IN} capacitor are suggested.

For high-side current sense configuration, to avoid high voltage transients into MY8103, selecting a greater C_{IN} capacitor and placing a TVS (Transient Voltage Suppressor) parallel to C_{IN} are suggested.

Inductor Selection

Use the following equation to calculate an approximate inductor value:

$$L = \frac{(VIN - nV_{LED} - V_{SENSE} - I_{LED} \times R_{DSON}) \times (nV_{LED} + V_D)}{(VIN + V_D) \cdot F_{SW} \cdot \Delta I}$$

Where V_{SENSE} is the voltage across R_{SENSE}, nV_{LED} is the voltage across the LED string, V_D is the forward voltage of Schottky diode, ΔI is the ripple current of inductor, and F_{SW} is the switching frequency.

The inductor's maximum current rating which equals or exceeds twice the I_{LED} is recommended. For example, when set I_{LED} at 500mA, an inductor with at least 1000mA current rating is recommended.

For EMI improvement, it is recommended using a shield inductor.

Freewheel-Diode Selection

For performance and best efficiency, a Schottky diode is a good choice as long as its breakdown voltage is high enough to withstand the maximum operating voltage. The peak repetitive current rating of the Schottky diode should be greater than the peak current flowing through the inductor. Also the continuous current rating of the Schottky should be greater than the average LED current. The voltage rating of the diode should be greater than the peak supply voltage transient preventing any breakdown or leakage.

Output Capacitor Selection

Adding a capacitor to CSP pin to GND can reduce the peak to peak current ripple of I_{LED}. If needed, a larger capacitor can be used to further reduce the LED current ripple. For common anode configuration, the output capacitor is necessary and a value of 22uF will meet most requirements.

Soft-Start

For many applications, it is necessary to minimize the inrush current at start-up. Extra soft-start time reduces the start-up current spike and output voltage overshoot. Add a capacitor to VDIM pin to GND increases soft-start time.

Thermal Compensation

Use an external temperature sensing network (ex. NTC thermistor attached to the LED(s)) and connected to the VDIM pin in order to reduce output current when the temperature of the LED string exceeds a specified temperature point.

Board Layout Consideration

The GND pin should be connected directly to the ground plane on the PCB. It is important to achieve good electrical and thermal contact between the exposed pad and the ground plane of the PCB. To reduce EMI and switching noise, the inductor and Schottky should all be placed close to MY8103. It is important to minimize the layout area of the LX pin. The input bypass capacitor should be placed as close as possible to the VIN pin. To protect VDIM pin from voltage surges, adding a series resistor on VDIM pin is recommended.

