3-Channel Constant Current Driver

Product Description

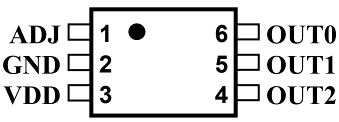
The SCT2001 is designed to drive multiple LEDs in series from a high input voltage rail. The SCT2001 contains three output channels which are regulated to sink constant current for driving LEDs of large range VF variations.

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

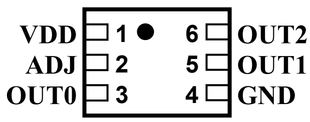
Features

- Three constant-current outputs rate at 24V
- Constant current range:10 – 45mA
- Wide operating operation by adding resistor from high rail to supply input
- ±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 ADJ 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
SOT-236	DFN6		
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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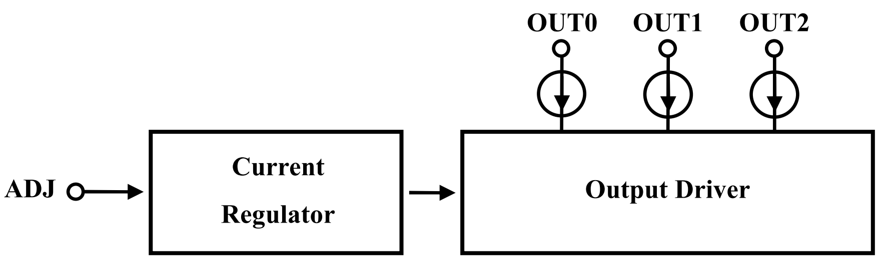
Block Diagram



SCT2001

Maximum Ratings (T_A = 25°C)

Characteristic		Symbol	Rating	Unit
Supply voltage(DC)		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

The absolute maximum ratings are a set of ratings not to be exceeded. Stresses beyond those listed under "Maximum Ratings" may cause the device breakdown, deterioration even permanent damage. Exposure to the maximum rating conditions for extended periods may affect device reliability.

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

Characteristic	Symbol	Conditions	Min.	Typ.	Max.	Unit
Supply voltage(DC)	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

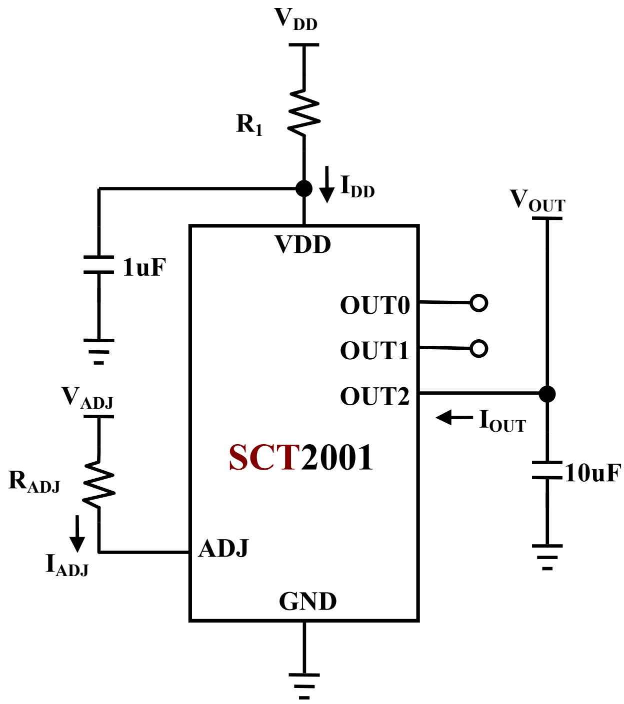
1. The output current keep constant in range of 10-45mA if V_{OUT}=1V.
   However, user can minimize V_{OUT} to reduce power dissipation according to used current, e.g., set V_{OUT} to 0.3V if I_{OUT}=20mA.
2. The maximum V_{OUT} is package thermal limited, user should keep Vout under maximum power dissipation.

Electrical Characteristics (V_{DD}=5-15V, V_{ADJ}=5V, R_1=2K, T_A=25°C unless otherwise specified)

Characteristic	Symbol	Conditions	Min.	Typ.	Max.	Unit
Supply current	I_{DD}	V_{DD}=5/15V, R_1=2K	-	1/1.5	2	mA
ADJ input voltage	V_{IH}	-	2.5	-	-	V
	V_{IL}	-	-	-	20	mV
ADJ input current	I_{ADJ}	V_{ADJ}=5V, 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[1]	dI_{OUT1}	V_{OUT}=1V,R_{ADJ}=4.8K	-	±2	±3	%
Current chip skew[2]	dI_{OUT2}	V_{OUT}=1V,R_{ADJ}=4.8K	-	±4	±6	%
Line regulation[3] I_{OUT} vs. V_{DD}	%/dV_{DD}	5V < V_{DD} < 15V, R_1=2K V_{OUT} >1 V, R_{ADJ}=4.8K	-	-	±1	%/V
Load regulation[4] 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

