0.8A/40V Input，800kHz Buck LED Driver

General Description

LN5019 is a current mode monolithic buck switching regulator. Operating with an input range of 4.5V~40V, the LN5019 delivers 800mA of continuous output current with two integrated N-Channel MOSFETs. The internal synchronous power switches provide high efficiency without the use of an external Schottky diode. At light loads, the regulator operates in low frequency to maintain high efficiency and low output ripple. Current mode control provides tight load transient response and cycle-by-cycle current limit.

The LN5019 guarantees robustness with short-circuit protection, thermal protection, current run-away protection, and input under voltage lockout.

The LN5019 is available in 6-pin SOT23-6 package, which provides a compact solution with minimal external components.

Package

- SOT-23-6L

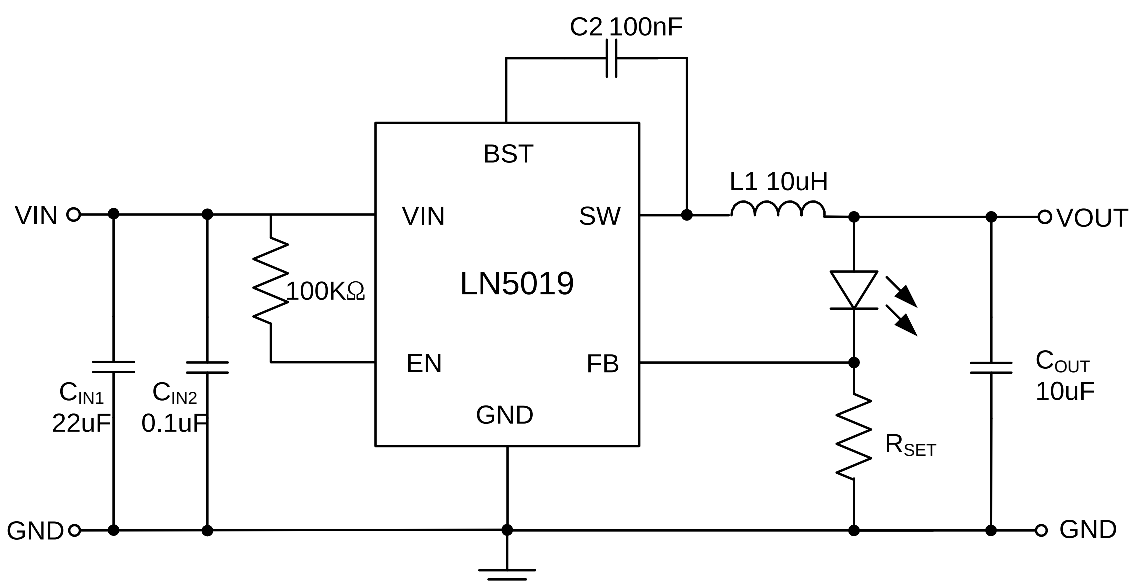
Features

- 4.5V to 40V Input Voltage Range
  800mA output current
- High Efficiency: Up to 95%
- No Schottky Diode Required
- 0.2V Reference
- Slope Compensated Current Mode Control for Excellent Line and Load Transient Response
- Integrated internal compensation
- Stable with Low ESR Ceramic Output Capacitors
- Input under voltage lockout
- Short circuit protection
- Thermal Shutdown
- Inrush Current Limit and Soft Start
- -40°C to +125°C Temperature Range

Applications

- Distributed Power Systems
- Automotive Systems
- High Voltage Power Convertion
- Industrial Power Systems
- Battery Powered Systems

Typical Application Circuit



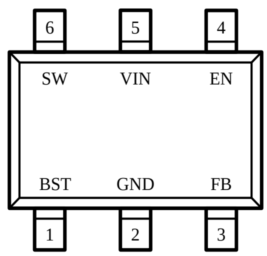
Note: Electrolytic capacitor is recommended for C_{IN1}, if C_{IN1} use ceramic capacitors, must connect a 3.3ohm resistor in series

