16-Channel Constant Current Driver

Product Description

The SCT2016 is a sixteen channels constant current driver best for the LED lighting. 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 SCT2016. The full scale current value of each output is set by an external resistor connected to REXT pin.

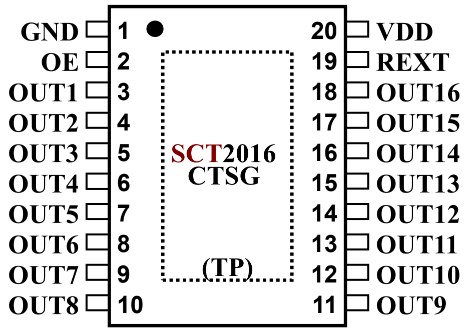
The SCT2016 guarantees to endure maximum DC 24V at each output port. Each output of SCT2016 can sink a constant current up to 80mA. Users can simply shunt the outputs to get higher current driver-ability, especially in the case of high power LED lighting.

The excellent current regulation capability allows SCT2016 easily drive each output current to a constant stable status nearly without affecting by power supply of LED, loading due to variant V_F of LEDs and operating temperature. The SCT2016 is equipped with over temperature protection. The sixteen channels IC stops driving the output while sense its junction temperature exceeds the 160°C high limit and the output will be reactivated while the junction temperature is below the 110°C low limit. In conclusion, the driver system is protected from damage of overheat.

Features

- Sixteen constant-current outputs rate at 24V
- Current regulated output channels, constant current range: 5 – 80mA
- Constant current source invariant to load voltage change
- Fast output current control, the minimum output enable pulse width = 200ns
- ±2%(typ) current matching between outputs
- ±4%(typ) current matching between ICs
- Low dropout output 0.4V@20mA
- All output current are adjusted through one external resistor
- Dimming control available
- Built-in power on reset and thermal protection function
- Supply voltage range: 3.3 - 5V
- Package: TSSOP20
- Application: LED lighting, LED backlight, LED lamp

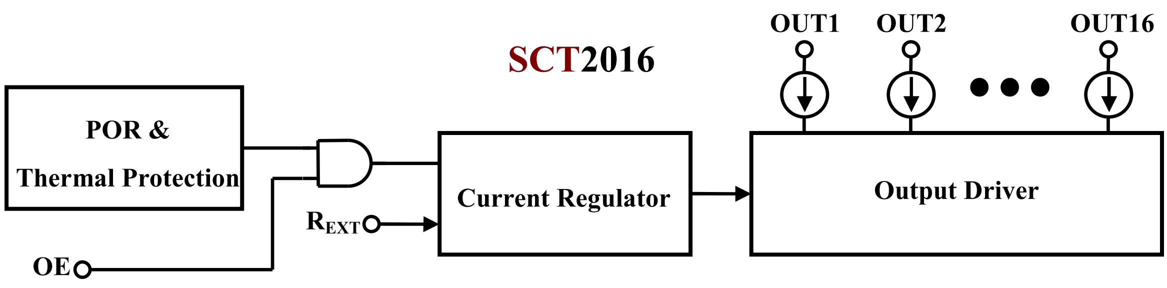
Pin Configuration



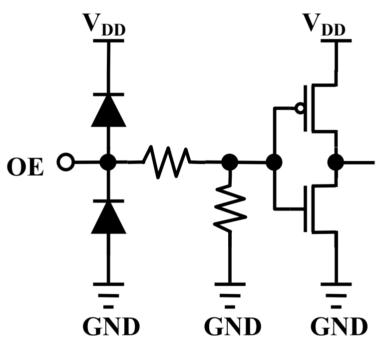
Terminal Description

Pin No.	Pin Name	Function
1	GND	Ground terminal
2	OE	Input terminal of output enable signal. Output is enabled when OE is high.
3~18	OUT1~16	Output terminals with constant current
19	REXT	Input terminal connected to an external resistor for setting up all output current
20	VDD	Supply voltage terminal
-	TP	NC, please connect thermal pad to ground

Block Diagram



Equivalent Circuits of Inputs



Ordering information

Part	Marking	Package	Unit per reel(pcs)
SCT2016CTSG	SCT2016CTSG	Green TSSOP20 with thermal pad	2500

StarChips Technology, Inc.

4F, No.5, Technology Rd., Science-Based Industrial Park, Hsin-Chu, Taiwan, R.O.C.

Tel : +886-3-577-5767 Ext.555

Fax: +886-3-577-6575

E-mail : service@starchips.com.tw

Maximum Ratings (T_A = 25°C)

Characteristic		Symbol	Rating	Unit
Supply voltage		V_{DD}	7	V
Input voltage		V_{IN}	-0.2 ~ V_{DD}+0.2	V
Output current		I_{OUT}	90	mA/Channel
Output voltage		V_{OUT}	24	V
Total GND terminals current		I_{GND}	1200	mA
Power dissipation	TSSOP20TP	P_D	1.39	W
Thermal resistance	TSSOP20TP	$R_{TH(j-a)}$	90	°C /W
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	V_{DD}	-	3	-	5.5	V
Output voltage	V_{OUT}	Output OFF	-	-	24	V
		Output ON	-	1[1]	4[2]	V
Output current	I_{OUT}	DC test circuit	5	-	80	mA
Input voltage	V_{IH}	-	0.7V_{DD}	-	V_{DD}	V
	V_{IL}	-	0	-	0.3V_{DD}	V
OE pulse width	t_w	V_{DD}=3.3-5V	200	-	-	ns

