IS31LT3170/71

10-TO-150MA CONSTANT-CURRENT LED DRIVER

Advanced Information
July 2014

GENERAL DESCRIPTION

The IS31LT3170 and IS31LT3171 are adjustable linear current devices with excellent temperature stability. A single resistor is all that is required to set the operating current from 10mA to 150mA. The devices can operate from an input voltage from 2.8V to 42V with a minimal voltage headroom of 0.264V. Designed with a low dropout voltage; the device can drive LED strings close to the supply voltage without switch capacitors or inductors.

The IS31LT3170/71 simplifies designs by providing a stable current without the additional requirement of input or output capacitors, inductors, FETs or diodes. The complete constant current driver requires only a current set resistor and a small PCB area making designs both efficient and cost effective.

The EN Pin (1) of the IS31LT3171 can function as the PWM signal input used for LED dimming purposes.

As a current sink it is ideal for LED lighting applications or current limiter for power supplies.

The device is provided in a lead (Pb) free, SOT23-6 package.

FEATURES

- Low-side current sink
  - Current preset to 10mA
  - Adjustable from 10mA to 150mA with external resistor selection
- Wide input voltage range from
  - 2.8V to 42V (IS31LT3171)
  - 5V to 42V (IS31LT3170)

  with a low dropout of 0.5V
- Up to 10kHz PWM input (IS31LT3171 only)
- Protection features:
  - 0.2%/K negative temperature coefficient for-thermal protection
  - Open circuit and over voltage protection
- Up to 1W power dissipation in a small SOT23-6 package
- RoHS compliant (Pb-free) package

APPLICATIONS

- Linear current sink
- Current limiter for power supplies
- LED signage
- Retail lighting in refrigerator, freezer case and vending machines
- Instrumentation LED lighting

TYPICAL APPLICATION CIRCUIT

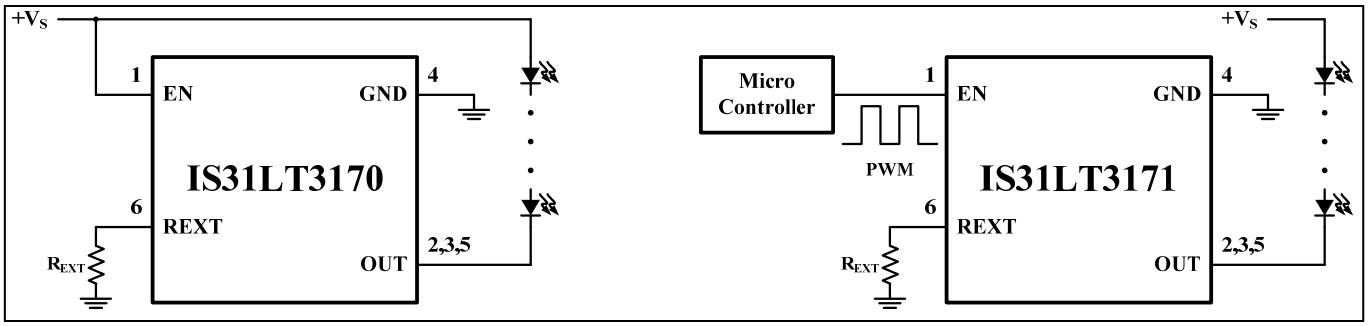
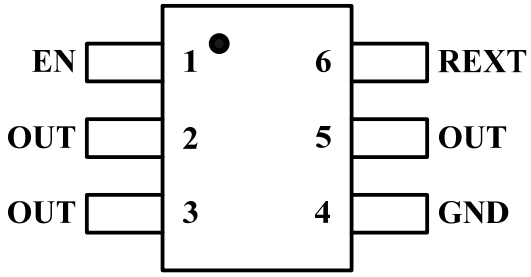


Figure 1 Typical Application Circuit

PIN CONFIGURATION

Package	Pin Configuration (Top View)
SOT23-6	

PIN DESCRIPTION

No.	Pin	Description
1	EN	Enable pin (PWM input IS31LT3171 only).
2,3,5	OUT	Current sink.
4	GND	Ground.
6	REXT	Optional current adjust.

