Boost With Integrated 3.5A 25V power MOSFET

1 Description

CN2901 is a high efficiency boost converter, with an integrated 3.5A 25V power MOSFET as main switch, it runs at optimal 1MHz frequency which enables use of small external components while providing high efficiency. The CN2901 employs protective functions such as cycle by cycle current limit, OVP and thermal shutdown.

CN2901 is available in SOT-23-6L package.

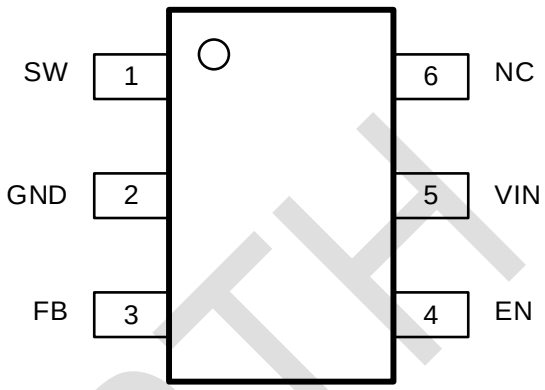
2 Features

- Up to 95% Efficiency
- 200mV ±3% Feedback Reference Voltage
- 1MHz Fixed Operation Frequency
- Maximum 25V output
- Power Save PFM Mode at Light Load
- Soft-start Limits Output Overshoot and Inrush Current
- 3.5A Cycle by Cycle Current Limit Protection
- OVP Protection
- Thermal Shutdown

3 Applications

- Smart Power Meters
- Industrial Applications
- Powering HV module from batteries
- Bluetooth Speaker
- Large LCD backlight and bias

4 Pin Configuration



SOT-23-6L

5 Marking

Product Number	Marking
CN2901TER	CN2901 YYWW

Note: YY=Year; WW=Week.

Green (RoHS & HF): CHIPNORTH defines "Green" to mean Pb-Free (RoHS compatible) and free of halogen substances. If you have additional comments or questions, please contact your CHIPNORTH representative directly.

Moisture sensitivity level (MSL):3

6 Ordering Information

Product Number	Package	Quantity/Tape
CN2901TER	SOT-23-6L	3000pcs

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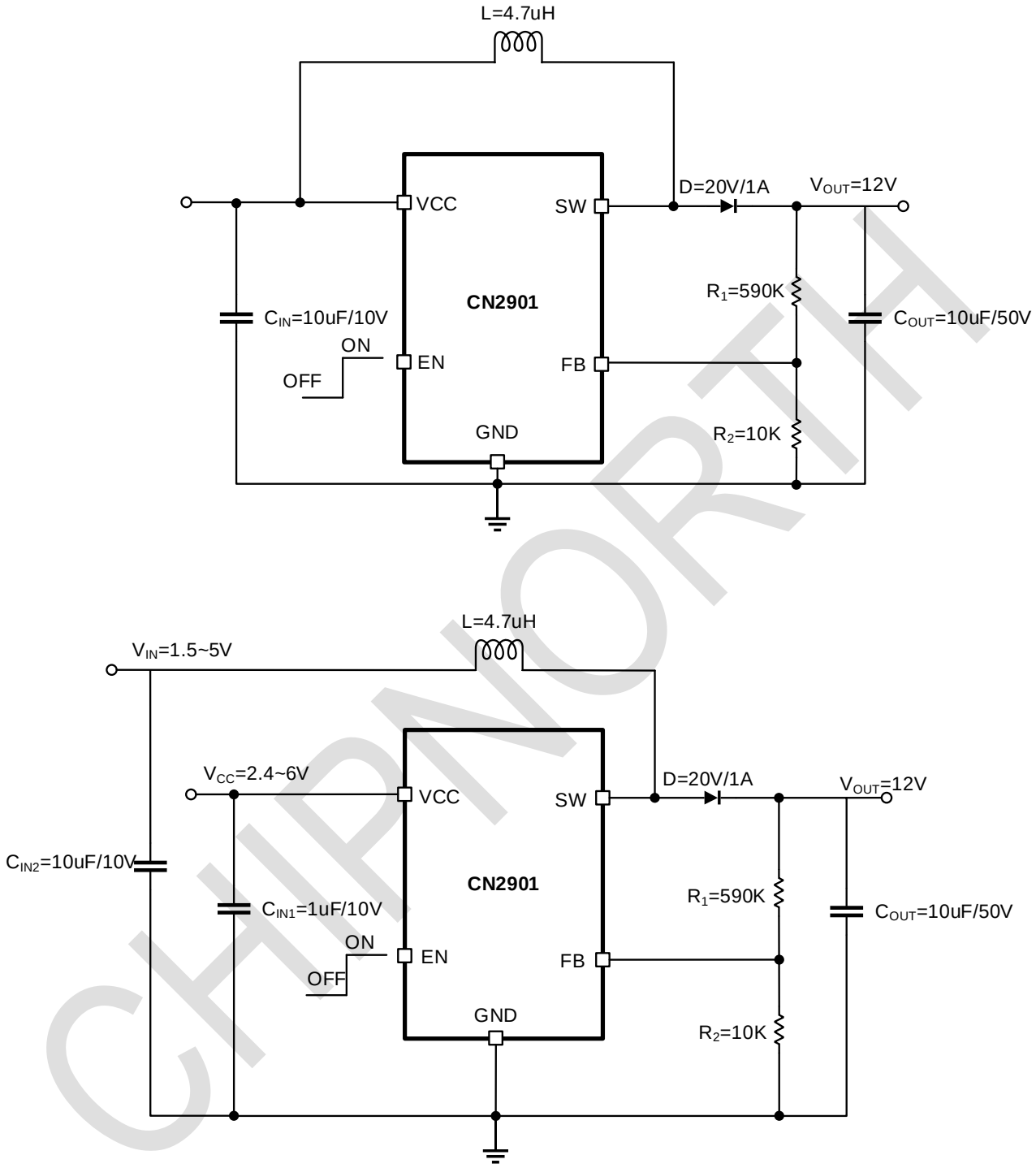
7 Typical Application



