1.5A, Hysteretic, High Brightness LED Driver with Internal Switch

GENERAL DESCRIPTION

The EC4304C is a continuous mode inductive step-down and buck-boost converter, designed for driving single or multiple series connected LEDs from a voltage source higher than or lower than the LED voltage. It operates from input supply between 7V and 40V and provides and externally adjustable output current up to 1.5A with proper supply voltage and external components, the EC4304C can provide more than 50 watts of output power .

This EC4304C includes the output switch and high-side output current sensing circuit, which uses an external resistor to set the nominal average output current.

The ADJ pin will accept either a wide range pulse dimming waveform or a DC voltage. This will provide either a continuous or gated output current depending upon the control frequency. The soft-start time can be increased by connecting an external capacitor from the ADJ pin to ground. The PWM filter components also serve as soft-start time setting. Applying a 0.2V or lower to the ADJ pin turns the output off and switches the device into a low current standby state.

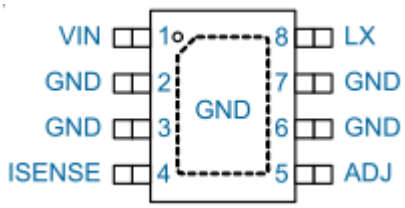
FEATURES

- Operates from 7V to 40V Supply Voltage
- Single Pin On/Off and Brightness Control Using DC Voltage or PWM
- Up to 95% Efficiency
- Internal 40V NDMOS Switch
- Up to 1.5A Output Current
- Typical +/-5% LED Current Accuracy
- Input Under Voltage Lockout
- SOP 8L(Exposed PAD) Package
- RoHS Compliant and Halogen-Free

Applications

- Automotive LED Lighting
- High Power LED Lighting
- Indicator and Emergency Lighting
- Architectural Lighting
- Low Voltage Industrial Lighting
- Signage and Decorative LED Lighting

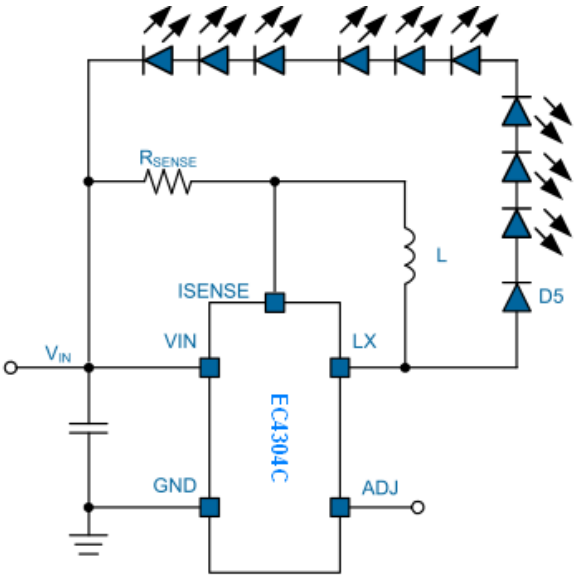
Pin Configuration



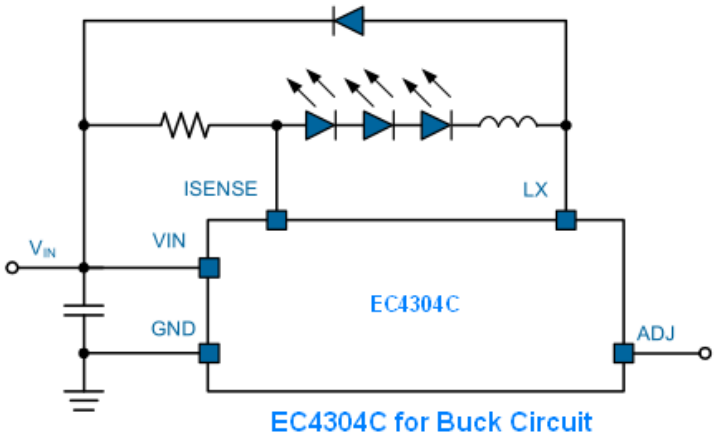
Pin Description

Pin No	Pin Name	Pin Function
1	VIN	**Power supply input pin.** Connect a nominal (7V~40V) power supply to this pin. The power- on-reset (POR) function monitors the input voltage by this pin. It is recommended that a decoupling capacitor (4.7μF or Higher X7R Ceramic capacitor) be connected to the GND for noise decoupling.
2/3/6/7	GND	**Ground for the IC.** All voltages levels are measured with respect to this pin.
4	ISENSE	**Current Sense Pin: Sense LED String Current.**
5	ADJ	**Multi-Function ON/OFF and Brightness Control Pin:** -Analog signal input for analog control of PWM dimming. -PWM signal input for digital PWM dimming.
8	LX	**Drain of NDMOS Switch.**
Exposed PAD		Ground and thermal Pad

