Features

- 9V ~ 36V Supply Voltage Range
- 45V Input Voltage Surge
- 38V Input Over Voltage Protection
- 2% Voltage Reference Accuracy
- 7% Constant Current Accuracy
- External Current Limit Setting
- Programmable Operation Frequency
- Programmable the current limit point of high side MOS
- Duty Cycle Range (0~95%)
- Single Pin to External Compensation and Shutdown Control
- Built in Adjustable Line-Compensation
- Internal Soft Start 3ms
- CC/CV Mode Control
- QFN20L-5×5 Package

Applications

- Car Chargers
- Portable Charger Devices
- General-Purpose DC/DC Converters with Current Limit

General Description

The SP1259HN is a synchronous buck converter with output current to 4.8A.It is designed to allow for operating a wide supply voltage range from 9V to 36V. The external shutdown function can be controlled by logic level to pull COMP/EN pin down, and then comes into standby mode. The external compensation makes feedback control have good line and load regulation with flexible external design.

The SP1259HN operates in the CC(Constant output Current) mode or CV(Constant output Voltage) mode, and the OCP current value is set by current sensing resisters.

The SP1259HN is suitable for the DC/DC switching power applications when requested the current limit function. The devices are available in QFN20L-5×5 package and require very few external devices for operation.

Simplified Application

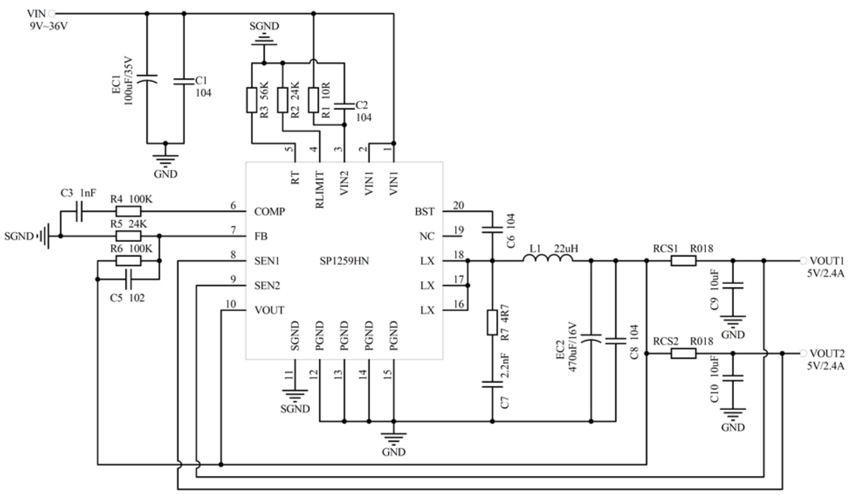


Figure 1 Typical Application of SP1259HN

Note: If output only one port, the other Sense pin need connect with VOUT.

