一级代理商诚信联科技 古小姐，13249827170 0755-86091963（直线） Q：1139196806

numen Technology 數能科技股份有限公司

Medium Power Lighting LED Driver **NU510**

160mA Single channel LED Driver

Features

- Up to 160mA single channel constant current regulator
- Current set by an external resistor
- 1.6V ~ 16V wide supply voltage range supports self-power structure in lighting application
- Minimum 0.4V (80mA) dropout voltage
- Fast current rising and falling
- -40℃ ~ 85℃ operating temperature
- Less than ±3% Chip to Chip current skew
- Less than 1%/V load (or line) regulation
- Normal mode 160°C half power / 115°C recovery thermal protect
- Cascade-able for higher voltage drop applications

Package Type

- SOT 23-6 (pin out compatible with NU501)
  (Part No. : NU510ST)
- MSOP 8 / SOP 8
  (MSOP 8 Part No. : NU510EM)
  (SOP 8 Part No. : NU510SO)

Product Description

NU510 is a medium power linear current regulation component that can be easily used in various LED lighting applications. It is equipped the excellent feature of good load/line regulation capability, minimized chip current skew, stable output current in high power or load voltage fluctuating environment that can be used in wide area of LED lighting source to maintain the uniformity of light intensity . NU510 also can be used in the digital PWM controlled circuit to achieve more precise current adjusting in gray level applications.

A special cascade mode is also provided by NU510. In high power supply voltage and low LED load dropout voltage application, two or more NU510 can be connected in series to share redundant high voltage. With the exclusive voltage sharing technology of NUMEN tech., the extra redundant voltage that exceeds the preset threshold voltage (Viboost) can be shared by next NU510.

With the feature of wide power supply range design and ultra-low I_{DD} consumption, the NU510 supports the self-powered structure in LED lighting applications. In this structure, the NU510 no need to be provided a dedicate power circuit even the system power voltage is much higher than the maximum operation voltage of NU510. The V_{DD} power can be gotten from the proper position in LED series of system.

Terminal Description

Pin name	Function
V_{DD}	Power supply
OPT	Current sink
R_{EXT}	Current setting Resistor
OE	Output enable
Mode	Cascade / Normal mode selection
GND	Ground

Block Diagram

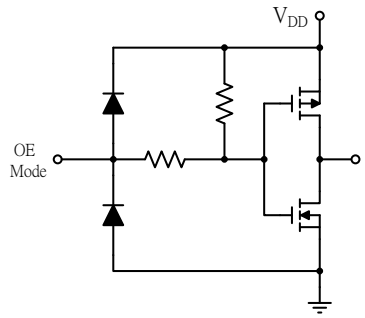
Applications

- General LED lighting
- Decoration lighting for architecture
- LED torch / flash light
- RGB lighting
- RGB display / indicator

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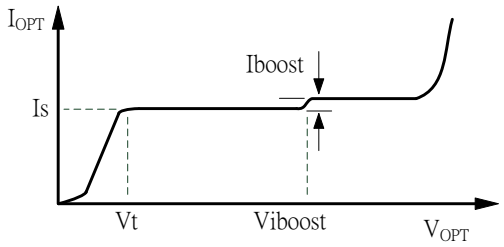
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Equivalent Circuits for Inputs

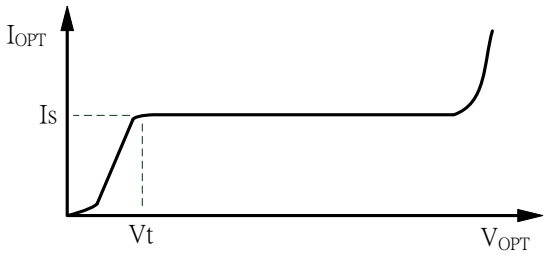


Ideal IV characteristic

Mode pin = Logic high (default, cascade mode)



Mode pin = Logic low (normal mode)



Mode	Mode Pin	Current boost	Leakage (Max.)
Cascade mode	Logic high	+8%~+12%* I_{OPT}	5uA
Normal mode	Logic low	-	0.5uA

Maximum Ratings (T = 25˚C)