Typical Application



EC4304C for Boost Circuit



EC4304C for Buck Circuit

Ordering/ Marking Information

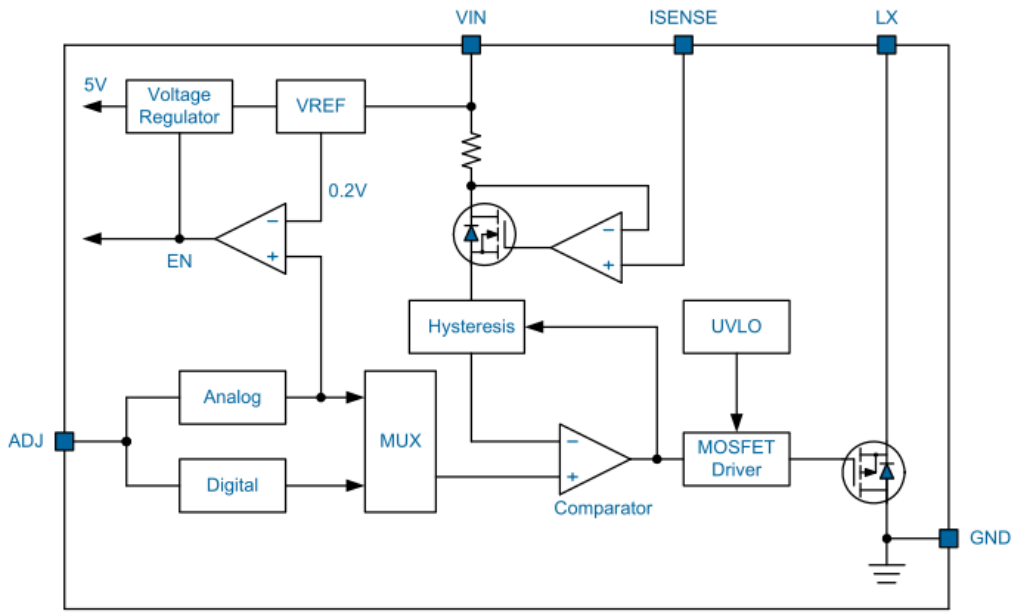
EC4304CN**XX** R

R=Tape & Reel

Package :
MH : SOP 8L
(Exposed PAD)

Part Number	Package	Marking	Marking Information
EC4304CNMHR	SOP 8L (Exposed PAD)	4304C LLLLL DDDDDD	LLLLL is Lot No DDDDDD : Date Code

Functional Block Diagram



Functional Description

The EC4304C is a simple high-efficiency, continuous mode inductive step-down converter. The device operates with an input voltage range from 7V to 40V and delivers up to 1.5A of output current. A high-side current-sense resistor sets the output current and a dedicated PWM dimming input enables pulsed LED dimming over a wide range of brightness levels. A high side current-sensing scheme and an on-board current setting circuitry minimize the number of external components which is required while delivering LED current with +5% accuracy, using a 1% sense resistor.

Adjusting Output Current

The device contains a low pass filter between the ADJ pin and the threshold comparator and an internal current limiting resistor between ADJ and the internal reference voltage. This allows the ADJ pin to be overdriven with either DC or pulse signals to change the V_{SENSE} switching threshold and adjust the output current. Details of the different modes of adjusting output current are given in the applications section by:

$$I_{OUTdc} = \frac{V_{ADJ}}{1.25} \times \frac{100mV}{R_{SENSE}} \quad (\text{for } 0.3V < V_{ADJ} < 2.5V)$$

The value of the output current is 1A at 0.1Ω (0.5A at 0.2Ω) and this is a calculated output current when the ADJ terminal is 1.25V floating.