1. Channel skew=(I_{OUT}-I_{AVG})/I_{AVG}, where I_{AVG}=($I_{OUT(max)}$+ $I_{OUT(min)}$)/2
2. Chip skew=(I_{AVG}-I_{CEN}) / I_{CEN}*100(%), where I_{CEN} is the statistics distribution center of output currents.
3. Line regulation=[I_{OUT}(V_{DD}=15V)-I_{OUT}(V_{DD}=5V)] / {[I_{OUT}(V_{DD}=15V)+I_{OUT}(V_{DD}=5V)]/2} / (15V-5V)*100(%/V)
4. Load regulation=[I_{OUT}(V_{OUT}=4V)-I_{OUT}(V_{OUT}=1V)] / {[I_{OUT}(V_{OUT}=4V)+I_{OUT}(V_{OUT}=1V)]/2} / (4V-1V)*100(%/V)

Test Circuit for Electrical Characteristics

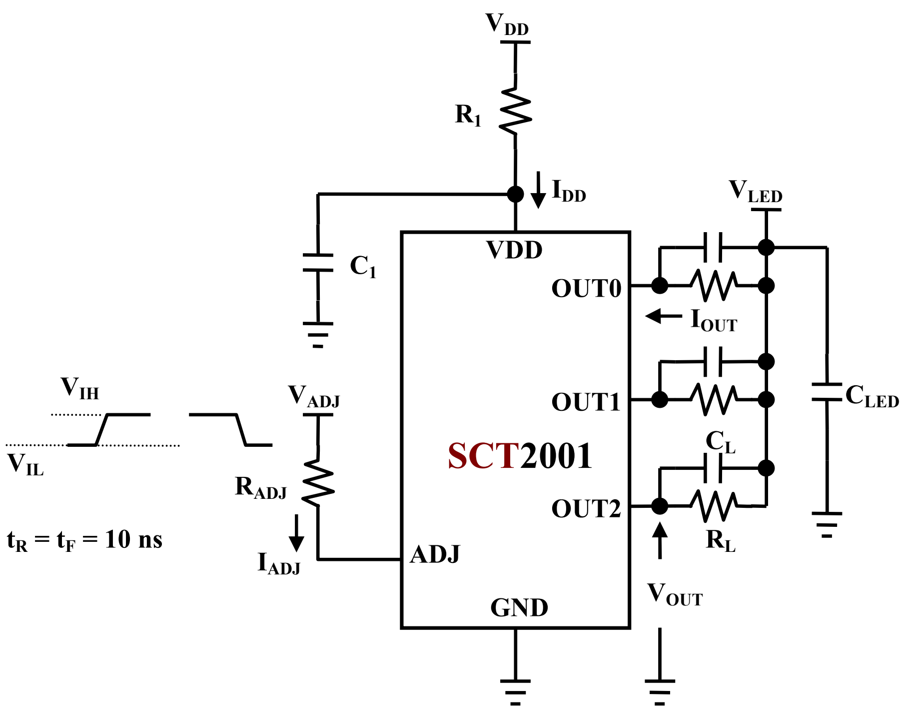


Please add R_1 during operation.

Switching Characteristics (V_{DD}=5-15V, R_1=2K, T_A=25°C unless otherwise noted)

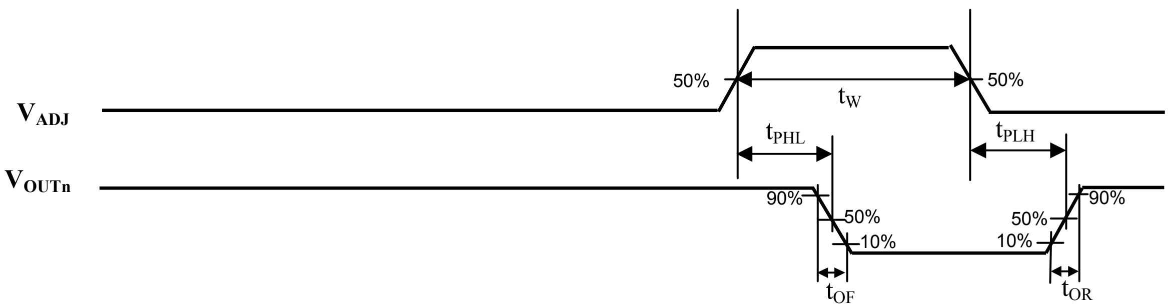
Characteristic		Symbol	Conditions	Min.	Typ.	Max.	Unit
Propagation delay time (“L” to “H”)	V_{ADJ} – V_{OUTn}	t_{PLH}	V_{LED} = 5V V_{IH} = 5V V_{IL}= GND V_{ADJ}= 5V R_{ADJ} = 4.8KΩ R_1 = 2KΩ C_1 = 1uF R_L = 180Ω C_L = 10pF C_{LED} = 47uF	-	200	400	ns
Propagation delay time (“H” to “L”)	V_{ADJ} - V_{OUTn}	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