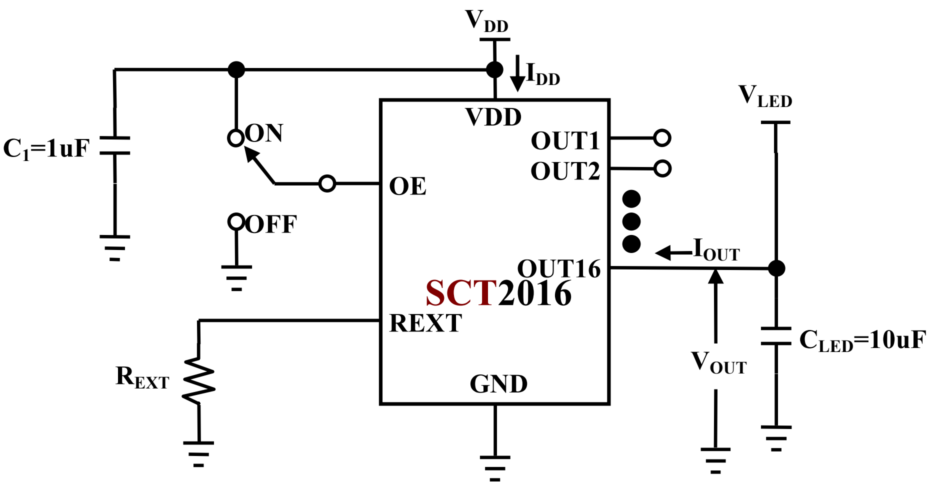
1. The output current keep constant in range of 5-80mA if V_{OUT}=1V.
   However, user can minimize V_{OUT} to reduce power dissipation according to used current, e.g., set V_{OUT} to 0.5V if I_{OUT}=20mA.
2. The maximum Vout is package thermal limited, user should keep Vout under maximum power dissipation.

Electrical Characteristics (V_{DD}=3.3/5V, T_A=25°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} = 24V		-	-	0.5	uA
Output current	I_{OUT}	V_{OUT}=1V	R_{EXT}=900Ω	-	21	-	mA
Current channel skew[1]	dI_{OUT1}	V_{OUT}=1V	R_{EXT}=900Ω	-	±2	±3	%
Current chip skew[2]	dI_{OUT2}	V_{OUT}=1V	R_{EXT}=900Ω	-	±4	±6	%
Line regulation I_{OUT} vs. V_{DD}[3]	$\%/dV_{DD}$	3V < V_{DD} < 5.5V, V_{OUT} > 1V, R_{EXT}=900Ω		-	±0.5	±1	%/V
Load regulation I_{OUT} vs. V_{OUT}[4]	$\%/dV_{OUT}$	1V < V_{OUT} < 4V, I_{OUT}=21mA, R_{EXT}=900Ω		-	±0.1	±0.5	%/V
Temp. regulation[5] I_{OUT} vs. T_A	$\%/dT_A$	-20°C < T_A < 80°C, I_{OUT}=10mA~60mA, V_{DD}=5V		-	±0.01	-	%/°C
Pull-down resistor	R_{DOWN}	OE		-	400	-	KΩ
Supply current OFF	$I_{DD(OFF)1}$	R_{EXT} = Open, OUT_1~OUT_{16}=OFF		-	4	6	mA
Supply current OFF	$I_{DD(OFF)2}$	R_{EXT} = 900Ω, OUT_1~OUT_{16}=OFF		-	7	9	mA
Supply current ON	$I_{DD(ON)}$	R_{EXT} = 900Ω, OUT_1~OUT_{16}=ON		-	9	12	mA

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}=5.5V)-I_{OUT}(V_{DD}=4.5V)] / {[I_{OUT}(V_{DD}=5.5V)+I_{OUT}(V_{DD}=4.5V)]/2} / (5.5V-4.5V)*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)
5. Temperature regulation=[I_{OUT}(T_A=80°C)-I_{OUT}(T_A=-20°C)] / {[I_{OUT}(T_A=80°C)+I_{OUT}(T_A=-20°C)]/2} / (80°C+20°C)*100(%/°C)

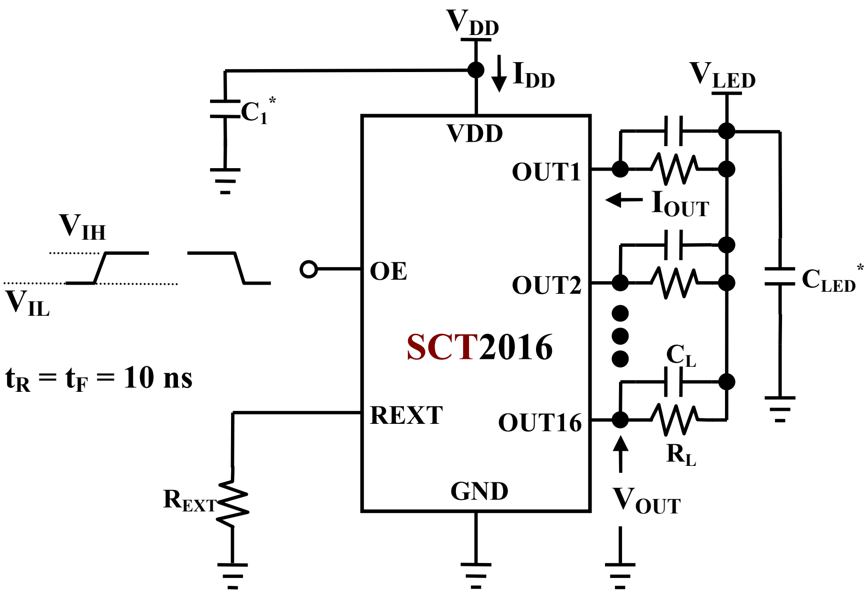
Test Circuit for Electrical Characteristics



