

## Linear Constant Current Regulated LED Driver

### DESCRIPTION

The TSCR400 & TSCR402 are High-Side Constant Current Regulator (CCR) for linear LED driving. The device regulates with a preset TSCR400 0.1mA and TSCR402 20mA nominal that can be adjusted with an external resistor up to 65mA. It is designed for driving LEDs in strings and will reduce current at increasing temperatures to self-protect. Operating as a series linear CCR for LED string current control, it can be used in multiple applications, as long as the maximum supply voltage to the device is <40V.

The output current at higher temperatures is the result of the negative temperature coefficient of - 0.07%/°C of the LED driver.

### FEATURES

- LED drive current preset:
  - TSCR400CX6: 0.1mA
  - TSCR402CX6: 20mA
- Continuous output current up to 65mA with an external resistor
- Easy paralleling of drivers to increase current
- Supply voltage up to 40V
- Good temperature coefficient vs. output current
- Compliant to RoHS Directive 2011/65/EU and in accordance to WEEE 2002/96/EC.
- Halogen-Free according to IEC 61249-2-21

### APPLICATION

- Automotive Interior Lighting
- Architectural LED lighting
- Signage, Advertising, Decorative Lighting
- Retail Lighting in Fridges, Freezer Cases and Vending Machines
- Emergency lighting (e.g. steps lighting, exit way signs etc.)



**SOT-26**

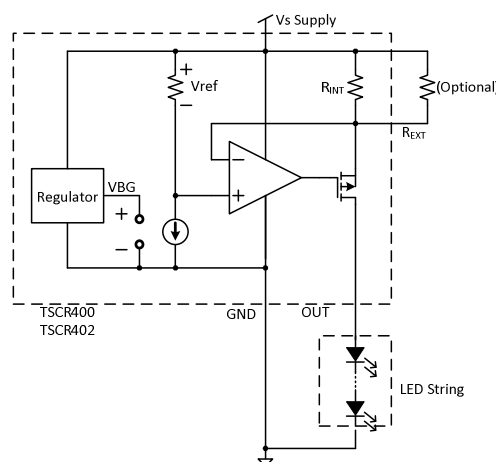


**Pin Definition:**

- |        |                     |
|--------|---------------------|
| 1. GND | 6. R <sub>EXT</sub> |
| 2. OUT | 5. OUT              |
| 3. OUT | 4. V <sub>S</sub>   |

**Notes:** MSL 3 (Moisture Sensitivity Level) per J-STD-020

### TYPICAL APPLICATION CIRCUIT



<b>ABSOLUTE MAXIMUM RATINGS</b> ( $T_A = 25^\circ\text{C}$ unless otherwise specified) <sup>(Note 1)</sup>			
<b>PARAMETER</b>	<b>SYMBOL</b>	<b>LIMIT</b>	<b>UNIT</b>
Supply Voltage	$V_S$	40	V
Output Current	$I_{OUT}$	65	mA
Output Voltage	$V_{OUT}$	38	V
Reverse voltage between all terminals	$V_R$	0.5	V
Total power dissipation @ $T_A=25^\circ\text{C}$ <sup>(Note)</sup>	$P_{TOT}$	1	W
Junction Temperature Range	$T_J$	-55 to +150	$^\circ\text{C}$
Storage Temperature Range	$T_{STG}$	-65 to +150	$^\circ\text{C}$
ESD Rating (Human Body Mode)	HBM	2	kV
ESD Rating (Machine Mode)	MM	200	V

**Note:**

Stresses above the max. values listed here may cause permanent damage to the device. Exposure to absolute maximum rating conditions for extended periods may affect device reliability. Maximum ratings are absolute ratings; exceeding only one of these values may cause irreversible damage to the integrated circuit.