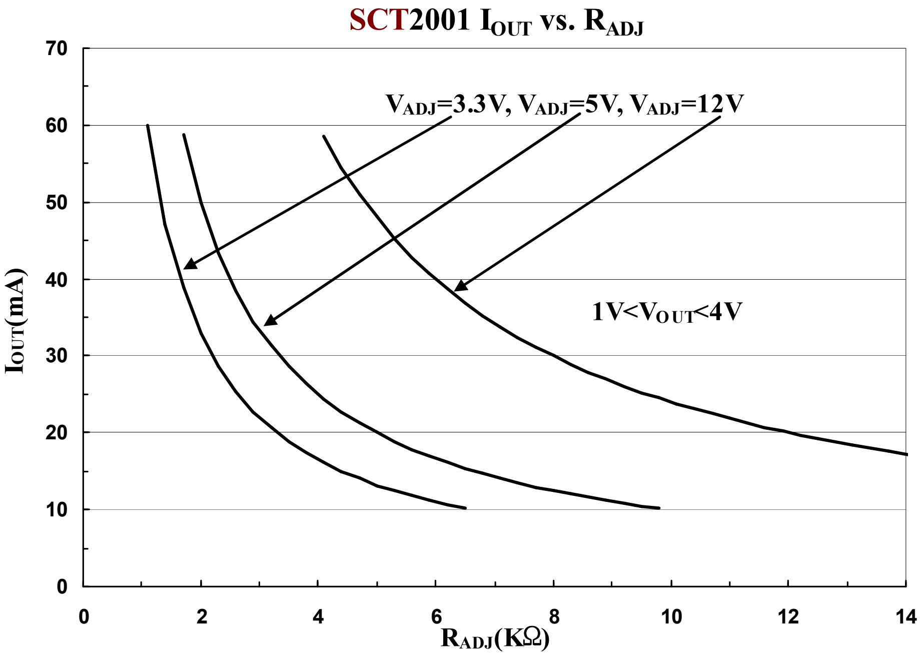
Please add R_1 during operation.

Timing Waveform



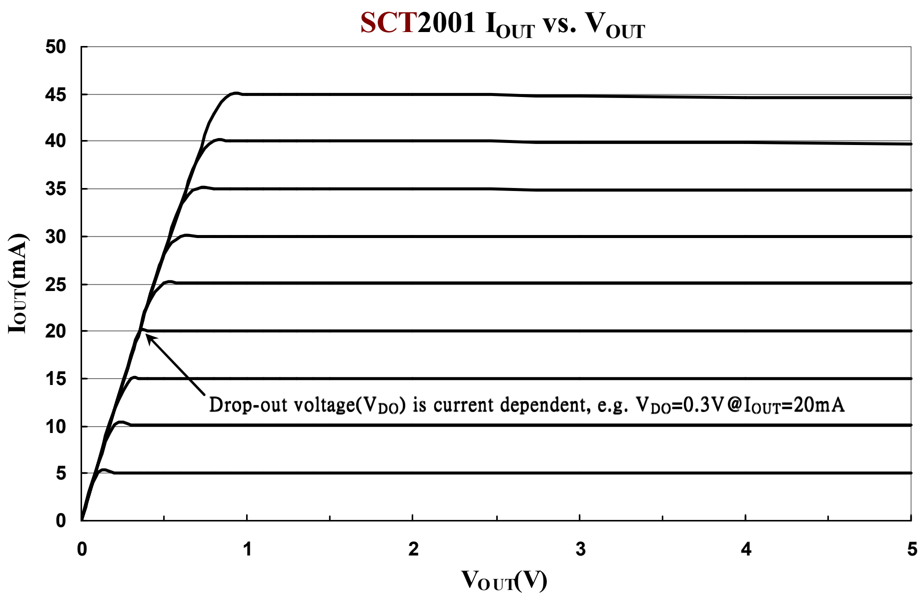
Adjusting Output Current

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%, 1V < V_{OUT} <4V).