Shutdown Mode

Taking the ADJ pin to a voltage below 0.2V for more than approximately 100μs will turn off the output, and supply current will fall to a low standby level of 20μA nominal.

Soft-Start

The device has inbuilt soft-start action due to the delay through the PWM filter. An external capacitor from the ADJ pin to ground will provide additional soft-start delay, by increasing the time taken for the voltage on this pin to rise to the turn-on threshold and by slowing down the rate of rise of the control voltage at the input of the comparator.
With no external capacitor, the time taken for the output to reach 90% of its final value is approximately 500μs. Adding capacitance increases this delay by approximately 0.5ms/ nF.

Inherent open-circuit LED protection

If the connection to the LED(s) is open-circuited, the coil is isolated from the LX pin of the chip, so the chip will not be damaged. Unlike in many boost converters, where the back EMF may damage the internal switch by forcing the drain above its breakdown voltage.

Absolute Maximum Rating(Note 1)

Supply Input Voltage, V_{IN} ---------- -0.3V to + 45V
ISENSE Voltage, V_{ISENSE} ---------- +0.3V to -5V(measured with respect to V_{IN})
LX Output Voltage, V_{LX} ---------- -0.3V to + 45V
Adjust Pin Input Voltage, V_{ADJ} ---------- -0.3V to + 6V
Switch Output Current, I_{LX} ---------- 1.8A
Operation Temperature Range ---------- -40°C to +150°C
Storage Temperature Range ---------- -55°C to +150°C
Junction Temperature ---------- 150°C
Lead Temperature (Soldering, 10 sec) ---------- 260°C
ESD Rating (Note 2)
HBM (Human Body Mode) ---------- 4kV
MM (Machine Mode) ---------- 200V

Thermal Information

Package Thermal Resistance (Note 3)
SOP 8L(Exposed PAD) θ_{JA} ---------- 47°C/W
SOP 8L(Exposed PAD) θ_{JC} ---------- 17.9°C/W
Power Dissipation, P_D @ T_A = 25°C
SOP 8L(Exposed PAD) ---------- 2.13W

Recommended Operation Conditions

Operating Junction Temperature Range (Note 4) ---------- -40°C to +125°C
Operating Ambient Temperature Range ---------- -40°C to +85°C

Note 1. Stresses listed as the above "Absolute Maximum Ratings" may cause permanent damage to the device. These are for stress ratings. Functional operation of the device at these or any other conditions beyond those indicated in the operational sections of the specifications is not implied. Exposure to absolute maximum rating conditions for extended periods may remain possibility to affect device reliability.
Note 2. Devices are ESD sensitive. Handling precaution recommended.
Note 3. θ_{JA} is measured in the natural convection at T_A = 25°C on a high effective thermal conductivity test board of JEDEC 51-7 thermal measurement standard.
Note 4. The device is not guaranteed to function outside its operating conditions.

Electrical Characteristics

(V_{IN} = 12V, T_A = 25℃, unless otherwise specified)

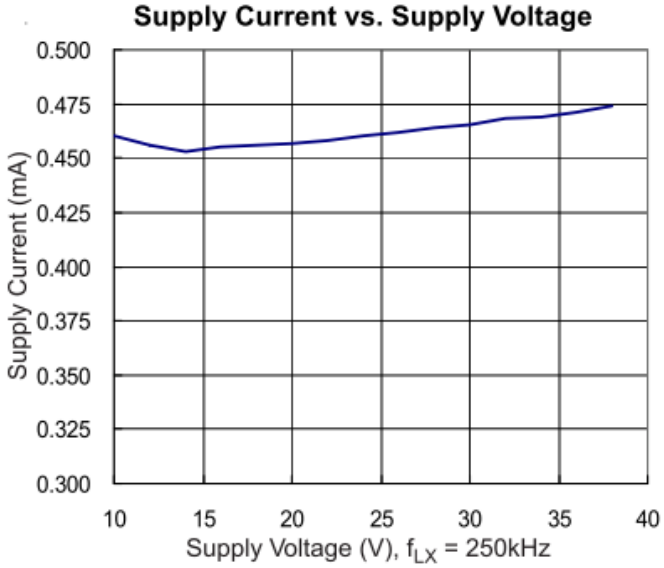
Parameter	Symbol	Test Conditions	Min	Typ	Max	Units
Supply Input						
Supply Voltage Range	V_{IN}		7	-	40	V
VIN POR Threshold	V_{INRTH}	V_{IN} Rising	-	4.95	-	V
VIN POR Threshold	V_{INFTH}	V_{IN} Falling	-	4.8	-	V
Quiescent Current with Output Off	$I_{_QOFF}$	ADJ pin grounded	-	20	40	μA
Quiescent Current with Output Switching	$I_{_QON}$	ADJ pin floating f = 250KHz	-	0.5	1.0	mA
ISENSE Pin						
Current Sense Threshold Voltage	V_{ISENSE}	ISENSE pin with respect to VIN, ADJ = 1.25V	95	100	105	mV
ISENSE Input Current	I_{SENSE}	V_{SENSE} = V_{IN}-0,1	-	-	1.0	μA
Reference						
Reference Voltage	V_{REF}	ADJ pin Voltage	-	1.25	-	V
Reference Voltage Temperature Coefficient			-	50	-	ppm/°K