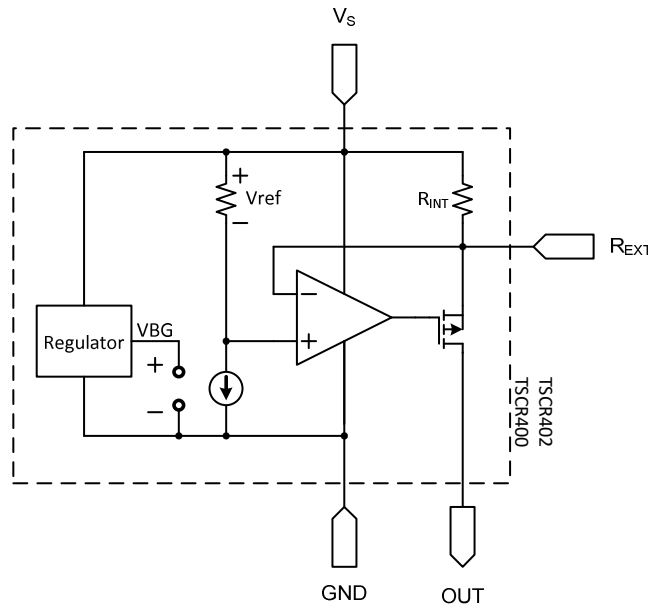
<b>THERMAL PERFORMANCE</b>			
<b>PARAMETER</b>	<b>SYMBOL</b>	<b>LIMIT</b>	<b>UNIT</b>
Thermal Resistance - Junction to Lead	$R_{\theta JL}$	50	$^\circ\text{C/W}$

<b>ELECTRICAL SPECIFICATIONS</b> ( $T_A = 25^\circ\text{C}$ unless otherwise noted)							
<b>PARAMETER</b>	<b>CONDITIONS</b>		<b>SYMBOL</b>	<b>MIN</b>	<b>TYP</b>	<b>MAX</b>	<b>UNIT</b>
Break Down Voltage			$V_{BR}$	40	--	--	V
Supply Current	TSCR400	$V_S=3\text{V}$	$I_S$	--	60	--	$\mu\text{A}$
	TSCR402	$V_S=10\text{V}$		--	150	--	$\mu\text{A}$
Internal Resistor	TSCR400	$I_{RINT}=0.1\text{mA}$	$R_{INT}$	5.85	6.5	7.15	K $\Omega$
	TSCR402	$I_{RINT}=20\text{mA}$		38	44	52	$\Omega$
Output Current	TSCR400	$V_S=3\text{V}$	$I_{OUT}$	0.085	0.1	0.115	mA
	TSCR402	$V_S=10\text{V}, V_{OUT}=8.6\text{V}$		18	20	22	
Voltage Drop ( $V_S - V_{REXT}$ )	TSCR400	$I_{OUT}=1\text{mA}$	$V_{DROP}$	--	0.65	--	V
	TSCR402	$I_{OUT}=20\text{mA}$		--	0.85	--	
Lowest Sufficient Battery Voltage	TSCR400	$I_{OUT}>85\mu\text{A}$	$V_{Smin}$	--	1.6	--	V
	TSCR402	$I_{OUT}>18\text{mA}$		--	1.4	--	
Output Current vs. Temperature	TSCR400	$V_S=3\text{V}$	$\Delta I_{OUT}/I_{OUT}$	--	-0.07	--	%/ $^\circ\text{C}$
	TSCR402	$V_S=10\text{V}$		--	-0.07	--	
Output Current vs. Supply Voltage	TSCR400	$V_S=3\text{V}$	$\Delta I_{OUT}/I_{OUT}$	--	0.33	--	%/ $\text{V}$
	TSCR402	$V_S=10\text{V}$		--	0.33	--	

**ORDERING INFORMATION**

PART NO.	PACKAGE	PACKING
TSCR400CX6 RFG	SOT-26	3,000pcs / 7"Reel
TSCR402CX6 RFG	SOT-26	3,000pcs / 7"Reel

