numen Technology 數能科技股份有限公司

80mA Single channel LED Driver

Features

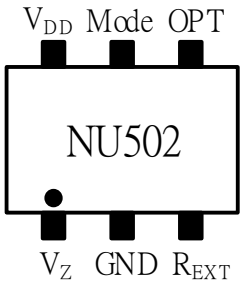
- Up to 80mA single channel constant current regulator
- 1.6V ~ 18V wide supply voltage range supports self-power structure in lighting application
- Current set by an external resistor
- Minimized 0.6V (80mA) dropout voltage
- Fast current rising and falling
- Built in 15V Zener diode for bias and high voltage protection
- Less than ±5% Chip to Chip current skew
- Less than ±0.5%/V load (or line) regulation
- 125˚C ~160˚C junction temperature current ramp down thermal protect
- -40˚C ~ 85˚C ambient operating temperature
- Cascade-able for higher voltage drop applications

Applications

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

Package Type

- SOT 23-6 (80mA)
  (Part No.: NU502ST)



Product Description

NU502 is a small/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.

Except for the power supply function, the VDD pin of NU502 is output enable (OE), and can be used in digital PWM controlled circuits for more precise current adjustment in gray level applications.

A special cascade mode is also provided by NU502. In high power supply voltage and low LED load dropout voltage application, two or more NU502 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 NU502.

With the feature of wide power supply range design and ultra low I_{DD} consumption, the NU502 supports the self powered structure in LED lighting applications. In this structure, the NU502 no need to be provided a dedicate power circuit even the system power voltage is much higher than the maximum operation voltage of NU502. The V_{DD} power can be gotten from the proper position in LED series of system.

Terminal Description

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

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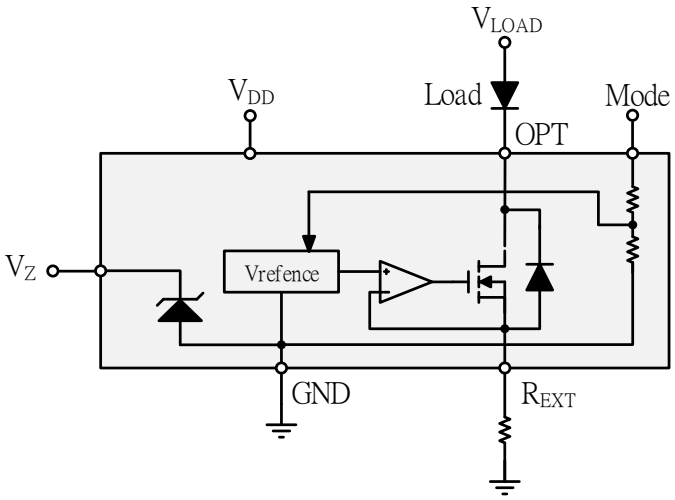
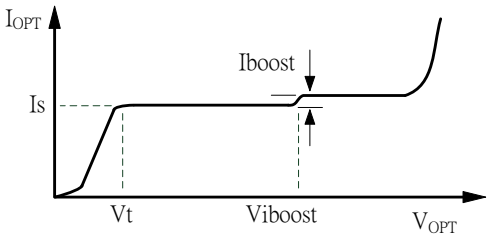
Block Diagram

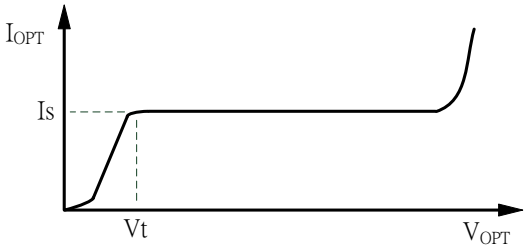


Ideal IV characteristic

V_{MODE} = V_{OPT} (cascade mode)



V_{MODE} = GND or Floating



Mode	Mode Pin	Current boost	Leakage (Max.)
Cascade mode	V_{MODE} = V_{OPT}	+5%~+11%* I_{OPT}	55uA
Normal mode	V_{MODE} = GND / Floating	-	0.5uA

Maximum Ratings (T = 25˚C)

Characteristic	Symbol	Rating	Unit
Supply voltage	V_{DD}	0 ~ 20	V
Input voltage	V_{MODE}	-0.2 ~ V_{DD}	V
	V_Z	-0.2 ~ 18	V
Output voltage(Output enable)	V_{OPT_Enable}	-0.2 ~ 16	V
Output voltage(Output disable)	$V_{OPT\_Disable}$	-0.2 ~ 20	V
Output current	I_{OPT}	120	mA
Power Dissipation (Ta=25℃)	PD	0.4	W
Thermal Resistance (On PCB, Ta=25℃)	$R_{TH(j-a)}$	300	℃ /W
Operating temperature	T_{OPR}	-40~+85	℃
Storage temperature	T_{STG}	-55~+150	℃

