

## 3-Channel Constant Current Driver

### Product Description

The SCT2002 is a three channels constant current driver best for LED backlight. It provides the PWM control effect by sinking constant current from LED clusters with minimum pulse width 200ns. The PWM control is performed by connecting the PWM signal from system control unit to OE pin of the SCT2002. The full scale current value of each output is set by an external resistor connected to REXT pin.

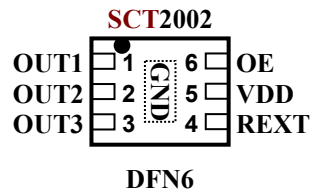
The SCT2002 guarantees to endure maximum DC 24V at each output port. Each output of SCT2002 can sink a constant current up to 45mA. Users can simply shunt the outputs to get higher current driver-ability, especially in the case of high power LED lighting.

The excellent current regulation capability allows SCT2002 easily drive each output current to a constant stable output nearly without affected by power supply of LED, loading due to variant  $V_F$  of LEDs and operating temperature. The SCT2002 is equipped with over temperature protection. The three channels IC stops driving the output while junction temperature exceeds 160°C the highest limit and the output will be reactivated while the junction temperature is below 110°C the low limit. In conclusion, the driver system is protected from damage of overheated. Furthermore, with wide operating range, the SCT2002 can be applied to lower input supply system.

### Features

- ◆ Three constant-current outputs rate at 24V
- ◆ Constant current range: 5 – 45mA@5V, 5-30mA@3.3V
- ◆ Excellent regulation to load, supply voltage and temperature
- ◆ Minimum PWM pulse width 200ns
- ◆  $\pm 2\%$ (typ) current matching between outputs
- ◆  $\pm 4\%$ (typ) current matching between ICs
- ◆ Low dropout output 0.5V@20mA
- ◆ All output current are adjusted through one external resistor
- ◆ Built-in power on reset and thermal protection
- ◆ Supply voltage range 3.3V to 5V
- ◆ Dimming control with schmitt triggered input
- ◆ Interlaced 30ns delay of output to lower bouncing noise
- ◆ Package: Small 2mmx2mm DFN
- ◆ Application: Mini light bar, LED backlight, LED lamp

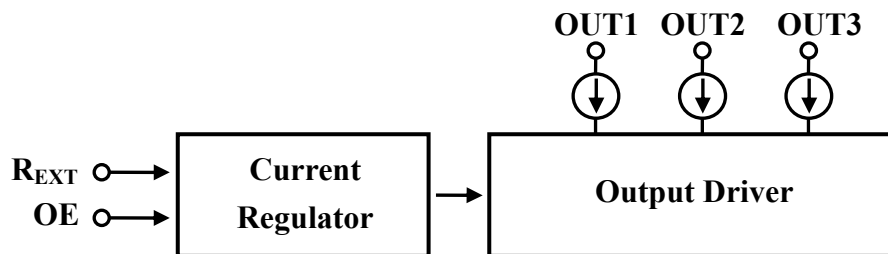
**Pin Configuration**



**Terminal Description**

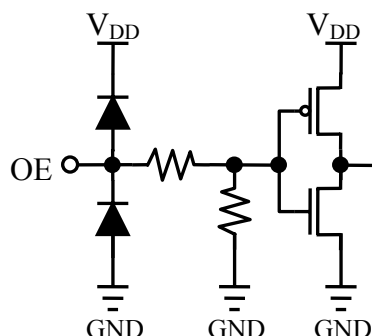
Pin No.	Pin Name	Function
TP	GND	Ground terminal
1~3	OUT1~3	Output terminals with constant current
4	REXT	Input terminal connected to an external resistor for setting up all output current
5	VDD	Supply voltage terminal
6	OE	Input terminal of output enable signal. Output is enabled when OE is high.

**Block Diagram**



**SCT2002**

## Equivalent Circuits of Inputs



## Ordering information

Part	Marking	Package	Unit per reel(pcs)
SCT2002ADNG	02A	Green DFN6	3000

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## Maximum Ratings (T<sub>A</sub> = 25°C)

Characteristic	Symbol	Rating	Unit
Supply voltage	V <sub>DD</sub>	7	V
Input voltage	V <sub>IN</sub>	-0.2 ~ V <sub>DD</sub> +0.2	V
Output current	I <sub>OUT</sub>	60	mA/Channel
Output voltage	V <sub>OUT</sub>	24	V
Total GND terminals current	I <sub>GND</sub>	200	mA
Power dissipation(on PCB)	DFN6 P <sub>D</sub>	2.16	W
Thermal resistance(on PCB)	DFN6 R <sub>TH(j-a)</sub>	58	°C /W
Operating temperature	T <sub>OPR</sub>	-40~+85	°C
Storage temperature	T <sub>STG</sub>	-55~+150	°C