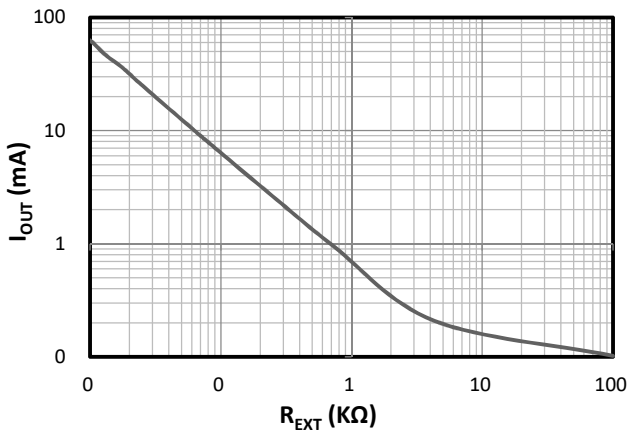
**FUNCTION BLOCK**



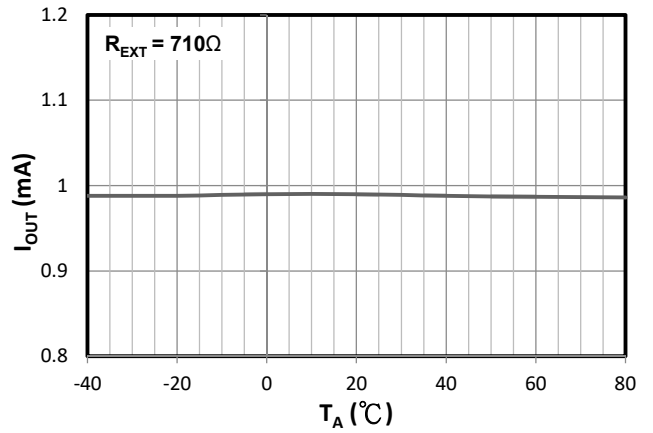
**PIN DESCRIPTION**

PIN NO.	NAME	FUNCTION
1	GND	Power ground
2	OUT	Regulated output current
3	OUT	Regulated output current
4	$V_s$	Supply voltage
5	OUT	Regulated output current
6	$R_{EXT}$	External resistor for adjusting output current

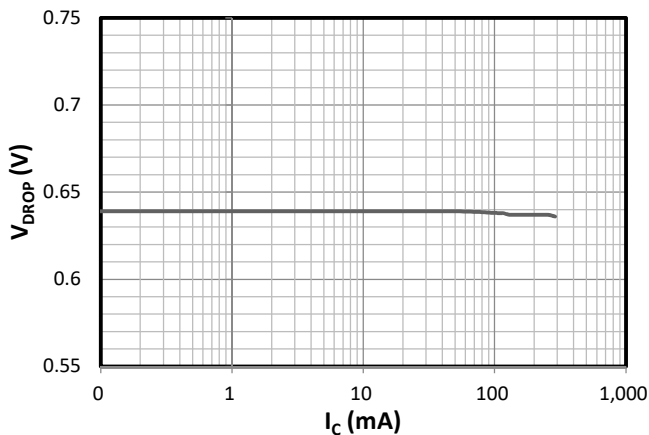
**TSCR400CX6 CHARACTERISTICS CURVES**



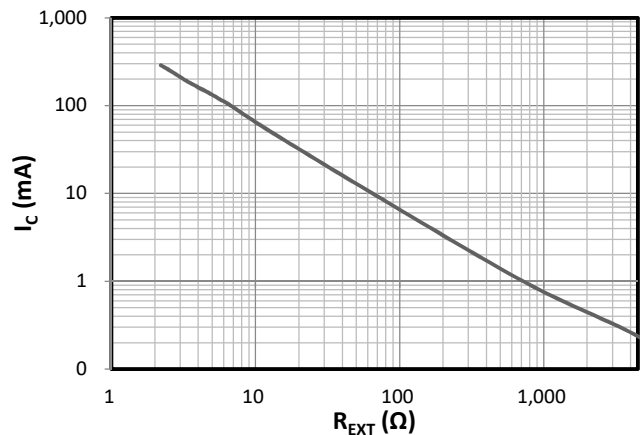
**Figure 1.  $I_{OUT}$  vs.  $R_{EXT}$**