Characteristic	Symbol		Rating	Unit
Supply voltage	V_{DD}		0 ~ 20	V
Input voltage (Digital I/O)	V_{OE}, V_{MODE}		-0.2 ~ V_{DD}	V
Output voltage	V_{OPT}		-0.2 ~ 20	V
Output current	I_{PN}		0 ~ 200	mA
Power Dissipation (Ta=25˚C)	PD_{MAX}	SOT 236	0.4	W
		MSOP 8	0.7	
		SOP 8	1	
Thermal Resistance (On PCB, Ta=25˚C)	$R_{TH(j-a)}$	SOT 236	400	˚C /W
		MSOP 8	240	
		SOP 8	100	
Operating temperature	T_{OPR}		-40~+85	˚C
Storage temperature	T_{STG}		-55~+150	˚C

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Electrical Characteristics and Recommended Operating Conditions

Characteristic	Symbol	Condition		Min.	Typ.	Max.	Unit
Supply voltage	V_{DD}	Room Temp. V_{OPT} = 1V		1.5	1.6	16	V
Output voltage	V_{OPT}	PD ≤ PD_{RMP}		-	-	17	V
Supply current	I_{DD}	V_{DD} ≤ 13V		40	80	150	uA
		V_{DD} ≤ 16V		-	-	2	mA
Minimum dropout voltage	V_{OPT}	V_{DD} ≥ 3V	I_S ≤ 20mA	0.25	0.3	0.4	V
			I_S ≤ 60mA	0.3	0.4	0.5	
			I_S ≤ 100mA	0.4	0.5	0.6	
			I_S ≤ 160mA	0.6	0.7	0.8	
Output current	I_{OPT}	PD ≤ PD_{RMP}		-	-	160	mA
Recommended Maximum Operating Power Dissipation	PD_{RMP}	(Ta=25℃)	SOT 236	-	-	0.25	W
			MSOP8	-	-	0.45	
			SOP8	-	-	0.65	
Leakage	$I_{Leakage}$	V_{DD} > 3V, V_{OPT} = 10V	Mode = high	1	-	5	uA
			Mode = low	-	-	0.5	
Line regulation	%/V_{DD}	13V > V_{DD} > 1.6V		-	-	±1	%/V
Load regulation	%/V_P	8V>V_{OPT}>0.4V, Mode = low		-	-	±1	%/V
Thermal regulation	%/10℃	V_{DD} = V_P = 3V		-	-	±0.5	%/10℃
Input voltage	V_{IH}	V_{DD} ≥ 5V		3.2	-	-	V
		V_{DD} < 5V		0.7*V_{DD}	-	-	V
	V_{IL}	V_{DD} ≥ 5V		-	-	2	V
		V_{DD} < 5V		-	-	0.3*V_{DD}	V
Half power temperature (Normal mode only)	T_{half}	$I_{OPT} \cong \frac{I_{NORMAL}}{2}$		-	160	-	℃
Half power recovery temperature (Normal mode only)	T_{recov}	I_{OPT} recover to I_{NORMAL}		-	115	-	
Current boost voltage	V_{iboost}	Mode = high		7	8	9	V
Current boost	I_{boost}	Mode = high		8	10	12	% * I_{OPT}
Chip current skew	I_{Skew}	V_{DD} = V_P = 3V		-	2	3	%

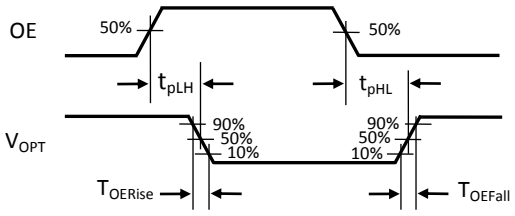
Switching Characteristics (T = 25℃)

Characteristic	Symbol	Condition	Min.	Typ.	Max.	Unit
Propagation Delay Time (OE from "L" to "H")	t_{pLH}	V_{DD}=4V, V_{OPT}=1V, I_{OPT}=120mA, OE= 0V → 4V	140	200	260	nS
Output current rising time (OE from "L" to "H")	t_{OERise}	V_{DD}=4V, V_{OPT} =1V, I_{OPT} =120mA, OE= 0V → 4V	30	40	60	nS
Propagation Delay Time (OE from "H" to "L")	t_{pHL}	V_{DD}=4V, V_{OPT} =1V, I_{OPT} =120mA, OE= 4V → 0V	260	320	380	nS