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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		1.6	-	18	V
Supply voltage rising and falling speed *1	V_{DDspd}	$V_{DD} \leqq 5V$		0.05	-	-	uS
		$V_{DD} > 5V$		5	-	-	
Output voltage	V_{OPT_Enable}	$V_{DD} > 1.6V$, $P_D \leqq P_{D\_recomd}$		-	-	15	V
	$V_{OPT\_Disable}$	$V_{DD} < 0.8V$		-	-	18	V
Supply current	I_{DD}	$V_{DD} \leqq 18V$		-	75	100	uA
Minimum dropout voltage	V_{OUT}	$V_{DD} \geqq 3V$	$I_S \leqq 20mA$	-	0.3	-	V
			$I_S \leqq 80mA$	-	0.6	-	
Output current	I_{OPT}	$V_{DD} \geqq 3V$		-	-	80	mA
Current set voltage	V_{REXT}	$V_{DD} > 1.6V$, Room Temp.		152	160	168	mV
Leakage	$I_{Leakage}$	V_{DD} = 0V, V_{OPT} = 15V	$V_{MODE} = V_{OPT}$	-	45	55	uA
			V_{MODE} = GND	-	-	0.5	
Zener break down voltage	V_Z	Room Temp.		-	15	-	V
Zener current	I_Z			-	-	20	mA
Line regulation	%/V_{DD}	$13V > V_{DD} > 3V$		-	-	±0.5	%/V
Load regulation	%/V_P	$15V > V_{OPT} > 0.4V$, V_{MODE} = GND		-	-	±0.5	%/V
Thermal regulation	%/10℃	V_{DD} = 3V, V_{OPT} = 1V, Temperature < 125℃		-1	-	0	%/10℃
Output ramp down temperature	T1	Output enabled		-	125	-	℃
Shutdown temperature	T2	I_{OPT}=0		-	160	-	
Current boost voltage	V_{iboost}	$V_{MODE} = V_{OPT}$		11	-	13	V
Current boost	I_{boost}	$V_{MODE} = V_{OPT}$, V_{OPT} varies from 11V to 13V		5	7	11	% * I_{OPT}
Chip current skew	I_{Skew}	V_{DD} = 3V, V_{OPT} = 1V		-	2	5	%
Power Dissipation	P_{D_recomd}	Room Temp.		-	-	0.25	W

*1 For the stable reason, the rising and falling speed of supply voltage (V_{DD}) on NU502 should be slower when higher V_{DD} than 5V is adopted. Fast and high V_{DD} transition will bring the timing of output current instable. Please refer to typical application circuit in this specification for proper using.

Switching Characteristics (T = 25˚C)

Characteristic	Symbol	Condition	Min.	Typ.	Max.	Unit
Propagation Delay Time V_{DD} from "L" to "H"	t_{pLH}	V_{OPT}= 1V, V_{DD} = 0V → 3V		0.5	1	uS
Output current rising time	t_{Rise}	V_{OPT}= 1V, V_{DD} = 0V → 3V		0.8	1.5	uS
Propagation Delay Time V_{DD} from "H" to "L"	t_{pHL}	V_{OPT}= 1V, V_{DD} = 3V → 0V		30	100	nS
Output current falling time	t_{Fall}	V_{OPT}= 1V, V_{DD} = 3V → 0V		100	300	nS

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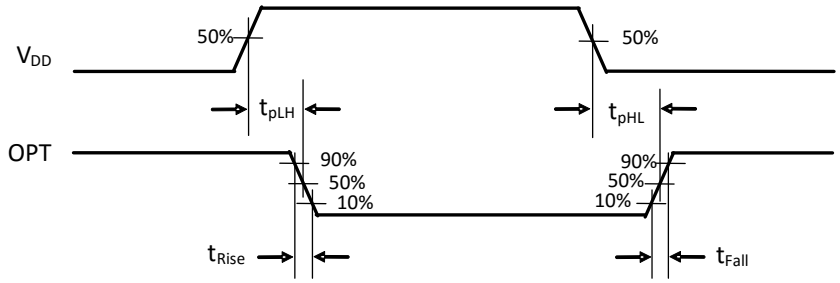
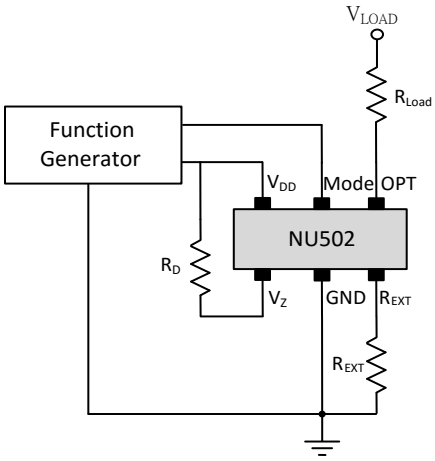
Timing Waveform



