

3-Channel PMU with Synchronous 38V-Buck, 20V-Boost and Super Capacitor Charger

1 Description

The CN8913 is a 3-Channel PMU that includes high efficiency synchronous 38V buck converter with 42V input standoff voltage, low startup high efficiency boost converter and a high accuracy super capacitor charger. A HV buck outputs fixed-3.3V/800mA saving external resistor divider. The boost converter could provide up to 12V/450mA output from super capacitor or other backup power supply at 2.5V. Boost output is set by external resistors. Supercapacitor constant voltage charging voltage is 2.55V.

The CN8913 also employs cycle by cycle current limit and hiccup OCP and Input OVP protections, as well as thermal shutdown.

The CN8913 is available in ESOP8L and DFN3X3-10L with exposed Thermal and GND pad.

2 Features

- 3-Channel PMU: Buck, Boost, Super Capacitor Charger
- Buck Wide Input from 7.8V to 38V with 42V Standoff
- 3.3V/800mA Output Capability Buck
- 12V/450mA Output Capability Boost at 2.5V Input
- Fixed Buck Output Voltage and Adjustable Boost Output Voltage
- Linear Charger for Super Capacitor with 60mA CC Current
- 1% Accuracy CV Voltage for Charger
- Up to 91% efficiency
- Enable pin to set Power Down Threshold
- Auto-alternated Boost Mode and Charger Mode
- Hic-cup Mode OCP protections
- Thermal Shutdown

3 Applications

- Smart Power Meters
- PLC Modules
- System that needs backup power by super capacitors

4 Marking and ordering information

Product Number	Package	Marking	Quantity/Tape
CN8913 EHR	ESOP8L	CN8913 YYWW	4000/Tape
CN8913 DDR	DFN3X3-10L	CN8913 YYWW	5000/Tape

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

5 Pinout

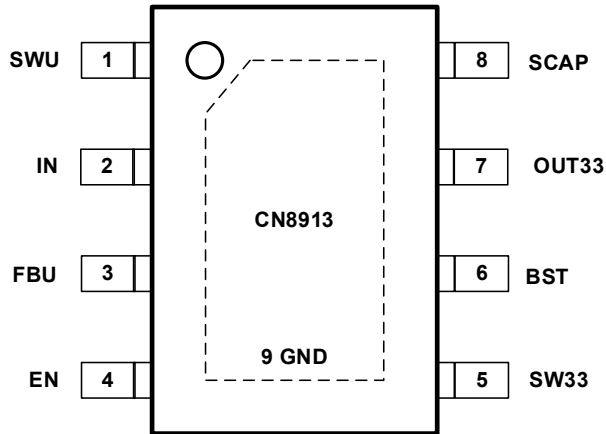


Figure 1 ESOP8L

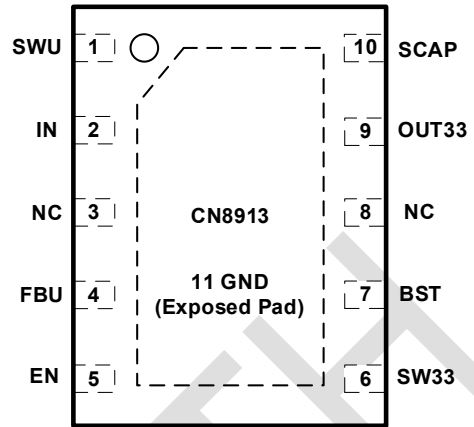


Figure 2 DFN3X3-10L

6 Typical Application

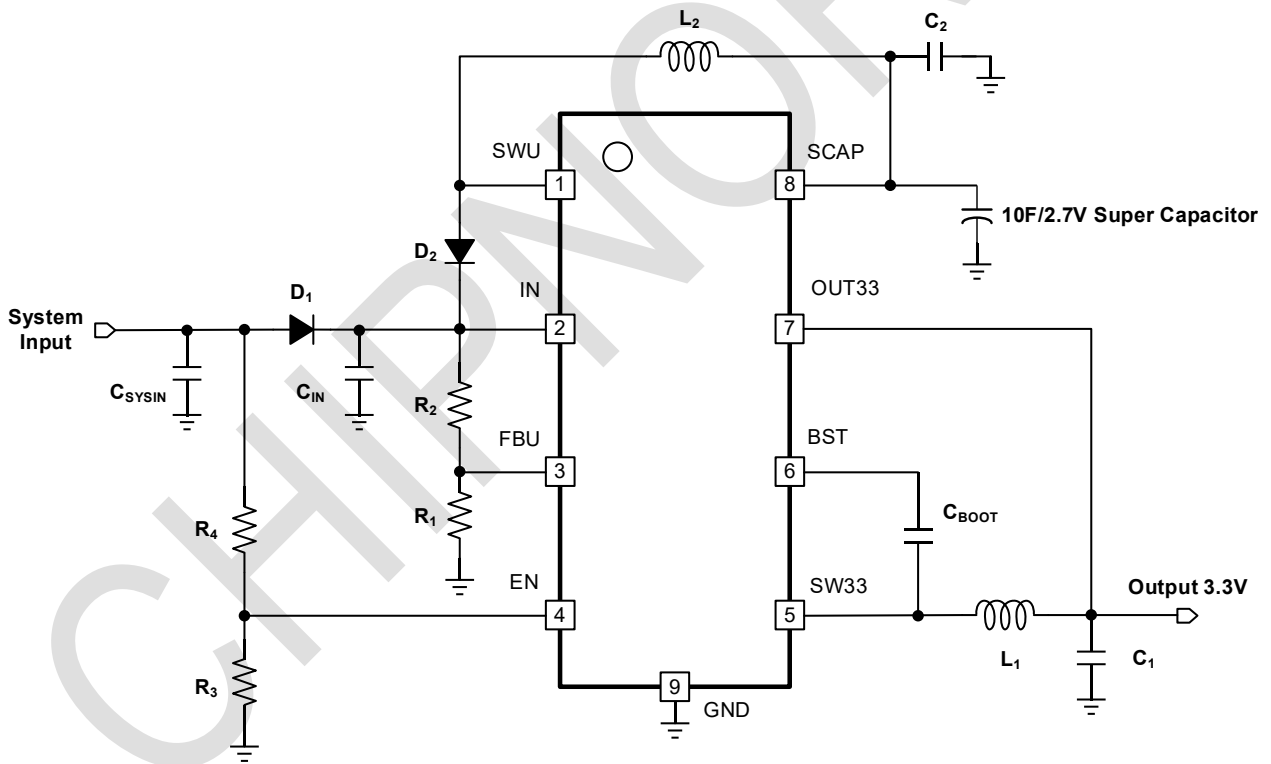


Figure 3 Typical Application

Note 1: System Input Power Down Threshold, $V_{PowerDown} = V_{EN} \times (R_3 + R_4) / R_3$