Ordering Information

LN5019P①②③

Designator	Symbol	Description
①	A	Feedback Voltage 0.2V
②	M	Package Type :SOT-23-6L
③	R	Embossed Tape : Standard Feed
	L	Embossed Tape : Reverse Feed

Pin Configuration

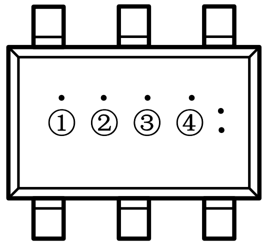


SOT-23-6L
(TOP VIEW)

Pin Assignment

Pin Number SOT-23-6L	Pin Name	Function
1	BST	Bootstrap pin. Connect a 100nF capacitor from this pin to SW.
2	GND	Ground.
3	FB	Feedback Input. Connect an external resistor divider from the output to FB and GND to set VOUT.
4	EN	Enable pin for the IC. Drive this pin high to enable the part, low to disable.
5	VIN	Supply Voltage. Bypass with a 22μF ceramic capacitor to GND.
6	SW	Inductor Connection. Connect an inductor Between SW and the regulator output.

■ Marking Rule



SOT-23-6L
(TOP VIEW)

① **Represents the product name**

Symbol	Product Name
5	LN5019P***

② **Represents the feedback voltage**

Symbol	Description
A	Feedback Voltage 0.2V

③ **Represents the packaging information**

Symbol	Package
M	SOT23-6L

④ **Represents the assembly lot No.**

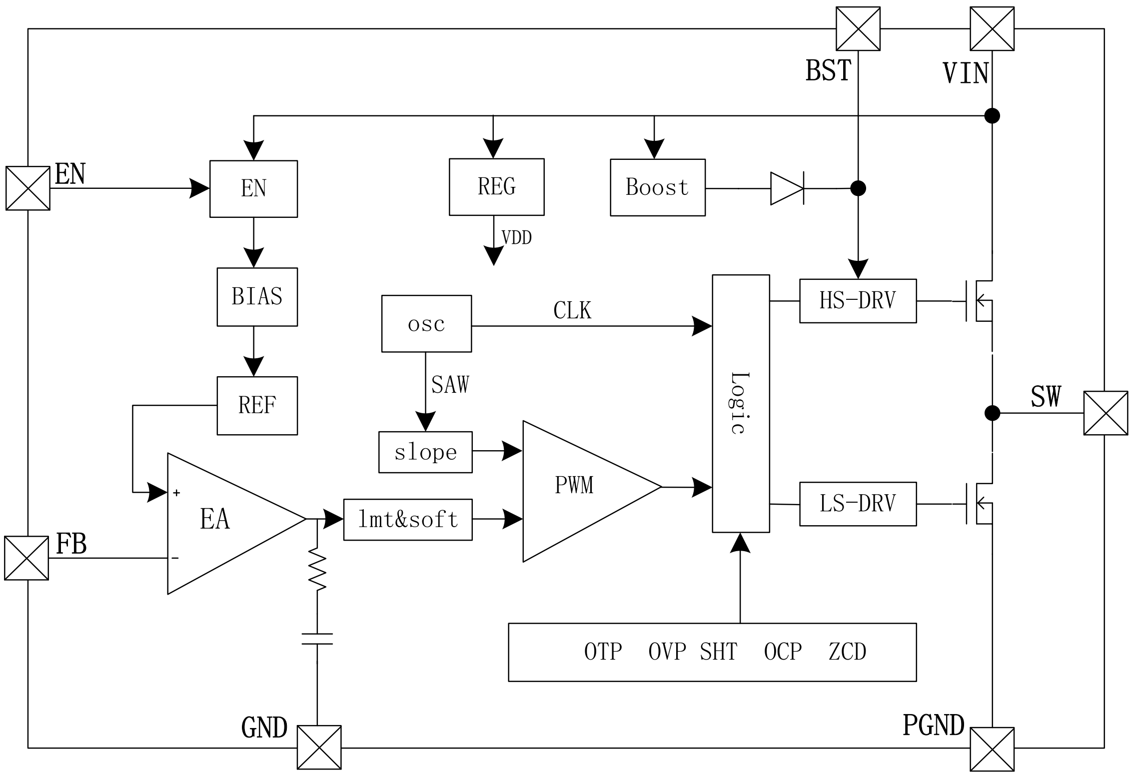
0-9，A-Z; 0-9，A-Z mirror writing，repeated（G，I，J，O，Q，W exception）