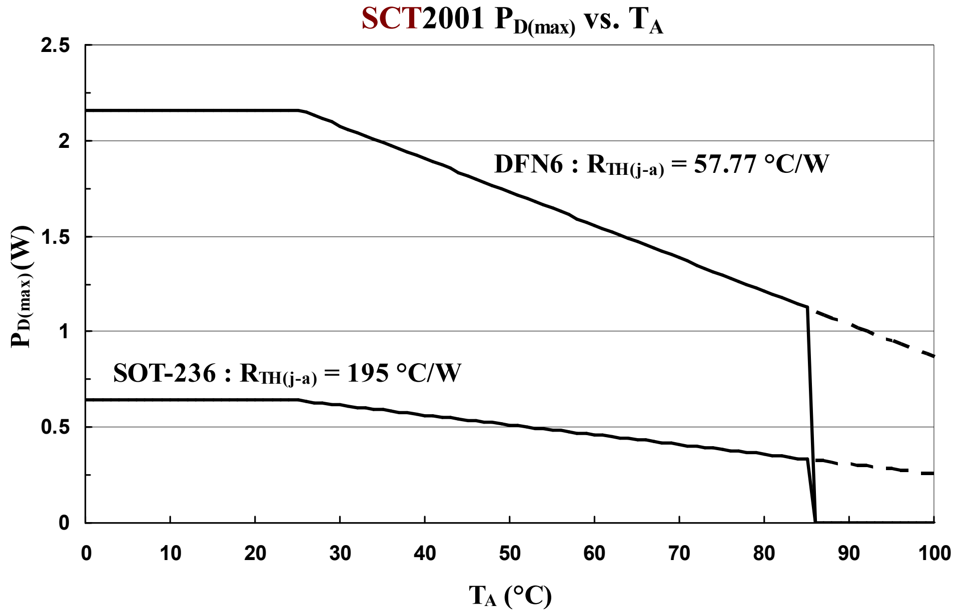
Output Characteristics

The current characteristic of output curve is flat. The output current can be kept constant regardless of the variations of LED forward voltage when $V_{OUT} > V_{DO}$(drop-out voltage). The relationship between I_{OUT} and V_{OUT} is shown below. The output voltage should be kept as low as possible to prevent the SCT2001 from being overheated.



Power Dissipation

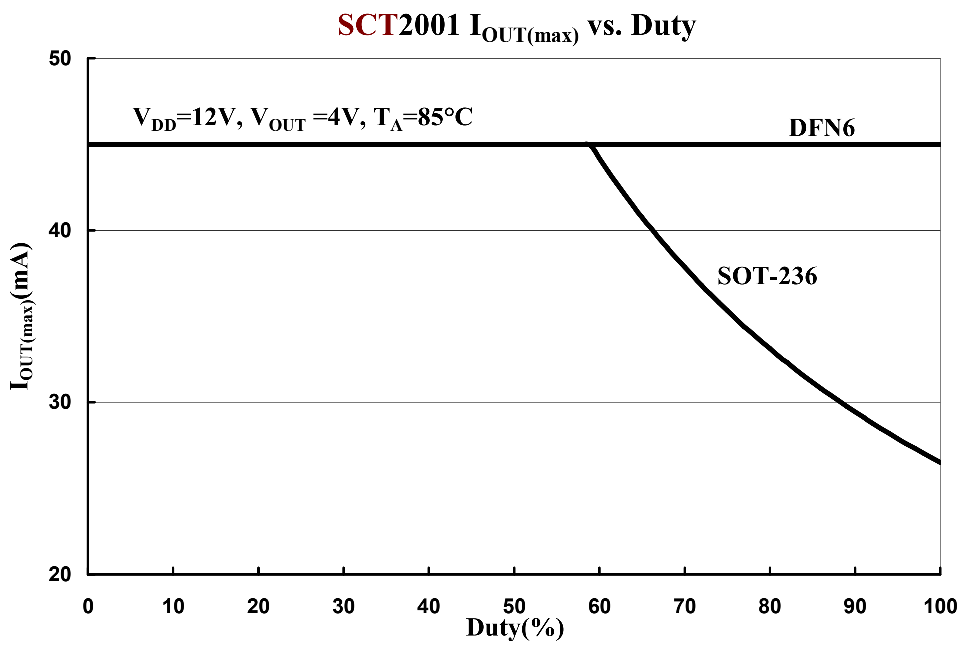
The maximum power dissipation ($P_{D(max)}$) of a semiconductor chip varies with different packages and ambient temperature. It's determined as $P_{D(max)}=(T_{J(max)} - T_A)/R_{TH(j-a)}$ where $T_{J(max)}$: maximum chip junction temperature is usually considered as 150°C, T_A: ambient temperature, $R_{TH(j-a)}$: thermal resistance. Since P=IV, for sinking larger I_{OUT}, users had better add proper voltage reducers on outputs to reduce the heat generated from the SCT2001.



