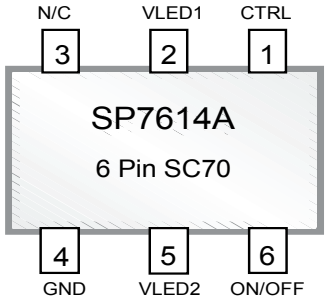
SP7612 SP7614

Low Dropout Linear LED Driver

FEATURES

- LED Drivers for parallel connected LEDs
- No EMI, no switching noise
- Integrated current matching
- PWM and Analog brightness control
- Enable/Shutdown control
- Shutdown current < 0.01µA
- Tiny, RoHS Compliant Lead-Free Packages: SC-70



Part #	Channels	Maximum Steady State Current per LED
SP7612	3	40mA
SP7614	2	80mA

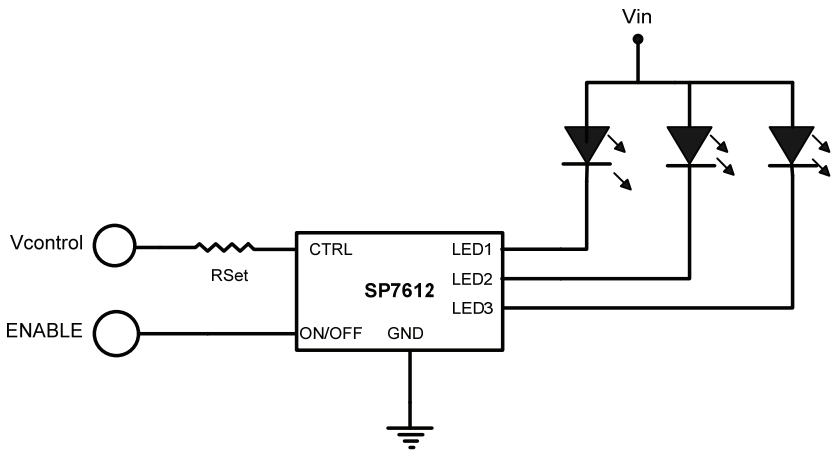
APPLICATIONS

- **Ultra low cost Handsets**
- **PDA, DSC, MP3 players**
- **Handheld Computers**
- **LCD Display Modules**
- **Keyboard Backlight**
- **LCD Backlight**

DESCRIPTION

The SP7612/4 provides a simple solution for a matched current source for any color LED. The current in the LEDs can be programmed by an external resistor. The SP7612 is capable of driving three LEDs, while the SP7614 can drive two LEDs. LED1 should always be connected to an LED and never left open in order to have the other LEDs driven with a matched current to LED1. The SP7612 and SP7614 feature Enable pins for flexible on/off control and PWM dimming. SP7612/4 has extremely low (0.01uA typical) shutdown current, prolonging the battery life and giving the longest standby period possible in today's modern design. It is available in a small footprint 6-pin SC-70 package.

TYPICAL APPLICATION SCHEMATIC



SP7612 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 periods of time may affect reliability.

V_{LED1}, V_{LED2}, V_{LED3}, V_{LED4} and ENABLE Voltage to GND ..... -0.3V to 6V
CTRL Voltage to GND . ...-0.5V
Output Current (I_{OUT}) (SP7612)..... 40mA
Output Current (I_{OUT}) (SP7614)..... 80mA
Power Dissipation per Package - 6-pin SC-70 at T_A =85°C..... 190mW
Junction Temperature ..... +150°C
Storage Temperature..... -55°C to +150°C
ESD Level..... 4kV HBM
ESD Level..... 1kV CDM

ELECTRICAL SPECIFICATIONS

Specifications are at T_A=25°C, V_{IN} = 3.3 to 5.5, ENABLE =V_{IN}, ♦ denotes the specifications which apply over the full operating temperature range, unless otherwise specified.

PARAMETER	PART #	MIN	TYP	MAX	UNITS	♦	CONDITIONS
LED Cathode Voltage (V_{LED})				5.5	V		See graph for LED Current vs. Cathode Voltage
Ambient Temperature		-40		85	ºC		
Output Current Multiplication Ratio in Linear Region (Note1)	SP7612	140	200	260			I_{SET} = 100µA V_{LED} = 300mV
	SP7614						I_{SET} = 100µA V_{LED} = 150mV
Output Current Multiplication Ratio in Saturation (Note1)	SP7612	365	435	505			I_{SET} = 25µA V_{LED} = 0.5V
	SP7614	730	870	1010			
LED to LED Current Matching		-3	0.8	3	%	♦	I_{SET} = 100µA V_{LED} = 300mV
Current in OFF Mode			0.01	1	µA	♦	V_{ENABLE} = 0.0V
Min. ENABLE ""ON Voltage" (Note 2)		3			V	♦	I_{SET} = 150µA
Max. ENABLE ""OFF Voltage" (Note 2)				0.5	V	♦	

