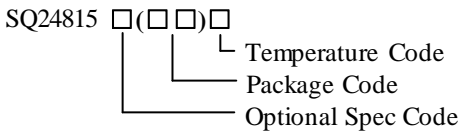


## Current Limit Switch with Output Voltage Clamping

### General Description

The SQ24815B is a current limit switch with input voltage range selection and output voltage clamping. Extremely low  $R_{DS(ON)}$  of the integrated protection N-channel FET helps to reduce the power loss during the normal operation. Programmable soft-start time controls the slew rate of the output voltage during start-up. Independent enable control allows the complicated system sequencing control. It integrates the over-temperature protection shutdown and the auto-recovery with hysteresis. This IC along with small DFN3×3-10 footprint provides small PCB area application.

### Ordering Information



| Ordering Number | Package type | Note |
|-----------------|--------------|------|
| SQ24815BDDB     | DFN3×3-10    | ---- |

### Features

- Wide Input Voltage Range from 2.5V to 6.5V with Surge up to 18V
- Ultra Low Bias Current: 50μA Typical
- Extremely Low  $R_{DS(ON)}$  for the Integrated Protection Switch: 40mΩ
- Programmable Soft-start Time
- 2 Level Current Limit:
  - 1.4A for 3.3 Mode
  - 2.75A for 5V Mode
- Short Circuit Protection
- Selectable Input and Clamping Voltage Range
- Enable Interface Pin
- Thermal Shutdown Protection & Auto Recovery
- RoHS Compliant and Halogen Free
- Compact Package: DFN3×3-10

### Applications

- Notebook PC
- I-pad Mini
- Server
- Service PC

### Typical Applications

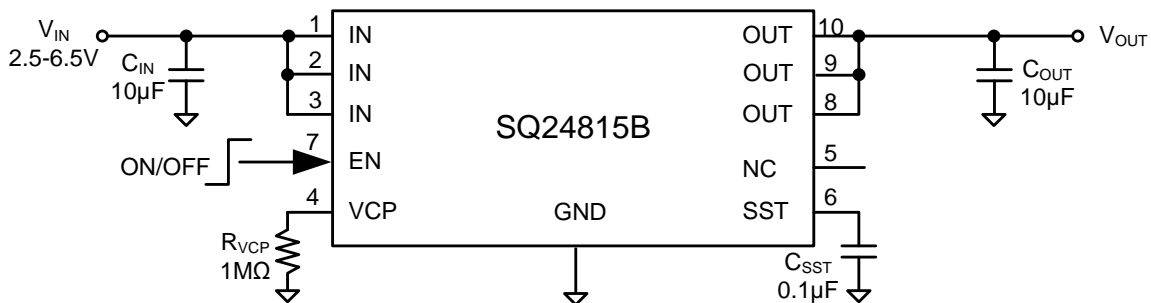
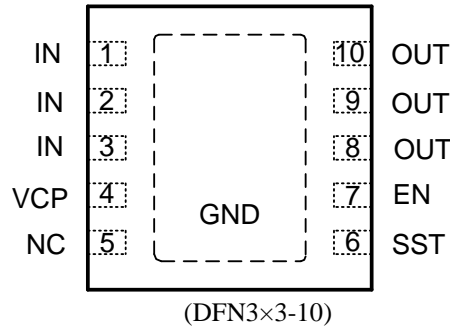


Figure1. Schematic Diagram

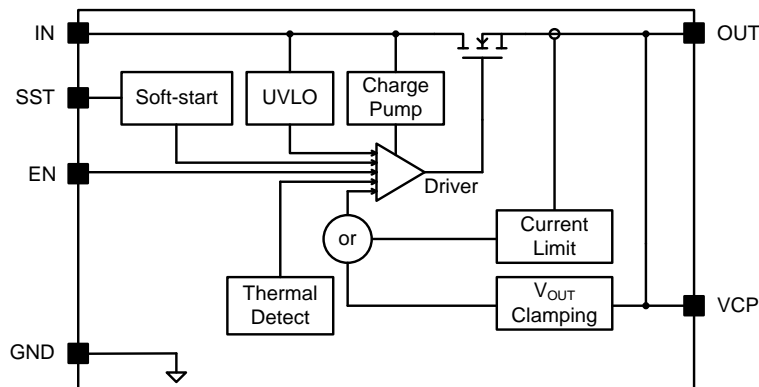
## Pinout (top view)



