Off-Line, Non-isolated Linear AC LED Driver

With Auto Power Compensation

General Description

The EMD2155 is a non-isolated linear LED driver for general purpose LED lighting applications. It is capable of driving LEDs in multiple series connections and operating in multiple phases. The EMD2155 is designed 3 steps constant current that balance each sink paths.

The EMD2155 has built-in temperature and power compensation mechanisms to compensate for the temperature and line voltage variation. TriAC and PWM dimming control circuits are available.

The EMD2155 is based on a patented architecture that allows minimal external components to greatly enhance the lighting system reliability and drastically reduce system cost. Due to its non-switching behavior, the system is never an EMI issue.

Features

- Non-isolated, Linear Application
- 110V or 220V Application
- High Power Factor
- High Efficiency
- Low EMI
- Adjustable LED Current
- Temperature Compensation
- Adjustable ratio for Auto Power Compensation
- TriAC Dimming (option)
- PWM Dimming
- Over Temperature Protection
- Over Voltage Protection
- UVLO
- E-SOP-8L Exposed Pad Package

Applications

- E27 Compatible Lamp
- LED Strings
- General Illumination

Typical Application

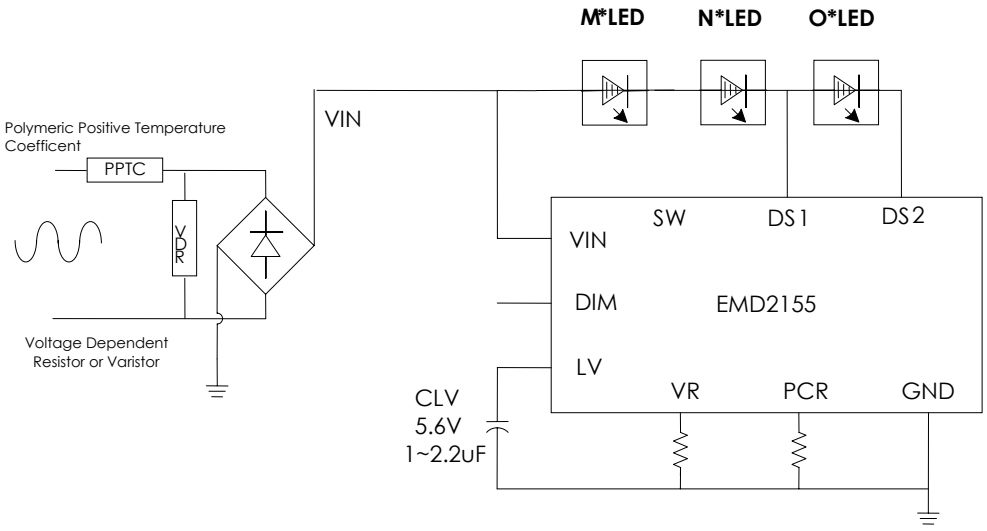
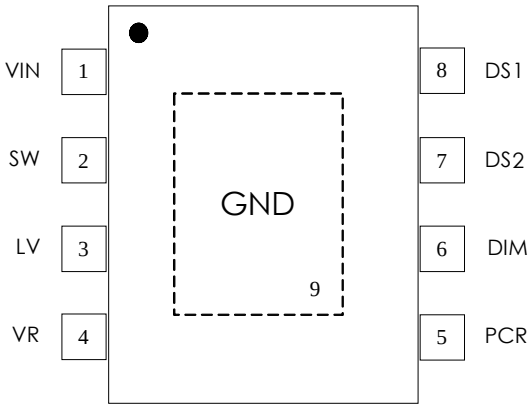


Fig. 1 2 steps application

Connection Diagram



Order Information

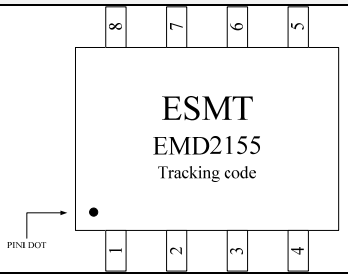
EMD2155-XXSG08NRR

XX LED current option code
00: IDS=68.4~75mA
02: IDS=61.8~68.4mA

SG08 E-SOP-8L Package

NRR RoHS & Halogen free package
Rating: -40 to 85°C
Package in Tape & Reel

Order, Marking & Packing Information

Package	Vout	Product ID	Marking	Packing
E-SOP-8L	Adjustable	EMD2155-00SG08NRR EMD2155-02SG08NRR		Tape & Reel 3Kpcs

