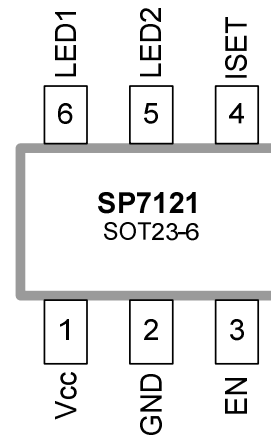


2-Channel Adjustable Low Dropout High Side Linear LED Driver

FEATURES

- LED Driver for common cathode parallel connected LEDs
- Ultra Low Dropout Voltage of 300mV @ 25mA
- No EMI, no switching noise
- Integrated current matching
- PWM brightness control
- Enable/Shutdown control
- Shutdown current < 1 μ A
- Adjustable Output current up to 30mA per channel
- Available in RoHS Compliant, Lead Free Package: Small footprint SOT23-6



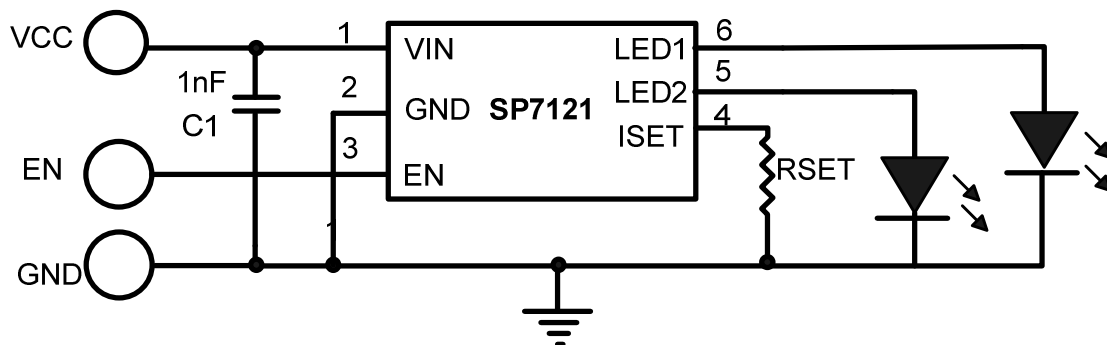
TYPICAL APPLICATION

- Mobile Phones
- PDA, DSC, MP3 players
- Handheld Computers
- Keypads and display backlight

GENERAL DESCRIPTION

The SP7121 LED driver provides a simple solution for a matched current source for any color common cathode LEDs. The common cathode connection allows the user to increase the LED power dissipation by having the cathodes heat sunk to the ground plane of the circuit board. The SP7121 output current value is set by an external resistor. At shutdown mode (EN pin is LOW), the supply current drops to .04 μ A typical. The SP7121 driver is available in a small footprint 6-pin SOT23-6 package.

TYPICAL APPLICATION



ABSOLUTE MAXIMUM RATINGS

These are stress ratings only and functional operation of the device at these ratings or any other above those indicated in the operation sections of the specifications below is not implied. Exposure to absolute maximum rating conditions for extended period may affect reliability.

Maximum LED current I_{LED1}, I_{LED2}.....30mA
V_{CC}, V_{LED1}, V_{LED2}, and EN to GND -0.3V to 6V

Junction Temperature.....+150°C
Operating Temperature.....-40 to +85°C
Storage Temperature.....-65°C to +150°C
Package Thermal resistance θ_{JA} 190°C/W
ESD Level.....2kV HBM
ESD Level Enable pin.....1.5KV HBM
ESD Level ISET pin (4).....1.5KV HBM
ESD Level.....200V MM
Lead Temperature (Soldering, 10 sec)....300°C

RECOMMENDED OPERATING CONDITIONS

Ambient operating temperature -40°C - +85°C

ELECTRICAL CHARACTERISTICS

Specifications are at T_A=25°C, V_{CC} = 2.7V to 5.5V, ENABLE = V_{CC}, I_{LED}=15mA unless specified.