ORDERING INFORMATION

Industrial Range: -40°C to +125°C

Order Part No.	Package	QTY/Reel
IS31LT3170-STLS4-TR IS31LT3171-STLS4-TR	SOT-23-6, Lead-free	3000

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a.) the risk of injury or damage has been minimized;
b.) the user assume all such risks; and
c.) potential liability of Integrated Silicon Solution, Inc is adequately protected under the circumstances

ABSOLUTE MAXIMUM RATINGS (Note 1)

Maximum enable voltage, $V_{EN(MAX)}$ only for IS31LT3170-STLS4-TR $V_{EN(MAX)}$ only for IS31LT3171-STLS4-TR	48V 4.5V
Maximum output current, $I_{OUT(MAX)}$	200mA
Maximum output voltage, $V_{OUT(MAX)}$	48V
Reverse voltage between all terminals, V_R	0.5V
Junction to ambient, θ_{JA}	191°C/W
Power dissipation, $P_{D(MAX)}$ (Note 2)	0.65W
Maximum junction temperature, T_{JMAX}	150°C
Storage temperature range, T_{STG}	−65°C ~ +150°C
Operating temperature range, T_A	−40°C ~ +125°C
ESD (HBM) ESD (CDM)	TBD

Note 1:
Stresses beyond those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress ratings only and functional operation of the device at these or any other condition beyond those indicated in the operational sections of the specifications is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

Note 2:
Detail information please refer to package thermal de-rating curve on Page 7.

ELECTRICAL CHARACTERISTICS (TBD)

Test condition is T_A = 25°C, unless otherwise specified.

- ● The symbol in the table means these parameters are only available for IS31LT3170-STLS4-TR.
- ○ The symbol in the table means these parameters are only available for IS31LT3171-STLS4-TR.

Symbol	Parameter	Condition		Min.	Typ.	Max.	Unit
V_{BD_OUT}	OUT pin breakdown voltage	V_{EN}= 0V		40			V
I_{EN}	Enable current	V_{EN}= 24V	●		1.2		mA
		V_{EN}= 3.3V	○		1.2		
R_{INT}	Internal resistor	I_{RINT} = 10mA		83.5	95	106.5	Ω
I_{OUT}	Output current	V_{OUT} = 1.4V, V_{EN} = 24V	●	9	10	11	mA
		V_{OUT} = 1.4V, V_{EN} = 3.3V	○	9	10	11	
	Output current at R_{EXT} = 5.1Ω	V_{OUT} > 2.0V, V_{EN} = 24V	●		150		mA
		V_{OUT} > 2.0V, V_{EN} = 3.3V	○		150		
V_{DROP}	Voltage drop (V_{REXT})	I_{OUT} = 10mA			0.08		V

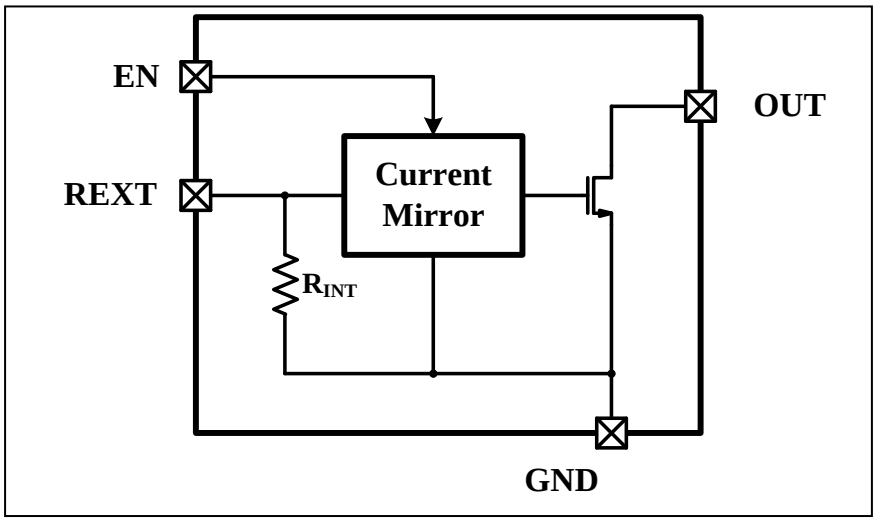
DC CHARACTERISTICS WITH STABILIZED LED LOAD (TBD)

Test condition is T_A = 25°C, unless otherwise specified.

