

## 4-Channel PMU with Bucks, Boost and Super-Cap Charger

### 1 Description

The CN8911B is a 4-channel PMU that includes a HV fixed output synchronous buck converter, a HV adjustable output synchronous buck converter, an asynchronous boost converter, a high accuracy super-capacitor charger. The fixed output buck outputs 3.3V/500mA. The adjustable output buck could generate a variable output voltage from 1V to 5V by setting external resistor divider. The boost converter could provide up to 12V/300mA output from super capacitor or other backup power supply at 2.5V. Boost output is internally fixed 12V with saving external resistors. CN8911B also integrates a linear supercapacitor charger with a high accuracy CC and CV mode. When the supply power down detected from DET pin, boost will startup and provide backup 12V voltage, and a PD signal will output.

The CN8911B also employs cycle by cycle current limit and hiccup OCP and Input OVP protections, as well as thermal shutdown.

The CN8911B is available in space saving QFN4x4-16L package.

### 2 Features

- In 1 PMU, 2-Bucks, 1-Boost, 1-SuperCap Charger
- Fixed output buck converter: 3.3V/500mA
- Adjustable output buck converter: 1V-5V
- Boost converter: 12V/300mA
- Super capacitor charger: 2.5V/60mA
- High Efficiency Pulse Skip Mode at Light Load
- Power Down Detection and Indication
- Auto-alternated Boost Mode and Charger Mode
- Hiccup Mode OCP Protections
- Thermal Shutdown

### 3 Applications

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

### 4 Pin Configuration

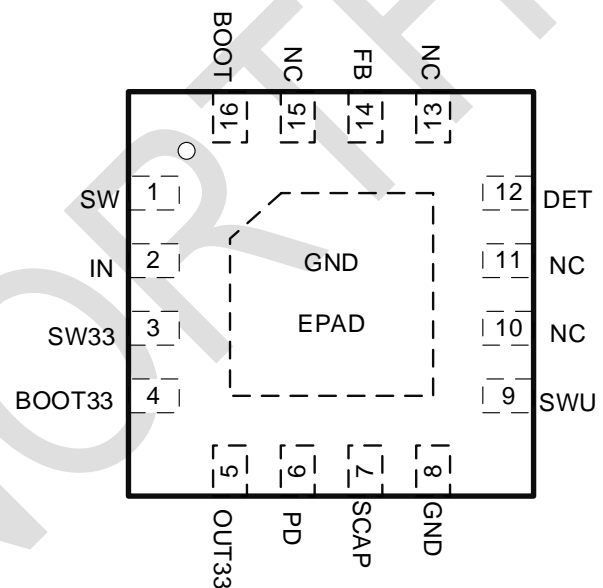


Figure 1 QFN4x4-16L

### 5 Ordering Information

Part NO	Marking	Package	Qty/Tape
CN8911B	CN8911B YYWW	QFN4x4-16L	3000/Tape 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

## 6 Typical Application

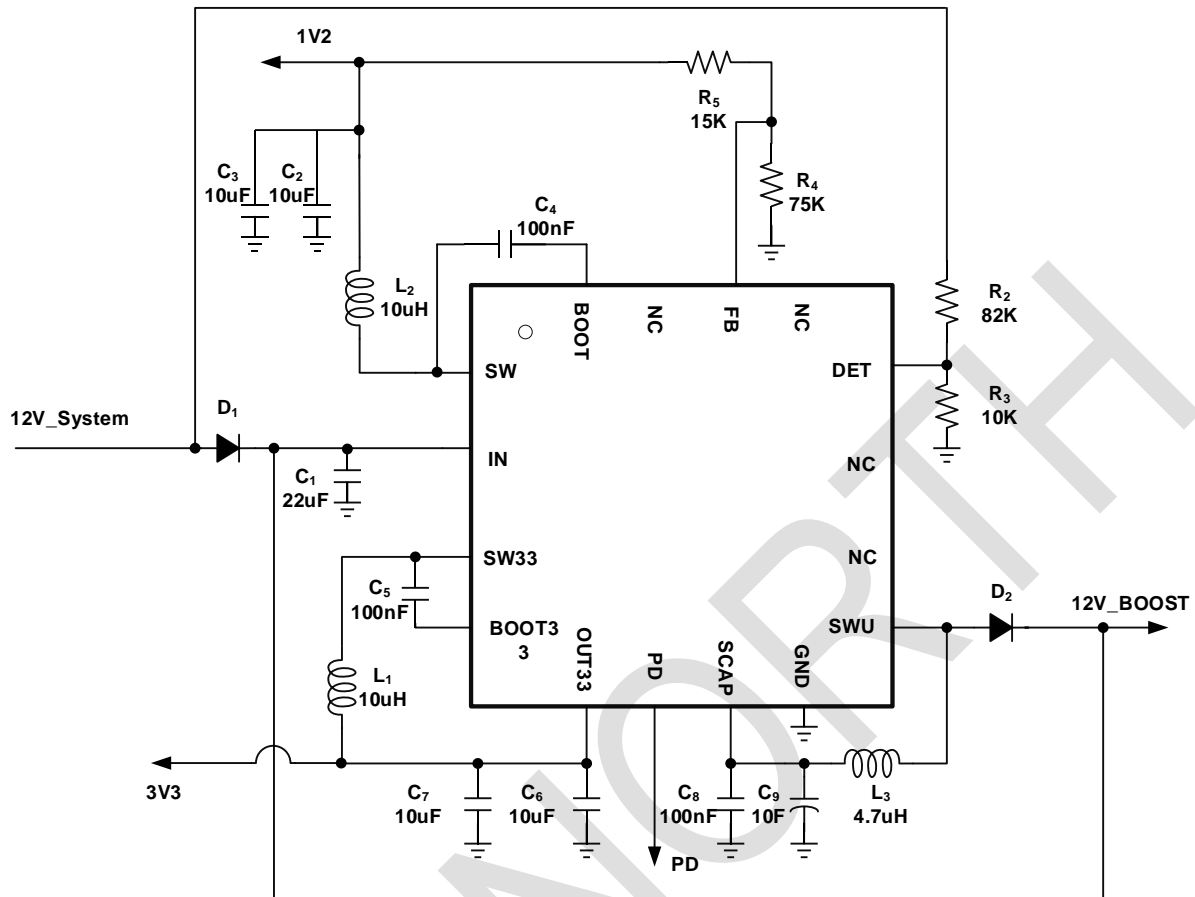


Figure 2 Typical Application

Note 1: System Input Power Down Threshold  $V_{PowerDown} = \frac{R_2 + R_3}{R_3}$

