3-Channel Constant Current Driver

Product Description

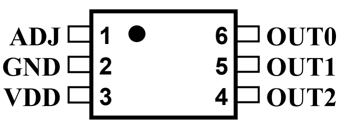
The SCT2001 is designed to drive multiple LEDs in series from a high input voltage rail. The SCT2001 contains three output channels which are regulated to sink constant current for driving LEDs of large range V_F variations.

In the field of LEDs driving applications, users can simply adjust the output current from 10 mA to 45 mA through an external resistor R_{ADJ} to control the light intensity of LEDs. The SCT2001 guarantees to endure maximum DC 24V at each output port.

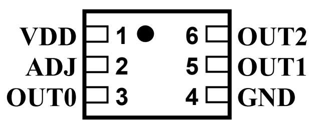
Features

- Three constant-current outputs rate at 24V
- Constant current range:10 – 45mA
- Wide operating supply input: 5 – 15V
- ±2%(typ) current matching between outputs
- ±4%(typ) current matching between ICs
- Smart dimming control via ADJ pin
- Low drop-out output 0.3V@20mA
- Excellent current regulation to load, supply voltage and temperature
- All output current are adjusted through one external resistor
- Hysteresis input for external resistor
- Built-in power on reset and thermal protection function
- Package: Small 2mmx2mm DFN and SOT-236
- Applications: Mini light bar, LED backlight, LED lamp

Pin Configurations



SOT-236



DFN6

Terminal Description

For SOT-236/DFN6

Pin No.		Pin Name	Function
1	2	ADJ	Input terminal used to set up all output current
2	4	GND	Ground terminal
3	1	VDD	Supply voltage terminal
4	6	OUT2	Output terminal 2
5	5	OUT1	Output terminal 1
6	3	OUT0	Output terminal 0

Ordering information

Part	Marking	Package	Unit per reel(pcs)
SCT2001AS1G	2001	Green SOT-236	3000
SCT2001ADNG	01A	Green DFN6	3000

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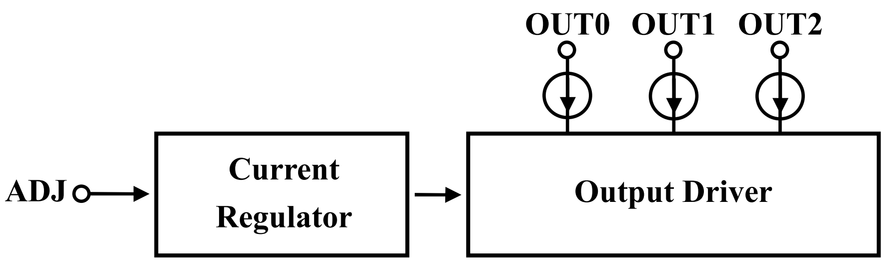
Block Diagram



SCT2001

Maximum Ratings (T_A = 25°C)

Characteristic		Symbol	Rating	Unit
Supply voltage		V_{DD}	17	V
Input voltage		V_{ADJ}	-0.4 ~ V_{DD}+0.4	V
Output current		I_{OUT}	60	mA
Output voltage		V_{OUT}	24	V
Total GND terminals current		I_{GND}	200	mA
Power dissipation(on PCB)	SOT-236	P_D	0.64	W
	DFN6		2.16	
Thermal resistance(on PCB)	SOT-236	$R_{TH(j-a)}$	195	°C /W
	DFN6		58	
Operating temperature		T_{OPR}	-40~+85	°C
Storage temperature		T_{STG}	-55~+150	°C

Recommended Operating Conditions (T_A= -40 to 85°C unless otherwise noted)

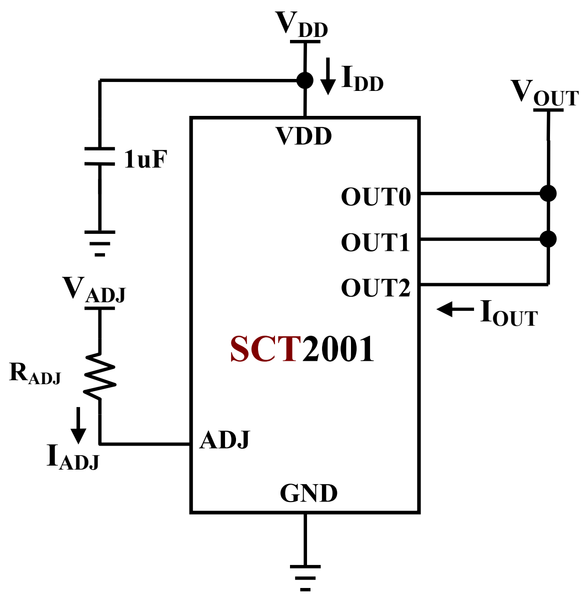
Characteristic	Symbol	Conditions	Min.	Typ.	Max.	Unit
Supply voltage	V_{DD}	-	5	-	15	V
Output voltage	V_{OUT}	Output OFF	-	-	24	V
		Output ON	-	1	4	V
Output current	I_{OUT}	DC test circuit	10	-	45	mA
Dimming pulse width	t_W	V_{DD}=5-15V	2	-	-	us
Dimming rise time	t_R	V_{DD}=5-15V	-	-	1	us
Dimming fall time	t_F	V_{DD}=5-15V	-	-	1	us