■ Absolute Maximum Ratings

Parameter	Symbol	Maximum Rating	Unit
Input Voltage	V_{IN}	V_{SS}-0.3～V_{SS}+45	V
SW Voltage		V_{SS}-0.3～V_{IN}+0.3	
EN Voltage		V_{SS}-0.3～V_{IN}+0.3	
BST Voltage		V_{SW}-0.3～V_{SW} +6	
FB Voltage		V_{SS}-0.3～V_{SS}+6	
Power Dissipation	P_D	SOT-23-6L: 600	mW
Thermal Resistance θ_{JC}	θ_{JC}	130	°C/W
Thermal Resistance θ_{JA}	θ_{JA}	170	°C/W
Operating Ambient Temperature	Topr	-40～125	°C
Storage Temperature	Tstg	-40～+150	
ESD HBM (Human Body Mode)		2	KV

Caution: The absolute maximum ratings are rated values exceeding which the product could suffer physical damage. These values must therefore not be exceeded under any conditions.

Function Block Diagram



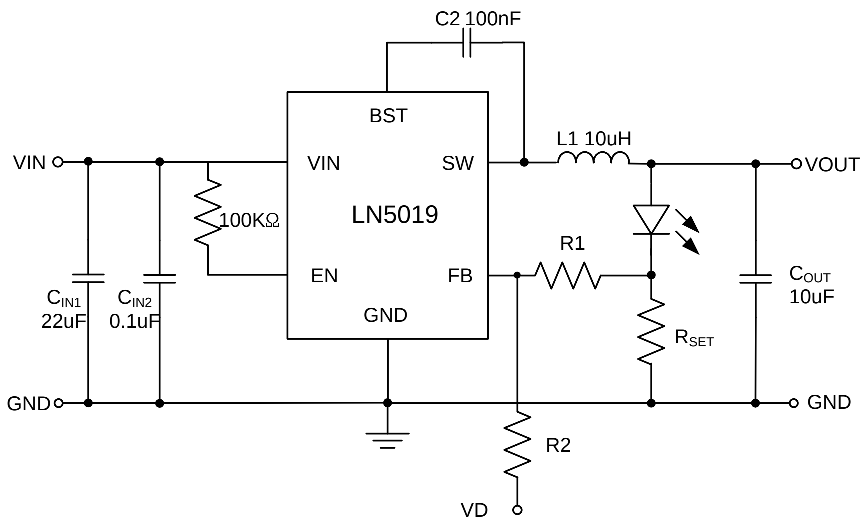
Electrical Characteristics

Note: VIN = 12V, VOUT = 5.0V, unless otherwise specified. Typical values are at TA = 25℃)

Parameter	Symbol	Condition	Min	Typ	Max	Unit
Input Voltage	V_{IN}		4.5		40	V
VIN Under Voltage Protect	V_{UV}			4.3		V
VIN Under Voltage Protect Hys.	V_{UV_hys}			0.2		V
Supply Current	I_{Q1}	V_{EN}=2V，V_{FB}=0.85V		40	60	µA
Supply Shutdown Current	I_{SD}		-1		1	µA
FB Voltage	V_{FB}	T_A=25°C，4.5V≤V_{IN}≤40V	0.19	0.2	0.21	V
Switching Frequency	F_{OSC}			800		kHz
Minimum On Time	T_{ON_MIN}			200		ns
Maximum Duty Cycle	DMAX			90		%
High Side Switch On Resistance	R_{DSON_H}			450		mΩ
Low Side Switch On Resistance	R_{DSON_L}			270		mΩ
High Side Current Limit	I_{LIM}			2		A
EN Rising Threshold	V_{ENH}			1.3		V
EN Falling Threshold	V_{ENL}			1.2		V
EN Input Current	I_{EN}	V_{EN}=5V		2		uA
Thermal Shutdown	T_{SHD}			160		°C
Thermal Shutdown Hys.	T_{SHD_Hys}			20		°C

