PWM/PFM control DC-DC Synchronous Step-Down Converter

General Description

The LN5058 is a current mode monolithic buck switching regulator. Operating with an input range of 2.5V-6.2V, the LN5058 delivers 1.5A of continuous output current with integrated P-Channel and N-Channel MOSFETs. The internal synchronous power switches provide high efficiency. At light loads, the regulator operate in low frequency to maintain high efficiency and low output ripples. Current mode control provides tight load transient response and cycle-by-cycle current limit.

The LN5058 guarantees robustness with hiccup output short-circuit protection, FB short-circuit protection, start-up current run-away protection, input under voltage lockout protection, hot-plug in protection, and thermal protection. The LN5058 provides output power good indication which is only available in SOT-23-5L package.

Applications

- Set Top Boxes
- Telecom/Networking Systems
- cameras, video equipment, communications equipment, regulated power supply
- GPU/DDR Power Supply

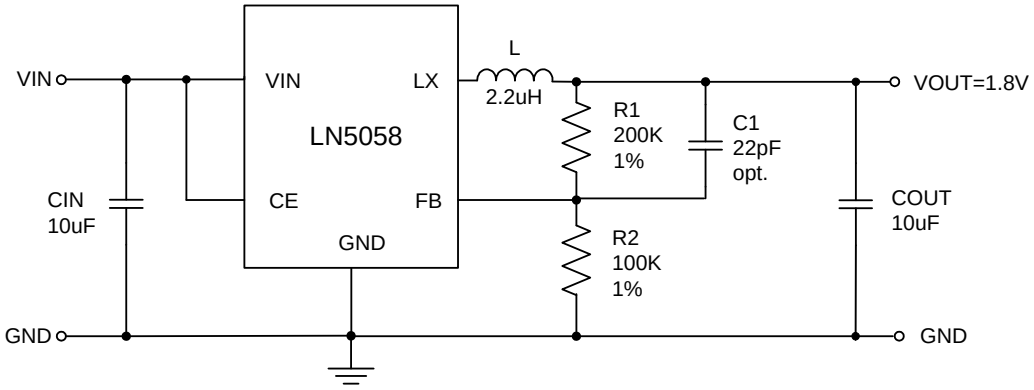
Features

- 1.5MHz switching frequency
- Up to 1.5A output current
- Up to 95% peak efficiency
- 2.5V to 6.2V operating input range
- can reach 100% duty cycle
- PWM automatic/PFM switching duty cycle adjustable to maintain a large load range of high efficiency, low ripple
- Short circuit protection

Package

- SOT-23-5L

Typical Application Circuit

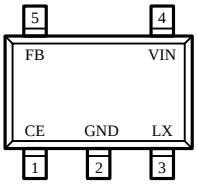


Ordering Information

LN5058A①②③

Item	Symbol	Description
①	F	Automatic switching mode PWM and PFM
	W	Pure PWM mode
②	M	Package type : SOT-23-5L
③	R	Embossed Tape: Standard Feed
	L	Embossed Tape: Reverse Feed

Pin Configuration



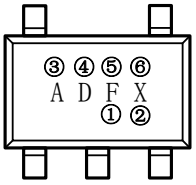
SOT-23-5L
(TOP VIEW)

Pin Assignment

Pin Number	Pin Name	Function Description
1	CE	Drive EN pin , high to turn on the regulator
2	GND	Ground
3	LX	internal power switch output port
4	VIN	Power Input
5	FB	Output feedback