Note：

1. $V_{OUT} = V_{REF} \times (R_1+R_2) / R_2$

2. For special applications where Boost does not operate but voltage is applied at the output, the Schottky diode withstand voltage must be greater than the voltage applied at the output.

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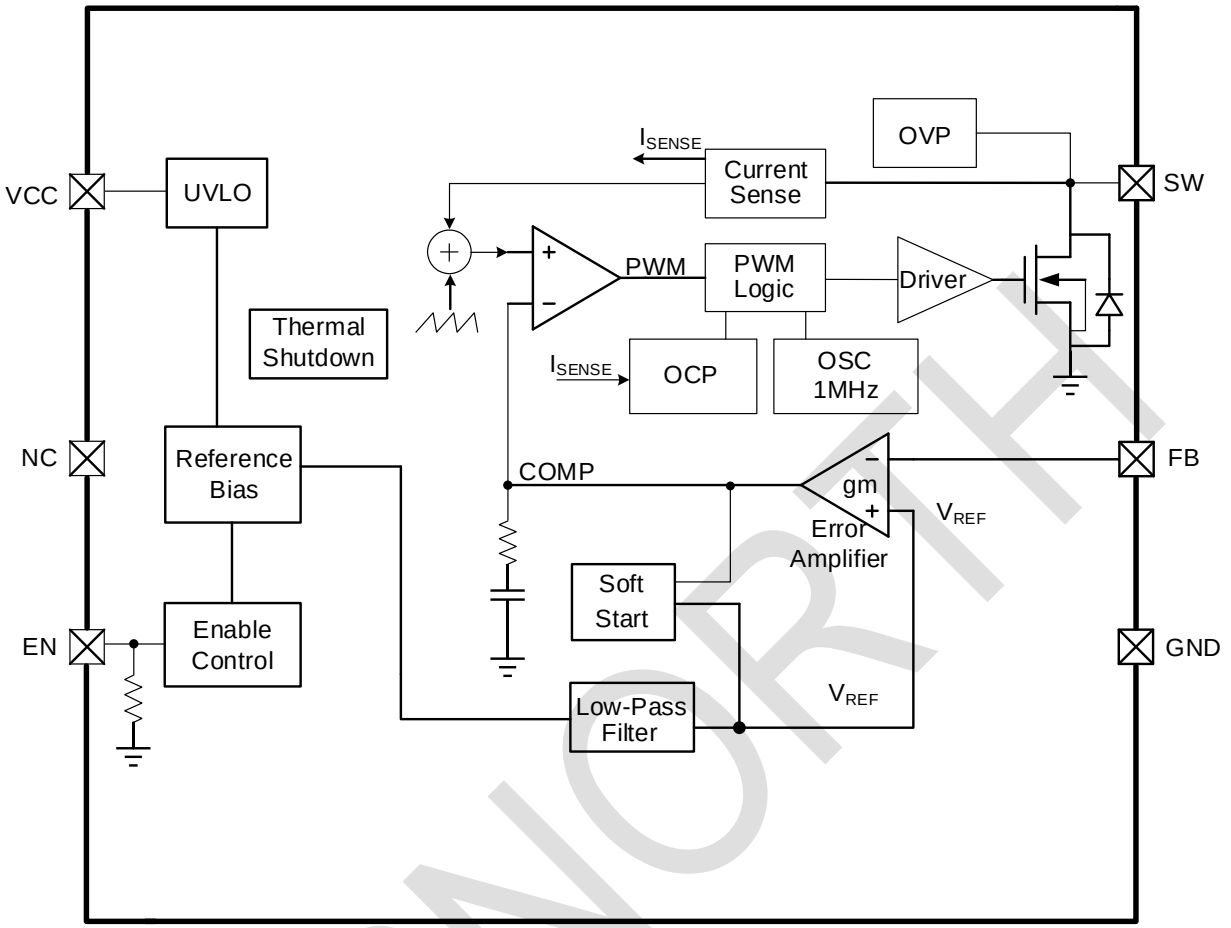
8 Block Diagram



9 Pin Descriptions

Pin No.	Pin Name	Descriptions
1	SW	Switch node pin. Connect an inductor Between SW and the input power supply
2	GND	Ground
3	FB	Feedback pin. Connect FB to the center of the external divider resistor from the output to GND
4	EN	Enable pin, active high. Drive this pin high to enable the part, low to disable. Connect EN to VCC if always on
5	VCC	Power supply input
6	NC	No Connection

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10 Specifications

10.1 Absolute Maximum Ratings

Parameter	Symbol	Value	Units
Supply Input Voltage, EN Voltage	V_{CC}, V_{EN}	-0.3~6.5	V
SW	V_{SW}	-0.3~28	V
FB Voltage	V_{FB}	-0.3~6.5	V
Operating Junction Temperature Range	T_J	-40~150	°C
Operating Ambient Temperature Range	T_A	-40~85	°C
Storage Temperature Range	T_{STG}	-55~150	°C

Note: Stress exceeds these ratings listed under “absolute maximum ratings” may cause permanent damage to the device. These are stress ratings only and functional operation of the device at these or any other conditions beyond those indicated under “recommended operating conditions” is not implied. Expose to absolute-maximum-rated conditions for extended periods may affect device reliability.