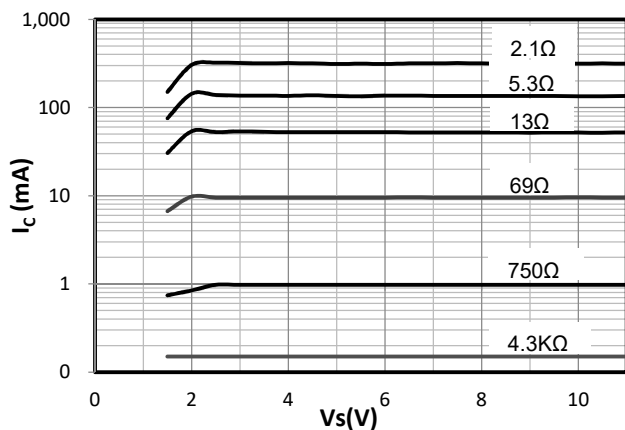
**Figure 2.  $I_{OUT}$  vs.  $T_A$  ( $R_{EXT}=710\Omega$ )**



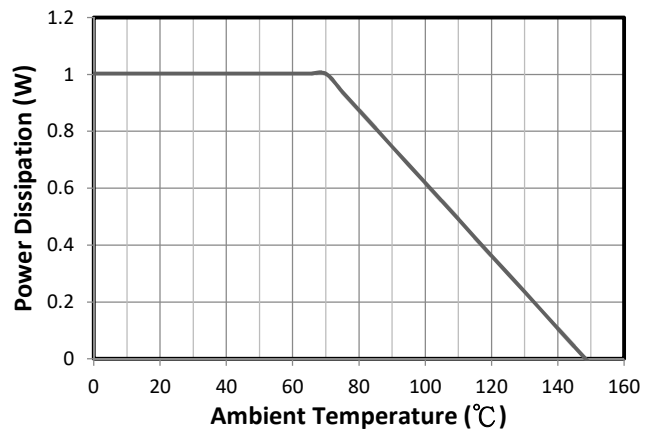
**Figure 3.  $V_{DROP}$  vs  $I_C$   
 $V_{DROP} = f(I_C)$  refer to stabilized NPN Transistor**



**Figure 4.  $V_{EN}$  vs  $I_{OUT}$  ( $R_{EXT}=\text{open}$ )  
Collector Current  $I_C = f(R_{EXT})$  refer to stabilized NPN Transistor**

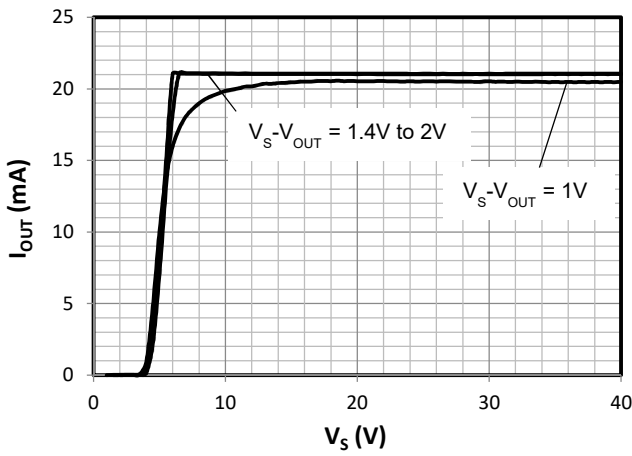


**Figure 5.  $I_C$  vs.  $V_S$  (Parameter  $R_{EXT}=(\Omega)$ )  
Collector Current  $I_C = f(V_S)$  refer to stabilized NPN Transistor**