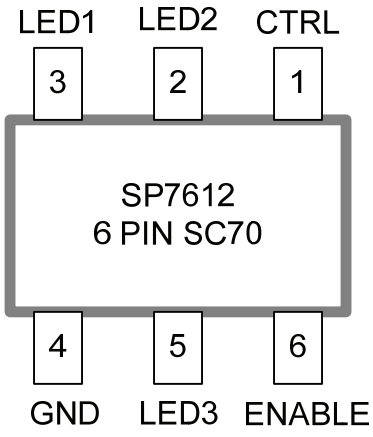
Note 1: Output current Multiplication Ratio (I_{LED}/I_{SET}) is not linear. For actual ratio and I_{LED} please refer to typical performance characteristics on pages 4 through 7.
Note 2: ENABLE "ON" is $V_{ON/OFF}$ where I_{LED1} > 20mA @ V_{LED1} = 0.3V.
ENABLE "OFF" is V where I < 1µA @ V > 0.3V.

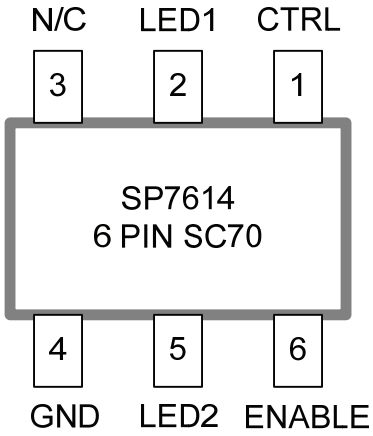
PIN DESCRIPTION

SC70 Package

Pin #	Pin Name		DESCRIPTION
	SP7612	**SP7614**	
1	CTRL	CTRL	Sets LED Current
2	LED2	LED1	Connect to Cathode of LED
3	LED1	NC	Connect to Cathode of LED
4	GND	GND	Ground
5	LED3	LED2	Connect to Cathode of LED
6	ENABLE	ENABLE	Chip ON/ OFF Disable