Limitation on Maximum Output Current

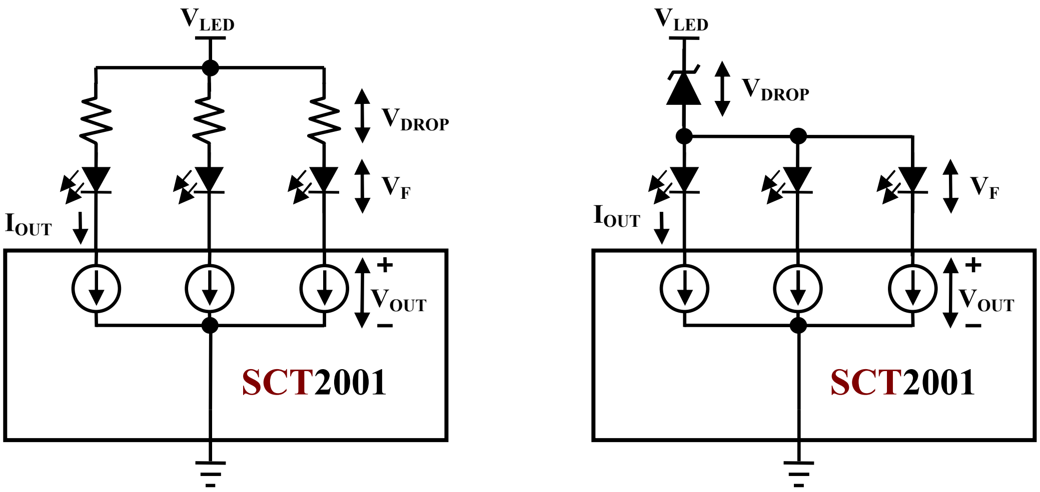
The maximum output current vs. duty cycle is estimated by:

$I_{OUT(max)}=(((T_{J(max)}-T_A)/R_{TH(j-a)})-(V_{DD}*I_{DD}))/V_{OUT}/Duty/N$ 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} ranges from 1V to 4V. However, 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 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 $V_{OUT}=V_{LED}-V_{DROP}-V_F$.

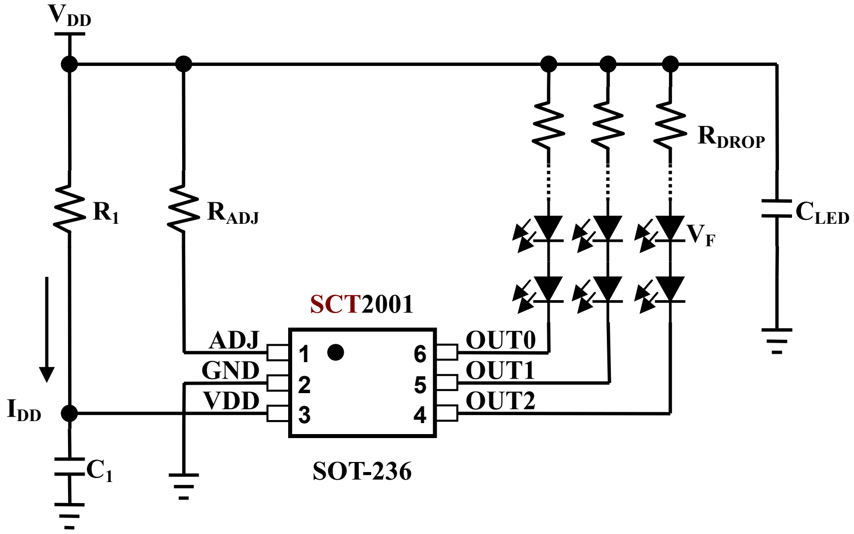


Over Temperature Shutdown

The SCT2001 contains thermal shutdown scheme to prevent damage from over-heating. The internal thermal sensor turns off all outputs when the die temperature exceeds +160°C. The outputs are enabled again when the die temperature drops below +110°C. During the thermal shutdown process, the LEDs look blinking since it is turned OFF then ON periodically.

