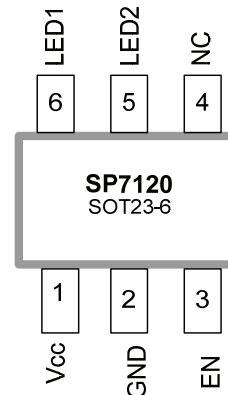


## 2 or 3 Channel Low Dropout High Side Linear LED Driver

### FEATURES

- LED Driver for common cathode parallel connected LEDs
- Ultra Low Dropout Voltage of 150mV
- No EMI, no switching noise
- Integrated current matching
- PWM and Analog brightness control
- Enable/Shutdown control
- Shutdown current < 1 $\mu$ A
- Lead Free, RoHS Compliant Package:  
Small footprint SOT23-6



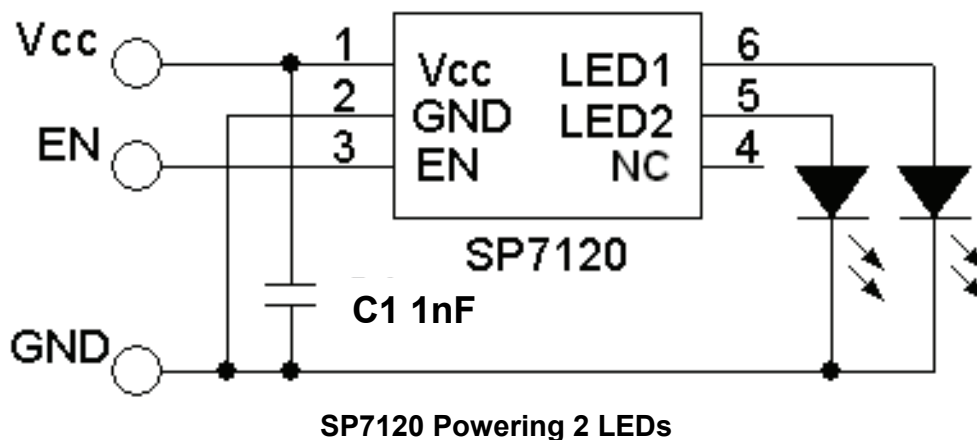
### APPLICATIONS

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

### GENERAL DESCRIPTION

The SP712X driver's family provides a simple solution for a matched current source for any color common cathode LED configuration. The common cathode connection allows the user to increase the LED power dissipation by having the cathodes heat-sinked to the ground plane of the circuit board. The SP7120 may drive two LEDs or one LED at twice the current with two channels connected in parallel. The SP7122 can drive three LEDs or one LED at three times the current. The factory preset current values are 15mA (version A), 20mA (version B), or 25mA (version C) per channel. In shutdown mode (EN pin is LOW), the supply current drops to 40nA typical. The SP712x drivers are available in a small footprint 6-pin SOT23-6 package.

### APPLICATION SCHEMATIC



## 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.

V<sub>CC</sub>, V<sub>LED1</sub>, V<sub>LED2</sub>, 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  $\theta_{JA}$  ..... 190°C/W  
 ESD Level.....2kV HBM  
 ESD Level.....200V MM  
 ESD Level EN.....1.5kV HBM  
 Lead Temperature (Soldering, 10 sec) ...300°C

### RECOMMENDED OPERATING CONDITIONS

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

## ELECTRICAL CHARACTERISTICS

Specifications are at T<sub>A</sub>=25°C, V<sub>CC</sub> = 2.7 to 5.5, ENABLE =V<sub>CC</sub>

| Parameter   | Min       | Typ  | Max             | Units | Conditions                                      |                                  |
|---|-----------|------|-----------------|-------|---|----------------------------------|
| V <sub>CC</sub>                                   | 2.7       |      | 5.5             | V     |   |                                  |
| Shutdown Current                                  |           | 0.04 | 1               | μA    | EN = LOW  |                                  |
| VLED Dropout Voltage, V <sub>d</sub> <sup>1</sup> |           | 160  | 200             | mV    | V <sub>CC</sub> = 5.5V, I <sub>LED</sub> = 20mA |                                  |
| VLED Dropout voltage, V <sub>d</sub> <sup>1</sup> |           | 140  | 180             | mV    | V <sub>CC</sub> = 5.5V, I <sub>LED</sub> = 15mA |                                  |
| LED Current Accuracy <sup>2</sup>                 | Version A | 14   | 15              | 16    | mA  | 300mV<V <sub>D</sub> <1.0V       |
|   | Version B | 19   | 20              | 21    |   | 300mV<V <sub>D</sub> <1.0V       |
|   | Version C | 24   | 25              | 26    |   | 300mV<V <sub>D</sub> <1.0V       |
| Quiescent Current                                 | Version A |      | 0.5             | 0.7   | mA  | SP7120 at V <sub>D</sub> = 300mV |
|   | Version B |      | 0.7             | 1.1   |   |                                  |
|   | Version C |      | 0.86            | 1.7   |   |                                  |
|   | Version A |      | 0.6             | 0.8   | mA  | SP7122 at V <sub>D</sub> = 300mV |
|   | Version B |      | 0.9             | 1.2   |   |                                  |
|   | Version C |      | 0.99            | 1.9   |   |                                  |
| LED to LED Current Matching <sup>6</sup>          |           | 0.8  |                 | %     | V <sub>CC</sub> = 5.5V, V <sub>D</sub> > 300mV  |                                  |
| LED Current Line Regulation <sup>3</sup>          |           |      | .25             | %/V   | 2.7V < V <sub>CC</sub> < 5.5V                   |                                  |
| LED Current Load Regulation <sup>4</sup>          |           |      | 1.0             | %/mA  | 300mV < V <sub>D</sub> < 1.0V                   |                                  |
| LED Current Thermal Regulation                    |           | 0.01 |                 | %/°C  | V <sub>D</sub> = 300mV                          |                                  |
| EN ON Voltage (HIGH) <sup>5</sup>                 | 2         |      | V <sub>CC</sub> | V     |   |                                  |
| EN OFF Voltage (LOW)                              | 0         |      | 0.8             | V     |   |                                  |
| EN Input Bias Current                             | 2         | 3    | 5               | μA    | V <sub>EN</sub> = V <sub>CC</sub> = 5.5V        |                                  |
| EN Switching Frequency                            |           |      | 20              | kHz   |   |                                  |
| EN ON Minimum Pulse Width                         |           |      | 15              | μs    |   |                                  |

1) Difference between V<sub>CC</sub> voltage and LED anode voltage at which I<sub>LED</sub> current drops 10% from nominal value

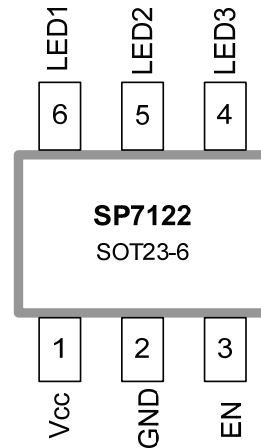
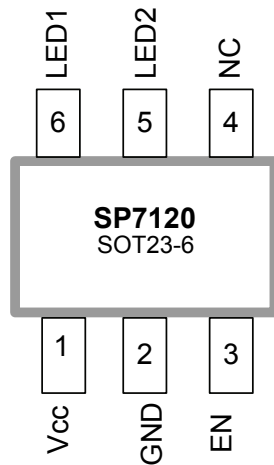
2) I<sub>LED</sub> Current Variations from specified value

3) I<sub>LED</sub> Current Variations per volt V<sub>CC</sub> change for any given temperature

4) I<sub>LED</sub> Current Variations at V<sub>D</sub> change from 0.3V to 1.0V

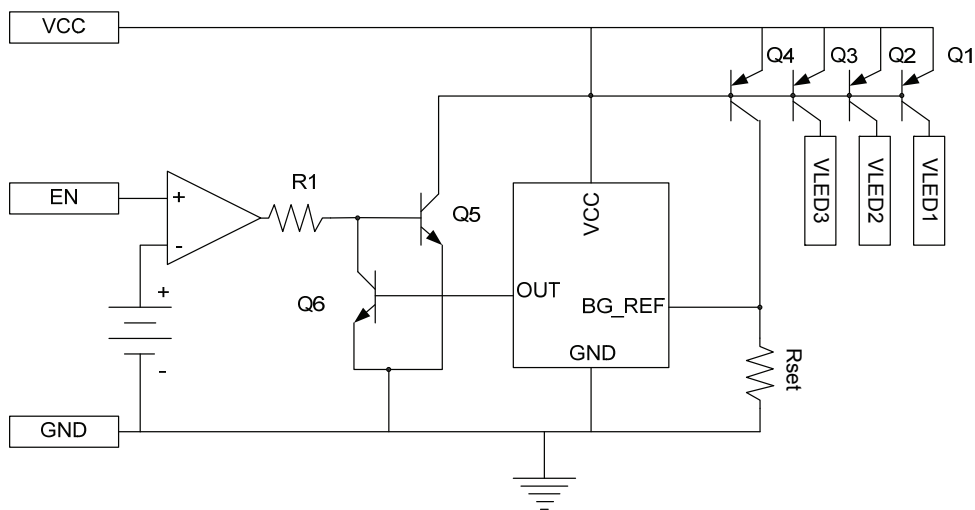
5) EN input voltage should not exceed V<sub>CC</sub> voltage at any condition