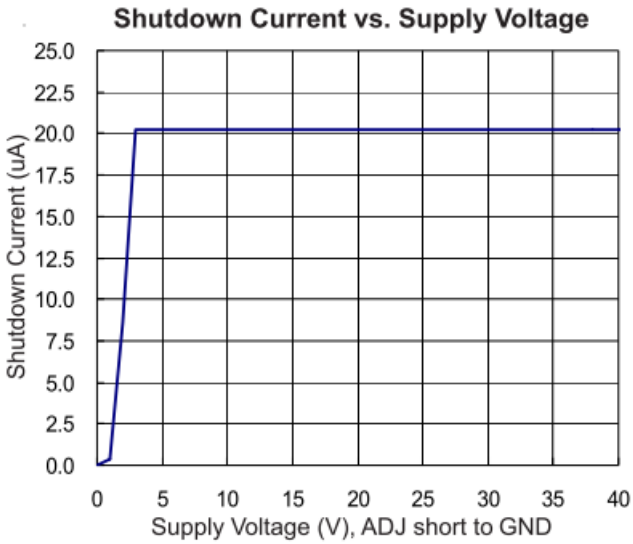
Electrical Characteristics

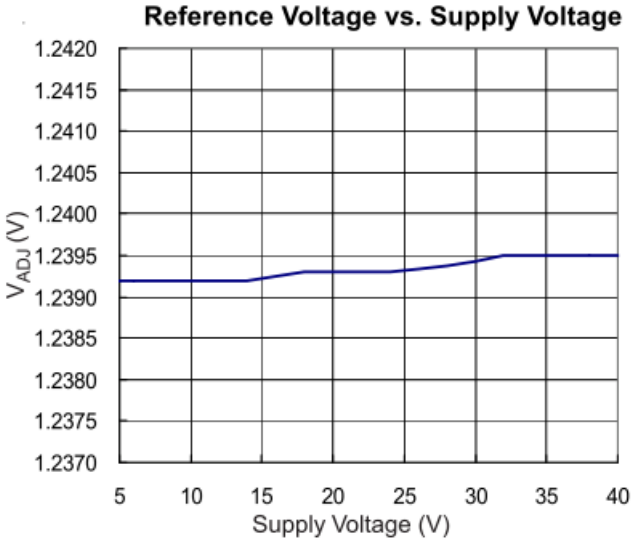
(V_{IN} = 12V, T_A = 25℃, unless otherwise specified)