Electrical Characteristics (V_{DD}=5-15V, V_{ADJ}=5V, T_A=25°C unless otherwise specified)

Characteristic	Symbol	Conditions	Min.	Typ.	Max.	Unit
Supply current	I_{DD}	V_{DD}=5/15V	-	1/1.5	2	mA
ADJ input voltage	V_{IH}	-	2.5	-	-	V
	V_{IL}	-	-	-	20	mV
ADJ input current	I_{ADJ}	R_{ADJ}=4.8K	-	1	-	mA
Output leakage	I_{OL}	V_{ADJ}=0V, V_{OUT}=24V,	-	-	0.5	uA
Output current	I_{OUT}	R_{ADJ}=4.8K	-	20	-	mA
Current channel skew*	dI_{OUT1}	V_{OUT}=1V,R_{ADJ}=4.8K	-	±2	±3	%
Current chip skew	dI_{OUT2}	V_{OUT}=1V,R_{ADJ}=4.8K	-	±4	±6	%
Line regulation I_{OUT} vs. V_{DD}	%/dV_{DD}	5V < V_{DD} < 15V, V_{OUT} >1 V, R_{ADJ}=4.8K	-	-	±1	%/V
Load regulation I_{OUT} vs. V_{OUT}	%/dV_{OUT}	1V < V_{OUT} < 4V, I_{OUT}=20mA, R_{ADJ}=4.8K	-	-	±1	%/V
Thermal shutdown	T_H	Junction Temperature	-	160	-	°C
	T_L		-	110	-	°C

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

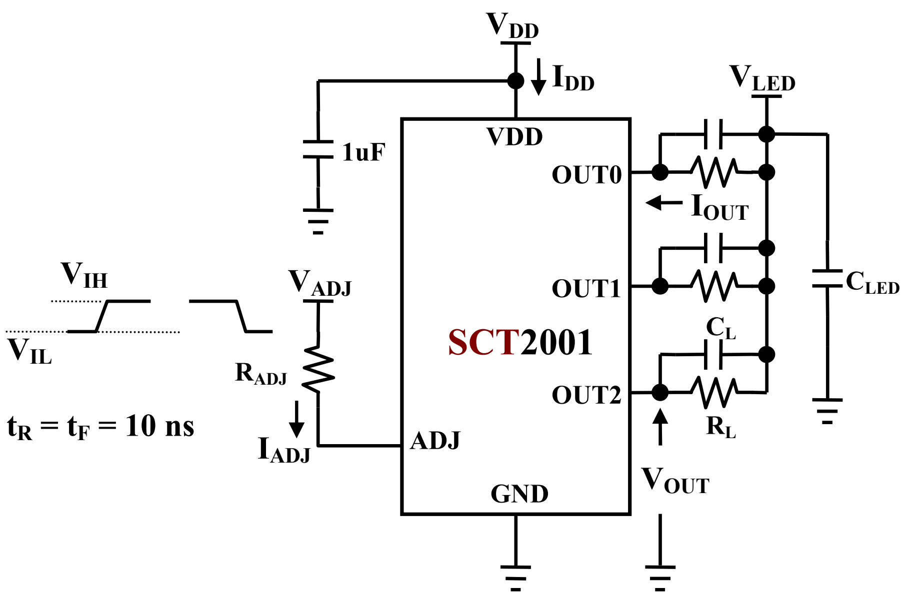
Test Circuit for Electrical Characteristics



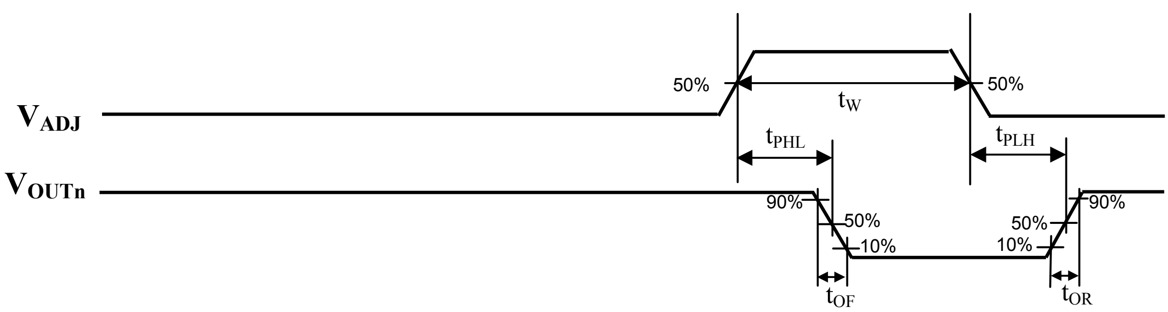
Switching Characteristics (V_{DD}=5-15V, T_A=25°C unless otherwise noted)