Pin Function Description

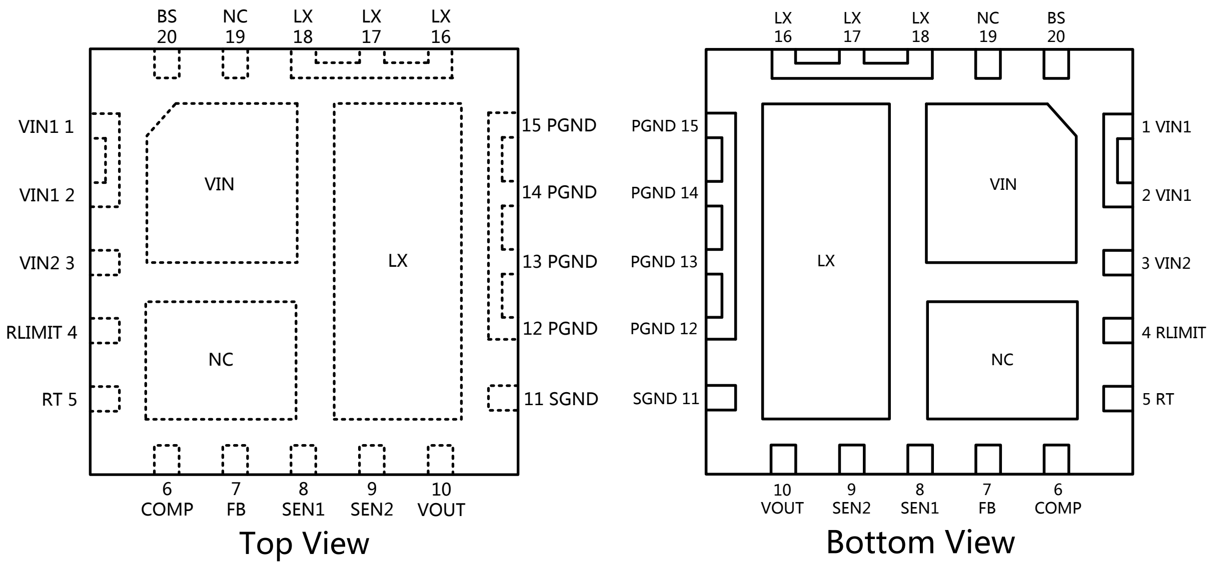


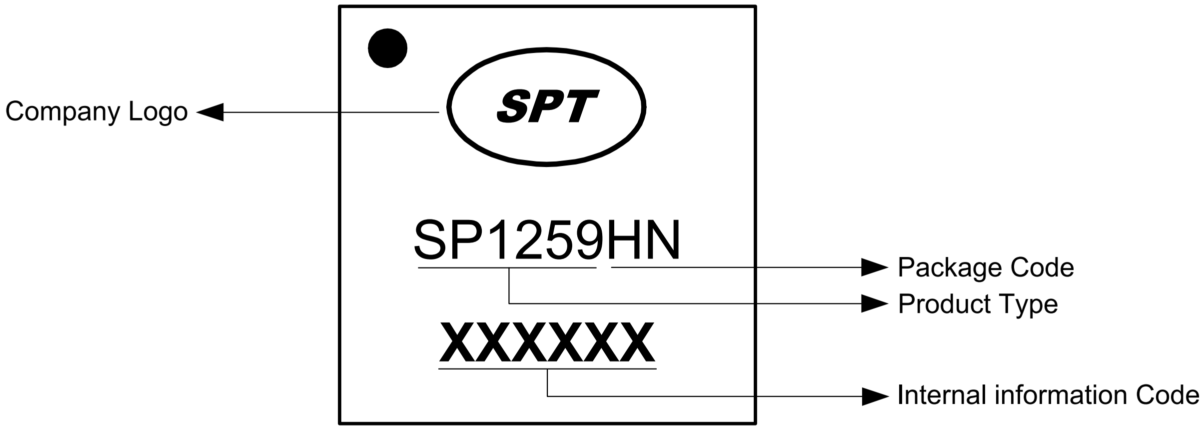
Figure 2 Pin Configuration

Pin No.	Pin Name	Function Description
1， 2	VIN1	Power supply input of high side MOS
3	VIN2	Power Supply Input. Bypass this pin with a 1uF ceramic capacitor to GND, placed as close to the IC as possible.
4	RLIMIT	Programmable the current limit point of high side MOS
5	RT	Programmable Operation Frequency
6	COMP	Error Amplifier Output. This is the output of the error amplifier (EA) and the non-inverting input of the PWM comparator. Use this pin in combination with the FB pin to compensate the voltage control feedback loop of the converter. Pulling COMP to a level below 0.4V nominal disables the controller, causes the oscillator to stop, and no switch wave.
7	FB	Feedback Pin. The voltage at this pin is regulated to 1.0V. Connect to the resistor divider between output and GND to set the output voltage.
8	SEN1	The Current Sense Input1 Pin. When the VOUT-SEN1 is larger than the current sense voltage, OCP function will enable.
9	SEN2	The Current Sense Input2 Pin. When the VOUT-SEN2 is larger than the current sense voltage, OCP function will enable.
10	VOUT	Output Port.
11	SGND	Signal Ground. Return FB, and COMP to this GND and connect this GND to power GND at a single point for best noise immunity.
12~15	PGND	Power Ground. Connect this pin to a large PCB copper area for best heat dissipation.