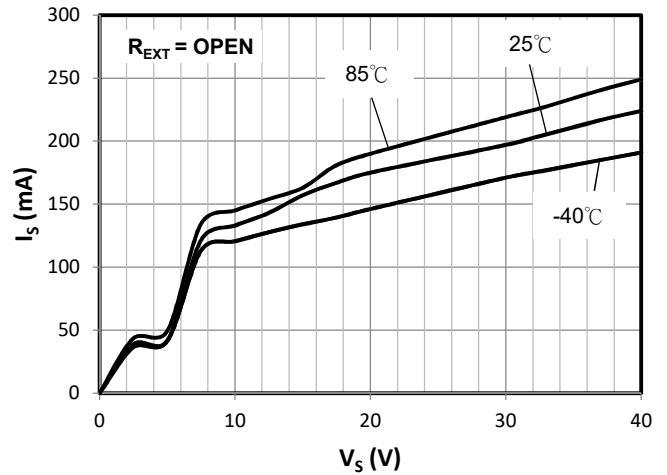


**Figure 6.  $P_D$  vs. Ambient Temperature**

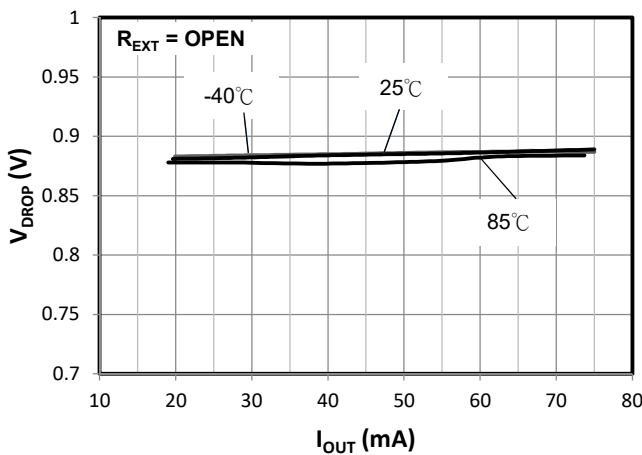
**TSCR402CX6 CHARACTERISTICS CURVES**



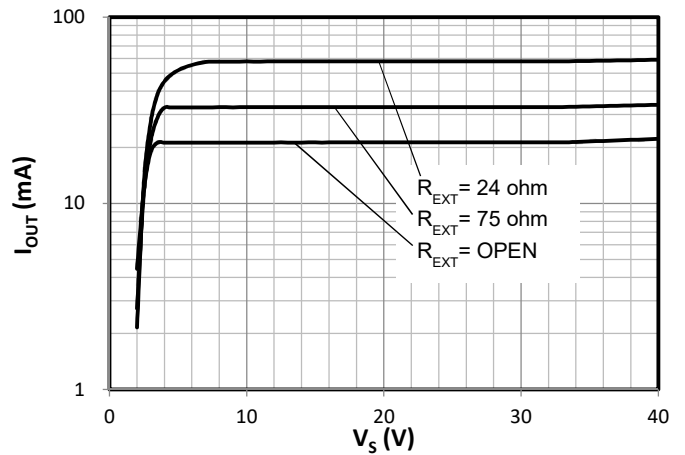
**Figure 7.  $V_S$  vs.  $I_{OUT}$**



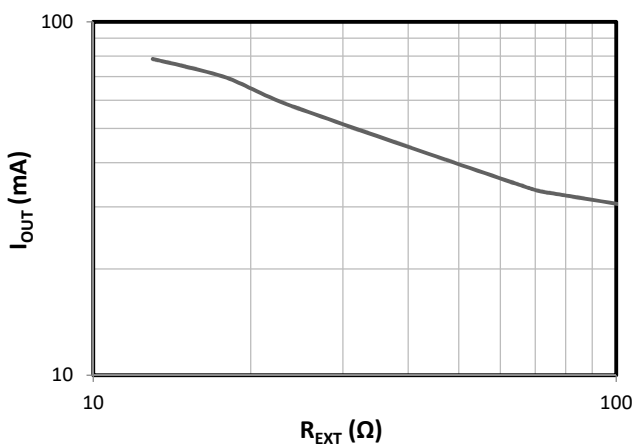
**Figure 8.  $V_S$  vs.  $I_S$  ( $R_{EXT}=OPEN$ )**