10.2 ESD Ratings

Discharge mode	Value	Units
HBM	±4000	V
CDM	±2000	V

10.3 Recommended Operating Range

Parameter	Symbol	Min.	Max.	Units
Operating Voltage Range	V_{CC}	2.4	6	V
Input Capacitor Range	C_{IN}	10		μF
Output Capacitor Range	C_{OUT}	10		μF
Inductor Range	L	4.7	10	μH

10.4 Thermal Information

Parameter	Descriptions	Value	Unit
$R_{\theta JA}$	Junction to ambient	134	°C/W
$R_{\theta JC}$	Junction to case	50	°C/W

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10.5 Electrical Characteristics

Test conditions: VCC=3.3V, T_A=25°C, unless otherwise specified.

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
Input voltage Range	V_{CC}		2.4	3	6	V
Input UVLO Threshold	V_{UVLO_R}	V_{IN} Rising, Hysteresis = 100mV	2	2.2	2.39	V
Input Quiescent Current	I_Q	No Switching V_{FB}=V_{REF} x 120%		0.25		mA
Supply Current		Switching at I_{OUT}=0		0.45		mA
Shutdown Current	I_{SHDN}	V_{IN} = 3V, EN = 0V		0.04	1	μA
FB Reference Voltage	V_{REF}		194	200	206	mV
FB Input Current	I_{FB}	V_{FB} = 2V		10		nA
Switching Frequency	F_{OSC}		800	1000	1200	KHz
Minimum On Time	T_{ON_MIN}			120		ns
Maximum Duty Cycle	D_{MAX}			91		%
NMOS On-Resistance	R_{ON}	I_{SW} = 100mA		100		mΩ
NMOS Current Limit	I_{LIMIT_HS}	Duty=50%		3.5		A
SW Leakage Current	I_{SW_LK}	V_{IN}=5V, EN=GND, V_{SW}=28V		0.1	1	μA
EN Rising Threshold	V_{EN_H}		1.3			V
EN Falling Threshold	V_{EN_L}				0.4	V
EN Input Current	I_{EN}	V_{IN} = 5V, V_{EN} = 5V		2.6		μA
Soft-Start Time	T_{SS}			0.5		ms
Output OVP Threshold		Rising, V_{FB}/V_{REF}		125		%
Thermal Shutdown Temperature	T_{SHDN}	Rising, Hysteresis = 30°C		160		°C