Top mark: **CLTxyz**(Device code: CLT, *x=year code, y=week code, z=lot number code*)

| Pin Name | Pin Number             | Pin Description   |      |      |      |                    |  |  |     |     |     |     |      |         |      |      |      |      |    |         |      |      |      |
|----------|------------------------|---|------|------|------|--------------------|--|--|-----|-----|-----|-----|------|---------|------|------|------|------|----|---------|------|------|------|
| IN       | 1, 2, 3                | Power input pin. Decouple high frequency noise by connecting at least 0.1μF MLCC to ground.   |      |      |      |                    |  |  |     |     |     |     |      |         |      |      |      |      |    |         |      |      |      |
| VCP      | 4                      | Output clamp voltage selection based on the input voltage. Pull VCP pin to high by connecting a resistor to IN, or pull VCP pin to low by connecting a resistor to ground. Recommend to decouple this pin with a 0.1μF capacitor. <table border="1" style="margin: 10px auto;"> <thead> <tr> <th rowspan="2">VCP</th> <th colspan="2" rowspan="2">IN</th> <th colspan="3">Clamping Threshold</th> </tr> <tr> <th>Min</th> <th>Typ</th> <th>Max</th> </tr> </thead> <tbody> <tr> <td>Low</td> <td>3.3V</td> <td>Over 4V</td> <td>3.6V</td> <td>3.8V</td> <td>4.0V</td> </tr> <tr> <td>High</td> <td>5V</td> <td>Over 6V</td> <td>5.4V</td> <td>5.7V</td> <td>6.0V</td> </tr> </tbody> </table> | VCP  | IN   |      | Clamping Threshold |  |  | Min | Typ | Max | Low | 3.3V | Over 4V | 3.6V | 3.8V | 4.0V | High | 5V | Over 6V | 5.4V | 5.7V | 6.0V |
| VCP      | IN                     |   |      |      |      | Clamping Threshold |  |  |     |     |     |     |      |         |      |      |      |      |    |         |      |      |      |
|          |                        |   | Min  | Typ  | Max  |                    |  |  |     |     |     |     |      |         |      |      |      |      |    |         |      |      |      |
| Low      | 3.3V                   | Over 4V   | 3.6V | 3.8V | 4.0V |                    |  |  |     |     |     |     |      |         |      |      |      |      |    |         |      |      |      |
| High     | 5V                     | Over 6V   | 5.4V | 5.7V | 6.0V |                    |  |  |     |     |     |     |      |         |      |      |      |      |    |         |      |      |      |
| NC       | 5                      | No connection.  |      |      |      |                    |  |  |     |     |     |     |      |         |      |      |      |      |    |         |      |      |      |
| SST      | 6                      | Soft-start time program pin. Connect a capacitor to ground to program the soft-start time.  |      |      |      |                    |  |  |     |     |     |     |      |         |      |      |      |      |    |         |      |      |      |
| EN       | 7                      | Enable control input. Pull it high to enable the IC.  |      |      |      |                    |  |  |     |     |     |     |      |         |      |      |      |      |    |         |      |      |      |
| OUT      | 8, 9, 10               | Power output pin.   |      |      |      |                    |  |  |     |     |     |     |      |         |      |      |      |      |    |         |      |      |      |
| GND      | 11<br>(exposed paddle) | Ground pin.   |      |      |      |                    |  |  |     |     |     |     |      |         |      |      |      |      |    |         |      |      |      |

## Block Diagram





**Absolute Maximum Ratings** (Note 1)

|  |                |
|--|----------------|
| IN, OUT, EN, VCP   | -0.3V to 18V   |
| SST  | -0.3V to 3.6V  |
| Power Dissipation, P <sub>D</sub> @ T <sub>A</sub> = 25°C DFN3×3-10, | 2.6W           |
| Package Thermal Resistance (Note 2)                                  |                |
| θ <sub>JA</sub>  | 38°C/W         |
| θ <sub>JC</sub>  | 8°C/W          |
| Junction Temperature Range   | -40°C to 125°C |
| Lead Temperature (Soldering, 10 sec.)                                | 260°C          |
| Storage Temperature Range  | -65°C to 150°C |

**Recommended Operating Conditions** (Note 3)

|                            |                |
|----------------------------|----------------|
| IN                         | 2.5V to 6.5V   |
| OUT, EN, VCP               | 0V to 6.5V     |
| SST                        | 0V to 3.3V     |
| Junction Temperature Range | -40°C to 125°C |
| Ambient Temperature Range  | -40°C to 85°C  |