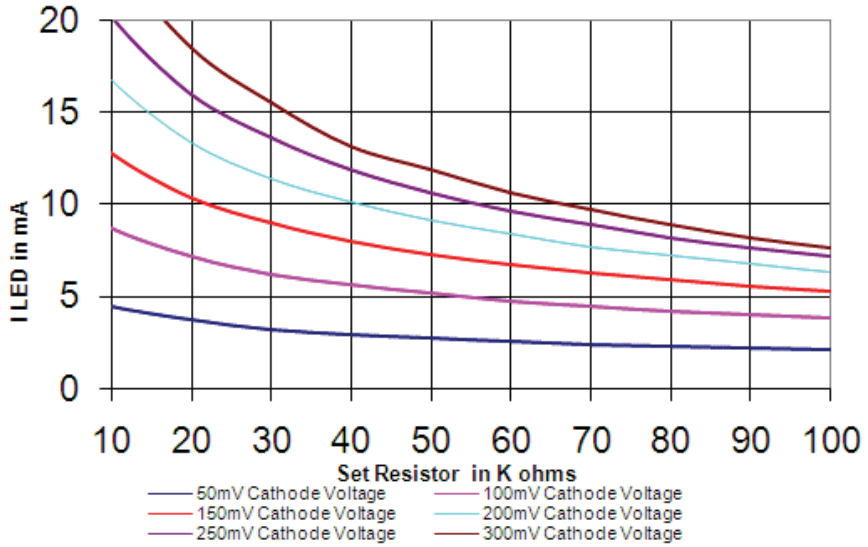
PINOUTS



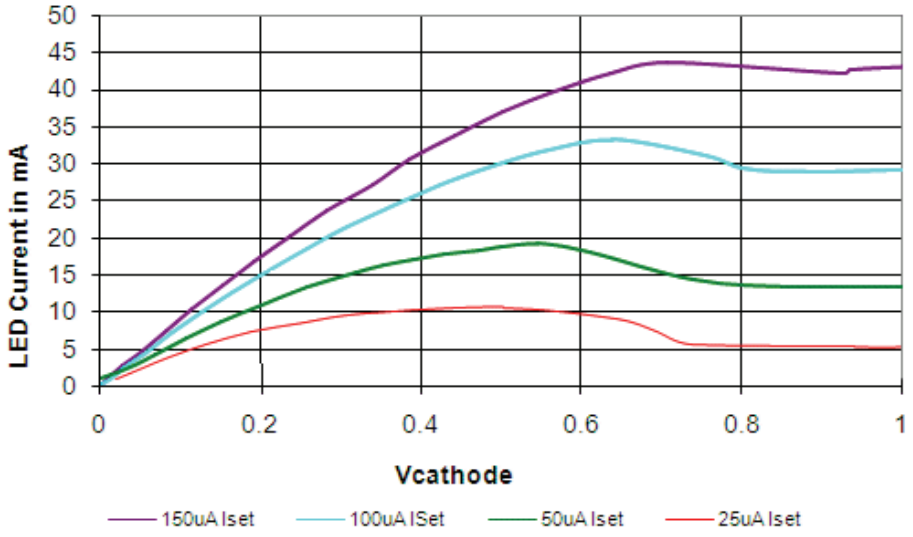


SP7612 TYPICAL PERFORMANCE CHARACTERISTICS

LED current vs Rset for LED voltage (Vcathode)
Vcontrol set to 3V

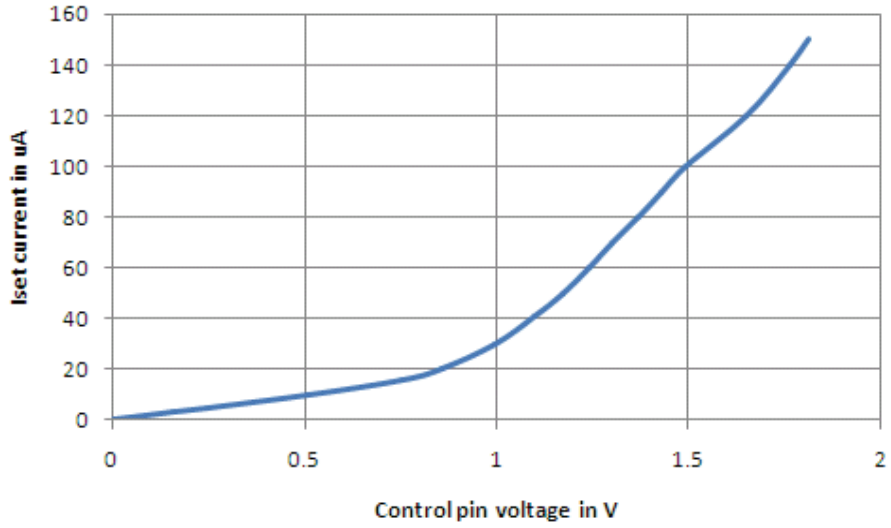


LED current vs Cathode voltage (VLED)



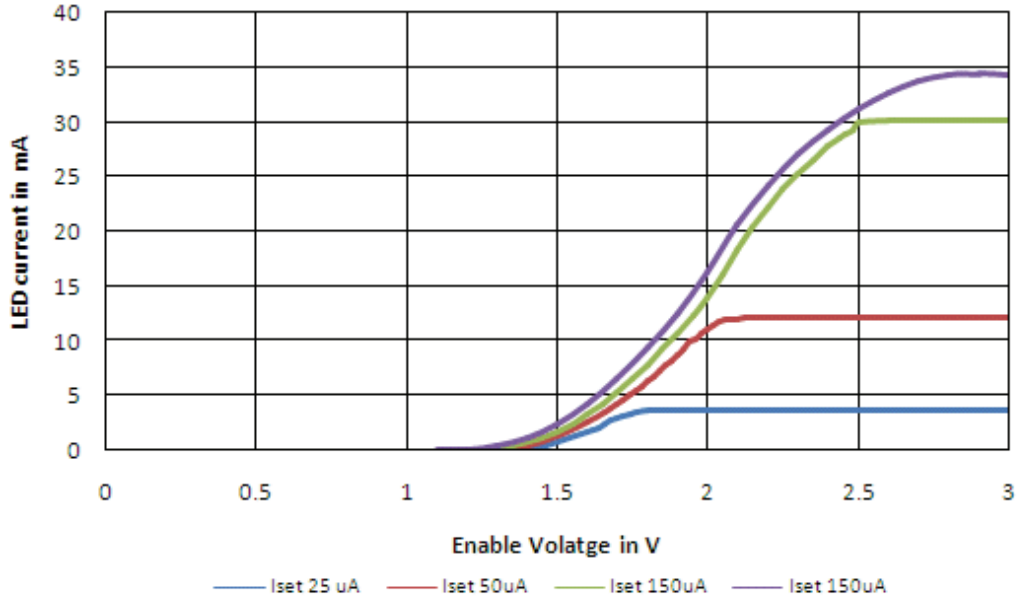
SP7612 TYPICAL PERFORMANCE CHARACTERISTICS