Note 2: Adjustable output  $V_{OUT} = \frac{R_5 + R_4}{R_4}$

## 7 Block Diagram

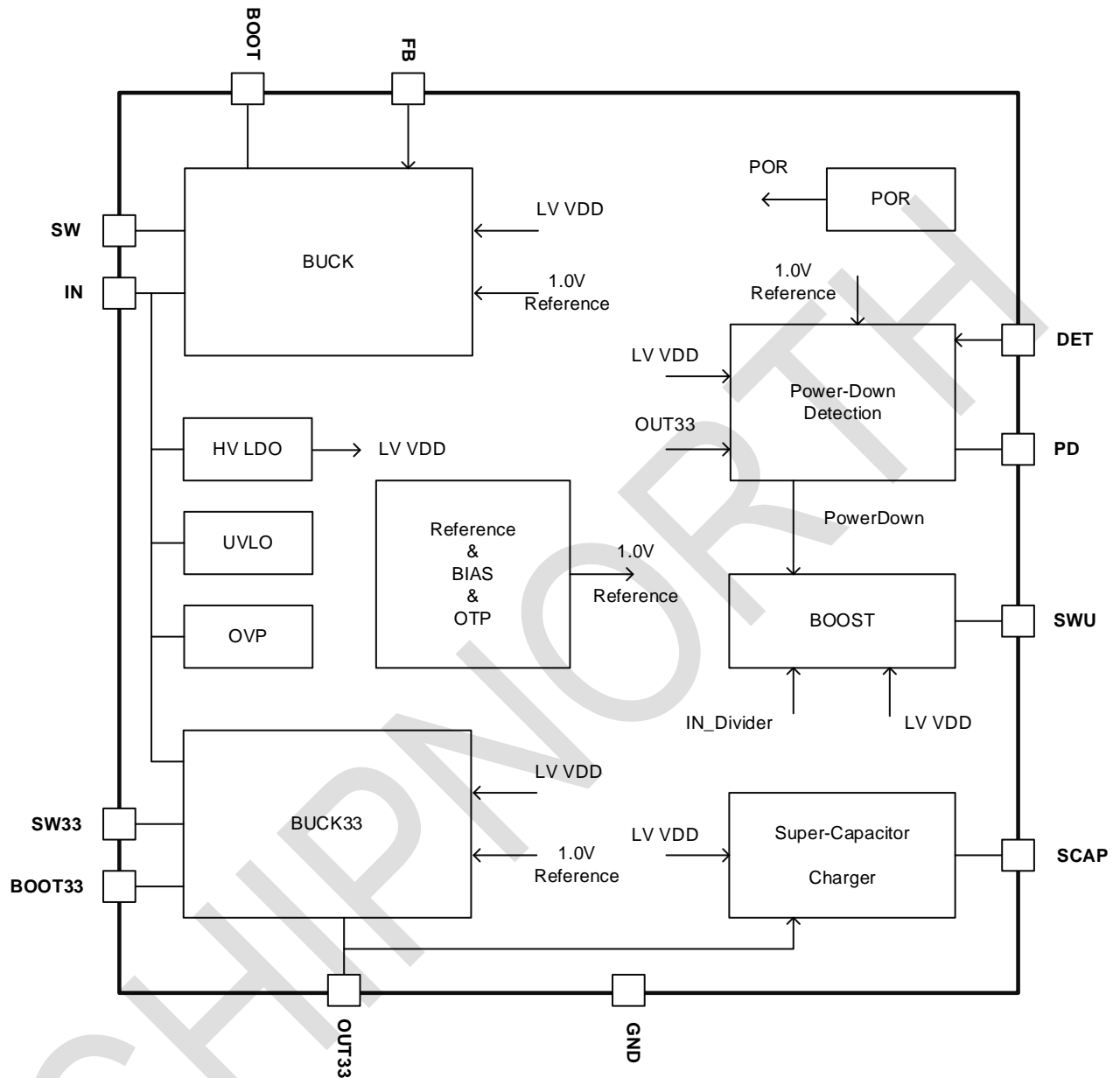


Figure 3 Function Block Diagram

## 8 Pin Descriptions

Pin No.	Pin Name	Descriptions
1	SW	Adjustable Buck Converter Switch Node
2	IN	IC Power Supply Input Pin
3	SW33	Fixed 3.3V Buck Converter Switch Node
4	BOOT33	Bootstrap Pin for Fixed 3.3V Buck Converter
5	OUT33	Output Pin for Fixed 3.3V Buck Converter
6	PD	CMOS Output Pin for Power Down Indication to SOC. Active High. High Level is 3.3V
7	SCAP	Connect to Super Capacitor. It is Internally Programmed to CV at 2.5V
8	GND	Connect to Ground
9	SWU	Boost Converter Switch Node
10~11, 13	NC	No Connect
12	DET	System Input Voltage Power Down Detect Pin. Connect a Resistor Divider from System Input to DET pin and Ground to Set System Input Voltage Power Down Threshold
14	FB	Adjustable Buck Converter Feedback Pin
15	NC	No Connect
16	BOOT	Bootstrap Pin for Adjustable Buck Converter
EPAD	GND	Connect to Ground. Analog and Power Ground Pin. Must Connected.

## 9 Specifications

### 9.1 Absolute Maximum Ratings\*

Parameter	Symbol	Value	Units
Supply Input Voltage	$V_{IN}$	-0.3 ~ 45	V
3.3V Buck and Buck Switch Node Voltage	$V_{SW33}, V_{SW}$	-0.3 ~ $V_{IN} + 0.3$	V
Boot to SW and Boot33 to SW33	$V_{BOOT}, V_{BOOT33}$	-0.3 ~ 6.5	V
Boost Switch Node Voltage	$V_{SWU}$	-0.3 ~ 22	V
Other Pins Voltage		-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.

### 9.2 ESD Ratings

Parameter	Symbol	Value	Units
Human-body model	HBM	±2000	V
Charged-device model	CDM	±2000	V

### 9.3 Recommended Operating Conditions

Parameter	Symbol	Value		Units
		Min.	Max.	
Operating Supply Voltage	$V_{IN}$	6.5	24	V
Adjustable Buck Output Voltage	$V_{OUT\_ADJ}$	1	5	V
Fixed 3.3V Buck Output Voltage	$V_{OUT\_33}$	3.3		V
Boost Output Voltage	$V_{OUT\_BOOST}$	12		V
Adjustable Buck Output Capacitor	$C_{OUT1}$	Typical 22		$\mu F$
Fixed 3.3V Buck Output Capacitor	$C_{OUT2}$	Typical 22		$\mu F$
Boost Output Capacitor	$C_{OUT3}$	Typical 22		$\mu F$
Bootstrap Capacitor Range	$C_{BOOT1}, C_{BOOT2}$	Typical 100		nF
Adjustable Buck Inductor	$L_1$	Typical 10		$\mu H$
Fixed 3.3V Buck Inductor	$L_2$	Typical 10		$\mu H$
Boost Inductor	$L_3$	Typical 4.7		$\mu H$

### 9.4 Thermal Information

Parameter	Symbol	Value	Units
Junction-to-ambient thermal resistance	$R_{\theta JA}$	48.2	$^{\circ}C/W$
Junction-to-case (top) thermal resistance	$R_{\theta JC}$	45.4	$^{\circ}C/W$

## 9.5 Electrical Characteristics

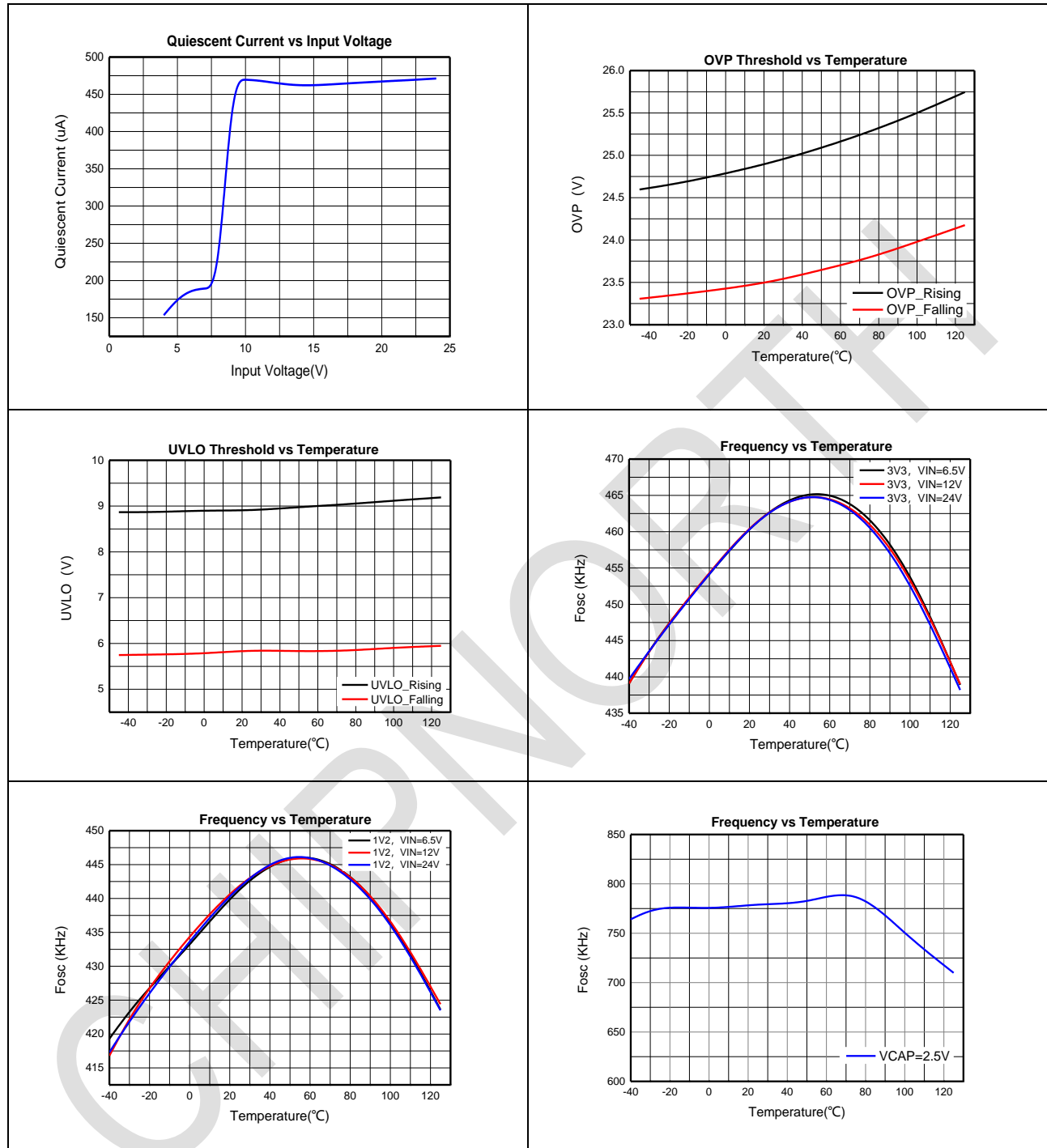
( $V_{IN}=12V$ ,  $T_A=25^{\circ}C$ , unless otherwise specified.)