6) This condition is part of the LED current accuracy and it shall not exceed that specification



| Pin Name | SP7120 | SP7122 | Pin Description   |
|----------|--------|--------|---|
| Vcc      | 1      | 1      | Power input pin. Bypass Vcc to GND with 1nF capacitor as close to VIN as possible |
| GND      | 2      | 2      | Ground pin  |
| EN       | 3      | 3      | Enable pin. Device is active if EN is logic HIGH                                  |
| NC       | 4      |        | No Connect should be left floating  |
| LED3     |        | 4      | Connect anode of LED3   |
| LED2     | 5      | 5      | Connect anode of LED2   |
| LED1     | 6      | 6      | Connect anode of LED1   |

BLOCK DIAGRAM



## OUTPUT CURRENT SELECTION TABLE

| Part Number | Output Current per channel | Number of Channels | Comments   |
|-------------|----------------------------|--------------------|--|
| SP7120A     | 15mA                       | 2                  | Channels can be combined for higher output current |
| SP7120B     | 20mA                       | 2                  | Channels can be combined for higher output current |
| SP7120C     | 25mA                       | 2                  | Channels can be combined for higher output current |
| SP7122A     | 15mA                       | 3                  | Channels can be combined for higher output current |
| SP7122B     | 20mA                       | 3                  | Channels can be combined for higher output current |
| SP7122C     | 25mA                       | 3                  | Channels can be combined for higher output current |

## CIRCUIT DESCRIPTION

The SP712X drivers are regulated current sources with an enable input. The SP7120 and SP7122 have factory preset LED current at three programmed levels: 15mA, 20mA or 25mA (versions A, B, and C respectively). The SP712X circuit consists of enable, bandgap reference, and current amplifier circuit blocks. Enable circuit block provides the enable and PWM function for the SP712x. The bandgap reference provides a stable voltage source from which the output current is derived.

### 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 set into shutdown mode using the EN pin (EN = LOW). The enable pin cannot be left floating. There are no predefined internal states, so leaving this pin open will cause the part to operate incorrectly.

### PWM Dimming

The SP712X drivers allow LED-dimming control by applying PWM signaling to EN pin. The acceptable frequency range of this signal is 100Hz to 20 kHz. The minimum ON time that is required for the Enable pin is 15µs. 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 are needed:

Step 1: Determine the time period of the PWM frequency

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

Where  $PWMf$  is the PWM frequency

Step 2: take the minimum enable ON time; this is 15µs for the SP712x parts

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

Example

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

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

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

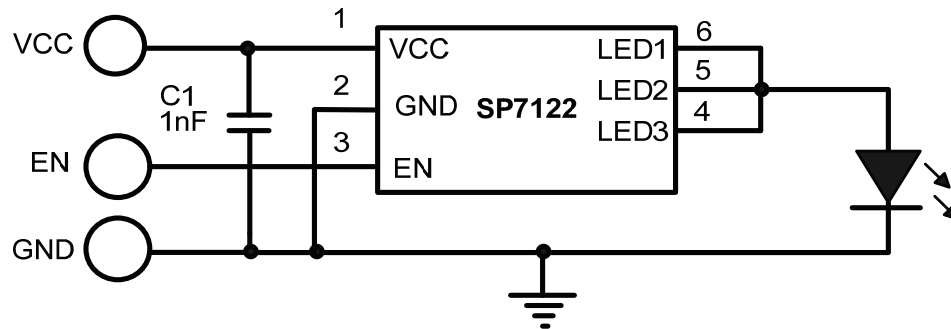
%Minimum Duty cycle = 3%

### Fault Operation

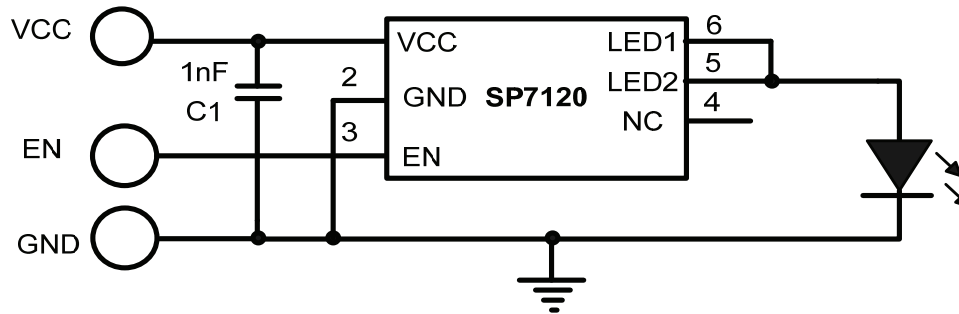
If one of LEDs is shorted, the voltage across The Sp712X for that LED pin will be Vcc, but that channel will still provide the nominal current value thus increasing power dissipation. If all channels are shorted, excessive power dissipation may damage the device. If an LED is open, the LED pin voltage will be pulled up to Vcc, and LED

current will be reduced to 3mA for the other channels.

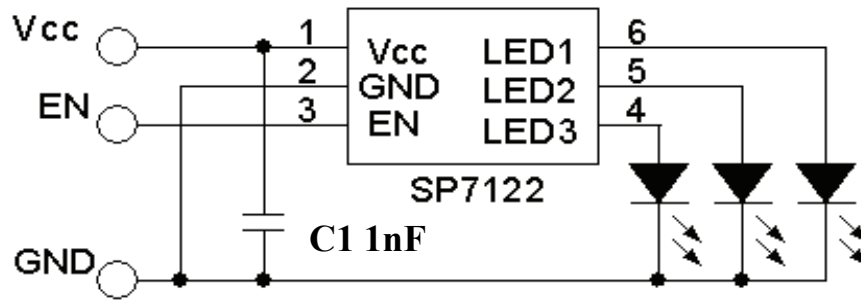
## APPLICATION CIRCUITS



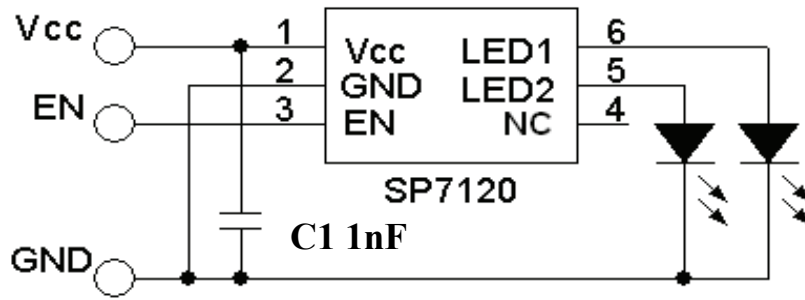
Powering 1 high power LED IOUT up to 75mA with C version



Powering 1 high power LED IOUT up to 50mA with C version



SP7122 Powering 3 LED's



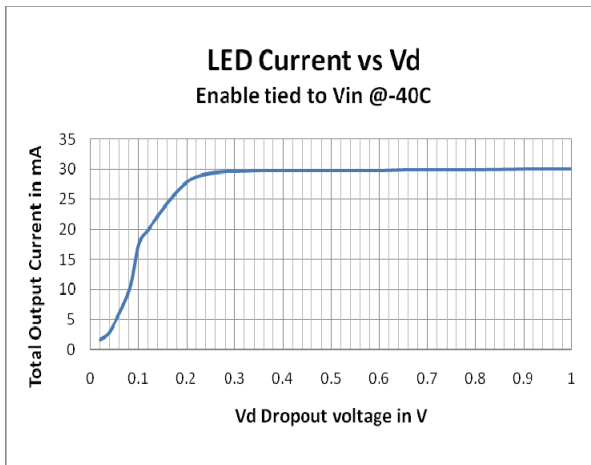
**SP7120 Powering 2 LEDs**

**BOARD LAYOUT AND GROUNDING**

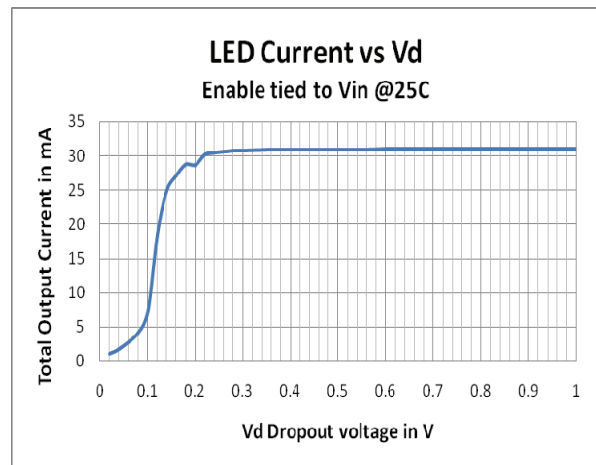
To obtain the best performance from the SP712X, a printed circuit board with ground plane is required. High quality, low series resistance ceramic 1nF bypass capacitors should be used at the Vcc and GND pins. This capacitor must be located as close to the pins as possible. The traces connecting the pins and these capacitors must be kept short and should be made as wide as possible.