Characteristic		Symbol	Conditions	Min.	Typ.	Max.	Unit
Propagation delay time ("L" to "H")	$V_{ADJ} – V_{OUTn}$	t_{PLH}	V_{LED} = 5V V_{IH} = 5V V_{IL}= GND R_{ADJ} = 4.8KΩ R_L = 180Ω C_L = 10pF C_{LED} = 47uF	-	200	400	ns
Propagation delay time ("H" to "L")	V_{ADJ} - V_{OUTn}	t_{PHL}		-	200	400	ns
Pulse width	V_{ADJ}	t_w		2	-	-	us
Output rise time of I_{OUT}		t_{OR}		-	200	400	ns
Output fall time of I_{OUT}		t_{OF}		-	200	400	ns

Test Circuit for Switching Characteristics

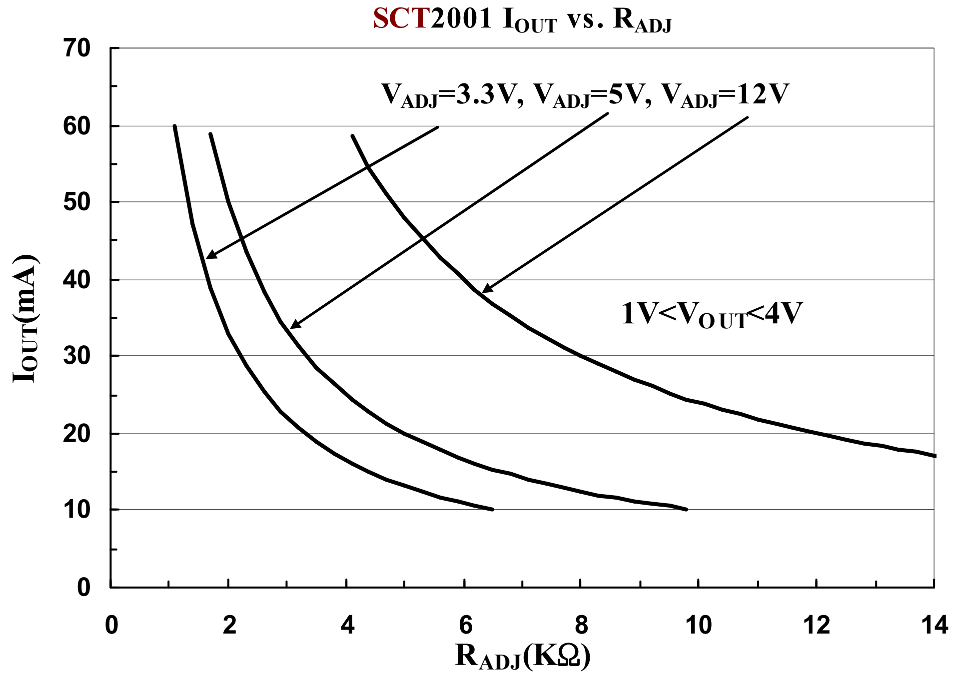


Timing Waveform



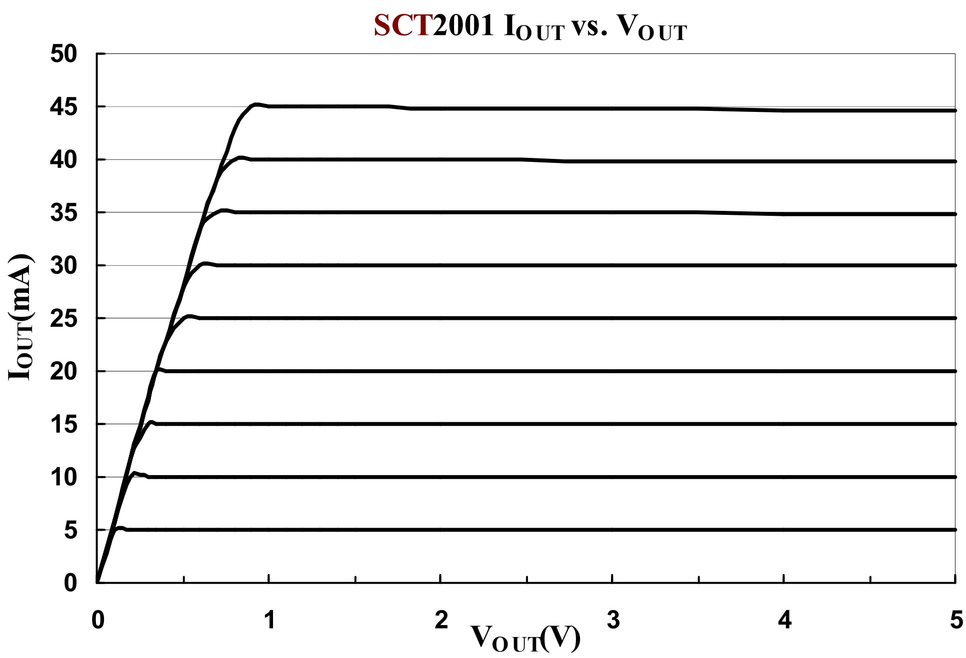
Adjusting Output Current

The output current (I_{OUT}) are set by one external resistor at pin ADJ. The relationship between I_{OUT}, resistance R_{ADJ} and reference voltage V_{ADJ} is shown as the following figure. V_{ADJ} connected