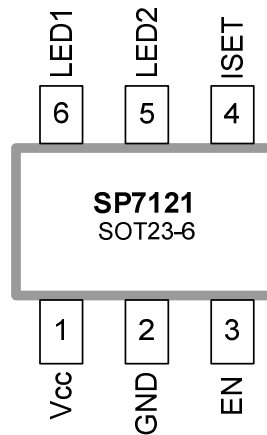
Parameter	Min	Typ	Max	Units	Conditions
V _{CC}	2.7		5.5	V	
Shutdown Current		0.04	1	μA	EN = LOW
V _{LED} Dropout Voltage, V _d ¹		135	200	mV	V _{CC} = 5.5V, I _{LED} = 20mA
LED to LED Current Matching	1	0.2	1	%	V _{CC} = 5.5V, V _d > 200mV
LED Current Line Regulation ²			0.3	%/V	2.7V < V _{CC} < 5.5V
LED Current Load Regulation ³			0.3	mA/V	V _{CC} =3.7V; 150mV < V _d < 1.0V
LED Current Thermal Regulation		0.01		%/°C	V _d = 300mV
EN ON Voltage (HIGH) ⁴	2.4		V _{CC}	V	
EN OFF Voltage (LOW)	0		0.8	V	
EN Input Bias Current	2	3	5	μA	V _{EN} = V _{CC} = 5.5V
EN Switching Frequency			20	kHz	
EN ON Minimum Pulse Width			15	μs	
LED current per channel	10		25	mA	
ISET Voltage	1.17	1.21	1.26	V	V _{EN} =V _{CC} =3.7V
ISET current multiplication ratio	200	205	210		V _{EN} =V _{CC} =3.7V

1) Difference between V_{CC} voltage and LED anode voltage at which I_{LED} current drops 10% from nominal value

2) I_{LED} Current Variations per Volt V_{CC} change

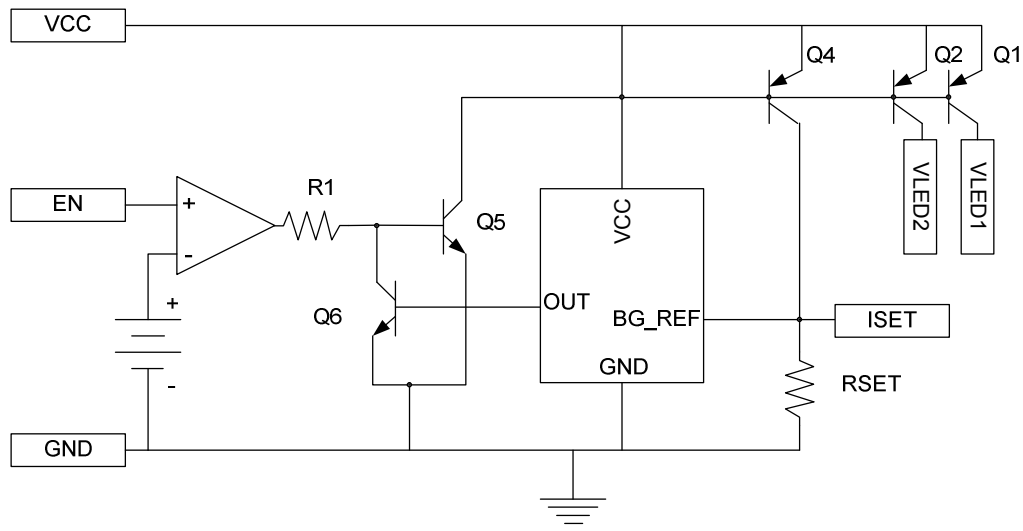
3) I_{LED} Current Variations at V_d change from 0.15 to 1.0V

4) EN input voltage should not exceed V_{CC} voltage at any condition



Pin Name	SP7121	Pin Description
Vcc	1	Power input pin. Bypass Vcc to GND with 1nF capacitor as close to VIN as possible
GND	2	Ground pin
EN	3	Enable pin. Device is active if EN is logic HIGH
ISET	4	Connect external resistor to set LED current
LED2	5	Connect anode of LED2
LED1	6	Connect anode of LED1

BLOCK DIAGRAM



The SP7121 allows the LED current level to be adjusted by an external resistor connected to the ISET pin. This option lets customer select LED current amplitude by selecting appropriate external RSET resistor value. The SP7121 circuit consists of enable, bandgap reference, and current amplifier circuit blocks. The Enable circuit block provides the enable and PWM function for the IC. The Bandgap reference provides a stable voltage source from which the output current is derived.