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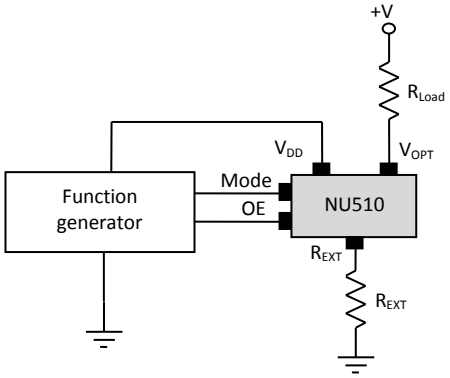
Characteristic	Symbol	Condition	Min.	Typ.	Max.	Unit
Output current falling time (OE from "H" to "L")	t_{OEFall}	V_{DD}=4V, V_{OPT} =1V, I_{OPT} =120mA, OE= 4V → 0V	30	50	80	nS

Timing Waveform



OE timing diagram

Test Circuit



Output Current Setting

The output current of NU510 is set by an external resistor (R_{EXT}). The output current can be figured out by following equation.

$$Iout \cong \frac{0.2V}{R_{EXT} + 0.07\Omega}$$

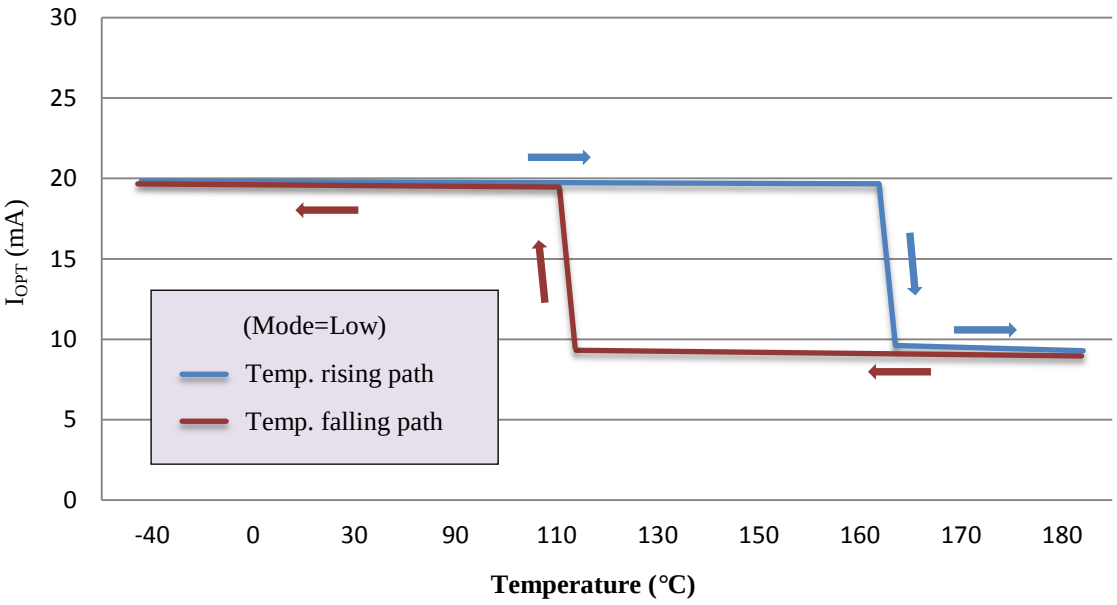
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Thermal protection

When NU510 is working at normal mode **(mode pin voltage low)** and junction temperature is more than half power temperature (~160°C), the output current of NU510 will decrease about 50% to lower down the power dissipation on chip. This lower power state will be recovered when the junction temperature is lower than recovery temperature (~115°C).

Note: There is no half power thermal protection function while NU510 is working at cascade mode.