Test Circuit



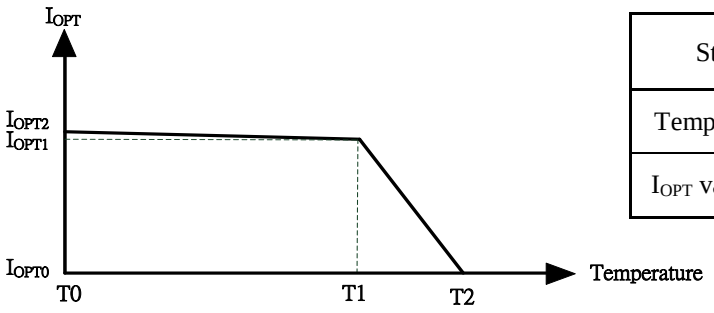
Output Current Setting

The output current of NU502 is set by an external resistor (R_{EXT}). The output current can be figured out by following equation.

$$I_{OPT} \cong \frac{0.16V}{R_{EXT} + 0.14\Omega}$$

Thermal protection

When junction temperature is more than thermal protection temperature (~125˚C), the output current of NU502 will start to decrease to lower down the power dissipation on chip. If the junction temperature reach 160˚C, the output current will almost shut down. The output current will restore in the same way when the temperature decrease.



State	Normal (T0 ↔ T1)	Thermal protect (T1 ↔ T2)	Unit
Temperature	-40 ↔ 125	125 ↔ 160	℃
I_{OPT} variation	-0.8	-28	%/10℃