Note 2: Boost Output Voltage: $V_{OUT} = V_{FB-REF} \times (R_1 + R_2) / R_1$

7 Block Diagram

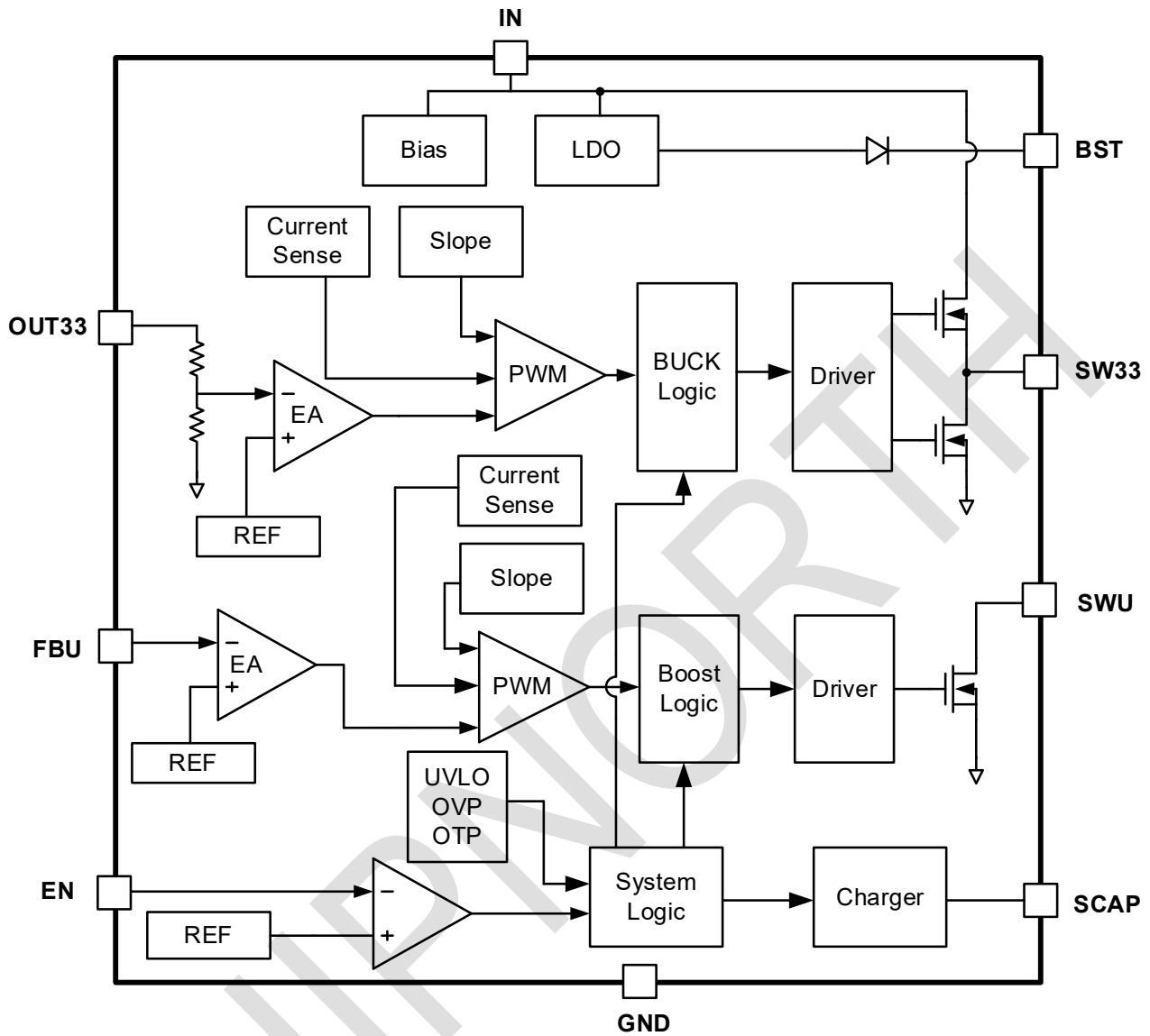


Figure 4 Block Diagram

8 Pin Descriptions

Pin No.		Pin Name	Descriptions
DFN3X3-10L	ESOP8L		
1	1	SWU	Boost Converter Switch Node
2	2	IN	IC Power Supply Input Pin
4	3	FBU	Adjustable Boost Converter Feedback Pin
5	4	EN	Enable Pin for auto-switching Boost and Charger. Use external resistors to set system input detection threshold to turn on Boost. EN=0, Boost On / Charger Off EN=1, Boost Off / Charger On
6	5	SW33	Fixed 3.3V Buck Converter Switch Node
7	6	BST	Bootstrap Pin for Fixed 3.3V Buck Converter
9	7	OUT33	Output Pin for Fixed 3.3V Buck Converter
10	8	SCAP	Connect to Super Capacitor. It is Internally Programmed to CV at 2.55V
11	9	GND	Connect to Ground. Analog and Power Ground Pin. Must Connected.
3、8	N/A	NC	NO Connect

9 Specifications

9.1 Absolute Maximum Ratings

Parameter	Symbol	Value	Units
Supply Input Voltage, EN Voltage	V_{IN}, V_{EN}	-0.3 ~ 45	V
Buck Switch Node Voltage	V_{SW33}	-0.3 ~ $V_{IN} + 0.3$	V
Buck Bootstrap Voltage	V_{BST}	-0.3 ~ Max. ($V_{SW} + 6.45$)	V
Boost Switch Node Voltage	V_{SWU}	-0.3 ~ 24	V
Other Pins Voltage		-0.3 ~ 6.5	V
Operating Ambient Temperature Range	T_A	-40 ~ 105	°C
Storage Temperature Range	T_{STG}	-55 ~ 150	°C
Soldering Temperature	T_{LEAD}	260(soldering, 10s)	°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.

9.2 ESD Ratings

Discharge mode	Value	Units
Human Body Model (HBM)	±5000	V
Charged Device Model (CDM)	±2000	V

9.3 Recommended Operating Range

Parameter	Symbol	Min.	Max.	Units
Operating Supply Voltage	V_{IN}	7.8	38	V
Buck Output Voltage	V_{OUT_33}	3.3		V
Boost Output Voltage	V_{OUT_BOOST}		20	V
IC Input Capacitor Range	C_{IN}	22		μF
Buck Output Capacitor	C_1	22		μF
Boost Input Capacitor	C_2	1		μF
Bootstrap Capacitor Range	C_{BOOT}	100		nF
Fixed 3.3V Buck Inductor	L_1	10		μH
Boost Inductor	L_2	4.7		μH

9.4 Thermal Information

Parameter	Descriptions	Symbol	Value	Unit
Thermal Resistance (ESOP8L)	Junction to ambient	θ_{ja}	60	$^{\circ}C/W$
	Junction to case(top)	$\theta_{jc(top)}$	56.1	$^{\circ}C/W$
	Junction to case(bottom)	$\theta_{jc(bot)}$	3.8	$^{\circ}C/W$
Thermal Resistance (DFN3X3-10L)	Junction to ambient	θ_{ja}	40.9	$^{\circ}C/W$
	Junction to case(top)	$\theta_{jc(top)}$	46.6	$^{\circ}C/W$
	Junction to case(bottom)	$\theta_{jc(bot)}$	2.9	$^{\circ}C/W$

