24V/3.5A High Efficiency Boost Converter

1 Description

The CN2902 is a 2.4V-6V wide input range high efficiency boost converter suitable for applications such as smart meters, LCD bias power supplies, Bluetooth speakers, and power systems that require batteries to power high voltage modules. The device integrates two power MOSFETs, eliminating the need for an external rectifier diode, and can provide a 24V/3.5A output. It enters PFM mode for light loads to improve efficiency, and PWM mode for heavy loads to provide a stable switching frequency and low output ripple, with a switching frequency of 1MHz, which allows it to provide high efficiency while using smaller external components, and has a built-in soft-start time of 0.6ms. The built-in 0.6ms soft-start time suppresses output voltage overshoot during startup.

The CN2902 features cycle-by-cycle current limiting, output overvoltage protection, and thermal shutdown in an ESOP8 package.

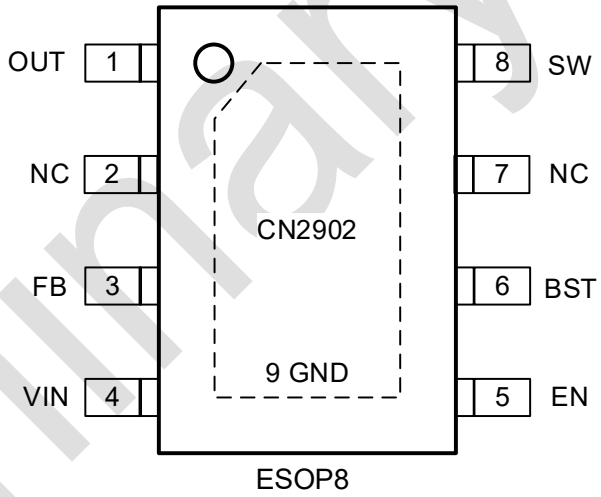
2 Features

- 2.4V to 6V Wide Input Operating Range
- 0.17mA Low Quiescent Current
- 0.05uA Shutdown Current
- Maximum Output Voltage 24V
- Maximum Output Current 3.5A
- High Efficiency Up to 90%
- Built-in power MOS, no external rectifier required
- 600mV ±3% Feedback Reference Voltage
- 1MHz Fixed Operation Frequency
- PFM mode at light load
- 0.6ms soft start to limit output voltage overshoot at startup
- Output Overvoltage Protection
- Cycle-by Cycle Current Limit
- Thermal Shutdown

3 Applications

- Smart Power Meters
- Industrial Applications
- Power systems that require batteries to power high voltage modules
- Bluetooth Speaker
- Large LCD bias power supply

4 Pinout



ESOP8

5 Ordering information

Product Number	Package	Quantity/Tape
CN2902	ESOP8	4000/Tape

6 Marking

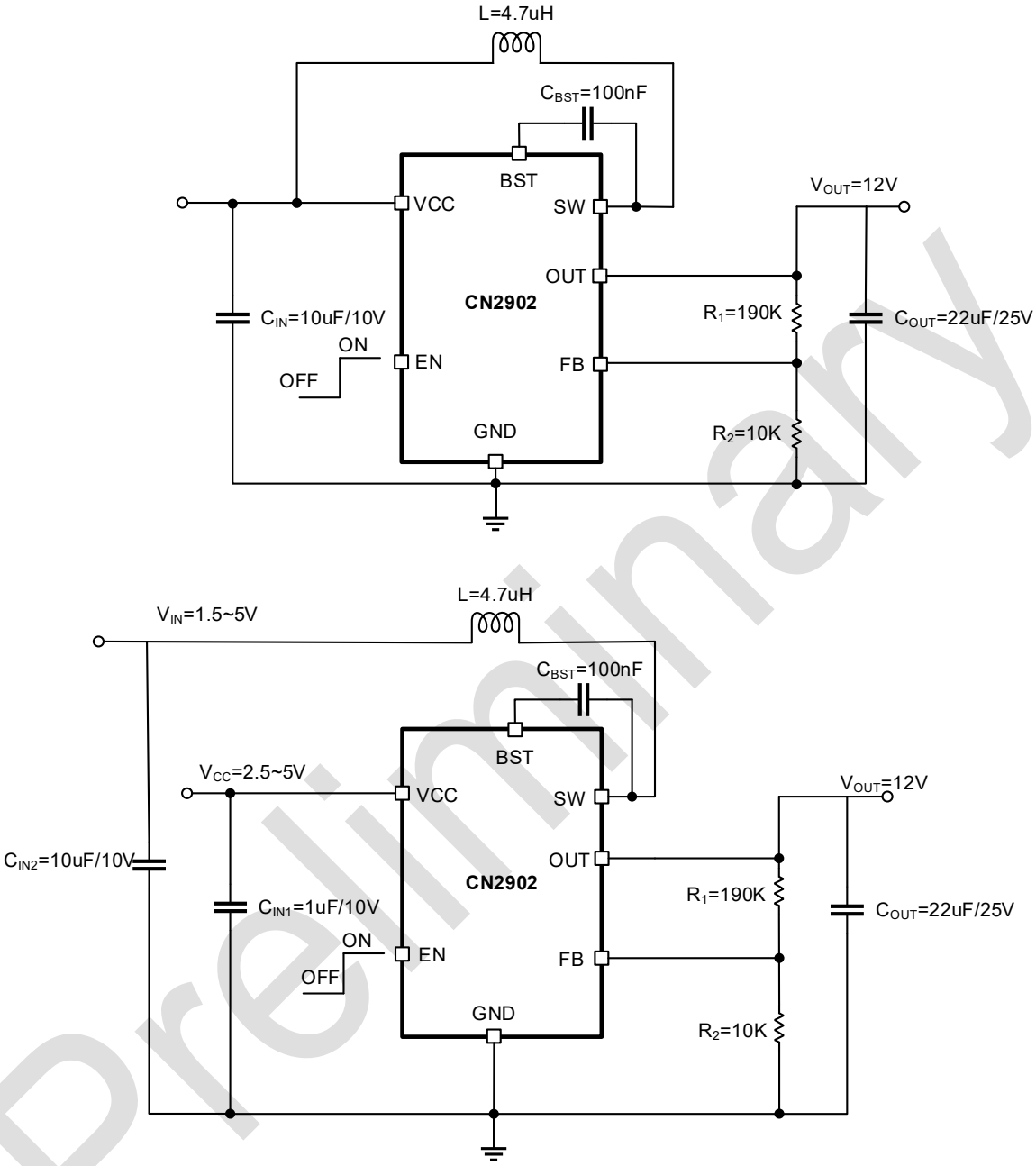
Product Number	Marking
CN2902	CN2902/YYWW