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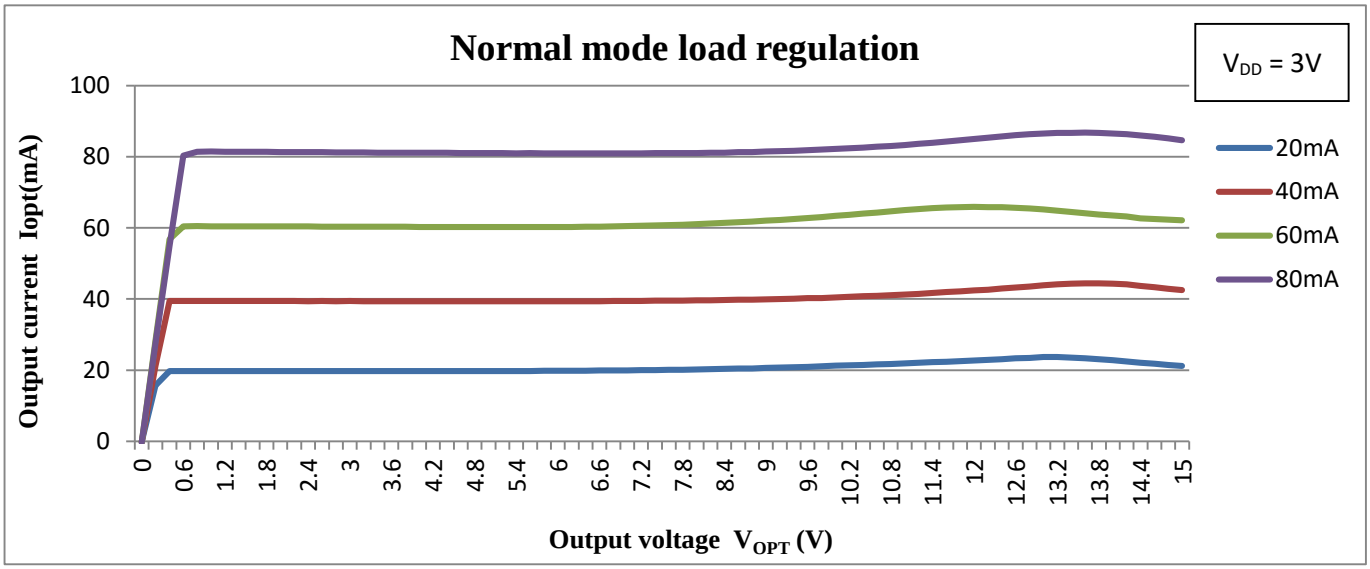
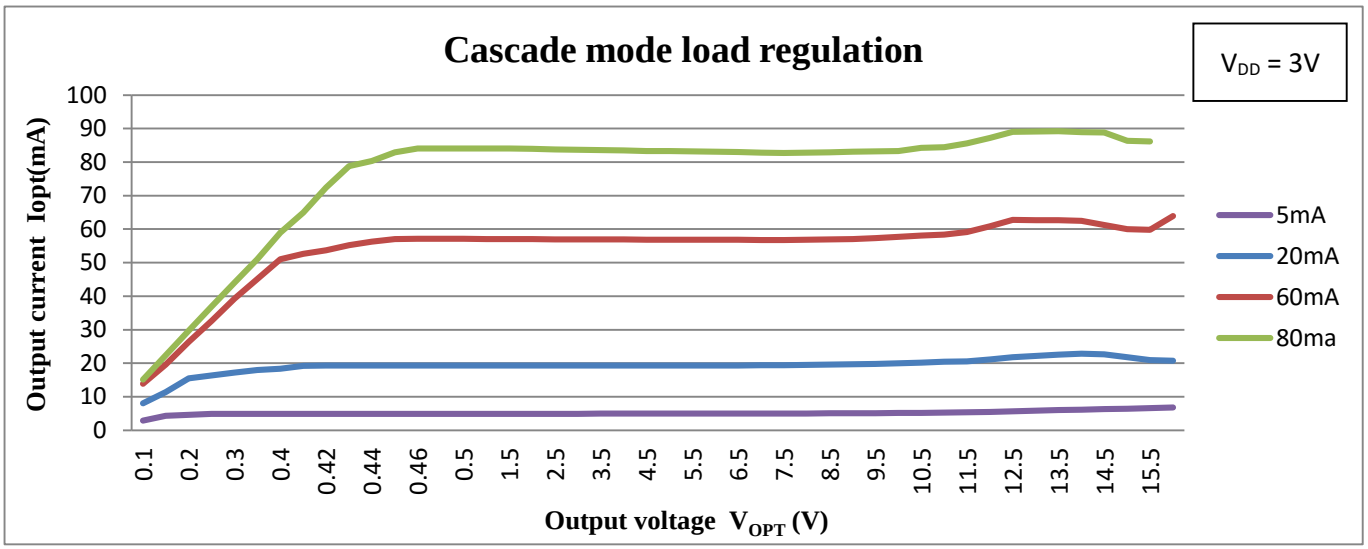
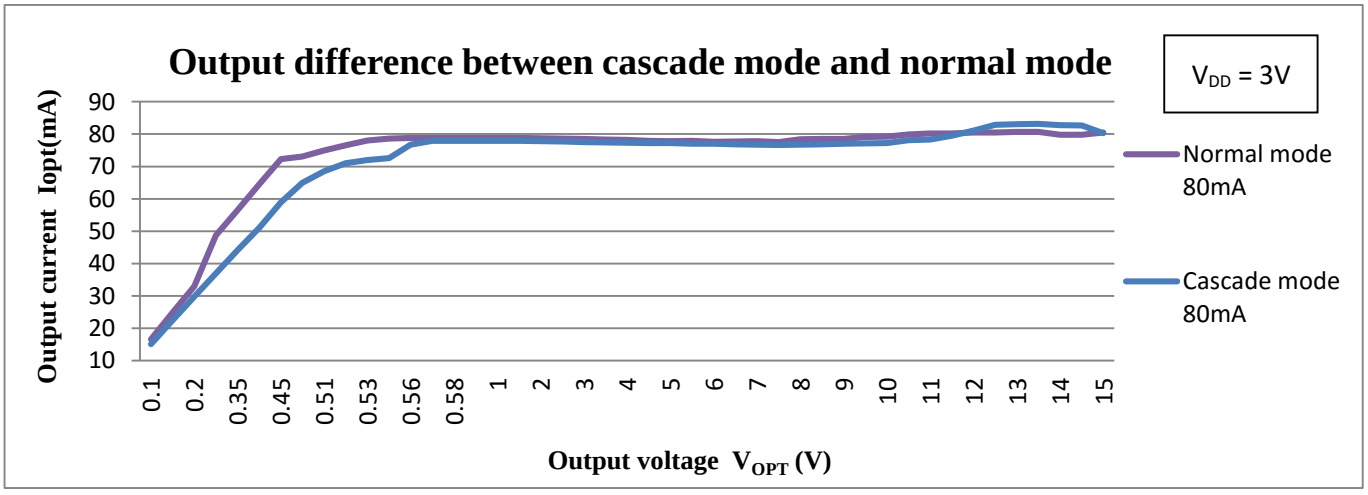
Output I/V Curve