9.5 Electrical Characteristics

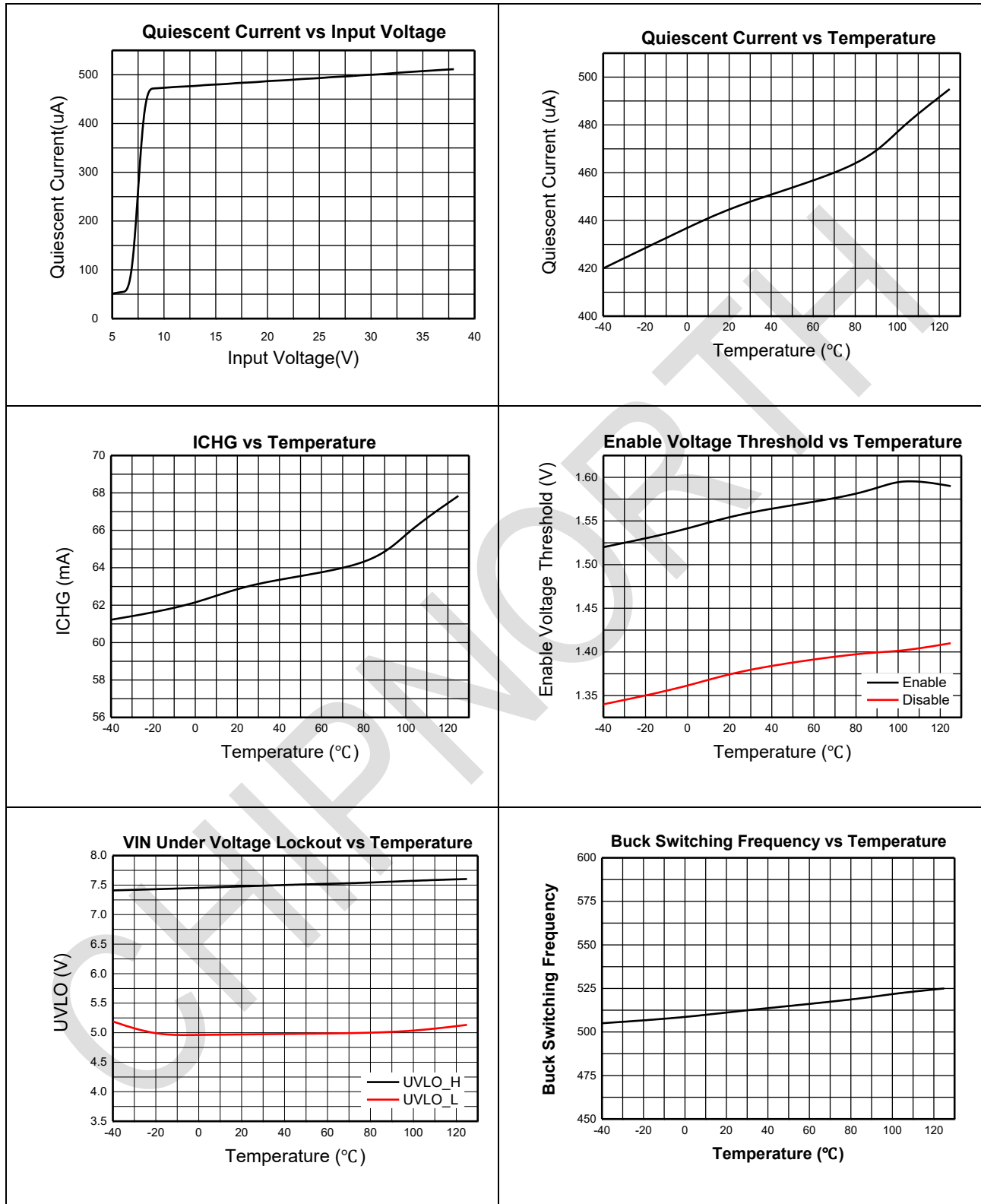
($V_{IN}=12V$, $T_A=25^{\circ}C$, unless otherwise specified.)

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
Power Supply						
Quiescent Current	I_Q	EN on, $I_{LOAD} = 0A$, $V_{FBU} = 1.1V_{REF}$, $V_{OUT33}=3.5V$	345	465	615	μA
VIN Under Voltage	UVLO_R	V_{IN} Rising	7.2	7.5	7.8	V
Lockout	UVLO_F	V_{IN} Falling	4.8	5	5.2	V
VIN Over Voltage	OVP_R	V_{IN} Rising	37	39	41	V
Threshold	OVP_F	V_{IN} Falling		37.5		V
Buck Characteristics						
Buck Switching Frequency	$F_{OSC, BK33}$	EN on, 3.3V Buck Switching	540	600	660	kHz
Buck Minimum On Time	$T_{ON_MIN, BK33}$			80		ns
High Side MOSFET On-Resistance	R_{ONH2}	$I_{SW33}=100mA$	400	600	800	m Ω
Low Side MOSFET On-Resistance	R_{ONL2}	$I_{SW33}=100mA$	200	300	400	m Ω
Soft Start-Up Time	T_{SS2}	From 10% to 90% of V_{OUT33}		1		ms
High Side Current Limit	$I_{LIMITH2}$		0.7	1.1	1.43	A
Low Side Current Limit	$I_{LIMITL2}$			1		A
Buck Output Voltage	V_{OUT_33}	$V_{EN}=2V$	3.24	3.3	3.36	V
High Side MOSFET Leakage Current	$I_{LKH, BK33}$	$V_{EN}=2V$, $V_{OUT33}=3.5V$			10	μA
Low Side MOSFET Leakage Current	$I_{LKL, BK33}$	$V_{SW33}=12V$			10	μA
Boost Characteristics						
Boost Switching Frequency	$F_{OSC, BST}$	EN on, Boost Switching	0.85	1	1.15	MHz
Boost Maximum Duty Cycle	$D_{MAX, BST}$			95		%
Boost Minimum On-Time	$T_{ON_MIN, BST}$			100		ns
Power MOSFET On-Resistance	R_{ONL3}	$I_{SWU}=100mA$	80	110	140	m Ω
Boost Current Limit	$I_{LIMITL3}$		2.8	3.76	5	A
FBU Reference Voltage	V_{FBU}		786	800	814	mV
FBU Input Current	I_{FBU}	$V_{FBU}=1.5V$		20	1000	nA
Power MOSFET Leakage Current	$I_{LKL, BST}$	Boost off			10	μA
Super Capacitor Charger						
Super Capacitor Charging Current	I_{SCAP}		52	60	78	mA
SCAP Charge Voltage	V_{SCAP}		2.525	2.55	2.575	V

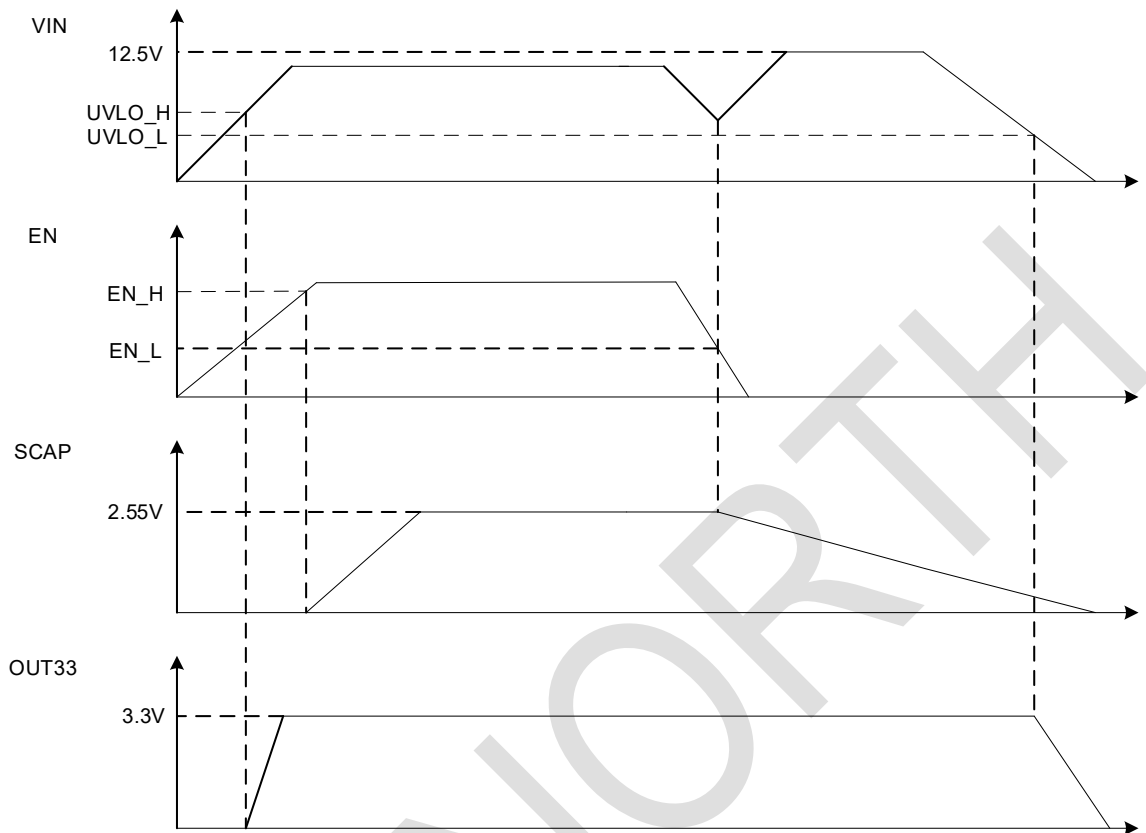
SCAP Charge Voltage Accuracy				1		%
EN Input						
EN Reference Voltage	V_{EN}	EN Rising		1.5		V
EN Hysteresis	$V_{EN, hys}$	Hysteresis		0.16		V
EN Input Current	I_{EN}	$V_{EN}=1.5V$		0.5	3	μA
Thermal Shutdown						
Thermal Shutdown Threshold	T_{SD}	Rising		155		$^{\circ}C$
T_{SD} Hysteresis	T_{HYS}	Hysteresis		20		$^{\circ}C$