Marking Rule

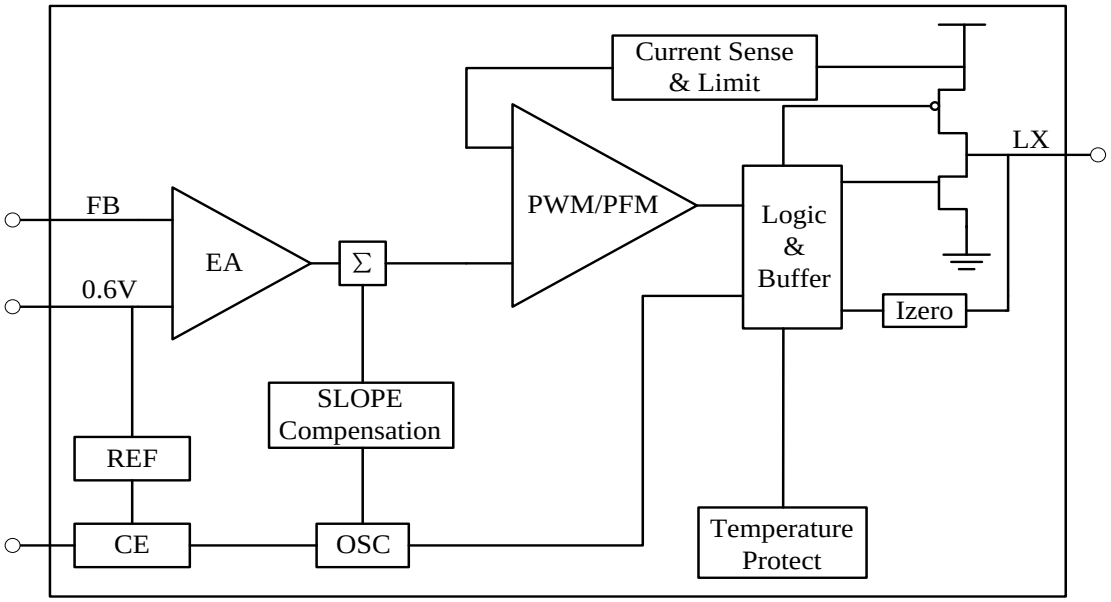
- SOT-23-5L



SOT-23-5L
(TOP VIEW)

符号	说明
ADF	output voltage adjustable、PFM mode
X	production information
①②③④⑤⑥	quality information

■ Function Block Diagram



■ Absolute Maximum Ratings

Parameter		Symbol	Maximum Rating	Unit
Input Voltage		VIN	-0.3～6.5	V
Output Voltage		VFB	-0.3～6.5	
		VLX	-0.3～VIN + 0.3	
Voltage of the CE		VCE	-0.3～VIN + 0.3	V
LX side current		ILX	±2	A
Power Dissipation	SOT-23-5L	Pd	350	mW
Operating Ambient Temperature		Topr	-40～＋85	℃
Storage Temperature		Tstg	-55～＋125	

■ Electrical Characteristics

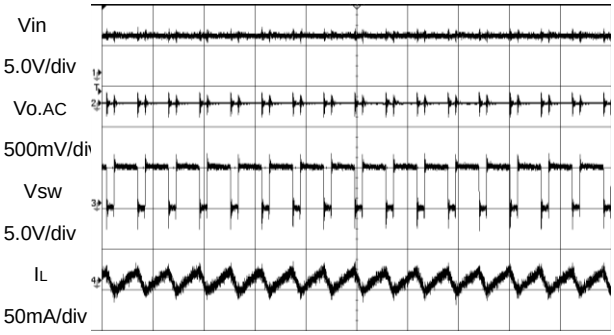
CIN=10uF, COUT=10uF, L=2.2uH (Ta=25℃Unless specified by a special)

项目	符号	条件	最小值	典型值	最大值	单位
Input Voltage	VIN	-	2.5	-	6.2	V
VIN Under Voltage Lockout Threshold	UVLO	-	-	2.4	-	V
VIN Under Voltage Lockout Threshold Delay	UVLO_HYS	-	-	500	-	mV
OVP	OVP	-	-	6.2	-	V
OVP Delay	OVP _HYS	-	-	300	-	mV
Regulated Feedback Voltage	VFB	Ta=25℃	0.588	0.6	0.612	V
Standby current	ISTB	VCE=0V, VIN=5V	0	-	1	uA
Quiescent Current	IQ	VFB=110%,ILOAD=0	-	40	-	uA
Supply Current	IACT	VFB=90%, ILOAD=0	-	150	300	uA
Peak Current Limit	ILIM	VFB=90%, VIN=5V	1.7	-	-	A
Load Regulation	ΔVOUT	ILOAD=10mA to 1.0A	-	0.5	-	%
Line Regulations	$\frac{\Delta VOUT}{\Delta VIN \times VOUT}$	VIN=2.5V to 6V	-	0.04	0.4	%
PFM switch point	ILOAD	VIN=3.6V, VOUT=1.8V	-	30	-	mA
Switch Frequency	FOSC	VOUT=100%	-	1.5	-	MHz
Maximum Duty Cycle	DMAX	-	100	-	-	%
PFET On Resistance	RDSON_P	VIN=5V	-	0.3	-	Ω
NFET On Resistance	RDSON_N	VIN=5V	-	0.2	-	Ω
SW side leakage current	ILEAK_SW	VCE=0V, VIN=5V	-	±0.01	±1	uA
CE “High” Voltage	VCEH	VIN=5V	1.2	-	-	V
CE “Low” Voltage	VCEL	VIN=5V	-	-	0.7	V
Output short	I_OS	FB<0.2V	-	0.2	-	A
Thermal Shutdown	TSHD	-	-	160	-	℃
Thermal Shutdown Delay	T_HYS	-	-	25	-	℃