16~18	LX	Power Switching Output to External Inductor.
19	NC	No connection
20	BS	Bootstrap Pin. This provides power to the internal higher MOSFET gate driver. Connect a 100nF capacitor from BS pin to LX pin.

Ordering and Marking Information

Part Number	Package Description	Top Marking	Package Form
SP1259	QFN20L-5×5	SP1259HN	QFN20L-5×5



Absolute Maximum Ratings

Characteristics	Symbol	Rating	Units
Supply Input Voltage	V_{IN}	-0.3 to +45	V
VOUT,SEN1,SEN2 to SGND		-0.3 to +30	V
BS to LX		-0.3 to +7	V
LX to SGND		-1 to V_{IN}+1	V
BS to SGND		V_{SW}-0.3 to V_{SW}+7	V
FB, COMP , RLIMIT,RT to SGND		-0.3 to +7	V
ESD HBM(Human Body Mode)		±2K	V
ESD MM(Machine Mode)		±200	V
Power Dissipation, PD @T_A=25℃	P_D	$(T_J-T_A)/\theta_{JA}$	W
Thermal Resistance from Junction to case	θ_{JC}	16	℃/W
Thermal Resistance from Junction to ambient	θ_{JA}	42	℃/W

Note:

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.

Recommended Operating Conditions

Symbol	Description	Value	Units
TST	Storage Temperature Range	-65 to +150	℃
TJ	Junction Temperature	-40 to +150	℃
TOP	Operating Temperature	-25 to +85	℃
	Lead Temperature Range(Soldering 10sec)	260	℃