■ Dimming Control

- Dimming control can be realized by using a DC voltage through the FB pin for LN5019 as below



Calculate ILED using the following equations

$$\mathrm{ILED} = \frac{1}{\mathrm{RSET}} \times \left[0.2 - \frac{\mathrm{R1}}{\mathrm{R2}} \times (\mathrm{VD} - 0.2)\right] \tag{1}$$

where VD is DC voltage

When the analog dimming voltage VD>>0.2V, the minimum value of ILED is approximately 0, calculated by

0.2=(VD-0.2)*R1/R2 (2)

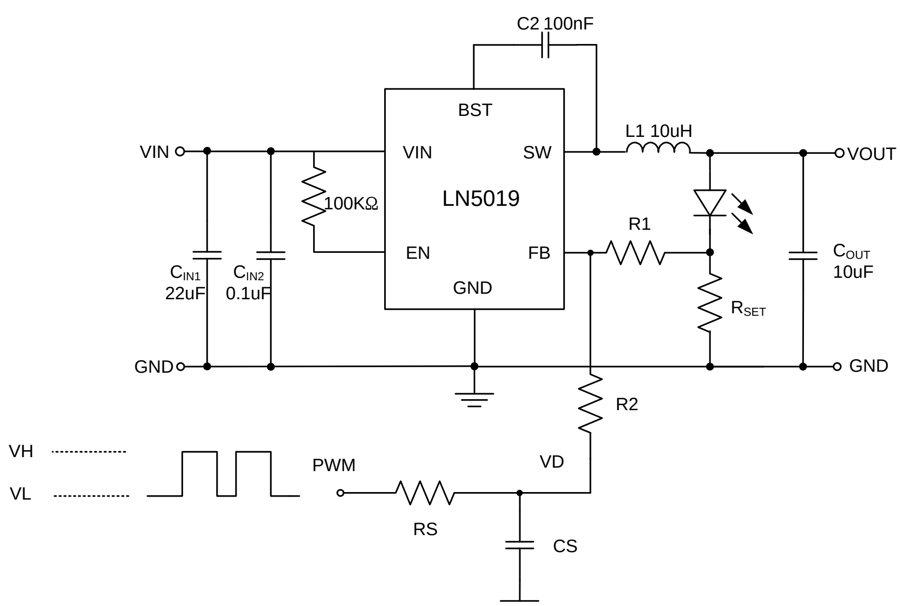
When the analog dimming voltage VD=0V, ILED reaches the maximum, calculated by

ILEDmax=1/RSET × (0.2 + 0.2*R1/R2) (3)

For example, RSET=0.22ohm, VD=1.8V, ILED=1A, then R2/R1=8. Considering the current capability of IO and other system factors, take R1=10K, then R2=80K

- Using PWM dimming signal we can get the DC voltage VD.

The low-pass filter composed of RS and CS converts the digital signal PWM into an analog signal VD.



VD=(VH-VL)*D, where D is the duty circle of PWM signal，VH-VL is the amplitude of PWM signal. The lower the frequency of the PWM signal, the greater the value of CS.

The IO voltage of the microcontroller is a certain value, that is, VH=VIO (assuming a system is 2.8V), VL=0.Combined with analog dimming ,then R2/R1=13,when R1=10K,then R2=130K.

When the PWM signal frequency is 100KHz, the minimum dimming duty ratio of 1%, RS and CS can be roughly determined according to the bandwidth formula of the resistance-capacitance low-pass filter , f=1/(2πRC). When CS=1uF，RS=3K，then f=17.6Hz<<1KHz.