### Electrical Characteristics

( $V_{IN} = 5V$ ,  $C_{SST} = 100nF$ ,  $C_{IN} = 10\mu F$ ,  $C_{OUT} = 10\mu F$ ,  $T_A = 25^\circ C$ , unless otherwise specified)

| Parameter                              | Symbol         | Test Conditions                                | Min     | Typ        | Max   | Unit       |   |
|--|----------------|--|---------|------------|-------|------------|---|
| Input Voltage Range                    | $V_{IN}$       |  | 2.5     |            | 6.5   | V          |   |
| Input UVLO Threshold                   | $V_{UVLO}$     | VCP=Low  | Falling | 2.05       |       | 2.35       | V |
|  |                |  | Rising  | 2.2        |       | 2.4        |   |
|  |                | VCP=High                                       | Falling | 3.25       |       | 3.75       | V |
|  |                |  | Rising  | 3.4        |       | 3.8        |   |
| Bias Current                           | $I_{BIAS}$     |  |         | 50         | 65    | $\mu A$    |   |
| Shutdown Current                       | $I_{SHDN}$     | EN=0   |         | 10         |       | $\mu A$    |   |
| Protection FET $R_{ON}$                | $R_{DS(ON)}$   |  |         | 40         | 60    | m $\Omega$ |   |
| Current Limit Threshold                | $I_{LIM}$      | VCP=Low  | 0.63    | 1.4        | 2.17  | A          |   |
|  |                | VCP=High                                       | 1.925   | 2.75       | 3.575 | A          |   |
| Fast Current Limit Response (Note 5)   | $t_{FST\_LIM}$ | $I_{OUT} = 10A/\mu s$                          |         | 2.5        |       | $\mu s$    |   |
| Clamping Output Voltage                | $V_{CLP}$      | VCP=Low  | 3.6     | 3.8        | 4.0   | V          |   |
|  |                | VCP=High                                       | 5.4     | 5.7        | 6.0   | V          |   |
| Output Clamping Response Time (Note 5) | $t_{CLP}$      | VCP=Low,<br>$V_{IN}$ slew rate 0.15V/ $\mu s$  |         | 100        |       | $\mu s$    |   |
|  |                | VCP=High,<br>$V_{IN}$ slew rate 0.15V/ $\mu s$ |         | 100        |       | $\mu s$    |   |
| Soft-start Time                        | $t_{SST}$      | $C_{SST} = 100nF$ (Note 4)                     |         | 23         |       | ms         |   |
| Soft-start Time Accuracy               |                |  |         | $\pm 30\%$ |       | $t_{SST}$  |   |
| EN Turn-on Threshold                   | $V_{EN\_ON}$   |  | 2       |            |       | V          |   |
| EN Turn-off Threshold                  | $V_{EN\_OFF}$  |  |         |            | 0.4   | V          |   |
| Capacitance Load Capability (Note 5)   | $C_{OUT}$      | $V_{IN} = 5V$ , VCP=High, null load            |         |            | 1000  | $\mu F$    |   |
| Thermal Shutdown Temperature           | $T_{SD}$       |  |         | 140        |       | $^\circ C$ |   |
| Thermal Shutdown Hysteresis            | $T_{HYS}$      |  |         | 20         |       | $^\circ C$ |   |

**Note 1:** Stresses beyond the “Absolute Maximum Ratings” may cause permanent damage to the device. These are stress ratings only. Functional operation of the device at these or any other conditions beyond those indicated in the operational sections of the specification is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability

**Note 2:**  $\theta_{JA}$  is measured in the natural convection at  $T_A = 25^\circ C$  on a low effective single layer thermal conductivity test board of JEDEC 51-3 thermal measurement standard. Paddle of DFN3x3-10 packages is the case position for  $\theta_{JC}$  measurement.