I_{OPT} vs. Temperature



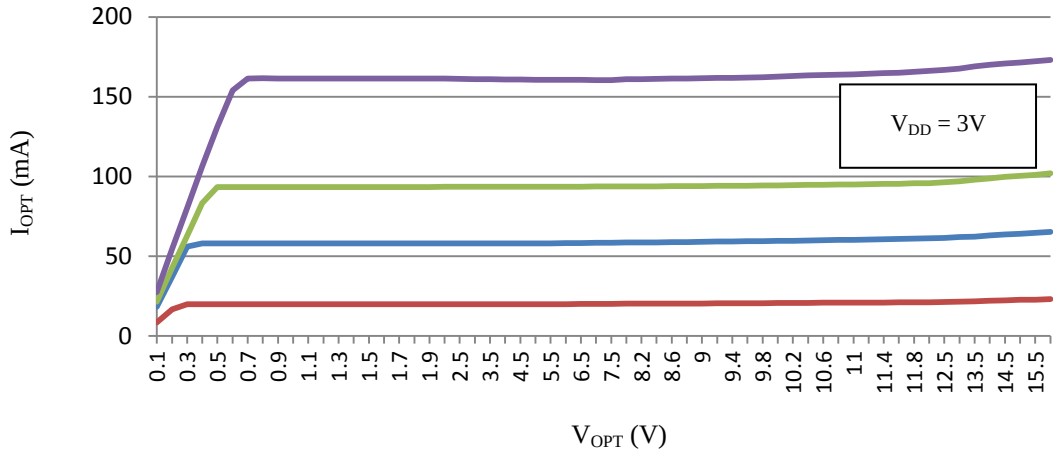
Power Dissipation and Recommended I_{OPT} - V_{OPT} Table

Package / I_{OPT} (mA)	SOT23-6		MSOP8		SOP8	
	V_{OPT} (<) Recommended	V_{OPT} (<) Maximum	V_{OPT} (<) Recommended	V_{OPT} (<) Maximum	V_{OPT} (<) Recommended	V_{OPT} (<) Maximum
20	12.5	20	17	20	17	20
40	6.3	10	11.2	17.5	16.2	20
60	4.2	6.6	7.5	11.6	10.8	16.6
80	3.1	5	5.6	8.7	8.1	12.5
100	2.5	4	4.5	7	6.5	10
120	2.1	3.3	3.7	5.8	5.4	8.3
140	1.8	2.8	3.2	5	4.6	7.1
160	1.5	2.5	2.8	4.3	4	6.2

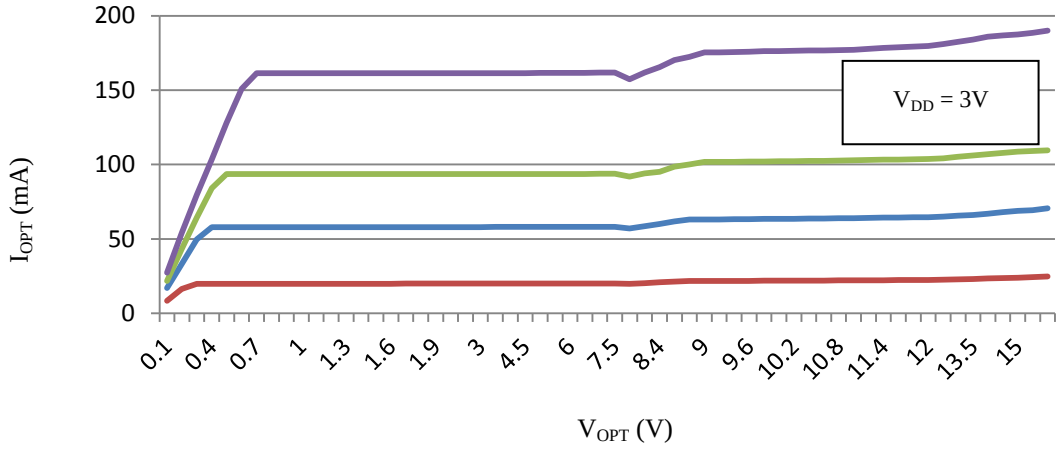
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Output I/V Curve

