

## 0.5A Two Channel LED Driver

### Features

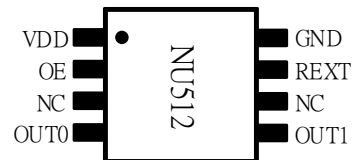
- 50mA~0.5A, two channel constant current regulator
- Output current adjustable by external resistor
- 3V ~ 12V wide range supply voltage
- 1MHz OE dimming support
- 400Hz V<sub>DD</sub> dimming support
- 0V ~ 17V output sustain voltage
- low output voltage dropout  
0.2V dropout at 80mA output  
0.6V dropout at 0.5A output
- Minimized I<sub>DD</sub> consumption
- 160°C half power thermal protect
- Less than ±4% chip/channel current skew
- Less than 0.5%/V line regulation
- Less than 1%/V load regulation
- Green package

### Applications

- General LED Lighting
- Decoration lighting for architecture
- LCD back lighting
- Street lamp

### Package Type

- ESOP8  
(Part No.: NU512ES)



### Product Description

The NU512 is a two channel, open drain, linear constant current LED driver. With up to 0.5A/channel driving current and maximum 1Mhz PWM dimming control support, NU512 can be used for 0.5W to 3W high power LED string in general or architecture decoration lighting applications.

The wide power supply range capability makes NU512 work stably in uncertain power supply applications. When the power supply voltage is changed or fluctuating, the output current still remains unchanged. With this dedicate designed function, the V<sub>DD</sub> power can be derived easily from the whole lighting system.

The output current of NU512 is set by an external resistor. While in full current output, the NU512 only need about 0.6V drop on output channel. The minimized voltage drop will increase the working range that limited by LED forward voltage variation in lighting system, to enhance the system efficiency and lower the heat generation from NU512.

### Terminal Description

Pin #	Pin name	Function
1	V <sub>DD</sub>	Power
2	OE	Output enable
3	NC	
4	OUT0	Output channel 0
5	OUT1	Output channel 1
6	NC	
7	REXT	R external
8	Gnd	Ground
-	<a href="#">Thermal pad</a>	<a href="#">Ground potential</a>

### Protection Circuit

- 8KV output channel ESD protection

**Maximum Ratings (T = 25°C)**

Characteristic	Symbol	Rating	Unit
Supply voltage	V <sub>DD</sub>	3.0 ~ 16	V
Output voltage	V <sub>OUTn</sub>	-0.2 ~ 20	V
Input voltage	V <sub>OE</sub>	-0.2 ~ V <sub>DD</sub>	V
Output current / Channel	I <sub>OUTn</sub>	0.6	A
Ground terminal current	I <sub>GND</sub>	1.2	A
Power Dissipation (On PCB)	P <sub>D</sub>	1	W
Thermal Resistance	R <sub>TH(j-a)</sub>	100	°C/W
Operating temperature	T <sub>OPR</sub>	-40 ~ +85	°C
Storage temperature	T <sub>STG</sub>	-55 ~ +150	°C

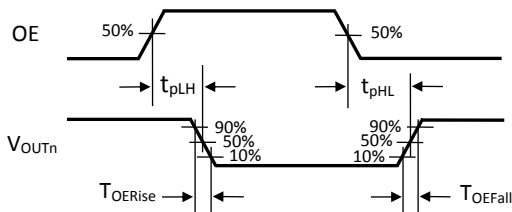
**Electrical Characteristics and Recommended Operating Conditions**