**TYPICAL PERFORMANCE SP7120A**

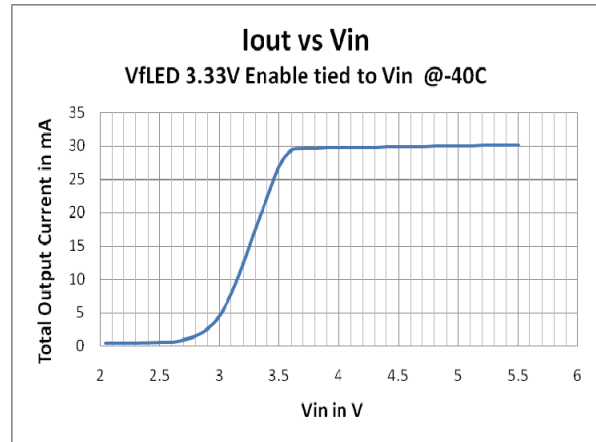
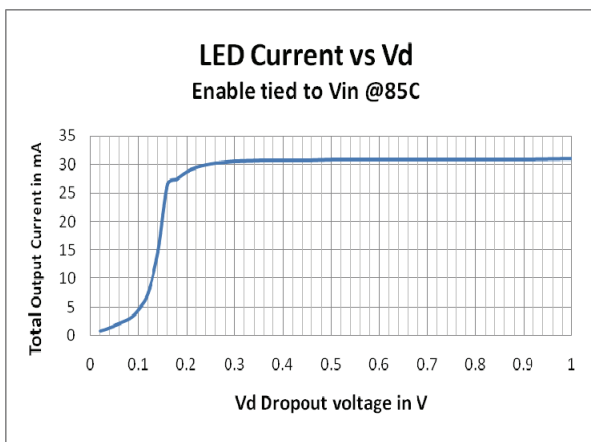
The quiescent current is part of the total output current



*I<sub>OUT</sub> is for 2 Channels 15mA per channel*



*I<sub>OUT</sub> is for 2 Channels 15mA per channel*

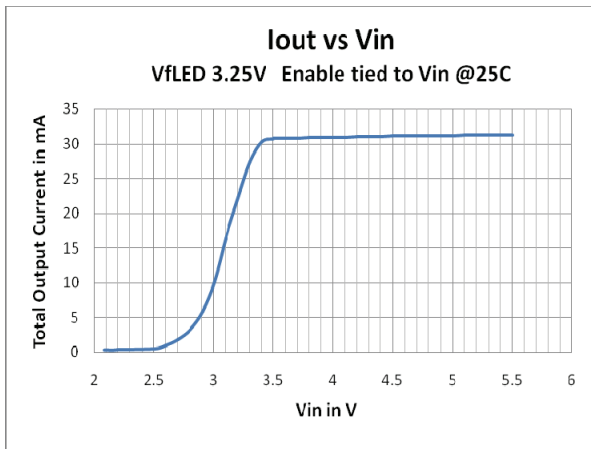


*I<sub>OUT</sub> is for 2 Channels 15mA per channel*

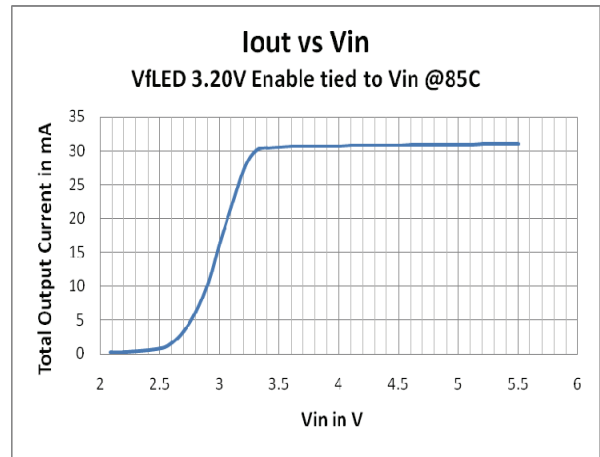
*I<sub>OUT</sub> is for 2 Channels 15mA per channel*

**TYPICAL PERFORMANCE SP7120A**

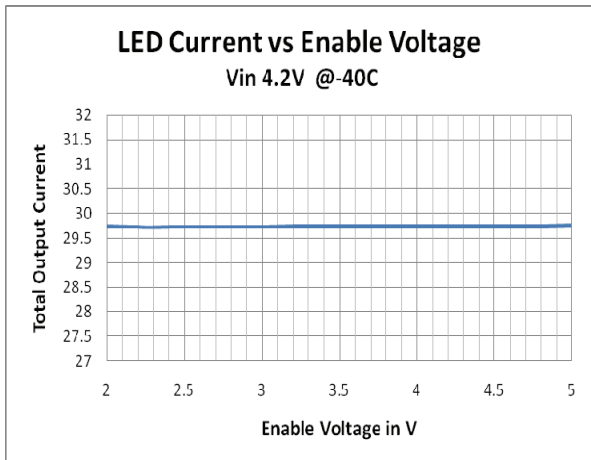
The quiescent current is part of the total output current



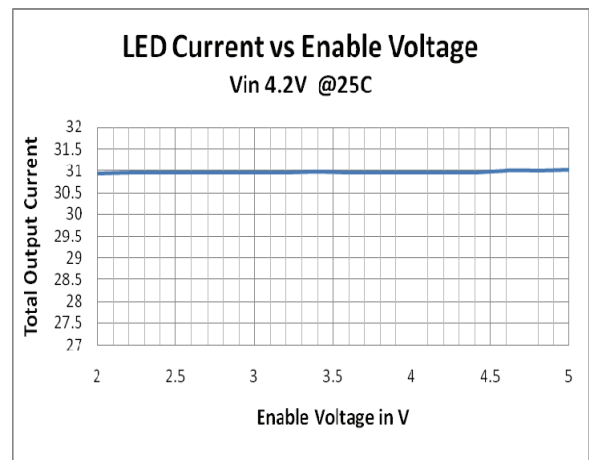
*I<sub>OUT</sub> is for 2 Channels 15mA per channel*



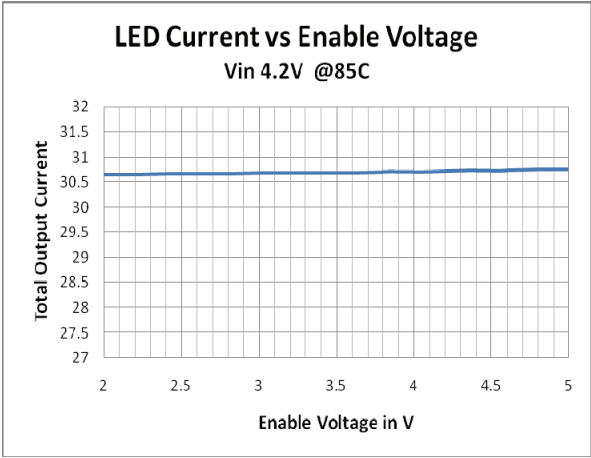
*I<sub>OUT</sub> is for 2 Channels 15mA per channel*



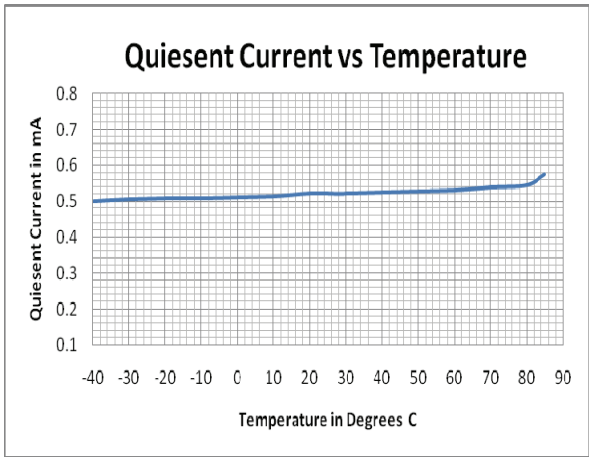
*I<sub>OUT</sub> is for 2 Channels 15mA per channel*