**Note 3:** The device is not guaranteed to function outside its operating conditions.

**Note 4:** Recommended Soft-start Time Program Table

|                     |      |     |      |     |
|---------------------|------|-----|------|-----|
| SST Capacitance(nF) | None | 10  | 47   | 100 |
| Rise time (ms)      | 0.6  | 2.3 | 10.8 | 23  |



Recommended formula for  $C_{SST}$  & soft-start time calculation

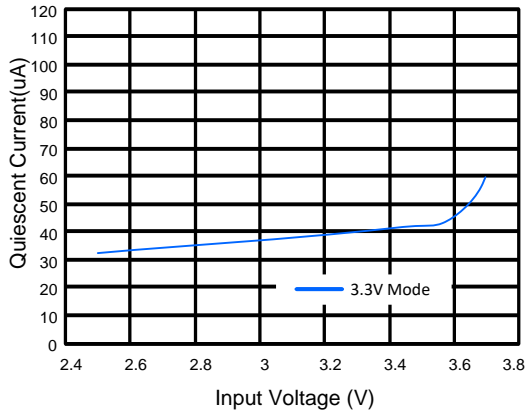
$$t_{SS} = \begin{cases} t_{SS\_DLT}, \text{ no external } C_{SST} \\ \frac{0.85 \times C_{SST}}{I_{INT}}, t_{SS} > t_{SS\_DLT} \end{cases}$$

Where,  $t_{SS\_DLT}$  is the internally fixed default soft-start time, about 0.6ms, which means there's no any external  $C_{SST}$ ;  $I_{INT}$  is the internal current source, about 3.7 $\mu$ A. The soft-start time tolerance for all condition is  $\pm 50\%$ .

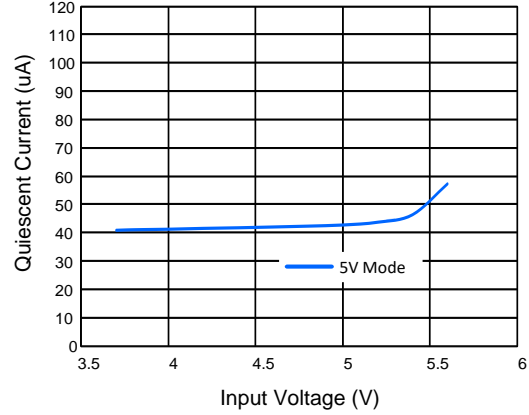
**Note 5:** Guaranteed by design.

## Typical Performance Characteristics

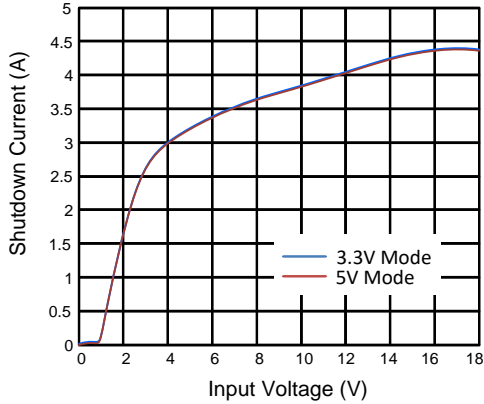
Quiescent Current vs. Input Voltage  
(EN=3V C<sub>IN</sub>=C<sub>OUT</sub>=10uF)



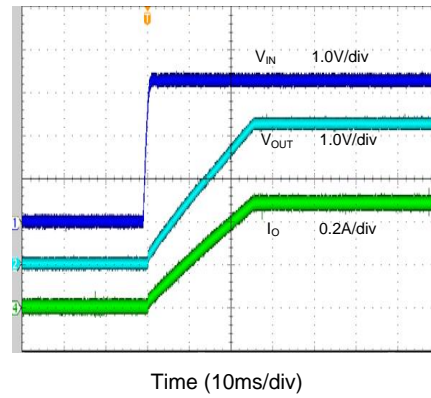
Quiescent Current vs. Input Voltage  
(EN=3V C<sub>IN</sub>=C<sub>OUT</sub>=10uF)



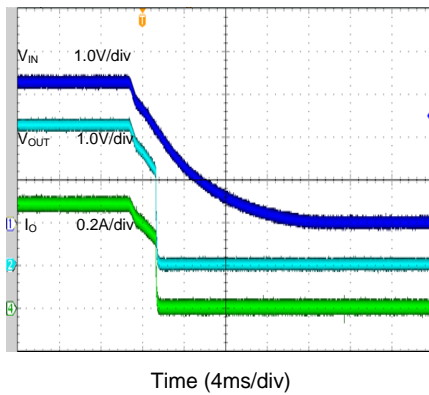
Shutdown Current vs. Input Voltage  
(EN=0V C<sub>IN</sub>=C<sub>OUT</sub>=10uF)