Switching Characteristics (V_{DD}=3.3/5V, T_A=25°C unless otherwise noted)

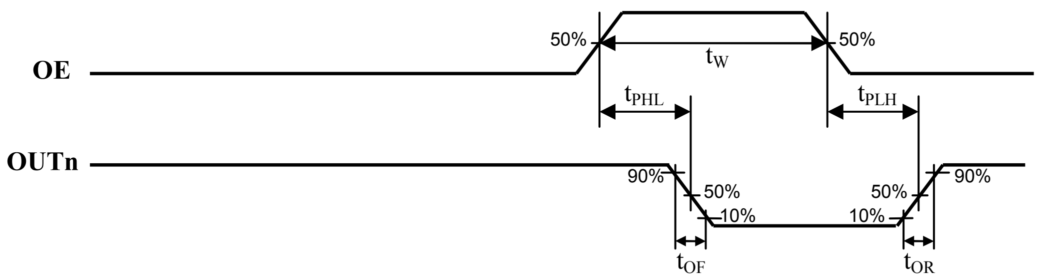
Characteristic		Symbol	Condition	Min.	Typ.	Max.	Unit
Propagation delay time ("L" to "H")	OE - OUTn	t_{PLH}	V_{DD} = 3.3/5 V V_{LED} = 5V V_{IH} = V_{DD} V_{IL}= GND R_{EXT} = 900Ω R_L = 180Ω C_L = 10pF C_1 = 1uF C_{LED} = 10uF	-	60	80	ns
Propagation delay time ("H" to "L")	OE - OUTn	t_{PHL}		-	60	80	ns
Pulse width	OE	t_w		200	-	-	ns
Output rise time of I_{OUT}		t_{OR}		-	60	80	ns
Output fall time of I_{OUT}		t_{OF}		-	60	80	ns

Test Circuit for Switching Characteristics



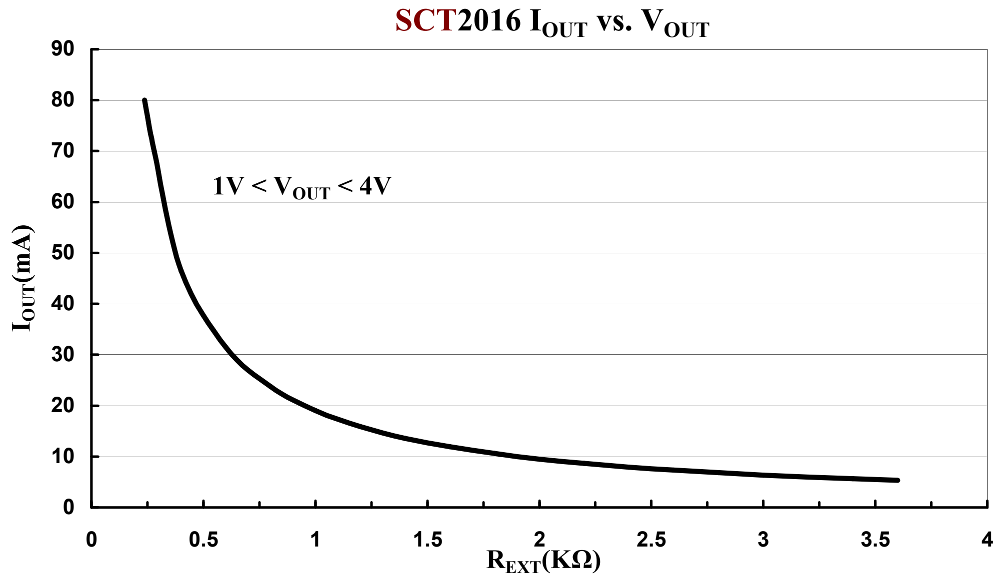
* Place the C_1/C_{LED} more close to IC VDD/OUT pin(not power supply) as possible.