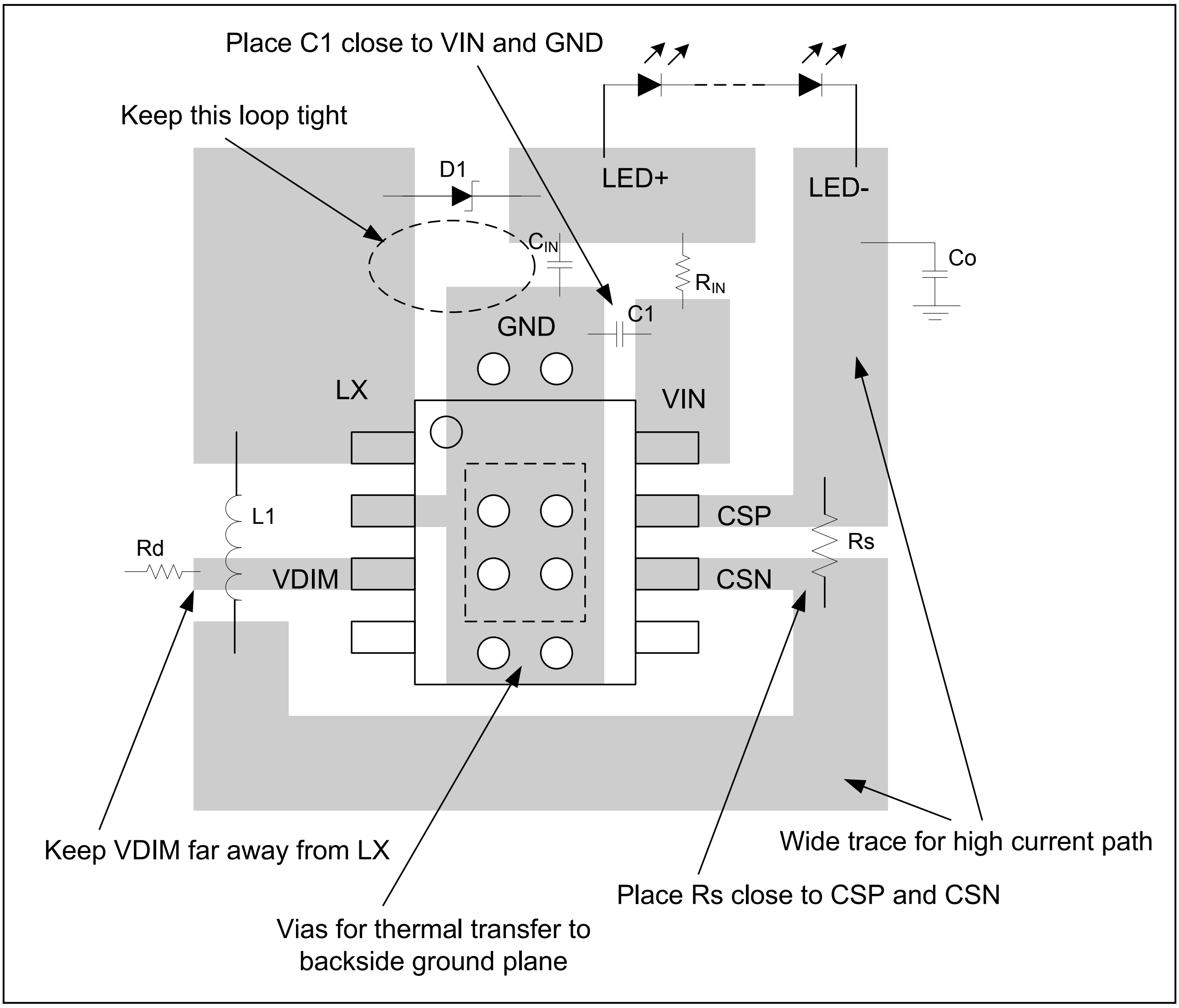


Figure 22. PCB Considerations

Power Dissipation

In secure operating conditions, the power consumption of an integrated chip should be less than the maximum permissible power dissipation which is determined by the package types and ambient temperature. The formula for maximum power dissipation is described as follows:

$$PD\ (max) = \frac{Tj(max)(℃) - Ta(℃)}{Rth(j\text{-}a)(℃/Watt)}$$

The PD (max) declines as the ambient temperature raises. Therefore, suitable operating conditions should be designed with caution according to the chosen package and the ambient temperature. The following figure illustrates the relation between the maximum power dissipation and the ambient temperature in the four different packages.