- ● The symbol in the table means these parameters are only available for IS31LT3170-STLS4-TR.
- ○ The symbol in the table means these parameters are only available for IS31LT3171-STLS4-TR.

Symbol	Parameter	Condition		Min.	Typ.	Max.	Unit
V_{SMIN}	Lowest sufficient supply voltage overhead	I_{OUT} > 18mA			1		V
$\Delta I_{OUT}/I_{OUT}$	Output current change versus T_A	V_{OUT} > 2.0V, V_{EN} = 24V	●		-0.2		%/K
		V_{OUT} > 2.0V, V_{EN} = 3.3V	○		-0.2		
	Output current change versus V_S	V_{OUT} > 2.0V, V_{EN} = 24V	●		1		%/V
		V_{OUT} > 2.0V, V_{EN} = 3.3V	○		1		

FUNCTIONAL BLOCK DIAGRAM



TYPICAL PERFORMANCE CHARACTERISTICS (TBD)

APPLICATIONS INFORMATION

IS31LT3170/71 provides an easy constant current source solution for LED lighting applications. It uses an external resistor to adjust the LED current from 10mA to 150mA. The LED current can be determined by the Equation (1):

$$I_{SET} = 15 \times \frac{0.065 \times (R_{INT} + R_{EXT})}{R_{INT} \cdot R_{EXT}} \qquad (1)$$

Where R_{INT} (96.7Ω typ) is an internal resistor and R_{EXT} is the external resistor.

Paralleling a low tolerance resistor R_{EXT} with the internal resistor R_{INT} will improve the overall accuracy of the current sense resistance. The resulting output current will vary slightly lower due to the negative temperature coefficient (NTC) resulting from the self heating of the IS31LT3170/71.

HIGH INPUT VOLTAGE APPLICATION

When driving a long string of LEDs whose total forward voltage drop exceeds the IS31LT3170 V_{BD_OUT} limit of 42V, it is possible to stack several LEDs(such as 2 LEDs) between the EN pin and the OUT pins 2,3, and 5 so the voltage on the EN pin is higher than 5V. The remaining string of LEDs can then be placed between power supply $+V_S$ and EN pin, (Figure 3). The number of LEDs required to stack at EN pin will depend on the LED's forward voltage drop (VF) and the $+V_S$ value.

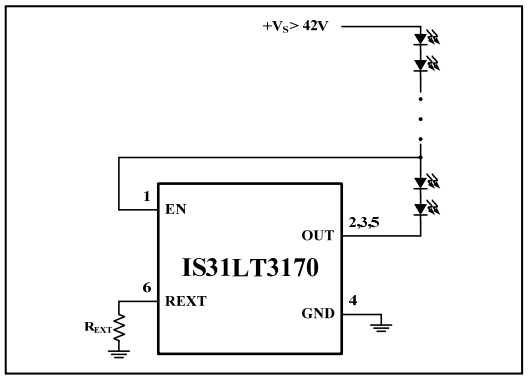


Figure 3 High Input Voltage Application Circuit

Note: when operating the IS31LT3170 at voltages exceeding the device operating limits, care needs to be taken to keep the EN pin and OUT pin voltage below 42V.

THERMAL PROTECTION AND DISSIPATION

The IS31LT3170/71 implements thermal foldback protection to reduce the LED current when the package's thermal dissipation is exceeded and prevent "thermal runaway". The thermal foldback implements a negative temperature coefficient (NTC) of -0.2%/K. The LED current can be calculated by Equation (2):

$$I_{LED} = I_{SET} \times 0.2\% \times (T_A - 25) \qquad (2)$$

When operating the chip at high ambient temperatures, or when driving maximum load current, care must be taken to avoid exceeding the package power dissipation limits. Exceeding the package dissipation will cause the device to enter thermal protection mode. The maximum package power dissipation can be calculated using the following equation (3):

$$P_{D(MAX)} = \frac{T_{J(MAX)} - T_A}{\theta_{JA}} \qquad (3)$$

Where $T_{J(MAX)}$ is the maximum junction temperature, T_A is the ambient temperature, and θ_{JA} is the junction to ambient thermal resistance; a metric for the relative thermal performance of a package.

