

## 3A Synchronous Buck Li-ion Charger

### FEATURES

- Input voltage range 4V~22V
- Dynamic input current allocation for maximum charging rate
- 3A Maximum Charge Current
- No External MOSFETs and Blocking Diode Required
- Efficiency up to 93%
- Constant-Current/Constant-Voltage Operation with Thermal Regulation to Maximize Charge Rate without Risk of Overheating
- Optional Battery Temperature Monitoring Before and During Charge Automatic Sleep Mode for Low-Power
- Over Current Protection
- Consumption Available in ESOP8 and DFN10
- RoHS Compliant and 100% Lead (Pb)-Free

### APPLICATIONS

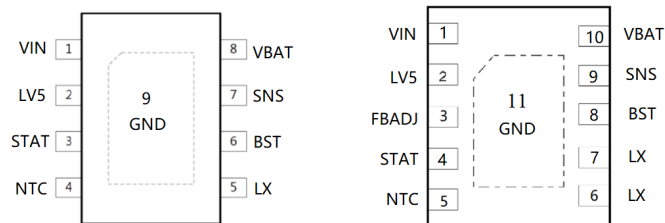
- Portable Media Players
- Cellular and Smart mobile phone
- PDA/DSC

- Handheld Battery-Powered Devices
- Handheld Computers
- Charging Docks and Cradles

### DESCRIPTION

The BC912 is a 3A Li-Ion battery charger. It utilizes a 500 KHz synchronous buck converter topology to reduce power dissipation during charging. Low power dissipation, an internal MOSFET allow a physically small charger that can be embedded in a wide range of handheld applications. The BC912 includes complete charge termination circuitry, automatic recharge and a  $\pm 1\%$  8.4V float voltage. Battery charge current, charge timeout and end-of-charge indication parameters are set with external components. Additional features include shorted cell detection; temperature qualified charging and overvoltage protection. The BC912 is available in a ESOP8 and DFN10 package

### PACKAGE



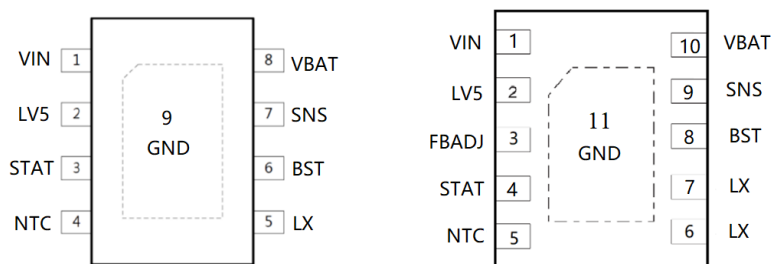
ESOP8 AND DFN10

### ORDING INFORMATION

| Part Number | Package Type | Package Qty | Op Temp(°C) |
|-------------|--------------|-------------|-------------|
| BC912       | ESOP8        | 4000        | -40~85      |
| BC912       | DFN10        | 5000        | -40~85      |

## 3A Synchronous Buck Li-ion Charger

### PINOUT



### PIN FUNCTIONS

| PIN NAME | PIN NUMBER |       | DESCRIPTION                                                                                                                                                                                                          |
|----------|------------|-------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|          | ESOP8      | DFN10 |                                                                                                                                                                                                                      |
| LX       | 5          | 6,7   | Switch pin. Connect to external inductor.                                                                                                                                                                            |
| BST      | 6          | 8     | Internal charge pump boost pin.                                                                                                                                                                                      |
| STAT     | 3          | 4     | Open-Drain Charge Status Output. When the battery is charging, this pin is pulled low by an internal N-channel MOSFET. When the BC912 detects an under voltage lockout condition, STAT is forced high impedance.     |
| NTC      | 4          | 5     | NTC (Negative Temperature Coefficient) Thermistor Input. This pin senses the Temperature of the battery pack and stops the charger when the temperature is out of range. Connect to GND for disabling this function. |
| VBAT     | 8          | 10    | Battery pin.                                                                                                                                                                                                         |
| SNS      | 7          | 9     | Detecting pin of charge current.                                                                                                                                                                                     |
| LV5      | 2          | 2     | 5V LDO output PIN.                                                                                                                                                                                                   |
| VIN      | 1          | 1     | Positive Supply Voltage Input. Decouple with a 10 $\mu$ F or larger surface mounted Ceramic capacitor.                                                                                                               |
| GND      | 9          | 11    | Ground connect with ePAD..                                                                                                                                                                                           |
| FBADJ    |            | 3     | CV adjust PIN.<br>Connect resistor to GND increase CV voltage.<br>Connect resistor to VBAT decrease CV voltage.                                                                                                      |