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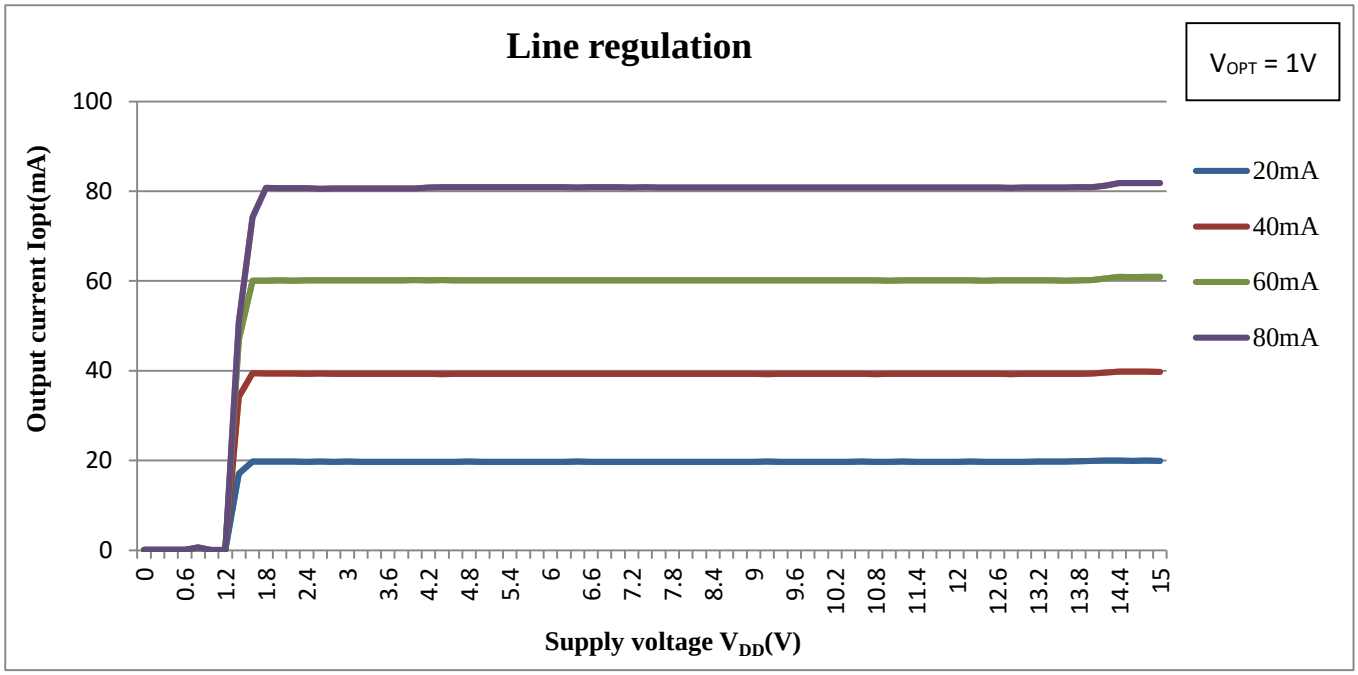