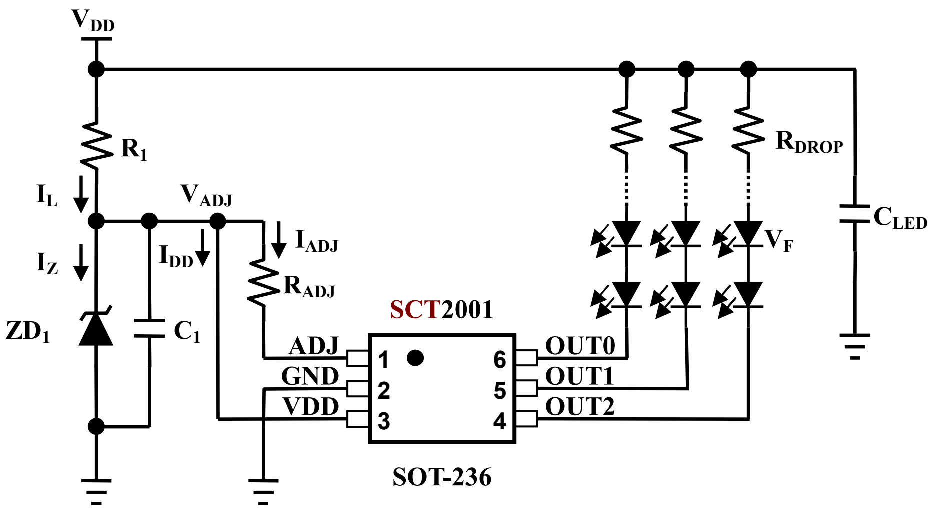
Typical Application Circuits

(1) Typical lighting application



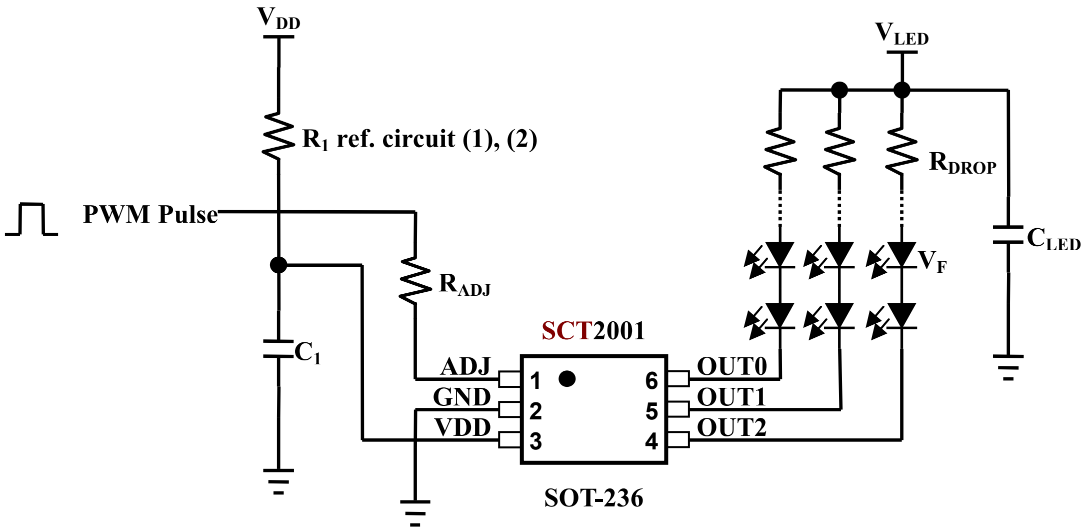
The SCT2001 can operate with wide supply input range by shunting a resistor R_1 to setup reference current of internal shunt regulator. The shunt regulator like structure can diminish negative influence of power bouncing or impact of instantly hot plug to system power. The calculation of R_1 is approximately expressed by: R_1 ~ $(V_{DD}$-5V)/$I_{DD(max)}$(2mA), the R_1 at least 2K from supply input to the SCT2001 is required. For example, if V_{DD}=24V, set R_1 ~ (24V-5V)/$I_{DD(max)}$(2mA)=9.5K, a higher R_1 e.g. 10K is recommended; if V_{DD}=12V, set R_1 ~ (12V-5V)/$I_{DD(max)}$=3.5K; however, if V_{DD}=5V, set R_1=2K directly.

(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 by using zener diode as reference voltage V_{ADJ}. An adaptive value of R_1 ~ $(V_{DD}-V_Z)/I_L$ is needed, 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 (V_Z = 5.6V), thus R_1 ~ (12V-5.6V)/3mA = 2.1K, a lower R_1 e.g. 2K is recommended.