to a stable reference voltage is suggested. Furthermore, I_{OUT} could be estimated by ~ $I_{OUT}(A) = 20*V_{ADJ} / (R_{ADJ} (\Omega) + 200)$ (chip skew < ±6%).



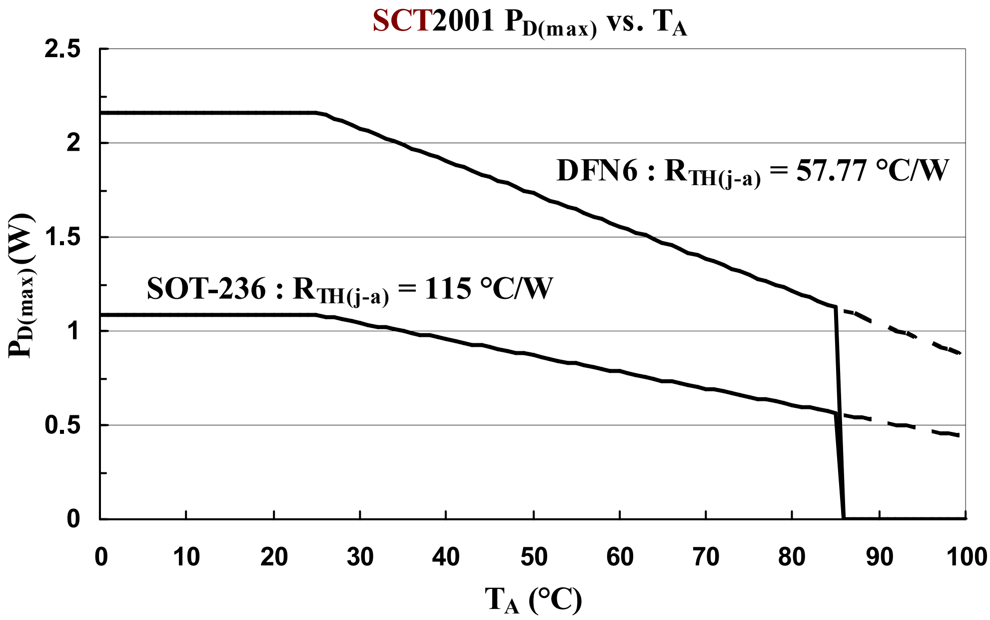
Output Characteristics

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



Power Dissipation

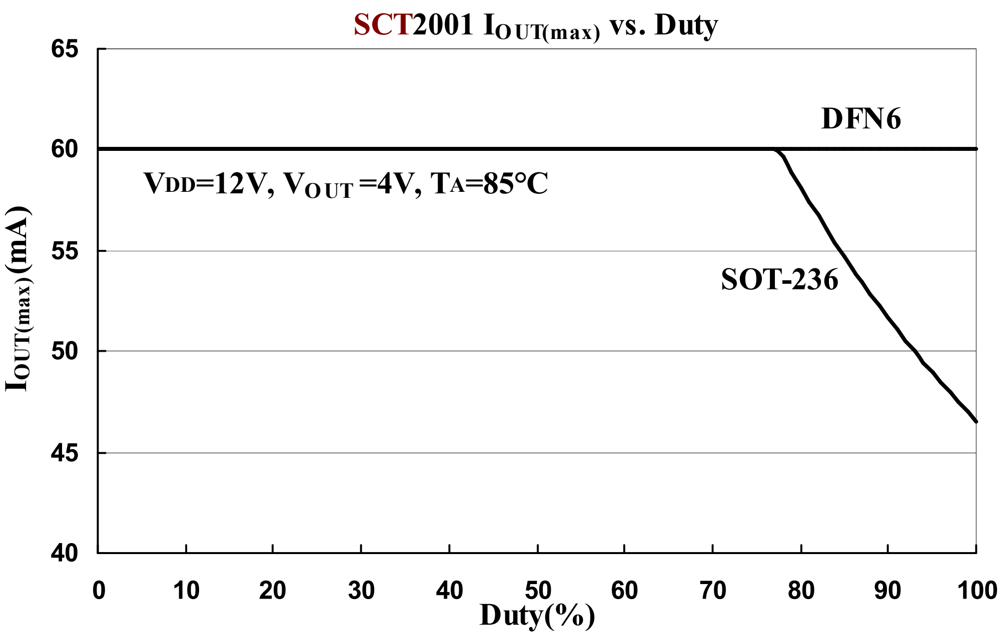
The power dissipation (P_D) of a semiconductor chip is limited by its package and ambient temperature. The maximum allowable power dissipation $P_{D(max)}$ is determined by $P_{D(max)}=(T_{J(max)} - T_A)/R_{TH(j-a)}$ where $T_{J(max)}$: maximum chip junction temperature, usually considered as 150°C, T_A: ambient temperature, $R_{TH(j-a)}$: thermal resistance of the package. The relationship between $P_{D(max)}$ and T_A is shown as the below figure:



Limitation on Maximum Output Current

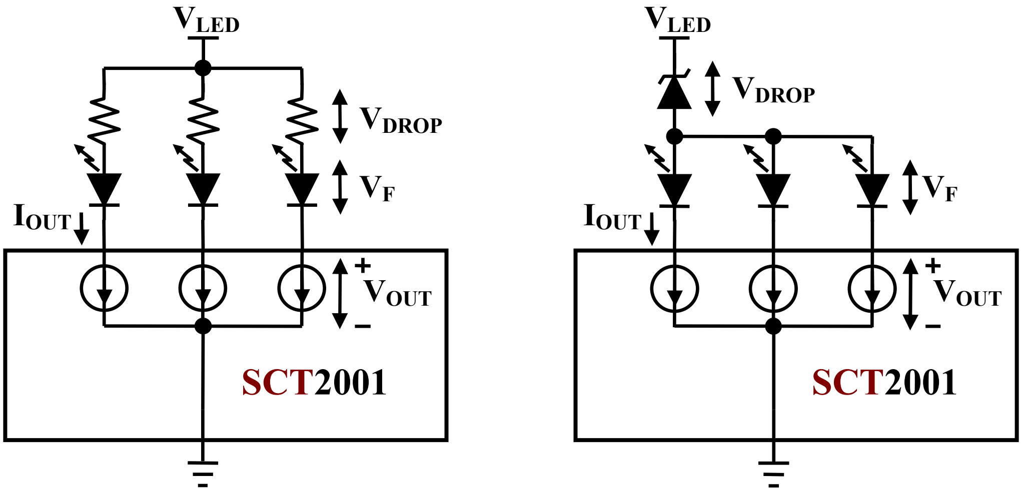
The maximum output current vs. duty cycle is estimated by:

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



Load Supply Voltage (V_{LED})

The SCT2001 can be operated very well when V_{OUT} ranging from 1V to 4V. So it is recommended to use the lowest possible supply voltage or set a voltage reducer to reduce the V_{OUT} voltage and then reduce the power dissipation of the SCT2001. Follow the diagram instructions shown below to lower down the output voltage. This can be done by adding additional resistor or zener diode, thus $V_{OUT}=V_{LED}-V_{DROP}-V_F$.

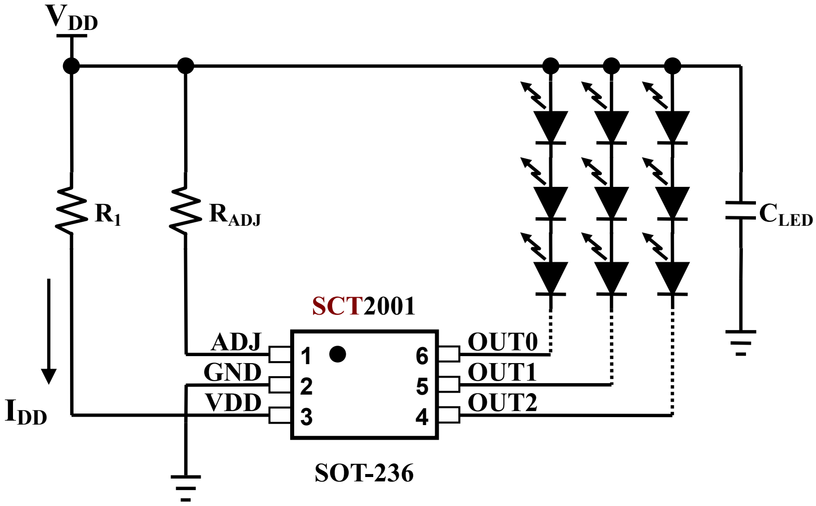


Over Temperature Shutdown

The SCT2001 contains thermal shutdown scheme to prevent damage from over heated. The internal thermal sensor turns off all outputs when the die temperature exceeds approximately +160°C. The outputs are enabled again when the die temperature drops below approximately +110°C.