(1) G = Ground, I = Input, O = Output, P = Power

## 3A Synchronous Buck Li-ion Charger

### ABSOLUTE MAXIMUM RATINGS <sup>(1)</sup>

Over recommended operating free-air temperature range (unless otherwise noted)

| PARAMETER                               |                        | MIN  | MAX | UNIT |
|-----------------------------------------|------------------------|------|-----|------|
| ALL OTHER PINS to GND                   | VIN, BAT, SNS          | -0.3 | 25  | V    |
| BST to LX                               | BST, LX                | -0.3 | 6.5 |      |
| LX, BST to GND                          | LX, BST                | -0.3 | 30  | V    |
| ESD rating, Human Body Model (HBM)      | VIN                    |      | 3   | kV   |
|                                         | BAT, SNS, LX, GND, BST |      | 3.5 |      |
| ESD rating, Charging Device Model (CDM) |                        |      | 200 | V    |
| Operating Junction Temperature          | T <sub>J</sub>         | -40  | 125 | °C   |
| Storage Temperature Range               | T <sub>stg</sub>       | -65  | 150 |      |

(1) Stresses beyond those 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. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.

### THERMAL CHARACTERISTICS

over operating free-air temperature range (unless otherwise noted)

| THERMAL METRIC( $\theta_{JA}$ ) |                                          |    | UNIT |
|---------------------------------|------------------------------------------|----|------|
| ESOP8                           | Package thermal impedance <sup>(1)</sup> | 45 | °C/W |
| DFN10                           | Package thermal impedance <sup>(1)</sup> | 65 | °C/W |

(1) The package thermal impedance is calculated in accordance with JESD 51-7.

## 3A Synchronous Buck Li-ion Charger

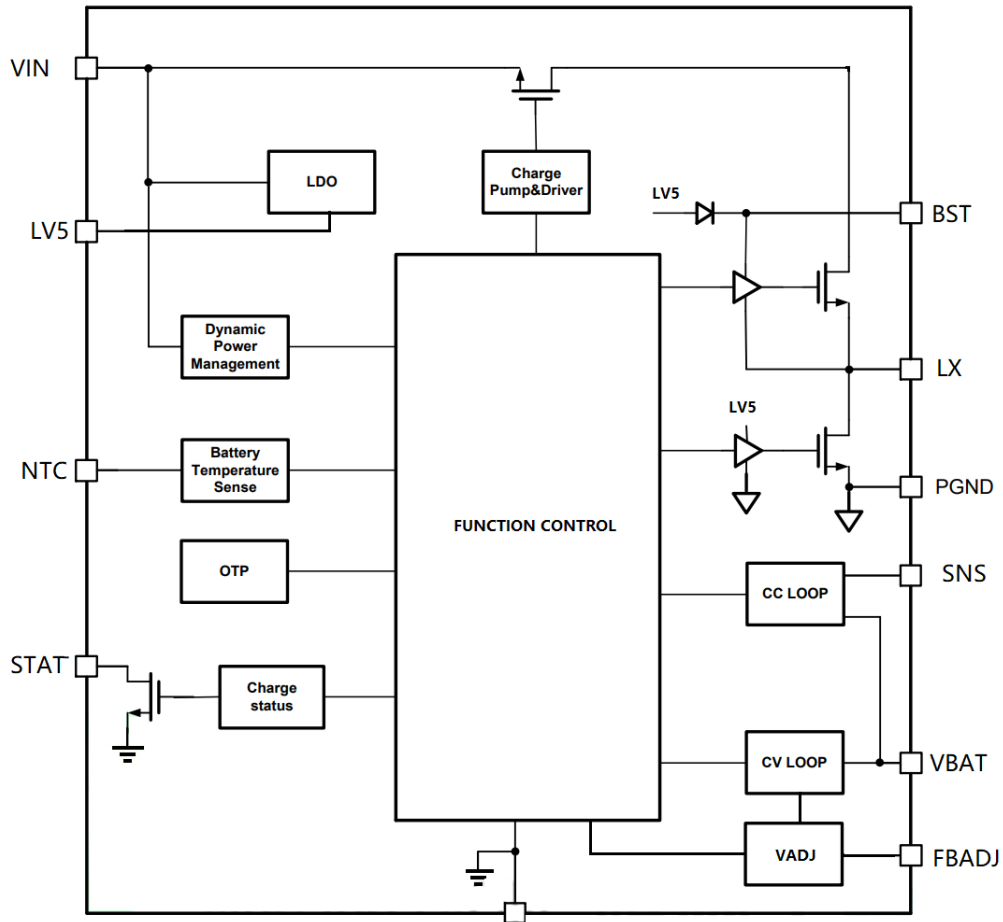
### ELECTRICAL CHARACTERISTICS

(TA=25°C, VIN = 10V, unless otherwise noted)