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.

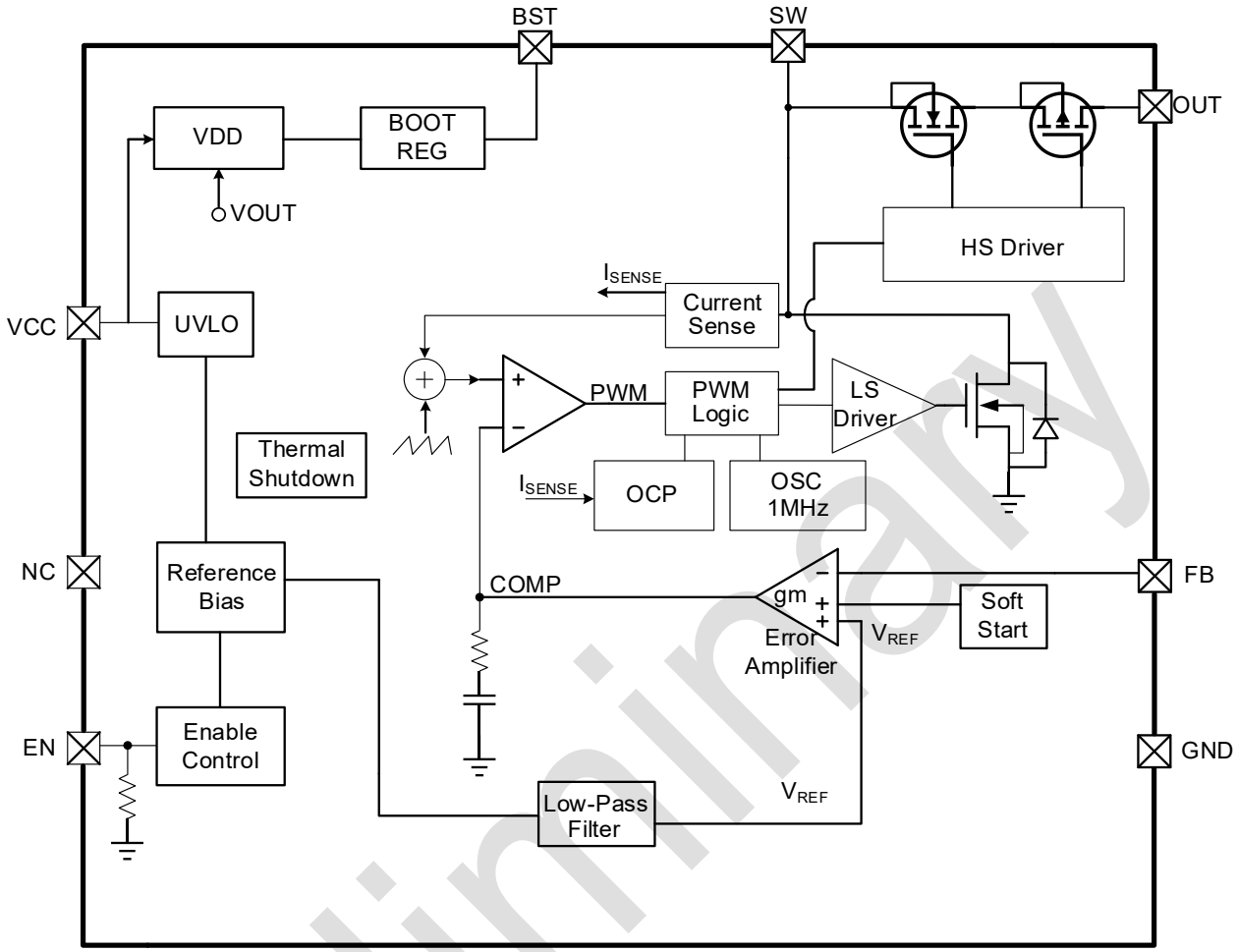
Moisture sensitivity level(MSL):3

7 Typical Application



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

8 Block Diagram



9 Pin Descriptions

Pin No.	Pin Name	Descriptions
1	OUT	Output pin.
2、7	NC	NO connection
3	FB	Feedback pin. Connect FB to the center point of external resistor divider from VOUT 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	Chip power supply side
6	BST	Bootstrap pin. Connect a 100nF capacitor between BST and SW
8	SW	Switch node pin. Connect an inductor between SW and COUT/VOUT.
9	GND	Ground.

10 Specifications

10.1 Absolute Maximum Ratings

Parameter	Symbol	Value	Units
Supply Input Voltage，EN Voltage	V_{CC}，V_{EN}	-0.3~6	V
SW Voltage	V_{SW}	-0.3~24	V
FB Voltage	V_{FB}	-0.3~6	V
Operating Ambient Temperature Range	T_A	-40~105	°C
Soldering Temperature	T_{LEAD}	260（soldering,10s）	°C
Storage Temperature Range	T_{STG}	-55~150	°C

Note1: 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	Standardize	Value	Units
HBM	ESDA/JEDEC JS-001-2017	2000	V
CDM	ANSI/ESDA/JEDEC JS-002-2022	2000	V

10.3 Recommended Operating Range

Parameter	Symbol	Min.	Max.	Unit
Operating Voltage Range	V_{CC}	2.4	6	V
Input Capacitor Range	C_{IN}	10		μF
Output Capacitor Range	C_{OUT}	22		μF
Inductor range	L	4.7	10	μH

10.4 Thermal Information

Symbol	Descriptions	Value	Unit
$R_{\theta JA}$	Junction to ambient	60	ºC/W
$R_{\theta JC}$	Junction to case（top）	50	ºC /W