Iset vs Control pin voltage

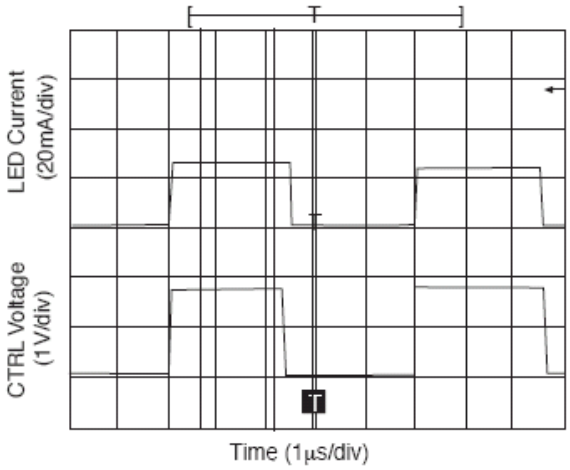


LED current vs Enable voltage

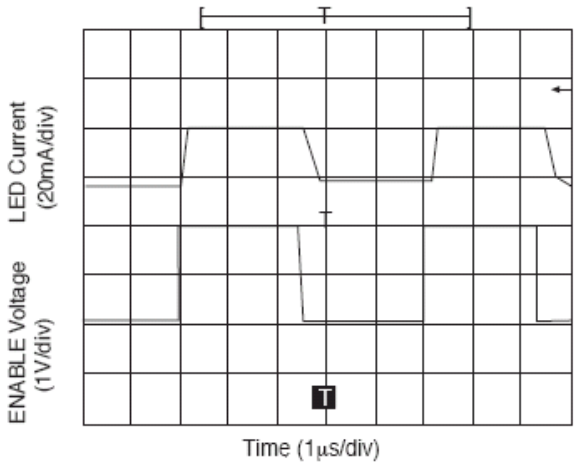
Iset at .5V VLED(cathode voltage)