Parameter	Symbol	Conditions	Value			Unit
			Min.	Typ.	Max.	
Power Supply						
Quiescent Current	I <sub>Q</sub>	I <sub>LOAD</sub> = 0A, V <sub>FB</sub> = 1.1V, no Switching		450		μA
VIN Under Voltage Lockout	UVLO_R	VIN Rising	8.5	8.9	9.4	V
	UVLO_F	VIN Falling	5.5	5.8	6.2	V
VIN Over Voltage Threshold	OVP_R	VIN Rising	23	24.5	26	V
	OVP_F	VIN Falling		23		V
Adjustable Buck Characteristics						
Buck Switching Frequency	F <sub>OSC, Buck</sub>	Buck Switching		450		kHz
Buck Maximum Duty Cycle	D <sub>MAX, Buck</sub>			85		%
Buck Minimum On Time	T <sub>ON_MIN, Buck</sub>			100		ns
High Side MOSFET On-Resistance	R <sub>ONH1</sub>			690		mΩ
Low Side MOSFET On-Resistance	R <sub>ONL1</sub>			370		mΩ
Soft Start-Up Time	T <sub>SS1</sub>			0.8		ms
High Side Current Limit	I <sub>LIMITH1</sub>			950		mA
Low Side Current Limit	I <sub>LIMITL1</sub>			750		mA
Feedback Reference Voltage	V <sub>FB1</sub>		0.98	1	1.02	V
Feedback Input Bias Current	I <sub>FB</sub>	V <sub>FB</sub> = 1.2V		10	100	nA
High Side MOSFET Leakage Current	I <sub>LKH, Buck</sub>				1	μA
Low Side MOSFET Leakage Current	I <sub>LKL, Buck</sub>				1	μA
3.3V Buck Characteristics						
3.3V Buck Switching Frequency	F <sub>OSC, Buck33</sub>	3.3V Buck Switching		450		kHz
3.3V Buck Minimum On Time	T <sub>ON_MIN, Buck33</sub>			100		ns
High Side MOSFET On-Resistance	R <sub>ONH2</sub>			690		mΩ
Low Side MOSFET On-Resistance	R <sub>ONL2</sub>			370		mΩ
Soft Start-Up Time	T <sub>SS2</sub>			0.8		ms
High Side Current Limit	I <sub>LIMITH2</sub>			1100		mA
Low Side Current Limit	I <sub>LIMITL2</sub>			750		mA
3.3V Buck Output Voltage	V <sub>OUT_33</sub>		3.2	3.3	3.4	V
High Side MOSFET Leakage Current	I <sub>LKH, Buck33</sub>				1	μA
Low Side MOSFET Leakage Current	I <sub>LKL, Buck33</sub>				1	μA

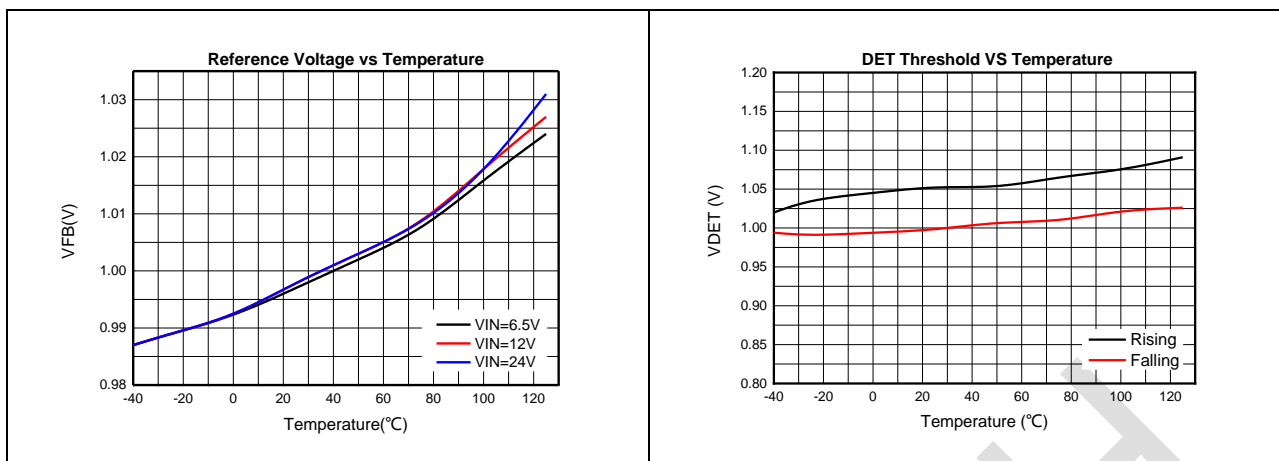
Boost Characteristics						
Boost Switching Frequency	$F_{OSC, BST}$	Boost Switching		750		kHz
Boost Maximum Duty Cycle	$D_{MAX, BST}$			90		%
Boost Minimum On-Time	$T_{ON, MIN, BST}$			120		ns
Power MOSFET On-Resistance	$R_{ONL3}$			110		mΩ
Boost Current Limit	$I_{LIMITL3}$			3		A
Boost 12V Output Voltage	$V_{OUT\_12}$		11.6	12	12.4	V
Power MOSFET Leakage Current	$I_{LKL, BST}$	Boost off			1	μA
Super Capacitor Charger						
Super Capacitor Charging Current	$I_{SCAP}$			60		mA
SCAP Charge Voltage	$V_{SCAP}$			2.5		V
SCAP Charge Voltage Accuracy				3		%
Power Down Detection						
DET Reference Voltage	$V_{DET}$		0.98	1	1.02	V
PD Output Voltage	$V_{PD\_H}$	High Level, 10mA	3			V
	$V_{PD\_L}$	Low Level, 10mA			0.2	V
Thermal Shutdown						
Thermal Shutdown Threshold	$T_{SD}$	Rising		150		°C
$T_{SD}$ Hysteresis	$T_{HYS}$	Hysteresis		30		°C

## 9.6 Characteristics Curve

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







## 10 Detailed Description

### 10.1 Overview

The CN8911B is a 4-channel PMU that includes a HV fixed output synchronous buck converter, a HV adjustable output synchronous buck converter, an asynchronous boost converter, a high accuracy supercapacitor charger. The fixed output buck outputs 3.3V/500mA. The adjustable output buck could generate a variable output voltage from 1V to 5V by setting external resistor divider. The boost converter could provide up to 12V/300mA output from super capacitor or other backup power supply at 2.5V. Boost output is internally fixed 12V with saving external resistors. CN8911B also integrates a linear supercapacitor charger with a high accuracy CC and CV mode. When the supply power down detected from DET pin, boost will startup and provide backup 12V voltage, and a PD signal will output.

### 10.2 Buck Converter

Both the 3V3 buck converter and the adjustable buck converter both 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, and the adjustable buck converter can set the output voltage with external resistors.