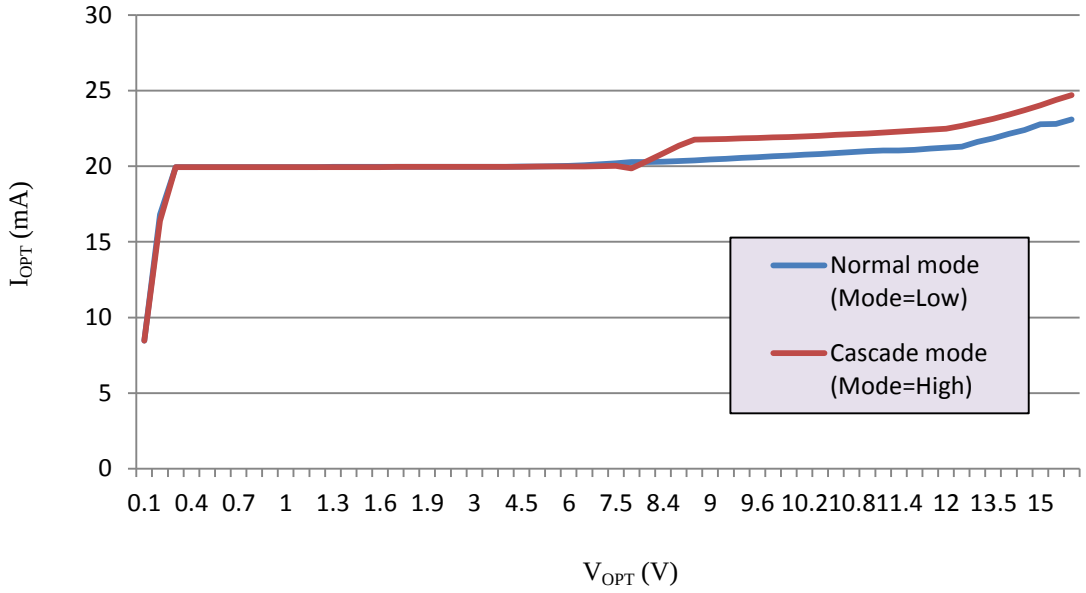
Normal mode output I/V curve



Cascade mode output I/V curve



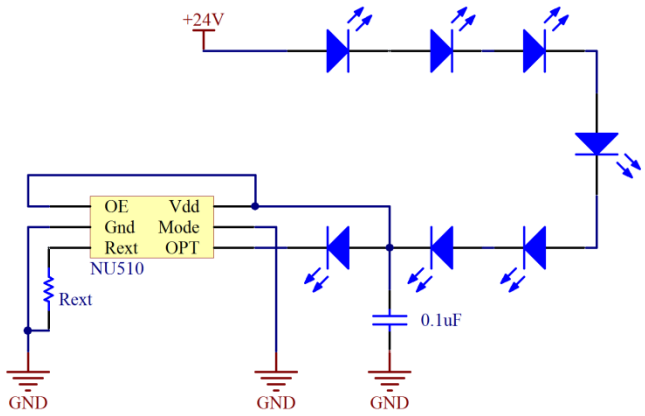
Output difference between cascade mode and normal mode



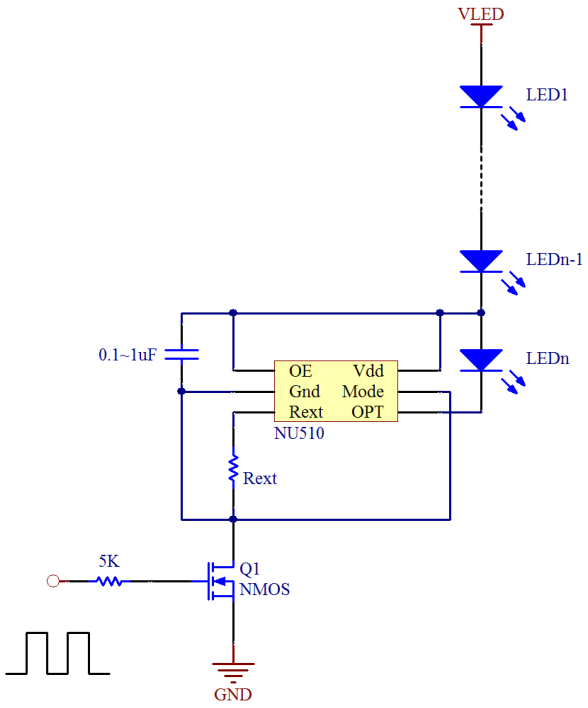
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Typical Application Circuit