*I<sub>OUT</sub> is for 2 Channels 15mA per channel*

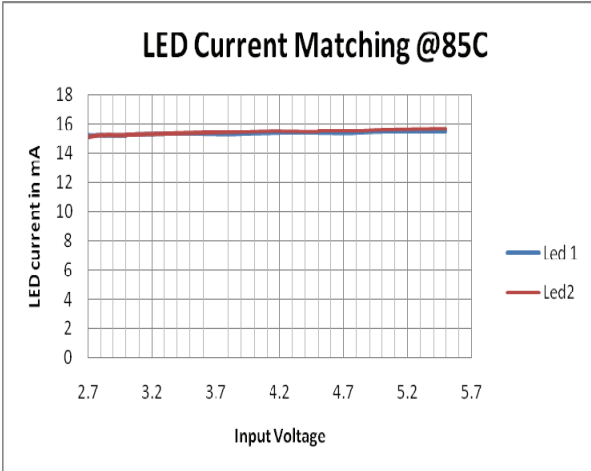
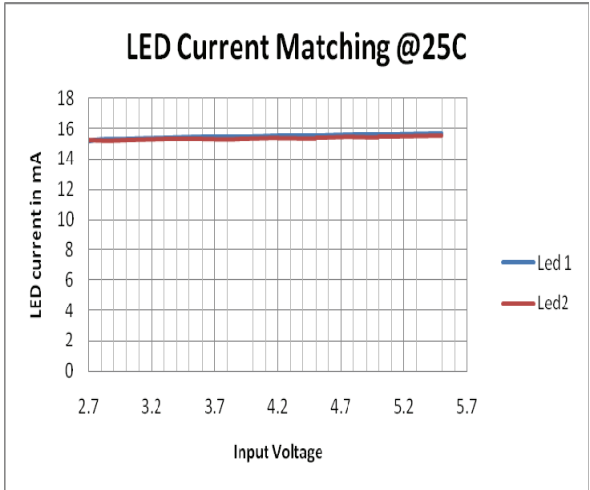
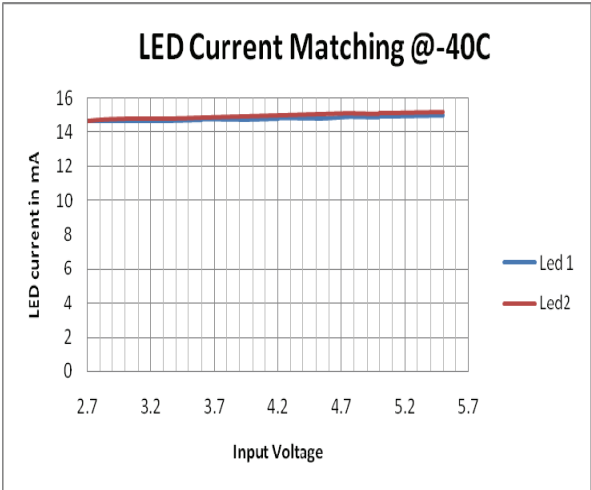


*I<sub>OUT</sub> is for 2 Channels 15mA per channel*

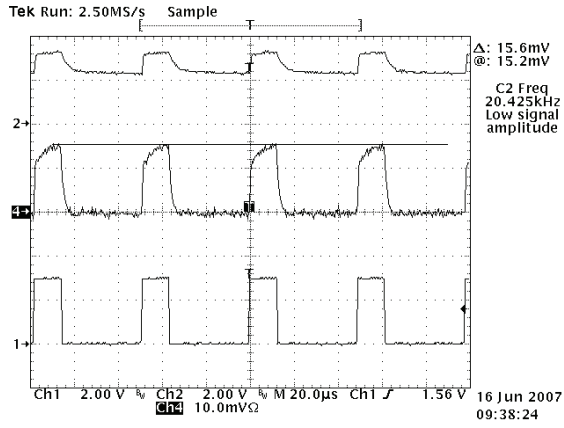


*I<sub>OUT</sub> is for 2 Channels 15mA per channel*

**TYPICAL PERFORMANCE SP7120A**

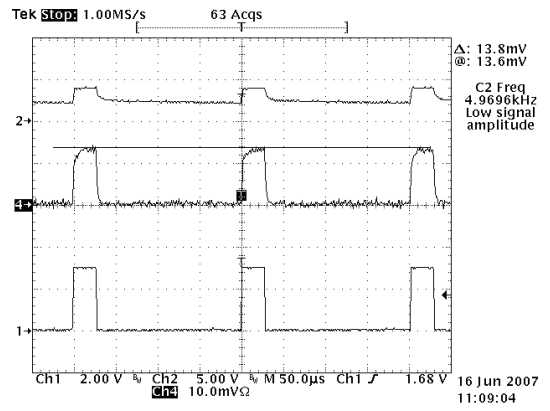






**PWM Minimum duty cycle 15µS 20kHz**

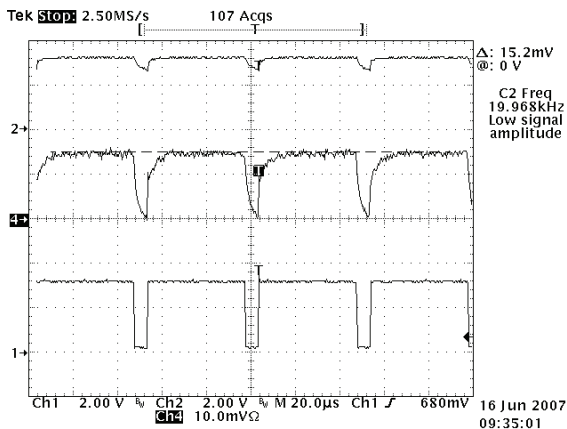
CH1: PWM Signal CH2 Anode of LED  
CH4: LED current 10mA/div



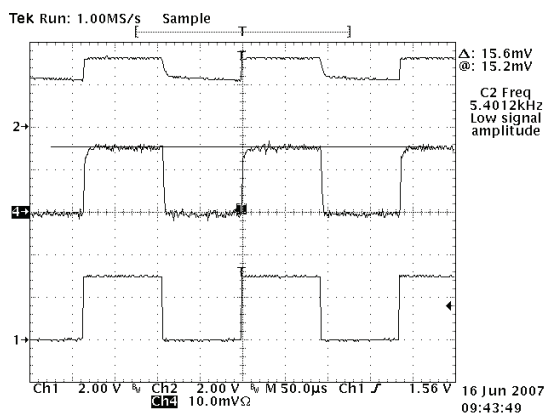
**PWM Low duty cycle 15µS 5kHz**

CH1: PWM Signal CH2: Anode of LED  
CH4: LED current 10mA/div

**TYPICAL PERFORMANCE SP7120A**



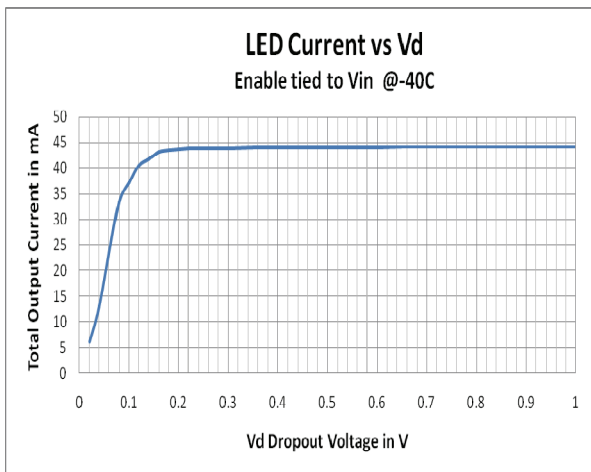
**PWM High Duty Cycle 20kHz**  
 CH1: PWM Signal CH2: Anode of LED  
 CH4: LED current 10mA/div



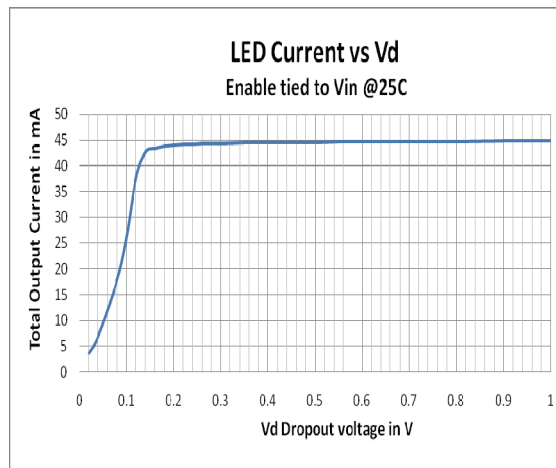
**PWM 50% Duty Cycle 5kHz**  
 CH1: PWM Signal CH2: Anode of LED  
 CH4: LED current 10mA/div

**TYPICAL PERFORMANCE SP7122A**

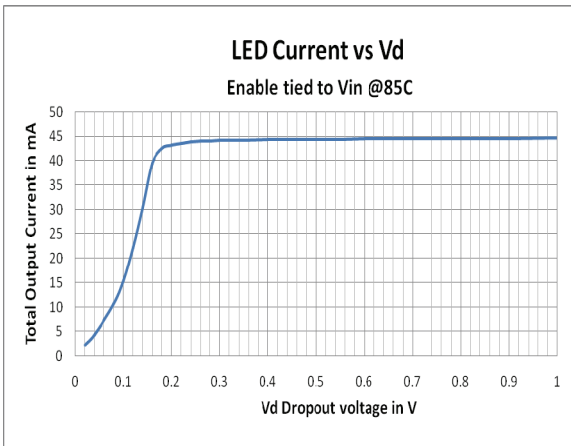
The quiescent current is part of the total output current