### 10.3 Boost Converter

CN8911B 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 0.3A. The switching frequency is 750K, so small inductors and ceramic capacitors can be used to achieve a small solution.

### 10.4 Charger

The supercapacitor charger integrates constant current and constant voltage functions, and the constant voltage is set to 2.5V. When the supercapacitor voltage is lower than 2.42V, the charging current is 60mA; when the supercapacitor voltage is 2.42V-2.5V, the charging current is 1mA; after the supercapacitor voltage reaches 2.5V, the charging voltage is constant. It is recommended to connect a 100nF capacitor to the charger output to suppress high-frequency noise.

## 10.5 Power Down Detection and Indication

CN8911B can set the power-down threshold of the power supply system through external resistor, and connect to the control system through the PD pin to realize the power down detection and indication function. When the power supply system is powered on and the DET voltage is higher than 1V, the buck converter and the supercapacitor charger runs, the boost converter is disabled, the PD output is low, and the power supply system is normal; When the power supply system is powered down and the DET voltage is below 1V, charger is disabled, the boost converter starts to work, converts the supercapacitor voltage to 12V, supplies power to the two buck converters, and pulls the PD up to 3.3V to notify the power down to the control system.

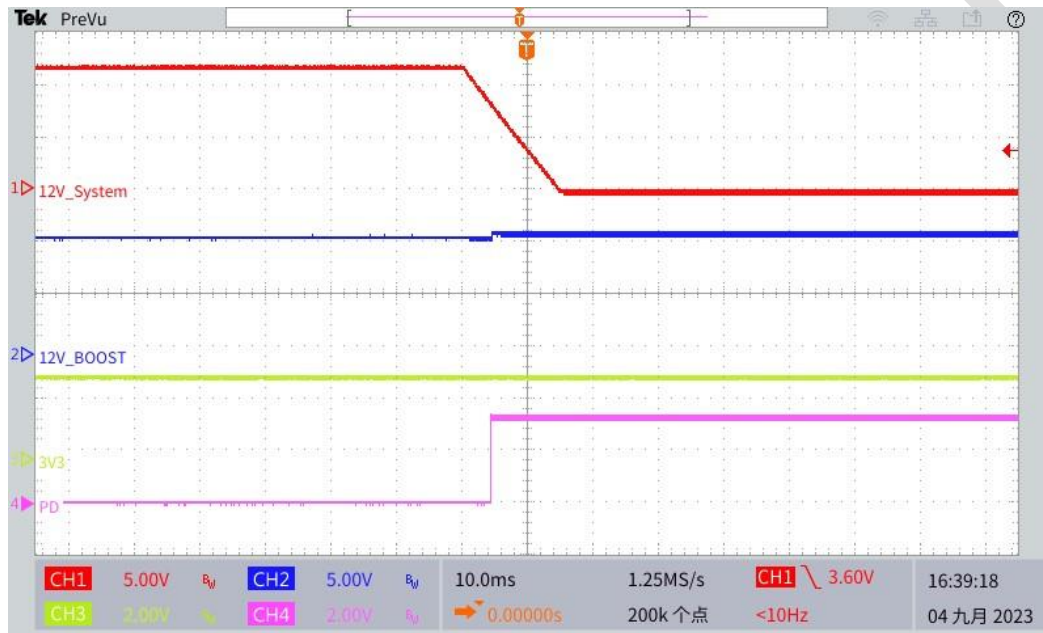


Figure 4 Power down detection and indication

## 10.6 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.

## 10.7 Over Current Protection

The buck converter will limit the peak inductor current to 1.1A and the inductor valley current to 0.75A 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 3A and is turned off the power switch until the next cycle, and so on until the overcurrent disappears.

## 10.8 Thermal Shutdown

CN8911B 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 150°C, it will shut down the buck converters and the boost converter. When the junction temperature drops to 120°C, the chip will restart.

## 11 Application Information

### 11.1 Typical Application

Figure 5 shows a typical application schematic that can be used to evaluate CN8911B performance. This part describes the specific design process of the application schematic.

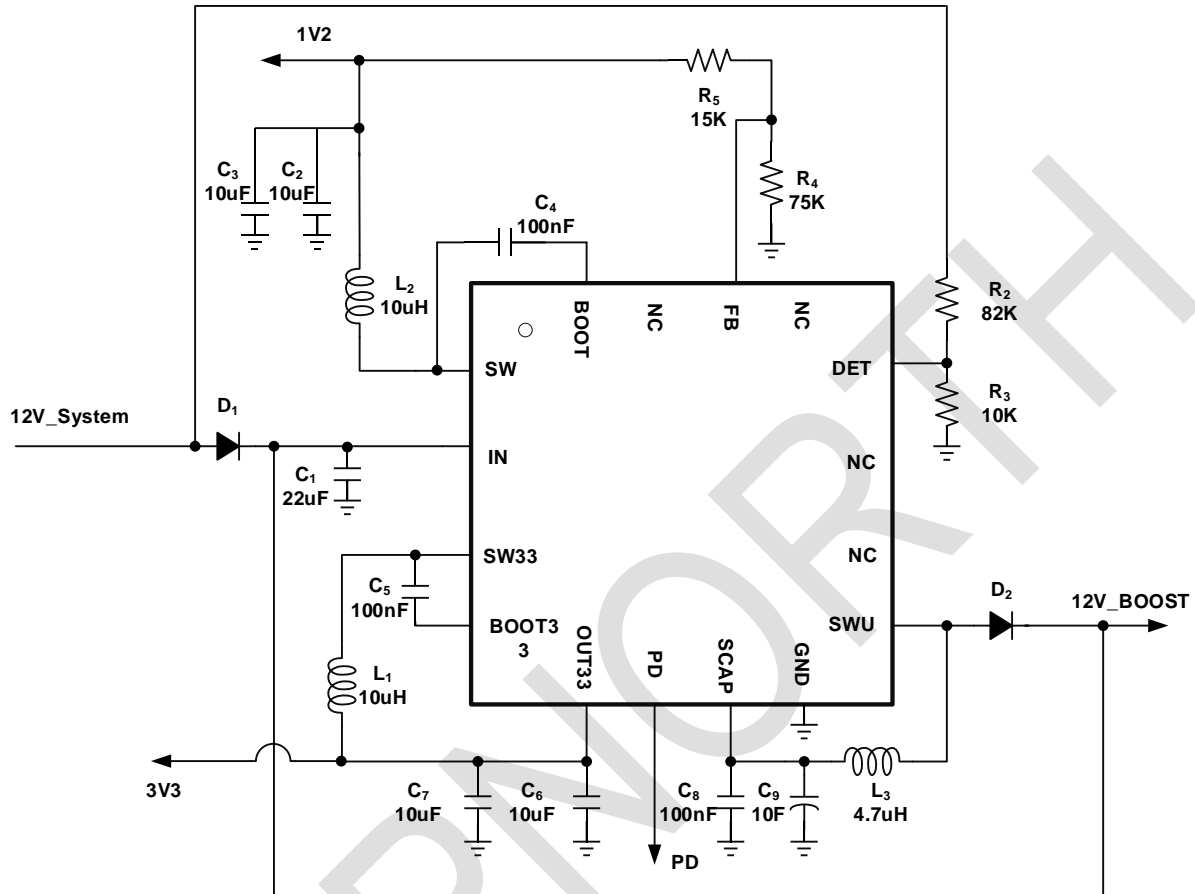


Figure 5 Application Schematic

### 11.2 Design Requirements

Requirement	Min	Typ	Max	Unit
1V2 output voltage	1.14	1.2	1.26	V
3V3 output voltage	3.146	3.3	3.465	V
12V_Boost output voltage	11.4	12	12.6	V
Input voltage	6.5	12	24	V
1V2 output ripple		30		mV
3V3 output ripple		50		
BOOST output ripple		100		

## 11.3 BUCK Circuit Design

### 11.3.1 Output Voltage

The adjustable output is set by external resistors. The FB threshold is 1V.

$$V_{OUT} = \frac{(R_5 + R_4)}{R_4}$$

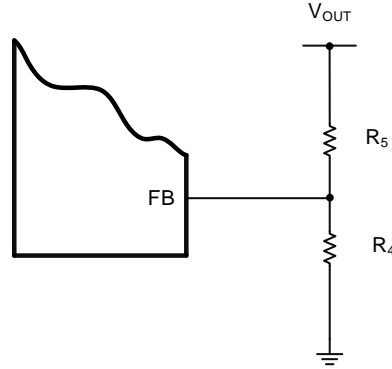


Figure 6 Output Voltage Setting

### 11.3.2 Inductor

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

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

- $V_{IN}$  is the input voltage
- $V_{OUT}$  is the output voltage
- $f_s$  is the switch frequency
- $\Delta I_L$  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:

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

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.