■ Typical Performance Characteristics

1、 Steady State Test

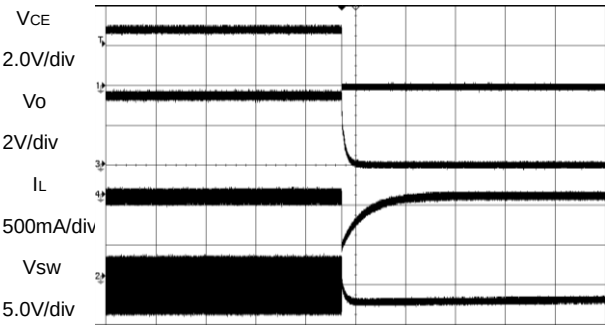
VIN=5.0V, VOUT=3.3V, IL=1.2A



1us/div

2、CE Open

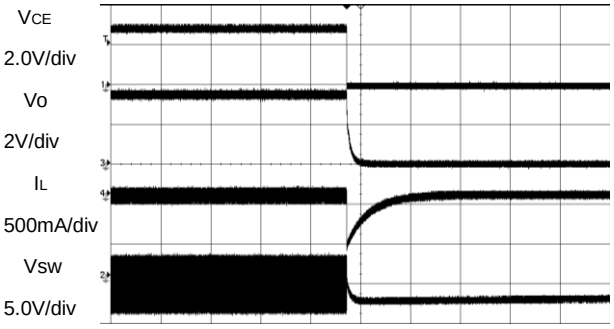
VIN=5.0V, VOUT=3.3V, IL=1.0A



1ms/div

3、CE Shut Off

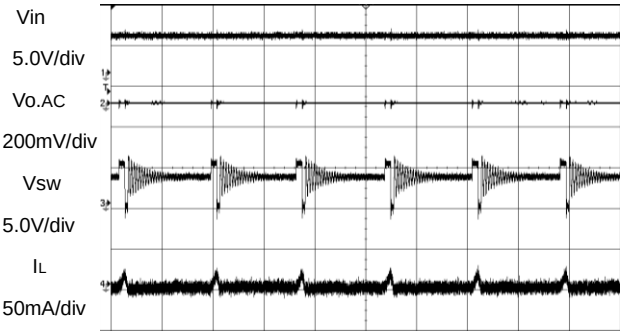
VIN=5.0V, VOUT=3.3V, IL=1.0A



1ms/div

4、Light Load Operation

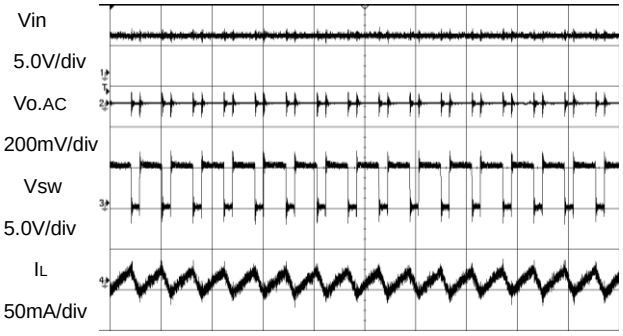
VIN=5.0V, VOUT=3.3V, IL=1mA



2us/div

5、Medium Load Operation

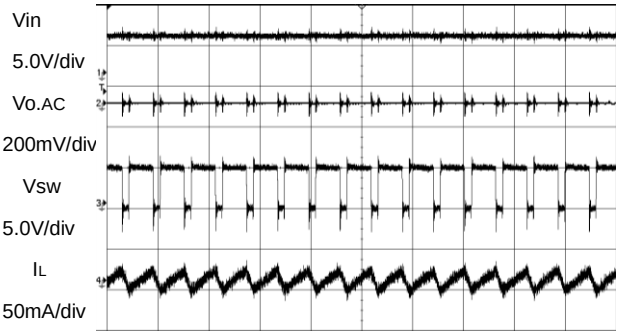
VIN=5.0V, VOUT=3.3V, IL=0.6A