The value of CS and RS depend on the frequency of PWM dimming signal. Suggested component selections as below for the application of the different PWM signal frequency.

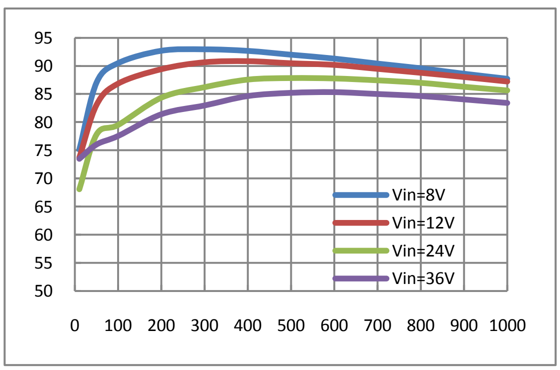
Frequency	1MHz	100KHz	10KHz
CS	0.1uF	1uF	2.2uF
RS	4.7K	10K	47K

■ Typical Performance Characteristics

Vin=12V，Vout=5.0V，L=10uF，Cout=10uF，TA=+25℃，unless otherwise noted.

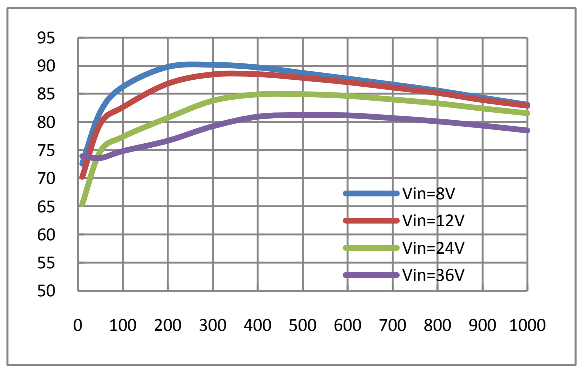
Efficient @Vout=5.0V

C_{VIN}=22uF，C_{OUT}=10uF，C_{BST}=0.1uF L_{IND}=10uH



Efficient @Vout=3.3V

C_{VIN}=22uF，C_{OUT}=10uF，C_{BST}=0.1uF L_{IND}=10uH



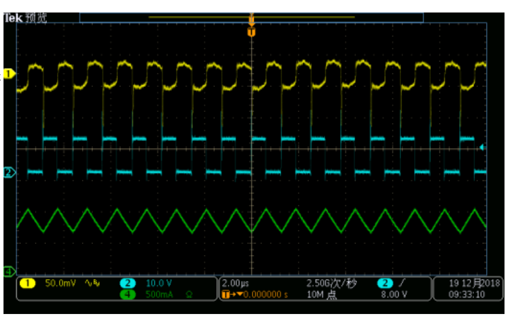
Steady State Test

Vin=12V，Vout=5.0V，Lout=800mA

V_{O_AC}

V_{SW}

I_L



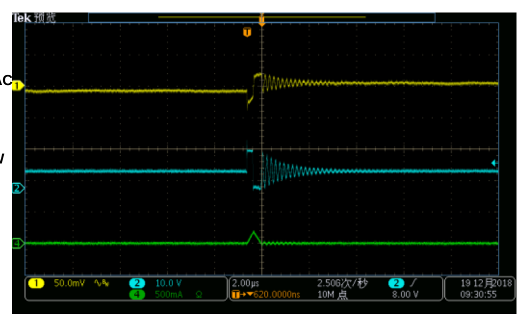
Light Load Operation

Vin=12V，Vout=5.0V， Iout=0A

V_{O_AC}

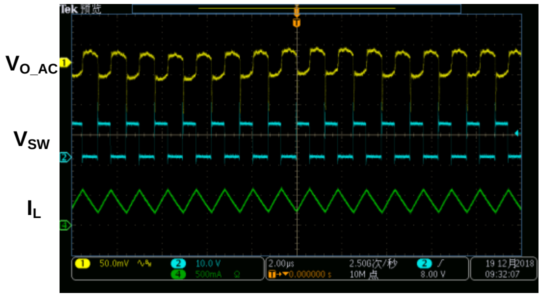
V_{SW}

I_L



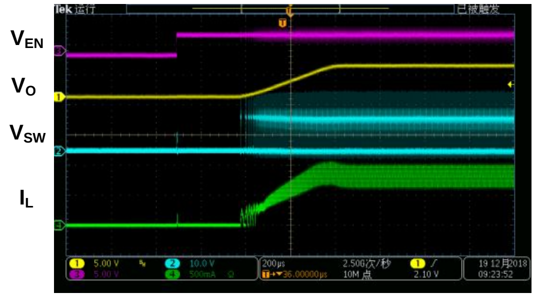
Medium Load Operation