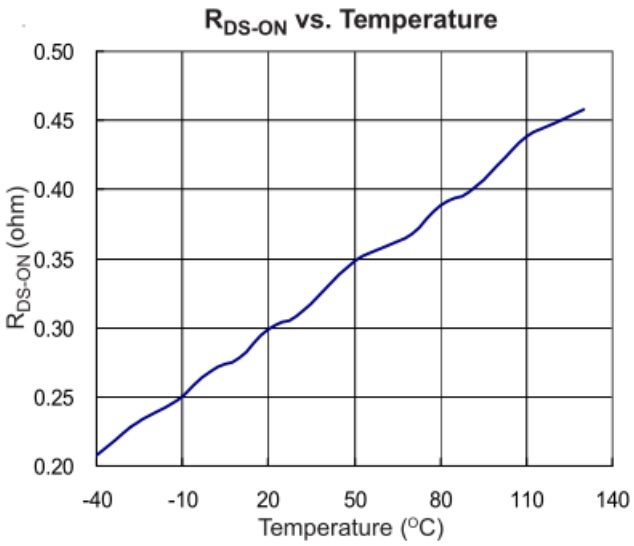
Parameter	Symbol	Test Conditions	Min	Typ	Max	Units
ADJ Pin						
ADJ Pin for DC Control Level	V_{ADJ}		0.3	-	2.5	V
ADJ to Switch Device from On State to Off State	V_{ADJ_OFF}	V_{ADJ} falling	0.15	0.2	0.25	V
ADJ to Switch Device from Off State to On State	V_{ADJ_ON}	V_{ADJ} rising	0.2	0.25	0.3	V
ADJ to VREF Resistance	R_{ADJ}	$0 < V_{ADJ} < V_{REF}$	135	-	250	KΩ
		$V_{ADJ} > V_{REF}$+100mV	13.5	-	25	KΩ
ADJ Pin Low Frequency Duty Cycle Range	D_{PWM} (LF)	PWM frequency < 500Hz	10	-	100	%
ADJ Pin High Frequency Duty Cycle Range	D_{PWM} (HF)	PWM frequency >10KHz	16	-	100	%
LX pin						
LX Switch Current	I_{LXmean}		-	-	1.5	A
LX R_{DS_ON}	R_{LX}	@I_{LX} = 1A	-	0.3	0.6	Ω
LX Leakage Current			-	-	5	μA
Minimum Switch ON Time	T_{ON_min}	LX Switch ON	-	240	-	ns
Minimum Switch OFF Time	T_{OFF_min}	LX Switch OFF	-	200	-	ns
Recommended Minimum Switch ON Time	$T_{ON_min_rec}$		-	800	-	ns
Frequency						
Operation Frequency	f_{LX}	ADJ pin floating, L=33μH (0.093Ω) I_{OUT} = 1A @ V_{LED}=3.6V driving 1LED	-	280	-	kHz
Recommended Maximum Operation Frequency	f_{LXmax}		-	-	1	MHz
Duty Cycle Range of Output Switch of Operation Frequency	D_{LX}		30	-	70	%
Internal Comparator Propagation Delay	t_{PD}		-	50	-	ns
Soft-Start						
Soft-Start Time	t_{SS}	Time taken for output current to reach 90% of final value after voltage on ADJ pin has risen above 0.3V.	-	500	-	μs