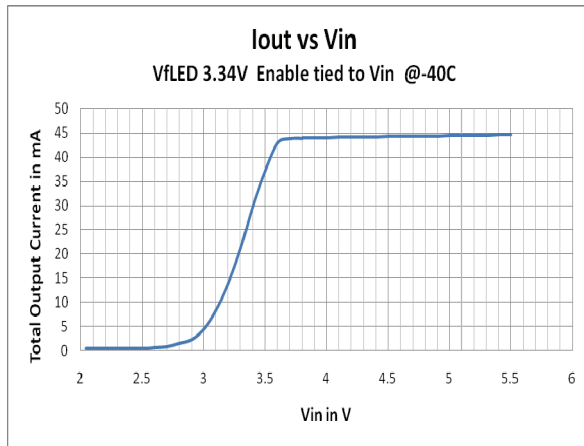
**IOUT is for 3 Channels 15mA per channel**



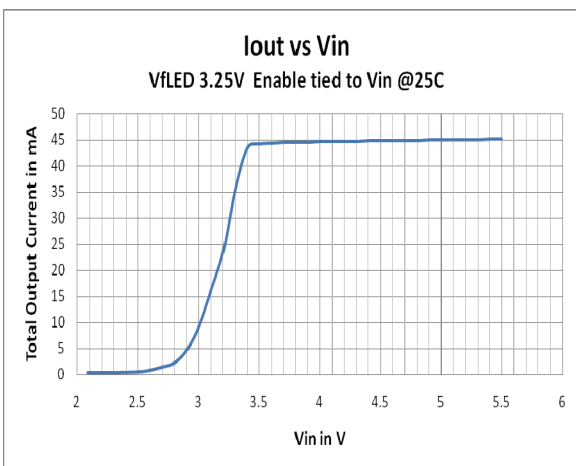
**IOUT is for 3 Channels 15mA per channel**



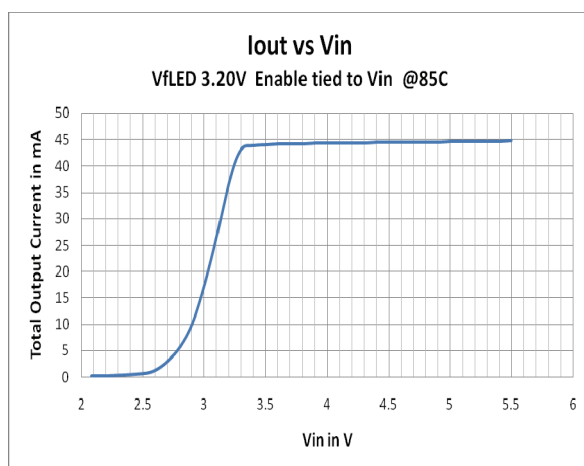
**IOUT is for 3 Channels 15mA per channel**



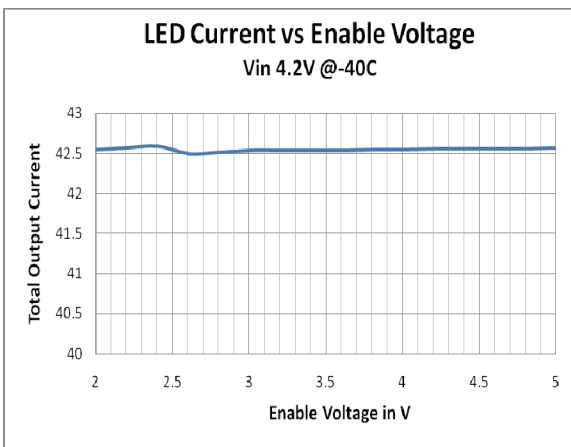
**IOUT is for 3 Channels 15mA per channel**



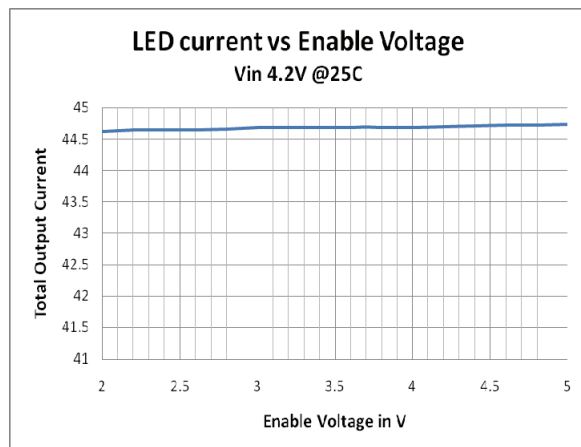
**IOUT is for 3 Channels 15mA per channel**



**IOUT is for 3 Channels 15mA per channel**

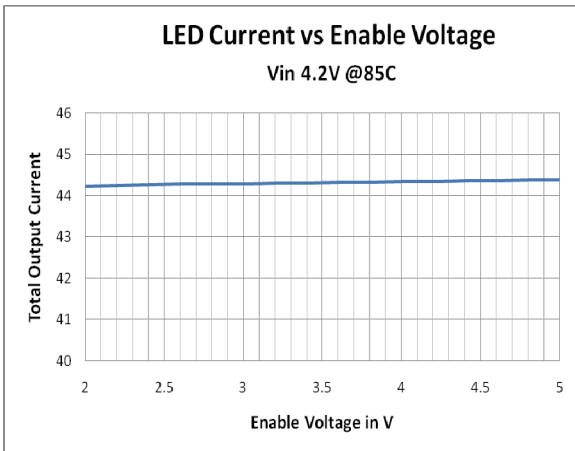


**IOUT is for 3 Channels 15mA per channel**

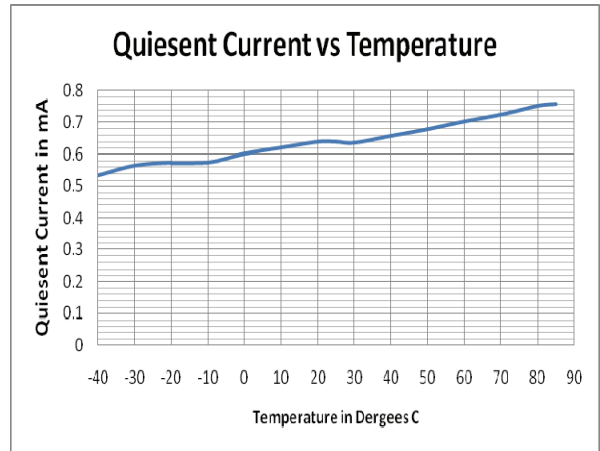


**IOUT is for 3 Channels 15mA per channel**

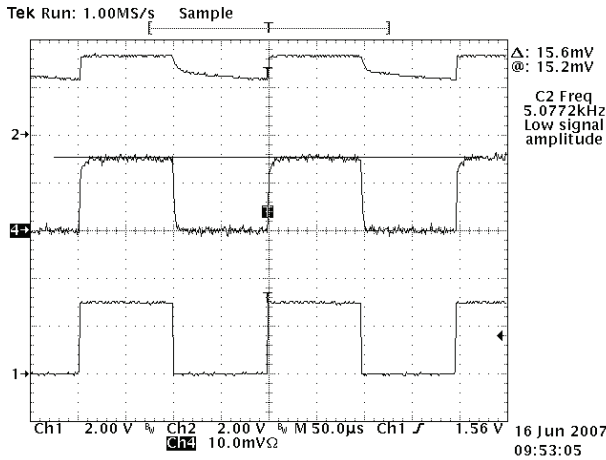
The quiescent current is part of the total output current



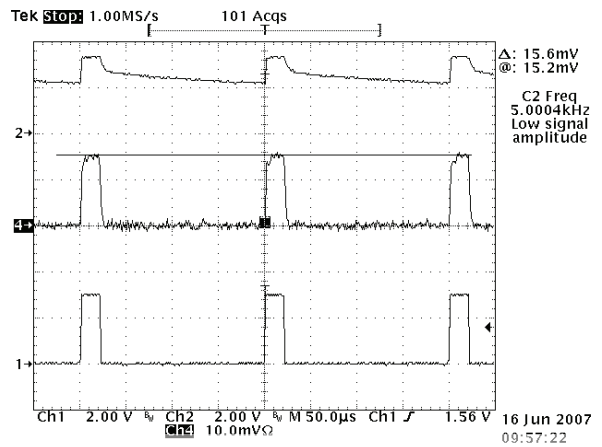
**IOUT is for 3 Channels 15mA per channel**



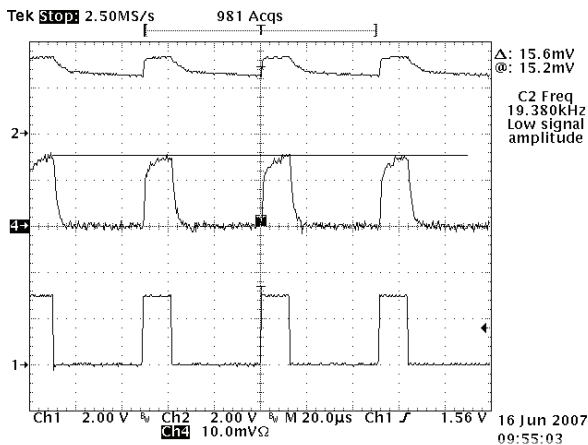
**IOUT is for 3 Channels 15mA per channel**