Function Block

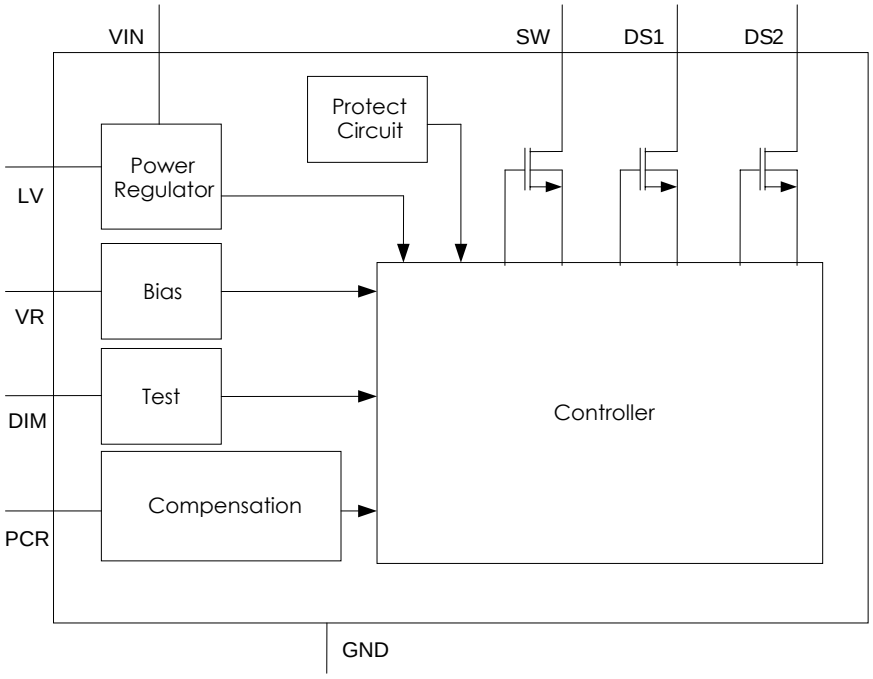


Fig. 2 EMD2155 Function block

Pin Functions

E-SOP-8L Pin #	Pin Name	Function
1	VIN	**Power Supply Input Pin.** Sustains the peak voltage of 240VAC power which is rectified by a bridge rectified. Un-rectified power is NOT allowed to connect with this terminal.
2	SW	**LED Segment1 cathode connection Pin. (Switching Pin.)** Connects to the cathode of segment1 HV LEDs , The anode of segment1 HV LEDs must be connected to VIN (Provide holding current when the chip operates with TriAC application).
3	LV	**Internal power Pin.** Power for internal circuit which is regulated by an internal power regulator. Connect capacitor directly to stable the internal power.
4	VR	**Output Power Adjustment Pin.** Connect a resistor between VR pin and GND to set the driving current.
5	PCR	**Power compensation Pin.** Connect a resistor between PCR pin and GND to set the current for compensation ratio.
6	DIM	**DIM Pin.** PWM dimming control pin, build-in auto-pull high which support open drain circuit with DIM pin. It's without PWM dimming application when keep DIM pin floating.
7	DS2	**LED Segment3 cathode connection Pin.** Connects to the cathode of segment3 HV LEDs.
8	DS1	**LED Segment2 cathode connection Pin.** Connects to the cathode of segment2 HV LEDs. The anode of segment1 HV LEDs must be connected to VIN terminal or SW PIN.
9	GND	**Ground Pin (thermal pad for package power dissipation also).**

Absolute Maximum Ratings

Devices are subjected to failure if they stay above absolute maximum ratings

VIN	<700V	Operating Temperature Range	–25°C to 125°C
DS1, DS2, SW	<500V	Storage Temperature	–65°C to 150°C
LV	<6V	Junction Temperature	150°C
VR, DIM, PCR	<LV	Lead Temperature (Soldering, 10 sec)	260°C
ESD Susceptibility	HBM 2kV		
	MM 200V		

Thermal data

Package	Thermal resistance	Parameter	Value
E-SOP-8L	θ_{JA} (Note 2)	Junction-ambient	75°C/W
	θ_{JT} (Note 3)	Junction-case	15°C/W

Note 1: T_J is a function of the ambient temperature T_A and power dissipation P_D ($T_J = T_A + (P_D) * (75°C/W)$).