### 11.3.3 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  $\Delta V_{OUT}$  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

#### 11.3.4 External Bootstrap Capacitor

CN8911B 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 Boot33-SW33 and Boot-SW.

### 11.4 BOOST Circuit Design

#### 11.4.1 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 inductor peak current
- $V_{OUT}$  is the output voltage
- $V_{IN}$  is the input voltage
- $I_{OUT}$  is the load current
- $\eta$  is the efficiency of Boost converter
- $\Delta I_L$  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.

#### 11.4.2 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.

#### 11.4.3 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  $\Delta V_O$  is mainly determined by the capacitor capacity, and the calculation formula is:

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

#### 11.4.4 Power System Power-down Threshold Setting

The power system power-down threshold can be set by the R2 and R3 resistors and is calculated as follows:

$$V_{PowerDown} = \frac{R_2 + R_3}{R_3} V_{SYS}$$

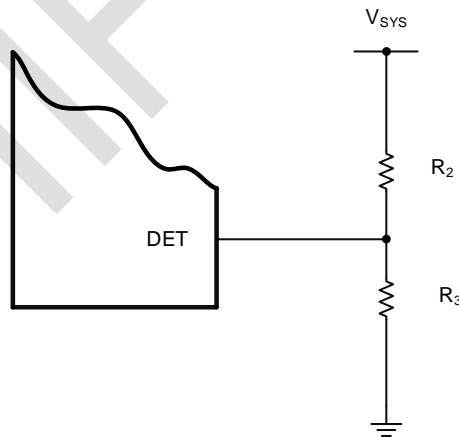


Figure 7 Power system power-down threshold setting

## 11.5 Bom List

Symbol	Description	Manufacturers	Part Number	Qty
C <sub>1</sub>	25V,X5R,±20%,0805	Murata Manufacturing	11M- GRM21BR61E226ME44L	1
C <sub>4</sub> 、C <sub>5</sub> 、C <sub>8</sub>	100nF,100V,X7R,±10%,0603	Murata Manufacturing	GCM188R72A104KA64D	3
C <sub>2</sub> 、C <sub>3</sub> 、 C <sub>6</sub> 、C <sub>7</sub>	10uF,50V,X5R,±10%,0805	Murata Manufacturing	GRM21BR61H106KE43K	4
R <sub>2</sub>	82K,±1%,0.1W,0603	VISHAY	CRCW060382K0FKTABC	1
R <sub>3</sub>	10K,±1%,0.1W,0603	VISHAY	CRCW060310K0FKTABC	1
R <sub>4</sub>	75K,±1%,0.1W,0603	VISHAY	CRCW060375K0FKTABC	1
R <sub>5</sub>	15K,±1%,0.1W,0603	VISHAY	CRCW060315K0FKTABC	1
D <sub>1</sub>	D0- 214AA,1500mA,100V,0.75V@1000mA	VISHAY	SS210-E3/5BT	1
D <sub>2</sub>	D0-214AB,3000mA,40V,0.5V@3000mA	VISHAY	SS34-E3/57T	1
L <sub>1</sub> 、L <sub>2</sub>	10uH,±20%,Rated current 3.4A,30mΩ,SMD	TDK	TU-B82464G4103M000	2
L <sub>3</sub>	4.7uH,±20%,Rated current 4A,48.4mΩ, SMD	TDK	SPM6530T-4R7M-HZ	1
C <sub>13</sub>	10F,- 10%~+30%,2.7V,35mΩ,20uA@72hrs	Ymin	SDL2R7L1061025	1