Characteristic	Symbol	Condition	Min.	Typ.	Max.	Unit
Supply voltage	V <sub>DD</sub>	Room Temp.	3	-	12	V
Output sustain voltage	V <sub>omax</sub>	I <sub>OUTn</sub> = 0A	-	-	17	V
Output current / Channel	I <sub>OUTn</sub>	-	50	-	500	mA
Output drop out voltage	V <sub>OUTn</sub>	V <sub>DD</sub> = 5V, I <sub>OUTn</sub> = 80mA	0.2	-	-	V
		V <sub>DD</sub> = 5V, I <sub>OUTn</sub> = 175mA	0.3	-	-	V
		V <sub>DD</sub> = 5V, I <sub>OUTn</sub> = 500mA	0.6	-	-	V
Power dissipation	P <sub>D</sub>	Room Temp.	-	-	0.65	W
Chip to chip current skew / Channel to channel skew	dI <sub>OUT</sub>	V <sub>DD</sub> >= 3V, I <sub>OUTn</sub> = 150mA	-	-	±4	%
Leakage	I <sub>Leakage</sub>	V <sub>OUT</sub> = 7V	-	-	1	uA
OE Input voltage	V <sub>IH</sub>	V <sub>DD</sub> < 5V	-	0.7*V <sub>DD</sub>	-	V
		V <sub>DD</sub> >= 5V	-	-	3.5	
	V <sub>IL</sub>	V <sub>DD</sub> < 5V	-	0.3*V <sub>DD</sub>	-	V
		V <sub>DD</sub> >= 5V	-	-	1.5	
Pull down resistor (OE)	R <sub>PD</sub>	On small area PCB	400	500	700	KΩ
Line regulation	%/V <sub>DD</sub>	3V < V <sub>DD</sub> < 12V	-	-	0.5	Δ%/V
Load regulation	%/V <sub>OUT</sub>	0.5V < V <sub>OUTn</sub> < 8V	-	-	1	Δ%/V
Operating Temperature	T <sub>OPR</sub>	Ambient temperature	-40	-	85	°C
Thermal protect (Junction temperature)	T <sub>HalfP</sub>	Half current output	-	160	-	°C
Thermal regulation	%/10°C	-	-	-	0.5	Δ%/10°C
Supply current	I <sub>DD</sub>	R <sub>EXT</sub> = Open, Output off	-	0.3	1	mA
		I <sub>OUTn</sub> = 180mA, Output on	2	4	4.5	mA
		I <sub>OUTn</sub> = 350mA, Output on	-	4.7	-	mA
		I <sub>OUTn</sub> = 500mA, Output on	-	5.0	-	mA
System voltage	V <sub>LED</sub>	V <sub>DD</sub> < 12V	5	-	24	V

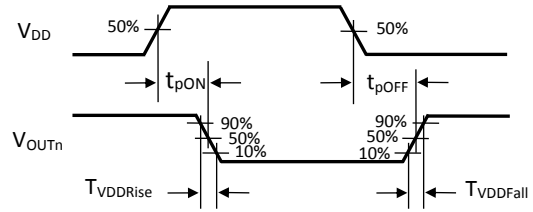
Switching Characteristics (T = 25°C)

Characteristic	Symbol	Condition	Min.	Typ.	Max.	Unit
Propagation Delay Time (OE from "L" to "H")	$t_{pLH}$	$V_{DD}=4V, V_{OUTn}=1V, I_{OUTn}=120mA, OE=0V \rightarrow 4V$	200	280	360	nS
Output current rising time (OE from "L" to "H")	$t_{OERise}$	$V_{DD}=4V, V_{OUTn}=1V, I_{OUTn}=120mA, OE=0V \rightarrow 4V$	30	50	80	nS
Propagation Delay Time (OE from "H" to "L")	$t_{pHL}$	$V_{DD}=4V, V_{OUTn}=1V, I_{OUTn}=120mA, OE=4V \rightarrow 0V$	560	620	680	nS
Output current falling time (OE from "H" to "L")	$t_{OEFall}$	$V_{DD}=4V, V_{OUTn}=1V, I_{OUTn}=120mA, OE=4V \rightarrow 0V$	60	90	130	nS
Propagation Delay Time ( $V_{DD}$ from "L" to "H")	$t_{pON}$	$V_{OUTn}=1V, I_{OUTn}=120mA, V_{DD}=OE=0V \rightarrow 3V$	-	30	-	uS
Output current rising time ( $V_{DD}$ from "L" to "H")	$t_{VDDRise}$	$V_{OUTn}=1V, I_{OUTn}=120mA, V_{DD}=OE=0V \rightarrow 3V$	-	5	-	uS
Propagation Delay Time ( $V_{DD}$ from "H" to "L")	$t_{pOFF}$	$V_{OUTn}=1V, I_{OUTn}=120mA, V_{DD}=OE=3V \rightarrow 0V$	-	3	-	uS
Output current falling time ( $V_{DD}$ from "H" to "L")	$t_{VDDFall}$	$V_{OUTn}=1V, I_{OUTn}=120mA, V_{DD}=OE=3V \rightarrow 0V$	-	5	-	uS