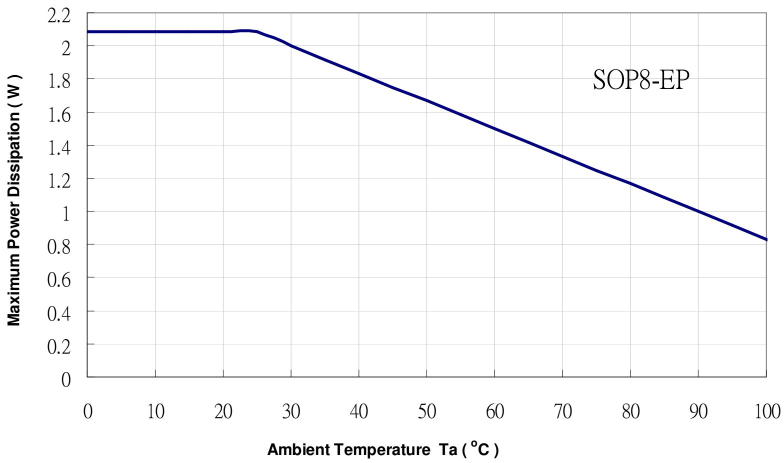


Figure 23. MY8103 Derating Curve

Applications

High-Side Current Sense Application

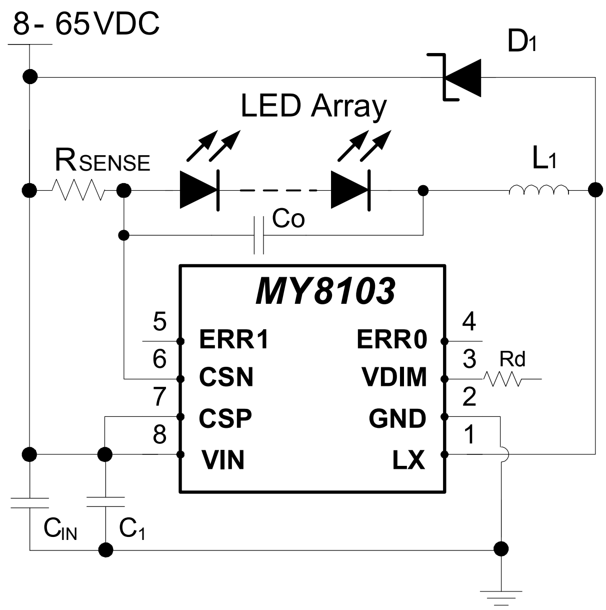


Figure 24.

Common Anode Connection

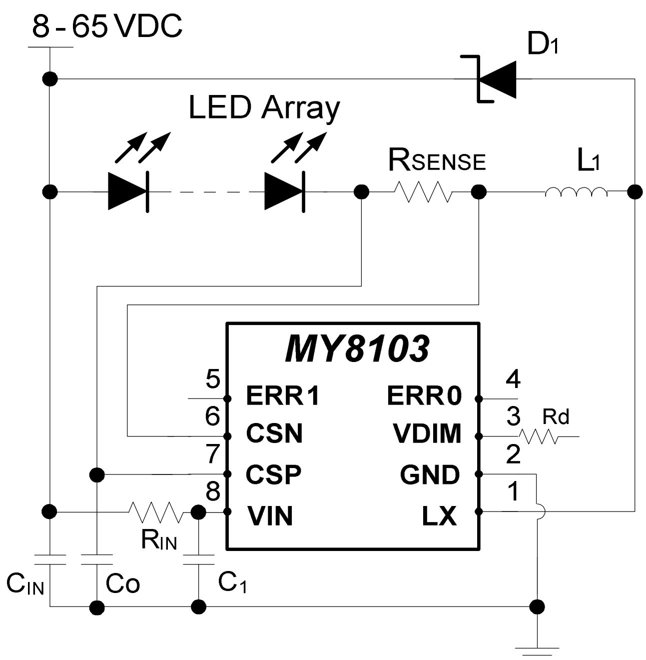


Figure 25.