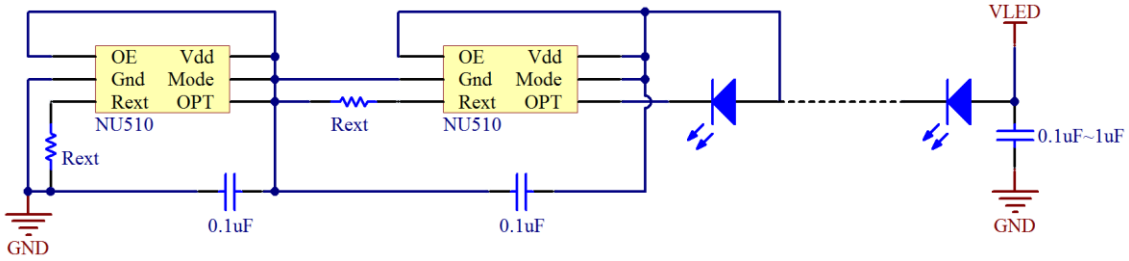
- 24v General lighting



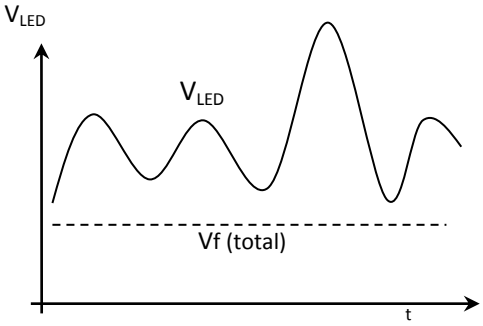
- PWM dimming application



- Cascade application



By cascade mode, two or more NU510 in series can absorb higher voltage variation in lighting system. Each NU510 can share about 8 volts redundant. The total voltage variation range that system can work is calculated by following equation.



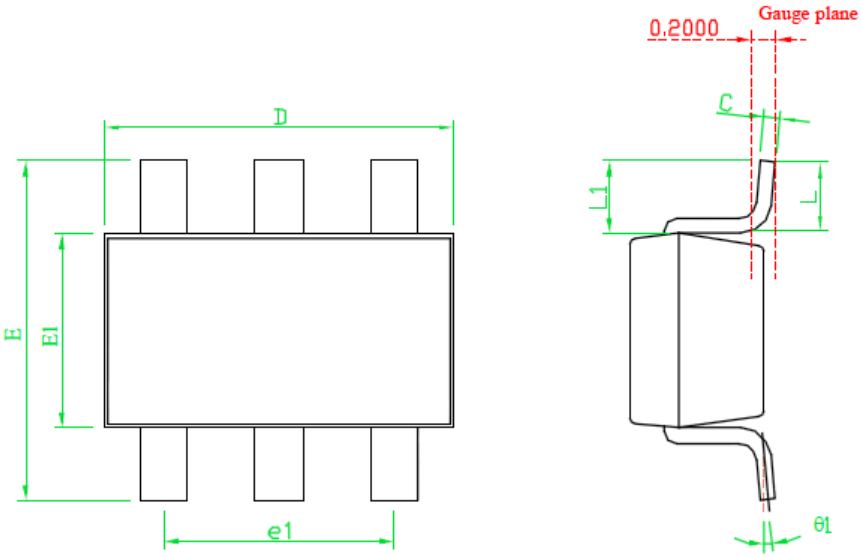
$$V_{LED(max)} \fallingdotseq 8 * N_{(NU510)} + Vf_{(total)}$$

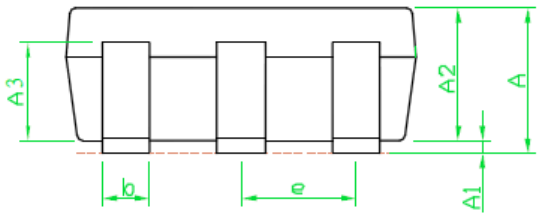
Where $V_{LED(max)}$ is the system power voltage, $N_{(NU510)}$ is the number of NU510 and $Vf_{(total)}$ is the total forward voltage of all LEDs.