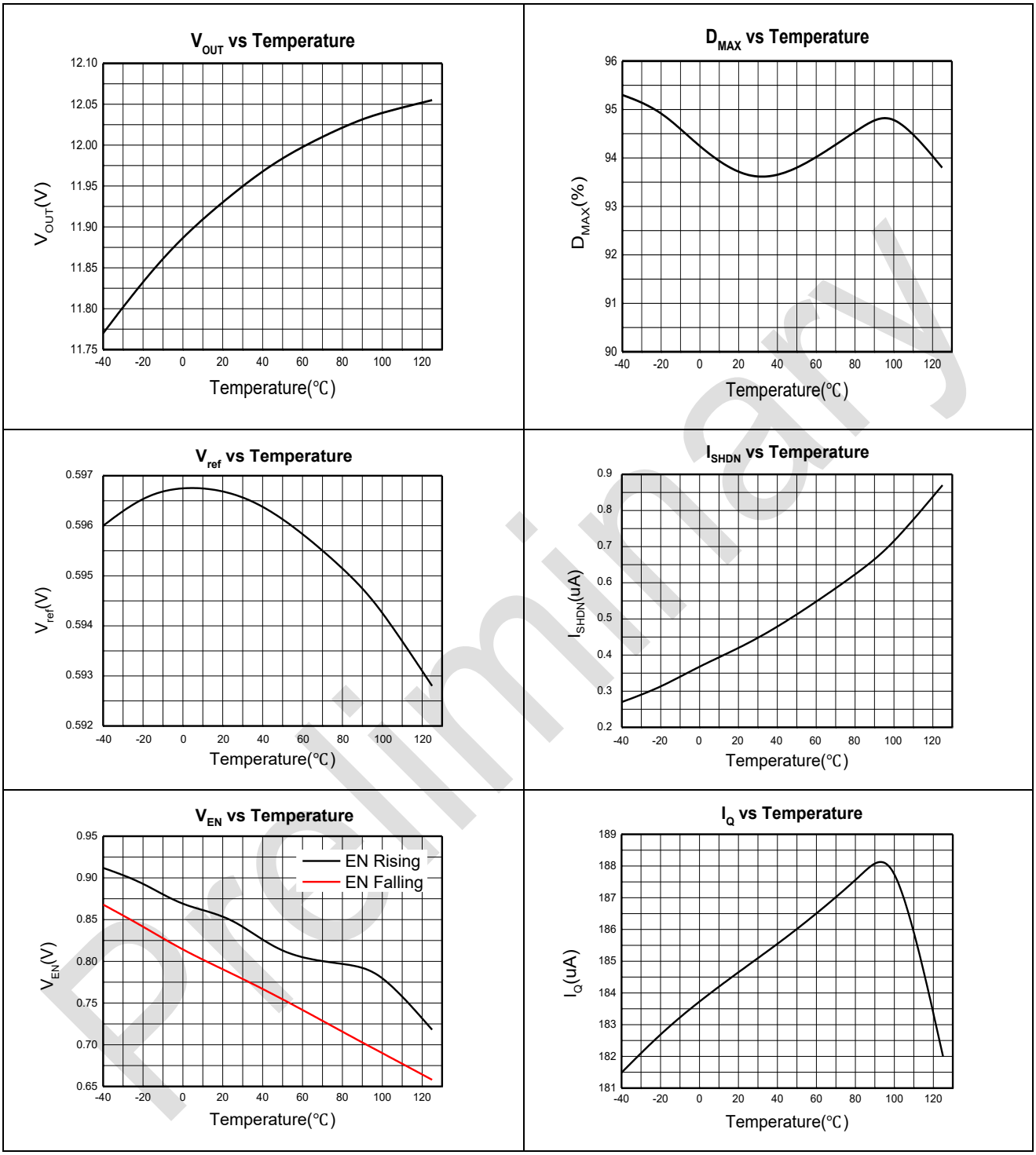
10.5 Electrical Characteristics

(V_{CC}=5V, 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_{CC} Rising，Hysteresis = 100mV		2.3		V
Input Quiescent Current	I_Q	No Switching V_{FB} = V_{REF} * 120%		0.17		mA
		I_{OUT} = 0, Switching		1.6		mA
Shutdown Current	I_{SHDN}	V_{IN} = 3V, V_{EN} = 0V		0.05	1	uA
FB Reference Voltage	V_{REF}		582	600	618	mV
FB Input Current	I_{FB}	V_{FB} = 2V		1		nA
Switching Frequency	F_{OSC}		800	1000	1200	kHz
Minimum On Time	T_{ON_MIN}			100		ns
Maximum Duty Cycle	D_{MAX}			95		%
NMOS On-Resistance	R_{ON}	I_{SW} = 100mA		110		mΩ
NMOS Current Limit	I_{LIMIT_HS}	Duty = 50%		3.9		A
SW Leakage Current	I_{SW_LK}	V_{CC}=5V, EN=GND, V_{SW} = 26V		0.1		uA
EN Input Threshold	V_{EN_R}	Rising	1.2			V
	V_{EN_F}	Falling			0.4	V
EN Input Current	I_{EN}	V_{CC}= 5V, EN = 5V		2.6		uA
Soft-Start Time	T_{SS}			0.6		ms
Output OVP Threshold		Rising，V_{FB} / V_{REF}		115		%
Thermal Shutdown Temperature	T_{SHDN}	Rising，Hysteresis = 30°C		150		°C

10.6 Characteristics Curve

(V_{CC}=5V, T_A=25°C, unless otherwise specified.)



11 Detailed Description

11.1 Overview

The CN2902 is a high efficiency, high output voltage boost converter. The device utilizes a fixed frequency, peak current mode boost regulator architecture to regulate the feedback pin voltage. The device integrates a 24V / 3.5A switching MOSFET, and the function block diagram provides an overview of the CN2902's operation.The CN2902 has an internal soft-start function to reduce inrush current and output voltage overshoot during startup.

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 detection amplifier and the result is fed into the positive input of the comparator to be compared with the COMP voltage on the negative side, when the COMP voltage is exceeded the power MOSFET is turned off until the next clock cycle arrives to turn the MOSFET on again.

11.3 Function Description

11.3.1 Over Current Protection

The CN2902 utilizes a cycle-by-cycle current limiting circuit to limit the peak current of the inductor under overload conditions. The current detection circuit detects the current flowing through the inductor during the charging phase. When the current value exceeds the current limit threshold, the power MOSFET turns off and the inductor will be forced to leave the charging phase and enter the discharging phase. Therefore, the inductor current will not exceed the current limit threshold.

11.3.2 Soft Start

The CN2902 implements a soft-start function to reduce the inrush current during startup. The CN2902 starts soft-start when the EN pin is pulled high. When VOUT is below 120% of VIN, the output voltage rises slowly and the switching frequency is fixed at 500 kHz (typical); when VOUT exceeds 120% of VIN, the switching frequency becomes 1MHz (typical) and raises the output voltage to the set value.

11.3.3 Output Short Circuit Protection

The CN2902 provides a hiccup protection mode when an output short circuit protection occurs. In the event of a short circuit, hiccups begin when VOUT drops below 105% of VIN and shuts down after continuously triggering the peak current limit for 1 ms. In the hiccup stabilized state, the device shuts itself down and restarts after a 32 ms (typical) wait time, which helps to reduce overall thermal dissipation during continuous short circuit conditions. After the short circuit is released, the device can automatically recover and re-enter the soft-start phase.