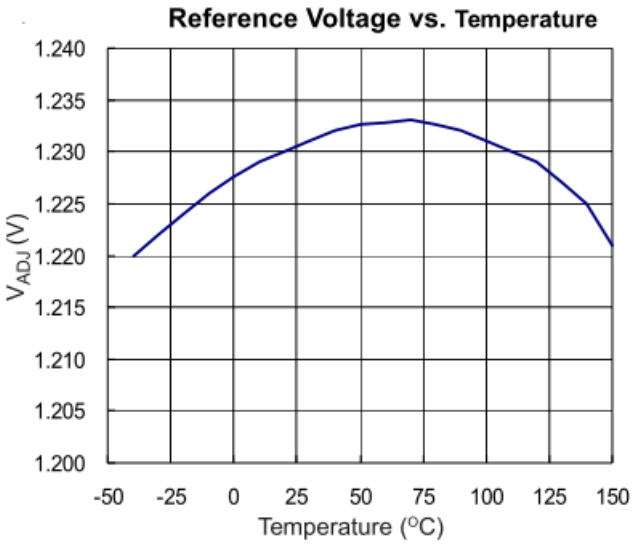
Typical Operation Characteristics

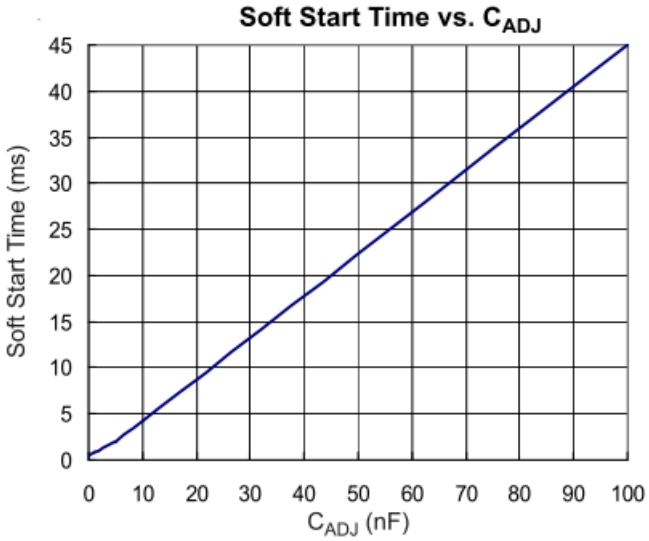




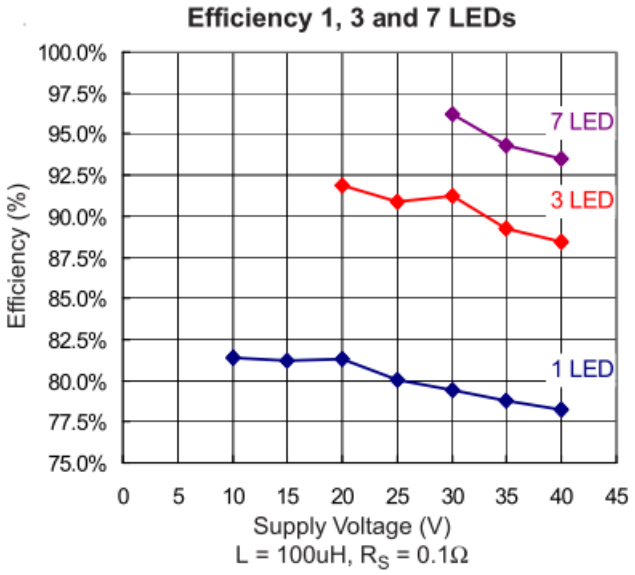


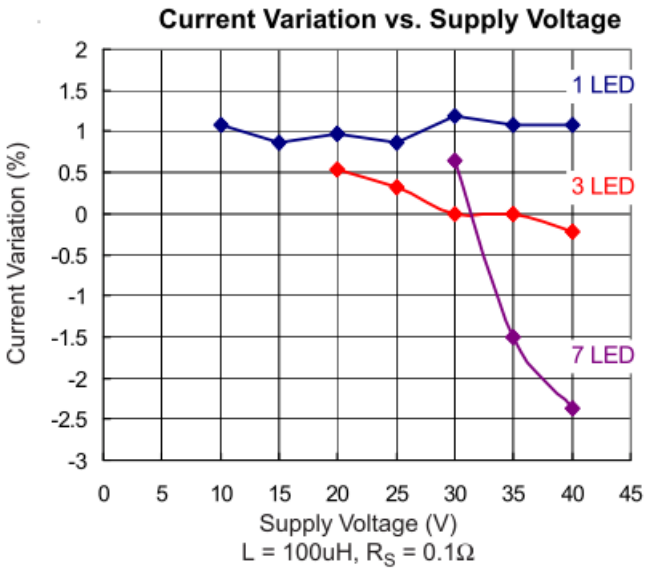


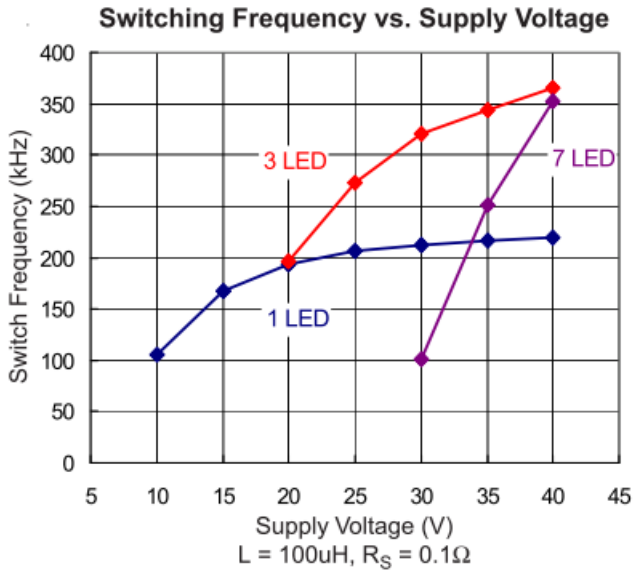


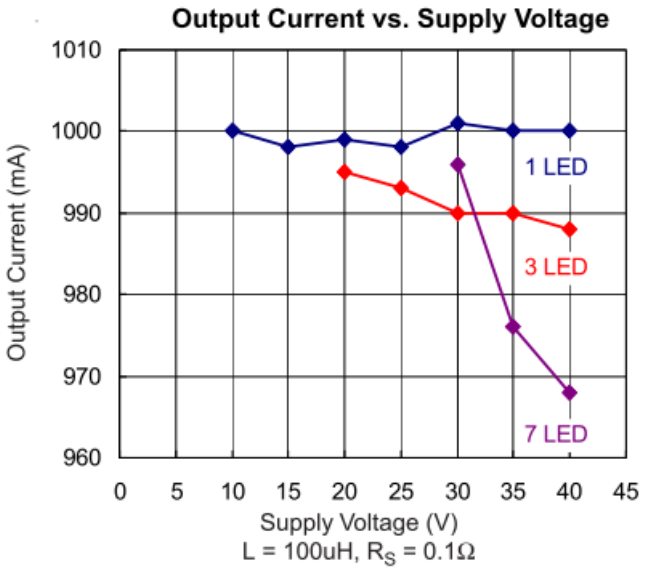


Typical Operation Characteristics

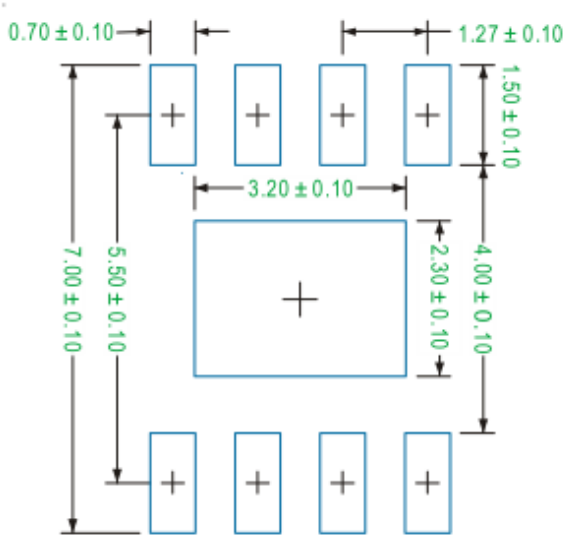




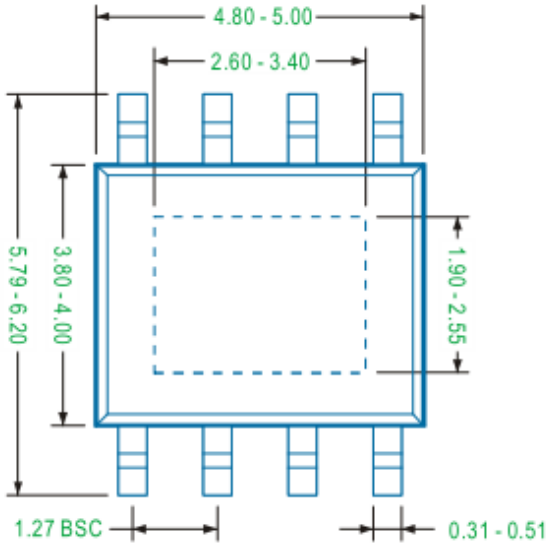


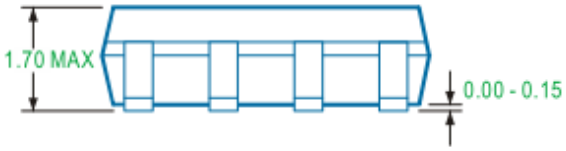


Package Information
SOP 8L(Exposed PAD)



Recommended Solder Pad Layout





Note
1.Package Outline Unit Description:
BSC: Basic. Represents theoretical exact dimension or dimension target
MIN: Minimum dimension specified.
MAX: Maximum dimension specified.
REF: Reference. Represents dimension for reference use only. This value is not a device specification.
TYP. Typical. Provided as a general value. This value is not a device specification.
2.Dimensions in Millimeters.
3.Drawing not to scale.
4.These dimensions do not include mold flash or protrusions. Mold flash or protrusions shall not exceed 0.15mm.