Setting the Current in the SP7121

The internal current amplifier provides a current gain function where the RSET resistor is connected from the ISET pin (pin 4) to GND. The current, produced by the RSET resistor is then amplified and delivered to the LED output. The external RSET resistor value for SP7121 is determined by following equation:

$$R_{SET} = 200 \times V_{SET} / I_{LED}$$

Where I_{LED} = required LED current value in mA per channel.
 $V_{SET} = 1.22V$
 200 is the typical gain

The LED current level can be set anywhere from 10mA to 25mA per each output. Specifications are not guaranteed for current levels that are set outside this range.

The SP7121 doesn't have protection from ISET pin being shorted to ground or the RSET value being too low. With an operational maximum current of 30mA per channel device may be damaged if the ISET pin is shorted to the ground or the RSET value is below 8kΩ.

ENABLE

The SP712X drivers have a low current shutdown function. In shutdown mode, the part draws less than 1μA current maximum. The part can be shut down using the EN pin (EN = LOW). The enable pin cannot be tri-stated or left floating. There are no predefined internal states, so leaving this pin open will cause the part to operate incorrectly.

PWM Dimming

The SP7121 driver allows LED-dimming control by applying a PWM signal to the EN pin. The acceptable frequency range of this signal is 100Hz to 20 kHz. The minimum ON time that is required for the ISET pin to set is 15μs from the time the Enable pin goes high. Thus, for a 2kHz PWM signal, the acceptable duty cycle range is 3% to 100%. To find the minimum PWM duty cycle the following steps need to be followed.

Step 1: Determine the time period of the PWM frequency.

$$T = \frac{1}{PWMf}$$

Where PWMf is the PWM frequency

Step 2: Obtain the minimum Enable ON time; this is 15μS for the SP7121 part.

$$\% \text{Minimum Duty Cycle} = \left(\frac{15\mu s}{T} \right) \cdot 100$$

Example

For a 2kHz signal, the minimum duty cycle for the PWM signal is

$$T = \frac{1}{2000\text{Hz}} = 500\mu\text{s}$$

$$\% \text{Minimum Duty Cycle} = \left(\frac{15\mu\text{s}}{500\mu\text{s}} \right) \cdot 100$$

$$\% \text{Minimum Duty cycle} = 3\%$$

Fault Operation

If one of the LEDs is shorted, the LED voltage at this pin will be VCC but that channel will provide the nominal current value, thereby increasing power dissipation. If all channels are shorted, excessive power dissipation may damage the device. If an LED is open, the LED pin voltage will be pulled up to Vcc, and the LED current will be reduced to 3mA for the other channels.

The SP7121 doesn't have protection from the ISET pin being shorted to ground or the RSET value being too low. With an operational maximum current of 30mA per channel, the device may be damaged if the ISET pin is shorted to the ground or the RSET value is below 8kΩ.

Thermal Considerations

The SP7121 does not have overtemperature protection. Special care needs to be taken to ensure that the driver's junction temperature stays below 125°C. The thermal resistance of the package is 160°C per Watt. Under normal operation conditions with about 30mA of current per LED and a voltage drop across the part of 1V, the part will still only dissipate .06 Watts -- giving a temperature rise of only 11.4°C

Example of thermal calculations.

$$P = V_d \cdot I_{out}$$

Where P is total power dissipation
Vd is the voltage drop across the SP7121
IOUT is the total output current

$$\text{Temp Rise} = P \cdot \theta_{JA}$$

Where P is the total power dissipation
θJA is the thermal resistance of the package per Watt.

Above example

$$P = 1V \cdot 60\text{ma}$$

$$\text{Temp Rise} = .06 \cdot 190$$

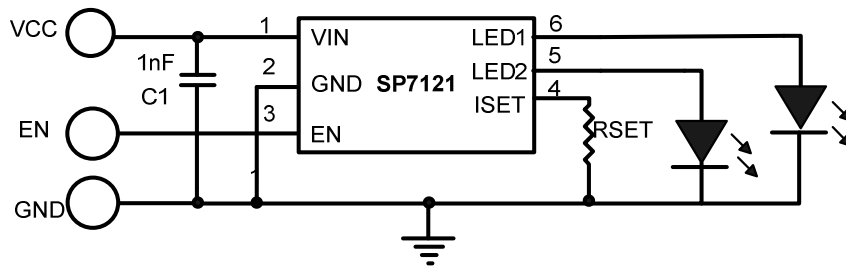
$$\text{Temperature Rise} = 11.4^\circ\text{C}$$

The part will be able will operate up to 85°C under these conditions.