(3) Lighting with dimming control

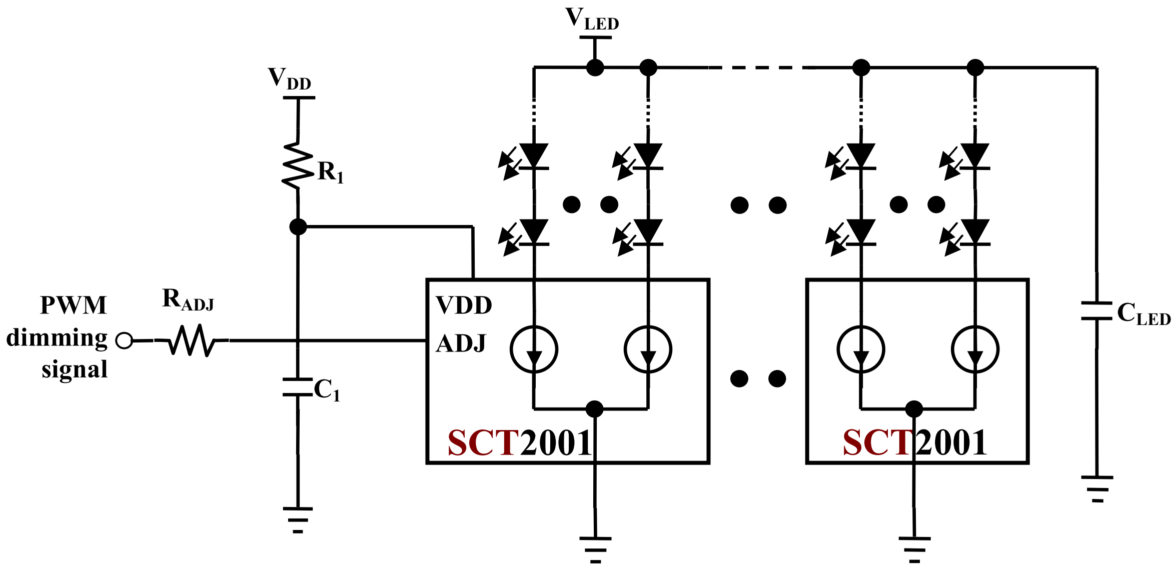


PCB Design Considerations

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

Decoupling Capacitor

Place a decoupling capacitor C_1 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. Inadequate VDD decoupling can cause timing problems, and very noisy LED supplies can affect LED current regulation.