## 11.6 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:

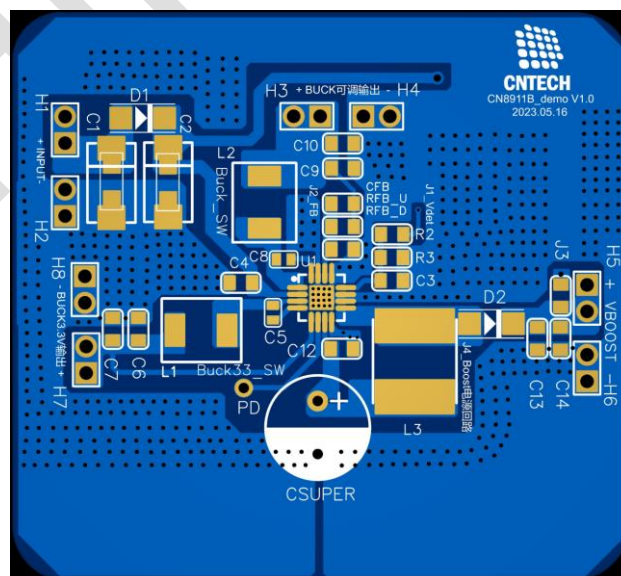
### 11.6.1 BUCK Converter

- 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

### 11.6.2 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

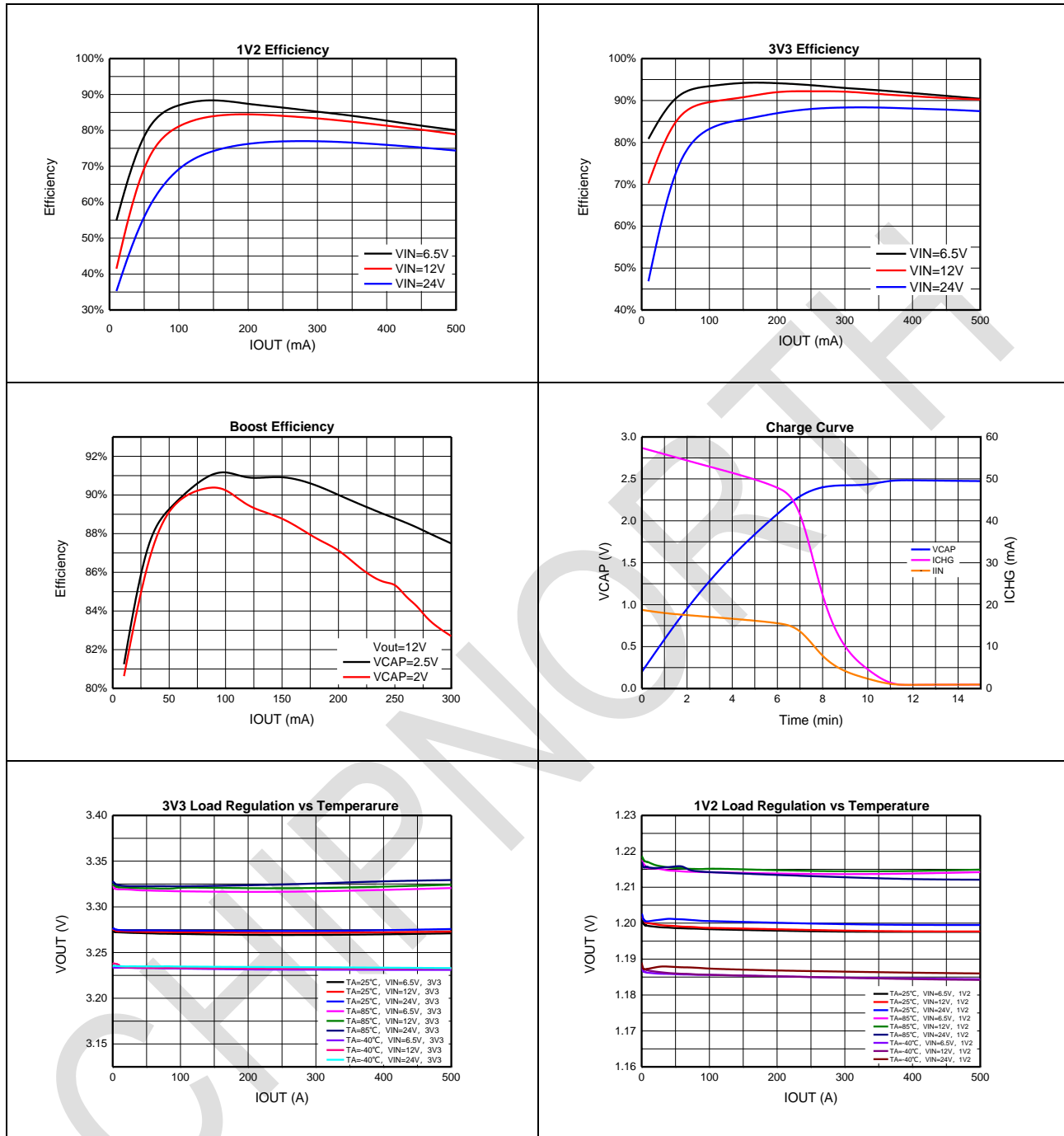
### 11.6.3 Layout

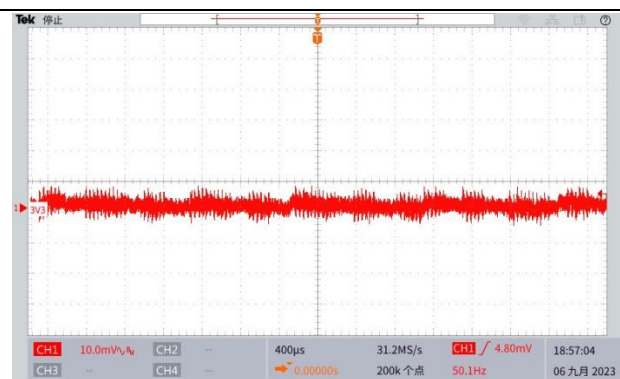
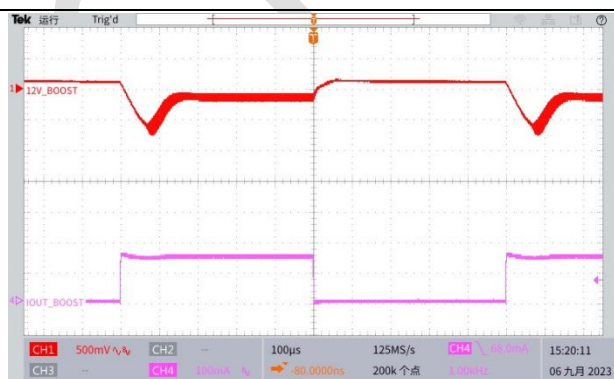
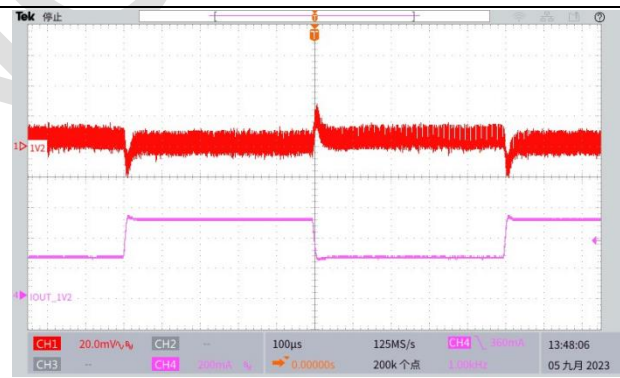
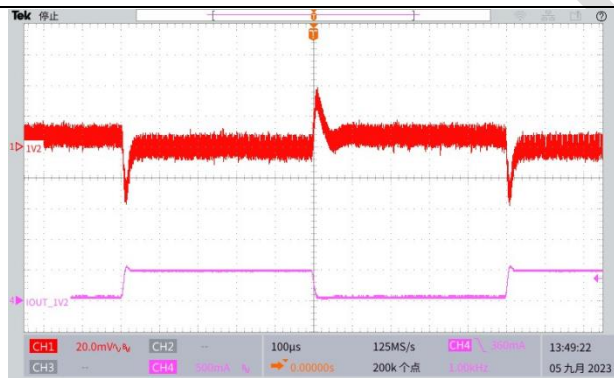
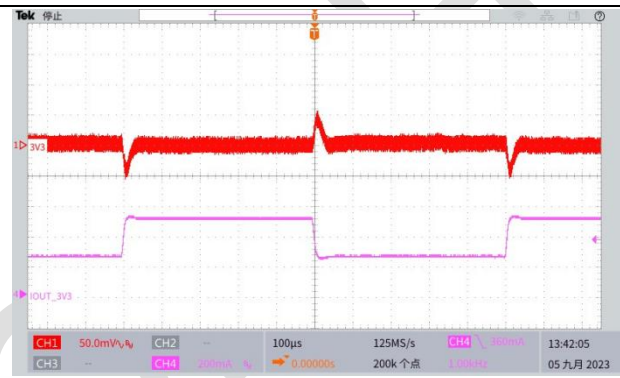
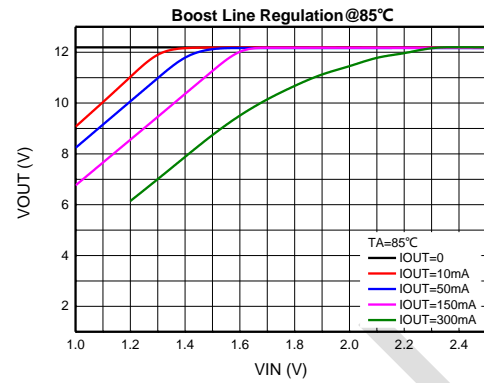
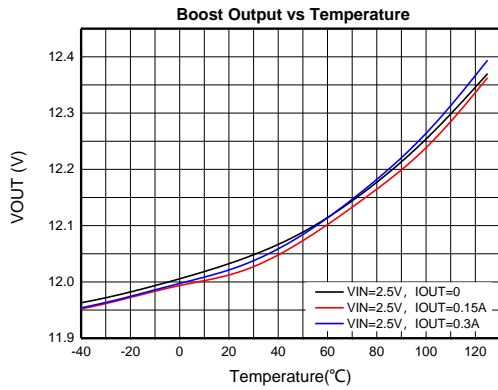