Control Voltage Transient Response

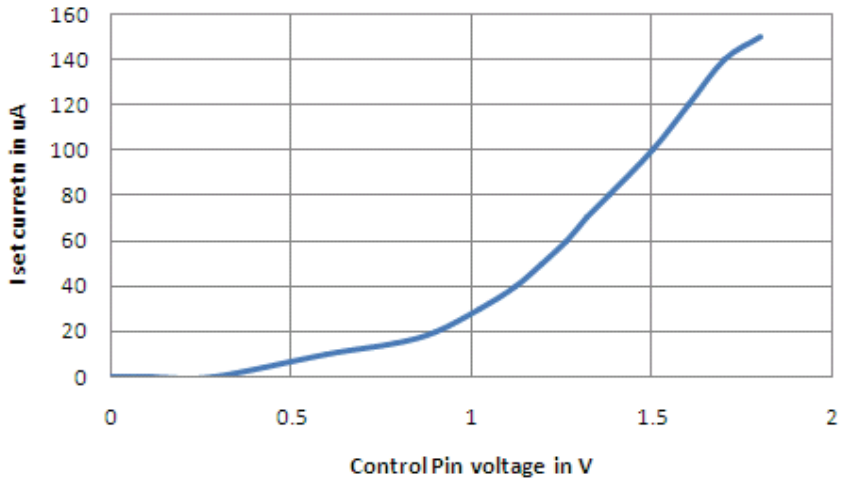


Enable Voltage Transient Response

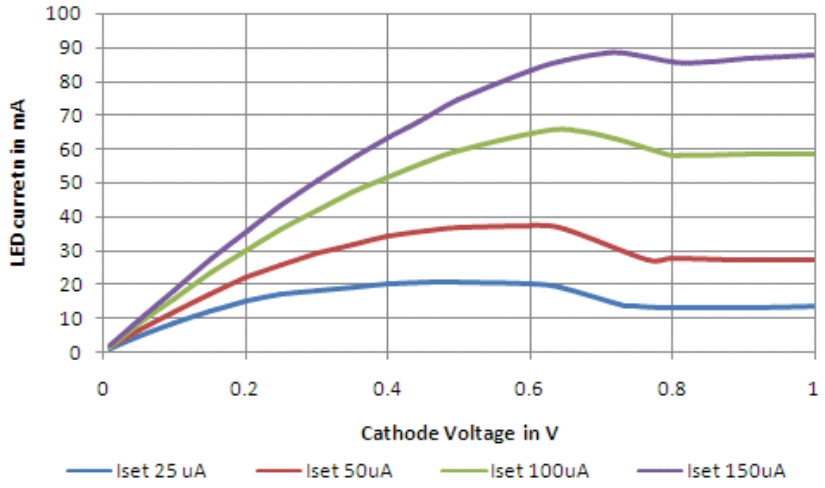


SP7614 TYPICAL PERFORMANCE CHARACTERISTICS

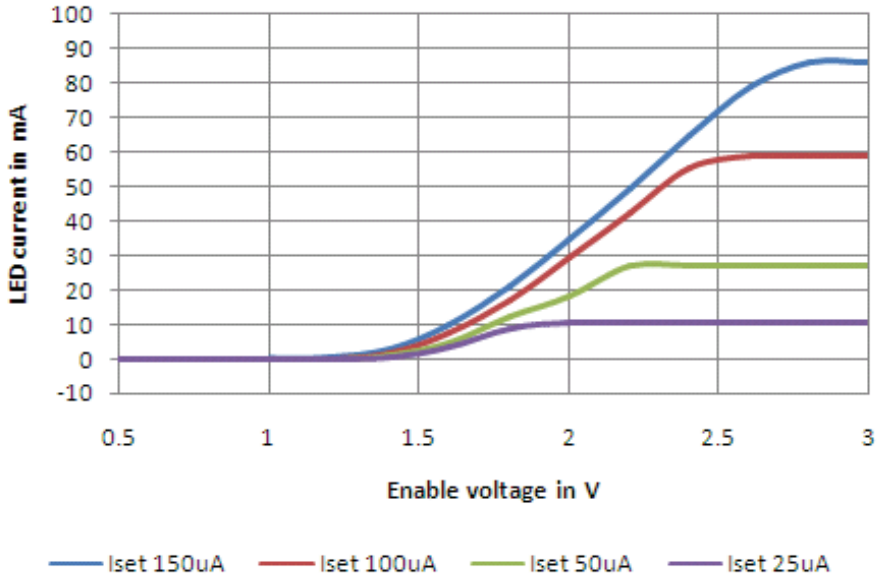
Iset vs Control pin voltage

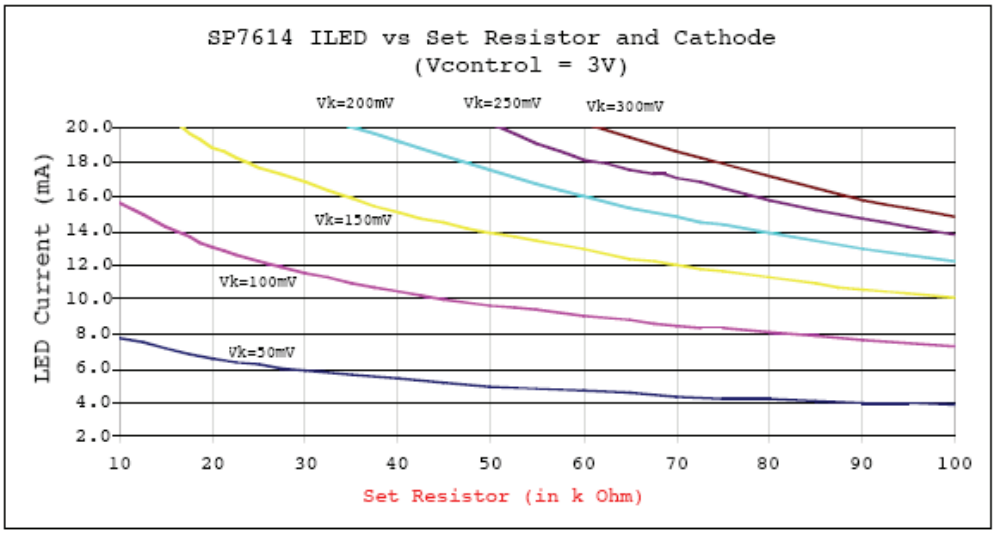


LED current vs Cathode voltage (VLED)

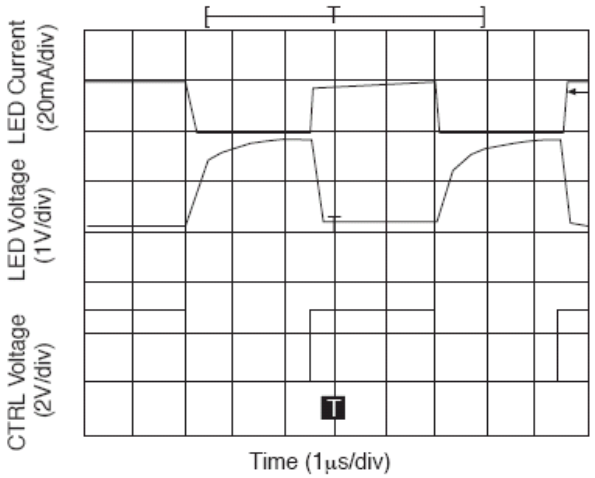


LED current vs Enable voltage
Iset at .5V VLED(cathode voltage)

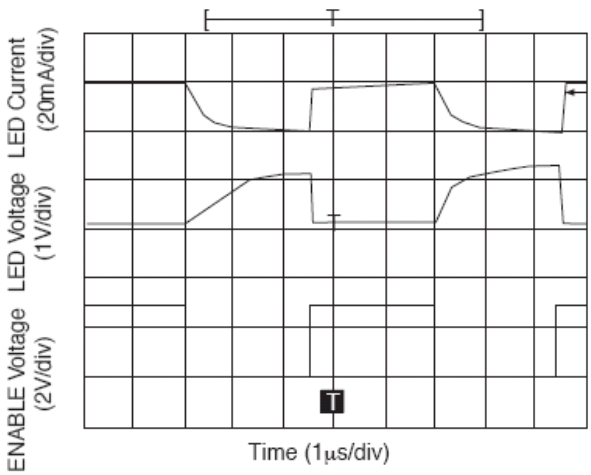




Control Voltage Transient Response



Enable Voltage Transient Response



Setting the LED Current

The LED current is controlled by $I_{CONTROL}$ and R_{SET} according to the following formula:

I_{LED} = Gain X ($V_{CONTROL}$ - V_{CTRL}) / R_{SET}

Gain depends on mode of operation
$V_{CONTROL}$ is the voltage going into R_{SET}
V_{CTRL} is the voltage at the pin of the device

The voltage V_{CTRL} can be determined using the I_{SET} vs Control voltage graph located in the typical performance characteristics section. As an example, to set the LED current for an SP761x the procedure is:

Take the LED current and divide it by the Gain to get I_{SET} = I_{LED} / Gain.
Look up the V_{CTRL} pin voltage using I_{SET} on the graph "Ctrl Current vs. Control Voltage".
Once V_{CTRL} is known, use the following formula to find R_{SET}. The gain is not linear, the LED current vs. Cathode voltage graph needs to be used to determine gain. Typically, the gain is ~870 for SP7614 and ~435 for SP7612 when the part is operating in the linear region.

$$R_{SET} = (V_{CONTROL} - V_{CTRL}) / I_{SET}$$

R_{SET} Example

For an SP7614 with $V_{CONTROL}$ of 3V and LED current of 20mA.