**Recommended Operating Conditions** ( $T_A = -40$  to  $85^\circ\text{C}$  unless otherwise noted)

Characteristic	Symbol	Conditions	Min.	Typ.	Max.	Unit
Supply voltage	$V_{DD}$	-	3	-	5.5	V
Output voltage	$V_{OUT}$	Output OFF	-	-	24	V
		Output ON	-	1	4	V
Output current	$I_{OUT}$	$V_{DD}=3.3/5V$	5	-	30/45	mA
Input voltage	$V_{IH}$	-	$0.7V_{DD}$	-	$V_{DD}$	V
	$V_{IL}$	-	0	-	$0.3V_{DD}$	V
OE pulse width	$t_w$	-	200	-	-	ns

**Electrical Characteristics** ( $V_{DD}=3.3/5V$ ,  $T_A=25^\circ\text{C}$  unless otherwise noted)

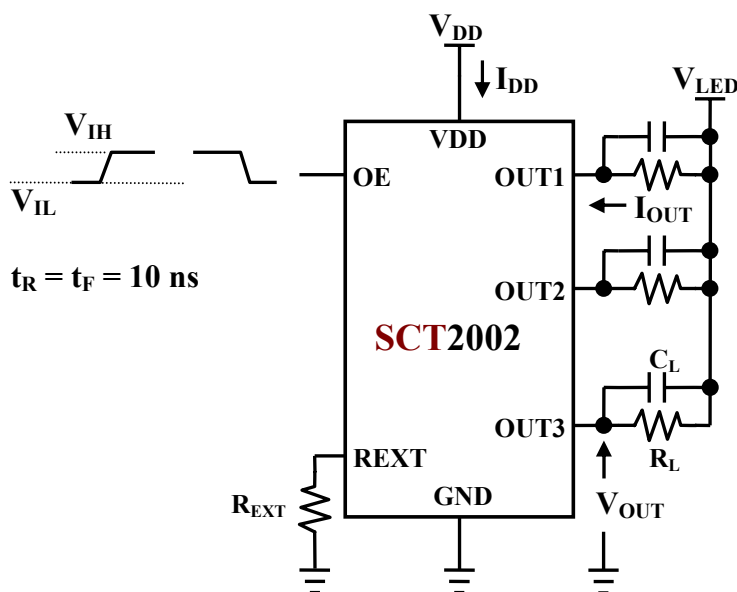
Characteristic	Symbol	Conditions	Min.	Typ.	Max.	Unit	
Input voltage	$V_{IH}$	-	$0.7V_{DD}$	-	$V_{DD}$	V	
	$V_{IL}$	-	0	-	$0.3V_{DD}$	V	
Output leakage current	$I_{OL}$	$V_{OUT} = 17V$	-	1	-	$\mu\text{A}$	
Output current	$I_{OUT}$	$V_{OUT}=1V$ , $R_{EXT}=900\Omega$	-	21	-	mA	
Current channel skew*	$dI_{OUT1}$	$V_{OUT}=1V$ , $R_{EXT}=900\Omega$	-	$\pm 2$	$\pm 3$	%	
Current chip skew	$dI_{OUT2}$	$V_{OUT}=1V$ , $R_{EXT}=900\Omega$	-	$\pm 4$	$\pm 6$	%	
Line regulation $I_{OUT}$ vs. $V_{DD}$	$\%/dV_{DD}$	$3V < V_{DD} < 5.5V$ $R_{EXT}=900\Omega$ , $V_{OUT} > 1V$	-	-	$\pm 1$	$\%/V$	
Load regulation $I_{OUT}$ vs. $V_{OUT}$	$\%/dV_{OUT}$	$1V < V_{OUT} < 4V$ , $R_{EXT}=900\Omega$ , $V_{DD}=3.3-5V$	-	-	$\pm 1$	$\%/V$	
Pull-down resistor	$R_{DOWN}$	OE	-	500	-	$\text{K}\Omega$	
Thermal shutdown	$T_H$	Junction Temperature	-	160	-	$^\circ\text{C}$	
	$T_L$		-	110	-	$^\circ\text{C}$	
Supply current	OFF	$I_{DD(OFF)1}$	$R_{EXT} = \text{Open}$ , $OUT_1 \sim OUT_3 = \text{OFF}$	-	2	3	mA
		$I_{DD(OFF)2}$	$R_{EXT} = 900\Omega$ , $OUT_1 \sim OUT_3 = \text{OFF}$	-	5	6	
	ON	$I_{DD(ON)}$	$R_{EXT} = 900\Omega$ , $OUT_1 \sim OUT_3 = \text{ON}$	-	6	7	