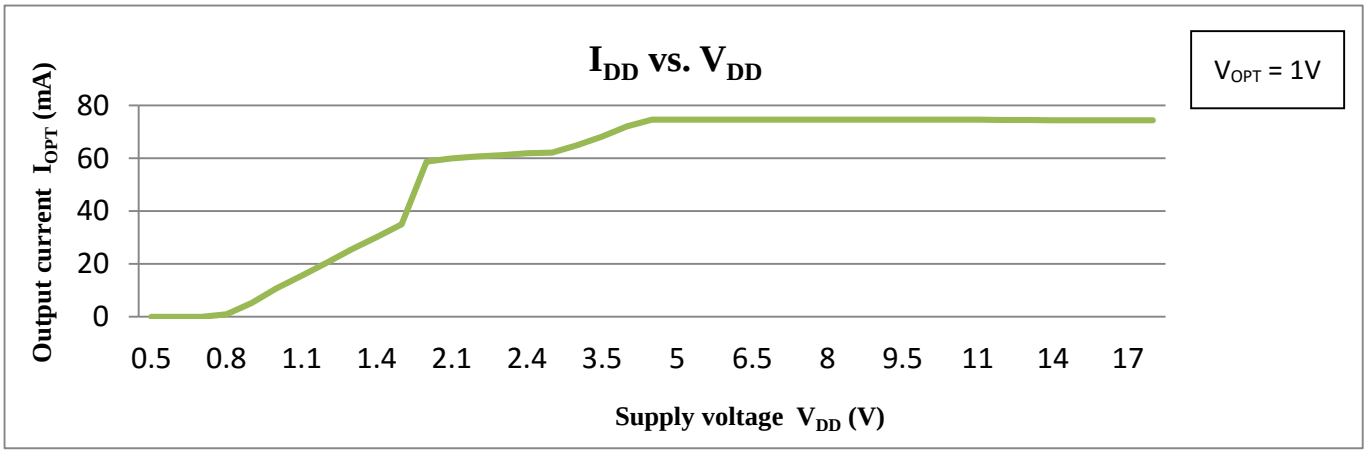

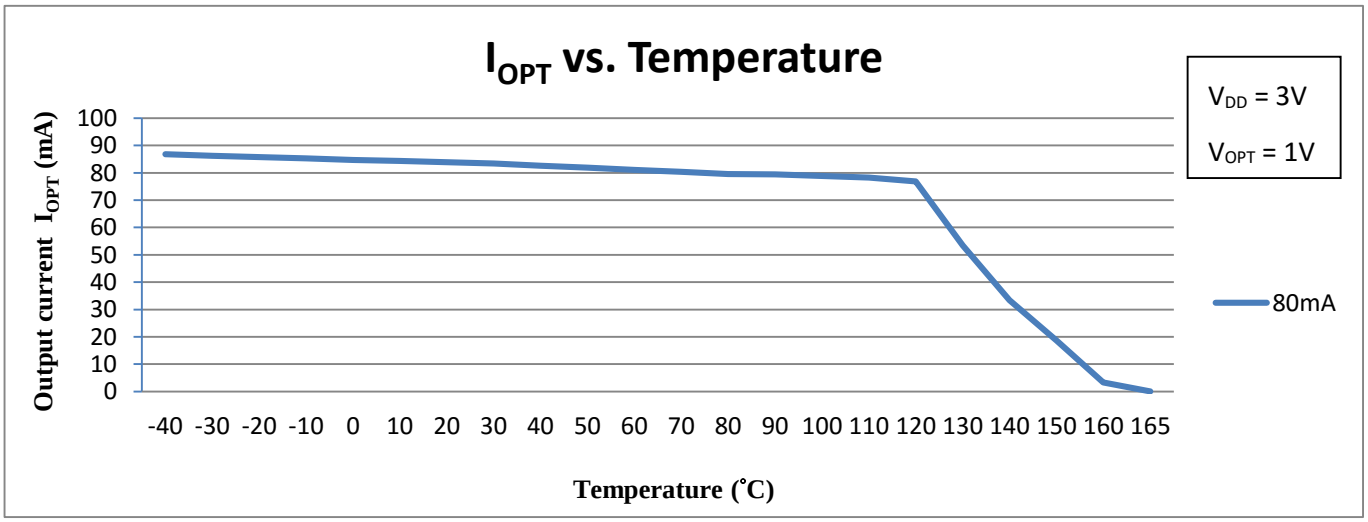

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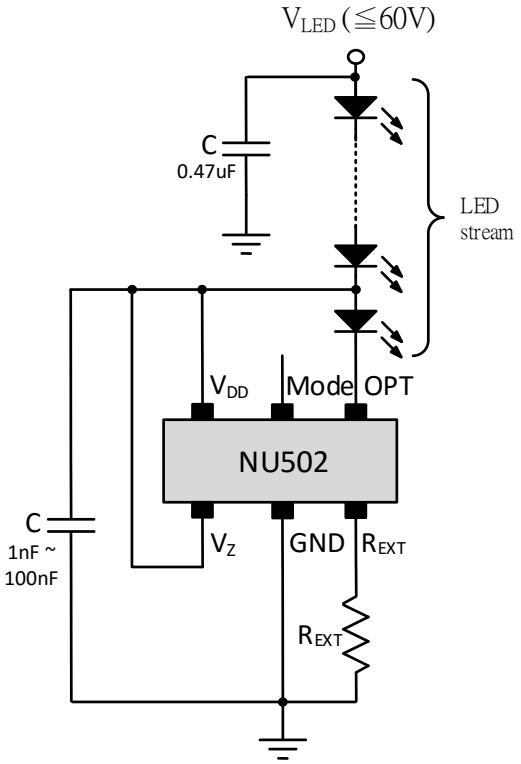
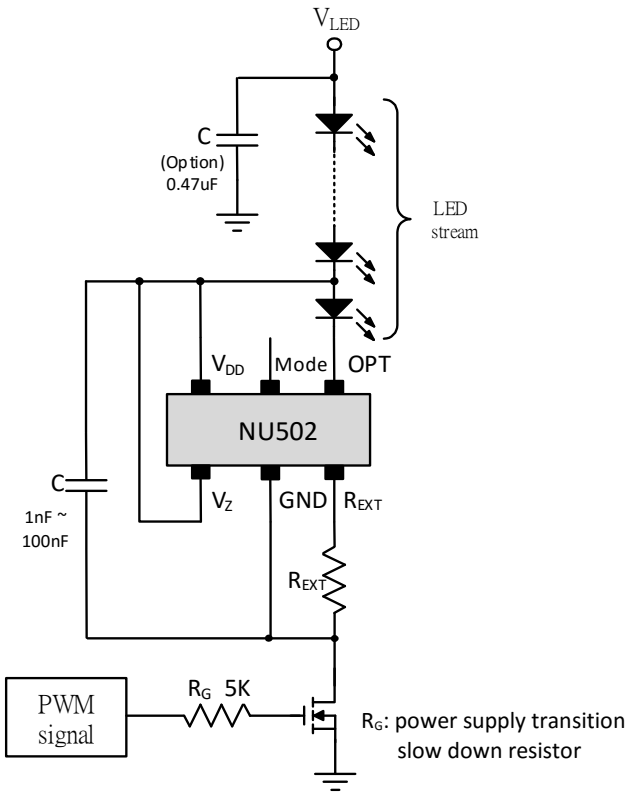
Typical Application Circuit

