

IS31LT3117 53V, 350mA, 4-CHANNEL CONSTANT CURRENT REGULATOR WITH OTP

DESCRIPTION

The IS31LT3117 is a 4-channel, linear regulated, constant current LED driver which can sink 4 equal currents of up to 350mA per channel to drive high brightness LEDs over an input voltage range of 6V to 53V, while maintaining an output leakage current of less than 1uA. The sink current is easily programmed using a single external resistor. The current sinks of the IS31LT3117 may be connected in parallel to allow greater than 350mA of LED current, i.e., all four VLEDx pins tied together for a maximum 1.4A sink available for one LED string. See limitations in the LED CURRENT SETTING section

The IS31LT3117 also features a PWM input to enable simple dimming control using a digital control signal

The IS31LT3117 features an optional 2.5V reference voltage output capable of supplying up to 10mA (typ.). This voltage may be used to drive the base of external BJTs for high current applications which are driven by a widely varying input voltage

FEATURES

- 6V to 53V input supply voltage range
- Up to 1.4A total sink current
- Over temperature protections
- Thermal current regulation above 130°C
- Sink current matching 3% between channels
- PWM dimming and Shutdown control input
- Optional 2.5V output to drive external standoff BJTs
- Very few external components

QUICK START

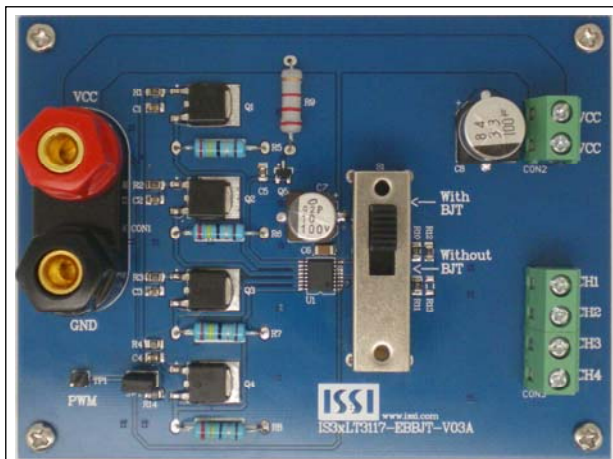


Figure 1: Photo of IS31LT3117-EBBJT Evaluation Board

RECOMMENDED EQUIPMENT

- 6.0V~53V, 2A DC power supply
- One digital voltmeter
- Four series-connected HB LED strings rated no less than 350mA
- A current probe to measure the HB LED current

ABSOLUTE MAXIMUM RATINGS

- ≤ 53V power supply

Caution: Do not exceed the conditions listed above, otherwise the board will be damaged.

EVALUATION BOARD OPERATION

The evaluation board can be configured to operate in one of two current level modes. The device input current is controlled by switch (S1), when S1 is pushed UP, <With BJT> mode, the HBLED string current at VLEDx pin is set to 350mA, when S1 is pushed DOWN, <Without BJT> mode, the HBLED string current is set to 100mA. The operating current (350mA or 100mA) is set by S1 switch selection of a resistor value at IS31LT3117 pin 8. See "LED CURRENT SETTING" section of the datasheet for guidance in calculating resistor values for specific currents.

PROCEDURE

The IS31LT3117 evaluation board is fully assembled and tested. Follow the steps listed below to verify board operation.

Caution: Do not turn on the power supply until all connections are completed.

- 1) Verify that the S1 is pushed UP to select <With BJT> mode.
- 2) Connect each HBLED string as follows:
CHx: Connect the HBLED string cathode to the CHx of CON3 and the anode to VCC on CON2
Where x is 1, 2, 3 and 4.
Unused CHx inputs should be connected to GND
- 3) Calculate the VCC, recommended value is 1V to 2V higher than the sum of the LED string's total forward voltage drop.
For example, if the LED string's total forward voltage is 10V@350mA (three LEDs with 3.33V forward voltage drop each), the recommended VCC is 11V to 12V.
Note: Selecting an input voltage much higher than the LED string's total forward voltage will cause power dissipation on the on board BJTs (Q1 – Q4).
- 4) Insert the current probe between the CHx terminal (CON3) and the cathode of the CHx LED string to measure the HBLED current.