I_{SET} = 20mA/870 (870 is the typical gain in linear operation) = 22uA.

Using the graph on page 5 in the typical performance section, the V_{CTRL} voltage on the control pin will be about 1.1V, then R_{SET} will be determined by:

R_{SET} = (3V - 1.1V) / 22uA
R_{SET} = 86KΩ

PWM FUNCTION

The LED's brightness can also be adjusted by driving either the ENABLE or the CTRL pin with a PWM signal. The driving signal frequency should be greater than 100Hz to avoid flickering, increasing to more than 1MHz, if necessary.

Temperature Considerations

LEDs are very sensitive to temperature. In most cases the maximum allowed junction temperature is 100ºC. The case of overtemperature due to power dissipation is de-scribed by the following:

$$T_J = T_A + \Theta_{JA} \times I \times V_F$$

where T_J is the LED junction temperature,
T_A is the ambient temperature,
Θ_{JA} is the junction to ambient thermal resistance,
I is the LED current and
VF is the LED forward voltage.

When the temperature rises and the cathode voltage increases, SP7612/4 reduces the current through LEDs. Refer to "LED Current vs. LED Cathode Voltage" graph under the Typical Performance Characteristics section.

Efficiency

The system efficiency, defined as the ratio between the LED's power and the input supplied power can be calculated as follows:

Efficiency = (V_{IN} - $V_{CATHODE}$) / V_{IN}

The lower the $V_{CATHODE}$, the higher the system efficiency. Efficiency can be further improved using a higher V_{IN} with more LEDs as shown in example 3. The SP7612/4 driver's low dropout architecture can significantly improve the efficiency compared to using simple ballast resistors.

Application Information

The ultra-low voltage drop across the SP7612/4 series of LED drivers allows the devices to drive white, blue, and other color LEDs in a wide range of input voltages. The driver can be used in many applications. Any of the SP7612/4 series of LED drivers can be used in the applications presented in this document, due to their similar operation.

Example 1:
Drive low V_F white or blue LEDs directly from single cell Li-Ion

When using white or blue low V_F LEDs, and utilizing the driver's low voltage drop, only 3.4V V_{IN} is needed for the full 20mA LED current. At 3.1V, there is still 5mA of typical current available for the LEDs.

The single cell Li-Ion battery is utilized in many applications like cell phones or digital still cameras. In most cases, the Li-Ion battery voltage level only goes down to 3.0V, and not down to the full discharge level (2.7V) before requesting the charger.

V_{DROP} < 0.3V. This is the dropout voltage for the SP7611A.
- V_F = 3.1V. Low V_F white LED forward voltage drop
- V_{IN} (at 20mA) needs to be greater than (V_{DROP}+V_F)
3.1V+.3V= 3.4V

Key Advantages

1) No boost circuit needed for the LCD or keyboard backlight.
2) Drivers directly connected to a Li-Ion battery.
3) No EMI, no switching noise, no boost converter efficiency loss, 1 capacitor, and no inductor.

Example 2:
Drive high V_F white or blue LEDs from existing bus ~ 4.0V to 5.5V
High V_F LEDs have a forward voltage drop in the range of 3.2V to 4.0V. In order to drive these LEDs with the maximum current of 20mA, enabling maximum brightness usually requires a boost circuit for a single cell Li-Ion power supply. The SP761X series is capable of driving high V_F white or blue LEDs with its ultra-low dropout feature. The V_{IN} needs to be only 300mV higher than the highest V_F in the circuit.

- V_{DROP} < 0.3V. Dropout voltage of the SP7611A
- V_F (at 20mA) < 3.3V to 4.0V (High VF)
- V_{IN} (at 20mA) = V_{DROP} + V_F = 3.6V to 4.3V
- V_{IN} (at 5mA typical) ~ 3.3V

Where V_{IN} = Existing bus = 3.3V to 4.3V

Key Advantages
1) No boost circuit needed for the LCD or keyboard backlight.
2) Drivers utilize existing bus.
3) Ultra-low voltage drop provides the full 20mA LED current at the lowest possible voltage level.

LED Brightness Control

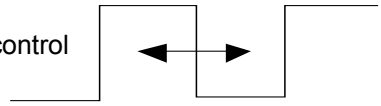
The SP7612/4 LED Drivers feature analog and PWM controls to give designers flexible brightness control. To determine the value of R_{SET} , use the "I_{SET} vs. V_{CRTL}" graph under the Typical Performance Characteristics.