The recommended maximum operating junction temperature, $T_{J(MAX)}$, is 150°C and so the maximum ambient temperature is determined by the package parameter; θ_{JA}. The θ_{JA} for the IS31LT3170/71 SOT23-6 package, is 191°C/W.

Therefore the maximum power dissipation at T_A = -40°C is:

$$P_{D(MAX)} = \frac{150°C + 40°C}{191°C/W} \approx 1W$$

The actual power dissipation P_D is:

$$P_D = V_{OUT} \times (I_{EN} + I_{OUT}) \qquad (4)$$

To ensure the performance, the die temperature (T_J) of the IS31LT3170/71 should not exceed 125°C. The graph below gives details for the package power derating.

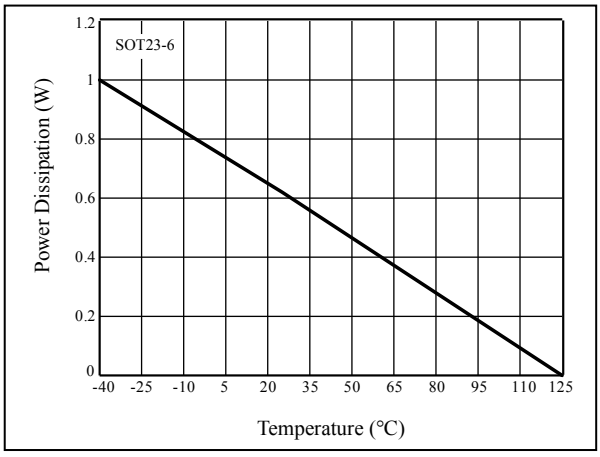


Figure 4 P_D vs. T_A (SOT23-6)

CLASSIFICATION REFLOW PROFILES

Profile Feature	Pb-Free Assembly
Preheat & Soak Temperature min (Tsmin) Temperature max (Tsmax) Time (Tsmin to Tsmax) (ts)	150°C 200°C 60-120 seconds
Average ramp-up rate (Tsmax to Tp)	3°C/second max.
Liquidous temperature (TL) Time at liquidous (tL)	217°C 60-150 seconds
Peak package body temperature (Tp)*	Max 260°C
Time (tp)** within 5°C of the specified classification temperature (Tc)	Max 30 seconds
Average ramp-down rate (Tp to Tsmax)	6°C/second max.
Time 25°C to peak temperature	8 minutes max.