Note 2: θ_{JA} is measured in the natural convection at T_A=25℃ on a highly effective thermal conductivity test board (2 layers , 2S0P) according to the JEDEC 51-7 thermal measurement standard.

Note 3: θ_{JT} represents the heat resistance between the chip and the package top case.

Electrical Characteristics

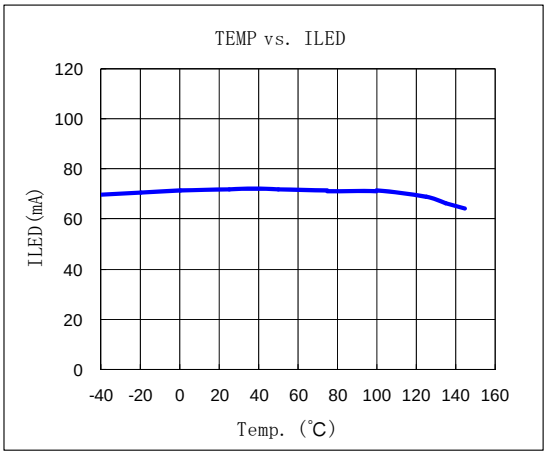
T_A = 25°C. V_{IN} = 110VAC unless otherwise specified.

Symbol	Parameter	Conditions		Min	Typ	Max	Units
V_{IN}	Input Voltage Range	For 110V application		90		130	Vac
	Input Voltage Range	For 220V application		200		240	Vac
I_{IN}	IC Supply Current			1.05	2.1	3.15	mA
R_{EXT}	External Resistor Range (VR)	PCR=NC		51		300	Kohm
V_OVP	Over Voltage Protection				400		V
I_{LED}	LED Current	RVR=200K, RPCR=NC	EMD2155-00	68.4	71.7	75	mA
			EMD2155-02	61.8	65.1	68.4	
I_{D_OFF}	IDS Leakage Current	DIM = 0V				1	uA
I_{LV}	LV Supply Current			0.25	1.3	2.35	mA
F_{PWM}	PWM Dimming Frequency					50	kHz
D_{PWM}	PWM Duty					100	%
V_{UVLO}	Under Voltage Lock Out			3.59	4	4.41	V
V_{DIM}	Dimming Control Threshold, V_{IH}					1.2	V
	Dimming Control Threshold, V_{IL}			0.4			V
OTP	Over Temperature Protection				150		℃
	hysteresis				50		℃

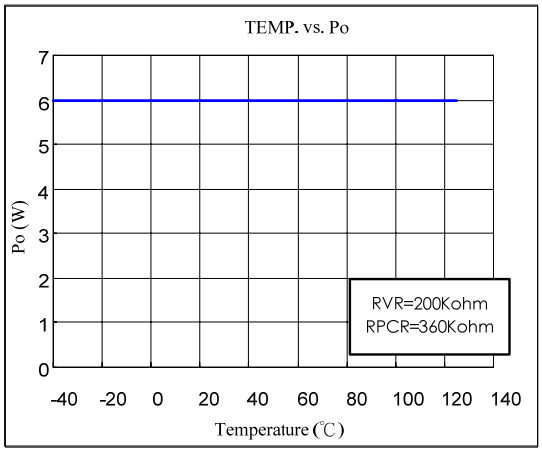
Typical Performance Characteristics

V_{IN}=110VAC, V_{LED}=120V, T_A=25℃, unless otherwise specified (EMD2155-00)