Timing Waveform

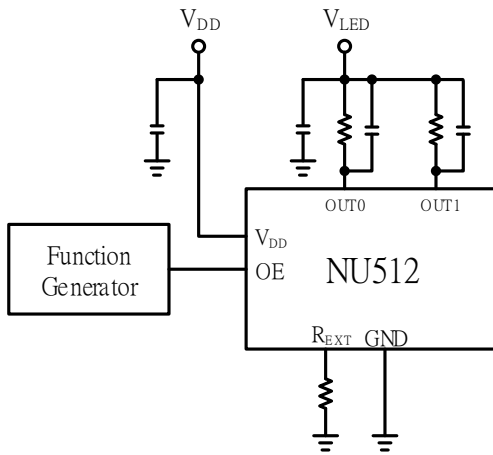


OE timing diagram

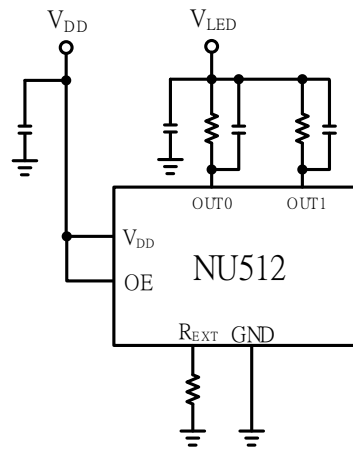


V<sub>DD</sub> timing diagram (V<sub>DD</sub>=V<sub>OE</sub>)