11.3.4 Output Over Voltage Protection

If an output voltage above the overvoltage protection threshold (typically 25 V) is detected, the CN2902 immediately stops switching until the voltage on the VOUT pin drops below the output overvoltage protection recovery threshold to restart soft-start. This feature prevents overvoltage of the device and ensures the safety of the circuitry connected to the output.

11.3.5 Shutdown Mode

Driving EN to GND puts the CN2902 into shutdown mode. In shutdown mode, the reference, control circuitry, and main switch are turned off and the input current drops to less than 1uA.

11.3.6 Thermal Shutdown

Once the junction temperature (TJ) exceeds 150°C (typical), the CN2902 enters thermal shutdown mode. In this mode, the main power MOSFET will turn off until the temperature drops below 120°C (typical) and then the device starts switching again.

12 Application Information

12.1 Typical Application

The following figure shows the schematic of a typical application circuit that can be used as a means of evaluating the performance of the CN2902. This section describes the design process specific to the application schematic.

12.2 Design Requirements

Requirement	Min.	Max.	Unit
5V Output	2.5	5	V
12V Output	11.88	12.12	V
Output Current		0.4	A
Ripple		50	mV

12.3 Circuit Design

12.3.1 Output Voltage Setting

The boost structure loop will make the FB pin voltage equal to the reference voltage VREF. therefore, when R2 is connected to the FB pin and GND, and R1 is connected to the output and the FB pin, the output voltage is set externally by means of a divider resistor with the following equation:

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

- VOUT is the output voltage
- VFB is the regulation voltage of FB pin
- R1 is the resistance between output and FB pin
- R2 is the resistance between FB pin and GND
- The recommended value of R2 is 1kΩ~10kΩ.

12.3.2 Selection Of Boost Inductors

Too small an inductance value will result in excessive ripple current, and too large an inductance value will result in poor dynamic characteristics and slow response. An appropriate inductance value should be selected to ensure loop stability. For 12V and 5V output applications, an inductance value of 4.7uH is recommended. In addition, the saturation and temperature rise currents of the inductors must be greater than the peak and average currents of the actual operating condition.

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

12.3.3 Selection Of Input Capacitors

The input capacitor reduces the AC voltage ripple on the input rails of the boost converter. The voltage rating of the capacitor depends on the input voltage of the application. A 10uF/10V X5R or X7R ceramic capacitor is recommended.

12.3.4 Selection Of Output Capacitors

Output capacitors are selected primarily to meet output ripple and loop stability requirements. The ripple voltage is related to the capacitance value of the capacitor and the equivalent series resistance (ESR). The capacitor's voltage rating depends on the output voltage of the application. A 22uF/25V X5R or X7R ceramic capacitor is recommended.