\* Skew =  $(I_{OUT} - I_{AVG}) / I_{AVG}$ , where  $I_{AVG} = (I_{max} + I_{min}) / 2$

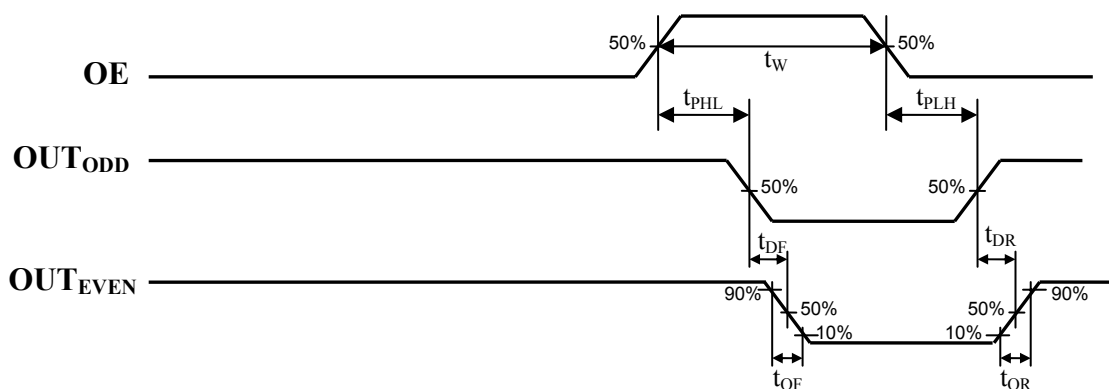
**Switching Characteristics** ( $V_{DD}=3.3/5V$ ,  $T_A=25^\circ C$  unless otherwise noted)

Characteristic		Symbol	Condition	Min.	Typ.	Max.	Unit
Propagation delay time ("L" to "H")	OE - OUTn	$t_{PLH}$	$V_{DD} = 3.3/5 V$ $V_{LED} = 5V$ $V_{IH} = V_{DD}$ $V_{IL} = GND$ $R_{EXT} = 900\Omega$ $R_L = 180\Omega$ $C_L = 10pF$	-	40	60	ns
Propagation delay time ("H" to "L")	OE - OUTn	$t_{PHL}$		-	40	60	ns
Pulse width	OE	$t_w$		200	-	-	ns
Output rise time of $I_{OUT}$		$t_{OR}$		-	40	60	ns
Output fall time of $I_{OUT}$		$t_{OF}$		-	40	60	ns
Output delay		$t_{DR}$		OUT <sub>EVEN</sub> to OUT <sub>ODD</sub>	-	30	-
		$t_{DF}$		-	30	-	ns