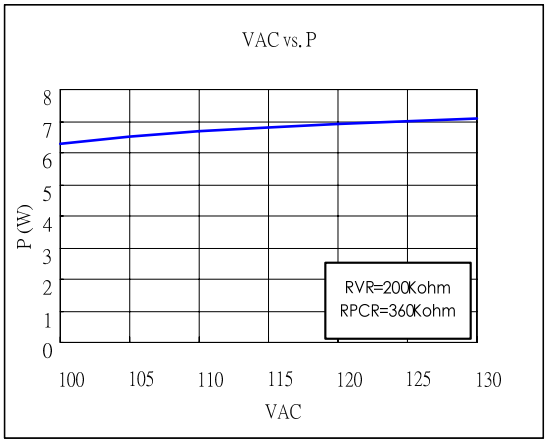
Temperature Compensation



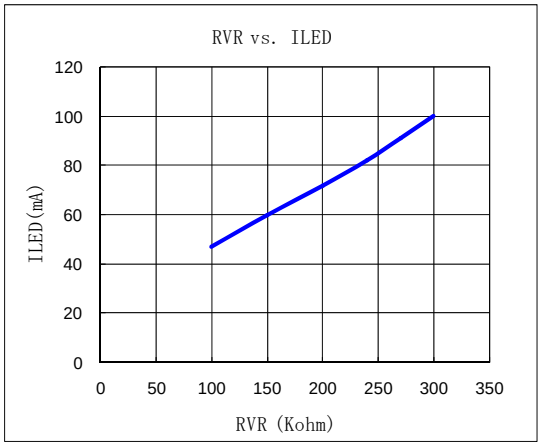
Temperature vs Input power



Input voltage vs input power



RVR vs ILED



Applications

Detailed Description

The EMD2155 is a non-isolated linear LED driver for general purpose LED lighting applications. The chip can monitor temperature with Build-in 3 500V HVMOS when IC using at heavy load. Each HVMOS has sequence operation turn-on time depend on AC Voltage and LED numbers of each Segment.

When AC voltage greater than Vf of M*LED+N*LED (See Fig.3(a)), the DS1 start sinking pre-set current. Until AC voltage greater than Vf of M*LED+N*LED+O*LED (See Fig.3(a)), the DS2 start sinking current Simultaneously turn-off DS1.

Capacitor Selection

The capacitor LV (CLV) is for stabilizing the internal power. LV pin can provide 1.3mA (typ.) for external circuit using if necessary. In typical applications, CLV should be larger than 1uF for proper operation.

VR Selection

The LED current can be controlled by the VR pin, connecting with an external resistor to GND which is equal to following table.(1). The value of the external resistor should be between 51K~300K and should not be left floating.

Table 1

EMD2155 -00	EMD2155 -02	RVR (KΩ)
33	26	51
47	40	100
60	53	150
72	65	200
82	75	240
91	84	270
100	93	300

(RPCR=NC)

Power Compensation

The EMD2155 detects Vin automatically, and compensates for the LED current based on the peak value of Vin. The LED current, set by VR, is seen as EMD2155 supplied by 110Vac. If Vin dropped (increased) to 90 (130) Vac, the LED current is increased (decreased) to compensate LED power.

For difference LED numbers of each LED segments application, EMD2155 provides PCR pin to adjust power compensation ratio, see table.(2). The value of the RPCR resistor should be between 200~1M. This feature can broaden LED's application range.

Table 2

ILED(typ.)	RPCR (KΩ)
72%	300
77%	390
81%	470
89%	910
100%	NC

(RVR=200KΩ)

Dimming Control

EMD2155 provides 3 types control mode for LED brightness controlling.

- Using a TriAC

TriAC is a common component with traditions lighting application, Increasing/decreasing the "conduction angle" of Triac(θ) which reduce/ increase average power. EMD2155 provides holding current with SW pin to reduction flicker issue when the "conduction angle" too small. Fig(4a)(4b) shows detailed application circuit and waveform.

- Using a PWM signal

The EMD2155 can perform the dimming control by applying a PWM single to DIM pin. The frequency of this PWM signal can range from 1KHz to 50KHz. The average LED driving current is directly proportional to the duty cycle of the PWM duty cycle, Fig.(5a)(5b) shows detailed application circuit and waveform. Build-in auto-pull high which support open drain circuit with DIM pin. There are about 700uA IDS current observed is possible when PWM dimming to 0% in EMD2155.

- Using a DC voltage

Another common application is using a DC voltage to adjust the LED brightness. The DC control circuit is shown in Fig.(6). The current regulator (OP, NMOS, R1, R2 and R3) adjusts current of VR pin which modulate LED's current. Connecting DIM pin between R1 & R2 that turn-off LED current when DC voltage too low. There are about 700uA IDS current observed is possible when 0-10V dimming to 0% in EMD2155.

Temperature Compensation

When the ambient temperature ≦120°C the LED current is set by external resistor. When ambient temperature >120°C LED current is decreased. The amount of reduced LED current depends on the temperature. The higher temperature is, the more the current reduction.

Protection Circuit

To improve the lighting system reliability, some protection circuits are designed in to protect both EMD2155 and LEDs from damage under the following unexpected conditions.