9.6 Characteristics Curve

($V_{IN}=12V$, $T_A=25^{\circ}C$, unless otherwise specified.)



10 Timing Chart



Note: The length of the line in the timing diagram has nothing to do with the actual ratio, only for schematic reference.
EN can follow the external input (affected by the ratio of R3 and R4), or it can add a control signal to control the charging and discharging of the super capacitor

11 Detailed Description

11.1 Overview

The CN8913 is a 3-channel PMU that includes a HV fixed output synchronous buck converter, an asynchronous boost converter, a high accuracy super-capacitor charger. The fixed output buck outputs 3.3V/800mA. The boost converter could provide up to 12V/450mA output from super capacitor or other backup power supply at 2.5V. The boost output can be set by external resistors. CN8913 also integrates a linear supercapacitor charger with a high accuracy CC and CV mode.

11.2 Buck Converter

The 3V3 buck converter use peak current control mode without external compensation, providing excellent transient performance while simplifying external component count and design. The chip can be seamlessly alternated between PSM mode and PWM mode, when activating PSM mode at light load to maintain high efficiency operation, when entering PWM mode at heavy load to provide stable switching frequency, lower ripple and fast transient response. The output of the 3V3 buck converter is fixed at 3.3V.

11.3 Boost Converter

CN8913 has a high-efficiency asynchronous boost converter that converts a supercapacitor or other spare 2.5V power to 12V with a maximum output current of 0.45A. The switching frequency is 1M, so small inductors and ceramic capacitors can be used to achieve a small solution.

11.4 Charger

The supercapacitor charger integrates constant current and constant voltage functions, and the constant voltage is set to 2.55V.; after the supercapacitor voltage reaches 2.55V, the charging voltage is constant. Considering that the Schottky diode will reverse leakage at high temperatures, resulting in an increase in SCAP voltage. Therefore, a clamp circuit is designed for SCAP inside the chip, with a clamp voltage of 2.64V and a clamp circuit of 15mA. It is recommended to connect a 1uF capacitor to the charger output to suppress high-frequency noise.

11.5 Input Over Voltage Protection

An OVP function protects the IC itself and its downstream system against input surges. When the input voltage is above the OVP threshold, buck converters and boost converter power switches are shut down, and the chip is restarted after the input voltage drops to the OVP recovery threshold.

11.6 Over Current Protection

The buck converter will limit the peak inductor current to 1.1A and the inductor valley current to 1A when the overcurrent protection is triggered, and turn off the power switches after 1024 cycles, delay 2048 cycles before soft-start, and if the overcurrent still exists after soft-start, trigger OCP again and enter hiccup mode.

When the boost converter triggers the OCP protection, it will limit the inductor peak current to 3.76A and is turned off the power switch until the next cycle, and so on until the overcurrent disappears.

11.7 Thermal Shutdown

CN8913 has a thermal shutdown function to prevent damage to the chip due to excessive temperature. Thermal protection is triggered when the die junction temperature rises to 155°C, it will shut down the buck converters and the boost converter. When the junction temperature drops to 135°C, the chip will restart.

12 Application Information

12.1 Typical Application

Figure 5 shows a typical application schematic that can be used to evaluate CN8913 performance. This part describes the specific design process of the application schematic.

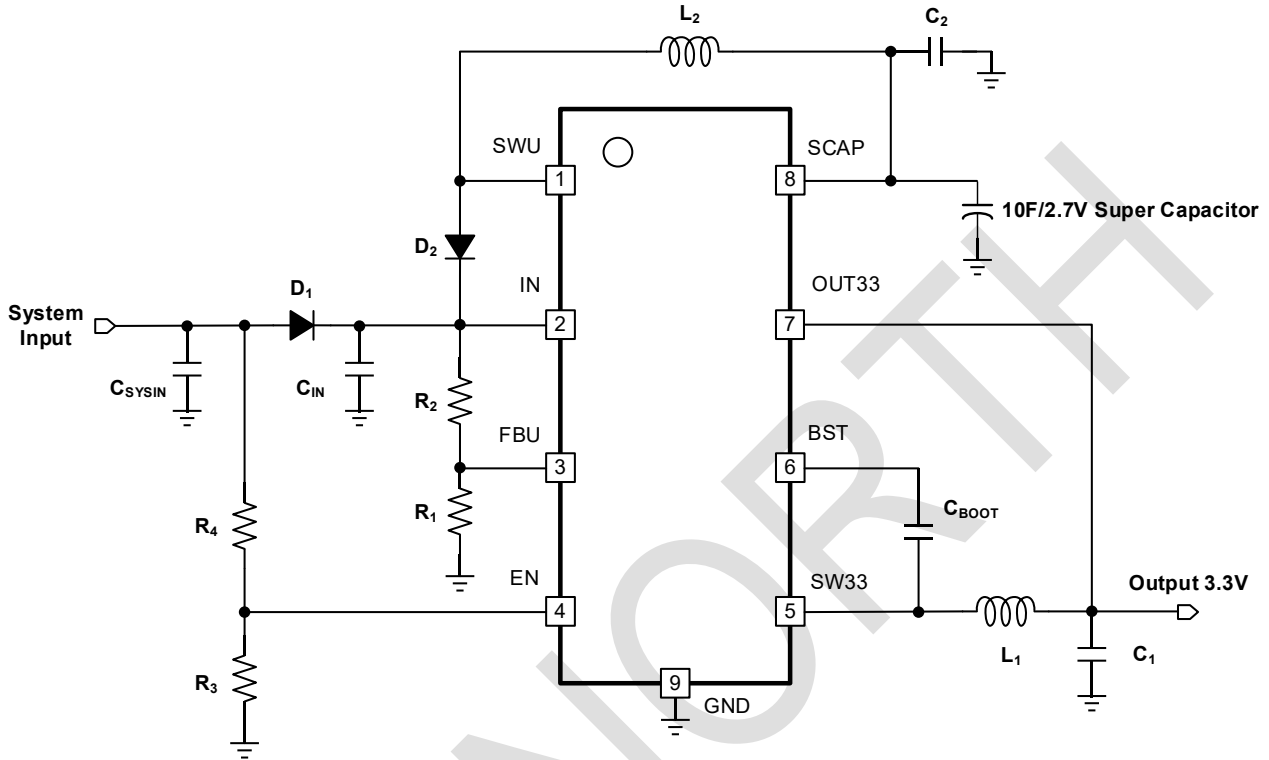


Figure 5 Typical Application

12.2 Design Requirements

Requirement	Min	Typ	Max	Unit
3V3 output voltage	3.146	3.3	3.465	V
12V_BOOST output voltage	11.4	12	12.6	V
Input voltage	10	12	24	V
3V3 output ripple		50		mV
BOOST output ripple		100		

12.3 BUCK Circuit Design

12.3.1 Inductor

Recommend the inductor value is 10uH. The inductance value is calculated using the following formula:

$$L = \frac{V_{OUT}}{f_s * \Delta I_L} * (1 - \frac{V_{OUT}}{V_{IN}})$$

- V_{IN} is the input voltage
- V_{OUT} is the output voltage
- f_s is the switch frequency
- ΔI_L is the peak-to-peak inductor ripple current, typically 30% of the load current
- I_{OUT} is the load current

The main parameter for inductor selection is the saturation current of the inductor, which must be higher than the inductor peak current calculated by the design with an additional 20% margin, which is calculated

using the following formula:

$$I_{LPEAK} = I_{OUT} + \frac{(V_{IN} - V_{OUT}) * V_{OUT}}{2 * V_{IN} * L * f_s}$$

The other important parameter is the inductor heat rating current, which must be higher than the load current with an additional 20% margin. On this basis, try to choose an inductor with a lower DC resistance to improve efficiency.