**Test Circuit**

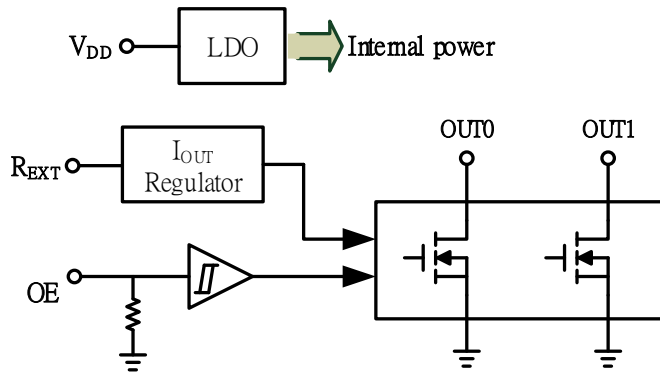


OE dimming and  $I_{OUT}$  test circuit



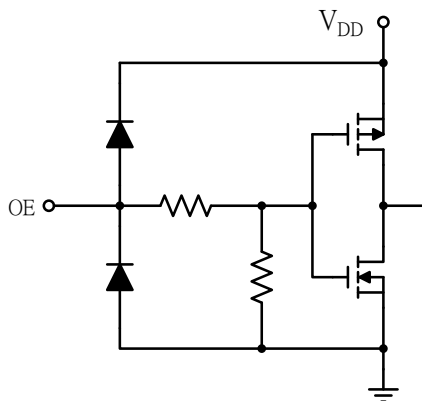
$V_{DD}$  dimming test circuit

**Block Diagram**



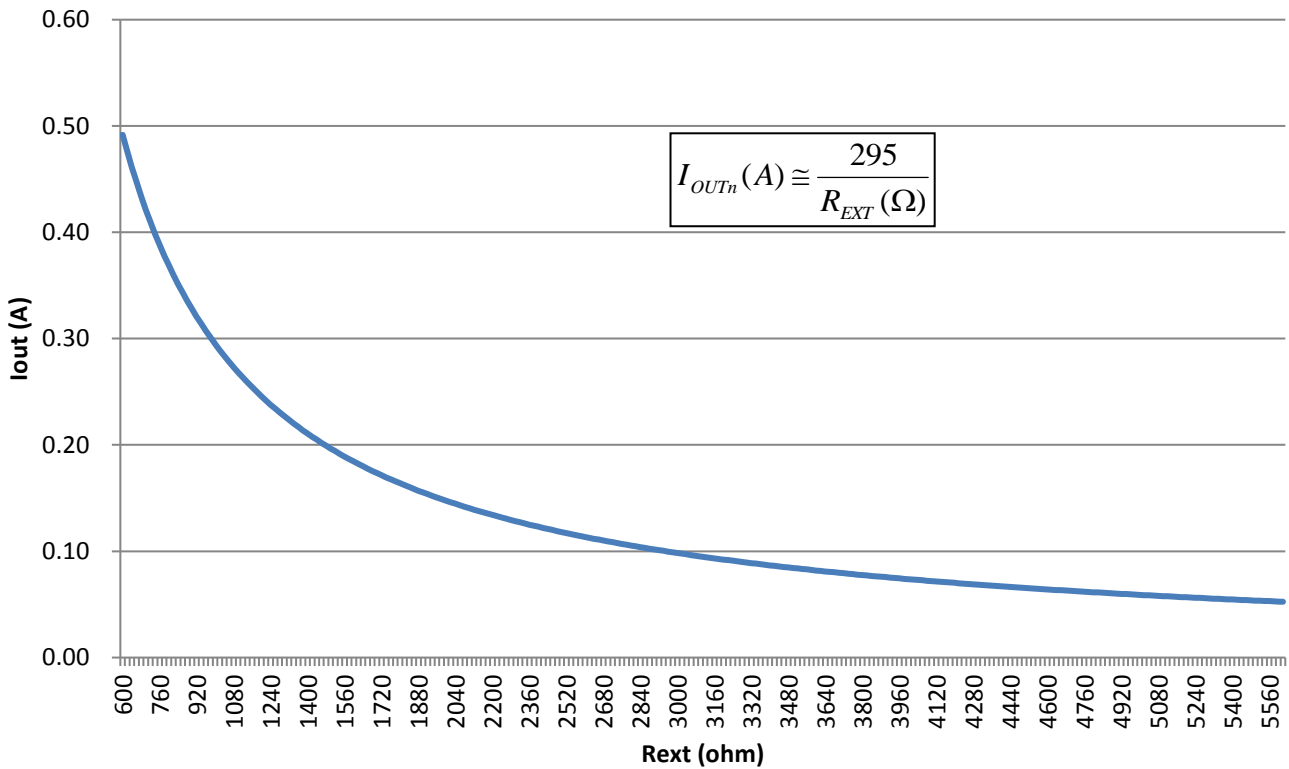
**Equivalent Circuits for Inputs**

There is only one OE input terminal to which a pull down resistor is connected. While OE is high voltage, both output channels are turned on.



### Output Current Setting

The output current of each channel of NU512 is set by an external resistor (R<sub>EXT</sub>). The relationship between channel output current and external resistor is shown in the figure or calculated from the equation following.