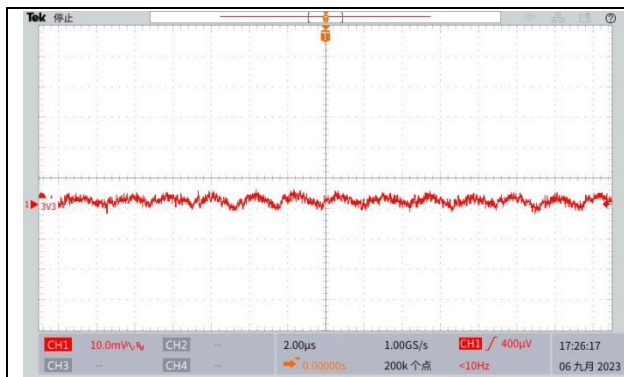


## 11.7 Basic performance

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



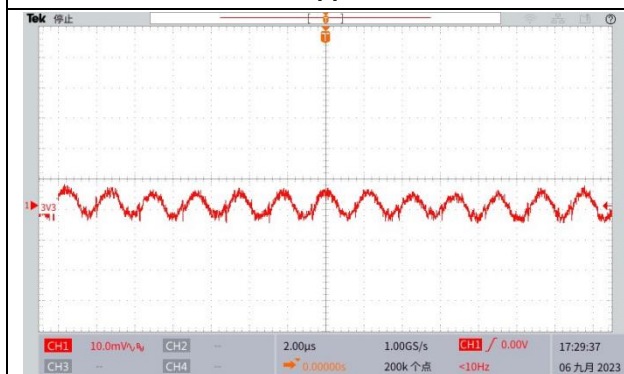




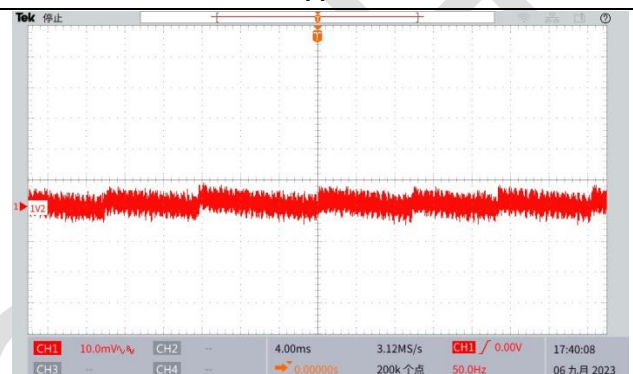
3V3, IOUT=50mA  
Ripple



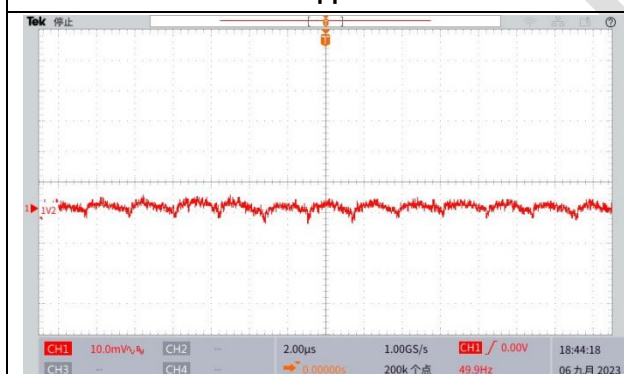
3V3, IOUT=250mA  
Ripple



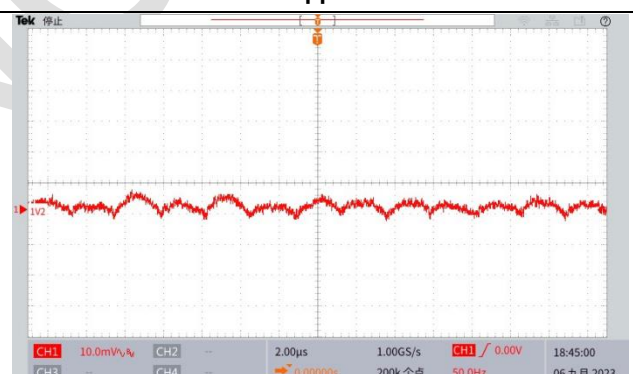
3V3, IOUT=500mA  
Ripple



1V2, IOUT=0  
Ripple



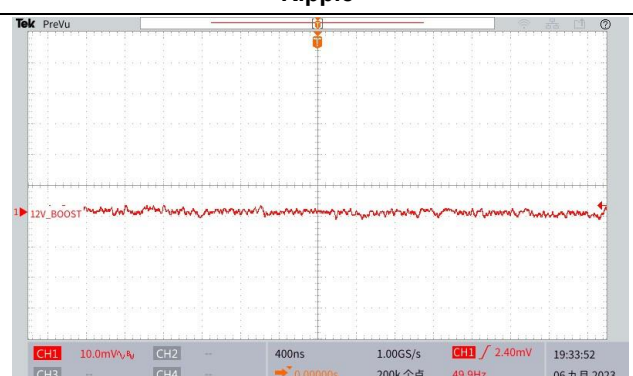
1V2, IOUT=50mA  
Ripple



1V2, IOUT=250mA  
Ripple



1V2, IOUT=500mA  
Ripple

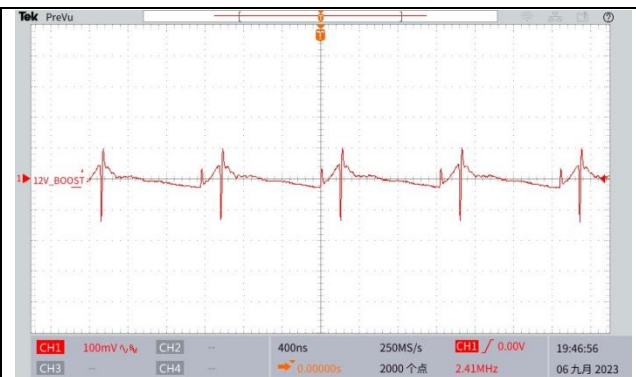


Boost, IOUT=0  
Ripple





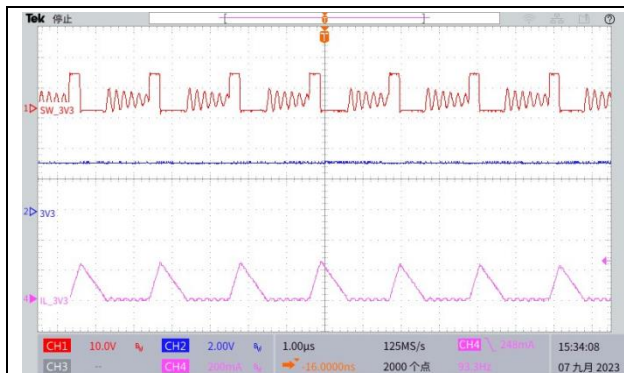
Boost, IOUT=150mA  
Ripple



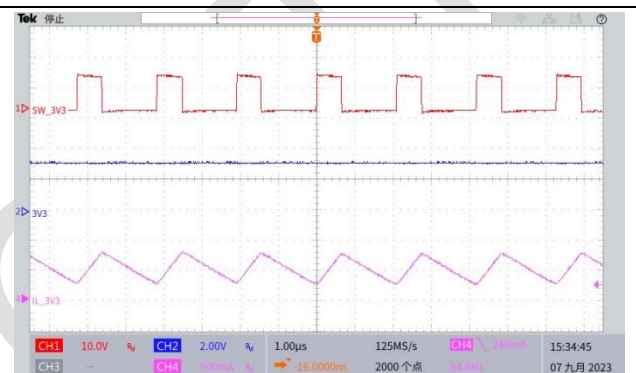
Boost, IOUT=300mA  
Ripple

## 11.8 Working waveform

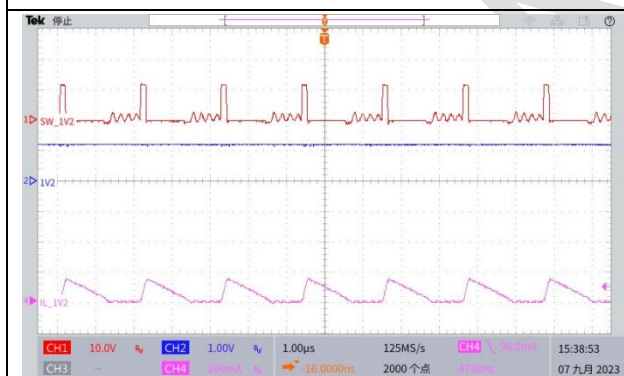
( $V_{IN}=12V$ ,  $T_A=25^{\circ}C$ , unless otherwise specified.)