1. SP7612/4
- **Analog using $V_{CONTROL}$**

Set $V_{CONTROL}$ and R_{SET} for LED current

SETTING THE LED CURRENT – page 8

- PWM - Vcontrol



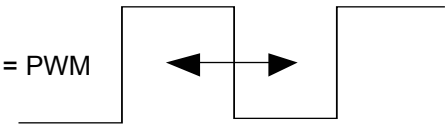
-Amplitude of PWM signal sets maximum LED current
-Pulse width controls current between 0 and maximum LED Set current

- **PWM using Enable**

- Set $V_{CONTROL}$ and R_{SET} for LED current

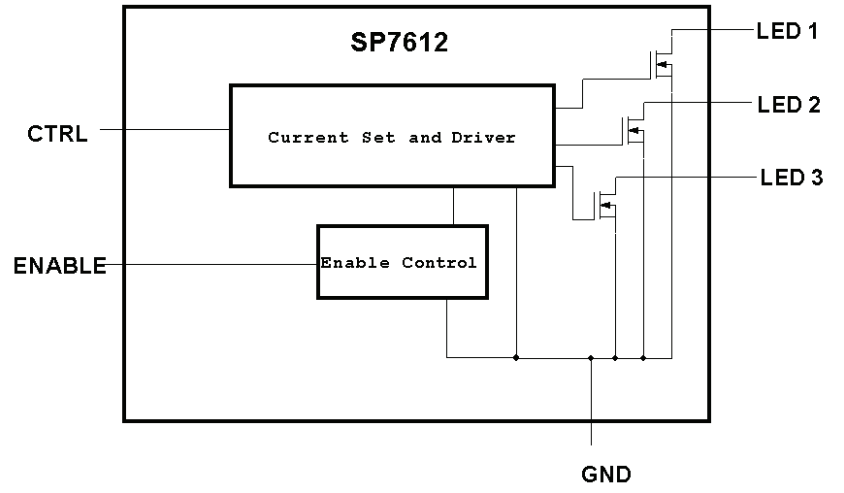
SETTING THE LED CURRENT – page 6

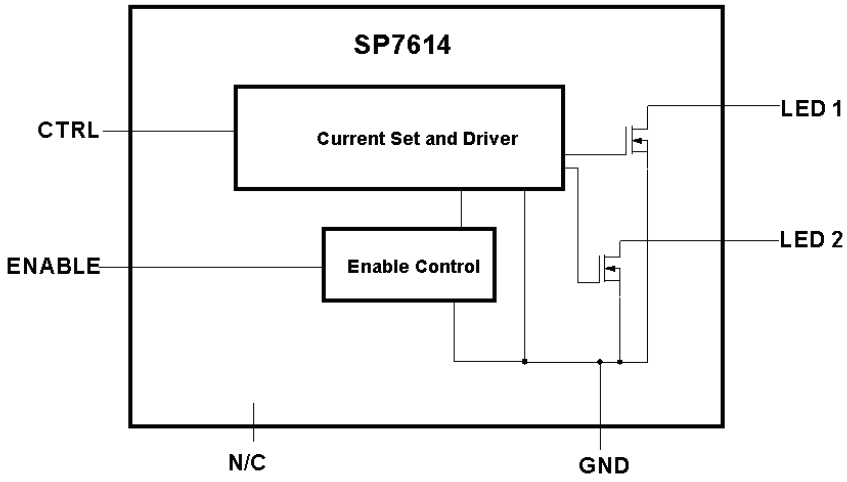
ENABLE = PWM



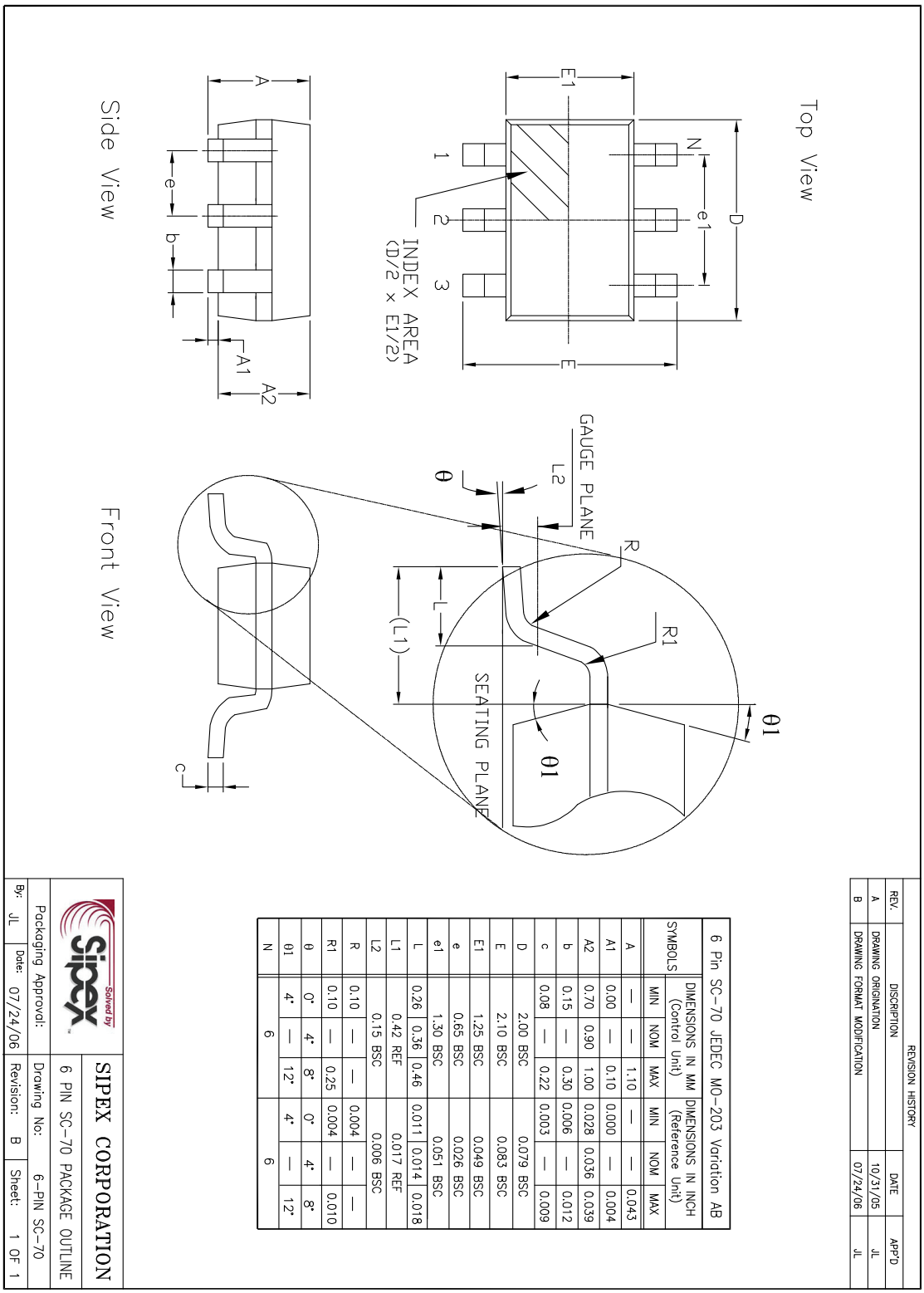
-Amplitude has no effect on current
-Pulse width controls current between 0 and maximum LED set current

BLOCK DIAGRAMS





PACKAGE: 6 PIN SC-70



REVISION HISTORY			
REV.	DESCRIPTION	DATE	APP'D
A	DRAWING ORGINATION	10/31/05	JL
B	DRAWING FORMAT MODIFICATION	07/24/06	JL

6 Pin SC-70 JEDEC MO-203 Variation AB

SYMBOLS	DIMENSIONS IN MM (Control Unit)			DIMENSIONS IN INCH (Reference Unit)		
	MIN	NOM	MAX	MIN	NOM	MAX
A	—	—	1.10	—	—	0.043
A1	0.00	—	0.10	0.000	—	0.004
A2	0.70	0.90	1.00	0.028	0.036	0.039
b	0.15	—	0.30	0.006	—	0.012
