# BX100

## One Cell Lithium-ion/Polymer Battery Protection IC



**Datasheet**
**DS-100-02**

**Version: 1.2**
**Released Date: 2017/05/12**

## INTRODUCTION

The BX100 product is a high integration solution for lithium-ion/polymer battery protection. BX100 contains advanced power MOSFET, high-accuracy voltage detection circuits and delay circuits. BX100 is put into an ultra-small DFN 2x2-6 package and only one external component makes it an ideal solution in limited space of battery pack.

BX100 has all the protection functions required in the battery application including over-charging, over-discharging, over-current and load short circuiting protection etc. The accurate over-charging detection voltage ensures safe and full utilization charging. The low standby current drains little current from the cell while in storage.

The device is not only targeted for digital cellular phones, but also for any other Li-Ion and Li-Poly battery-powered information appliances requiring long-term battery life.

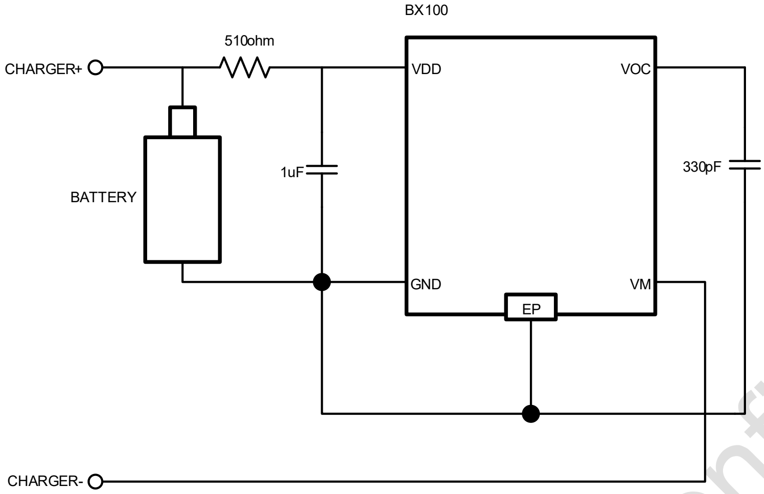
## MAIN APPLICATIONS

- One-Cell Lithium-ion Battery Pack
- Lithium-Polymer Battery Pack

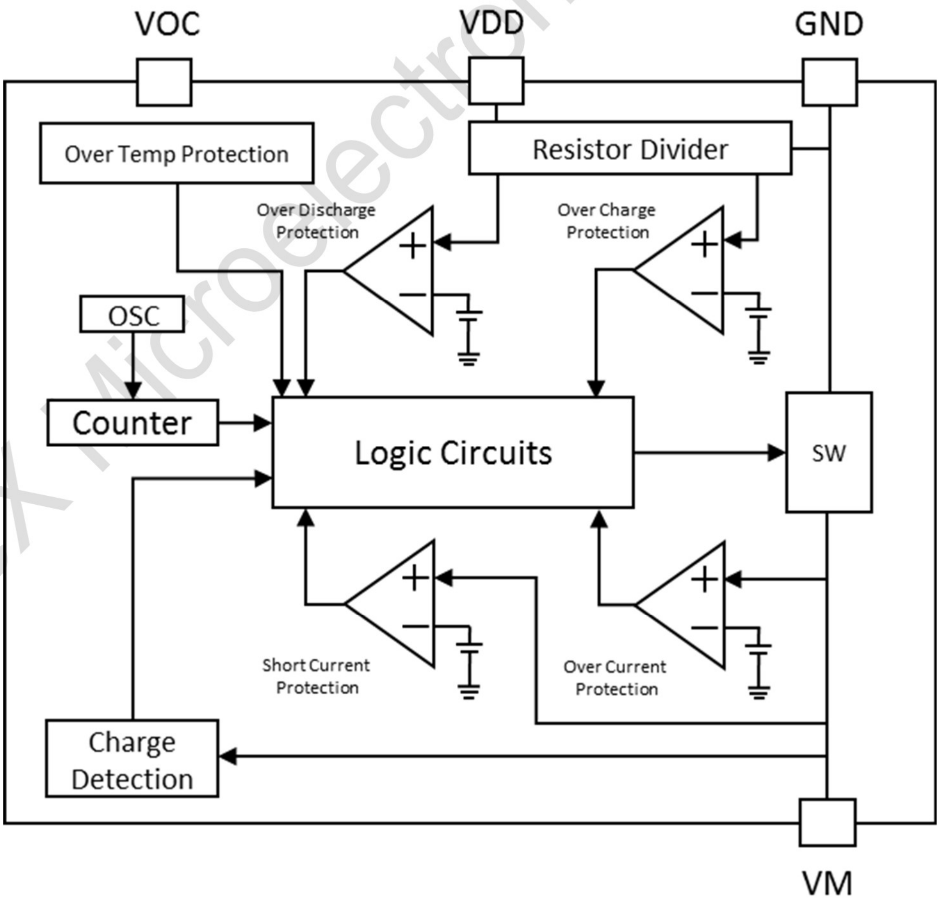
## FEATURE HIGHLIGHTS

- Protection of Charger Reverse Connection
- Protection of Battery Cell Reverse Connection
- Integrate Power MOSFET with 55mΩ $R_{SS(ON)}$ .
- Over-temperature Protection
- Overcharge Current Protection
- Two-step Overcurrent Detection
  - Over-discharge Current
  - Load Short Current Protection