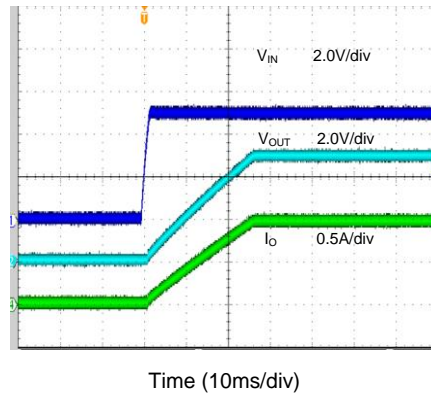
Start Up from VIN  
(3.3V Mode (VCP Low), V<sub>IN</sub>=3.3V, EN=3V R<sub>LOAD</sub>=6.6Ω)



Shut Down from VIN  
(3.3V Mode (VCP Low), V<sub>IN</sub>=3.3V, EN=3V R<sub>LOAD</sub>=6.6Ω)

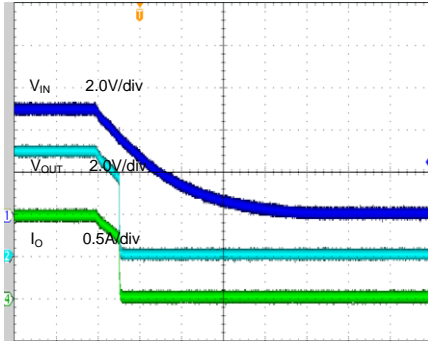


Start Up from VIN  
(5V Mode (VCP High), V<sub>IN</sub>=5V, EN=3V R<sub>LOAD</sub>=5Ω)



### Shut Down from VIN

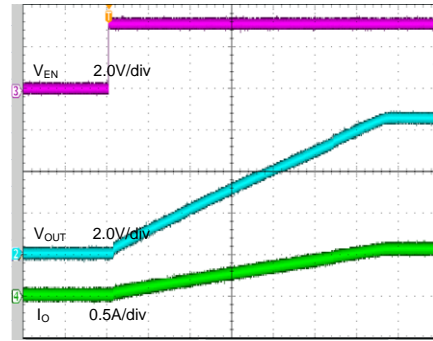
(5V Mode (VCP High),  $V_{IN}=5V$ ,  $EN=3V$   $R_{LOAD}=5\Omega$ )



Time (4ms/div)

### Start Up from EN

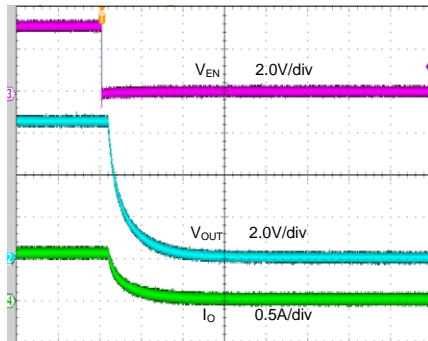
(3.3V Mode (VCP Low),  $V_{IN}=3.3V$ ,  $EN=3V$   $R_{LOAD}=6.6\Omega$ )



Time (4ms/div)

### Shutdown from EN

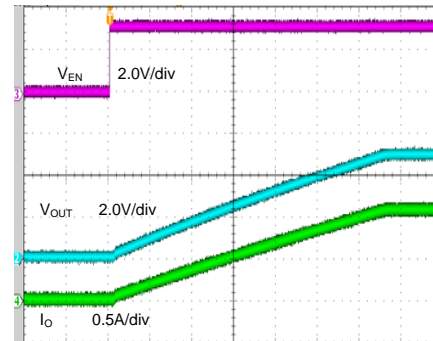
(3.3V Mode (VCP Low),  $V_{IN}=3.3V$ ,  $EN=3V$   $R_{LOAD}=6.6\Omega$ )



Time (100us/div)

### Start Up from EN

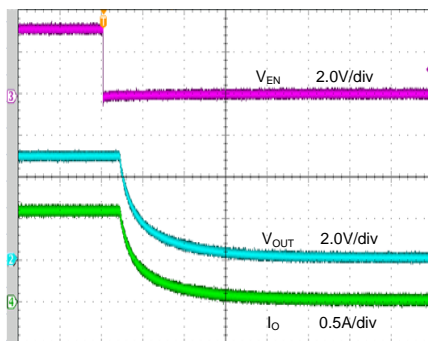
(5V Mode (VCP High),  $V_{IN}=5V$ ,  $EN=3V$   $R_{LOAD}=5\Omega$ )