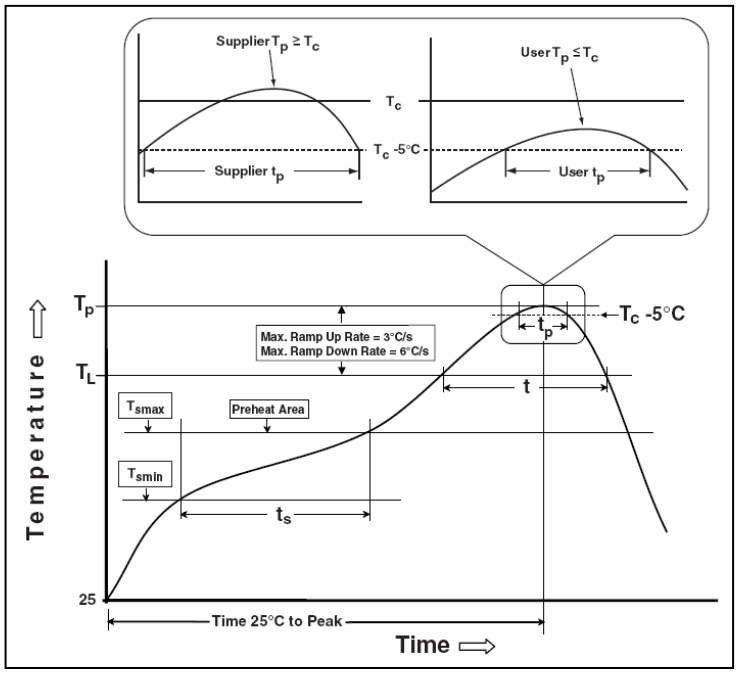
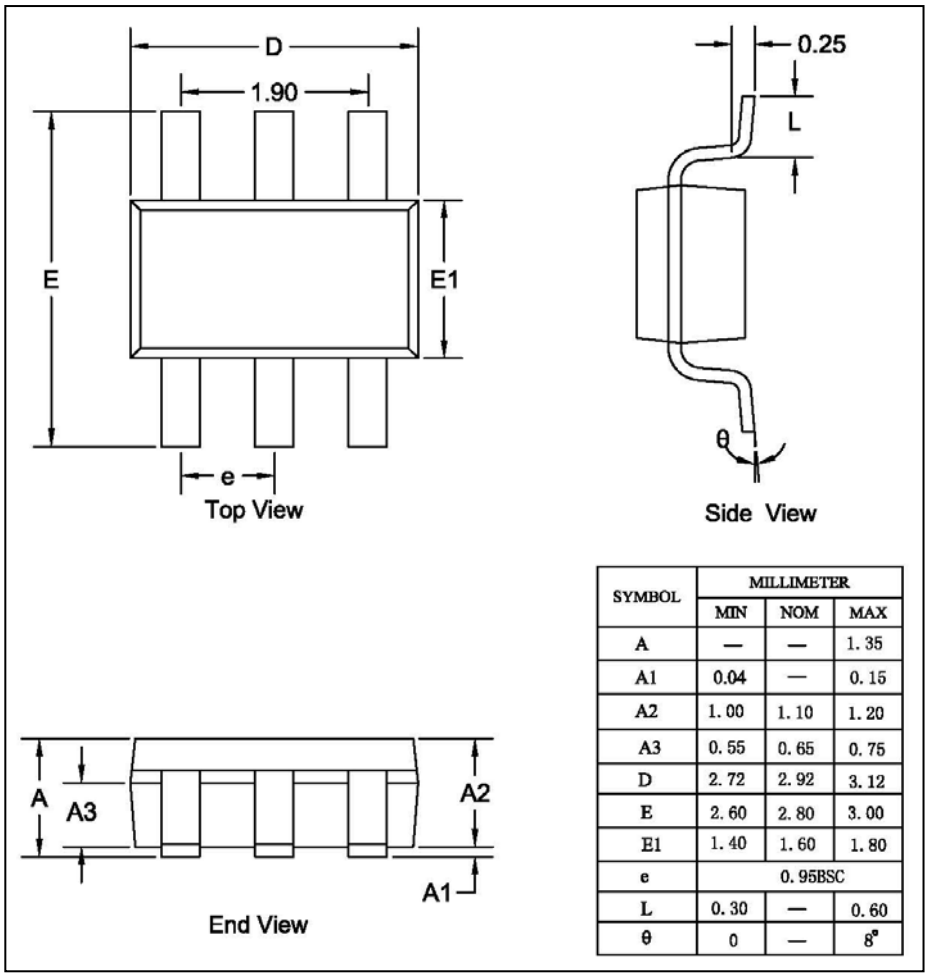


Figure 5 Classification Profile

PACKAGE INFORMATION

SOT23-6 (TBD)



SYMBOL	MILLIMETER		
	MIN	NOM	MAX
A	—	—	1.35
A1	0.04	—	0.15
A2	1.00	1.10	1.20
A3	0.55	0.65	0.75
D	2.72	2.92	3.12
E	2.60	2.80	3.00
E1	1.40	1.60	1.80
e	0.95BSC		
L	0.30	—	0.60
θ	0	—	8°

Note: All dimensions in millimeters unless otherwise stated.