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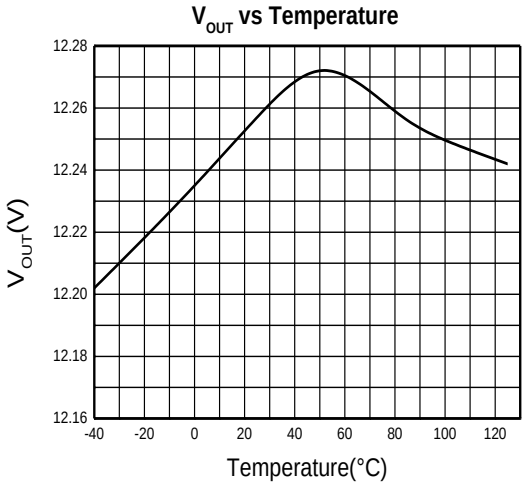
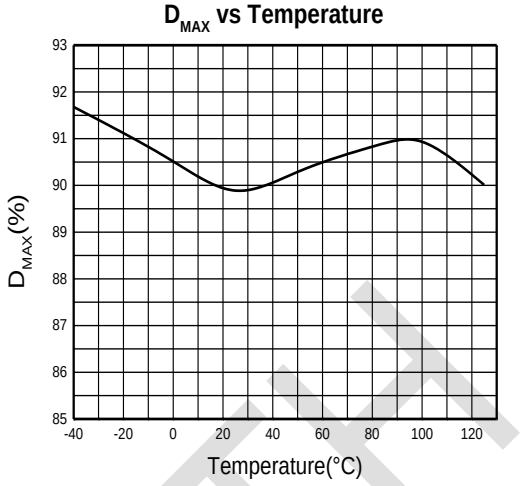
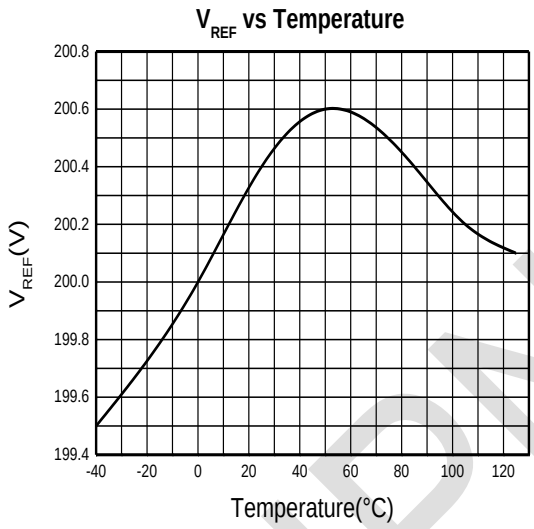
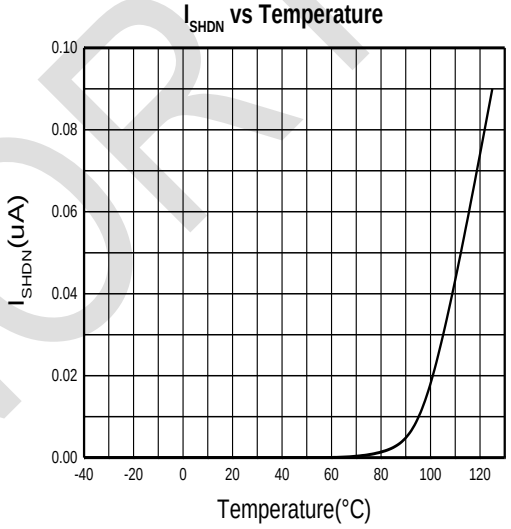
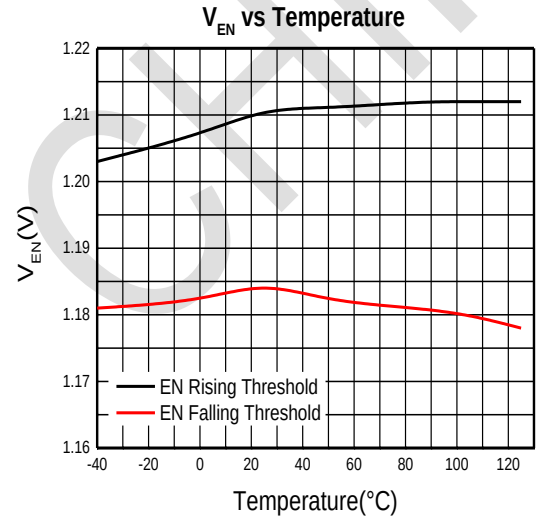
10.6 Characteristics Curve

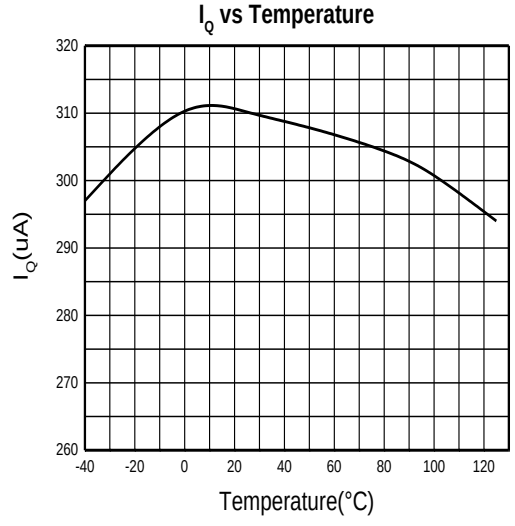












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11 Detailed Description

11.1 Overview

The CN2901 is a high efficiency, high output voltage boost converter. The device uses a fixed frequency, peak current mode boost regulator architecture to regulate the feedback pin voltage. The device integrates a 25V/3.5A switching MOSFET. The operation of the CN2901 can be understood by referring to the block diagram. CN2901 has internal soft start to limit the amount of input current at startup and to also limit the amount of overshoot on the output voltage.

11.2 Control Mechanism

The power MOSFET is turned on at the beginning of each clock cycle, a slope compensation ramp is added to the output of the current sense amplifier and the sum is fed into the positive input of the comparator and compared with the COMP voltage at the negative end, when the sum exceeds the COMP voltage, the power MOSFET is turned off until the next clock cycle arrives when the MOSFET is turned on again.

11.3 Functional Descriptions

11.3.1 Over Current Protection

The CN2901 uses a cycle-by-cycle current limit circuitry to limit the inductor peak current in the event of an overload condition. The current flow through inductor in charging phase is detected by a current sensing circuit. As the value goes over the current limiting threshold the power MOSFET turns off, so that the inductor will be forced to leave charging stage and enter discharging stage. Therefore, the inductor peak current will not exceed the current limiting threshold.

11.3.2 Output Open Circuit Protection

Output open circuit protection circuitry prevents the IC damage as the result of output open current. During each switching cycle, the CN2901 monitors the voltages on the SW pin and the FB pin. When both of the following conditions persist for 4 switching clock cycles, the circuit will keep turning off the switching MOSFET until EN or the power supply is restored to restart:

- The SW voltage exceeds the set threshold voltage of 18V;
- The FB voltage is below 50mV.

11.3.3 UVLO Protection

To avoid malfunction of the CN2901 at low input voltages, an under voltage lockout is included that disables the device, until the input voltage exceeds 2.2V (Typ.).

11.3.4 Shutdown Mode

Drive EN to GND to place the CN2901 in shutdown mode. In shutdown mode, the reference, control circuit, and the main switch turn off. Input current falls to smaller than 1μA during shutdown mode.