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Package Dimensions

- SOT23-6

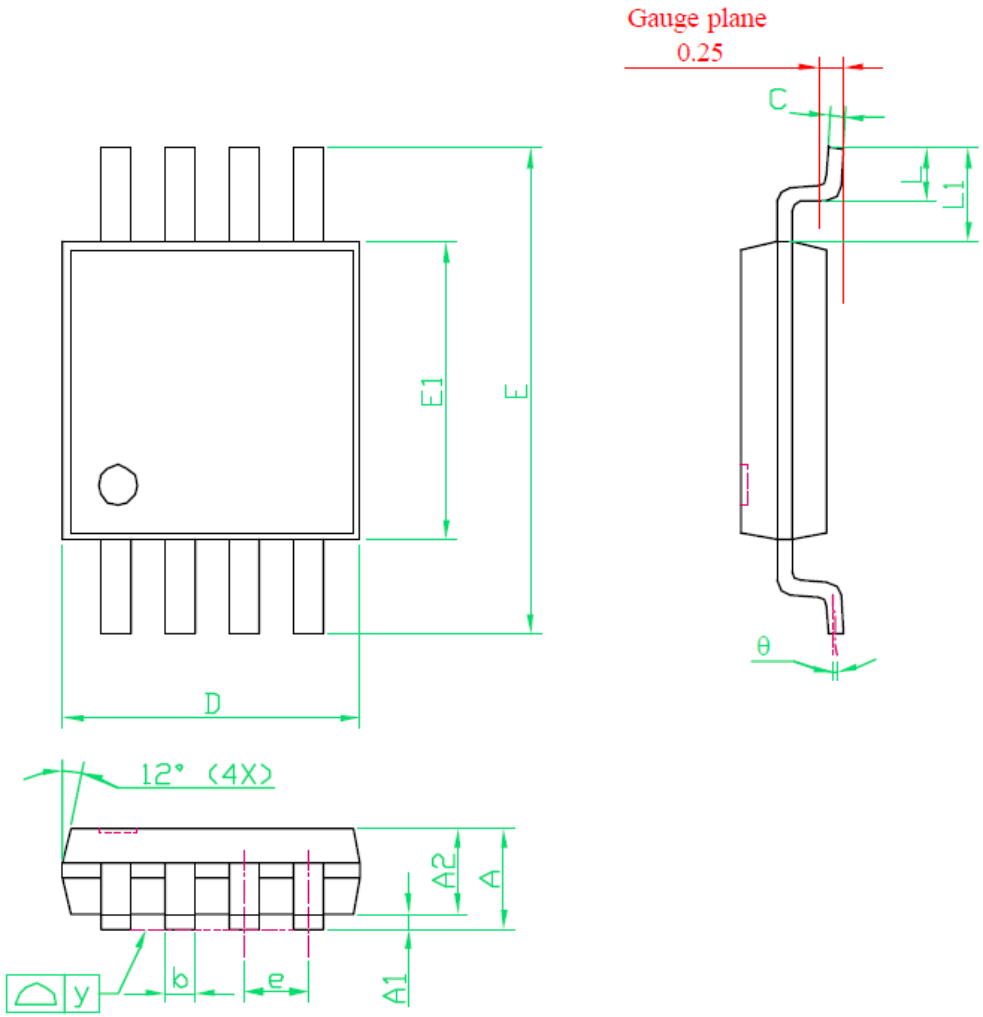




SYMBOLS	DIMENSIONS IN MILLIMETERS		
	MIN	NOM	MAX
A	1.00	1.10	1.40
A1	0.00	---	0.10
A2	1.00	1.10	1.30
A3	0.70	0.80	0.90
b	0.35	0.40	0.50
C	0.10	0.15	0.25
D	2.70	2.90	3.10
E1	1.40	1.60	1.80
e1	---	1.90(TYP)	---
E	2.60	2.80	3.00
L	0.37	---	---
θ1	1°	5°	9°
e	---	0.95(TYP)	---
L1	0.5	0.6	0.7