Time (4ms/div)

### Shutdown from EN

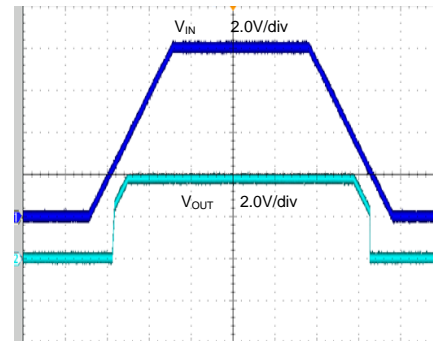
(5V Mode (VCP High),  $V_{IN}=5V$ ,  $EN=3V$   $R_{LOAD}=5\Omega$ )



Time (40us/div)

### Clamping Output Voltage Test

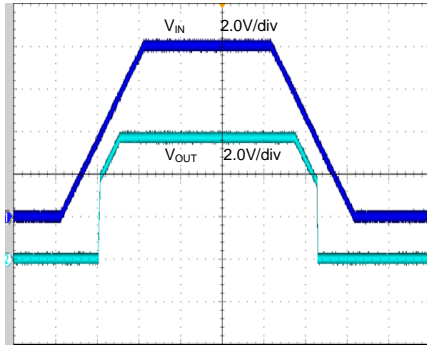
3.3V Mode (VCP Low),  $V_{IN}=0-8-0V$ ,  $EN=3V$   $R_{LOAD}=OPEN$



Time (400ms/div)

### Clamping Output Voltage Test

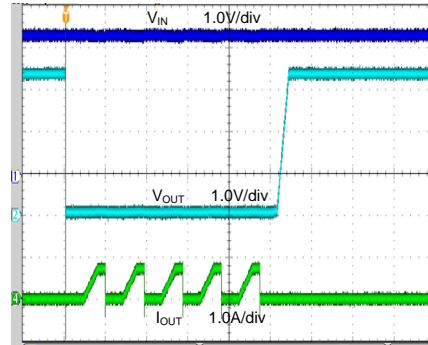
5V Mode (VCP High),  $V_{IN}=0-8-0V$ ,  $EN=3V$   $R_{LOAD}=OPEN$



Time (400ms/div)

### Short Test

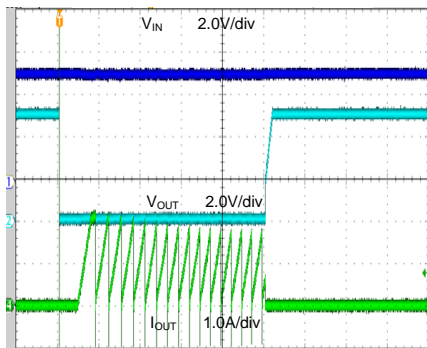
3.3V Mode (VCP Low),  $V_{IN}=3.3V$ ,  $EN=3V$   
open to short, short to open



Time (100ms/div)

### Short Test

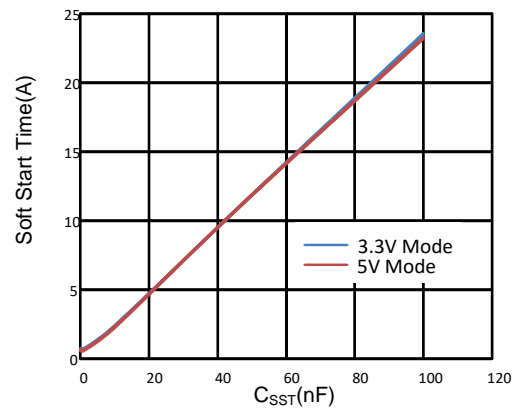
5V Mode (VCP High),  $V_{IN}=5V$ ,  $EN=3V$   
open to short, short to open



Time (100ms/div)

### Program Soft-start Time

( $EN=3V$   $R_{LOAD}=Open$ )



## Applications Information

SQ24815B is a current limit switch with input voltage range selection and output voltage clamping. Extremely low  $R_{DS(ON)}$  of the integrated protection N-channel FET helps to reduce the power loss during the normal operation. Programmable soft-start time controls the slew rate of the output voltage during start-up. Independent enable control allows the complicated system sequencing control. It integrates the over-temperature protection shutdown and the auto-recovery with hysteresis. This IC along with small DFN3×3-10 footprint provides small PCB area application.