Block Diagram

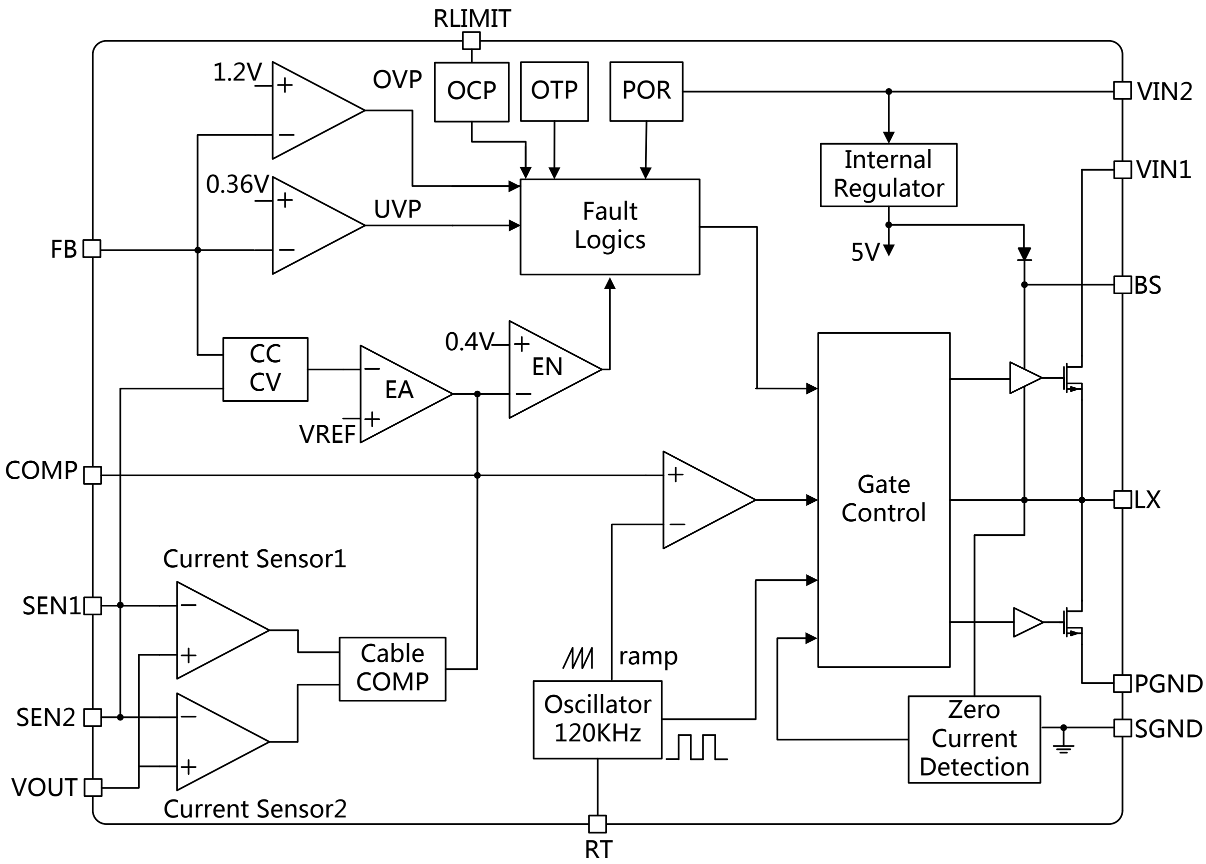


Figure 3 Block diagram of SP1259HN

Electrical Characteristics

V_{CC} = 12V, T_A = +25°C, unless otherwise specified

Characteristics	Symbol	Test Conditions	Min	Typ	Max	Units
Supply Voltage Range V_{IN}	Vcc		9	-	36	V
Input Over Voltage Protection	V_{OVP}		-	38	-	V
Input OVP Hysteresis	V_{OVP_HYS}		-	1.5	-	V
Supply Input Current	I_{CCQ}	COMP/EN=GND	-	0.65	-	mA
	I_{CC}	12Vin Vout=5V,No load	-	0.8	-	mA
	I_{CC}	24Vin Vout=5V, No load	-	0.7	-	mA
Power-On-Reset						
VCC POR Threshold	V_{CCRTH}	Vcc Rising.	-	7.5	-	V
	V_{CCFTH}	Vcc Falling.	-	7	-	
Oscillator						
PWM Frequency	F_{OSC}	RT=56K	96	120	144	KHz
Minimum On-Time	T_{ON-MIN}		-	200	-	ns
Duty Cycle Range	Duty		0	-	95	%
Reference						
Reference Voltage	V_{REF}		-	1.0	-	V
Reference Voltage Tolerance			-2	-	+2	%
Line compensation Current	I_{FB}		-	2.5	-	uA
PWM Error Amplifier						
COMP Shutdown Threshold Voltage			-	0.4	-	V
COMP Source Current		V_{COMP}= V_{COMP_H}-1V	-	-60	-	uA
COMP Sink Current		V_{COMP}=1V	-	60	-	uA
Current Sense Amplifier						
VOUT-SEN1 Voltage	V_{SEN1}		55.8	60	64.2	mV
VOUT-SEN2 Voltage	V_{SEN2}		55.8	60	64.2	mV
Protection						
FB Over Voltage Level	V_{OVP_FB}	Recent of V_{REF}		120		%
Over Temperature Shutdown	T_{SD}		-	145	-	℃
Over Temperature Hysteresis	T_{SDHYS}		-	40	-	℃
Short Circuit Fold Back Voltage	V_{SCP}		-	0.4	-	V
Recycle Time			-	0.5	-	s
Soft Start						
Soft Start Time	T_{SS}		-	3	-	ms
MOSFET						
High Side NMOS RDSON	Rdson		-	14	-	mΩ
Low Side NMOS RDSON	Rdson		-	8	-	mΩ

Functional Description

CV/CC mode control

The SP1259HN provides CC/CV function. The Constant output Current control Mode and Constant output Voltage control Mode.