| Symbol               | Parameter                                            | Condition                                                      | Min | Typ  | Max | Units             |
|----------------------|------------------------------------------------------|----------------------------------------------------------------|-----|------|-----|-------------------|
| V <sub>IN</sub>      | Adapter/USB Voltage Range                            |                                                                | 4   |      | 22  | V                 |
| I <sub>CC</sub>      | Input Supply Current                                 | Standby Mode<br>(Charge Terminated)                            |     | 1    |     | mA                |
| V <sub>FLOAT</sub>   | Regulated Output (Float) Voltage                     | FBADJ floating                                                 |     | 8.4  |     | V                 |
| V <sub>RS</sub>      | Program Charging Current<br>(For RS to BAT)          | V <sub>TRIKL</sub> < V <sub>BAT</sub> < V <sub>FLOAT</sub>     |     | 50   |     | mV                |
| I <sub>BAT</sub>     | BAT Pin Current                                      | R <sub>SNS</sub> =45mΩ, Current Mode                           |     | 1000 |     | mA                |
|                      |                                                      | R <sub>SNS</sub> =22.5mΩ, Current Mode                         |     | 2000 |     | mA                |
|                      |                                                      | Standby Mode                                                   |     | 4    |     | μA                |
| I <sub>TRIKL</sub>   | Trickle Charge Current                               | V <sub>BAT</sub> < V <sub>TRIKL</sub> , R <sub>SNS</sub> =45mΩ |     | 50   |     | mA                |
|                      |                                                      | V <sub>BAT</sub> < 2.3V                                        |     | 30   |     | mA                |
| V <sub>TRIKL</sub>   | Trickle Charge Threshold Voltage                     | R <sub>SNS</sub> =50mΩ, V <sub>BAT</sub> Rising                |     | 5.6  |     | V                 |
| V <sub>TRHYS</sub>   | Trickle Charge Hysteresis Voltage                    | R <sub>SNS</sub> =50mΩ                                         |     | 100  |     | mV                |
| V <sub>STAT</sub>    | STAT Pin Output Low Voltage                          | I <sub>STAT</sub> =5mA                                         |     |      | 0.5 | V                 |
| I <sub>STAT</sub>    | STAT Pin Weak Pull-Down Current                      | V <sub>STAT</sub> =5V                                          |     |      | 5   | uA                |
| ΔV <sub>RECHRG</sub> | Recharge Battery Threshold Voltage                   | V <sub>FLOAT</sub> -V <sub>RECHRG</sub>                        |     | 150  |     | mV                |
| T <sub>LIM</sub>     | Junction Temperature in Constant<br>Temperature Mode |                                                                |     | 150  |     | °C                |
| I <sub>TERM</sub>    | C/10 Terminal Current                                | R <sub>SNS</sub> =50mΩ                                         |     | 100  |     | mA                |
| VIN UVLO             | Under Voltage Lockout of VIN                         | V <sub>IN</sub> rising                                         |     | 4    |     | V                 |
|                      |                                                      | V <sub>IN</sub> falling                                        |     | 3.8  |     | V                 |
| VIN OVP              | VIN over voltage protect                             | V <sub>IN</sub> rising                                         |     | 25   |     | V                 |
|                      |                                                      | hysteresis                                                     |     | 1    |     |                   |
| V <sub>NTC-H</sub>   | High Temperature Protection Threshold<br>Voltage     | Battery Temperature rising                                     |     | 30   |     | %V <sub>LV5</sub> |
| V <sub>NTC-L</sub>   | Low Temperature Protection<br>Threshold Voltage      | Battery Temperature falling                                    |     | 70   |     | %V <sub>LV5</sub> |
| F <sub>OSC</sub>     | Frequency                                            |                                                                |     | 500  |     | KHz               |