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- 5) JP1 is used to configure the PWM signal input mode. When JP1 is "ON" the IS31LT3117 is enabled and no external PWM signal should be connected. When JP1 is "OFF" the IS31LT3117 must be driven by an external PWM signal source.
Caution: Always remove JP1 when driving the IS31LT3117 with an external PWM source. JP1 ON pulls up the TP1 pin to a possibly high VCC voltage that may damage the PWM signal source.
- 6) Turn on the power supply (VCC) and measure the HBLED current using the current probe and verify all channels (CHx).
- 7) Slide S1 down to select <Without BJT> mode.
- 8) Measure the HBLED current using the current probe and verify all channels (CHx).

POWER SUPPLY AND POWER DISSIPATION

The dissipation is proportional to the voltage across the LED and the sink current that can be defined as:

$$P_{LEDx} = V_{LEDSx} \times I_{OUTx}$$

Where x is 1, 2, 3 or 4. V_{LEDSx} is the total forward voltage of LEDs in series, I_{OUTx} is the current of the LED series.

When working with BJT (S1 UP),

$$P_{BJTx} = (V_{CC} - V_{VLEDx} - V_{LEDSx}) \times I_{OUTx}$$

$$P_{3117} = \sum_{x=1}^4 (V_{VLEDx} \times I_{OUTx}) + V_{CC} \times I_Q$$

Where x is 1, 2, 3 or 4. V_{VLEDx} is the voltage of the IS31LT3117 VLEDx pin (Headroom voltage), see Equation (3) of the datasheet for guidance in calculating the V_{VLEDx} . I_{OUTx} is the current of the LED series, I_Q is the operation current of IS31LT3117 and Q5. Assume $I_{OUTx} = 350\text{mA}$, $V_{LEDSx} = 10\text{V}$, $V_{CC} = 12\text{V}$, $I_Q = 18\text{mA}$, $V_{VLEDx} = 0.4\text{V}$.

$$P_{LEDx} = 10\text{V} \times 0.35\text{A} = 3.5\text{W}$$

$$P_{BJTx} = (12\text{V} - 10\text{V} - 0.4\text{V}) \times 0.35\text{A} = 0.56\text{W}$$

$$P_{3117} = 0.4\text{V} \times 0.35\text{A} \times 4 + 12\text{V} \times 0.018\text{A} = 0.582\text{W}$$

Caution: If VCC is much higher than V_{LEDSx} , then verify that $P_{BJTx} < 1.5\text{W}$ for all conditions.

When working without BJT (S1 DOWN),

$$P_{3117} = \sum_{x=1}^4 (V_{VLEDx} \times I_{OUTx}) + V_{CC} \times I_Q$$

$$= \sum_{x=1}^4 (V_{CC} - V_{LEDSx} - V_{Rx}) \times I_{OUTx} + V_{CC} \times I_Q$$

Where x is 1, 2, 3 or 4. V_{Rx} is the voltage across R_x (x=5 to 8), V_{LEDSx} is the total forward voltage of LEDs in series, see Figure 2 for details.

The voltage at VLEDx pin of the IS31LT3117 will be the remaining value of $V_{CC} - V_{OUTx} - V_{Rx}$, and if it is larger than $1.8\text{V}@350\text{mA}$, the IC dissipation will be high which may trigger the IC over temperature protection (OTP). Assume $V_{CC} = 12\text{V}$, $I_{OUTx} = 100\text{mA}$, $V_{LEDSx} = 9.0\text{V}$, $R_x = 24\Omega$, $I_Q = 5\text{mA}$.

$$P_{LEDx} = 9.0\text{V} \times 0.1\text{A} = 0.9\text{W}$$

$$P_{Rx} = 0.1\text{A} \times 0.1\text{A} \times 24\Omega = 0.24\text{W}$$

$$P_{3117} = (12\text{V} - (0.1\text{A} \times 24\Omega) - 9.0\text{V}) \times 0.1\text{A} \times 4 + 12\text{V} \times 0.005\text{A} = 0.3\text{W}$$