Vin=12V，Vout=5.0V，Lout=400mA



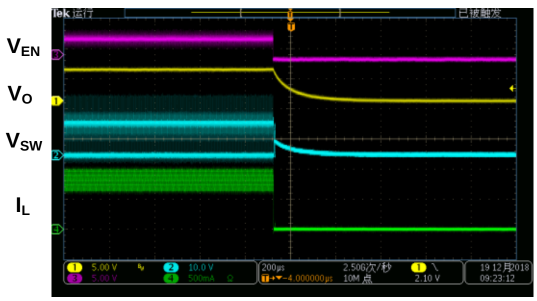
Startup through Enable

Vin=12V，Vout=5.0V，Lout=800mA（Resistive load）



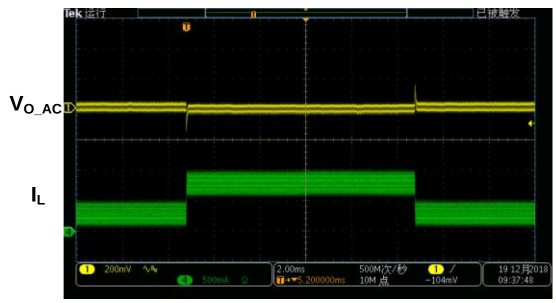
Shutdown through Enable

Vin=12V，Vout=5.0V，Lout=800mA（Resistive load）



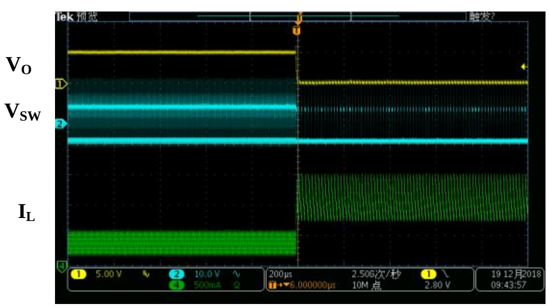
Load Transient

Load：300mA ->800mA ->300mA



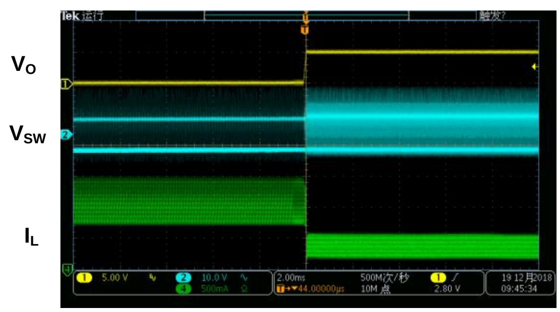
Short Circuit Protection

Vin=12V，Vout=5.0V，Lout=800mA - Short



Short Circuit Protection

Vin=12V，Vout=5.0V，Lout= Short - 800mA



■ Functional Description

The LN5019 is a current mode step down LED driver that provides excellent transient response with no extra external compensation components. This device contains an internal, low resistance, high voltage power MOSFET, and operates at a high 500kHz operating frequency to ensure a compact, high efficiency design with excellent AC and DC performance.