11.3.5 Thermal Shutdown

As soon as the junction temperature (TJ) exceeds 160°C (Typ.), the CN2901 goes into thermal shutdown. In this mode, the main power MOSFET is turned off until temperature falls below 130°C (Typ.). Then the device starts switching again.

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12 Application Information

12.1 Typical Application Requirements

Input voltage range 2.4V-6V, Output 12V/400mA.

12.2 Circuit Design

12.2.1 Output Voltage Set

The loop of Boost structure will keep the FB pin voltage equal to the reference voltage V_{REF}. Therefore, when R_1 connects OUT pin and FB pin, R_2 connects FB pin and GND, the output voltage is set externally by using a resistor divider, which is equal to following equation:

$$V_{OUT} = V_{FB} \times (1 + {}^{R_1}/_{R_2})$$

where:

- V_{OUT}: output voltage
- V_{FB}: regulated voltage of FB pin
- R_1: Resistance between output and FB pin
- R_2: resistance between FB pin and GND
- The recommended value of R_2 is 1kΩ~10kΩ

12.2.2 Boost Inductor Selection

Small inductance will make the ripple current large and too large inductance will cause poor dynamic characteristics and the slow response. The proper inductance should be selected to ensure the loop stability. For the application with 12V and 5V output, an inductance value of 4.7μH is recommended. In addition, the saturation current and temperature rise currents of the inductors must be greater than the peak and average currents of the actual operating condition.

For the application with 12V, 400mA output, a saturation current greater than 3.4A and a temperature rise current greater than 3.1A are recommended.

12.2.3 Input Capacitor Selection

Input capacitance reduces the ac voltage ripple on the input rail for the boost converter. The rated voltage of capacitor depends on the applied input voltage. The recommended capacitor is a 10μF/50V, X5R or X7R ceramic capacitor.

12.2.4 Output Capacitor Selection

The output capacitor is mainly selected to meet the requirements for the output ripple and loop stability. This ripple voltage is related to the capacitor's capacitance and its equivalent series resistance (ESR). The rated voltage of capacitor depends on the applied output voltage. The recommended capacitor is a 10μF/50V, X5R or X7R ceramic capacitor.

12.2.5 Diodes Selection

The rectifier diode provides a current path to the inductor when the internal MOSFET is turned off. Use a Schottky diode with a lower forward voltage to minimize losses. The Schottky diode's reverse blocking voltage rating should be greater than the output voltage used. The average current rating must be greater than the expected maximum load current and the peak current rating must be greater than the peak current of the inductor.

For 12V, 400mA output applications, select a min 1A Schottky diode with a withstand voltage of 20V or more.

Note: For special applications where the Boost does not operate but a voltage is applied at the output, the Schottky diode withstand voltage must be greater than the voltage applied at the output.