3-Channel Common Anode Application

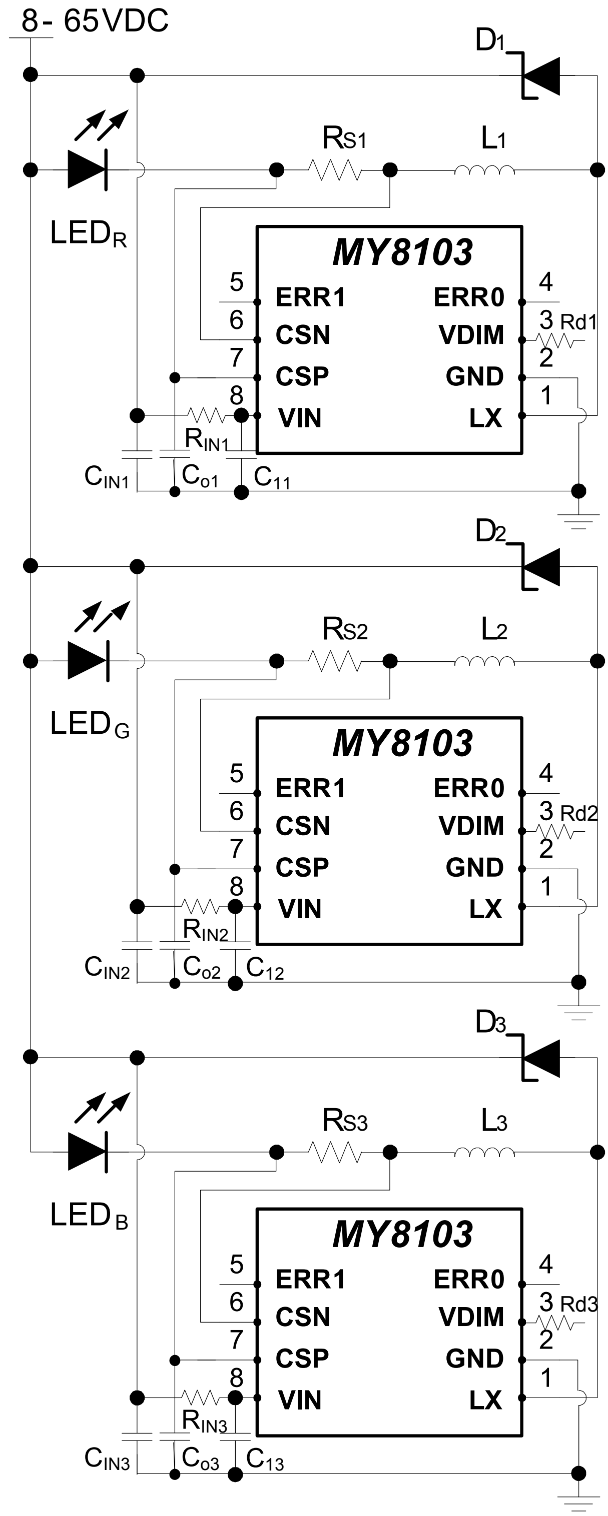
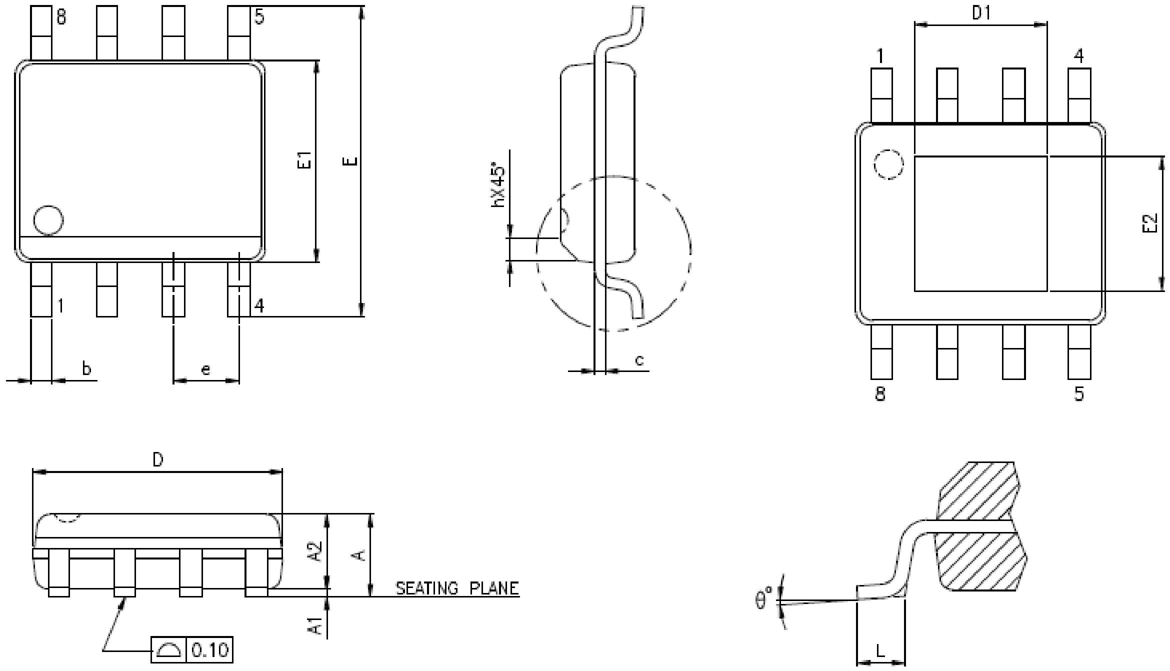


Figure 26.

Package Outline Dimension

SOP8-EP



Symbol	Dimensions (mm)	
	Min	Max
A	—	1.75
A1	0.10	0.25
A2	1.25	—
b	0.31	0.51
c	0.10	0.25
D	4.90 BSC	
E	6.00 BSC	
E1	3.90 BSC	
e	1.27 BSC	
L	0.40	1.27
H	0.25	0.50
θ°	0	8
E2	2.05	2.41
D1	2.81	3.30