Current-Mode Control

The LN5019 utilizes current-mode control to regulate the output current. The output current is measured at the FB pin through a resistive voltage divider and the error is amplified by the internal transconductance error amplifier. Output of the internal error amplifier is compared with the switch current measured internally to control the output current.

PFM Mode

The LN5019 operates in PFM mode at light load. In PFM mode, switch frequency decreases when load current drops to boost power efficiency at light load by reducing switch-loss, while switch frequency increases when load current rises, minimizing output voltage ripples..

Shutdown Mode

The LN5019 shuts down when voltage at EN pin is below 0.3V. The entire regulator is off and the supply current consumed by the LN5019 drops below 0.1uA.

Power Switch

N-Channel MOSFET switches are integrated on the LN5019 to down convert the input voltage to the regulated output voltage. Since the top MOSFET needs a gate voltage great than the input voltage, a boost capacitor connected between BST and SW pins is required to drive the gate of the top switch. The boost capacitor is charged by the internal 4.0V rail when SW is low.

Vin Under Voltage Protection

A resistive divider can be connected between Vin and ground, with the central tap connected to EN, so that when Vin drops to the pre-set value, EN drops below 1.2V to trigger input under voltage lockout protection.

Over-Current-Protection and Hiccup

At start-up, due to the high voltage at input and low voltage at output, current inertia of the output inductance can be easily built up, resulting in a large start-up output current. In the LN5019 used current limit of low side power mosfet to control the output current at start-up.

Output Short Protection

When output is shorted to ground, output current rapidly reaches its peak current limit and the top power switch is turned off. And the bottom power switch is turned on and stay on until the output current falls below the current limit. When output current is below the current limit, the top power switch will be turned on again and if the output short is still present, the top power switch is turned off when the peak current limit is reached and the bottom power switch is turned on. This cycle goes on until the output short is removed and the regulator comes into normal operation again.

Thermal Protection

When the temperature of the LN5019 rises above 160°C, it is forced into thermal shut-down. Only when core temperature drops below 140°C can the regulator becomes active again

Application Information

Setting the Output Current

The external resistor R_{SET} is used to set the output current (see Typical Application on page 1). R_{SET} is then given by:

$$R2 = \frac{0.2}{I_{LOAD}}$$

Inductor Selection

A 4.7μH to 22μH inductor with a DC current rating of at least 25% percent higher than the maximum load current is recommended for most applications. For highest efficiency, the inductor DC resistance should be less than 15mΩ. For most designs, the inductance value can be derived from the following equation.

$$L > \frac{V_{OUT} \times (V_{IN} - V_{OUT})}{V_{IN} \times \Delta I_L \times f_{OSC}}$$

Where ΔI_L is the inductor ripple current.

Choose ΔI_L to be approximately 30% of the maximum load current.

Under light load conditions below 100mA, larger inductance is recommended for improved efficiency.

Note：If the output voltage is less than 2.5V, it is recommended to use a larger inductance and add a small capacitance（10nF） parallel to R1.

Input Capacitor Selection

The input capacitor reduces the surge current drawn from the input and switching noise from the device. The input capacitor impedance at the switching frequency should be less than input source impedance to prevent high frequency switching current passing to the input. A low ESR input capacitor sized for maximum RMS current must be used. Ceramic capacitors with X5R or X7R dielectrics are highly recommended because of their low ESR and small temperature coefficients. A 22μF ceramic capacitor for most applications is sufficient. Include a capacitor with a value of 0.1 μF for high-frequency filtering and place it as close as possible to the device pins.

Output Capacitor Selection

The output capacitor (C_{OUT}) is required to maintain the DC output voltage, and the capacitance value determines the output ripple voltage. The output voltage ripple can be calculated by:

$$\Delta V_{OUT} = \frac{V_{OUT} \times (V_{IN} - V_{OUT})}{V_{IN} \times f_{OSC} \times L} \times (R_{ESR} + \frac{1}{8 \times f_{OSC} \times C_{OUT}})$$

Where L is the inductor value and R_{ESR} is the equivalent series resistance (ESR) value of the output capacitor.