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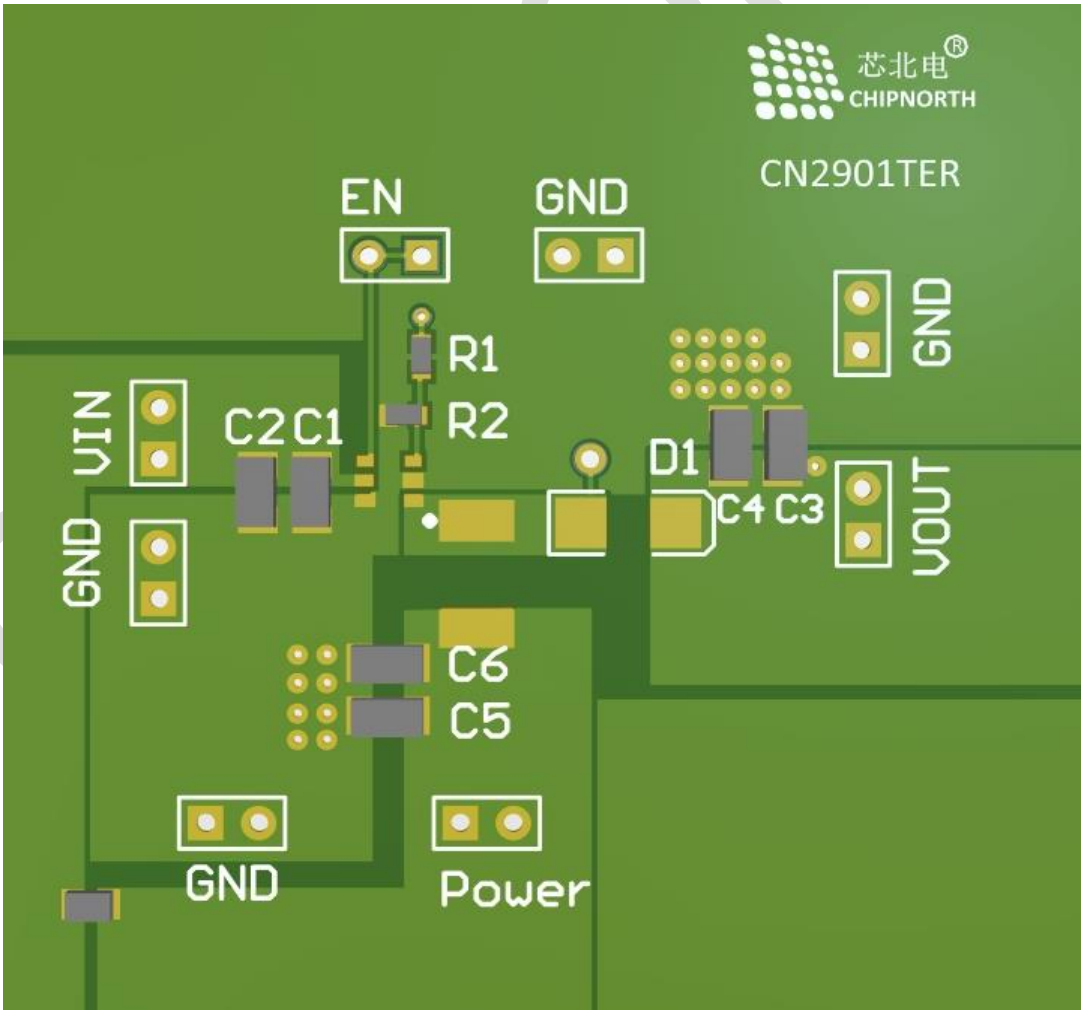
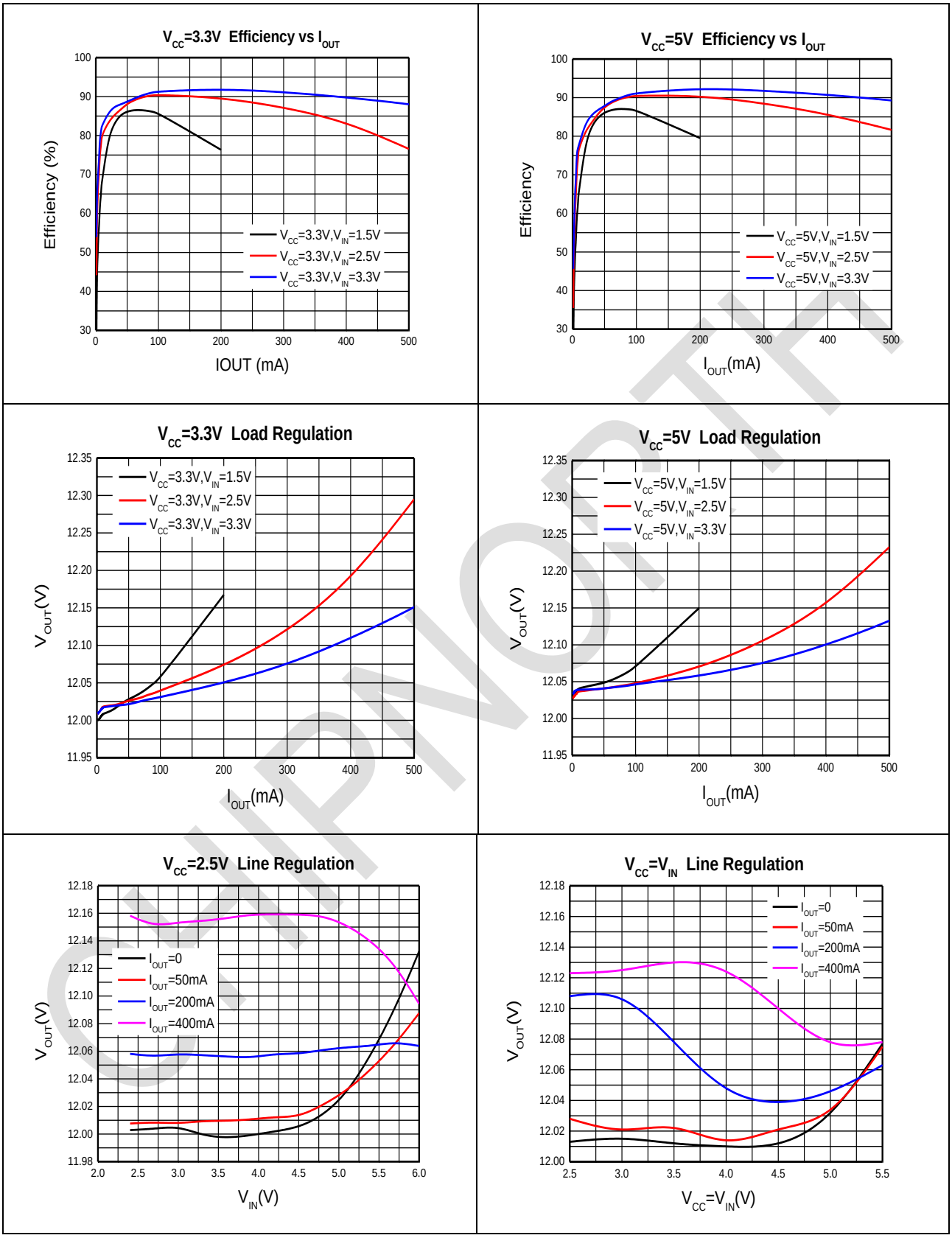
12.3 PCB Layout Guidelines

- Prioritize to ensure that the ground terminal of C_{OUT} is close to the GND pin of IC, the ground terminal of C_{OUT} is connected to the bottom ground plane through via, the positive terminal of C_{OUT} is close to the negative terminal of the Schottky diode, and the positive terminal of the Schottky diode is placed close to the SW pin.
- The power terminal of C_{IN} is placed close to VCC pin, the ground terminal of C_{IN} is connected to the bottom ground plane through via
- The terminals of inductor are placed as close as possible to the SW pin and the power terminal of C_{IN} respectively.
- The signal area should be separated from the power area to avoid electromagnetic coupling interference by being surrounded by the power circuit.
- The feedback trace of output should be away from sources of interference such as the inductor and SW pin, and is connected to the bottom of the PCB through via, and place ground shields on both sides of the route to filter the interference, then connected to the top of the PCB through via, connected to R_1 finally.
- Place the voltage divider pull-down resistor R_2 as close to the FB pin as possible, because the FB pin is a high impedance input pin and is susceptible to noise.
- The EN pin is routed in the signal area as much as possible to avoid interference in the power area.
- Bottom ground plane should be kept as integrity as possible with fewer cuts.