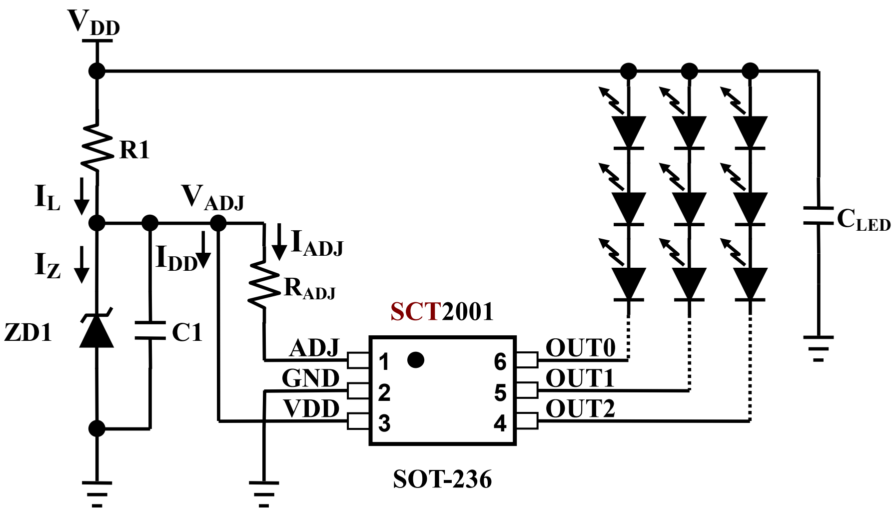
Typical Application Circuits

(1) Typical lighting application with e.g. V_{DD}=24V



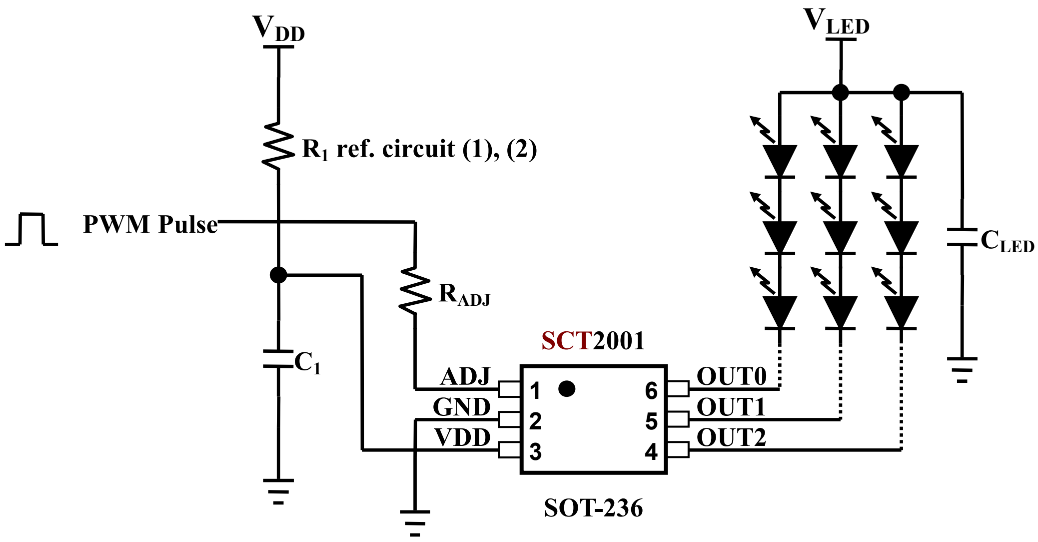
The SCT2001 can operate well with wide supply input range: 5-15V, a lower supply input of SCT2001 is suggested to diminish the influence of power bouncing. If V_{DD}=24V, set R_1 ~ (24V-5V)/$I_{DD(max)}$(2mA)=9.5K, a higher R_1 e.g. 10K is recommended.

(2) Typical lighting application (Zener diode as reference voltage)



Since output current of SCT2001 is V_{ADJ} dependent, to have a constant output with the most economic solution is to use zener diode as reference voltage V_{ADJ}. An adaptive value of R_1 ~ (V_{DD}-V_Z)/I_L is suggested, where I_L = I_Z + I_{DD} + I_{ADJ}. If I_Z ~ 1mA, V_Z = 5.6V is selected, and V_{DD}=12V, I_{OUT}=20mA is intended current, typically I_{ADJ} ~ I_{DD} ~ 1mA in this case, thus R_1 ~ (12V-5.6V)/3mA = 2.1K, a lower R_1 e.g. 2K is recommended.

(3) Lighting with dimming control

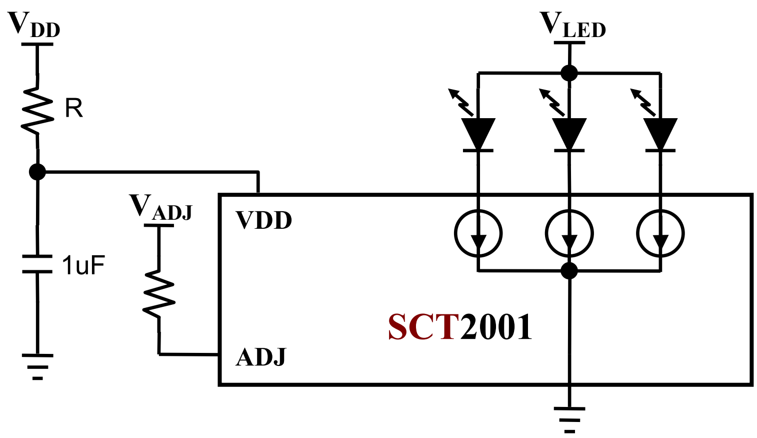


PCB Design Considerations

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

Decoupling Capacitor

Place a decoupling capacitor e.g. 1uF between VDD and GND pins of the SCT2001. Locate the capacitor as close to the SCT2001 as possible. The necessary capacitance depends on the LED load current and dimming frequency.