**Test Circuit for Switching Characteristics**

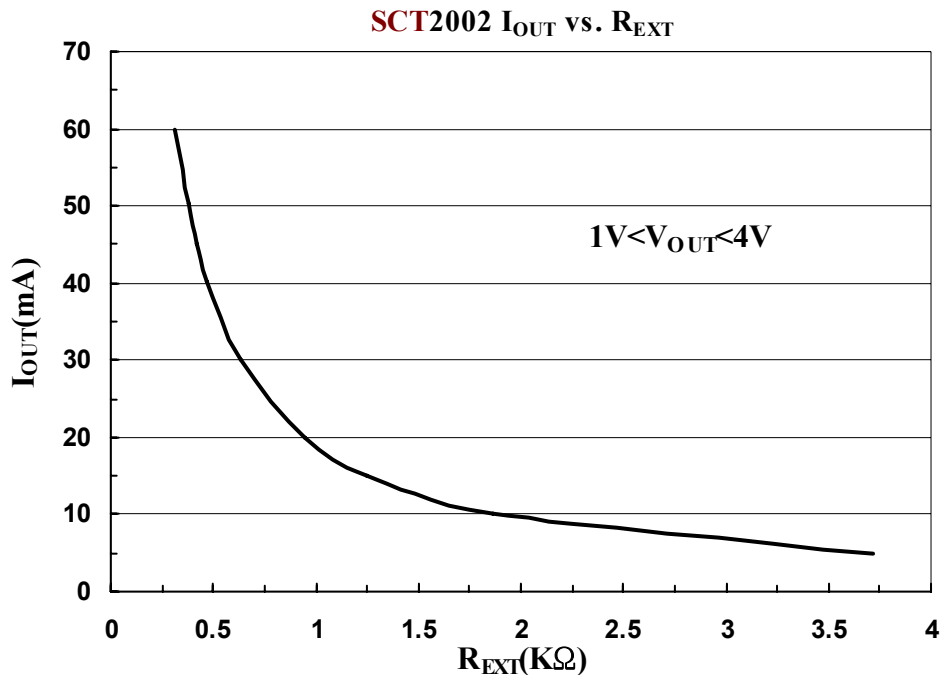


**Timing Waveform**



### Adjusting Output Current

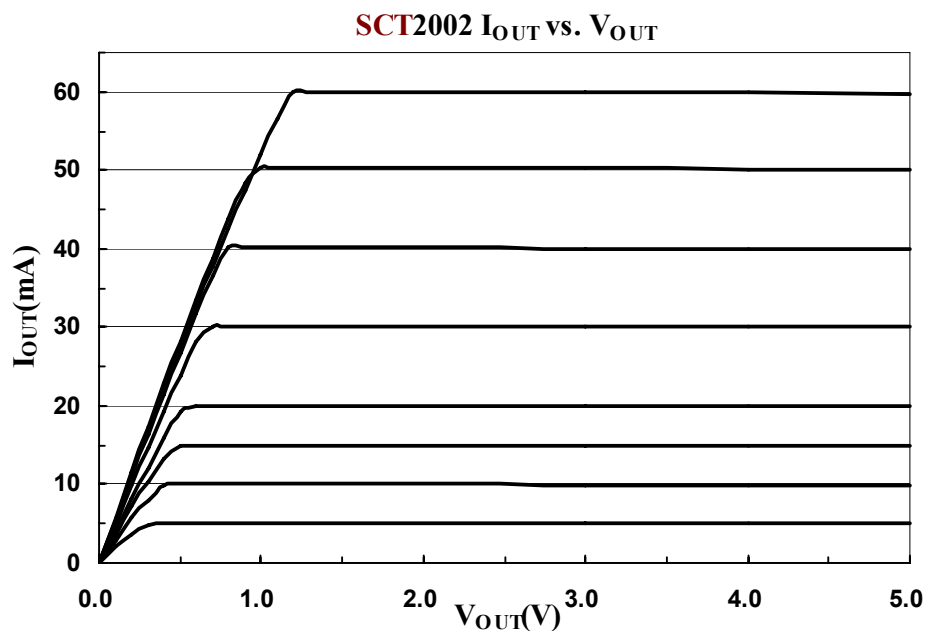
All SCT2002's output currents ( $I_{OUT}$ ) are set by one external resistor at pin  $R_{EXT}$ . The output current  $I_{OUT}$  versus resistance of  $R_{EXT}$  is shown as the following figure.



Furthermore, when the SCT2002's output voltage is set between 1 Volt and 4 Volt, the output current can be estimated approximately by:  $I_{OUT} = 30(630 / R_{EXT})$  (mA) (chip skew  $< \pm 6\%$ ). Thus the output currents are set about 21mA at  $R_{EXT} = 900\Omega$ .

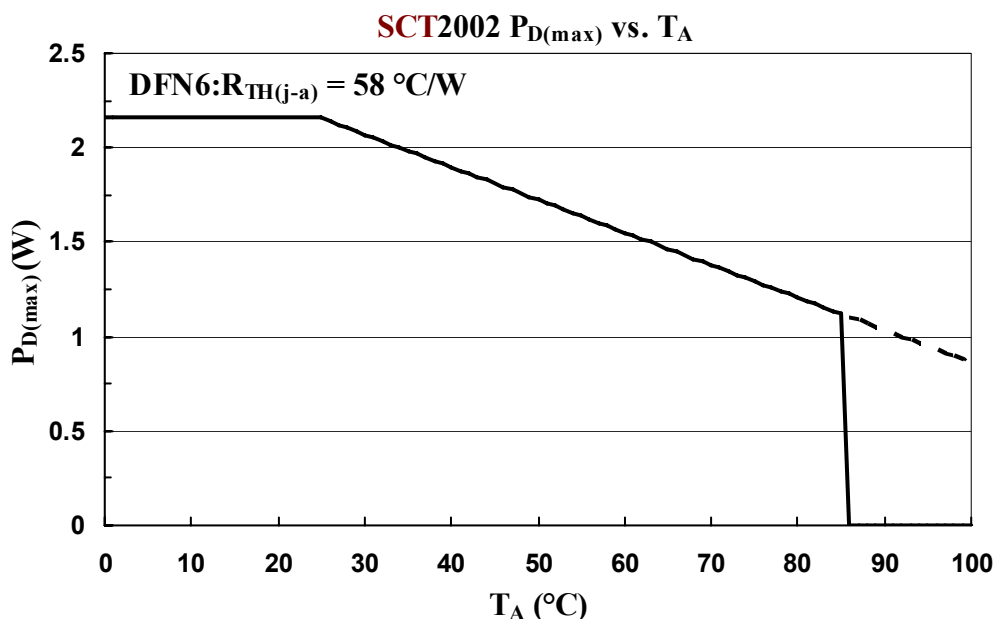
### Output Characteristics

The current characteristic of output curve is flat. The output current can be kept constantly regardless of the variations of LED forward voltage when  $V_{OUT} > 1V$ . The relationship between  $I_{OUT}$  and  $V_{OUT}$  is shown below:



### Maximum Power Dissipation

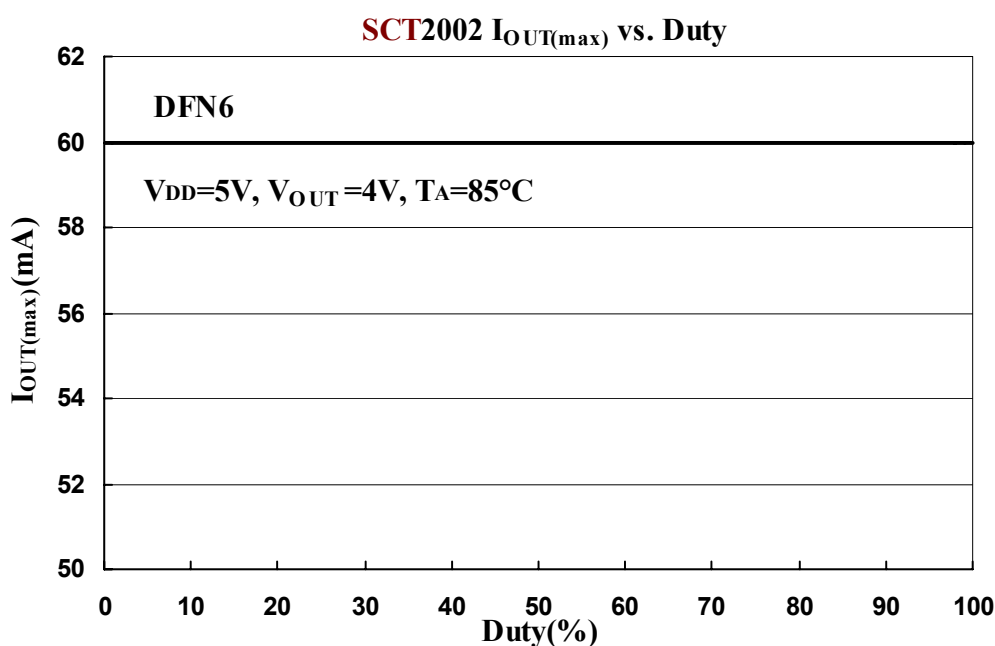
The maximum power dissipation ( $P_{D(max)}$ ) of a semiconductor chip varied to different package and ambient temperature. It's determined as  $P_{D(max)}=(T_{J(max)} - T_A)/R_{TH(j-a)}$  where  $T_{J(max)}$ : maximum chip junction temperature usually considered as 150°C,  $T_A$ : ambient temperature,  $R_{TH(j-a)}$ : thermal resistance. Since  $P=IV$ , for sink larger  $I_{OUT}$ , users are encouraged to add proper voltage reducers on output to reduce the heat generated from the SCT2002.



### Limitation on Maximum Output Current

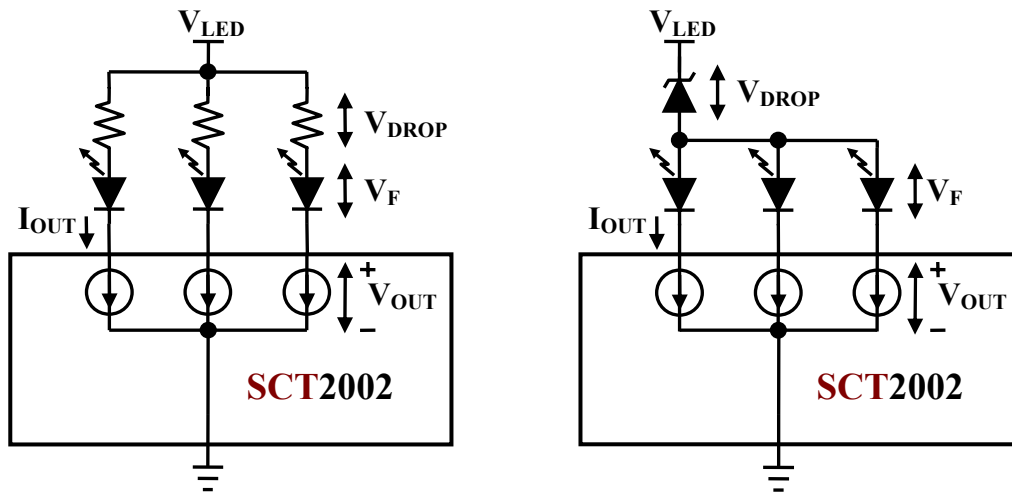
The maximum output current vs. duty cycle is estimated by:

$$I_{OUT(max)} = (((T_{J(max)} - T_A) / R_{TH(j-a)}) - (V_{DD} * I_{DD})) / V_{OUT} / \text{Duty} / N, \text{ where } T_{J(max)} = 150^\circ\text{C}, N = 3(\text{all ON})$$



### Load Supply Voltage ( $V_{LED}$ )

The SCT2002 can be operated very well when  $V_{OUT}$  ranging from 1V to 4V. It is recommended to use the lowest possible supply voltage or set a voltage reducer to reduce the  $V_{OUT}$  voltage, at the same time reduce the power dissipation of the SCT2002. The diagram instructions shown below are to lower down the output voltage. This can be done by adding additional resistor or zener diode, thus  $V_{OUT} = V_{LED} - V_{DROP} - V_F$ .

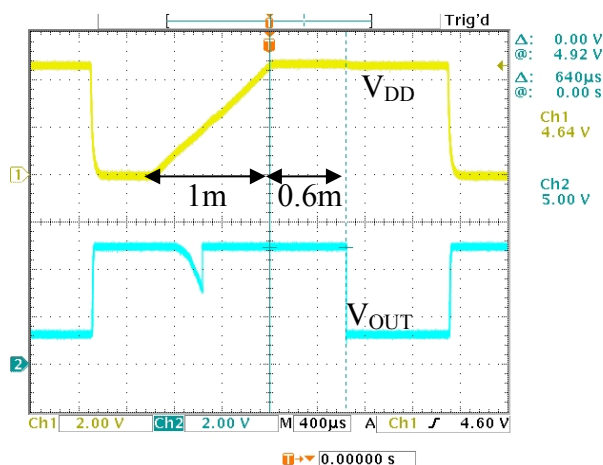


### Over Temperature Shutdown

The SCT2002 contains thermal shutdown scheme to prevent damage from over heated. The internal thermal sensor turns off all outputs when the die temperature exceeds  $\sim +160^{\circ}\text{C}$ . The outputs are enabled again when the die temperature drops below  $\sim +110^{\circ}\text{C}$ .

### Power On Reset

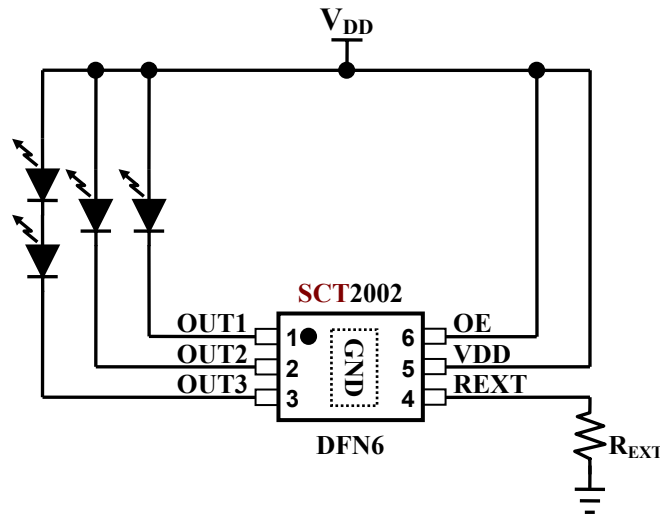
The SCT2002 incorporated power-on-reset(POR) function to delay the output when power input is instantly ON. The POR function protected system from inrush current damage is raised especially when many LED drivers are currently ON. Below diagram shown if  $V_{DD}$  is rising with  $1\text{ms}@5\text{V}$ , the  $V_{OUT}$  is delayed with around  $\sim 0.6\text{ms}$ .