12.4 Basic Performance



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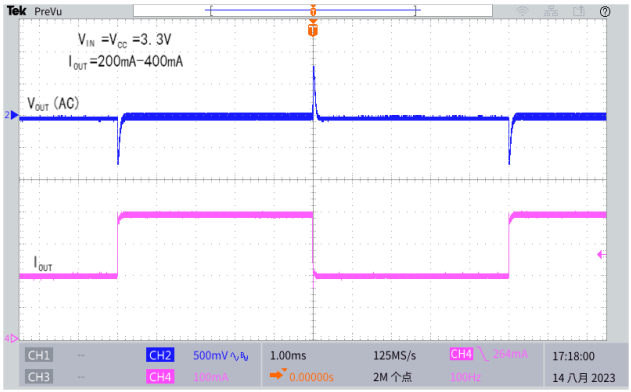
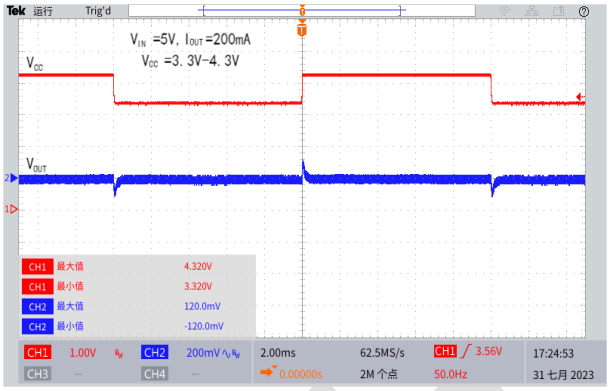
Load Transient Response



Line Transient Response



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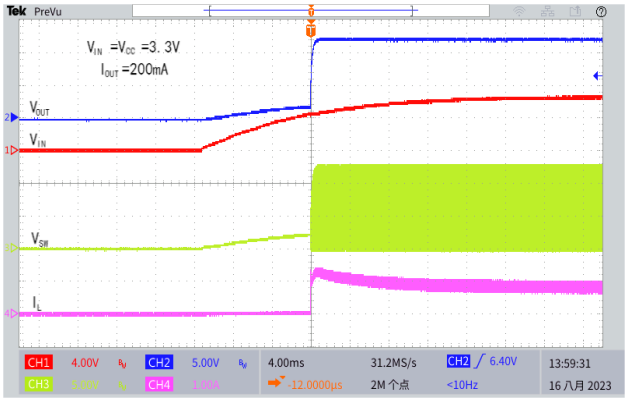
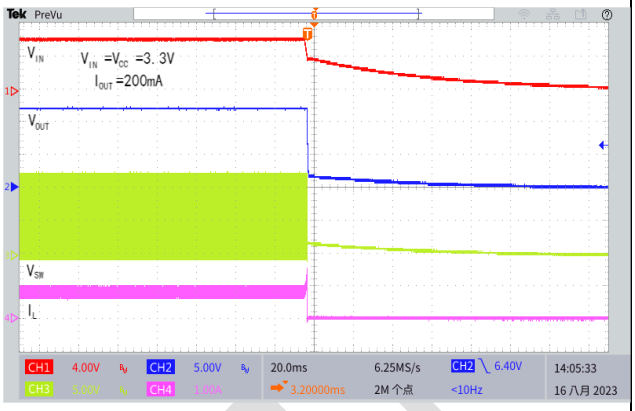
12.5 Working Waveforms

Test conditions: T_A=25°C, L=4.7μH, C_{IN}=C_{OUT}=10μF, unless otherwise specified.