1us/div

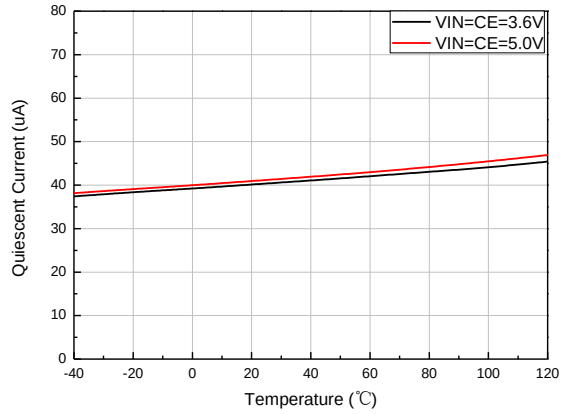
6、Heavy Load Operation

VIN=5.0V, VOUT=3.3V, IL=1.2A

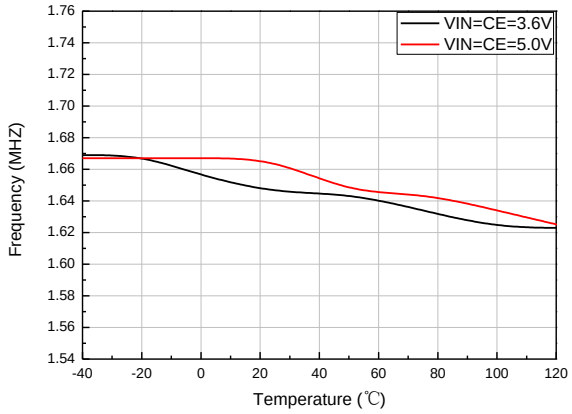


1us/div

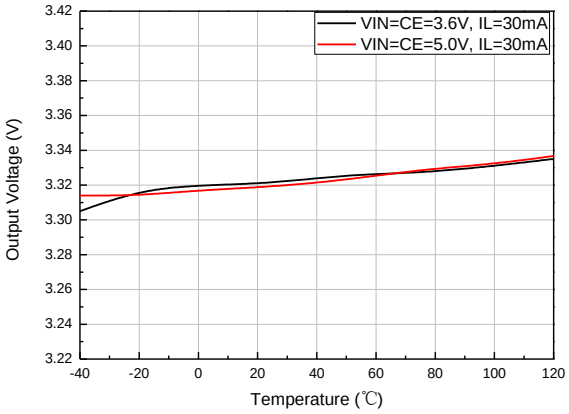
7、Quiescent Current Vs. Temperature



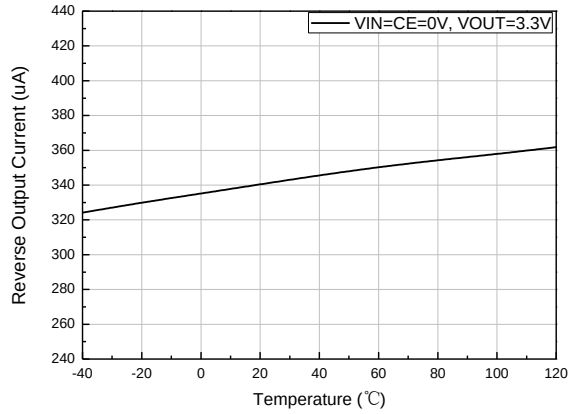
8、Frequency Vs. Temperature



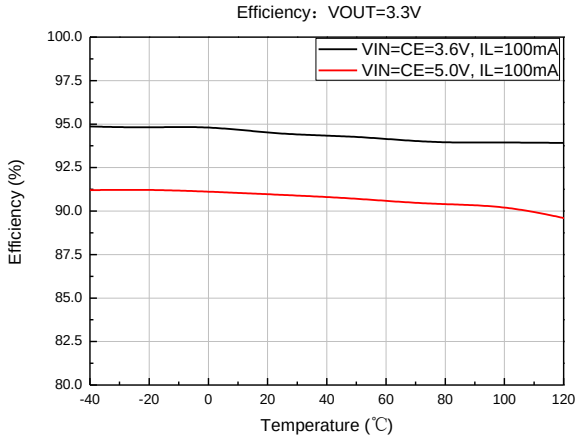
9、Output Voltage Vs. Temperature



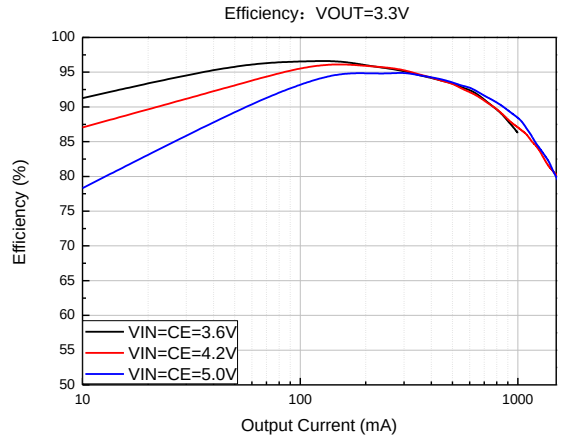
10、Reverse Output Current Vs. Temperature



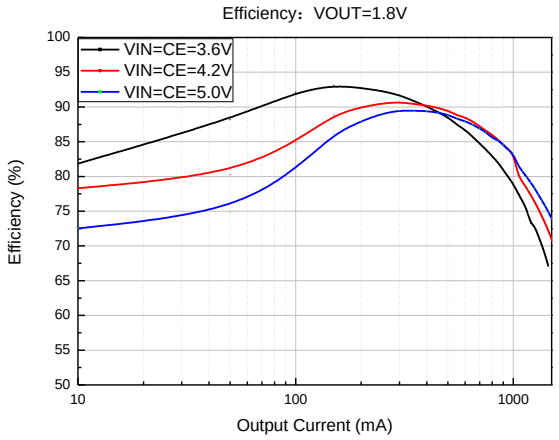