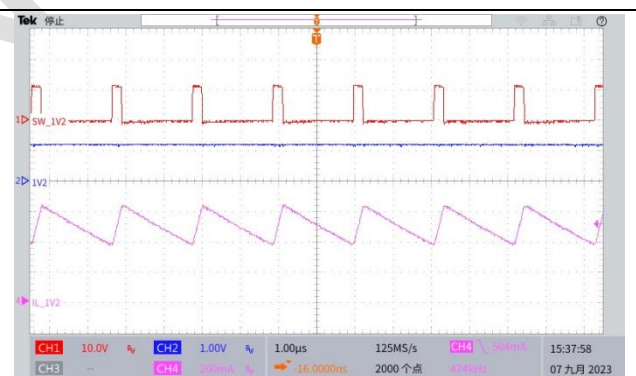
3V3, IOUT=50mA



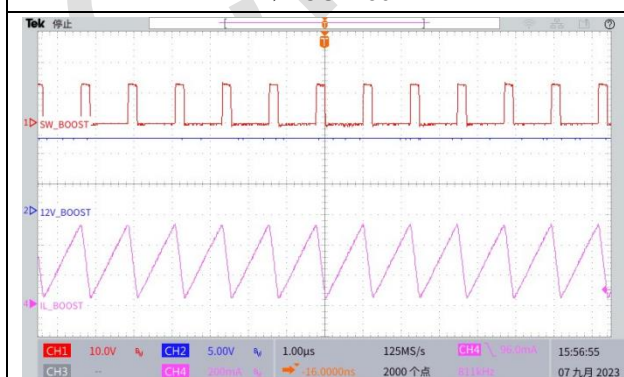
3V3, IOUT=500mA



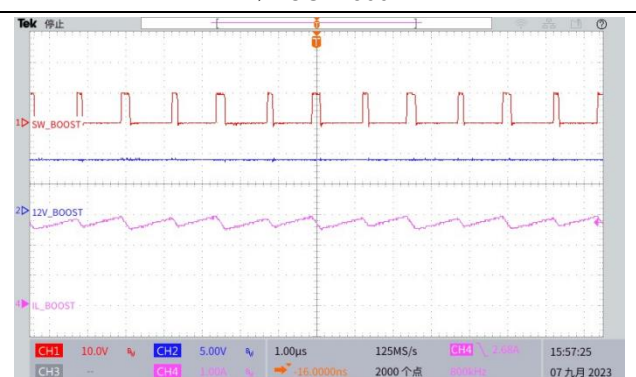
1V2, IOUT=50mA



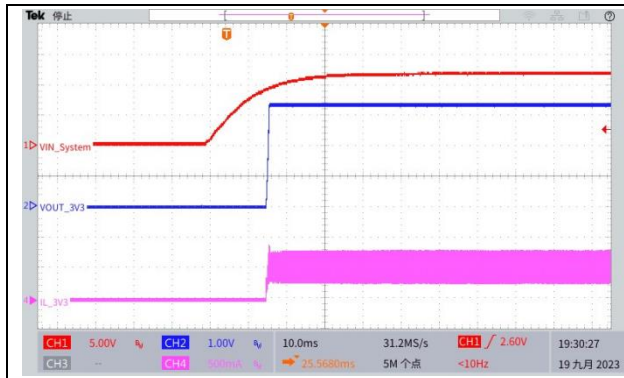
1V2, IOUT=500mA



Boost, IOUT=50mA



Boost, IOUT=300mA



3V3 Startup, IOU=500mA



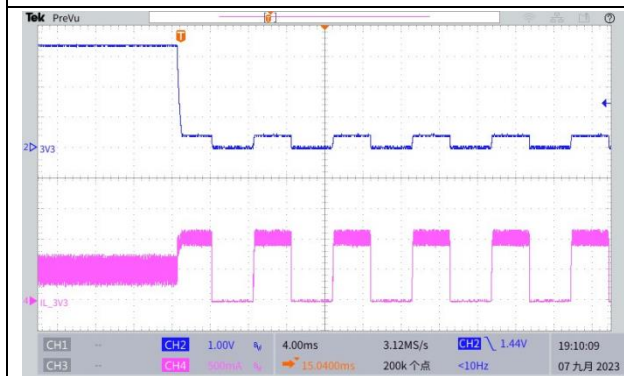
3V3 Shutdown, IOU=500mA



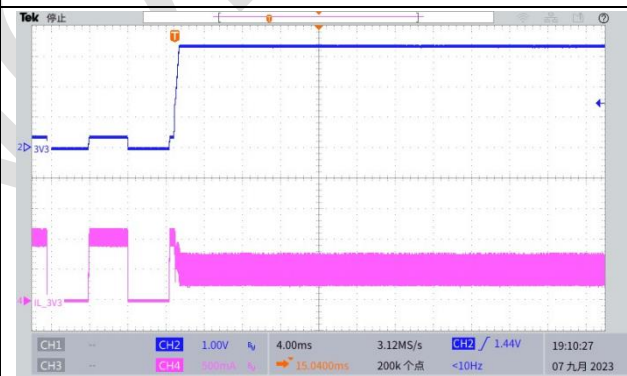
1V2 Startup, IOU=500mA



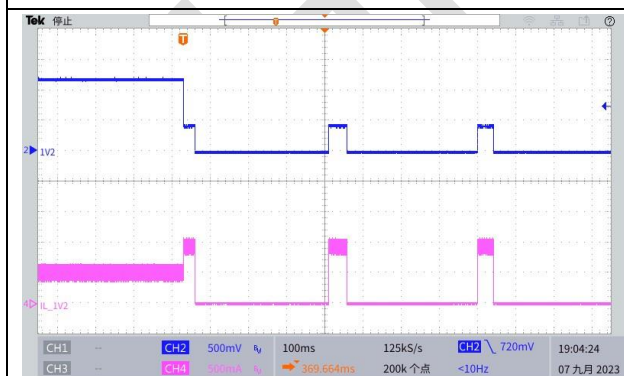
1V2 Shutdown, IOU=500mA



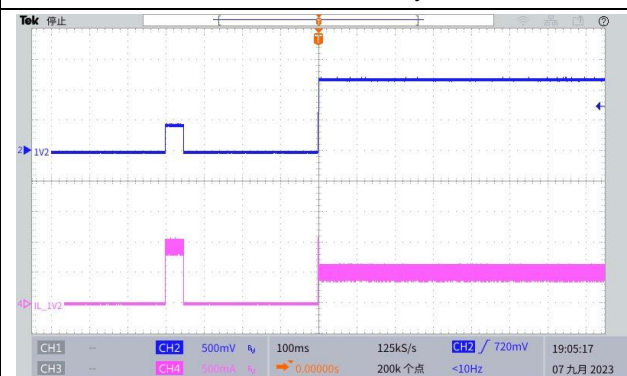
3V3 OCP



3V3 OCP Recovery



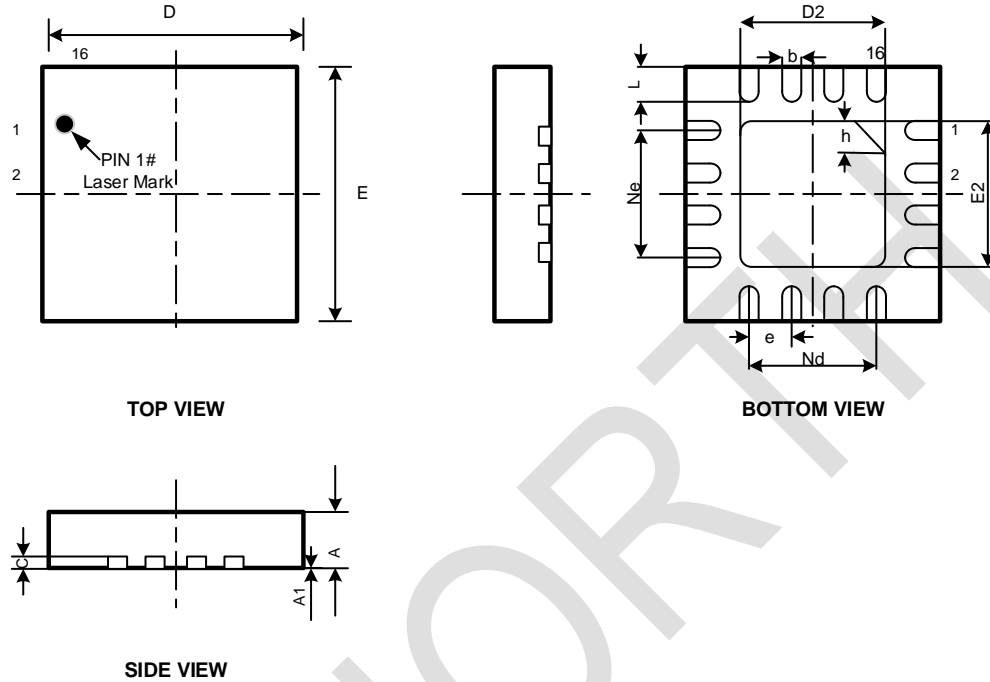
1V2 OCP



1V2 OCP Recovery

## 12 Package Description

### QFN4X4-16L



SYMBOL	MILLIMETER		
	MIN	NOM	MAX
A	0.70	0.75	0.80
A1	-	0.02	0.05
b	0.25	0.30	0.35
c	0.18	0.20	0.25
D	3.90	4.00	4.10
D2	2.10	2.20	2.30
e	0.650BSC		
Ne	1.95BSC		
Nd	1.95BSC		
E	3.90	4.00	4.10
E2	2.10	2.20	2.30
L	0.45	0.55	0.65
h	0.30	0.35	0.40

### 13 Important Statement

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