- OVP (Over Voltage Protection):

The EMD2155 will be shut down if Vin is over 400V. The EMD2155 will remain in shut down mode until Vin drops below 40V.

- OTP (Over Temperature Protection):

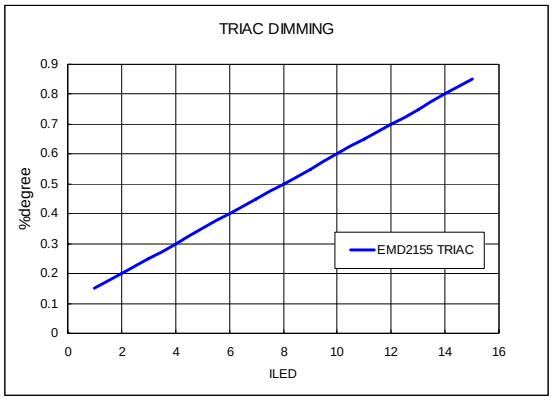
The EMD2155 will be shut down if the ambient temperature is over 150°C. The EMD2155 will remain in shut down mode until the ambient temperature drops below 100°C.

- UVLO:

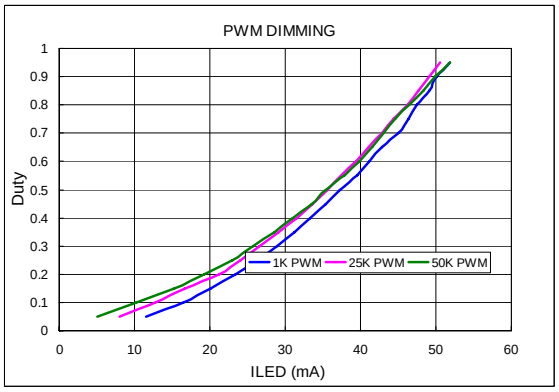
The EMD2155 will be shut down when the internal supply voltage is lower than 4.0V(typ.). The EMD2155 will remain in shut down mode until the internal supply voltage is increased higher than 5.0V(typ.).

Dimming Application Characteristics

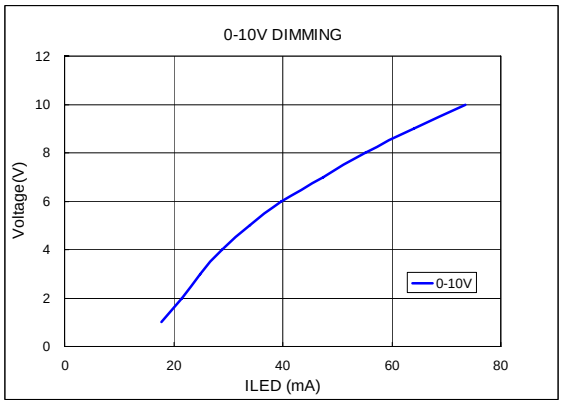
TRIAC DIMMING: Degree% vs. ILED - Fig4(a)



PWM DIMMING: Duty% vs. ILED - Fig5(a)



