ACT6311

ACT6311 WHITE LED/OLED Step-Up Converter

FEATURES

- Inherently Matched LED Current
- Adjustable Output Switch
- 30V High Voltage Switch
- 1.2MHz Switching Frequency
- Tiny Inductor and Capacitors are Allowed
- Tiny SOT23-5 Package

APPLICATIONS

- Cell Phones
- Digital Cameras
- PDAs, Handheld Computers
- MP3 Players
- GPS
- OLED Drivers

GENERAL DESCRIPTION

The ACT6311 step-up DC/DC converter drives white LEDs with a programmable constant current. The device is capable of driving up to seven LEDs in series from a Lithium-Ion battery. Current matching and uniform brightness is inherent in serial connection.

The ACT6311 also drives OLED

The ACT6311 incorporates a 30V high voltage switch. The device operates at 1.2MHz and allows the use of few external components.The ACT6311 is available in the tiny SOT-23 package.

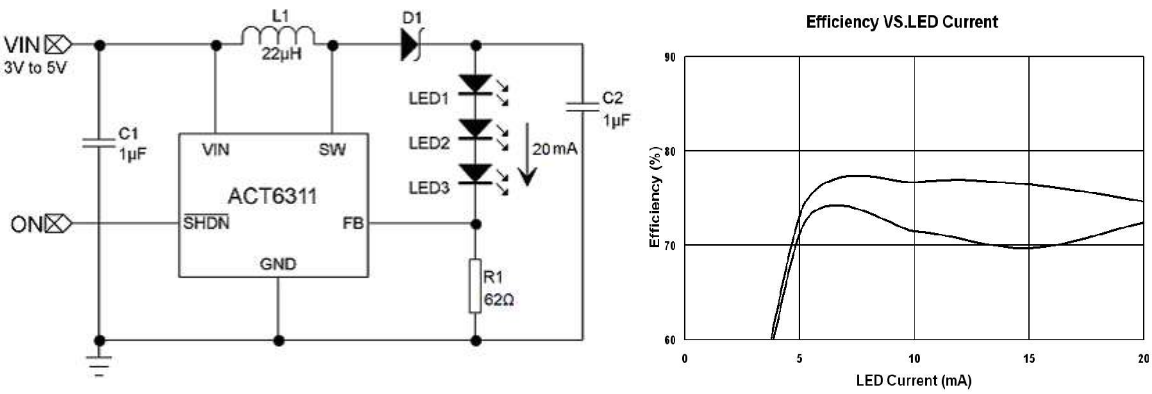


Figure 1A Typical Application Circuit

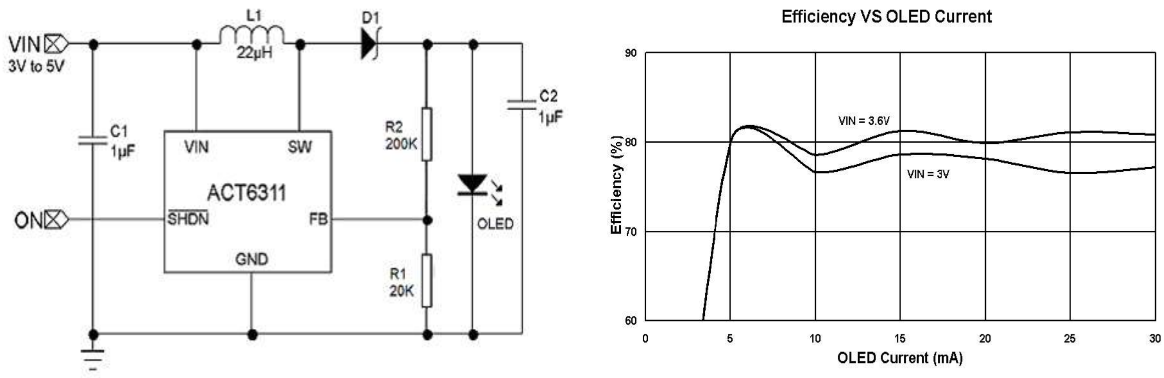
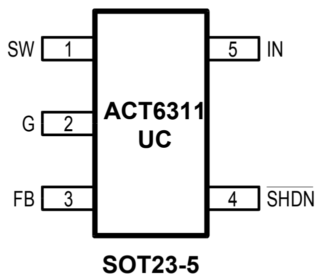