### Input Pin

In order to prevent the input voltage drooping during hot-plug events, a 0.1μF ceramic capacitors from VIN to GND is strongly recommended. However, higher capacitor values could reduce the voltage droop on the input further. Furthermore, an output short will cause ringing on the input without the input capacitor. It could destroy the internal circuitry when the input transient exceeds the absolute maximum supply voltage even for a short duration.

### Soft start Time Program

Recommended Current Soft-start Time Program Table

| SST Cap (nF) | None | 10  | 47   | 100 |
|--------------|------|-----|------|-----|
| Rise (ms)    | 0.6  | 2.3 | 10.8 | 23  |

Recommended Formula for CSS & Soft-start slew rate Calculation:

$$t_{SS} = \begin{cases} t_{SS\_DLT}, \text{no external } C_{SST} \\ \frac{0.85 \times C_{SST}}{I_{INT}}, t_{SS} > t_{SS\_DLT} \end{cases}$$

Where,  $t_{SS\_DLT}$  is the internally fixed default soft-start time, about 0.6ms, which means there's no any external  $C_{SST}$ ;  $I_{INT}$  is the internal current source, about 3.7μA.

### Output Pin

A 10μF output ceramic capacitor is recommended to be placed close to the IC and output connector to reduce voltage drop during load transient. Higher values of output capacitor can be used for further reducing the voltage drop during high current application.

### Enable Function

The SQ24815B has the enable pin EN that can be used to enable or disable the device. Pull down the EN pin to disable the device and the Power FET is turned off. Pull up the EN pin to enable the device and turn on the Power FET if there's no any protection occurring.

### Output Clamp Voltage Pin

The SQ24815B Output clamp voltage selection based on the input voltage. Pull VCP pin to high by connecting a resistor to IN, or pull VCP pin to low by connecting a resistor to ground.

| VCP  | IN   |         | Clamping Threshold |      |      |
|------|------|---------|--------------------|------|------|
|      |      |         | Min                | Typ  | Max  |
| Low  | 3.3V | Over 4V | 3.6V               | 3.8V | 4.0V |
| High | 5V   | Over 6V | 5.4V               | 5.7V | 6.0V |

### PCB Layout Guide

For best performance of the SQ24815B, the following guidelines must be strictly followed:

1. Keep all power traces as short and wide as possible and use at least 2 ounce copper for all power traces.
2. Place a ground plane under all circuitry to lower both resistance and inductance and improve DC and transient performance.
3. Locate the output capacitors as close to the connectors as possible to lower the impedance (mainly inductance) between the port and the capacitor and improve transient performance.
4. Input and output capacitors should be placed closed to the IC and connected to ground plane to reduce noise coupling.

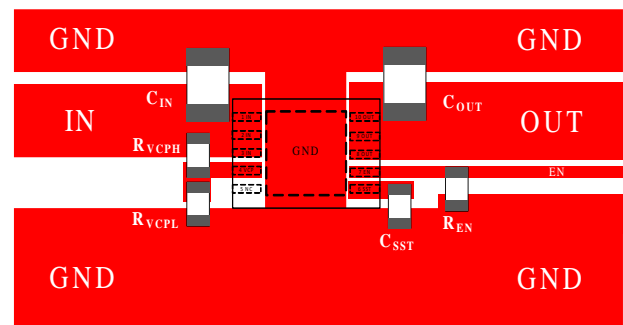
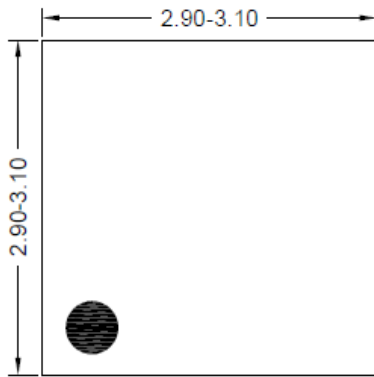
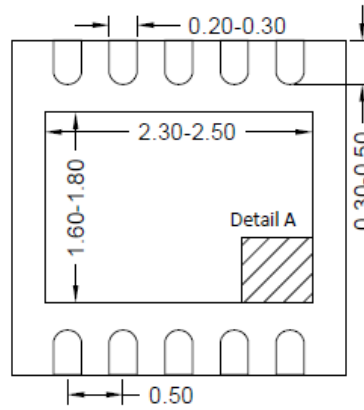