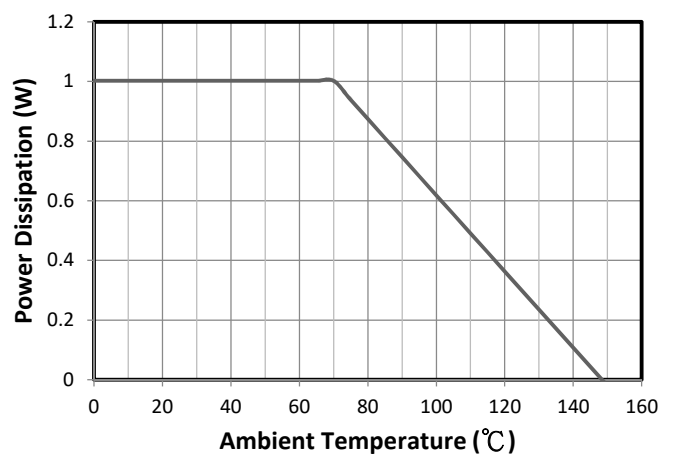
**Figure 9.  $I_{OUT}$  vs.  $V_{DROP}$  ( $R_{EXT}=OPEN$ )**



**Figure 10.  $V_S$  vs.  $I_{OUT}$**



**Figure 11.  $R_{EXT}$  vs.  $I_{OUT}$**



**Figure 12.  $P_D$  vs. Ambient Temperature**

**APPLICATION INFORMATION**

The TSCR400 & TSCR402 are designed for driving low current LEDs with typical LED currents of 0.1mA to 65mA. They provide a cost-effective way for driving low current LEDs compared with more complex switching regulator solutions. Furthermore, they reduce the PCB board area of the solution as there is no need for external components like inductors, capacitors and switching diodes

Figure 13 shows circuit diagram for stand along application an external resistor  $R_{EXT}$  can be connected to adjust the current. The device comes with an internal resistor ( $R_{INT}$ ) of typically 6.5K $\Omega$  and 44 $\Omega$  which in the absence of an external resistor, sets an LED current of 0.1mA (typical) for TSCR400 and 20mA (typical) for TSCR402. LED current can be increased to a desired value by choosing an appropriate external resistor,  $R_{EXT}$ .

$$R_{EXT} = V_{DROP} / (I_{OUT} - (V_{DROP}/R_{INT}))$$

Figure 14 shows boost mode configuration of LED current can be extended to drive high power LEDs

The  $R_{EXT}$  vs  $I_{LED}$  graphs should be used to select the appropriate resistor. Choosing a low tolerance  $R_{EXT}$  will improve the overall accuracy of the current sense formed by the parallel connection of  $R_{INT}$  and  $R_{EXT}$ .

$$R_{EXT} = V_{DROP} / (I_{LED} - (V_{DROP}/R_{INT}))$$

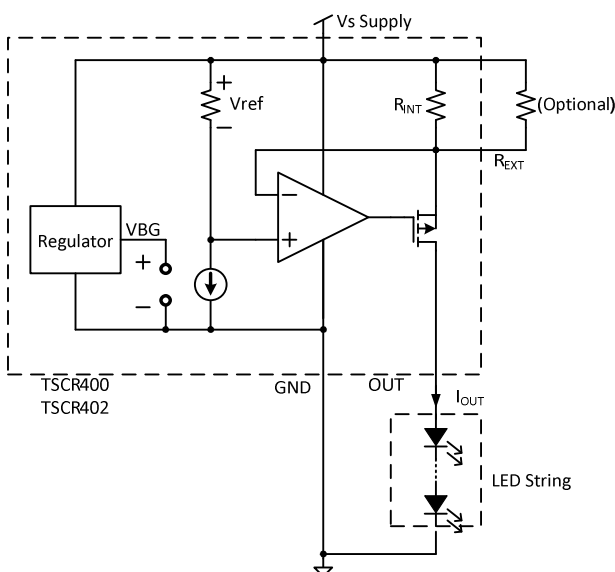
Consideration of the expected linear mode power dissipation must be factored into the design, with respect to the TSCR400 & TSCR402's thermal resistance. The maximum voltage across the device can be calculated by taking the maximum supply voltage and subtracting the voltage across the LED string.