Over Current Protection

The SP1259HN provides over current protection. A drop voltage on the current sensing resister is over the OCP value, the OCP function will shut down the controller.

Soft Start

The SP1259HN has internal soft start function to control rise rate of the output voltage and limits the large inrush current at start up. The typical soft start interval is about 3ms.

Power on Reset

A power-on reset circuit monitors the input voltage. When the input voltage exceeds 7.5V, the converter will start operation. Once input voltage falls below 6.5V, the controller will shut down.

Over Temperature Protection

The SP1259HN provides over temperature protection. The OTP will shut down the converter when junction temperature exceeds 145℃. Once the junction temperature cools down by approximately 40℃, the converter will resume normal operation.

High Side MOS Current Limit Protection

The SP1259HN provides high side MOS Over-Current Protection(OCP). The OCP is set by outside resistance (R_{RLIMIT}). The OCP set according to the following equation:

$$IOCP(A) = \frac{24K}{R_{RLIMIT}} \cdot 10A$$

Programmable Operation Frequency

The SP1259HN provides programmable operation frequency. The frequency set according to the following equation:

$$Fosc(KHz) = \frac{56K}{R_T} \cdot 120KHz$$

Current Limit Protection

The Current limit is set by outside resistance (R_{SENSE}), When the (VOUT- SEN1) or (VOUT-SEN2) voltage larger than 60mV, the current limit is happened that driver can be turned off. The current limit set according to the following equation:

$$CurrentLimit(A) = \frac{60mV}{R_{SENSE}}$$

Output Over Voltage Protection

The SP1259HN provides output over voltage protection function .Once the feedback voltage is over the 120% of the internal reference voltage, the OVP will be triggered to shut down the controller.

Output Short-Circuit Protection

The SP1259HN provides output short-circuit protection function. When V_{OUT} is short (V_{FB}<0.4V), the auto restart function can be started that restart the regulator cycle by cycle. The cycle time is set by internal counter.

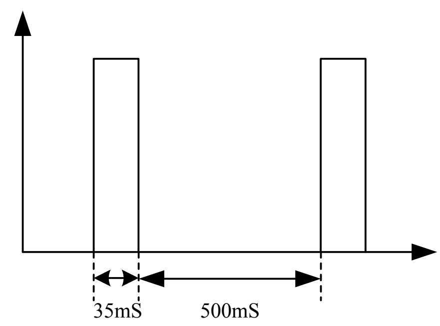


Figure 4 short-circuit protection time

APPLICATION INFORMATION

Output Voltage Setting

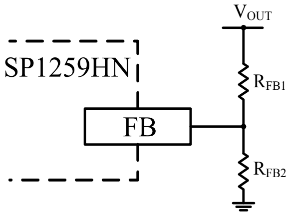


Figure 5 Output Voltage Setting

Figure 5 shows the connections for setting the output voltage. Select the proper ratio of the two feedback resistors R_{FB1} and R_{FB2} based on the output voltage. Typically, use $R_{FB2}\approx 1k\Omega$ and determine R_{FB1} from the following equation:

$$R_{FB1} = R_{FB2}\left(\frac{V_{OUT}}{V_{FB}} - 1\right)$$

Output Cable Resistance Compensation

To compensate for resistive voltage drop across the charger's output cable, the SP1259HN integrates a simple, user-programmable cable voltage drop compensation using the impedance at the FB pin. Use the curve in Figure 6 to choose the proper feedback resistance values for cable compensation. R_{FB1} is the high side resistor of voltage divider. The Vout-Vsen1 or Vout-Vsen2 take the big one.