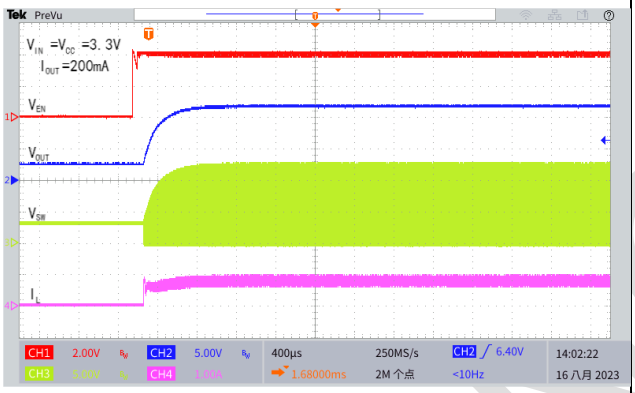
Start-Up From VIN



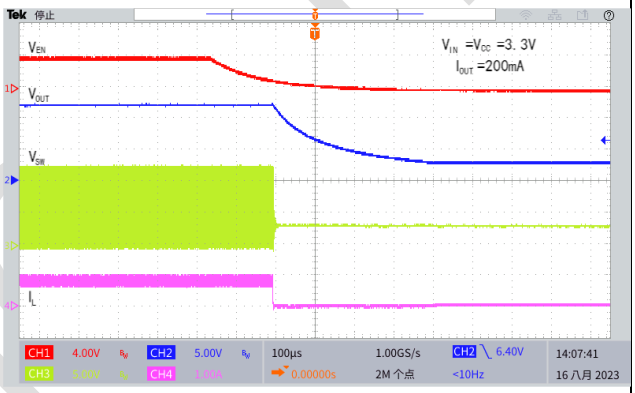
Shut-Down From VIN



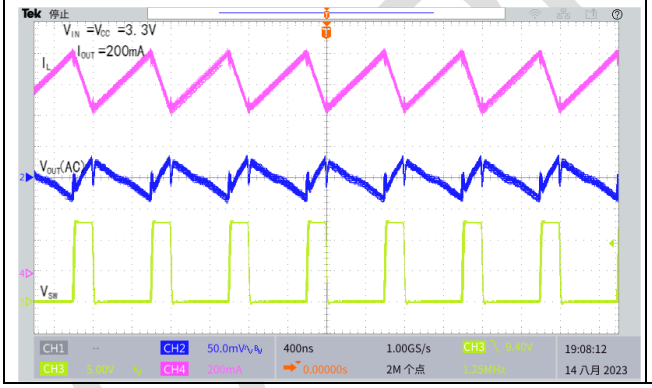
Start-Up From EN



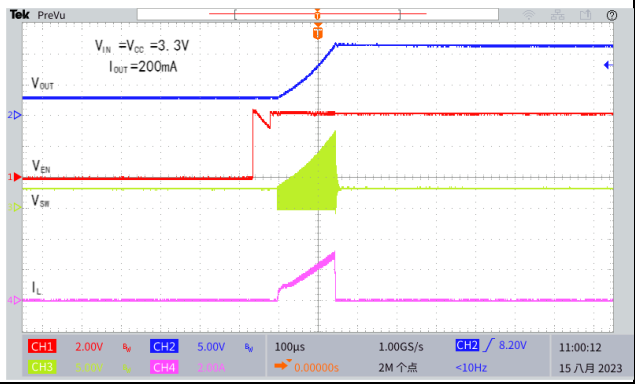
Shut-Down From EN



Operation Waveforms

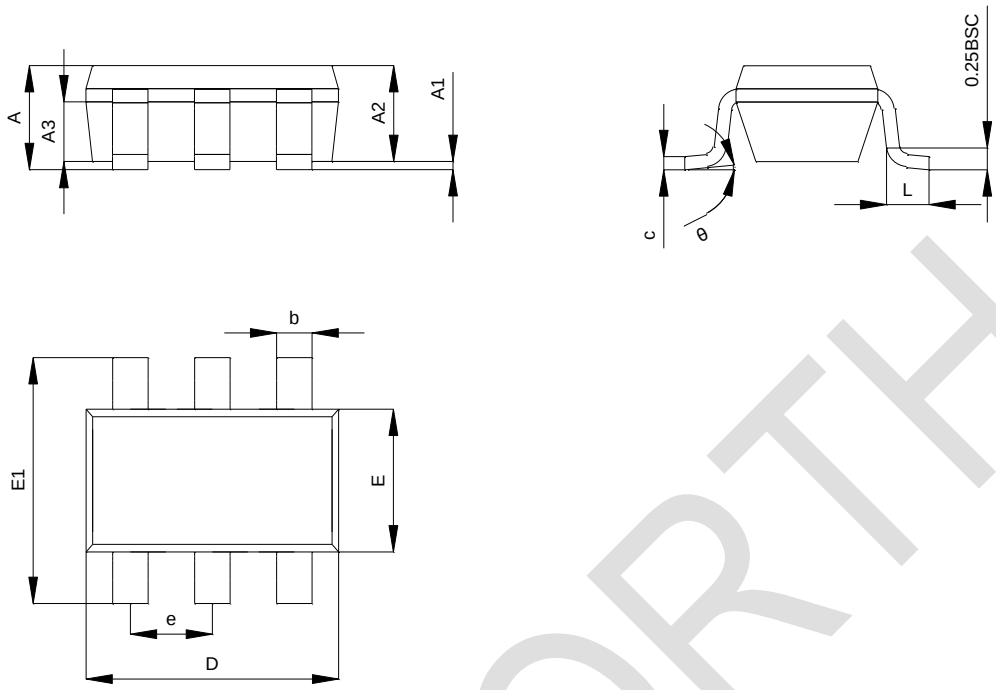


Output Open Circuit Protection



13 Package Information

SOT-23-6L



Dimension / Symbol	Min (mm)	Nom (mm)	Max (mm)
A	1.050	1.150	1.250
A1	0.000	0.060	0.100
A2	1.000	1.100	1.200
A3	0.550	0.650	0.750
D	2.820	2.920	3.020
E	1.510	1.610	1.700
E1	2.650	2.800	2.950
b	0.300	0.400	0.500
e	0.950BSC		
θ	0	4°	8°
L	0.300	0.420	0.570
c	0.100	0.152	0.200

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