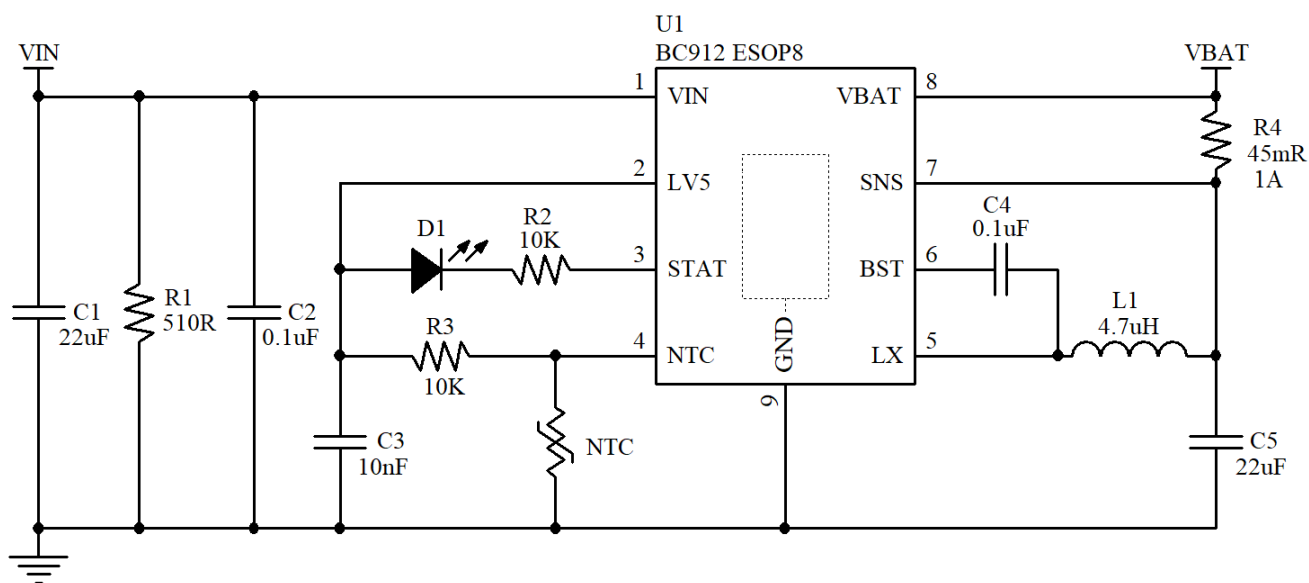
## 3A Synchronous Buck Li-ion Charger

### FUNCTION BLOCK DIAGRAM

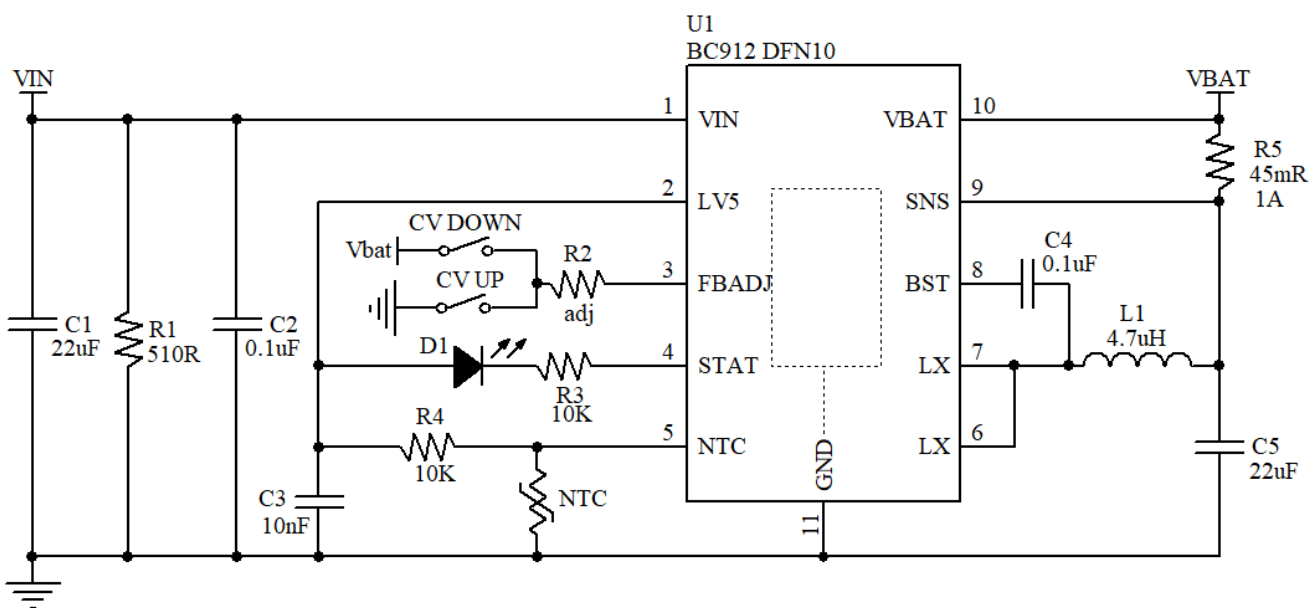


## 3A Synchronous Buck Li-ion Charger

### TYPICAL APPLICATION



ESOP8 Application Circuit

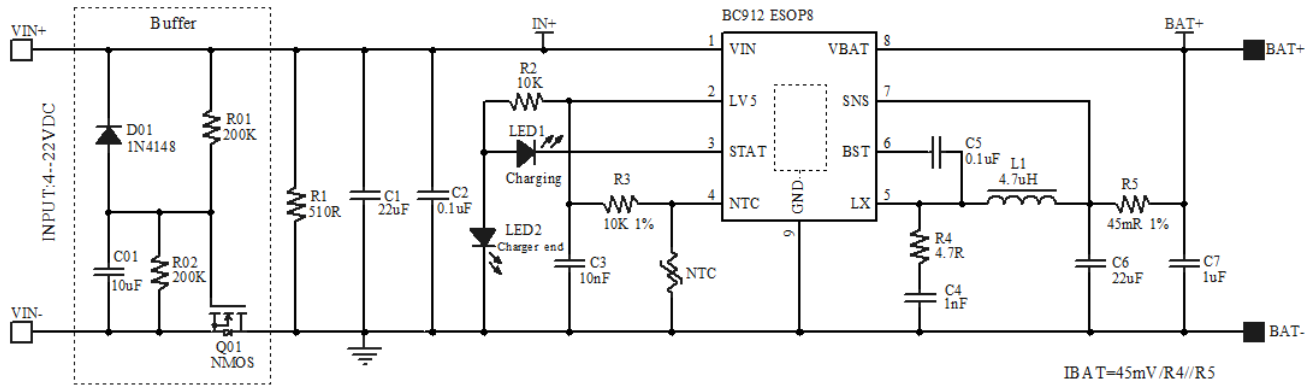


DFN10 application Circuit

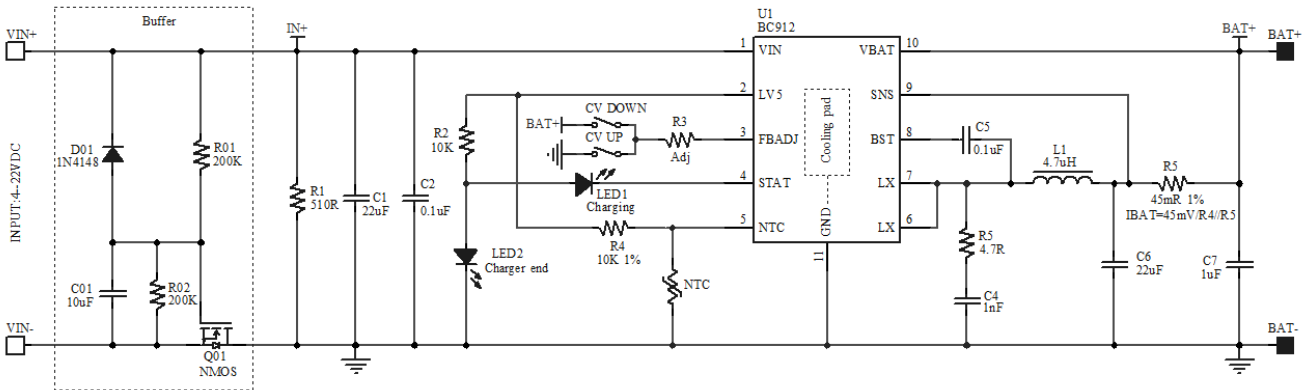
Note: To decrease the CV value, connect resistor  $R2$  to  $V_{BAT}$ . To increase the CV value, connect resistor  $R2$  to GND.

## 3A Synchronous Buck Li-ion Charger

### Detailed Schematic



ESOP8 Detailed Schematic



DFN10 Detailed Schematic

Note: Buffer circuit shall be added when the input voltage reaches 12V.