Timing Waveform



Adjusting Output Current

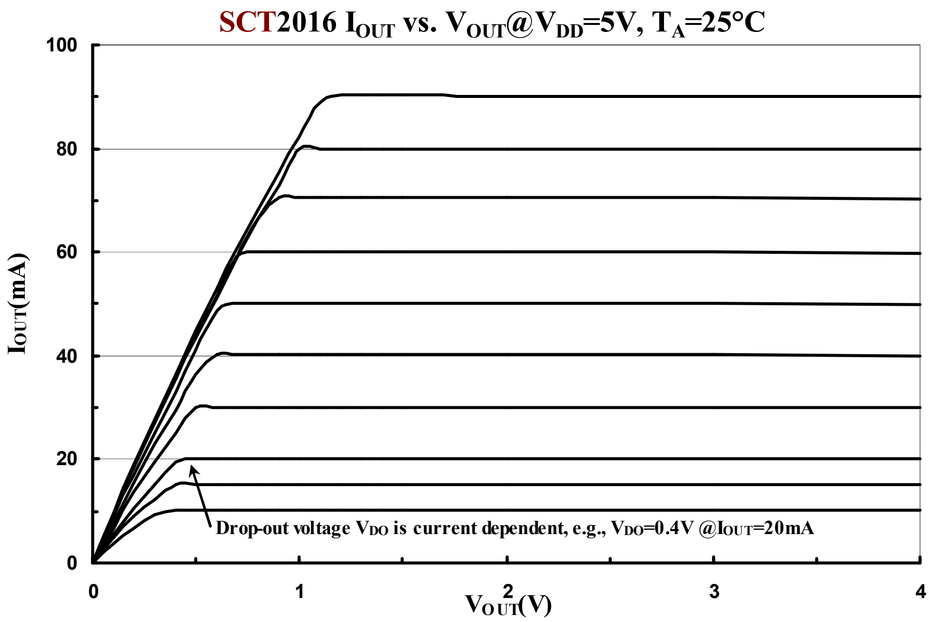
All SCT2016's output current (I_{OUT}) are set by one external resistor at pin REXT. The output current I_{OUT} versus resistance of R_{EXT} is shown as the following figure.



Furthermore, when SCT2016'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 < ±6%). Thus the output current is set to be about 21mA at R_{EXT} = 900Ω.

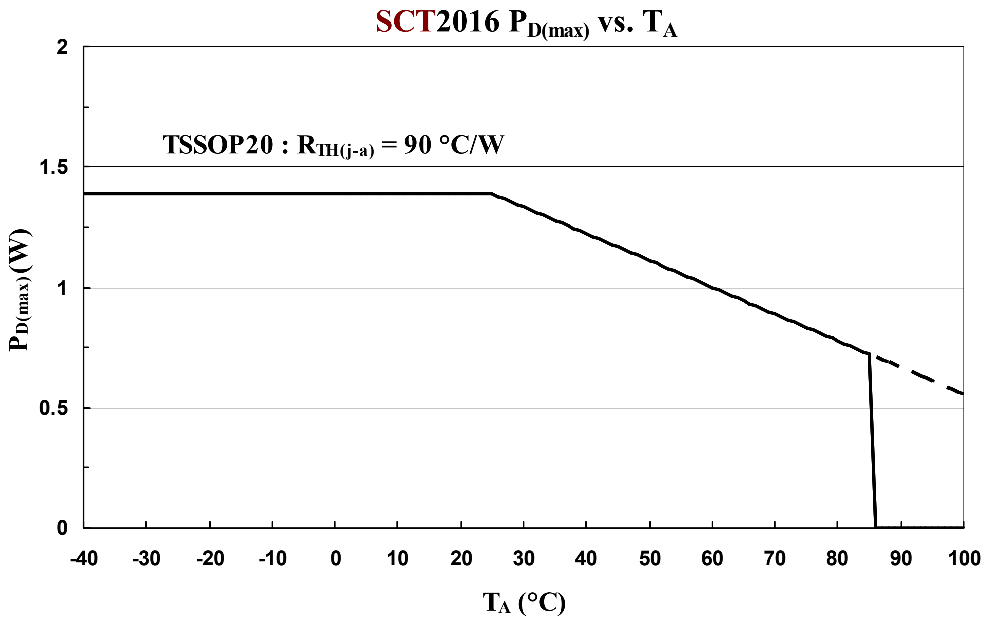
Output Characteristics

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}. The relationship between I_{OUT} and V_{OUT} is shown below. The output voltage should be kept as low as possible to prevent the SCT2016 from being overheated.



Maximum Power Dissipation

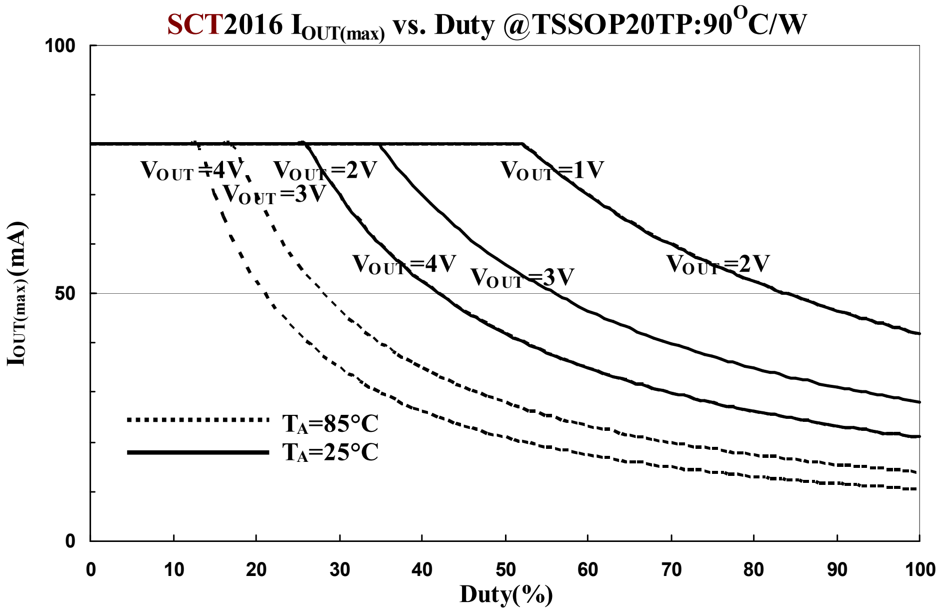
The maximum power dissipation ($P_{D(max)}$) of a semiconductor chip varies with different packages and ambient temperature. It's determined as $P_{D(max)}=(T_{J(max)} - T_A)/R_{TH(j-a)}$ where $T_{J(max)}$: maximum chip junction temperature is usually considered as 150°C, T_A: ambient temperature, $R_{TH(j-a)}$: 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 SCT2016.