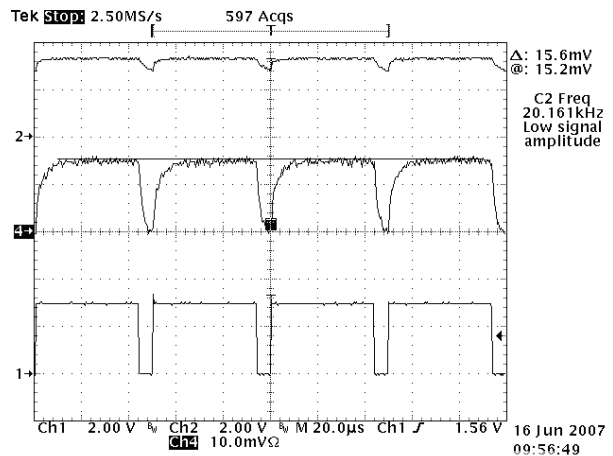
**50% Duty Cycle 5KHz PWM**  
CH1: PWM Signal CH2: Anode of LED  
CH4: LED current 10mA/div



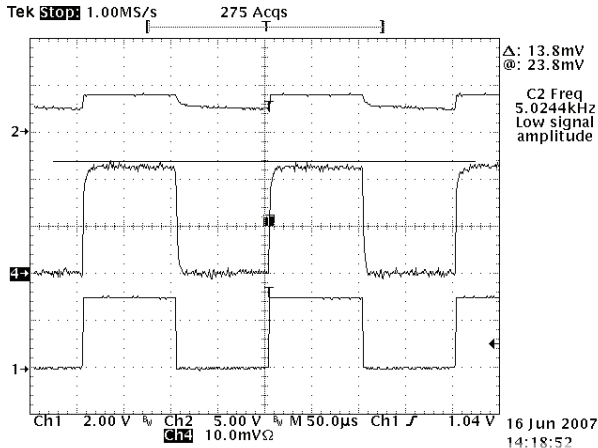
**Low duty cycle 5KHz**  
CH1: PWM Signal CH2: Anode of LED  
CH4: LED current 10mA/div



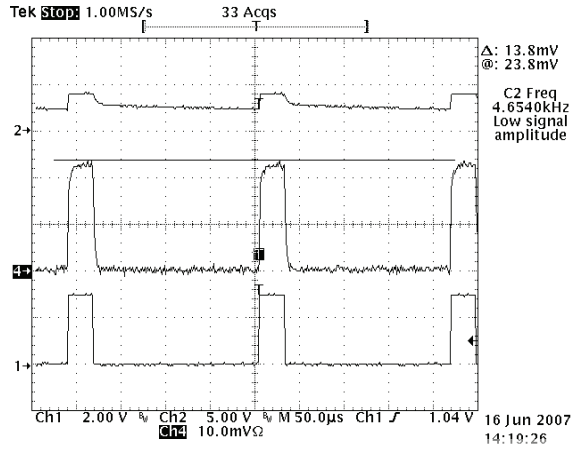
**Minimum On time 15µS 20kHz PWM**  
CH1: PWM Signal CH2: Anode of LED  
CH4: LED current 10mA/div



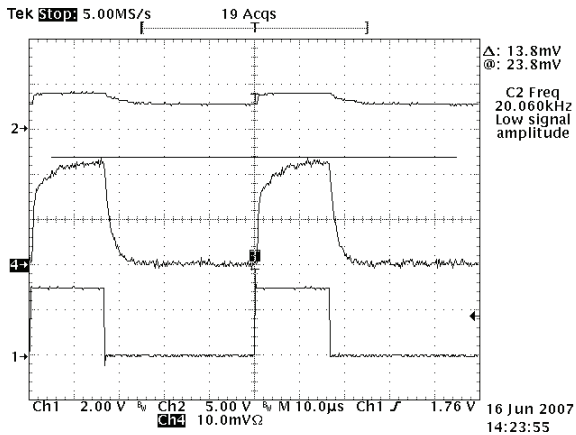
**High Duty Cycle 20kHz**  
CH1: PWM Signal CH2: Anode of LED  
CH4: LED current 10mA/div



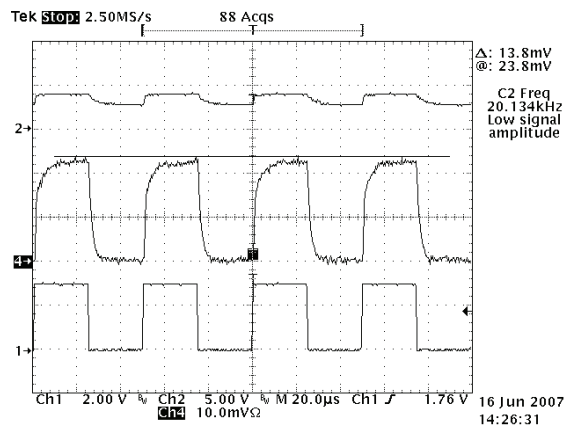
**PWM 50% Duty Cycle Single LED 5kHz**  
 CH1: PWM Signal CH2 Anode of LED  
 CH4: LED current 20mA/div



**PWM Low Duty Cycle Single LED 5kHz**  
 CH1: PWM Signal CH2 Anode of LED  
 CH4: LED current 20mA/div

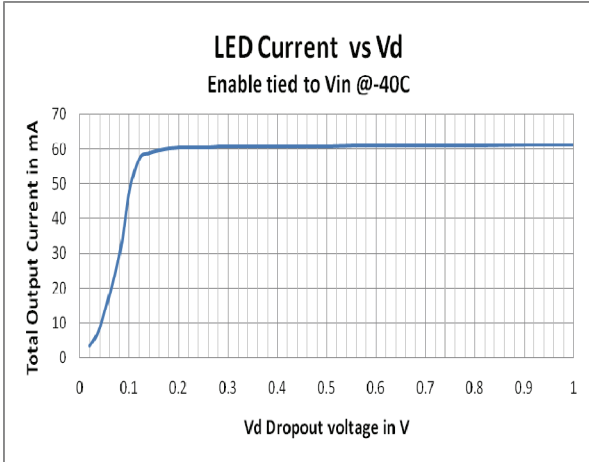


**PWM Minimum on time 15µS Single LED 20kHz**  
 CH1: PWM Signal CH2 Anode of LED  
 CH4: LED current 20mA/div

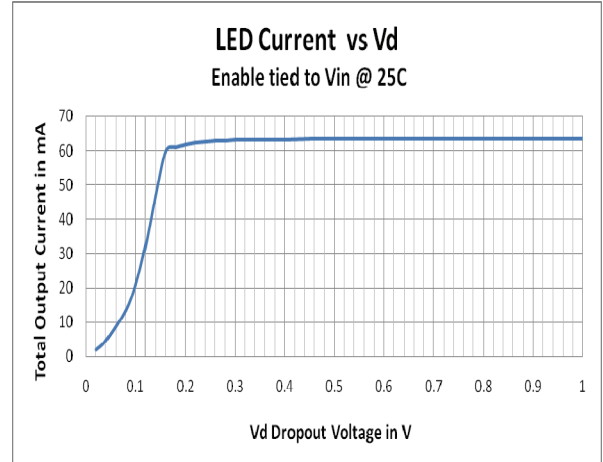


**PWM 50% Single LED 20kHz**  
 CH1: PWM Signal CH2 Anode of LED  
 CH4: LED current 20mA/div

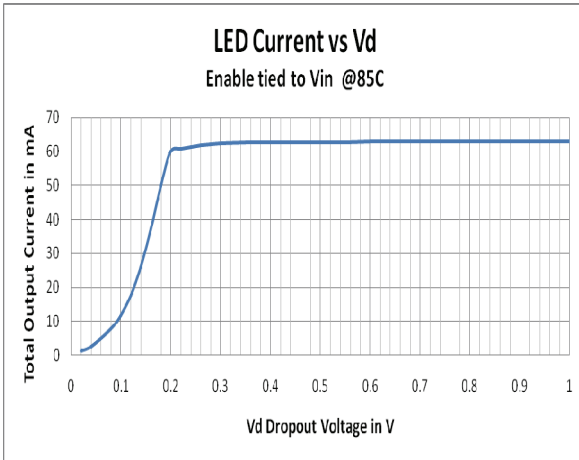
The quiescent current is part of the total output current



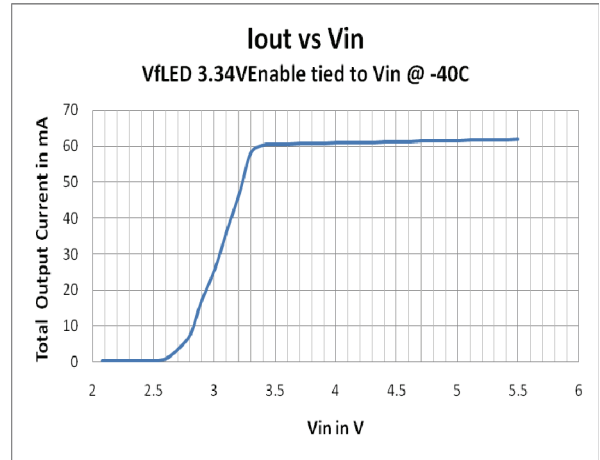
***I<sub>OUT</sub> is for 3 channels 20mA per channel***