11、Efficiency Vs. Temperature



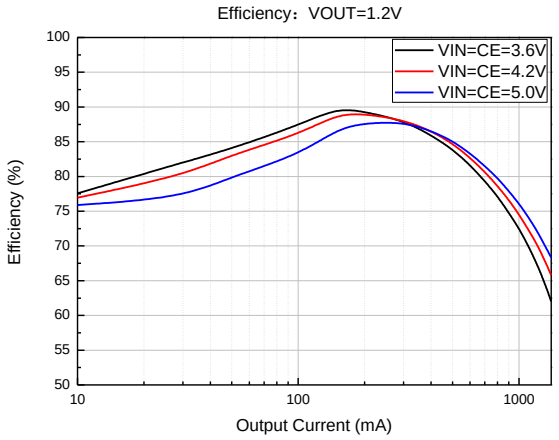
12、Efficiency @ VOUT=3.3V



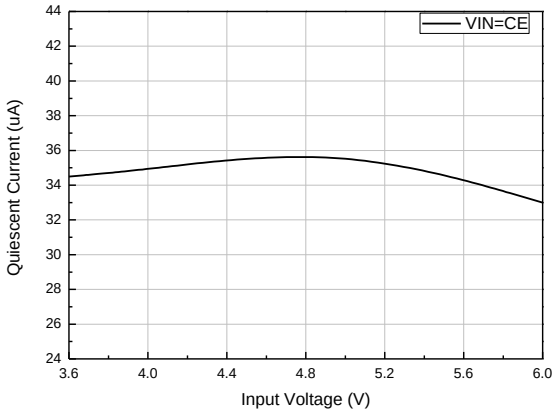
13、Efficiency @ VOUT=1.8V



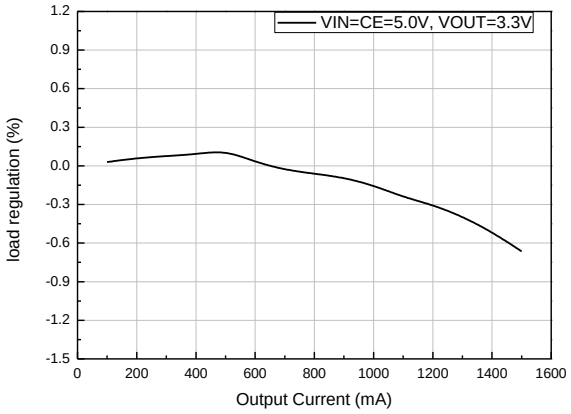
14、Efficiency @ VOUT=1.2V



15、Quiescent Current Vs. Input Voltage



16、Load Regulation @ VOUT=3.3V



FUNCTIONAL DESCRIPTION

The LN5058 is a synchronous, current-mode step-down regulator. It regulates input voltages from 2.5V~6.2V down to an output voltage as low as 0.6V, and is capable of supplying up to 1.5A of load current.