12.3.2 Output Capacitor

The selection of output capacitor is important because it directly affects output ripple, loop stability, and upshoot and undershoot during transient response. Recommend to choose ceramic capacitors, a 22uF ceramic capacitor or two 10uF ceramic capacitors in parallel can be selected in typical application. It is also necessary to pay attention to the DC Bias Characteristics.

Since the parasitic ESR and ESL of ceramic capacitors are very small and can be ignored, the output ripple ΔV_{OUT} is mainly determined by the capacitor value, and the calculation formula is:

$$\Delta V_{OUT} = \frac{V_{OUT}}{f_s * L} * \left(1 - \frac{V_{OUT}}{V_{IN}}\right) * \left(R_{ESR} + \frac{1}{8 * f_s * C_{OUT}}\right)$$

- C_{OUT} is the output capacitance value
- R_{ESR} is the equivalent series resistance value of the output capacitor

In transient response, when the light load quickly becomes heavy load, the output capacitor needs to supply current to the load before the loop adjusts the inductor current to the appropriate current, and the loop control generally takes at least 4 cycles to respond to the drop of the output voltage. The output capacitance must be large enough to supply the current difference for four clock cycles to maintain the output voltage within the specified range. The minimum output capacitance required to meet the undershoot specification can be calculated using the following equation:

$$C_{OUT} > \frac{4 * (I_{OH} - I_{OL})}{f_s * V_{US}}$$

When a sudden large load decrease happens, the output capacitors absorb energy stored in the inductor, which results in an output voltage overshoot. The minimum capacitance required to keep the voltage overshoot within a specified range can be calculated:

$$C_{OUT} > \frac{I_{OH}^2 - I_{OL}^2}{(V_{OUT} + V_{OS})^2 - V_{OUT}^2} * L$$

- I_{OH} is the high-level output current during load transient
- I_{OL} is the low-level output current during load transient
- V_{US} is the target output voltage undershoot
- V_{OS} is the target output voltage overshoot

12.3.3 External Bootstrap Capacitor

CN8913 requires a bootstrap capacitor to supply the drive voltage to the high-side power switch of buck converters. It is recommended to connect a 0.1uF low ESR ceramic capacitor between the BST and SW33.

12.4 BOOST Circuit Design

12.4.1 Inductor

For typical application, a 4.7uH inductor is recommended. As with buck, Boost needs to consider inductance value, saturation current and heat rating current. Inductance value is calculated using the following formula:

$$D = \frac{V_{OUT} - V_{IN}}{V_{OUT}}$$

$$I_L = \frac{I_{OUT} * V_{OUT}}{V_{IN} * \eta}$$

$$L = \frac{(V_{OUT} - V_{IN}) * D}{\Delta I_L * f_s}$$

- D is the duty cycle
- I_L is the average value of inductor current
- V_{OUT} is the output voltage
- V_{IN} is the input voltage
- I_{OUT} is the load current
- η is the efficiency of Boost converter
- ΔI_L is the inductor ripple current, typically 30% of the average inductor current
- f_s is the switching frequency

The saturation current of the inductor must be higher than the peak inductor current calculated by the design with an additional 20% margin, and the inductor peak current is calculated using the following equation:

$$\Delta I_L = \frac{1}{\left\{ L * f_s * \left(\frac{1}{V_{OUT} - V_{IN}} + \frac{1}{V_{IN}} \right) \right\}}$$

$$I_{L_{PEAK}} = I_L + \frac{\Delta I_L}{2}$$

The other important parameter is the inductor heat rating current, which must be higher than the load current with an additional 20% margin. On this basis, try to choose an inductor with a lower DC resistance to improve efficiency.

12.4.2 Rectifier Diode Selection

To achieve high efficiency, a Schottky type must be used for the rectifier diode, its reverse rated voltage must be higher than the converter's maximum output voltage, and the forward average current must be greater than the maximum output current.

The average forward current of a Schottky diode is equal to the output current, and it is recommended that the average Schottky current be 2 times the output current, and the Schottky peak current needs to be higher than the inductor peak current with at least 20% margin.

12.4.3 Output Capacitor Selection

For typical applications, one 22uF ceramic capacitor or two 10uF ceramic capacitors in parallel are recommended.

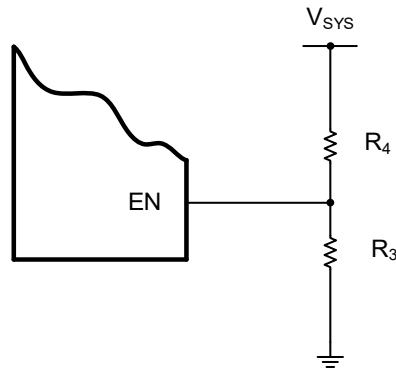
Since the parasitic ESR and ESL of ceramic capacitors are very small and can be ignored, the output ripple ΔV_O is mainly determined by the capacitor capacity, and the calculation formula is:

$$\Delta V_{OUT_C} = \frac{I_O}{(f_s * C_{OUT})} * \left(1 - \frac{V_{IN}}{V_{OUT}} \right)$$

12.4.4 Power System Power-down Threshold Setting

The power system power-down threshold can be set by the R3 and R4 resistors and is calculated as follows:

$$V_{PowerDown} = \frac{R_4 + R_3}{R_3} * 1.34$$



12.5 Bom List

Symbol	Description	Manufacturers	Part Number	Qty
C _{IN} , C ₁	22uF, 25V, X5R, ±20%, 0805	TDK	C3216X5R1V226MTJ00E	2
R ₁	11K, ±1%, 0603	UNI-ROYAL(厚声)	0603WAF1102T5E	1
R ₂	154K, ±1%, 0603	UNI-ROYAL(厚声)	0603WAF1543T5E	1
R ₃	12K, ±1%, 0603	UNI-ROYAL(厚声)	0603WAF1202T5E	1
R ₄	68K, ±1%, 0603	UNI-ROYAL(厚声)	0603WAF6802T5E	1
D ₁	500mV@1A, Vr=40V, Io=1A	GOOD-ARK(固得)	SK14	1
D ₂	550mV@5A, Vr=40V, Io=5A	GOOD-ARK(固得)	SK54	1
L ₂	4.7uH±20%, Irms=4A, Isat=6.2A, DCR=48.4mΩ	TDK	SPM6530T-4R7M-HZR	1
C ₂	1uF/25V, X5R, ±10%, 0603	Murata Manufacturing	GRM188R61E105KA12D	1
Super Capacitor	10F, -10%~+30%, 2.7V, 35mΩ, 20uA@72hrs	Ymin	SDL2R7L1061025	1
C _{BOOT}	100nF, 100V, X7R, ±10%, 0603	Murata Manufacturing	GCM188R72A104KA64D	1
L ₁	10uH, ±20%, Rated current 3.4A, 30mΩ, SMD	TDK	TU-B82464G4103M000	1