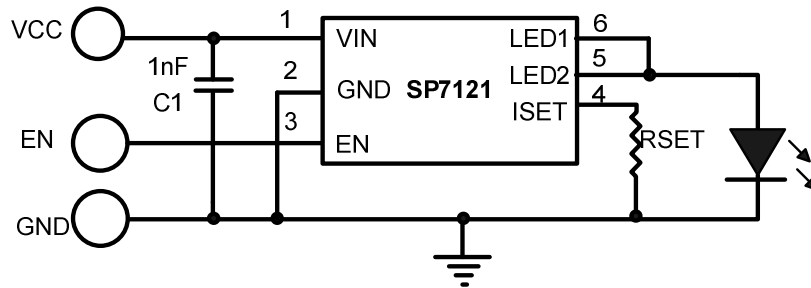
BOARD LAYOUT AND GROUNDING

Although the SP7121 does not require an input capacitor for normal operation, a 1nF capacitor can be used to obtain better overall circuit performance. To obtain the best performance from the SP7121, a printed circuit board with ground plane is required. High quality, low series resistance

ceramic 1nF bypass capacitors should be used at the Vcc and GND pins (pins 1 and 2). This capacitor must be located as close to the pins as possible. The traces connecting the pins and the capacitor must be kept short and should be made as wide as possible.



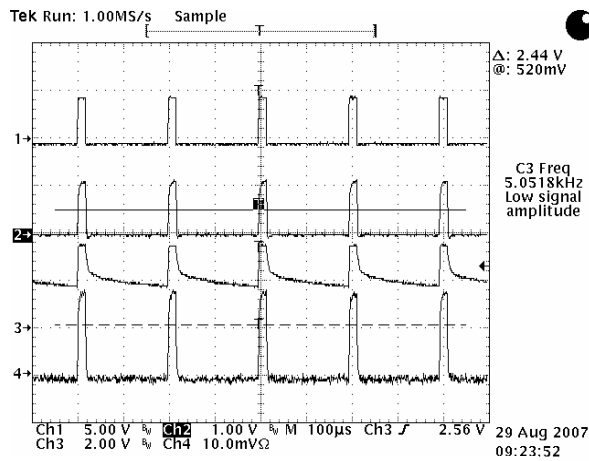
SP7121 Powering 2 LEDs



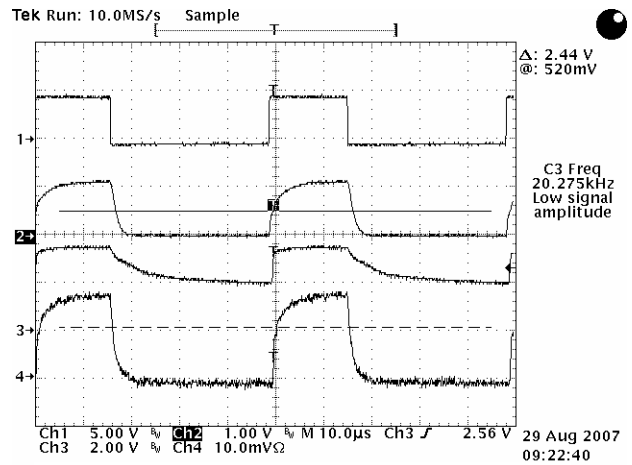
Powering high 1 high power LED with SP7121 IOUT up to 50mA

TYPICAL PERFORMANCE CHARACTERISTICS

PWM FUNCTION -- 2 LEDs

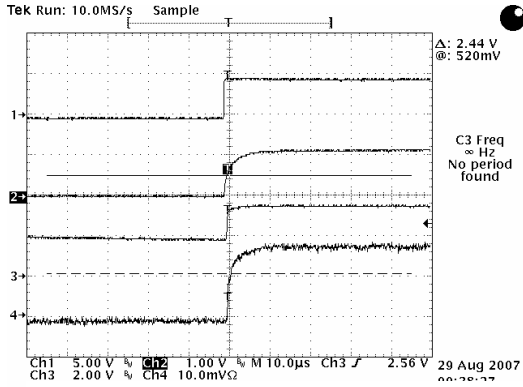


PWM minimum duty cycle 5kHz
 Channel 1 PWM signal; Channel 2 ISET pin;
 Channel 3 VLED; Channel 4 ILED 20ma/Div