c	0.08	—	0.22	0.003	—	0.009
D	2.00 BSC			0.079 BSC		
E	2.10 BSC			0.083 BSC		
E1	1.25 BSC			0.049 BSC		
e	0.65 BSC			0.026 BSC		
e1	1.30 BSC			0.051 BSC		
L	0.26	0.36	0.46	0.011	0.014	0.018
L1	0.42 REF			0.017 REF		
L2	0.15 BSC			0.006 BSC		
R	0.10	—	—	0.004	—	—
R1	0.10	—	0.25	0.004	—	0.010
θ	0°	4°	8°	0°	4°	8°
θ1	4°	—	12°	4°	—	12°
N	6			6		

SIPEX CORPORATION			
6 PIN SC-70 PACKAGE OUTLINE			
Packaging Approval:	Drawing No:	6-PIN SC-70	
By: JL	Date: 07/24/06	Revision: B	Sheet: 1 OF 1

ORDERING INFORMATION

Part Number	Temperature Range	Package	RoHS	Pack Type	Pack Quantity	Status
SP7612EC6-L	-40°C to +85°C	6 Pin SC70	Yes	Canister	Any	Active
SP7612EC6-L/TR	-40°C to +85°C	6 Pin SC70	Yes	Tape & Reel	3000	Active
SP7614EC6-L	-40°C to +85°C	6 Pin SC70	Yes	Canister	Any	Active
SP7614EC6-L/TR	-40°C to +85°C	6 Pin SC70	Yes	Tape & Reel	3000	Active

/TR = Tape and Reel
Pack quantity is 2500 for SC70

For further assistance:

Email: customersupport@exar.com
EXAR Technical Documentation: http://www.exar.com/TechDoc/default.aspx?

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