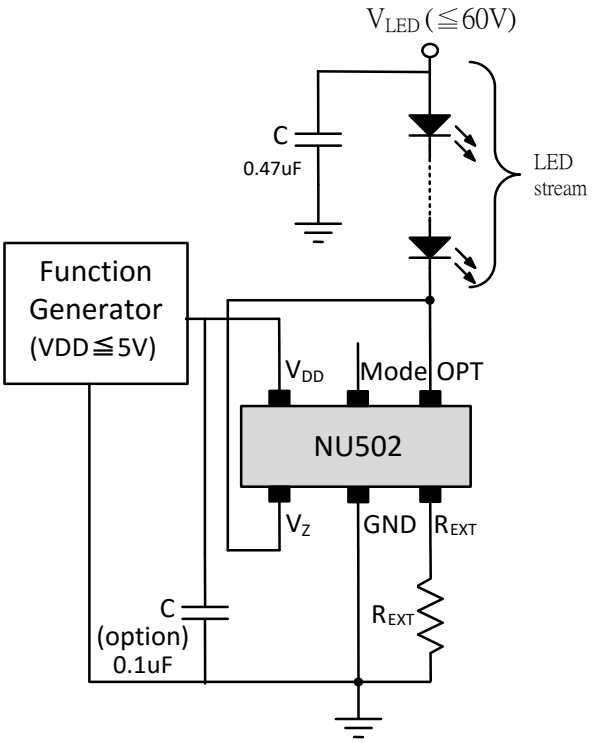
- DC power general lighting



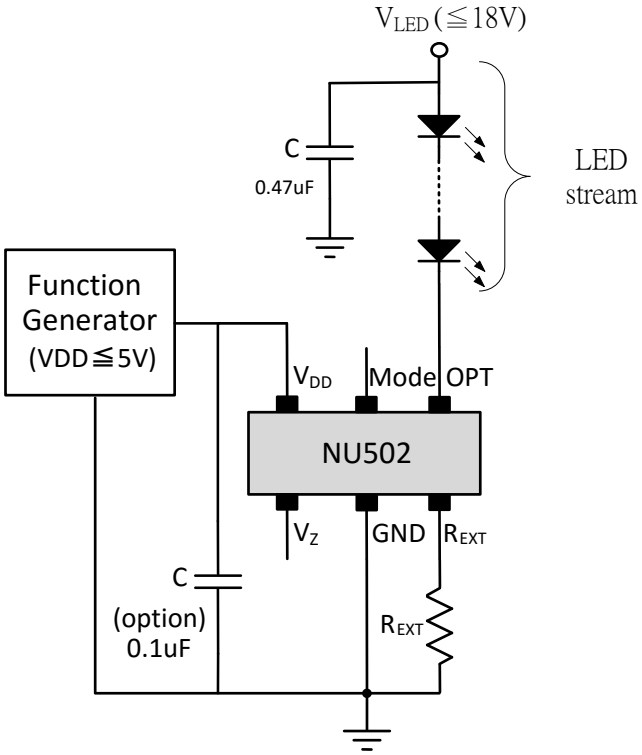
- DC power dimming application



- DC PWM dimming application



- DC PWM dimming application (No leakage current)