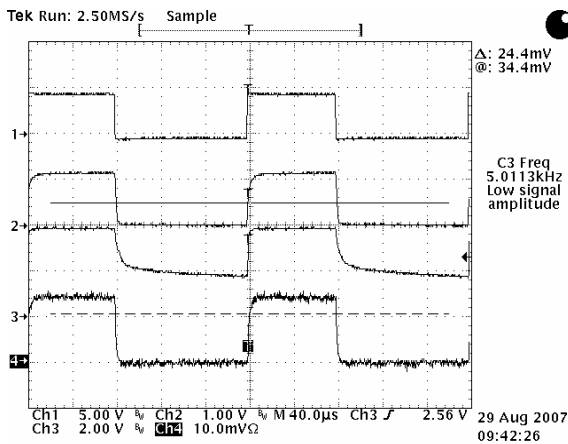
PWM minimum duty cycle 20kHz
 Channel 1 PWM signal; Channel 2 ISET pin;
 Channel 3 VLED; Channel 4 ILED 20ma/Div

PWM FUNCTION -- 2 LEDs continued

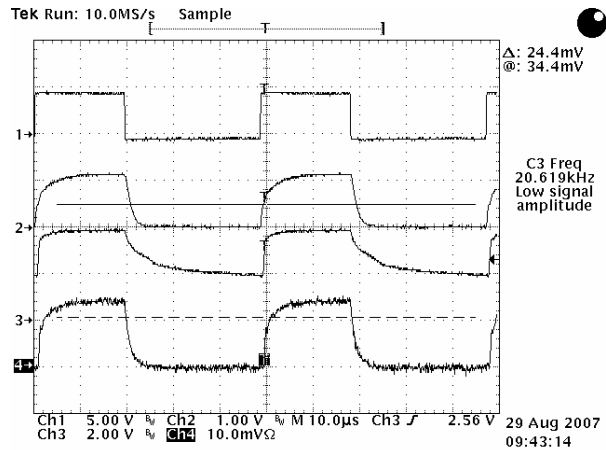


Zoom of the startup
 Channel 1 Enable; Channel 2 ISET pin;
 Channel 3 VLED; Channel 4 ILED 20ma/Div