12.6 PCB Layout Guidelines

For all switching power supplies, the layout is an important step, especially in the case of high peak currents and high frequencies, and the careful layout may affect the stability of the converter and electromagnetic interference. Here are some suggestions for place-and-route:

12.6.1 BUCK Converter

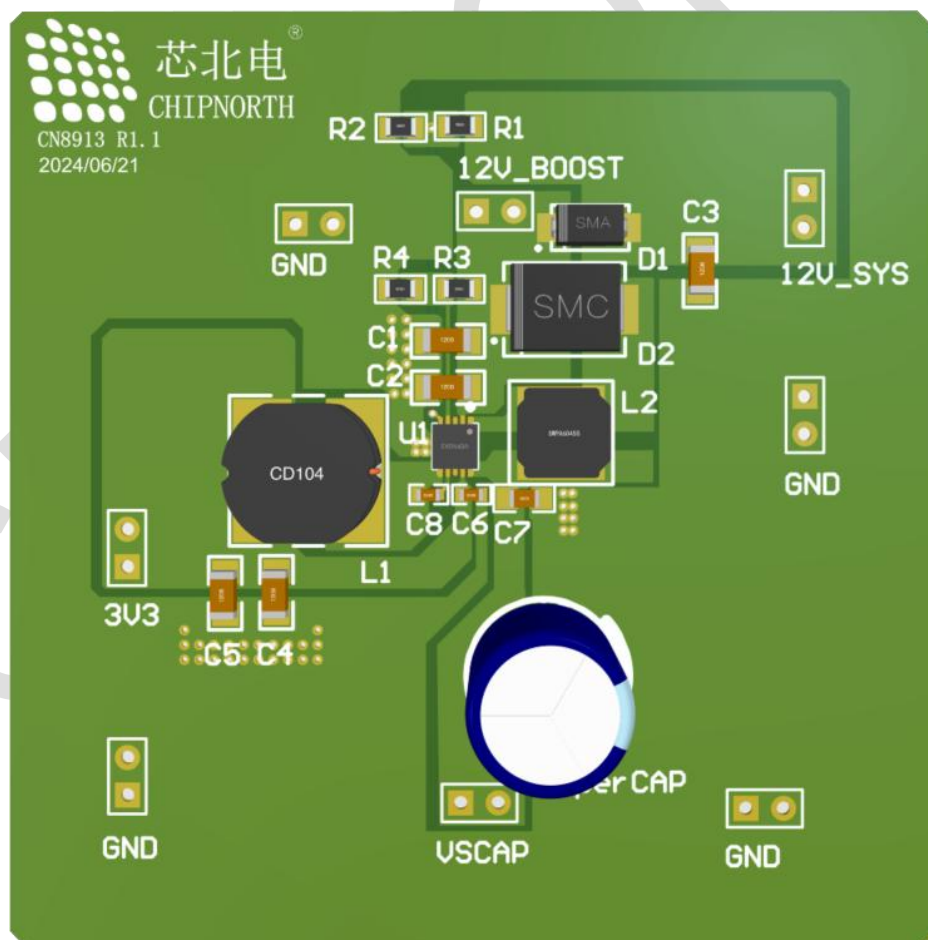
- The upper and the lower switch conduction loop should be as small as possible, especially the common loop of the upper and the lower switch parasitic diode should be small, the specific method is that the input capacitor, especially the small capacitor (such as 100nF) should be close to the VIN and GND of the chip, and the output capacitor should be close to the inductor and the chip GND
- The inductor should be placed close to the SW

- Vout feedback lines are kept away from interference sources such as inductor and SW, and ground wires are shielded and filtered on both sides of the traces
- The signal part and the power part should be separated, to avoid interference by the electromagnetic coupling of the power loop, refer to the datasheet is separated up and down, the signal part is below, and the power part is above
- The ground floor is as complete as possible, with less cutting
- Input and output positive and negative terminals should be placed close to the input and output capacitors, especially the GND terminal, which cannot be placed arbitrarily, which will affect the actual path of current return and affect the layout effect
- In addition, the point that needs to add power or signal, the point to be measured, it is best to lead out and connect to the terminal, convenient for testing, pay attention to these connections do not go arbitrarily, but also refer to the above principles to avoid interference and interference

12.6.2 BOOST Converter

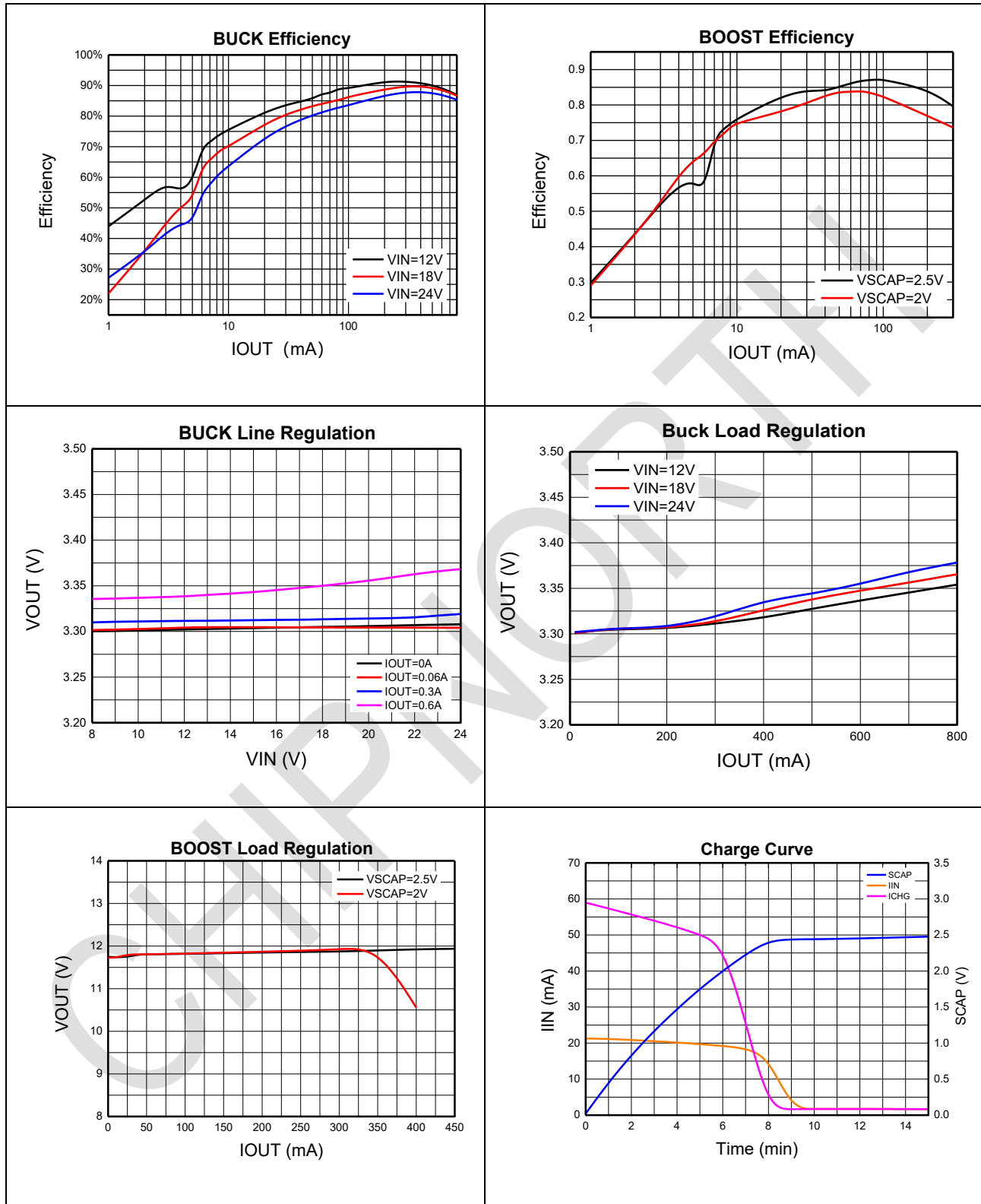
- Priority is given to ensuring that the ground terminal of the output capacitor is close to the GND of the IC and through the vias to the ground plane, the positive terminal of the output capacitor is close to the negative terminal of the diode, and the positive terminal of the diode is placed close to SW
- Place both ends of the inductor as close as possible to the power supply of the input capacitor and SW