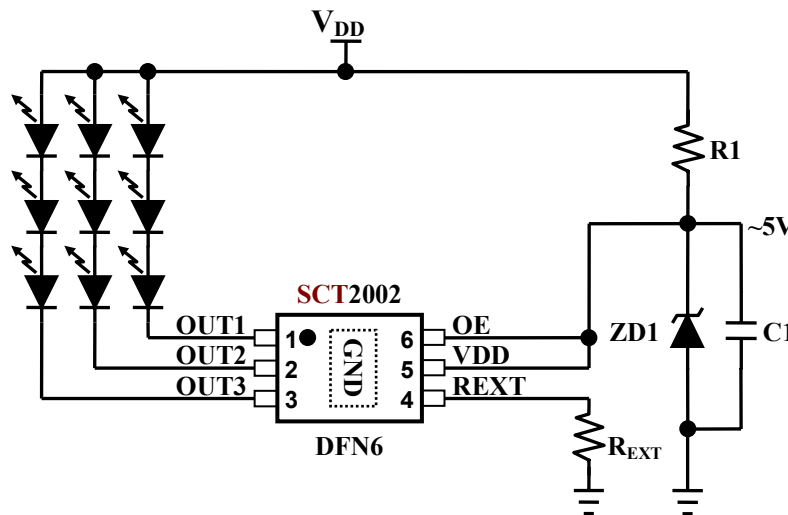


**Typical Application Circuits**

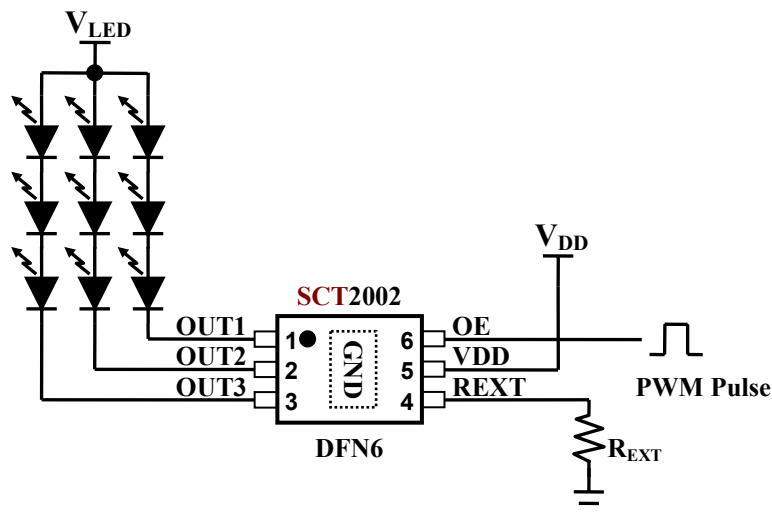
**(1) Lighting with recommended  $V_{DD}=3.3/5V$**



**(2) Lighting with  $V_{DD} > 5V$ , e.g.  $V_{DD}=12V/24V$**



**(3) Lighting with dimming control**

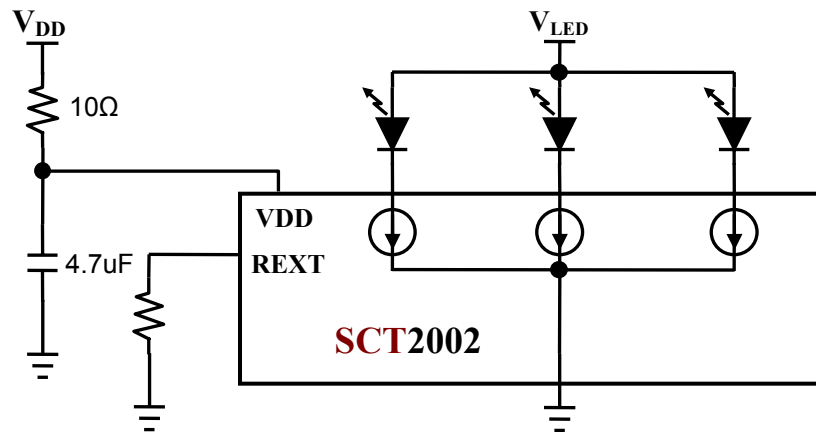


## PCB Design Considerations

Use the following general guide-line when designing printed circuit boards (PCB) :

### Decoupling Capacitor

Place a decoupling capacitor e.g. 4.7 $\mu$ F between VDD and GND pins of the SCT2002. Locate the capacitor as close to the SCT2002 as possible. The necessary capacitance depends on the LED load current and dimming frequency.