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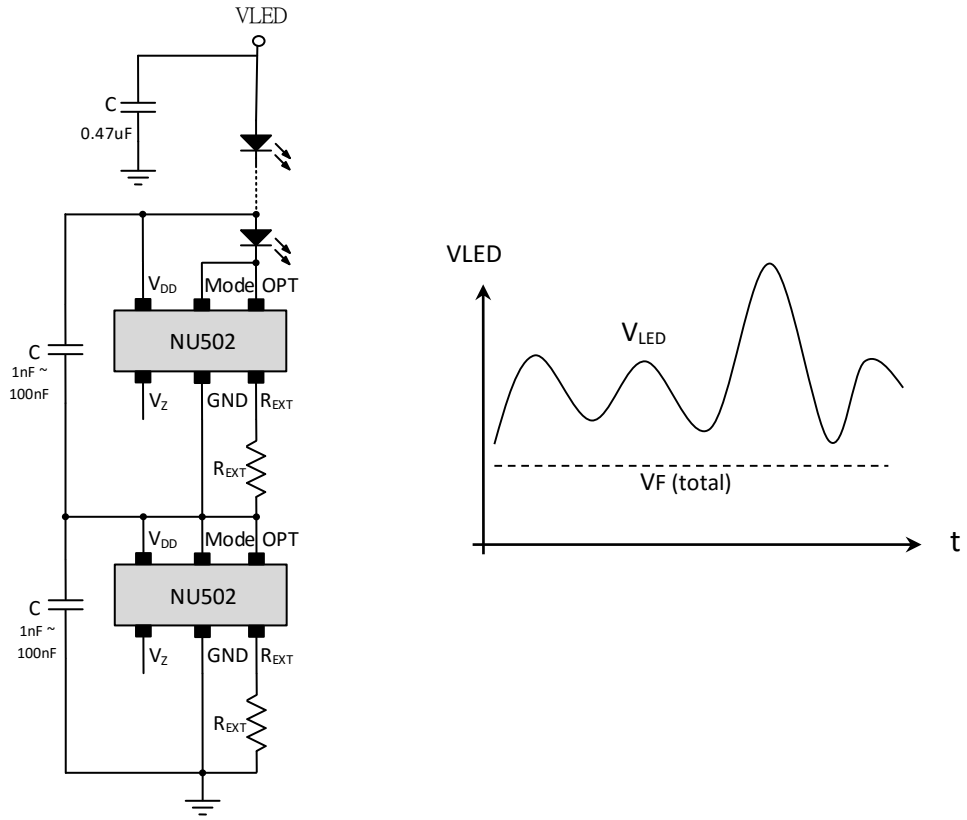
- Cascade application



By cascade mode, two or more NU502 in series can absorb higher voltage variation in lighting system. Each NU502 can share about 12 volts redundant. The total voltage variation range that system can work is calculated by following equation.

$$VLED_{(max)} \fallingdotseq 12 * N_{(NU502)} + VF_{(total)}$$

Where $V_{LED(max)}$ is the system power voltage, $N_{(NU502)}$ is the number of NU502 and $VF_{(total)}$ is the total forward voltage of all LEDs.

Note: Generally, The capacitance of V_{DD} capacitor when self-power structure is used is about the same as LED typical current. For example, if the typical current of LED is 20mA, the capacitance is about 20nF. The capacitance can be adjusted according to the requirement of real applications.

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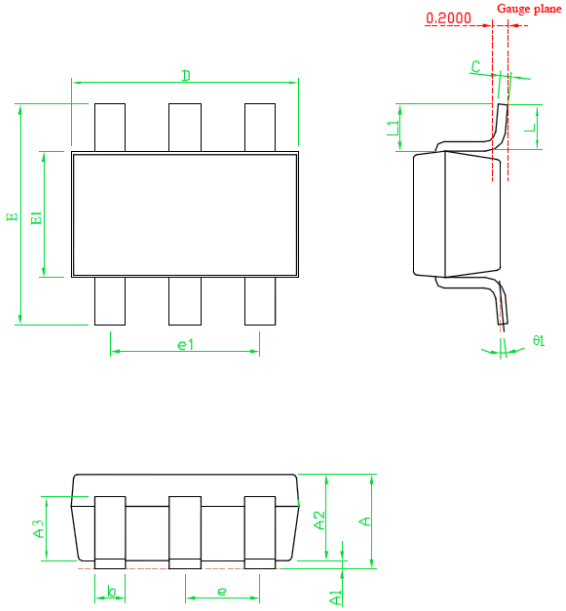
Package Dimensions

- SOT 23-6



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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