Limitation on Maximum Output Current

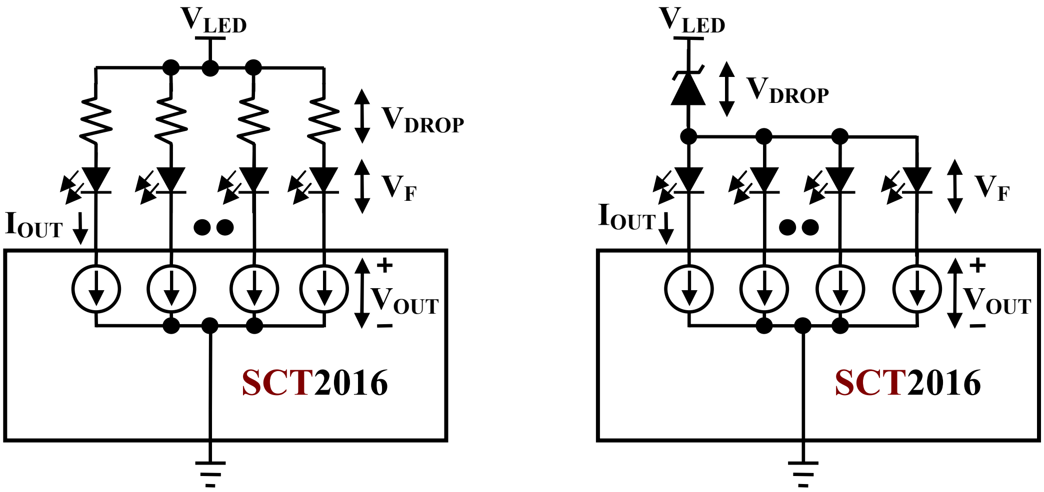
The maximum output current vs. duty cycle is estimated by:

$I_{OUT(max)}=(((T_{J(max)}-T_A)/R_{TH(j-a)})-(V_{DD}*I_{DD}))/V_{OUT}/Duty/N$, where $T_{J(max)}$=150°C, N=16(all ON)



Load Supply Voltage (V_{LED})

The SCT2016 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 SCT2016. Follow the diagram instructions shown below to lower down the output voltage. This can be done by adding additional resistor or zener diode, thus $V_{OUT}=V_{LED}-V_{DROP}-V_F$.

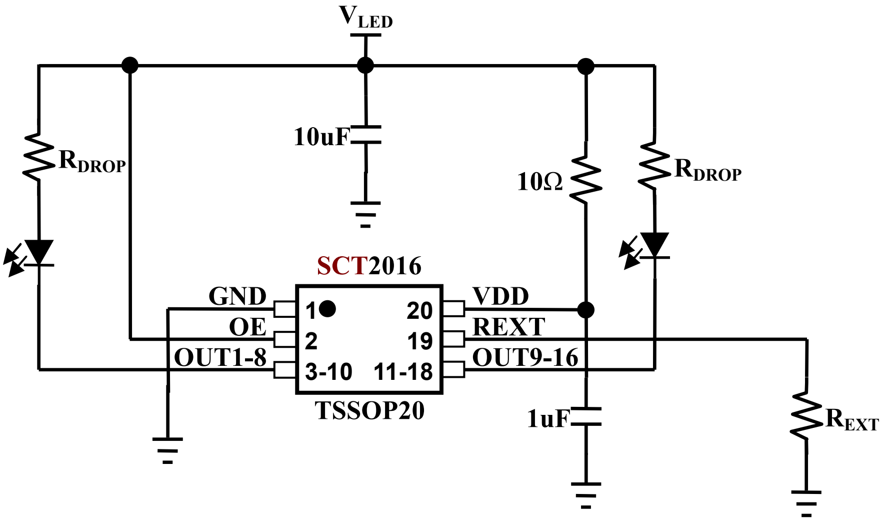


Over Temperature Shutdown

The SCT2016 contains thermal shutdown scheme to prevent damage from over heated. 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.