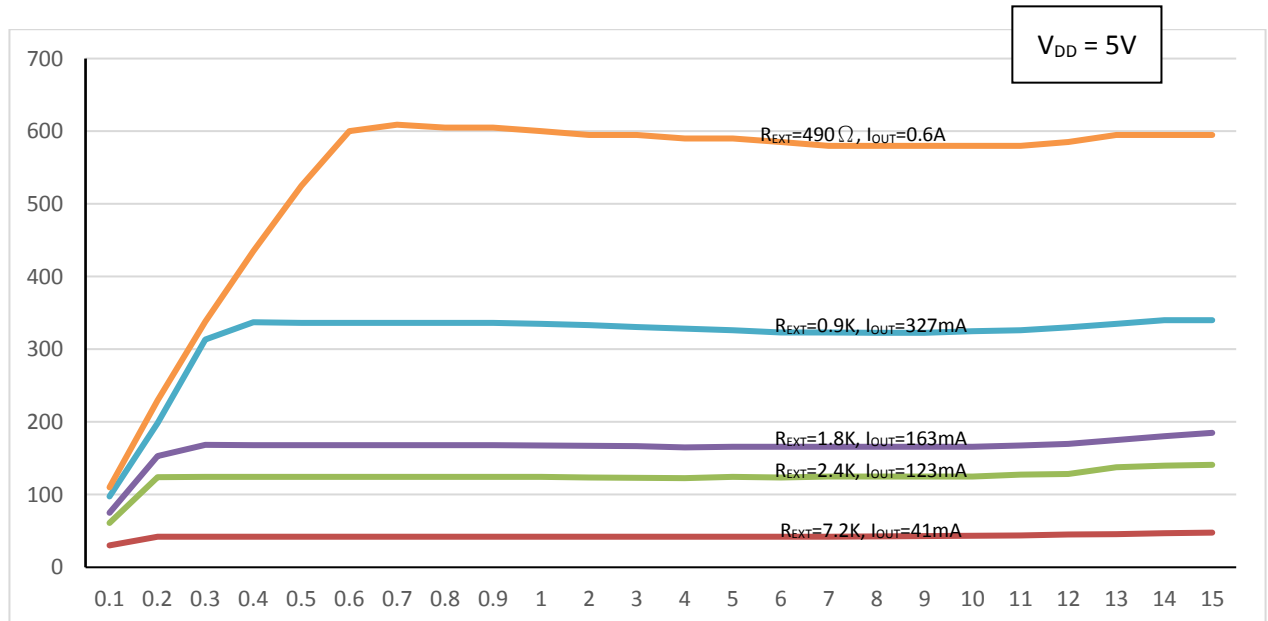


Example:  $I_{OUTn} = 200\text{mA}$

$$0.2(A) \cong \frac{295}{R(\Omega)} \Rightarrow R(\Omega) \cong \frac{0295}{0.2(A)} \Rightarrow 1475(\Omega)$$

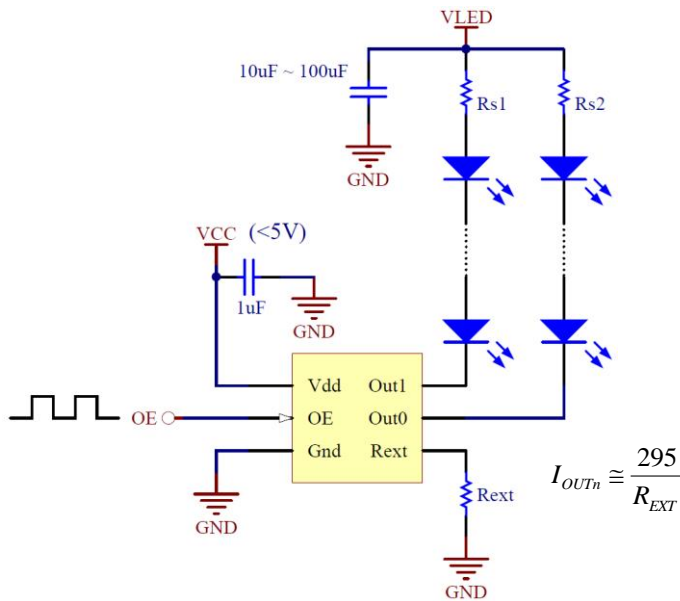
### I/V Curve

$I_{OUT}$  vs.  $V_{OUT}$  curve (Single channel)