LED CURRENT SETTING

The maximum sink current of all four channels (VLEDx) is set by resistor (R_{ISET}) connected from the IS31LT3117 I_{SET} pin (8) to ground. The maximum possible current is 350mA per VLEDx pin, however, more than one VLEDx pin can be tied together to allow for larger currents. Two combined VLEDx pins will double the available sink current for the LED string, while combining all four VLEDx pins will result in 4x the sink current for one LED string. The VLEDx sink current can be calculated by the following; $V_{ISET} = 1.27\text{V}$ (typ):

$$I_{SINKx} = 1600 \times \frac{V_{ISET}}{R_{ISET}}$$

When S1 UP With BJT, $R_{ISET} = R10//R12$, and S1 DOWN Without BJT, $R_{ISET} = R11$. For accurate LED current, resistors should be 1% or better tolerance. More information please refers to the IS31LT3117 datasheet.

HB LED DIGITAL-DIMMING CONTROL

The JP1 connector is used for configuring the dimming function as in the table below:

JP1	Configuration Description
ON	No external PWM signal
OFF	Connect external PWM signal source

The evaluation board features a PWM input terminal for connecting an external digital PWM signal. JP1 connector is used to connect or disconnect a 100k ohm pull up resistor (R14) to the PWM input. Apply a digital PWM signal with a 0.8V logic-low (or less) and a 2.1V logic high (or greater) level, and frequencies from 4kHz to 100kHz. To adjust the HB LED brightness, vary the signal duty cycle from 0 to 100.

Caution: If JP1 is "ON" the PWM pin will be pulled up to the input VCC which can be up to 53V.



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BILL OF MATERIALS

Name	Symbol	Description	Qty	Supplier	Part No.
LED Driver	U1	Constant current LED driver	1	ISSI	IS31LT3117
BJT	Q1~Q4	NPN power Transistor	4	ONSEMI	MJD31
BJT	Q5	60V/1A NPN BISS Transistor	1	NXP	PBSS4160U
Resistors	R1~R4	RES, 430R, 1/16W, ±5%, SMD	4	YAGEO	RC0805JR-07430L
Resistors	R5~R8	RES, 24R, 1W, ±5%, DIP	4		
Resistor	R9	RES, 2.2K, 0.5W, ±5%, DIP	1		
Resistor	R10	RES, 6.2K, 1/10W, ±1%, SMD	1	YAGEO	RC0805FR-076.2KL
Resistor	R12	RES, 91K, 1/10W, ±1%, SMD	1	YAGEO	RC0805FR-0791KL
Resistor	R11	RES, 20K, 1/10W, ±1%, SMD	1	YAGEO	RC0805FR-0720KL
Resistor	R14	RES, 100K, 1/10W, ±5%, SMD	1	YAGEO	RC0805JR-07100KL
Resistor	R13	NC			
Capacitors	C1~C4	CAP, 0.1µF, 10V, ±10%, SMD	4	YAGEO	CC0805DKX7R6BB104
Capacitors	C5	CAP, 1µF, 10V, ±10%, SMD	1	YAGEO	CC0805DKX7R6BB105
Capacitor	C6	CAP, 0.1µF, 100V, ±10%, SMD	1	YAGEO	CC1206DKX7R0BB104
Capacitor	C7	CAP, 10µF, 100V, ±20%, SMD	1		
Capacitor	C8	CAP, 33µF, 100V, ±20%, SMD	1		
Switch	S1	6P2T DIP	1		
Jumper	JP1	2.54mm Jumper	1		
Connector	CON1, CON2	DC connector	2		

Bill of materials, refer to Figure 2 above.