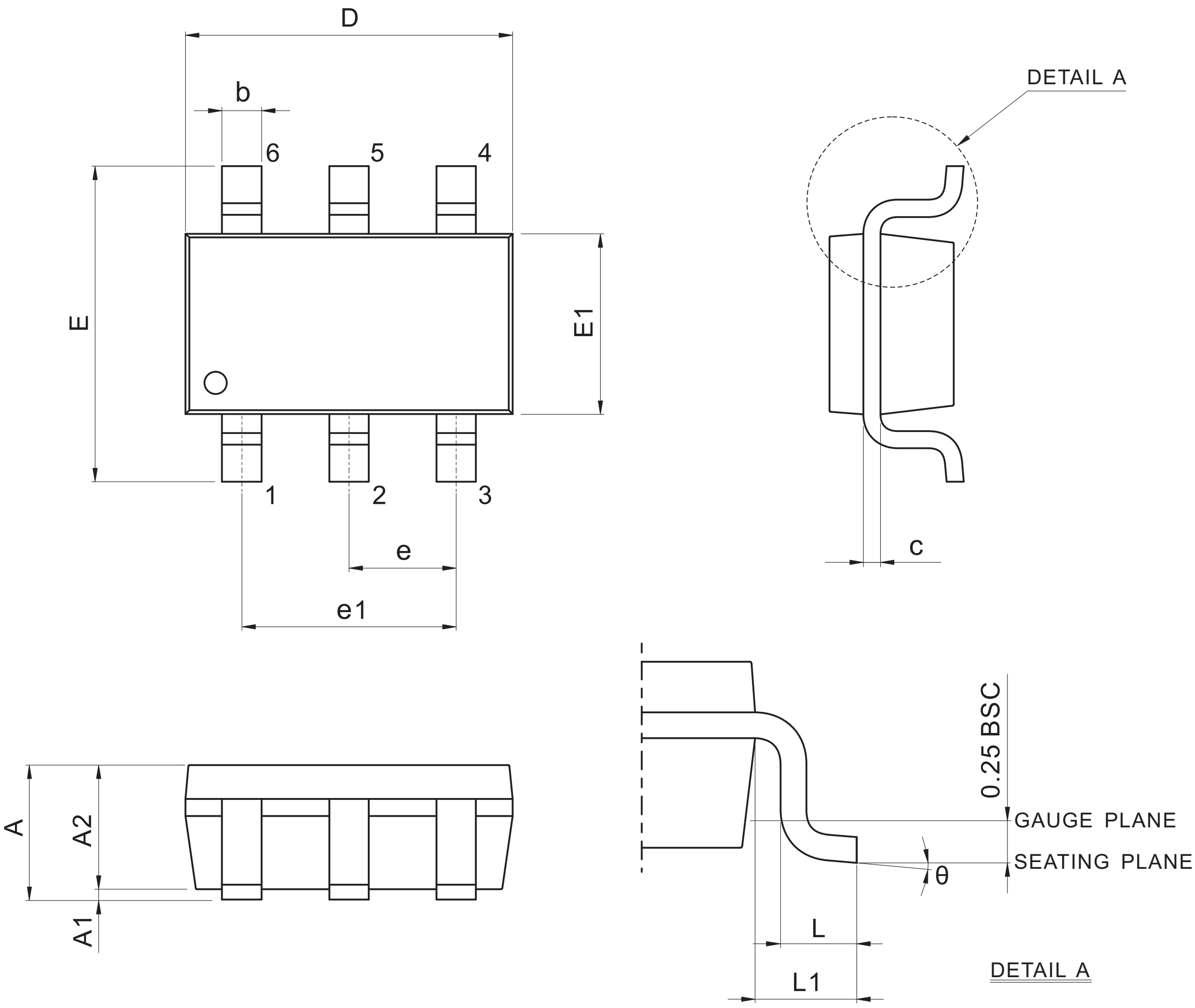


Power and Ground

Maximizing the width and minimizing the length of VDD and GND trace improves efficiency and ground bouncing by effect of reducing both power and ground parasitic resistance and inductance. An adaptive value of resistor R_1 in power input of the SCT2001 in conjunction with decoupling capacitor shunting the IC is required. Separating and feeding the LED power from another stable supply terminal V_{LED}, furthermore adding a capacitor C_{LED} greater than 10uF beside the LED are recommended. Please adapt C_{LED} according to total system current consumption.

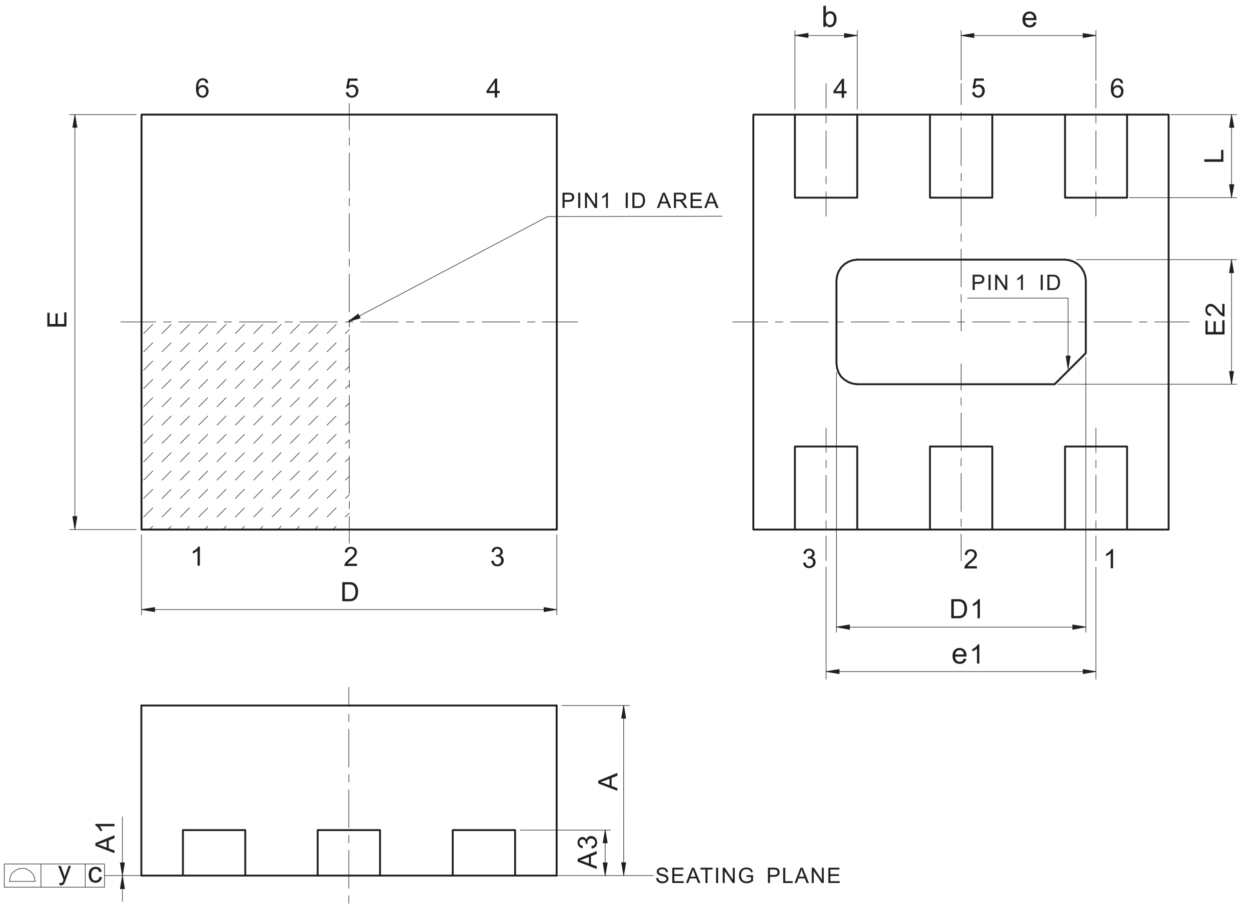
Package Dimension

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 (check up-to-date version)

Data Sheet Version	Remark
V02_03	Add R1 to VDD pin at testing & application circuit

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.

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