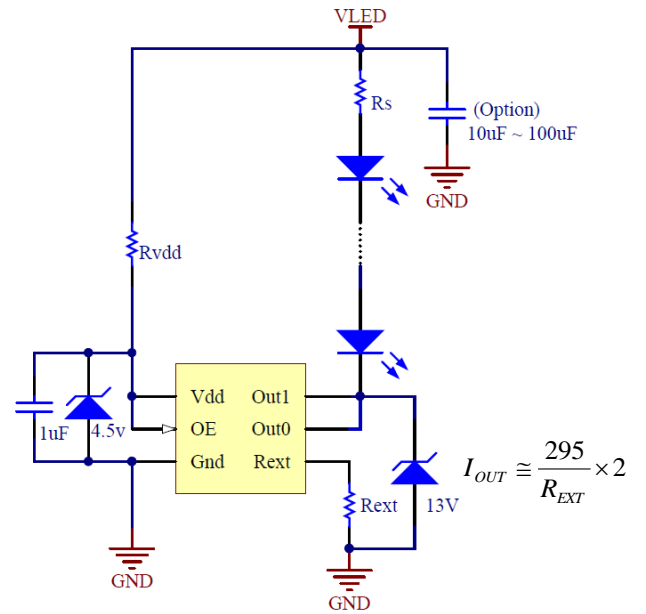


Typical Application Circuit

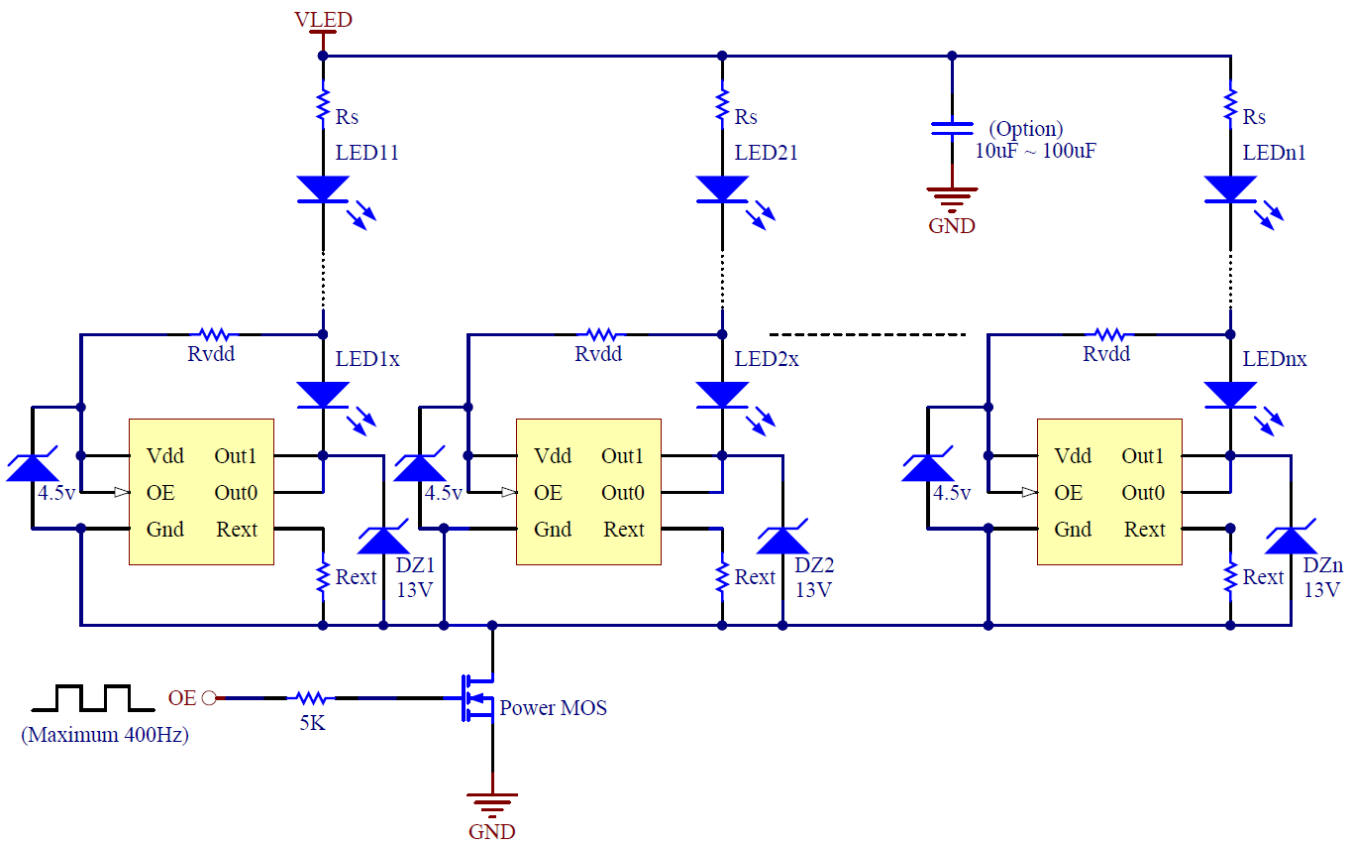
● Dimming application



● General lighting application 1



● General lighting application 2



**Note:**

1. For the heat consideration on driver,  $V_{OUT}$  of NU512 should be minimized. The power calculation equation is shown as bellow.

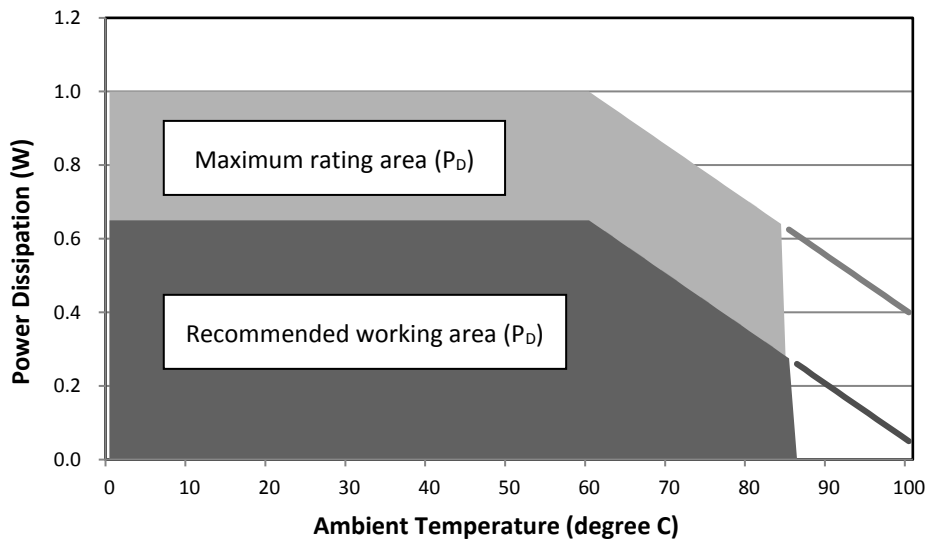
$$V_{OUT} = V_{LED} - V_F * n$$

$$P_D = V_{OUT} * I_{OUT} * 2$$

Where  $V_{OUT}$  is the voltage on output pins,  $I_{OUT}$  is channel output current of NU512,  $V_F$  is voltage drop of LED and  $n$  is the number of LEDs. In some higher  $V_{OUT}$  applications, to series a proper resistor in output current path can decrease the  $V_{OUT}$  and get less heat generation from NU512.