Figure 1B. ACT6311 as an OLED Driver

ORDERING INFORMATION

PART NUMBER	TEMPERATURE RANGE	PACKAGE	PINS	TOP MARK
ACT6311UC	-40°C to 85°C	SOT23-5	5	YCXB

PIN CONFIGURATION



PIN DESCRIPTION

PIN NUMBER	PIN NAME	PIN DESCRIPTION
1	SW	Switch Output. Connect this pin to the inductor and the Schottky diode. To reduce EMI, minimize the PCB trace path between this pin and the input bypass capacitor.
2	G	Ground
3	FB	Feedback Input. This pin is referenced to 1.23V. Connect this pin to the cathode of the lowest LED. Also connect a current feedback resistor R_1 between this pin and G based on the following equation: $R_1 = 1.23V/I_{LED}$
4	$\overline{SHDN}$	Shutdown Control. Connect to a logic high to enable device. Connect to a logic low to disable device and never leave the pin unconnected.
5	IN	Supply Input. Bypass to G with a capacitor of 1 µF or higher.

ABSOLUTE MAXIMUM RATINGS

(Note: Do not exceed these limits to prevent damage to the device. Exposure to absolute maximum rating conditions for long periods may affect device reliability.)

PARAMETER	VALUE	UNIT
VIN Input Voltage	-0.3 to 6	V
SW Voltage	-0.3 to 30	V
FB Voltage	-0.3 to V_{OUT}	V
SHDN Voltage	-0.3 to 6	V
Maximum Power Dissipation	0.4	W
Junction to Ambient Thermal Resistance (θ_{JA})	190	°C/W
Operating Junction Temperature	-40 to 150	°C
Lead Temperature (Soldering, 10 sec)	300	°C

ELECTRICAL CHARACTERISTICS

(T_A = 25°C, VIN = 3V, $V_{\overline{SHDN}}$ = 3V, unless otherwise specified.)

PARAMETER	SYMBOL	TEST CONDITIONS	MIN	TYP	MAX	UNIT
Minimum Input Voltage			2.5			V
Maximum Input Voltage					5.5	V
Feedback Voltage	V_{FB}	V_{IN} = 3V	1.20	1.24	1.28	V
FB Input Current				50		nA
Supply Current				0.7	1.5	mA
Supply Current in Shutdown		$\overline{SHDN}$ = G		0	1	µA
Switching Frequency	f_{SW}		0.8	1.2	1.6	MHz
Maximum Duty Cycle	D_{MAX}		80	85		%
Switch Current Limit	I_{LIM}			320		mA
Switch On Voltage		I_{SW} = 200mA		350		mV
Switch Leakage Current		V_{SW} = 30V, V_{IN} = 3V, $\overline{SHDN}$ = 0V			10	µA
$\overline{SHDN}$ Logic High Threshold		$V_{\overline{SHDN}}$ = G	1.6			V
$\overline{SHDN}$ Logic Low Threshold					0.4	V
$\overline{SHDN}$ Input Current				0	1	µA