$$V_{DEVICE} = V_S - V_{LED}$$

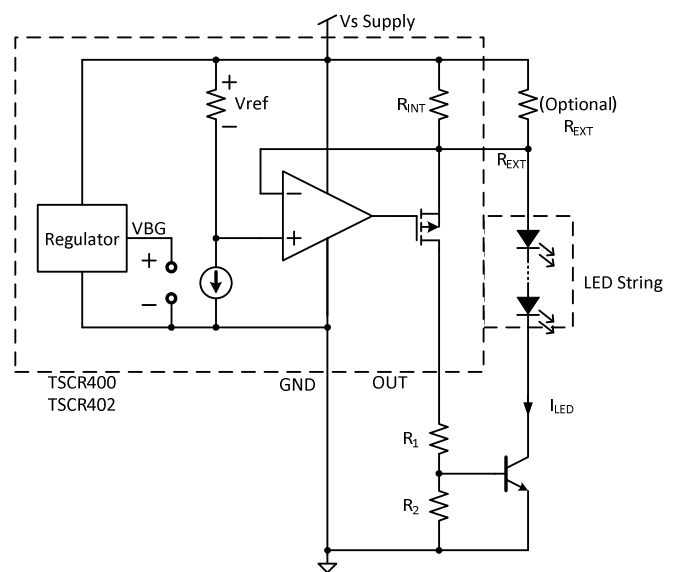
$$P_D = (V_{DEVICE} \times I_{LED}) + (V_S \times I_{GND})$$

As the output current of TSCR400 & TSCR402 increases, it is necessary to provide appropriate thermal relief to the device. The power dissipation supported by the device is dependent upon the PCB board material, the copper area and the ambient temperature. The maximum dissipation the device can handle is given by:

$$P_D = (T_{J(MAX)} - T_A) / R_{\theta JA}$$



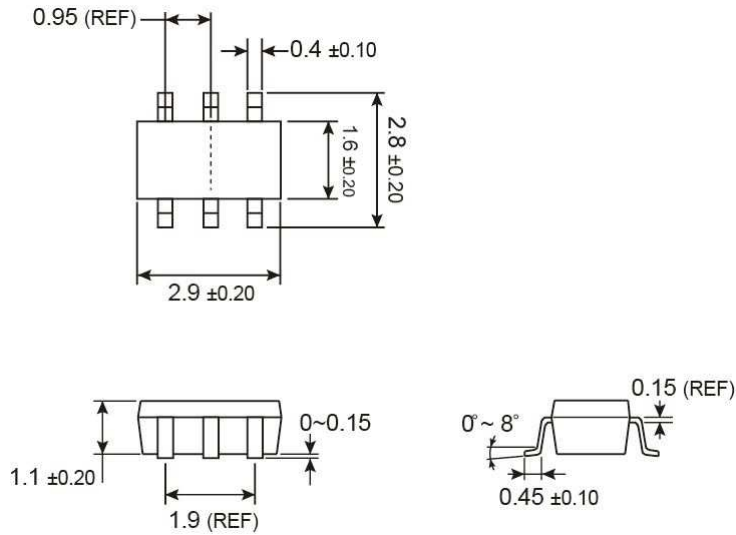
**Figure 13: Application circuit for Stand along current source**



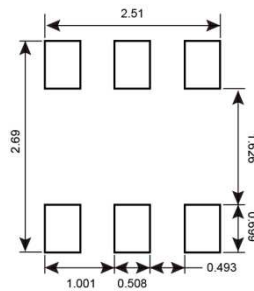
**Figure 14: Application Circuit for Boost mode current source with external power transistor**

**PACKAGE OUTLINE DIMENSIONS** (Unit: Millimeters)

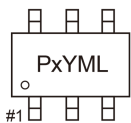
**SOT-26**



**SUGGESTED PAD LAYOUT** (Unit: Millimeters)



**MARKING DIAGRAM**



- Px** = Device Code  
P1 =TSCR400CX6  
P2 =TSCR402CX6
- Y** = Year Code
- M** = Month Code for Halogen Free Product  
**O** =Jan    **P** =Feb    **Q** =Mar    **R** =Apr  
**S** =May    **T** =Jun    **U** =Jul    **V** =Aug  
**W** =Sep    **X** =Oct    **Y** =Nov    **Z** =Dec
- L** = Lot Code (1~9, A~Z)

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