External Resistor (R_{ADJ})

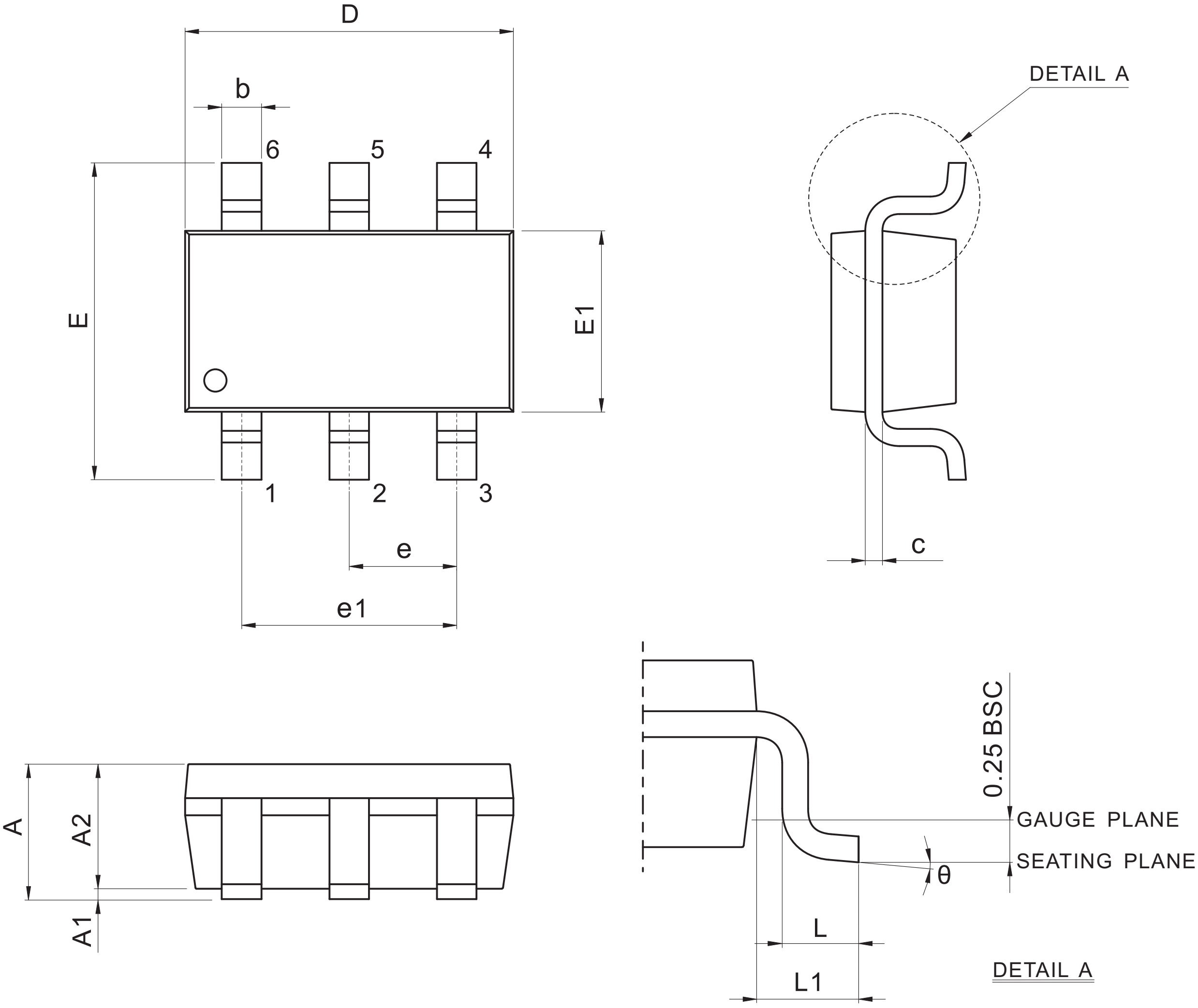
Locate the external resistor as close to the ADJ pin in as possible to avoid the noise influence.

Power and Ground

Maximizing the width and minimizing the length of V_{DD} and GND trace improve efficiency and lower ground bouncing by effect of reducing both power and ground parasitic resistance and inductance. A series resistor R(Ref. application circuit) in power input of the SCT2001 in conjunction with decoupling capacitor shunting the ICs is recommended. Separating and feeding the LED power from another stable supply terminal V_{LED} is strongly recommended.