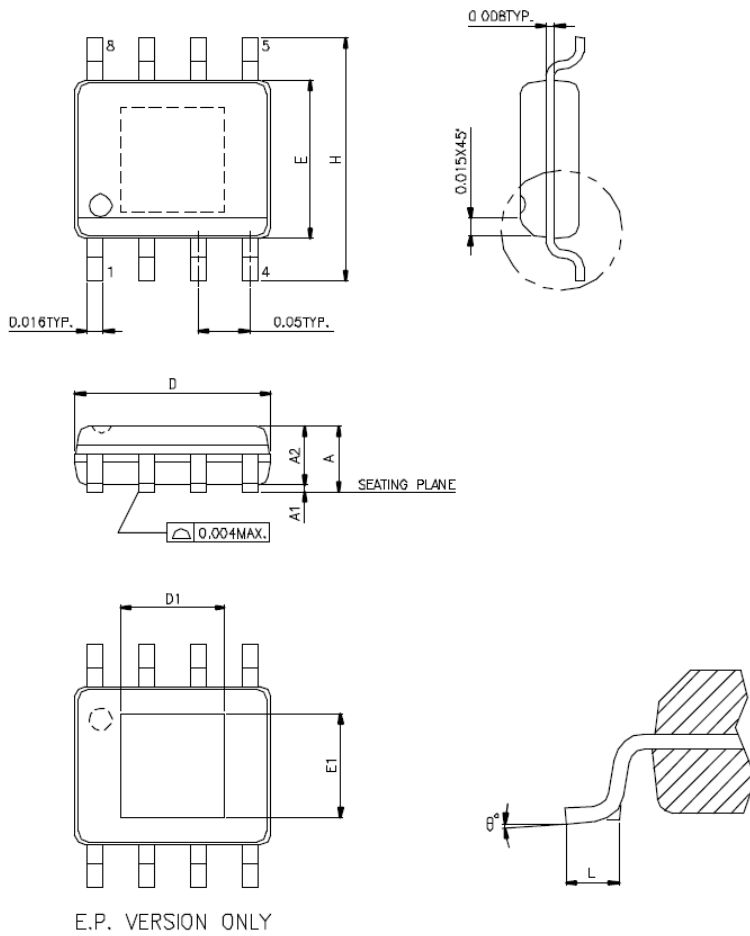
2. For the efficiency consideration, higher  $V_{LED}$  voltage and more LEDs in current path will get higher electrical efficiency. With the wide range supply voltage design and self powering structure like the lighting application circuit on previous page, NU512 can be used in maximum 24V ( $V_{LED}$ ) power system directly. If higher than 24V power is adopted, a 12V Zener diode connected between output and ground for voltage protection is required.
3. More LED in series, the total voltage drop variation on LEDs will increase. This variation is derived from the different  $V_F$  bins of LEDs and LED temperature rising while system is working. That probably increases  $P_D$ . So, it is another trade off to select the proper  $V_{LED}$  voltage and the number of LEDs in system. The more output current is driving, the less LED in series is better.

**Power Dissipation and Recommend Iout-Vout Table**



Iout	Max. Vout (V) recommended	Max. Vout (V)
50mA * 2	6.5	10
100mA * 2	3.25	5
200mA * 2	1.63	2.5
300mA * 2	1.1	1.67
400mA * 2	0.82	1.25
500mA * 2	0.65	1

Package Dimensions



Taping Specification

PACKAGE	Q'TY/REEL
ESOP8	3,000 ea

SYMBOLS	MIN.	MAX.
A	0.053	0.069
A1	0.002	0.006
A2	-	0.059
D	0.189	0.196
E	0.150	0.157
H	0.228	0.244
L	0.016	0.050
6°	0	8

UNIT : INCH

THERMALLY ENHANCED DIMENSIONS

PAD SIZE	E1	D1
90X90E	0.081 REF	0.081 REF
95X130E	0.086 REF	0.117 REF

UNIT : INCH

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