The LN5058 uses a constant frequency, current mode step-down architecture. Both the main (P-channel MOSFET) and synchronous (N-channel MOSFET) switches are internal. During normal operation, the internal top power MOSFET is turned on each cycle when the oscillator sets the RS latch, and turned off when the current comparator, ICOMP, resets the RS latch. The peak inductor current at which ICOMP resets the RS latch, is controlled by the output of error amplifier EA.

When the load current increases, it causes a slight decrease in the feedback voltage, FB, relative to the 0.6V reference, which in turn, causes the EA amplifier' s output voltage to increase until the average inductor current matches the new load current. While the top MOSFET is off, the bottom MOSFET is turned on until either the inductor current starts to reverse, as indicated by the current reversal comparator IRCMP, or the beginning of the next clock cycle.

- **PFM Mode**

The LN5058 operates in PFM mode at light load. In PFM mode, switch frequency is continuously controlled in proportion to the load current, i.e. 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.

- **Shut-Down Mode**

The LN5058 operates in shut-down mode when voltage at CE pin is driven below 0.7V. In shut-down mode, the entire regulator is off and the supply current consumed by theLN5058 drops below 1uA.

- **Hot-Plug In Protection**

If the Vin voltage exceeds 6.2V, IC will turn off power switch, entering over-voltage protection. It will remain in this state until Vin voltage is less than 6V.

- **Short Circuit Protection**

When output is shorted to ground, the switching frequency is reduced to prevent the inductor current from increasing beyond PFET current limit.

- **Thermal Protection**

When the temperature of the LN5058 rises above 160°C, it is forced into thermal shut-down.

Only when core temperature drops below 135°C can the regulator becomes active again.

APPLICATION INFORMATION

- **Output Voltage Set**

The output voltage is determined by the resistor divider connected at the FB pin, and the voltage can be calculated by:

$$VOUT = 0.6 \times (1 + \frac{R1}{R2})$$

The recommended value of R2 is KΩ.

- **Input Capacitor**

The input capacitor is used to supply the AC input current to the step-down converter and maintaining the DC input voltage. The input capacitor can be calculated by the following equation when the input ripple voltage is determined.

$$CIN = \frac{ILOAD}{\text{fs} \times \Delta VIN} \times \frac{VOUT}{VIN} \times \left(1 - \frac{VOUT}{VIN}\right)$$

where fs is the switching frequency, △VIN is the input ripple current.

The input capacitor can be electrolytic, tantalum or ceramic. To minimizing the potential noise, a small X5R or X7R ceramic capacitor, i.e. 0.1uF, should be placed as close to the IC as possible when using electrolytic capacitors.

A 10uF ceramic capacitor is recommended in typical application.

- **Output Capacitor**

The output capacitor 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:

$$\Delta VOUT = \frac{VOUT}{\text{fs} \times L} \times \left(1 - \frac{VOUT}{VIN}\right) \times \left(RESR + \frac{1}{8 \times \text{fs} \times COUT}\right)$$

where COUT is the output capacitance value and RESR is the equivalent series resistance 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 output capacitors also affect the system stability and transient response, and a 10uF ceramic capacitor is recommended in typical application.

- **Inductor**

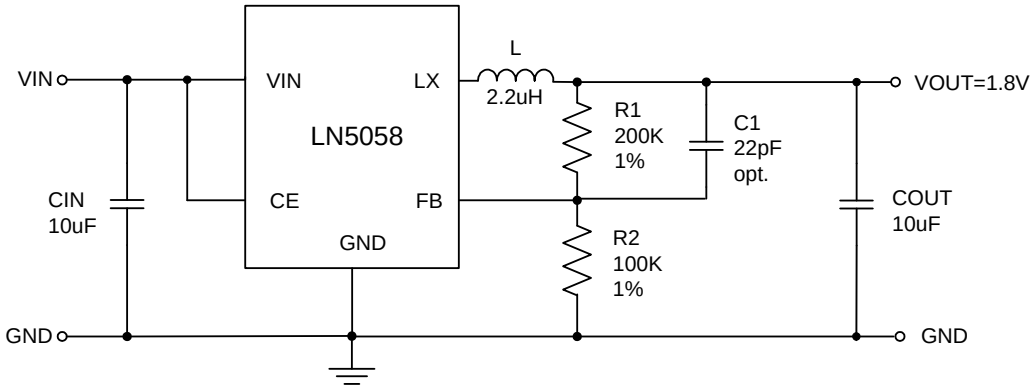
The inductor is used to supply constant current to the output load, and the value determines the ripple current which affect the efficiency and the output voltage ripple. The ripple current is typically allowed to be 40% of the maximum switch current limit, thus the inductance value can be calculated by:

$$L = \frac{VOUT}{\text{fs} \times \Delta IL} \times \left(1 - \frac{VOUT}{VIN}\right)$$

where VIN is the input voltage, VOUT is the output voltage, fs is the switching frequency, and ∆ IL is the peak-to-peak inductor ripple current.

A 2.2uH inductor is recommended in typical application.

REFERENCE DESIGN



Notes: C1 is optional.

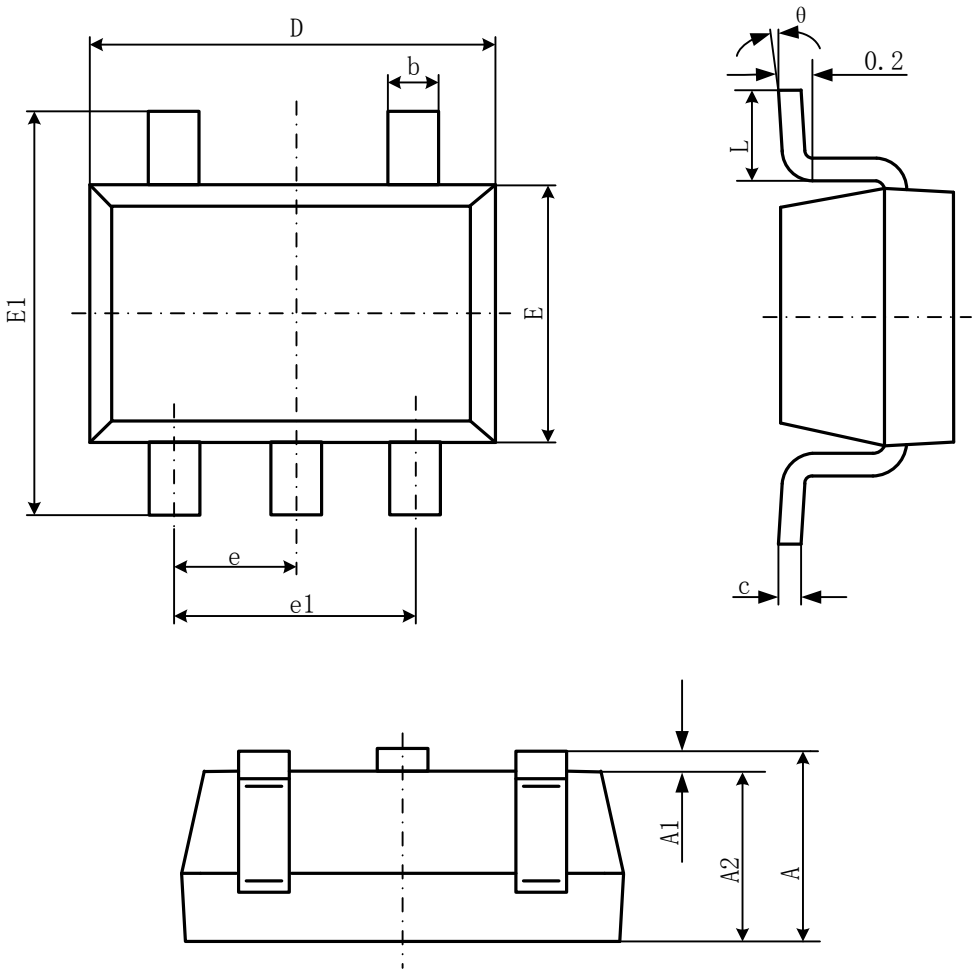
PCB Layout Note

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 LN5058 (VIN pin and PGND) as possible to eliminate noise at the input pin.
2. The loop area formed by input capacitor and GND must be minimized.
3. Put the feedback trace as far away from the inductor and noisy power traces as possible.
4. The ground plane on the PCB should be as large as possible for better heat dissipation.

Package Information

- **SOT-23-5L**



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°