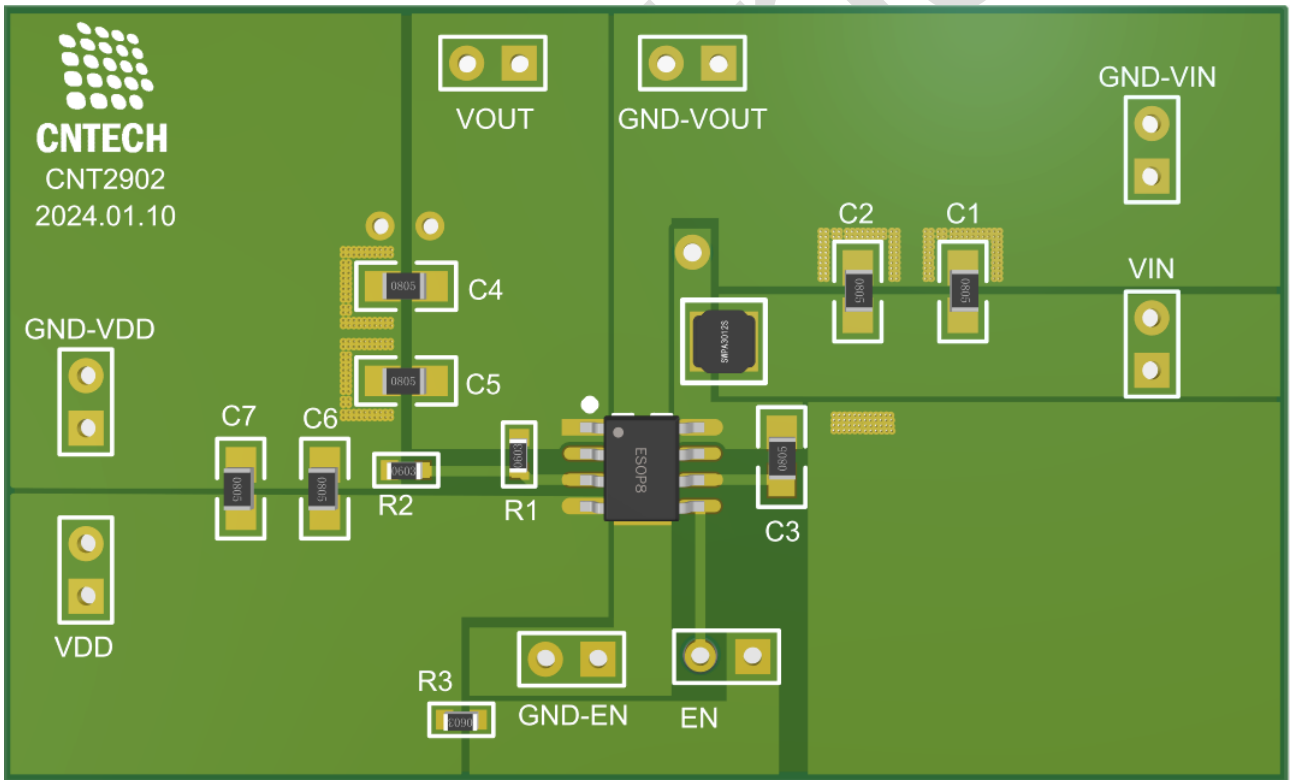
12.4 Bom List

Symbol	Description	Manufacturers	Part Number	Qty
C_{IN1}	Ceramic Capacitor，1uF，10V，X5R，±10%，0402	TDK	C1005X7S1A105KT000E	1
C_{IN2}	Ceramic Capacitor，10uF，10V，X7R，±10%，0603	MURATA MANUFACTURING	GRM188Z71A106KA73D	1
C_{OUT}	Ceramic Capacitor，22uF，25V，X5R，±20%，0805	SAMSUNG	CL21A226MAQNNNE	1
C_{BST}	Ceramic Capacitor，100nF，50V，X7R，±10%，0603	YAGEO	CC0603KRX7R9BB104	1
R_1	Chip Resistor，190k，±1%，0.5W,1210	UNI-ROYAL	1210W2F1903T5E	1
R_2	Chip Resistor，10k，±1%，0.1W,0603	UNI-ROYAL	0603WAF1002T5E	1
L	Chip Inductor，4.7uH，±20%，5A，SMD	Sunlord	ACPR1208S4R7MT	1

12.5 PCB Layout Guidelines

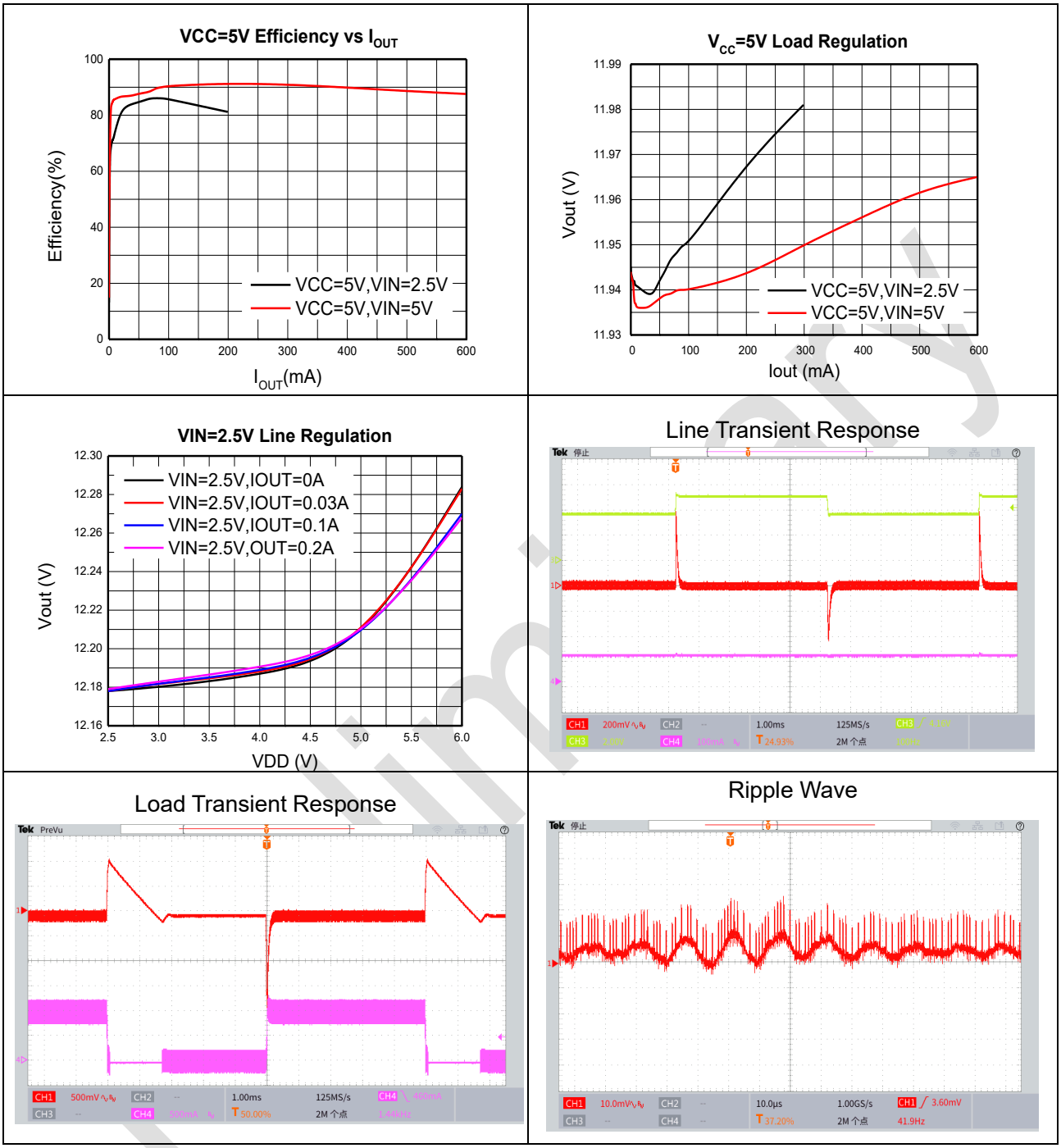
- It is a priority to ensure that the ground terminal of COUT is placed close to GND of the IC and punched to the bottom ground plane, and the positive terminal of COUT is placed close to the VOUT PIN.
- The power end of CIN is placed close to the VCC pin, and the ground end of CIN is perforated to the bottom ground plane.
- The inductor ends are placed as close as possible to the power end of CIN and SW respectively.
- The signal area should be separated from the power area to avoid electromagnetic coupling interference by being surrounded by the power loop.
- The output feedback line should be far away from the inductor and SW and other sources of interference, punched through the holes from the bottom of the alignment, and in the alignment on both sides of the cloth ground shielding filter.
- Place the voltage divider pull-down resistor R2 as close to the FB pin as possible, because the FB pin is a high impedance input pin that is susceptible to noise and high voltage spikes.
- EN Route as much as possible in the signal region to avoid interference in the power region.
- The bottom ground plane is as complete as possible with fewer cuts.