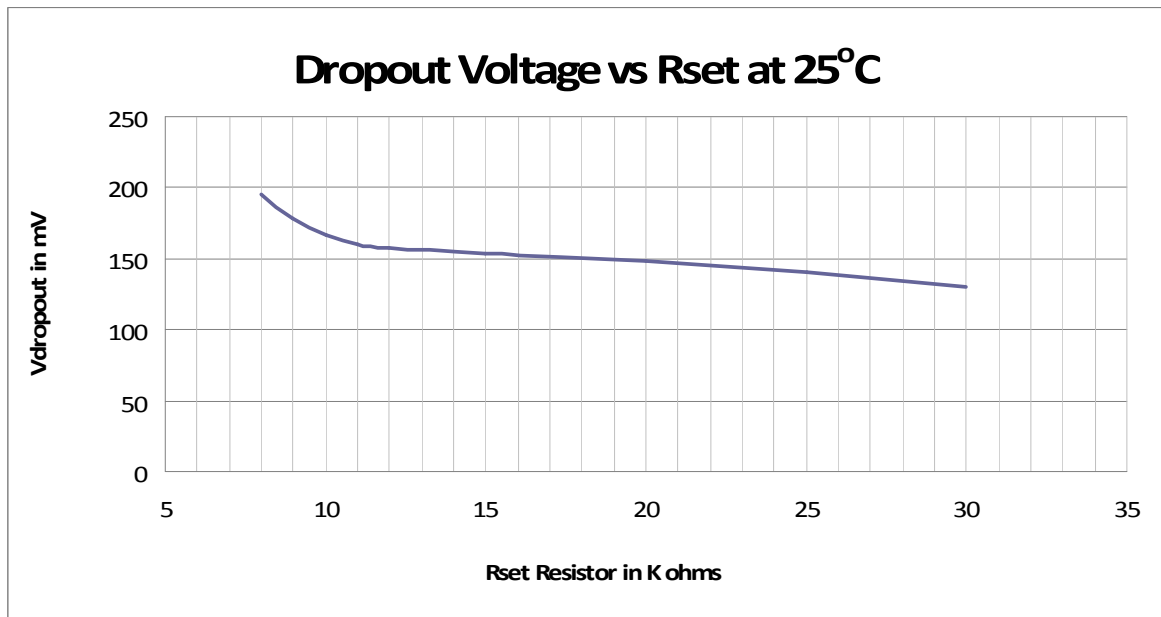
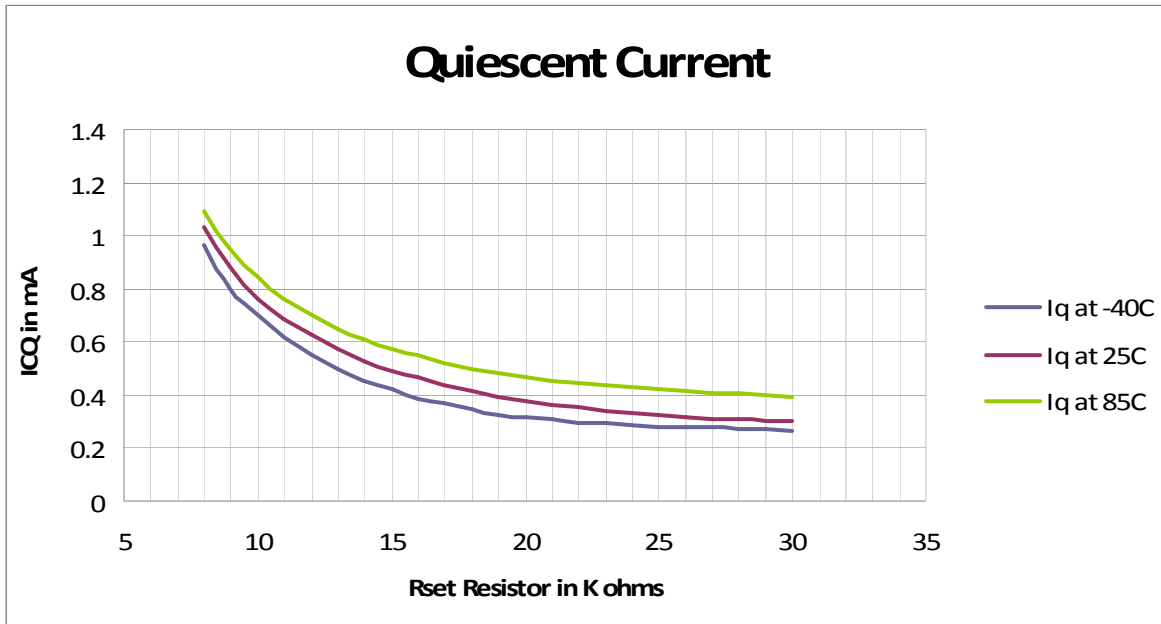
PWM FUNCTION -- SINGLE HIGH POWER LED