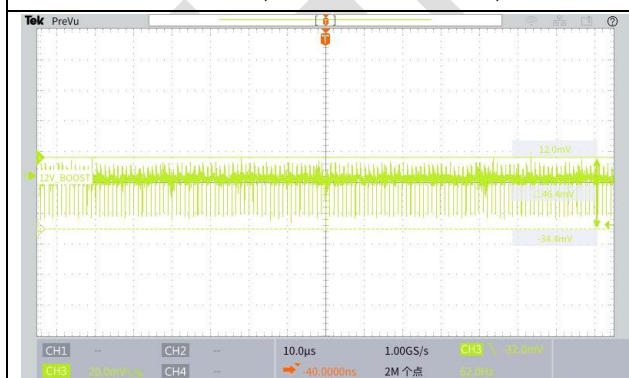
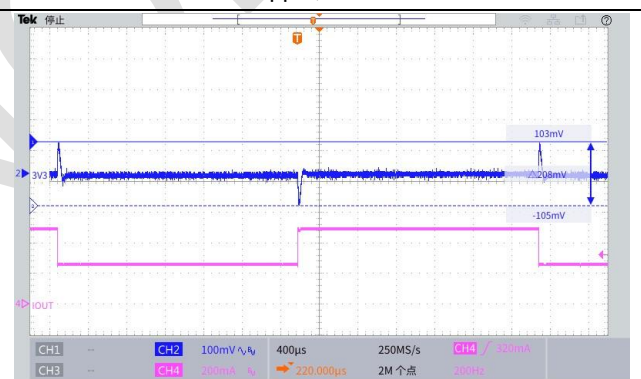
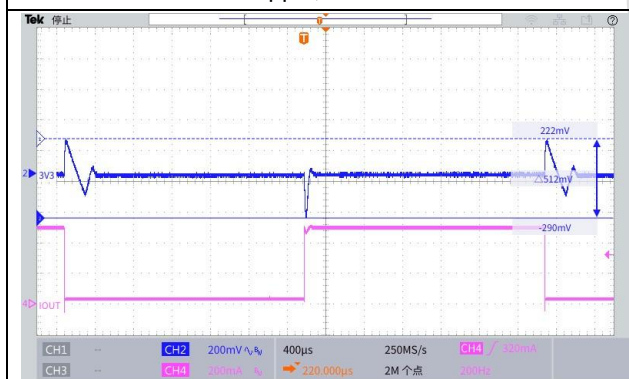
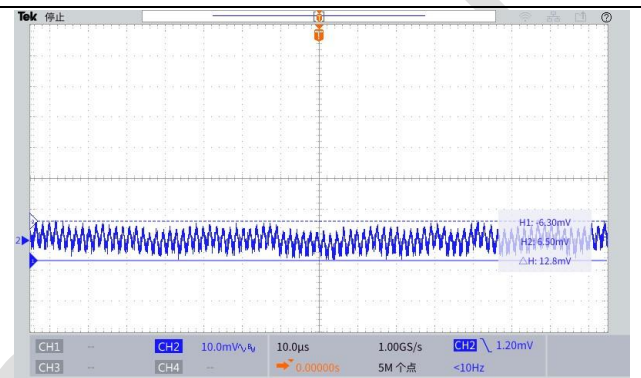
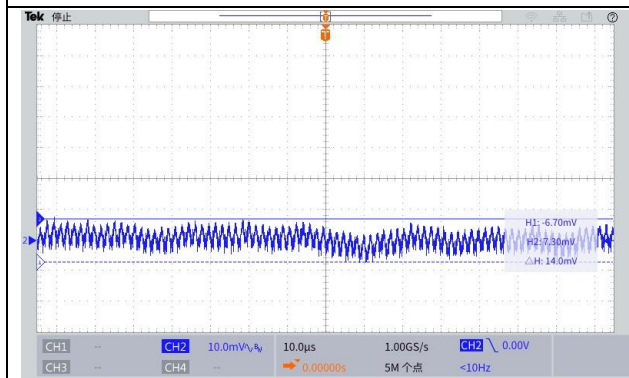
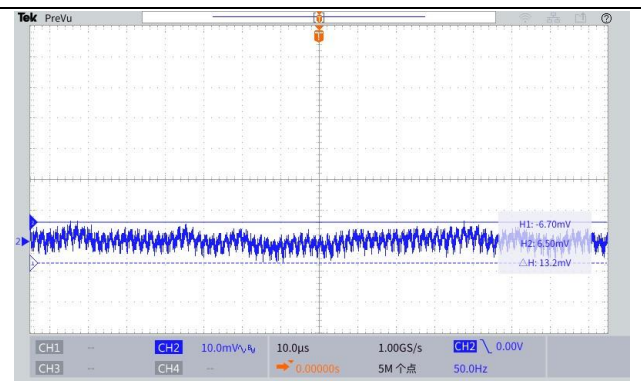
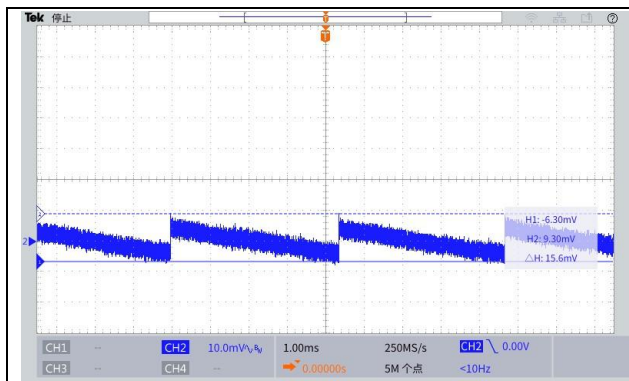
12.6.3 Layout

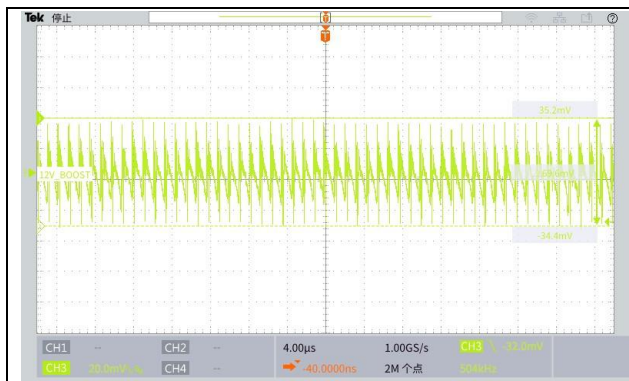


12.7 Basic performance

($V_{IN}=12V$, $T_A=25^{\circ}C$, unless otherwise specified.)