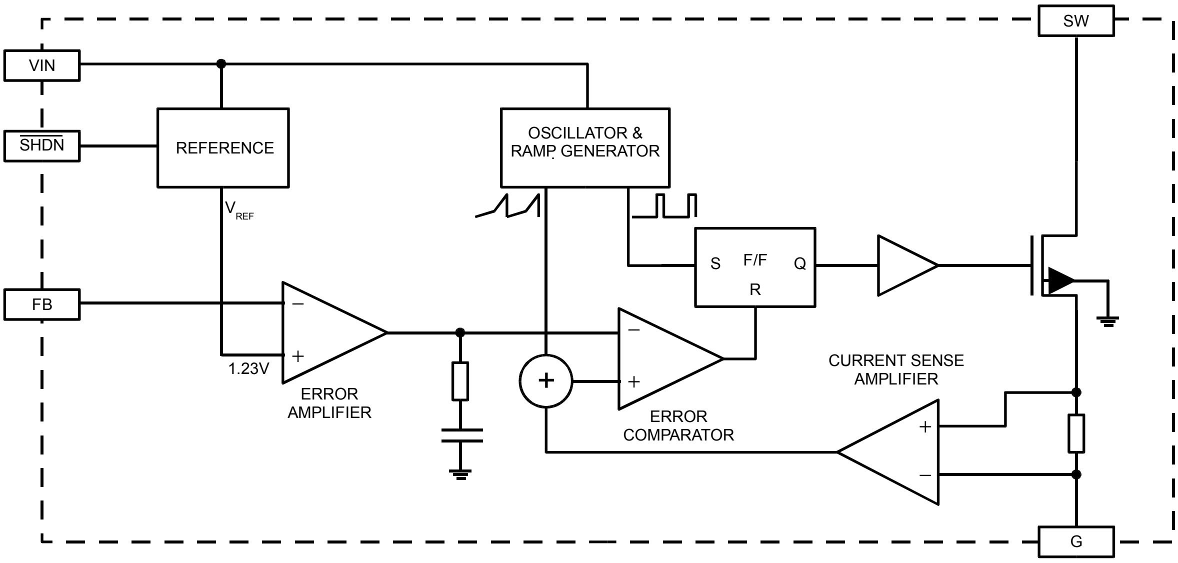


Figure 2. Functional Block Diagram

FUNCTIONAL DESCRIPTION

The ACT6311 is a highly efficient step-up DC/DC converter that employs current-mode, fixed frequency pulse-width modulation (PWM) architecture with excellent line and load regulation. Figure 2 shows the functional block diagram of the IC. The flip-flop is set at the start of each oscillator cycle, and turns on the power switch. During this ON time, the switch current level is sensed and added to a ramp signal, and the resulting sum is compared with the output of the error amplifier. If the error comparator output is high, the flip-flop is reset and the power switch turns off. Thus, the peak inductor current level is controlled by the error amplifier output, which is integrated from the difference between FB input and the 1.23V reference point.

The ACT6311 operates at constant switching frequency for output current higher than 4mA (for 3 LEDs from 4.2V supply). If the output current decreases further, the IC will enter pulse skipping mode, resulting in some low frequency ripple.

For medium level output current, the IC operates in discontinuous conduction mode (see *Switching Waveform in Discontinuous Mode* in Typical Performance Characteristics) and the waveform exhibits ringing as the inductor current drops to zero. This ringing has low energy, and can be suppressed by adding a 300Ω resistor in parallel with the inductor.

APPLICATION INFORMATION

INDUCTOR SELECTION

PART NUMBER	CURRENT RATING (mA)	DCR (Ω)	SUPPLIER
CDRH3D16-220	350	0.5	Sumida
ELJPC220KF	160	4.0	Panasonic
LQH3C220	250	0.7	Murata
LEM2520-220	125	5.5	Taiyo Yuden

A 22µH inductor is typically used for the ACT6311. The inductor should have low DC resistance (DCR) and losses at 1.2MHz. See Table 1 for examples of small size inductors.

CAPACITOR SELECTION

The ACT6311 only requires a 1µF input capacitor and a 1µF output capacitor for most applications. Ceramic capacitors are ideal for these applications. For best performance, use X5R and X7R type ceramic capacitors, which possess less degradation in capacitance over voltage and temperature ranges.

DIODE SELECTION

The ACT6311 requires a Schottky diode as the rectifier. Select a low forward voltage drop Schottky diode with a forward current (IF) rating of 100mA to 200mA and a sufficient peak repetitive reverse voltage (VRRM). The required minimum VRRM is 4.5V multiplied by the number of white LEDs. Some suitable Schottky diodes are listed in Table 2.

Table 2. Recommended Schottky Diodes

PART NUMBER	IF (mA)	VRRM (V)	SUPPLIER
CMDSH-3	100	30	Central
CMDSH2-3	200	30	Central
BAT54	200	30	Zetex

LED CURRENT SETTING

The LED current is determined by the value of the feedback resistor R1. Because the FB input of the IC is regulated to 1.23V, the LED current is determined by $I_{LED} = 1.23V / R_1$. The value of R_1 for different LED currents is shown in table 3.

Table 3. R_1 Resistor Value Selection

I_{LED} (mA)	R_1 (Ω)
5	246
10	123
12	102.5
15	82
20	61.5

The following are dimming control methods for the ACT6311:

1. PWM Signal Driving $\overline{SHDN}$

When a PWM signal is connected to the SHDN pin, the ACT6311 is turned on and off alternatively under the control of the PWM signal. The current through the LEDs is either zero or full. By changing the duty cycle of the PWM signal (typically 1kHz to 10kHz), a controlled average current is obtained.