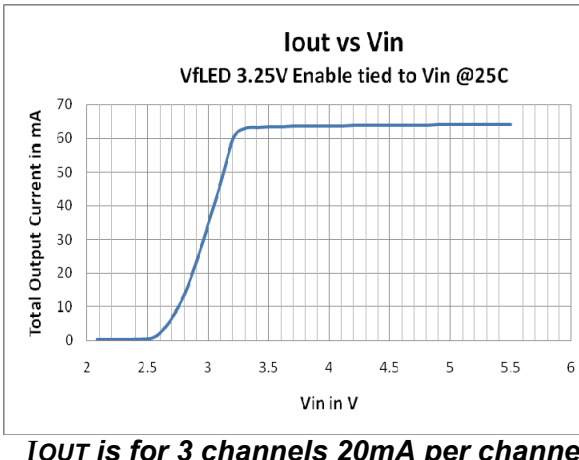
***I<sub>OUT</sub> is for 3 channels 20mA per channel***



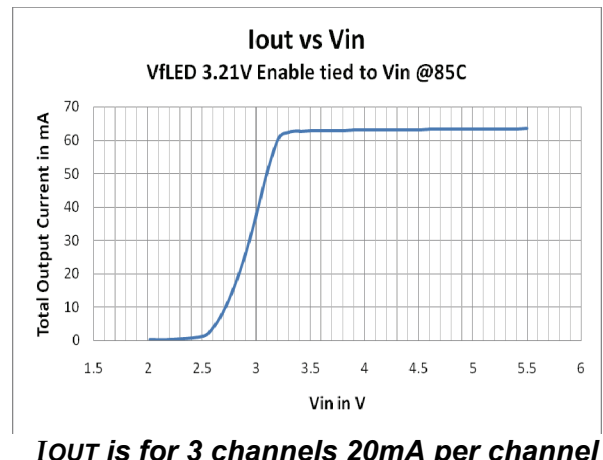
***I<sub>OUT</sub> is for 3 channels 20mA per channel***



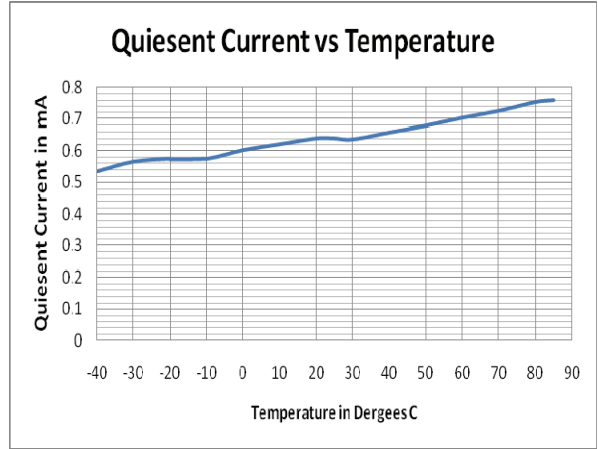
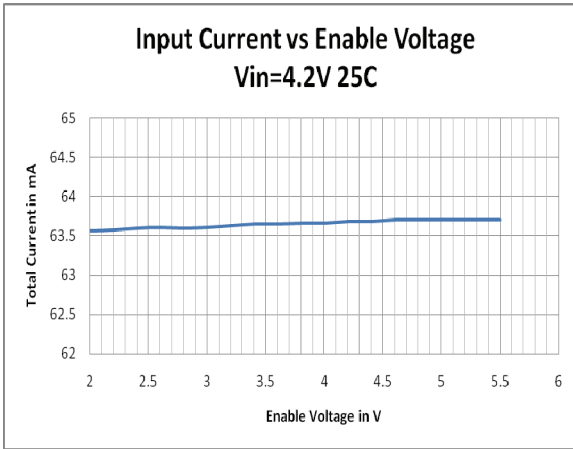
***I<sub>OUT</sub> is for 3 channels 20mA per channel***



***I<sub>OUT</sub> is for 3 channels 20mA per channel***

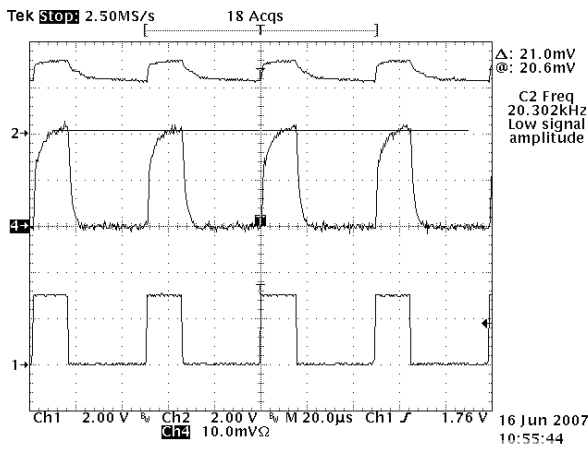


***I<sub>OUT</sub> is for 3 channels 20mA per channel***

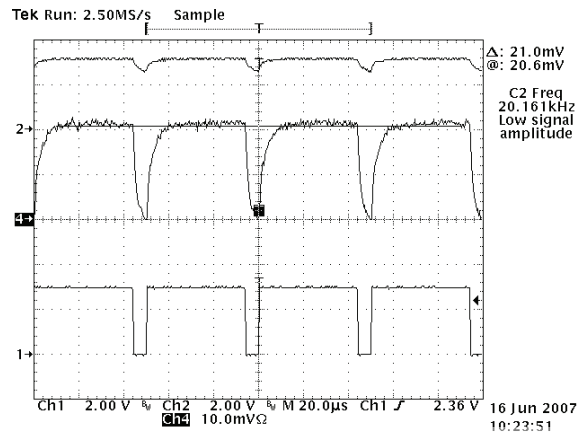


*I<sub>OUT</sub> is for 3 channels 20mA per channel*

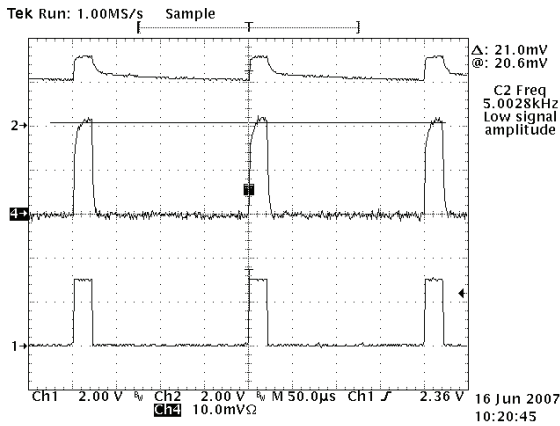
*I<sub>OUT</sub> is for 3 channels 20mA per channel*



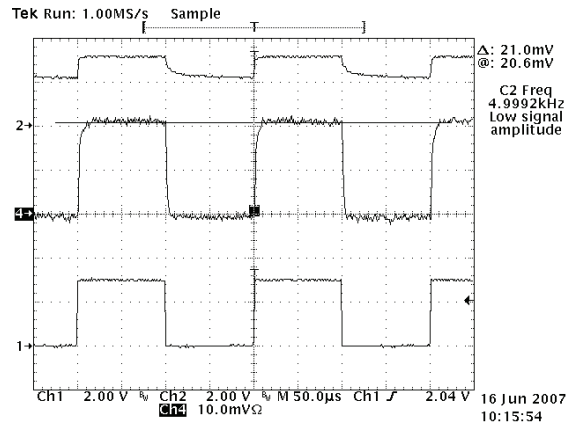
**PWM Minimum on time 15µs 20kHz**  
 CH1: PWM Signal CH2: Anode of LED  
 CH4: LED current 10mA/div



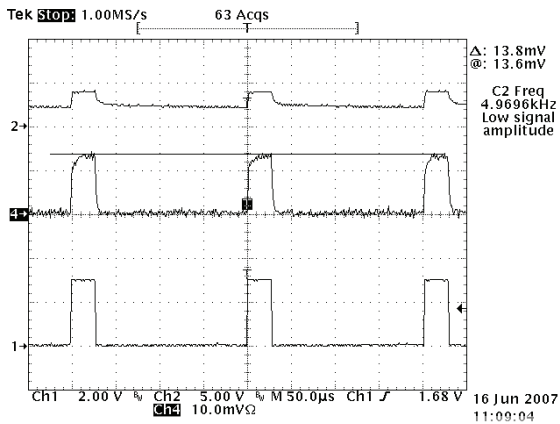
**PWM High Duty Cycle 20kHz**  
 CH1: PWM Signal CH2: Anode of LED  
 CH4: LED current 10mA/div