0-10V DIMMING: Voltage vs. ILED - Fig6



Application Circuit

- **Typical application**

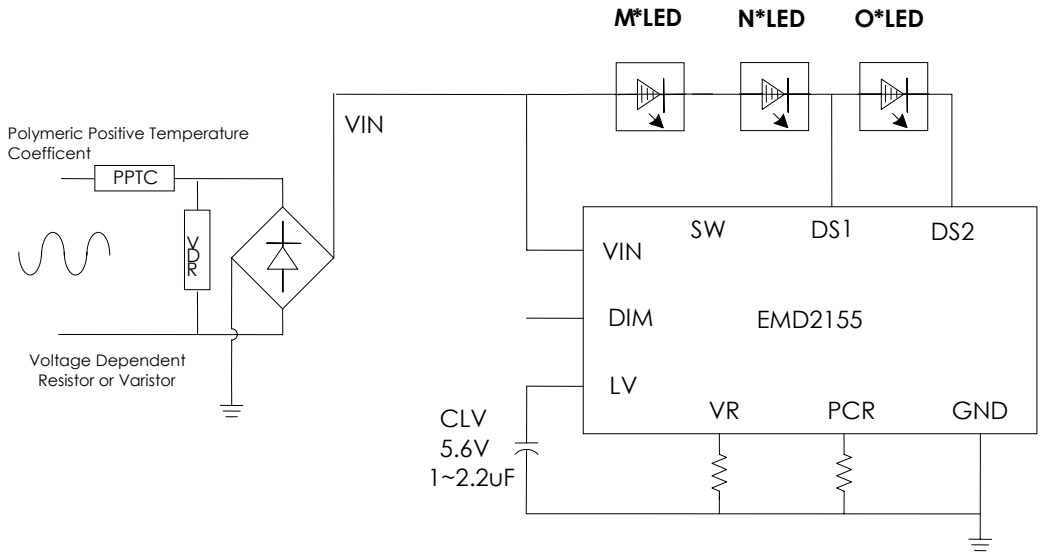


Fig. 3(a) 2 steps application

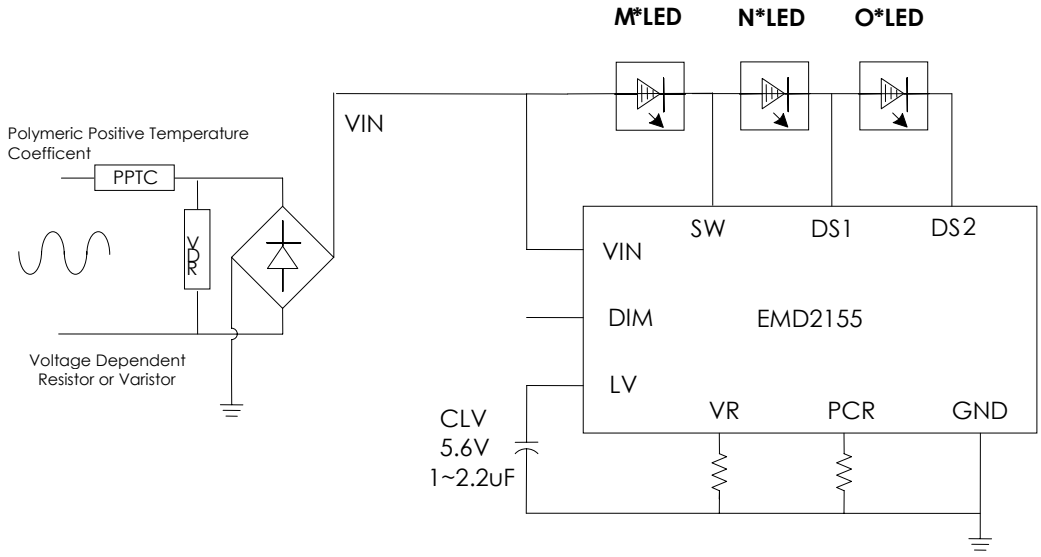


Fig. 3(b) 3 steps application (THD improve)

Application Circuit (cont.)