2. DC Voltage Control

Figure 3 shows an application in which a DC voltage is used to adjust the LED current. The LED current increases when V_{DC} is lower than V_{FB} and decreases when V_{DC} is higher than V_{FB}. In Figure 3, the LED current range of 15mA to 0 is controlled by V_{DC} = 0 to 2V.

3. Filtered PWM Control

Figure 4 shows an application using a filtered PWM signal to control dimming.

4. Logic Control

A logic signal can be used to adjust the LED current in a discrete step, as shown in Figure 5.

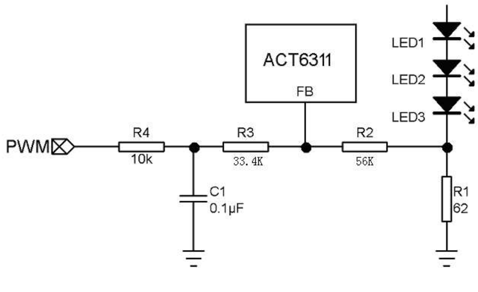


Figure 3. DC Voltage PWM Controlled Dimming

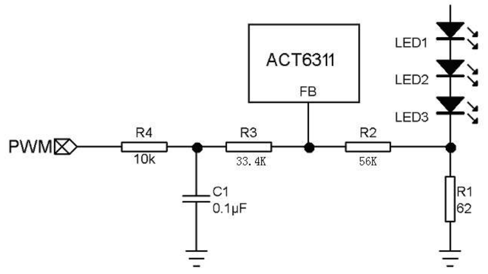


Figure 4. Filtered PWM Controlled Dimming

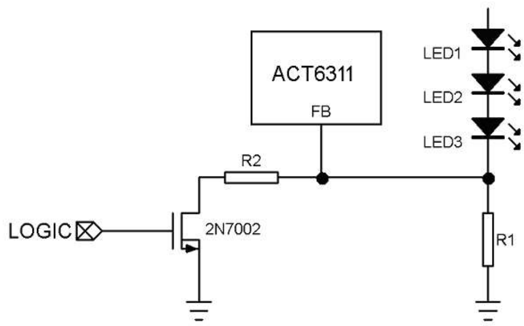


Figure 5. Logic Controlled Dimming

START-UP AND INRUSH CURRENT

In order to start the ACT6311 quickly, a soft-start circuit is not incorporated into the IC. When the IC is first turned on with no external soft-start circuit, the inrush current is about 200mA. Figure 6 shows an implementation for soft-start. When soft-start and dimming controls are used simultaneously, a low frequency PWM signal (less than 10kHz) or use the methods in Figures 3, 4, and 5 should be used.

OPEN-CIRCUIT PROTECTION

When one of the LEDs is disconnected or fails open, the FB voltage drops to zero and the IC switches to maximum duty cycle. This results in a high voltage that may exceed SW voltage rating. To limit this voltage, use a Zener diode as shown in Figure 7. The Zener voltage must be larger than the' total forward voltage of the LED and the current rating should be higher than 1mA.

BOARD LAYOUT

To reduce EMI, minimize the area and path length of all traces connected to SW. Use a ground plane under the switching regulator and connect R1 directly to the G pin of the IC.