To decrease the CV value, connect resistor R3 to VBAT. To increase the CV value, connect resistor R3 to GND.

## 3A Synchronous Buck Li-ion Charger

### Application Information

BC912 is a wide range VIN, 3A 2 cell asynchronous boost Li-Ion battery charger integrates 500KHz switching frequency and full protection functions. The charge current can be programmed up to Max 2.5A by using the external resistor for different portable applications and indicates the charger current information simultaneous. In constant current mode, the charge current is set by the external sense resistor RSNS and an internal 50mV reference;

$$I_{BAT} = V_{RS} / R_{SNS} = 45mV / R_{SNS}$$

For example,  $R_{SNS} = 45m\Omega$ ,  $I_{BAT} = 1A$ ;  $R_{SNS} = 22.5m\Omega$ ,  $I_{BAT} = 2A$ ;

When the battery voltage approaches the programmed float voltage, the charge current will start to decrease. When the current drops to 10% of the full-scale charge current, an internal comparator turns off charging is terminated

### Input Source Qualification

After REGN amplifier powers up, the BC912 checks the current capability of the input source. The input source has to meet the  $V_{REG} > 1V$  to enable the chip

### Battery Temperature Detection

The BC912 continuously monitors temperature by measuring the voltage between the NTC and GND pins. A negative or a positive temperature coefficient thermistor (NTC, PTC) and an external voltage divider typically develop this voltage. The BC912 compares this voltage against its internal VNTC-H and VNTC-L thresholds to determine if charging is allowed. The temperature sensing circuit is immune to any fluctuation in LV5, since both the external voltage divider and the internal thresholds (VNTC-H and VNTC-L) are referenced to LV5.

The resistor values of R1 and R2 are calculated by the following equations:

For NTC Thermistors:

$$K1 (V_{NTC-H}) = 30\%,$$

$$K2 (V_{NTC-L}) = 70\%.$$

### Automatic Recharge

Once the charge cycle is terminated, the BC912 continuously monitors the voltage on the BAT pin using a comparator with a 1.8ms filter time ( $T_{RECHARGE}$ ). A charge cycle restarts when the battery voltage falls below 8.1V (which corresponds to approximately 80% to 90% battery capacity). This ensures that the battery is kept at or near a fully charged condition and eliminates the need for periodic charge cycle initiations.

Where RTL is the low temperature resistance and RTH is the high temperature resistance of thermistor, as specified by the thermistor manufacturer. R1 or R2 can be omitted if only one temperature (low or high) setting is required. Applying a voltage between the VNTC-H and VNTC-L thresholds to pin NTC disables the temperature-sensing feature.

## 3A Synchronous Buck Li-ion Charger

### CV adjustment

Battery termination voltage default set to 8.4V. If other CV voltage wanted, the follow equations change the CV voltage.

If increase CV voltage, connect a resistor from FBADJ to GND. the increased voltage determined by:

$$\Delta V = \frac{2.1}{R_{trim}} * R_{divup}$$

If decrease CV voltage, connect a resistor from battery to FBADJ, the decreased voltage determined by

$$\Delta V = \frac{V_{CV} - 2.1}{R_{trim}} * R_{divdown}$$

R<sub>div up</sub>=156K

R<sub>div down</sub>=156K/3 for 2cell

### Shutdown

The BC912 can be shut down by pulling the NTC pin to VIN. When the NTC pin is released, the internal timer is reset and a new charge cycle starts.

### Inductor Selection

An operating frequency was chosen for the buck switcher in order to minimize the size of the inductor. However, take care to use inductors with low core loss at this frequency. To calculate the inductor ripple current:

### Charge Status Indicator (STAT)

The charge status output has two different states: strong pull-down (~5mA) and high impedance. The strong pull-down state indicates that the BC912 is in a charge cycle. Once the charge cycle has terminated, the pin state is determined by under voltage lockout conditions. High impedance indicates that the charge cycle complete.