$$V_{OUT} = \left[(1+\frac{R_{FB1}}{R_{FB2}})\cdot V_{FB}\right] + \left[R_{FB1}\cdot(\frac{\Delta V_{SEN}}{16.6K} - 1uA)\cdot 0.5\right]$$

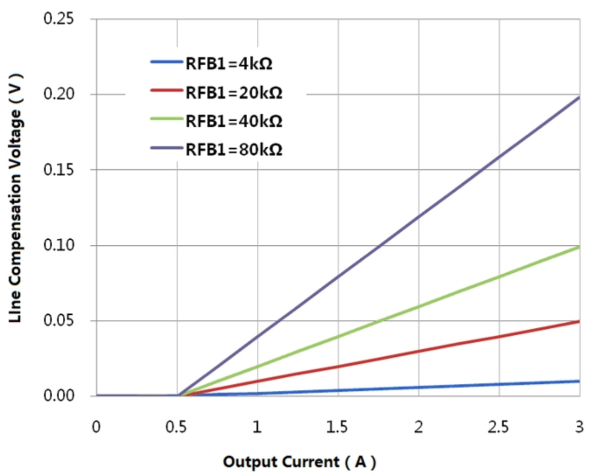


Figure 6 12Vin to 5Vout Cable Compensation (RSEN=33mΩ)

Inductor Selection

The inductor maintains a continuous current to the output load. This inductor current has a ripple that is dependent on the inductance value:

Higher inductance reduces the peak-to-peak ripple current. The tradeoff for high inductance value is the increase in inductor core size and series resistance, and the reduction in current handling capability. In general, select an inductance value L based on ripple current requirement:

$$L = \frac{V_{OUT}\times(V_{IN} - V_{OUT})}{V_{IN} f_{LX} I_{OUTMAX} K_{RIPPLE}}$$

Where V_{IN} is the input voltage, V_{OUT} is the output voltage, f_{LX} is the switching frequency, I_{OUTMAX} is the maximum output current, and K_{RIPPLE} is the ripple factor. Typically, choose K_{RIPPLE}=30% to correspond to the peak-to-peak ripple current being 30% of the maximum output current.

With this inductor value, the peak inductor current is $I_{OUT}\times(1+K_{RIPPLE}/2)$. Make sure that this peak inductor current is less than the controller's current limit. Finally, select the inductor core size so that it does not saturate at the peak inductor current.

Input Capacitor

The input capacitor needs to be carefully selected to maintain sufficiently low ripple at the supply input of the converter. A low ESR capacitor is highly recommended. Since large current flows in and out of this capacitor during switching, its ESR also affects efficiency.

The input capacitance needs to be higher than 100μF. The best choice is the ceramic type, however, low ESR tantalum or electrolytic types may also be used provided that the RMS ripple current rating is higher than 50% of the output current. The input capacitor should be placed close to the VIN and SGND pins of the IC, with the shortest traces possible. In the case of tantalum or electrolytic types, they can be further away if a small parallel 1μF ceramic capacitor is placed right next to the IC. Especially C2 capacitor should be placed as close as possible to the VIN pin.

Output Capacitor

The output capacitor also needs to have low ESR to keep low output voltage ripple. The output ripple voltage is:

$$V_{RIPPLE} = I_{OUT} K_{RIPPLE} R_{ESR} + \frac{V_{IN}}{28 \times f_{LX}^2 L C_{OUT}}$$