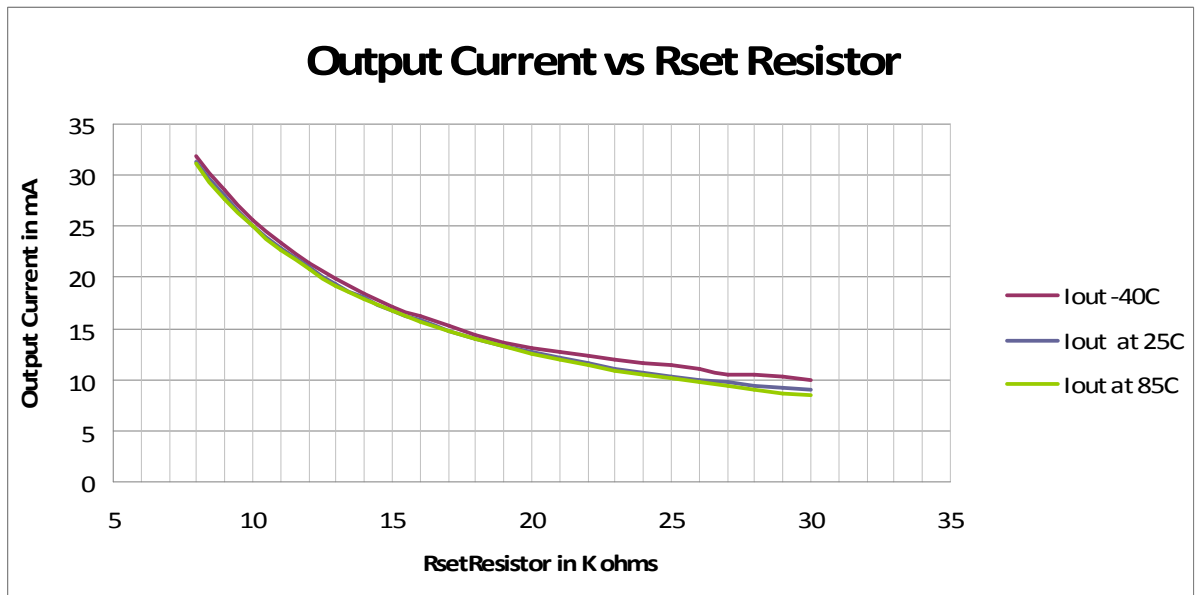
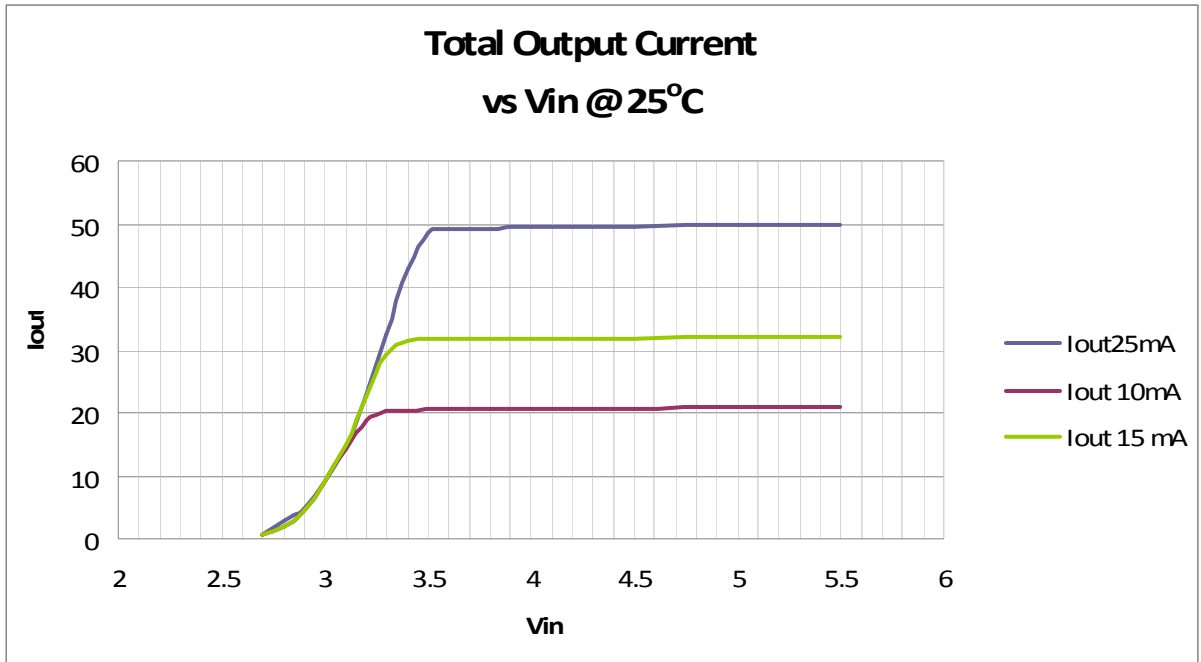