Typical Application Circuits

(1) Lighting with recommended V_{LED}=3.3/5V



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

Components suggestion:

$R_1=(V_{LED}-V_Z)/(I_{DD}+I_Z)$

If V_{LED}=24V, V_Z=5.1V, I_Z=1mA

R_{EXT}=900Ω, $I_{DD(max)}$=12mA, then

R_1~1.5K is obtained. Beware that:

I_{DD} is R_{EXT} dependent, the higher

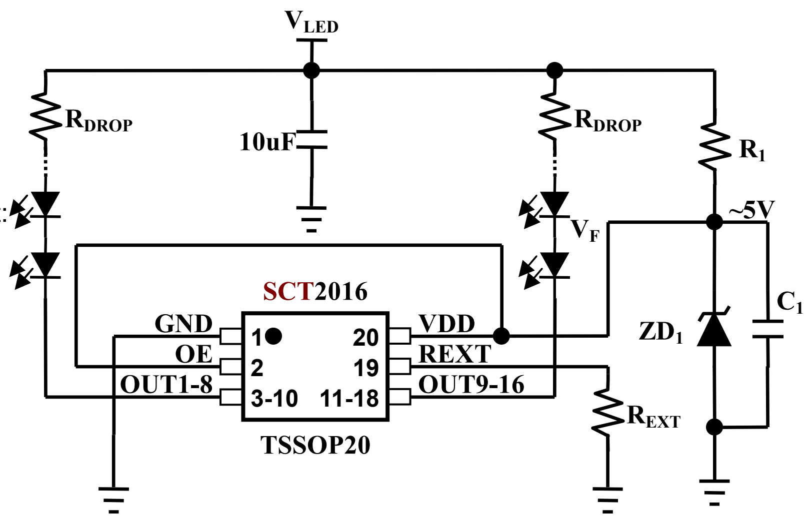
R_{EXT} the lower I_{DD}, vice versa.

$R_{DROP}=(V_{LED}-n*V_F-V_{DO})/I_{OUT}$

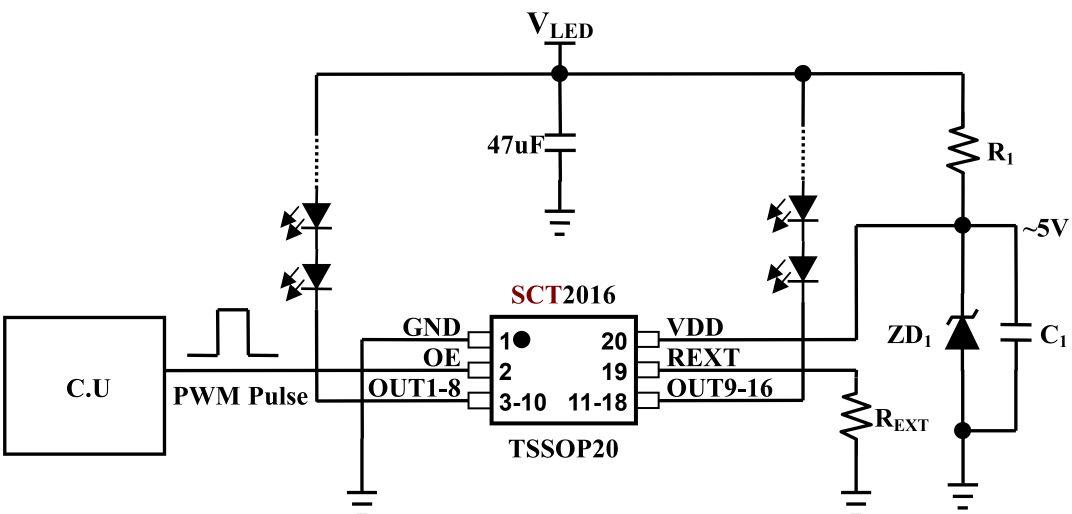
V_{DO} is the drop-out voltage of

intended output current.

C_1=1uF



(3) Lighting with dimming control

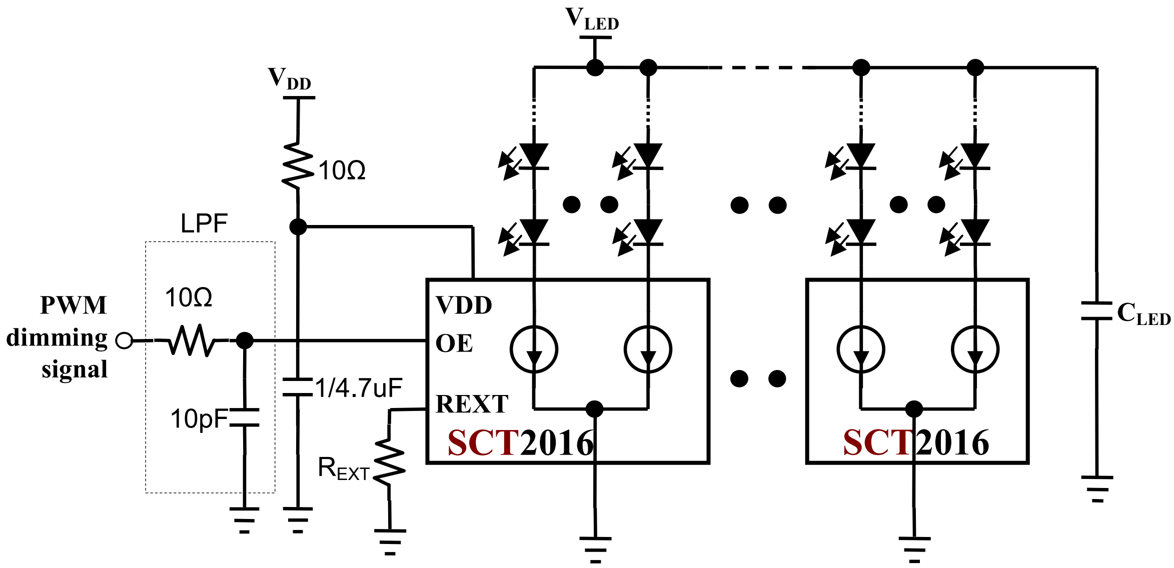


PCB Design Considerations

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

Decoupling Capacitor

Place a decoupling capacitor e.g. 1/4.7uF between VDD and GND pins of the SCT2016. Locate the capacitor as close to the SCT2016 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.