### External Resistor ( $R_{EXT}$ )

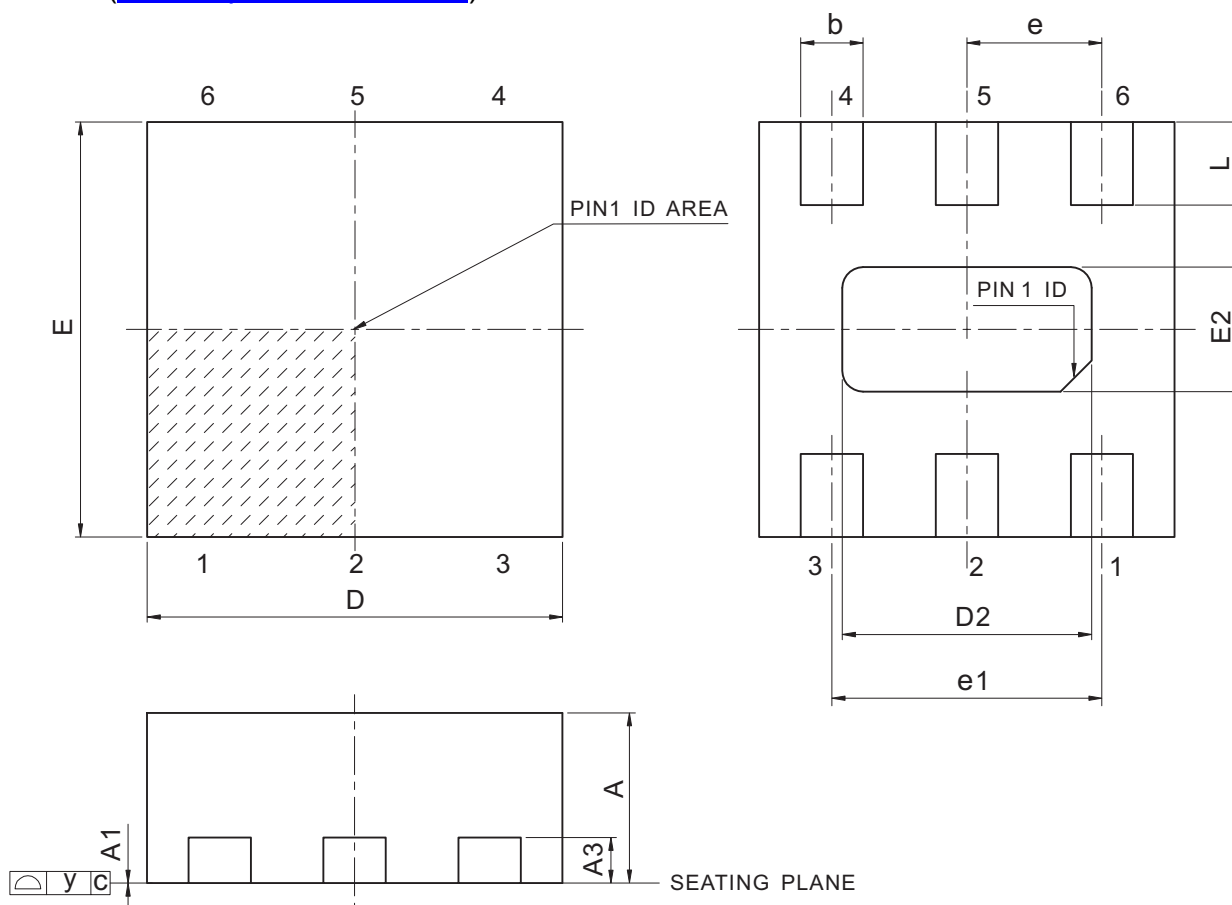
Locate the external resistor as close to the REXT pin in as possible to avoid noise.

### Power and Ground

Maximizing the width and minimizing the length of V<sub>DD</sub> and GND trace improve efficiency and lower ground bouncing by reducing both power and ground parasitic resistance and inductance. A small value of resistor e.g. 10 $\Omega$  series in power input of the SCT2002 in conjunction with decoupling capacitor shunting the ICs is recommended. Separating and feeding the LED power from another stable supply terminal V<sub>LED</sub> is strongly recommended.

**Package Dimension**

DFN6([check up-to-date version](#))



Symbol	Dimension (mm)			Dimension (mil)		
	Min.	Nom.	Max.	Min.	Nom.	Max.
A	0.70	0.75	0.80	27.6	29.5	31.5
A1	0.00	0.02	0.05	0.0	0.8	2.0
A3	0.20 REF			7.9 REF		
b	0.20	0.30	0.40	7.9	11.8	15.7
D	1.90	2.00	2.10	74.8	78.7	82.7
D2	0.00	1.20	1.25	0.0	47.2	49.2
E	1.90	2.00	2.10	74.8	78.7	82.7
E2	0.00	0.60	0.65	0.0	23.6	25.6
e	0.65 BSC			25.6 BSC		
e1	1.30 BSC			51.2 BSC		
L	0.40 REF			15.7 REF		
y	-	-	0.08	-	-	3.1

**Revision History** ([check up-to-date version](#))

Data Sheet Version	Remark
V01_01	New release

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