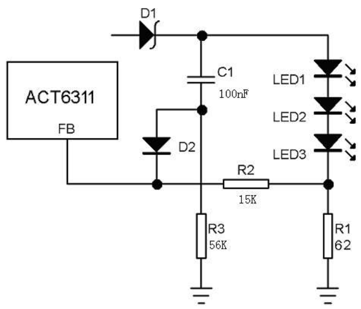


Figure 6. Soft-Start Circuit

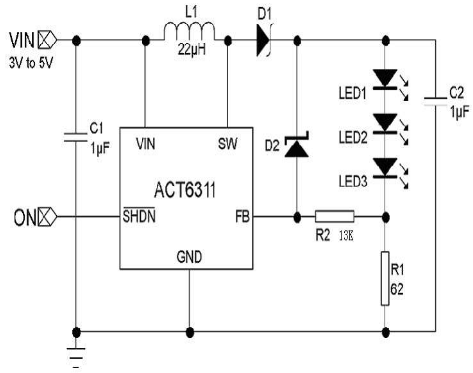
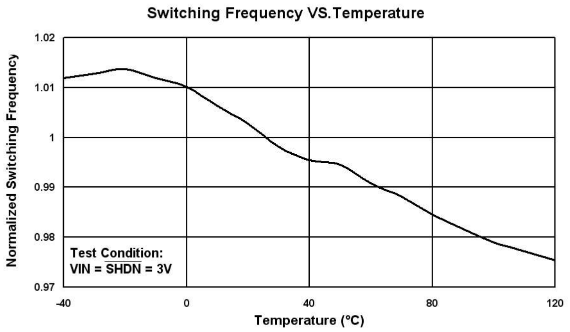
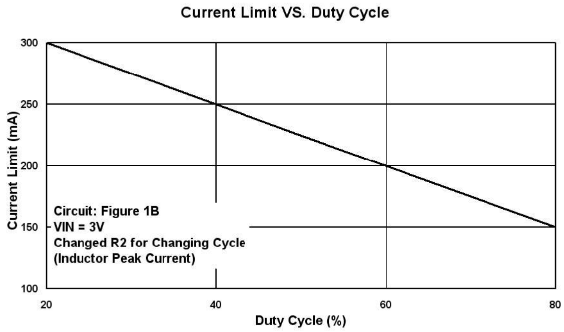
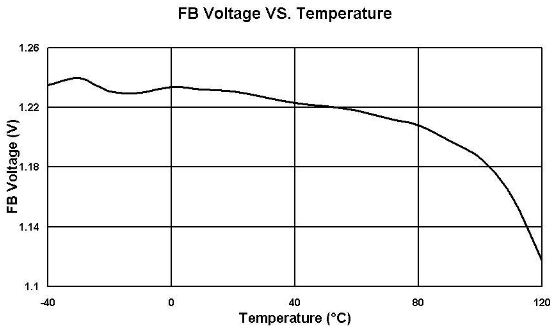