The output capacitor can be low ESR electrolytic, tantalum or ceramic, which lower ESR capacitors get lower output ripple voltage.

The characteristics of the output capacitor also affect the stability of the regulation system, and a 10uF ceramic capacitor is recommended in typical application.The LN5019 can be optimized for a wide range of capacitance and ESR values.

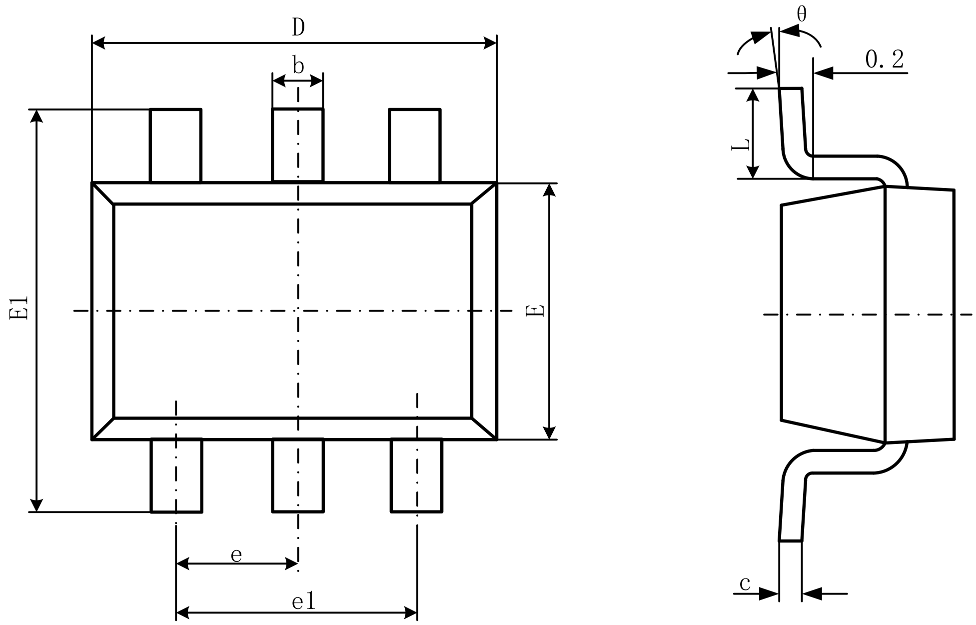
Application Information

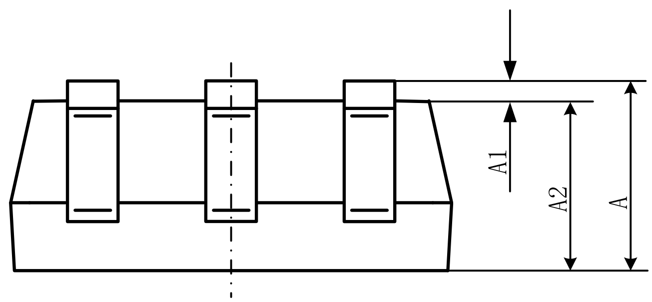
For minimum noise problem and best operating performance, the PCB is preferred to following the guidelines as reference.

1. Place the input decoupling capacitor as close to LN5019 (VIN pin and GND) as possible to eliminate noise at the input pin. The loop area formed by input capacitor and GND must be minimized.
2. Put the feedback trace as far away from the inductor and noisy power traces as possible.
3. The ground plane on the PCB should be as large as possible for better heat dissipation.

■ Package Information

- **SOT-23-6L**





Symbol	Dimensions In Millimeters		Dimensions 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	0.500	0.012	0.020
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(BSC)		0.037(BSC)	
e1	1.800	2.000	0.071	0.079
L	0.300	0.600	0.012	0.024
θ	0°	8°	0°	8°