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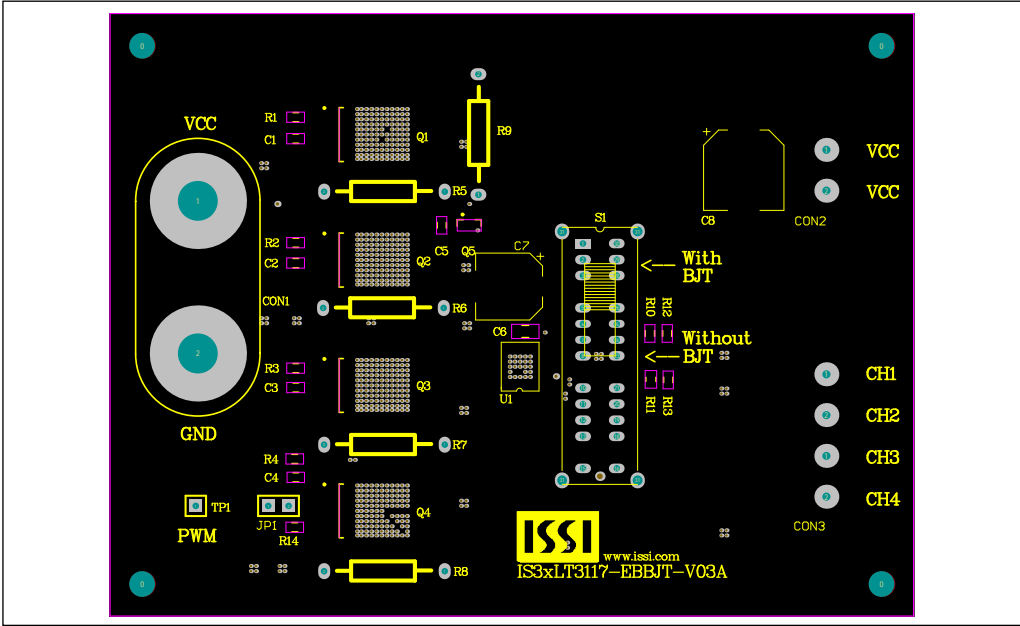