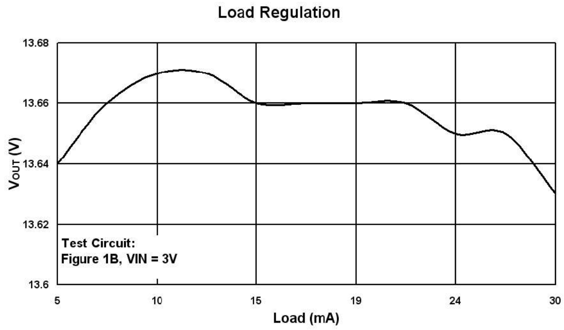
Figure 7. Open-Circuit Protection

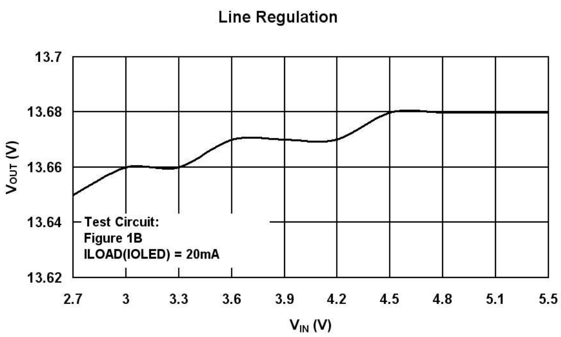
TYPICAL PERFORMANCE CHARACTERISTICS





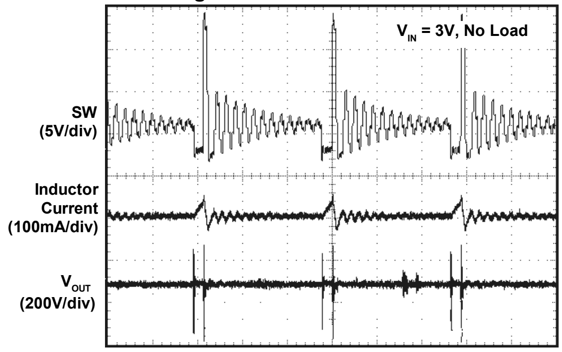




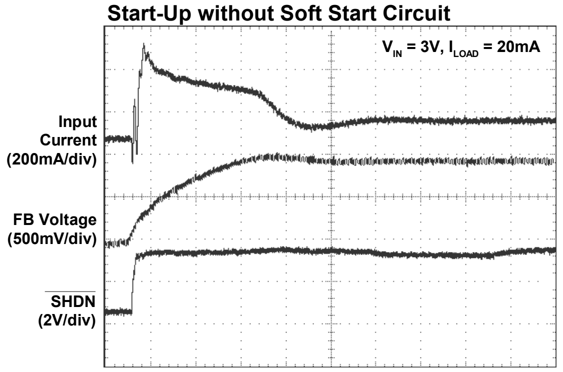


TYPICAL PERFORMANCE CHARACTERISTICS CONT'D

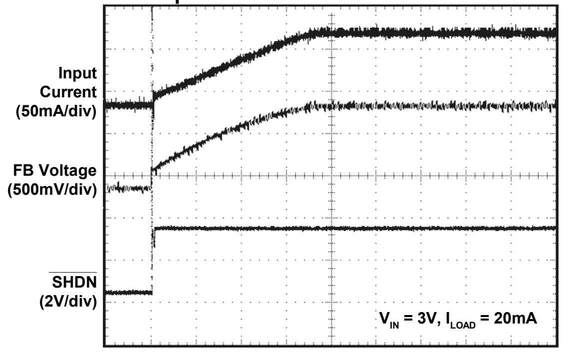
Switching Waveform in Discontinuous Mode



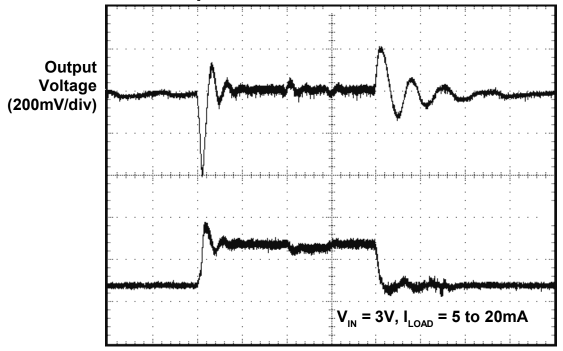
Start-Up without Soft Start Circuit



Start-Up with Soft Start Circuit

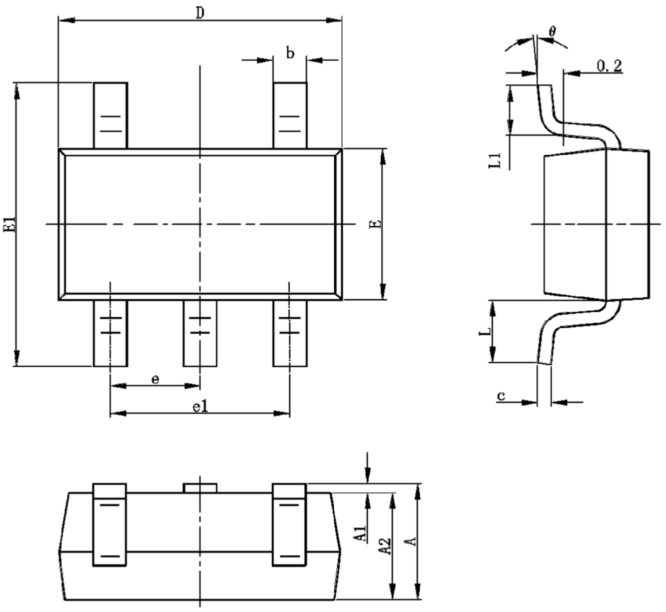


Load Step



PACKAGE OUTLINE

SOT23-5 PACKAGE OUTLINE AND DIMENSIONS



SYMBOL	DIMENSION IN MILIMETERS		DIMENSION IN INCHES	
	MIN	MAX	MIN	MAX
A	1.050	1.250	0.041	0.049
A1	0.000	0.100	0.000	0.004
A2	1.050	1.150	0.041	0.045
b	0.300	0.400	0.012	0.016
c	0.100	0.200	0.004	0.008
D	2.820	3.020	0.111	0.119
E	1.500	1.700	0.059	0.067
E1	2.650	2.950	0.104	0.116
e	0.950 TYP		0.037 TYP	
e1	1.800	2.000	0.071	0.079
L	0.700 REF		0.028 REF	
L1	0.300	0.600	0.012	0.024
θ	0°	8°	0°	8°

1270 Oakmead Parkway, Suite 310, Sunnyvale, California 94085-4044, USA