Figure 2. PCB Layout Suggestion

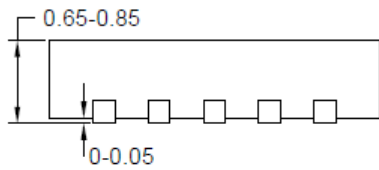
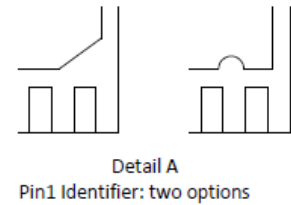
## DFN3×3-10 Package Outline



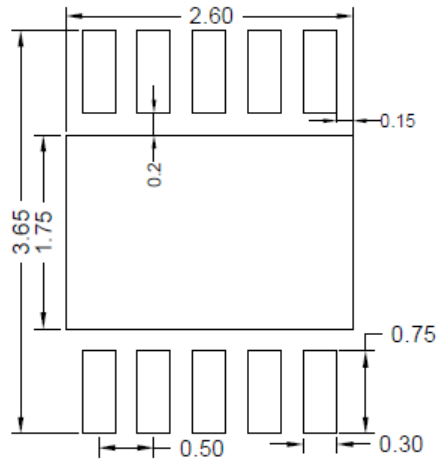
**Top View**



**Bottom View**



**Side View**



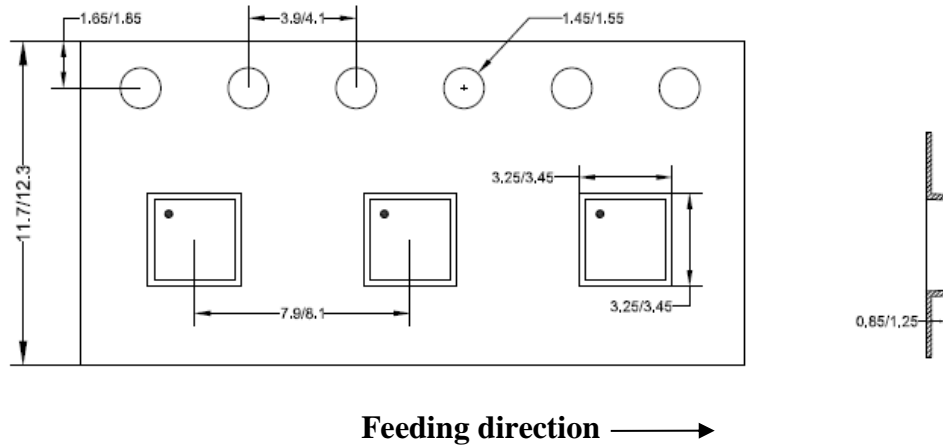
**PCB Layout (recommended)**

**Notes: All dimension in millimeter and exclude mold flash & metal burr.**

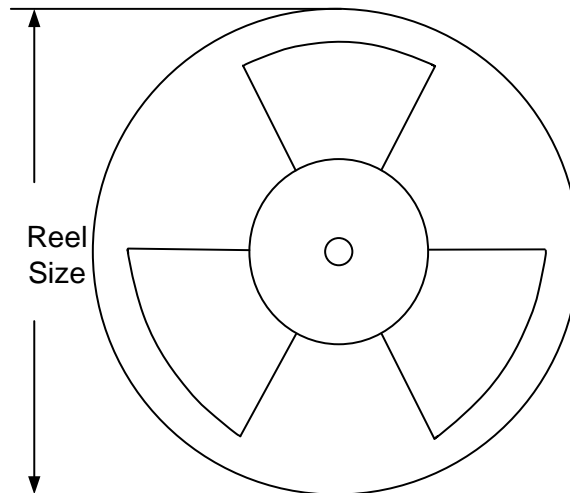
## Taping & Reel Specification

### 1. Taping orientation

DFN3×3-10



### 2. Carrier Tape & Reel specification for packages



| Package types | Tape width (mm) | Pocket pitch(mm) | Reel size (Inch) | Trailer length(mm) | Leader length (mm) | Qty per reel |
|---------------|-----------------|------------------|------------------|--------------------|--------------------|--------------|
| DFN3×3        | 12              | 8                | 13"              | 400                | 400                | 5000         |

### 3. Others: NA



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