### Layout Considerations

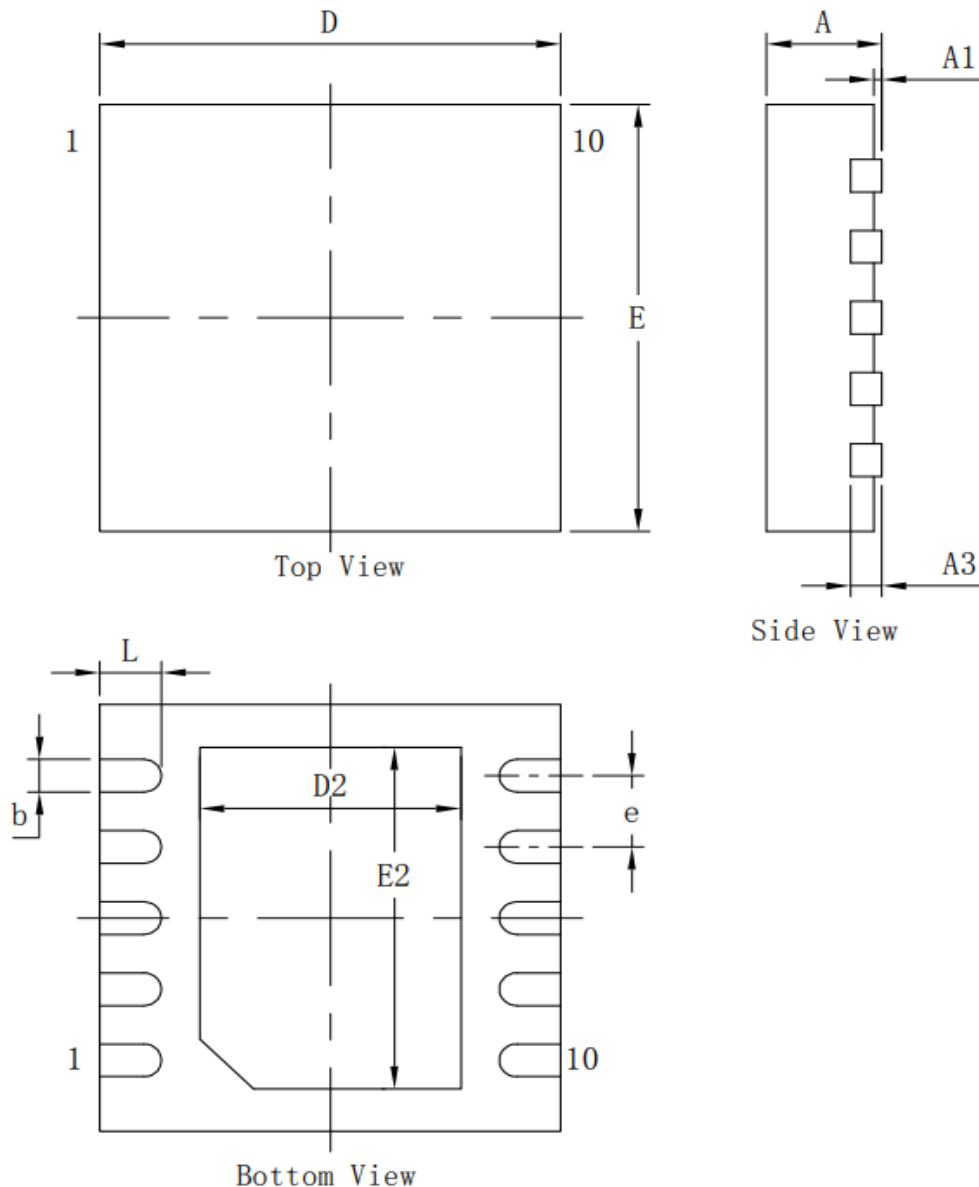
Switch rise and fall times are kept under 5ns for maximum efficiency. To minimize radiation, the SW pin and input bypass capacitor leads (between VIN and GND) should be kept as short as possible. A ground plane should be used under the switching circuitry to prevent inter plane coupling. The Exposed Pad must be connected to the ground plane for proper power dissipation. The other paths contain only DC and/or 500KHz tri-wave ripple current and are less critical. With the exception of the input and output filter capacitors (which should be connected to GND) all other components that return to ground.