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 VDD and GND trace improves efficiency and ground bouncing by effect of reducing both power and ground parasitic resistance and inductance. A small value of resistor, e.g., 10Ω (higher if I_{OUT} is larger) series in power input of the SCT2016 in conjunction with decoupling capacitor shunting the IC is recommended. 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.

EMI Reduction

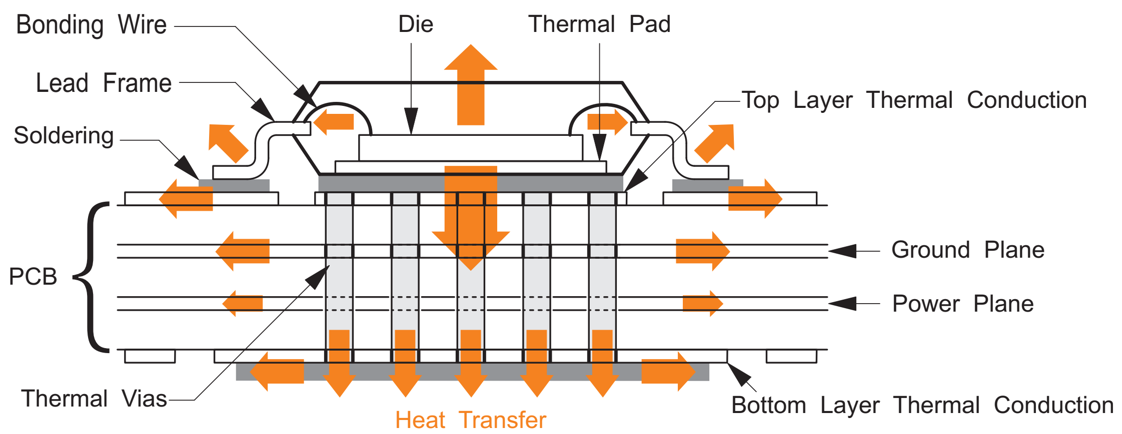
To reduce the EMI radiation from system, an economical solution of RC low pass filter (LPF) is suggested to be used to lower the transient edge of PWM dimming signal OE, as shown in the figure above. Using at least four layers PCB board with two interior power and ground planes is a good scheme to decrease the signal current path which is the source of radiation emission. As a result, EMI radiation can be decreased.

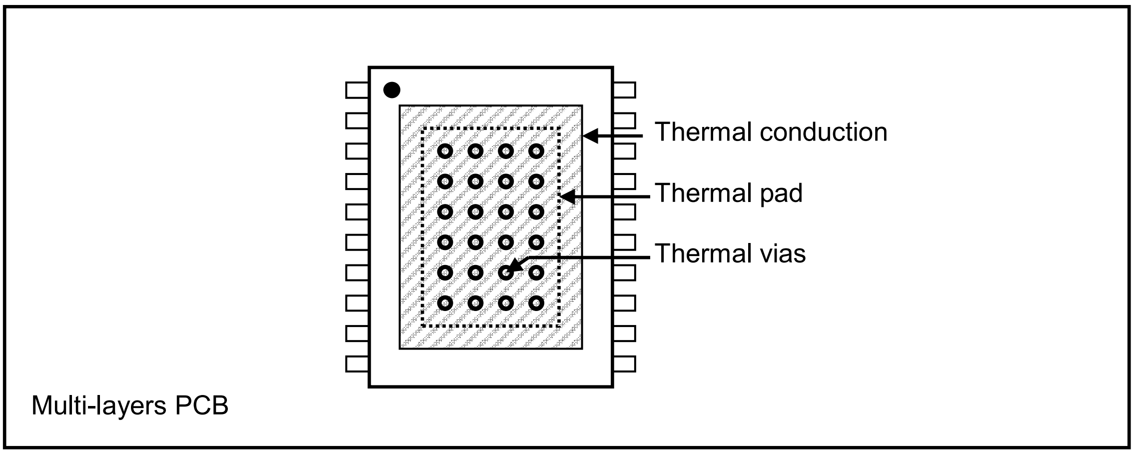
Thermal Pad Consideration

The "thermal pad" (also named as "exposed pad") TSSOP20 package beneath is NOT directly wired to ground terminal (pin1) internally. User should be aware of this electrical connection when designing the PCB board. In most application, connecting the thermal pad to system ground is strongly suggested.