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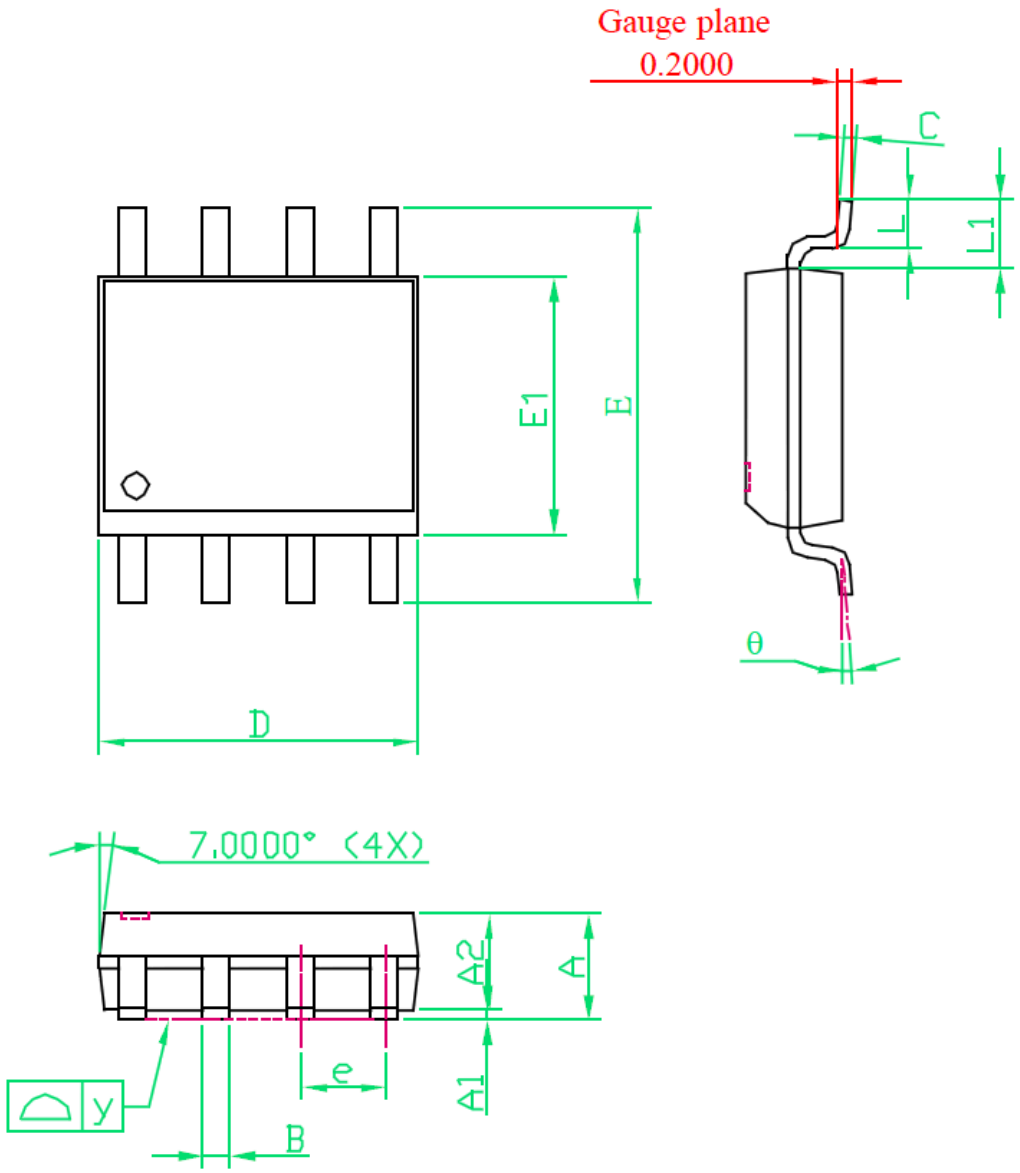
- MSOP-8



SYMBOLS	DIMENSIONS IN MILLIMETER		
	MIN	NOM	MAX
A	---	---	1.10
A1	0.00	---	0.10
A2	0.75	0.85	0.95
b	0.22	0.30	0.38
C	0.13	0.15	0.23
D	---	3.00BSC	---
E	---	4.90BSC	---
E1	---	3.00BSC	---
e	---	0.65BSC	---
L	0.40	0.53	0.66
y	---	---	0.10
θ	0°	---	6°
L1	0.85	0.95	1.05

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- SOP-8



SYMBOLS	DIMENSIONS IN MILLIMETER			DIMENSIONS IN INCH		
	MIN	NOM	MAX	MIN	NOM	MAX
A	1.35	1.60	1.75	0.053	0.063	0.069
A1	0.10	---	0.25	0.004	---	0.010
A2	---	1.45	---	---	0.057	---
B	0.33	---	0.51	0.013	---	0.020
C	0.19	---	0.25	0.007	---	0.010
D	4.80	---	5.00	0.189	---	0.197
E1	3.80	3.90	4.00	0.150	0.153	0.157
e	---	1.27	---	---	0.050	---
E	5.80	6.00	6.20	0.228	0.236	0.244
L	0.40	---	1.27	0.016	---	0.050
y	---	---	0.10	---	---	0.004
θ	0°	---	8°	0°	---	8°
L1	0.95	1.05	1.15	0.037	0.041	0.045

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