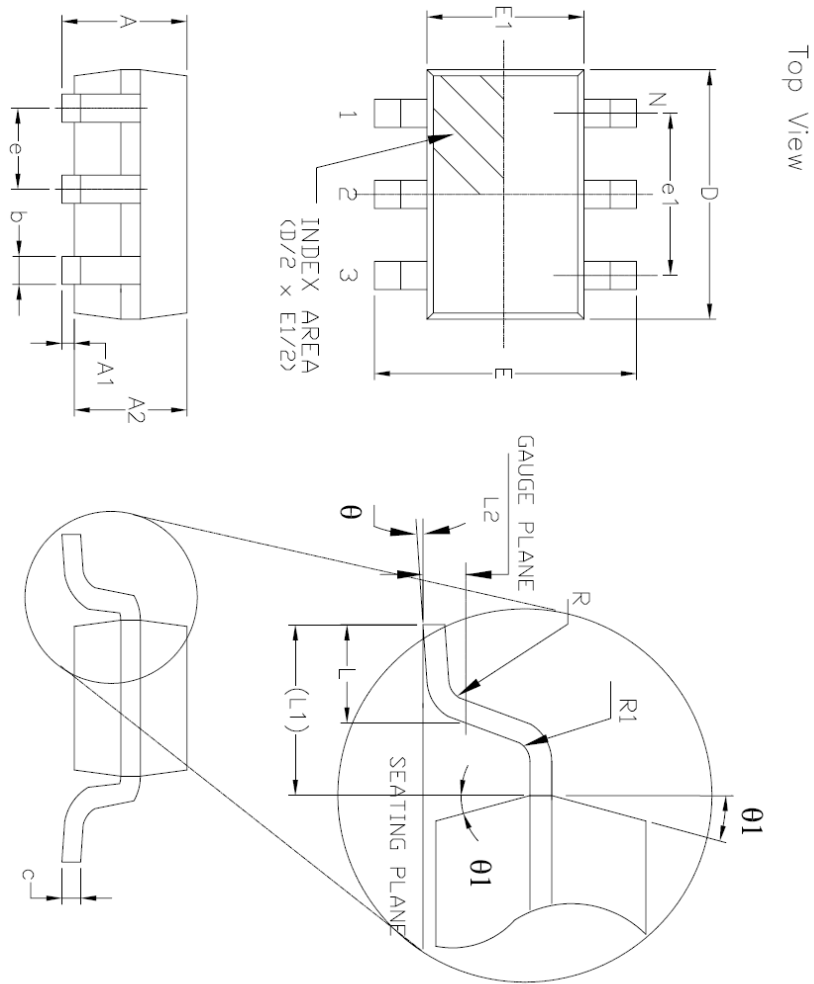
PWM minimum duty cycle 20kHz
 Channel 1 PWM signal; Channel 2 ISET pin;
 Channel 3 VLED; Channel 4 ILED 50ma/Div



PWM minimum duty cycle 20kHz
 Channel 1 PWM signal; Channel 2 ISET pin;
 Channel 3 VLED; Channel 4 ILED 50ma/Div







6 Pin SOT-23 JEDEC MO-178 Variation AB

SYMBOLS	DIMENSIONS IN MM (Control Unit)			DIMENSIONS IN INCH (Reference Unit)		
	MIN	NOM	MAX	MIN	NOM	MAX
A	—	1.45	—	—	0.057	—
A1	0.00	—	0.15	0.000	—	0.006
A2	0.90	1.15	1.30	0.036	0.045	0.051
b	0.30	—	0.50	0.012	—	0.020
c	0.08	—	0.22	0.003	—	0.009
D	2.90	BSC	—	0.115	BSC	—
E	2.80	BSC	—	0.111	BSC	—
E1	1.60	BSC	—	0.063	BSC	—
e	0.95	BSC	—	0.038	BSC	—
e1	1.90	BSC	—	0.075	BSC	—
L	0.30	0.45	0.60	0.012	0.018	0.024
L1	0.60	REF	—	0.024	REF	—
L2	0.25	BSC	—	0.010	BSC	—
R	0.10	—	—	0.004	—	—
R1	0.10	—	0.25	0.004	—	0.010
θ	0°	4°	8°	0°	4°	8°
θ1	5°	10°	15°	5°	10°	15°
N	6	6	6	6	6	6

REVISION HISTORY

REV.	DESCRIPTION	DATE	APPRO.
A	DRAWING ORIGINATION	10/3/05	JL
B	DRAWING FORMAT MODIFICATION	07/25/06	JL

SIPLEX CORPORATION

6 PIN SOT-23 PACKAGE OUTLINE

Packaging Approval: **Sipex**

By: JL Date: 07/25/06

Drawing No: 6-PIN SOT-23

Revision: B Sheet: 1 OF 1

Part Number	Temp Range	RoHS/ Lead Free	Package	Θ_{ja}	Moisture Sensitivity Level	Pack Type	Pack Quantity
SP7121EK-L	-40 °C to +85 °C	Yes	SOT23-6	190 °C/W	L1 @ 260°C	Canister	Any
SP7121EK-L/TR	-40 °C to +85 °C	Yes	SOT23-6	190 °C/W	L1 @ 260°C	Tape & Reel	2500

For further assistance:

Email: Sipexsupport@sipex.com
 WWW Support page: <http://www.sipex.com/content.aspx?p=support>
 Sipex Application Notes: <http://www.sipex.com/applicationNotes.aspx>



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