In general, the heat generated from an IC is conducted to the PCB then radiates to the ambient. Thermal pad specifically increases the maximum power dissipation capability of the IC packages. To provide lower thermal resistance from the IC to the ambient air, PCB designers should layout larger thermal conduction areas on top layer (component side) and bottom layer as well as thermal vias, the more the better. In addition, connecting thermal via to the ground plane also increases thermal conduction areas, this improves the heat transfer efficiency at the same time greatly dissipates heat generated from the package. Furthermore, coating solder on bottom layer and selecting e.g. 2 oz. copper which will increase the total thickness of thermal conduction is an alternative.

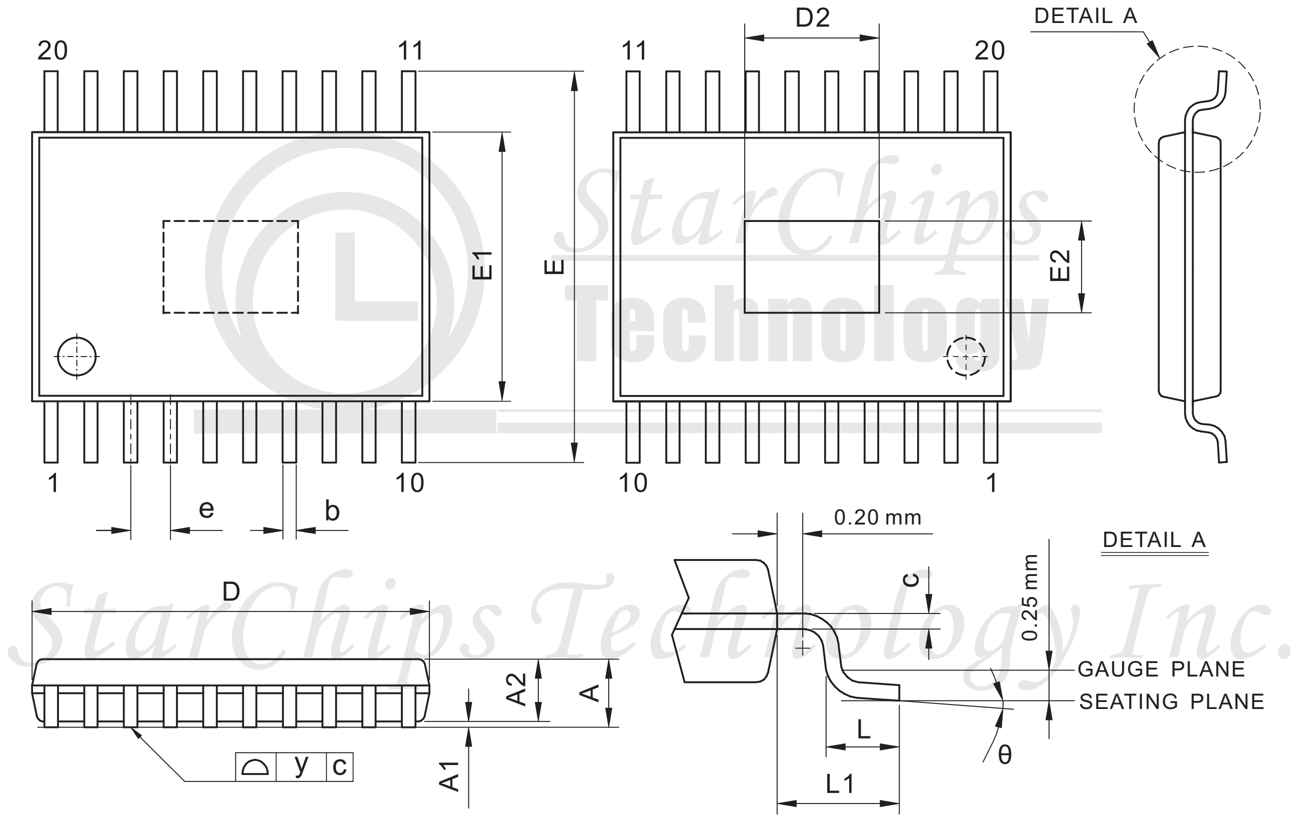
When making the solder paste screen, an opening should be created for the thermal pad. This way the thermal pad can be electrically and thermally connected to the PCB. As the thermal pad is soldered on copper polygon, the chance of inadvertently shorting the thermal pad to traces routed underneath it could be eliminated.





Package Dimension

TSSOP20TP(check up-to-date version)



Symbol	Dimension (mm)			Dimension (mil)		
	Min.	Nom.	Max.	Min.	Nom.	Max.
A	-	-	1.20	-	-	47.2
A1	0.05	-	0.15	2.0	-	6.0
A2	0.80	0.90	1.05	31.0	35.0	41.0
b	0.19	-	0.30	7.0	-	12.0
c	0.09	-	0.20	4.0	-	8.0
D	6.40	6.50	6.60	252.0	255.9	259.8
E1	4.30	4.40	4.50	169.0	173.0	177.0
E	6.40 BSC			252.0 BSC		
e	0.65 BSC			26.0 BSC		
L1	1.00 REF			39.0 REF		
L	0.45	0.60	0.75	18.0	24.0	30.0
y	-	-	0.10	-	-	4.0
θ	0°	-	8°	0°	-	8°
D2	-	3.81	-	-	150.0	-
E2	-	3.00	-	-	118.1	-

Revision History(check up-to-date version)

Data Sheet Version	Remark
V03_01	Updated supply & PWM characteristics

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