12.6 Layout



12.7 Basic performance

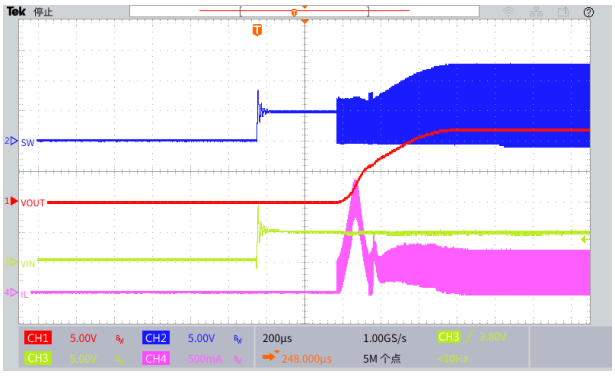
(V_{CC}=5V, T_A=25°C, unless otherwise specified.)



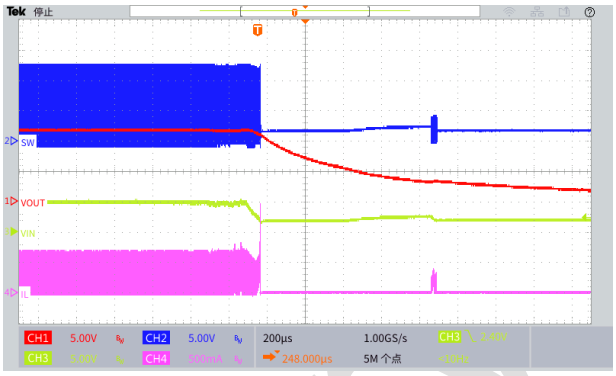
12.8 Operating waveforms

(T_A=25℃, L=4.7uH, C_{IN}=10uF, C_{OUT}=22uF, unless otherwise specified.)