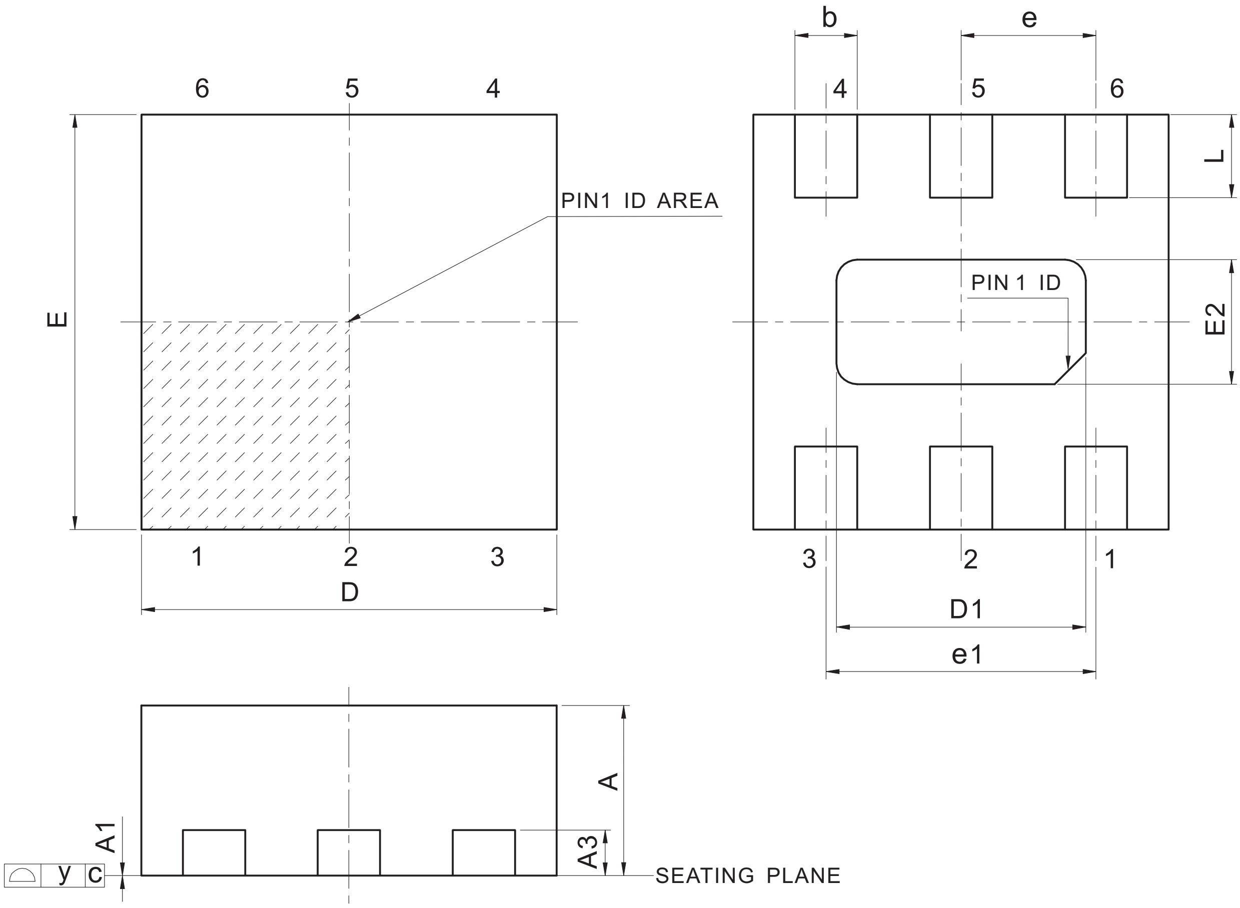
Package Dimension

SOT-236(check up-to-date version)



Symbol	Dimension (mm)			Dimension (mil)		
	Min.	Nom.	Max.	Min.	Nom.	Max.
A	-	-	1.45	-	-	57.1
A1	0.00	-	0.15	0.0	-	5.9
A2	0.90	1.15	1.30	35.4	45.3	51.2
b	0.30	-	0.50	11.8	-	19.7
c	0.08	-	0.22	3.2	-	8.7
D	2.90 BSC			114.2 BSC		
E	2.80 BSC			110.2 BSC		
E1	1.60 BSC			63.0 BSC		
e	0.95 BSC			37.4 BSC		
e1	1.90 BSC			74.8 BSC		
L	0.30	0.45	0.60	11.8	17.7	23.6
L1	0.60 REF			23.6 REF		
θ	0°	4°	8°	0°	4°	8°

DFN6-2x2(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	1.9	2.00	2.10	74.8	78.7	82.7
D1	0.00	1.20	1.25	0.0	47.2	49.2
E	1.9	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

Data Sheet Version	Remark(check up-to-date version)
V02_02	Application circuits descriptions added

Information provided by StarChips Technology is believed to be accurate and reliable. Application circuits shown, if any, are typical examples illustrating the operation of the devices. Starchips can not assume responsibility and any problem raising out of the use of the circuits. Starchips reserves the right to change product specification without prior notice.