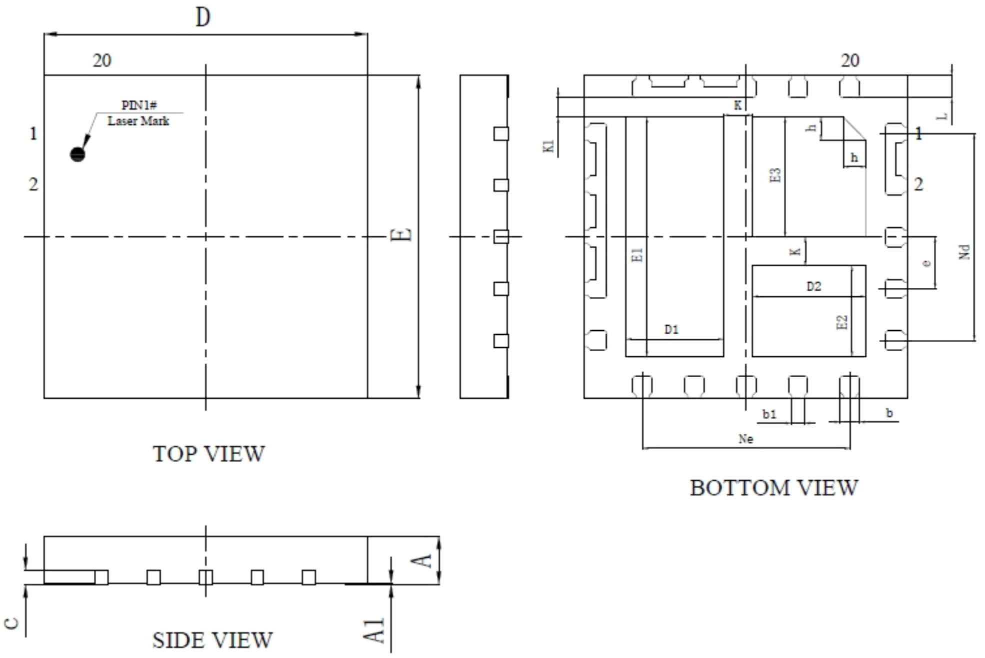
where I_{OUTMAX} is the maximum output current, K_{RIPPLE} is the ripple factor, R_{ESR} is the ESR of the output capacitor, f_{LX} is the switching frequency, L is the inductor value, and C_{OUT} is the output capacitance. In the case of ceramic output capacitors, R_{ESR} is very small and does not contribute to the ripple. Therefore, a lower capacitance value can be used for ceramic type. In the case of tantalum or electrolytic capacitors, the ripple is dominated by R_{ESR} multiplied by the ripple current. In that case, the output capacitor is chosen to have sufficiently low ESR.

For ceramic output capacitor, typically choose a capacitance of about 470μF. For tantalum or electrolytic capacitors, choose a capacitor with less than 50mΩ ESR.

PCB Layout Recommendations

1. PCB trance defined as LX node, which connects to the inductor, should be as short and wide as possible.
2. Inductance between the LX terminal and the output VOUT as far as possible with the ground wire to reduce the output side of the switch coupling.
3. ALL sensitive analog traces such as SEN1, SEN2, COMP and FB should place away from high-voltage switching nodes LX nodes to avoid coupling.
4. C2 input bypass capacitor should be placed to the IN pin as close as possible.
5. R5 and R6 feedback resistor should be placed to the FB pin as close as possible.
6. The compensation network R4, C3 should be placed to the COMP pin as close as possible.
7. Signal ground and power ground should be connected strongly together near the device.
8. The ground of input capacitance and output capacitance should be placed as close as possible.

Package Information（Units:mm）



Symbol	Dimensions in Millimeters		
	Min.	Nom.	Max.
A	0.70	0.75	0.80
A1	0	0.02	0.05
b	0.25	0.30	0.35
b1	0.20REF		
c	0.18	0.20	0.25
D	4.90	5.00	5.10
D1	1.40	1.50	1.60
D2	1.65	1.75	1.85
e	0.80BSC		
Ne	3.20BSC		
Nd	3.20BSC		
E	4.90	5.00	5.10
E1	3.60	3.70	3.80
E2	1.30	1.40	1.50
E3	1.75	1.85	1.95
L	0.30	0.35	0.40
h	0.30	0.35	0.40
K	0.40	0.45	0.50
K1	0.25	0.30	0.35

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