# 3A Synchronous Buck Li-ion Charger

## PACKAGE INFORMATION

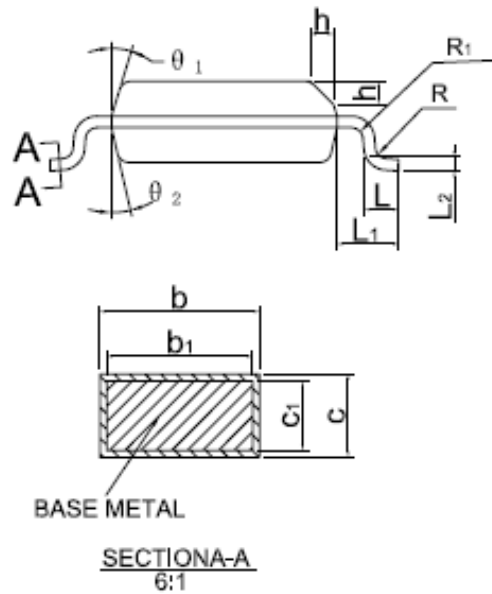
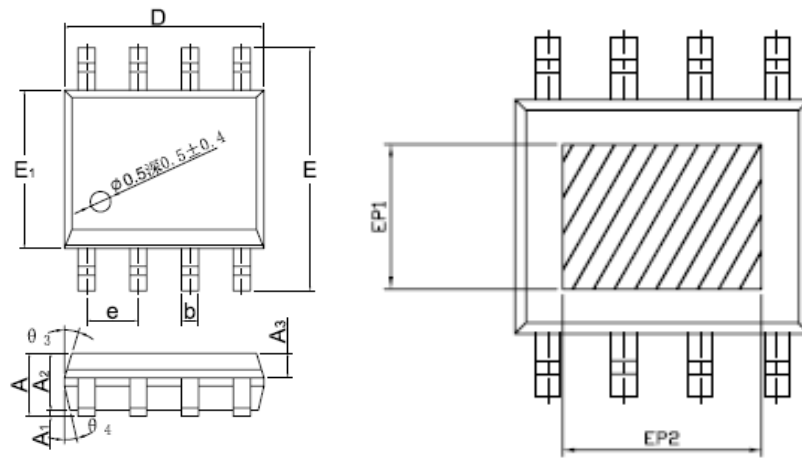
### DFN10

| Symbol \ Size | Min(mm)   | Nom(mm) | Max(mm) | Symbol \ Size | Min(mm)  | Nom(mm) | Max(mm) |
|---------------|-----------|---------|---------|---------------|----------|---------|---------|
| A             | 0.70      | 0.75    | 0.80    | E             | 2.90     | 3.00    | 3.10    |
| A1            | -         | -       | 0.05    | D2            | 1.60     | 1.70    | 1.80    |
| A3            | 0.203 REF |         |         | E2            | 2.30     | 2.40    | 2.50    |
| b             | 0.18      | 0.23    | 0.28    | e             | 0.50 TYP |         |         |
| D             | 2.90      | 3.00    | 3.10    | L             | 0.35     | 0.40    | 0.45    |



# 3A Synchronous Buck Li-ion Charger

## ESOP8



DIMENSIONS IN MILLIMETERS

| SYMBOL         | MIN  | NOM     | MAX  |
|----------------|------|---------|------|
| A              | 1,35 | 1,55    | 1,75 |
| A <sub>1</sub> | 0,00 | —       | 0,10 |
| A <sub>2</sub> | 1,25 | 1,40    | 1,65 |
| A <sub>3</sub> | 0,50 | 0,60    | 0,70 |
| b              | 0,39 | —       | 0,49 |
| b <sub>1</sub> | 0,28 | —       | 0,48 |
| c              | 0,10 | —       | 0,25 |
| c <sub>1</sub> | 0,10 | —       | 0,23 |
| D              | 4,80 | 4,90    | 5,00 |
| E              | 5,80 | 6,00    | 6,20 |
| E <sub>1</sub> | 3,80 | 3,90    | 4,00 |
| e              | —    | 1,27BSC | —    |
| L              | 0,45 | —       | 1,00 |
| L <sub>1</sub> | —    | 1,04REF | —    |
| L <sub>2</sub> | —    | 0,25BSC | —    |
| R              | 0,07 | —       | —    |
| R <sub>1</sub> | 0,07 | —       | —    |
| h              | 0,3  | 0,4     | 0,5  |
| θ <sub>1</sub> | 11°  | 17°     | 19°  |
| θ <sub>2</sub> | 11°  | 13°     | 15°  |
| θ <sub>3</sub> | 15°  | 17°     | 19°  |
| θ <sub>4</sub> | 11°  | 13°     | 15°  |
| EP1            | 2,40 | —       | —    |
| EP2            | 3,30 | —       | —    |

## 3A Synchronous Buck Li-ion Charger

### Revision history

**Table 1.Document revision history**

| Date     | Revision | Changes                                                     |
|----------|----------|-------------------------------------------------------------|
| 2026/6/5 | 1.5      | Modify the schematic and add an input discharge resistor R1 |