- **Application circuit for TriAC dimming**

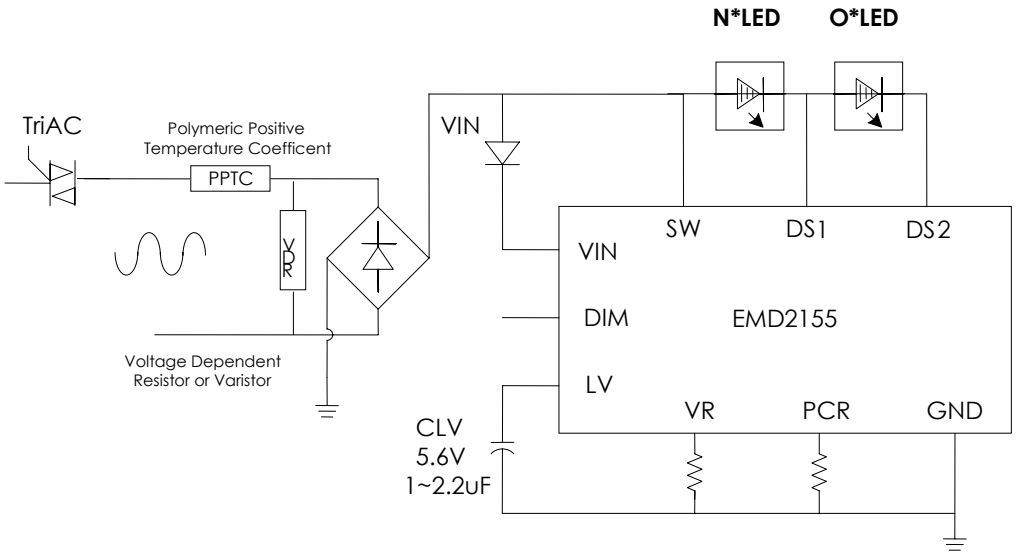


Fig. 4(a) TriAC application circuit

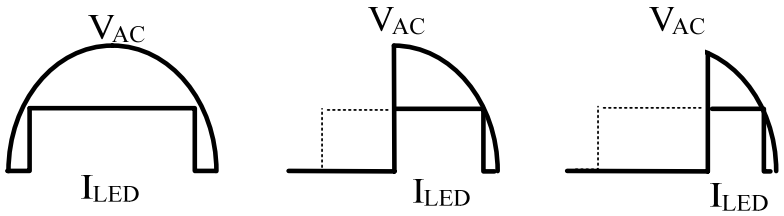


Fig. 4(b) TriAC application waveform

Application Circuit (cont.)

- **Application circuit for PWM dimming**

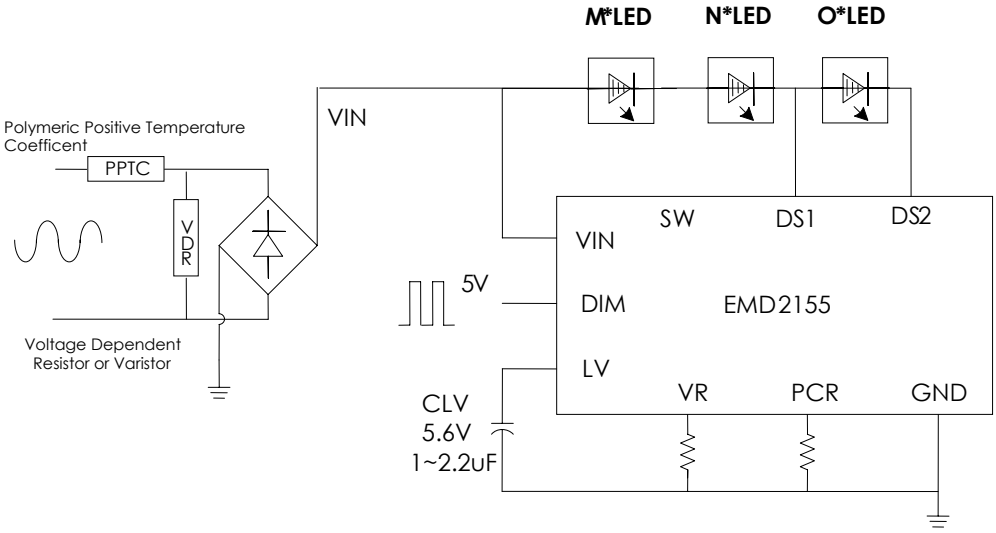


Fig. 5(a) PWM dimming control application circuit

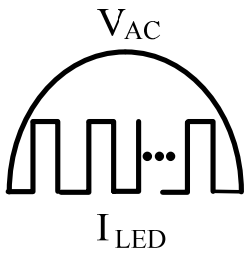


Fig. 5(b) PWM dimming control application waveform

Application Circuit (cont.)