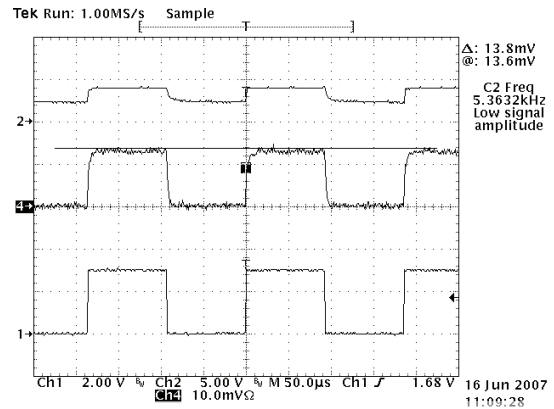
**PWM Low Duty Cycle 5kHz**  
 CH1: PWM Signal CH2: Anode of LED  
 CH4: LED current 10mA/div



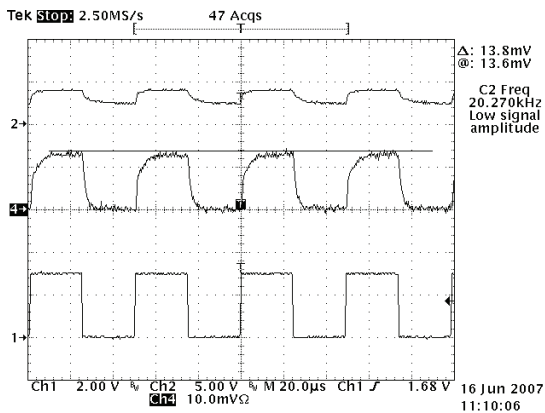
**PWM 50%Duty Cycle 5kHz**  
 CH1: PWM Signal CH2: Anode of LED  
 CH4: LED current 10mA/div



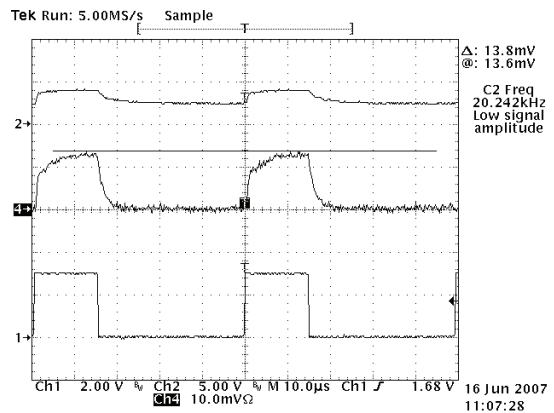
**PWM Low Duty Cycle Single LED 5kHz**  
CH1: PWM Signal CH2 Anode of LED  
CH4: LED current 50mA/div



**PWM 50% Duty Cycle Single LED 5kHz**  
CH1: PWM Signal CH2 Anode of LED  
CH4: LED current 50mA/div

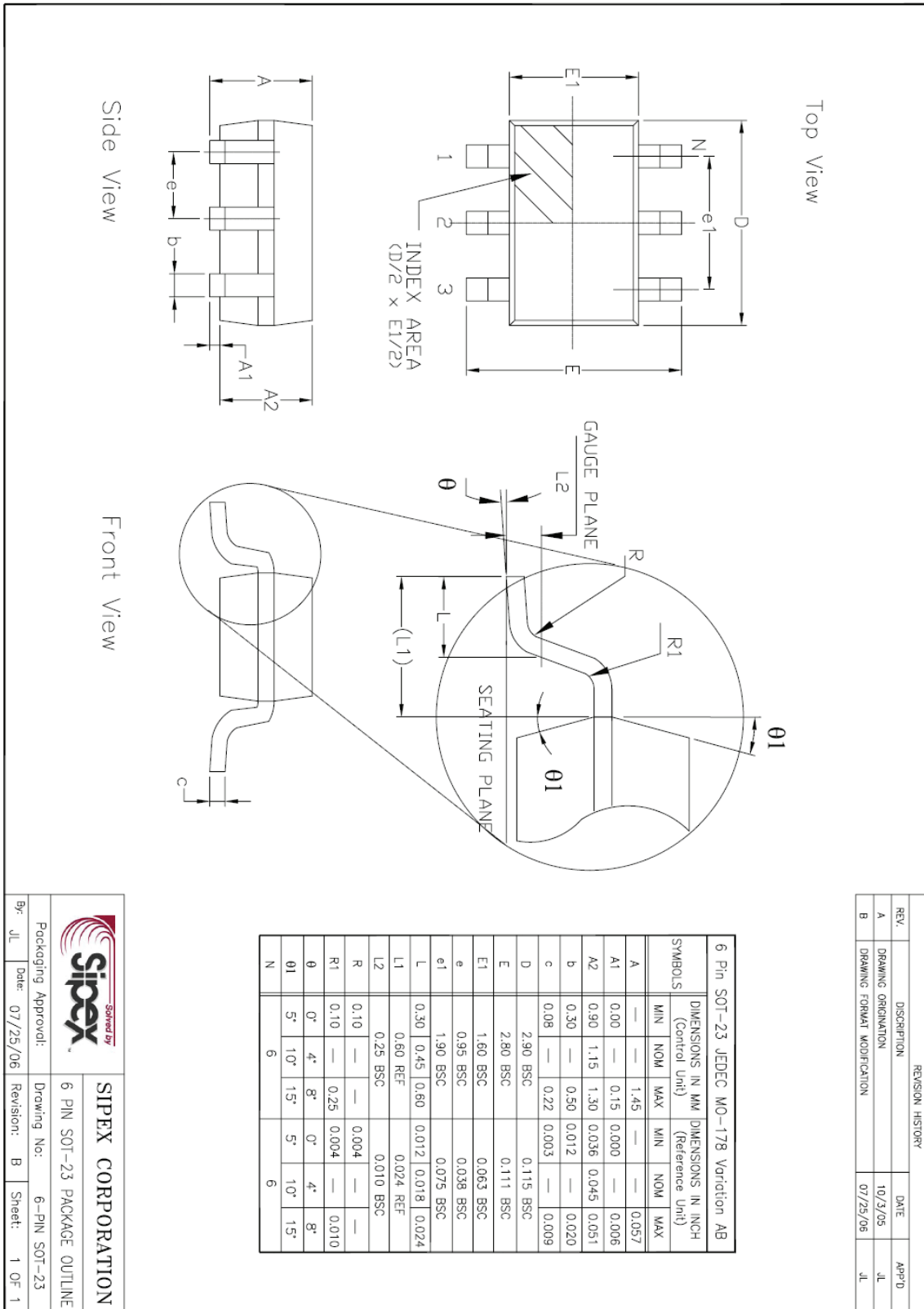


**PWM 50% Duty Cycle Single LED 20kHz**  
CH1: PWM Signal CH2 Anode of LED  
CH4: LED current 50mA/div




**PWM Minimum Duty Cycle 15μs Single LED 20kHz**  
CH1: PWM Signal CH2 Anode of LED  
CH4: LED current 50mA/div





| REVISION HISTORY |                             |          |       |
|------------------|-----------------------------|----------|-------|
| REV.             | DESCRIPTION                 | DATE     | APP'D |
| A                | DRAWING ORIGINATION         | 10/23/05 | JL    |
| B                | DRAWING FORMAT MODIFICATION | 07/25/06 | JL    |


**SIPEX CORPORATION**  
 Packaging Approval: 6 PIN SOT-23 PACKAGE OUTLINE  
 Drawing No: 6-PIN SOT-23  
 By: JL Date: 07/25/06 Revision: B Sheet: 1 OF 1

| Part Number    | Temp Range     | Package Type | RoHS/Lead Free | Output Current per Channel | # of Channels | $\Theta_{JA}$ (°C/W) | Moisture Sensitivity Level |
|----------------|----------------|--------------|----------------|----------------------------|---------------|----------------------|----------------------------|
| SP7120AEK-L/TR | -40°C to +85°C | SOT23-6      | Yes            | 15mA                       | 2             | 190                  | L1 @ 260°C                 |
| SP7120BEK-L/TR | -40°C to +85°C | SOT23-6      | Yes            | 20mA                       | 2             | 190                  | L1 @ 260°C                 |
| SP7120CEK-L/TR | -40°C to +85°C | SOT23-6      | Yes            | 25mA                       | 2             | 190                  | L1 @ 260°C                 |
| SP7122AEK-L/TR | -40°C to +85°C | SOT23-6      | Yes            | 15mA                       | 3             | 190                  | L1 @ 260°C                 |
| SP7122BEK-L/TR | -40°C to +85°C | SOT23-6      | Yes            | 20mA                       | 3             | 190                  | L1 @ 260°C                 |
| SP7122CEK-L/TR | -40°C to +85°C | SOT23-6      | Yes            | 25mA                       | 3             | 190                  | L1 @ 260°C                 |

Pack quantity is 2500 for SOT23-6 tape and reel.

For further assistance:

Email: [Sipexsupport@sipex.com](mailto: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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