Figure 3: Board Component Placement Guide -Top Layer

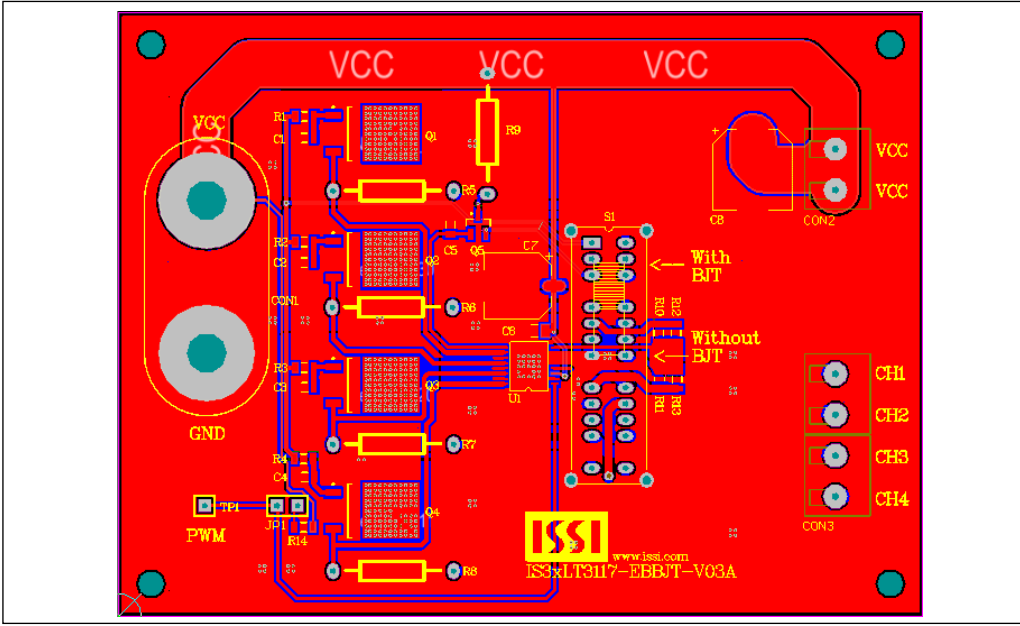


Figure 4: Board PCB Layout- Top Layer

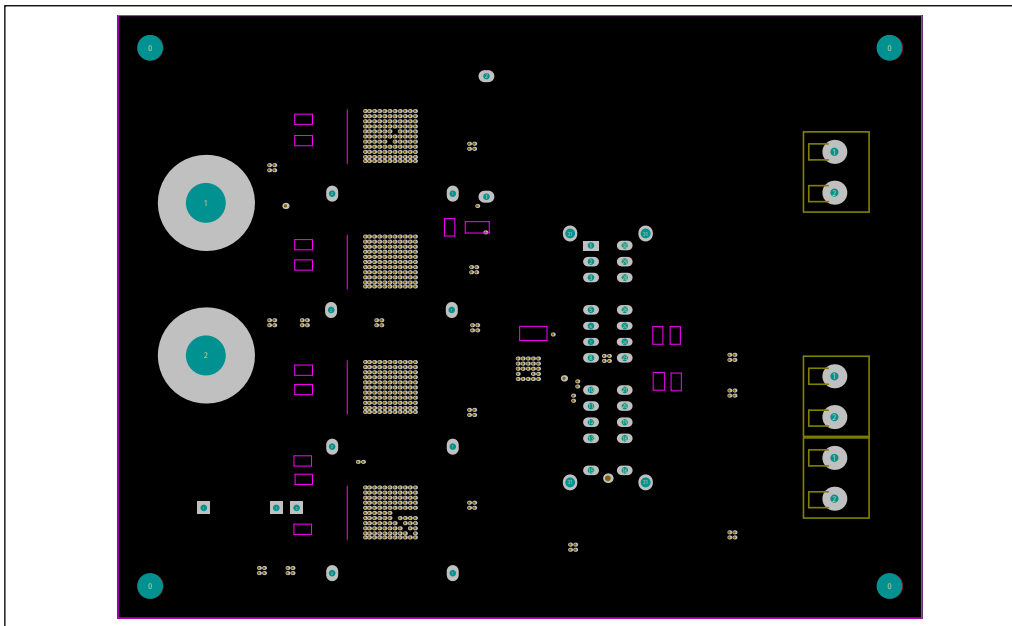


Figure 5: Board Component Placement Guide -Bottom Layer

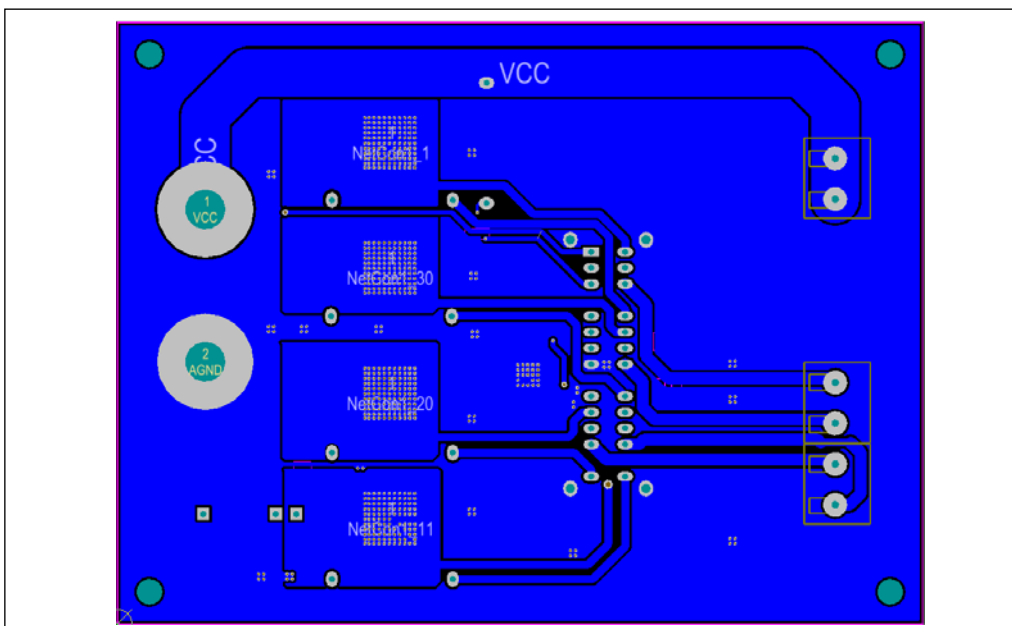


Figure 6: Board PCB Layout-Bottom Layer

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