- **Application circuit for DC voltage dimming**

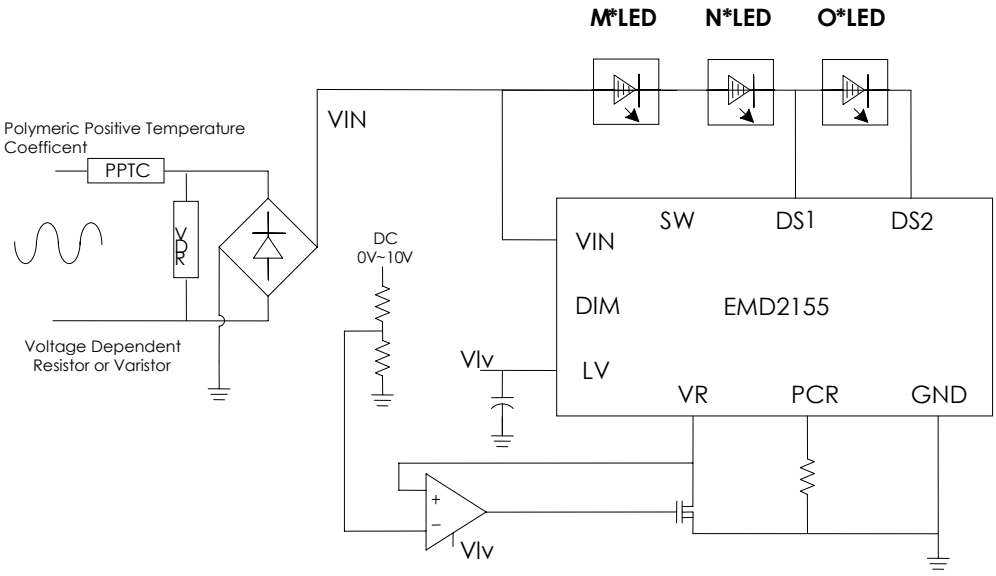
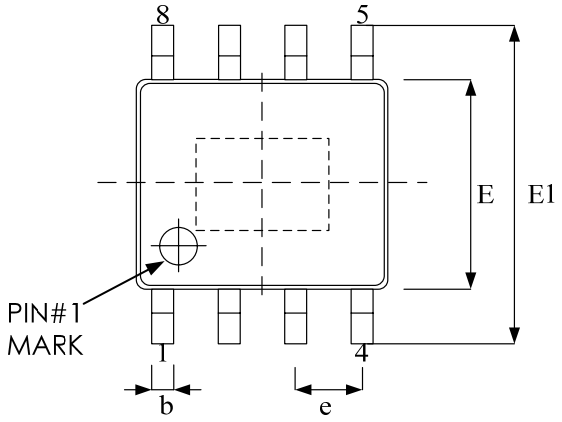
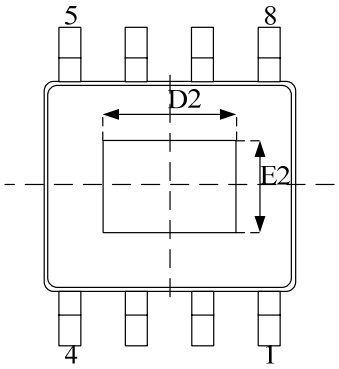


Fig. 6 DC Voltage dimming control application circuit

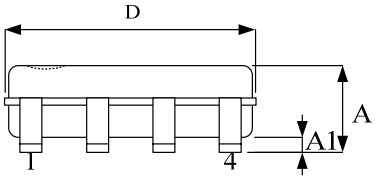
Package Outline Drawing
E-SOP-8 (150 mil)



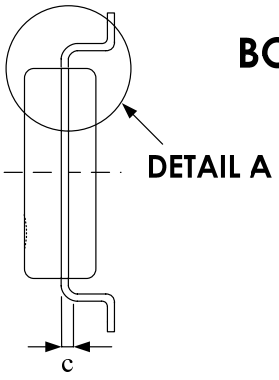
TOP VIEW

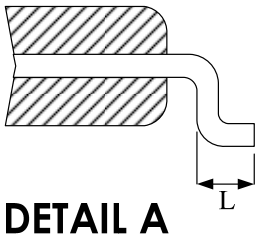


BOTTOM VIEW



SIDE VIEW





DETAIL A

Symbol	Dimension in mm	
	Min	Max
A	1.35	1.75
A1	0.00	0.25
b	0.33	0.51
c	0.17	0.25
D	4.80	5.00
E	3.81	4.00
E1	5.79	6.20
e	1.27 BSC	
L	0.41	1.27

Exposed pad

	Dimension in mm	
	Min	Max
D2	2.84	3.10
E2	2.06	2.31

Revision History

Revision	Date	Description
0.01	2014.06.17	Draft version.
0.02	2014.07.22	Typical Application, Package & Marking Information revise.
0.03	2014.08.06	Added Dimming application characteristics and RVR/RPCR relative function, fill RVR value in Table(1), add Table(2).
0.04	2014.10.07	Revised LED current accuracy tolerance, RVR(RPCR) setting range.
0.1	2015.03.10	Initial version.
1.0	2015.03.24	Modified version to 1.0, removed preliminary.
1.1	2015.11.05	1) Removed the dimming function supports in EMD2155. 2) Put the upper and lower limit spec. into the electrical characteristics, includes IIN, ILV and VUVLO. 3) New LED current option added into this datasheet
1.2	2016.03.13	1) Added the dimming function supports in EMD2155. 2) Update I_{D_OFF} spec., Order information

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