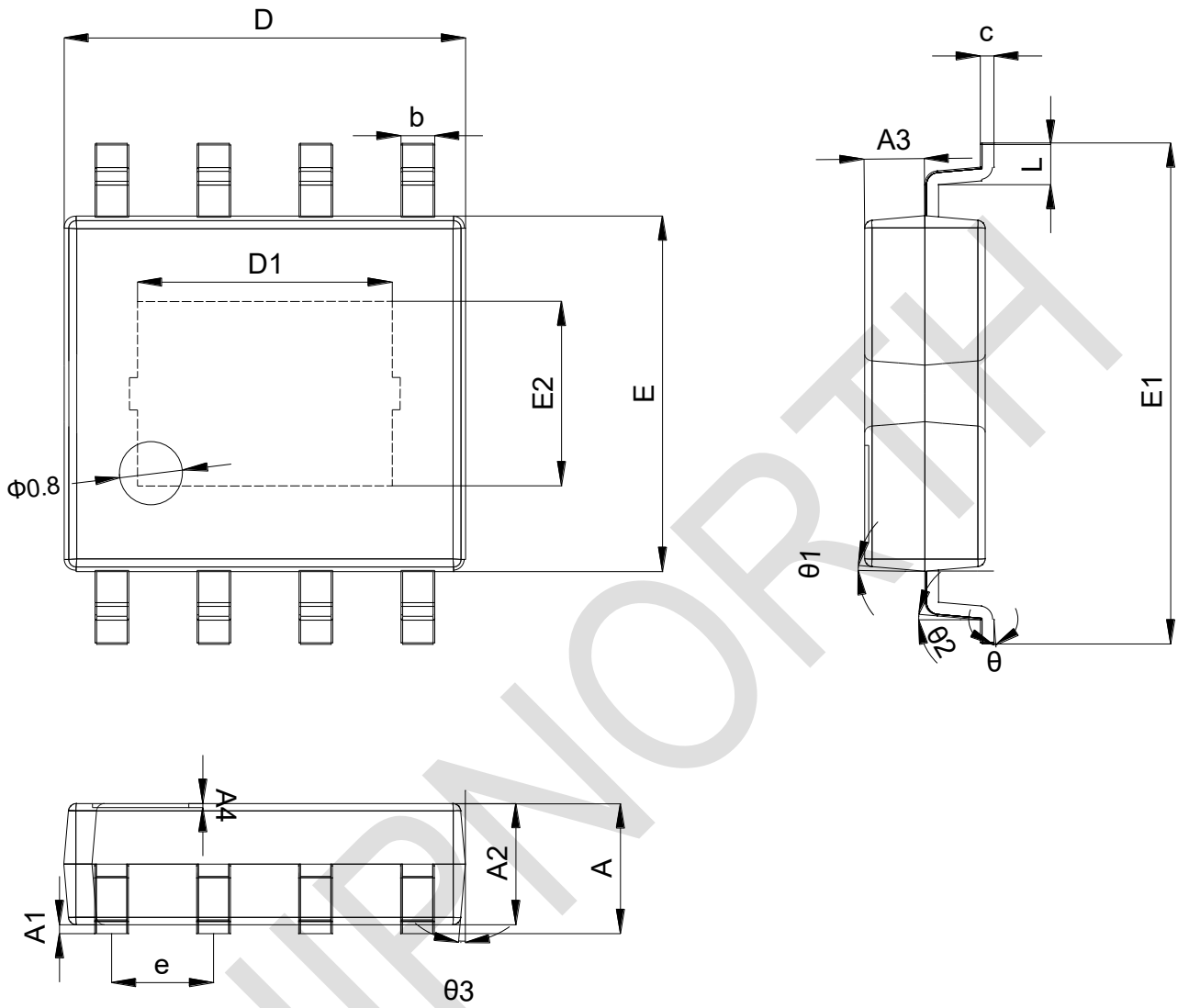






13 Package Information

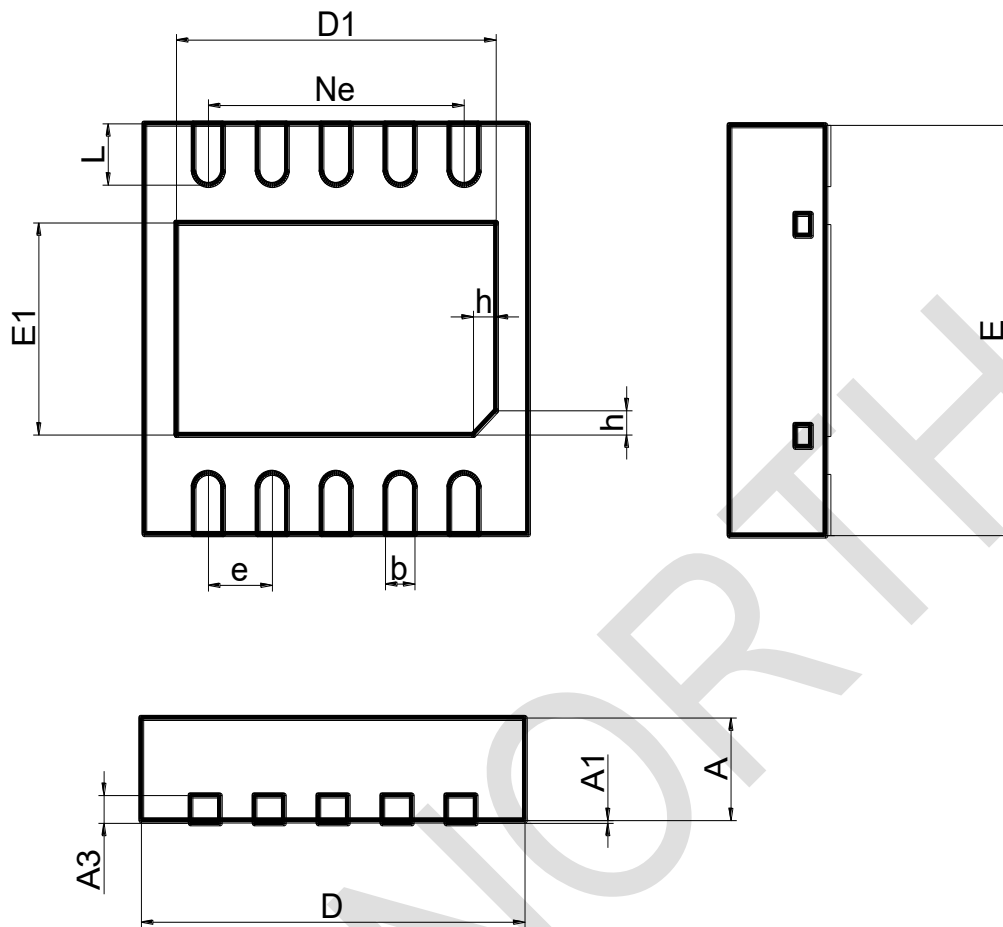
ESOP8L



Dimension Symbol	Min (mm)	Nom (mm)	Max (mm)
A	1.300	1.500	1.700
A1	0.000	0.100	0.150
A2	1.350	1.420	1.550
A3	0.645	0.670	0.695
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°	8°
θ1	12°REF		
θ2	5°REF		
θ3	12°REF		

L/F Size (mil)	Dimension Symbol	Min (mm)	Nom (mm)	Max (mm)
95*130	D1	3.072	3.172	3.272
	E2	2.183	2.283	2.383

DFN3X3-10L



Dimension Symbol	Min (mm)	Nom (mm)	Max (mm)
A	0.700	0.750	0.800
A1	0.000	0.020	0.050
A3	0.203REF		
D	2.900	3.000	3.100
E	2.900	3.000	3.100
D1	2.400	2.500	2.600
E1	1.450	1.550	1.650
h	0.200	0.250	0.300
b	0.180	0.230	0.300
e	0.500BSC		
Ne	2.000BSC		
L	0.300	0.400	0.500

14 Important Statement

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15 Revision History

Date	Version Number	Revision Notes
2026/09/11	R1.2	1、Update Absolute Maximum Ratings 2、Update Operating Conditions

CHIPNORTH