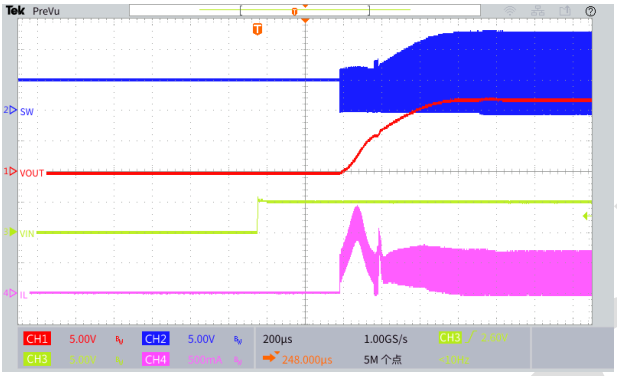
Start-Up From V_{IN}



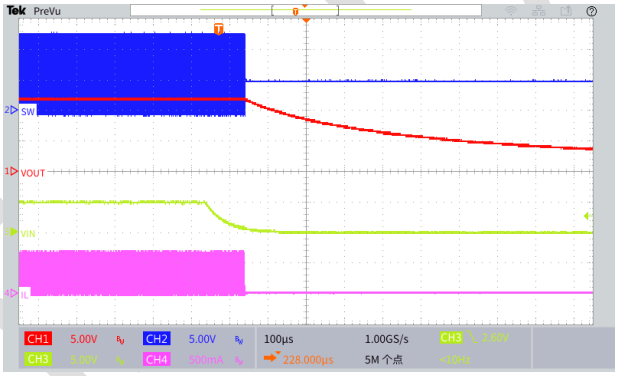
Shut-Down From V_{IN}



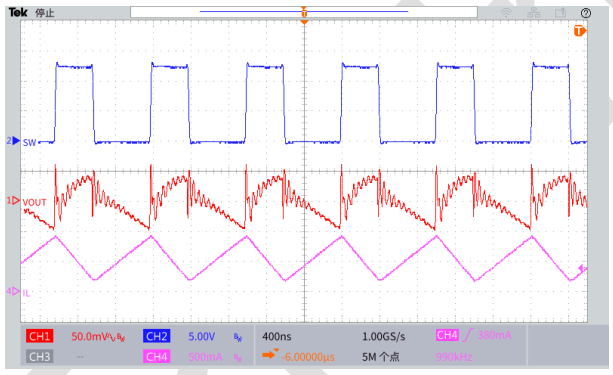
Start-Up From EN



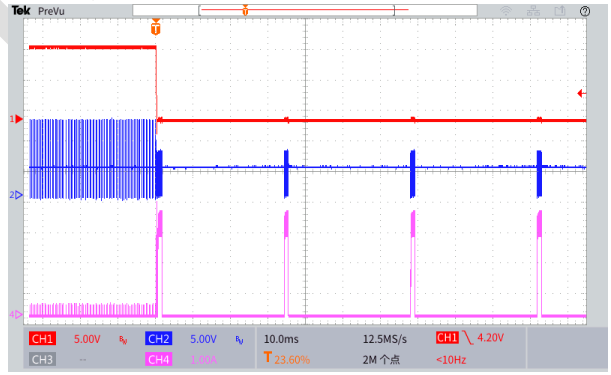
Shut-Down From EN



Operation Waveforms

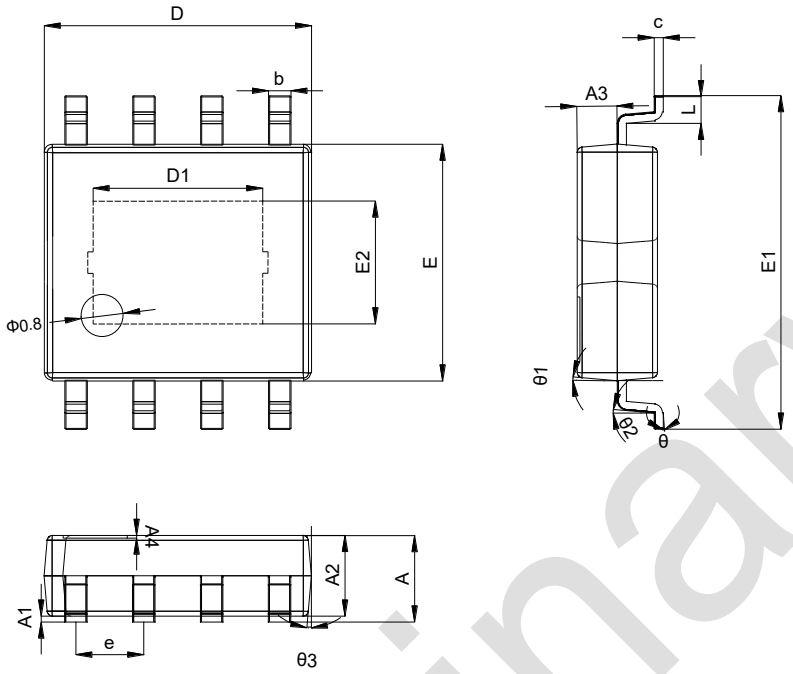


OUT Short Protection



13 Package Information

ESOP8



Millimeter / Sybol	Min(mm)	Typ(mm)	Max(mm)
A	1.300	1.500	1.700
A1	0.100	0.150	0.200
A2	1.350	1.420	1.550
A3	0.660	0.670	0.680
A4	0.020		0.050
C	0.170	0.203	0.250
E	3.800	3.900	4.000
E1	5.800	6.000	6.200
L	0.450	0.600	0.750
b	0.330	0.400	0.510
D	4.800	4.900	5.000
e	1.270BSC		
θ	0°	3°	6°
θ1	12°REF.		
θ2	5°REF.		
θ3	12°REF.		

14 Important Statement

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