- Charger Detection Function
- 0V Battery Charging Function
- Low Current Consumption @ 300nA(typ)
- High accuracy delay times
- RoHS Compliant and Lead (Pb) Free
- Ultra-small DFN 2x2-6 Package

## APPLICATION CIRCUIT




## BLOCK DIAGRAM



## PACKAGE PIN DEFINITION

### 1C XXXX

| Pin | Symbol | Description |
|---|---|---|
| 1 2 | GND | Ground, connect the negative terminal of the battery to this pin |
| 3 | VDD | Power Supply |
| 4 | VOC | Internal voltage, connected with external capacitor |
| 5 | NC | No Connect |
| 6 | VM | The negative terminal of the battery pack |
| 7 | EP | Exposed Pad, connected to Ground |

### 1D XXXX

| Pin | Symbol | Description |
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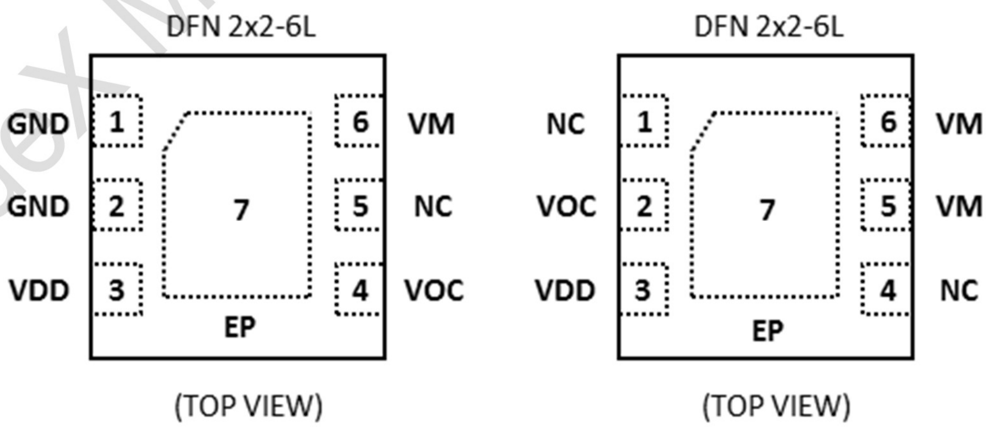



1C XXXX　　　1D XXXX

## ABSOLUTE MAXIMUM RATINGS

(Note: Do not exceed these limits to prevent damage to the device. Exposure to absolute maximum rating conditions for long periods may affect device reliability.)

| PARAMETER | VALUE | UNIT |
|---|---|---|
| VDD ,other pins. | -0.3 to 5 | V |
| VM | -5 to 5 | V |
| Operating Ambient Temperature | -40 to 85 | °C |
| Maximum Junction Temperature | 125 | °C |
| Storage Temperature | -55 to 150 | °C |
| Lead Temperature ( Soldering, 10 sec) | 300 | °C |
| Power Dissipation at T=25°C | 0.4 | W |
| Package Thermal Resistance (Junction to Ambient) $\theta_{JA}$ | 250 | °C/W |
| Package Thermal Resistance (Junction to Case) $\theta_{JC}$ | 130 | °C/W |

## ELECTRONICAL CHARACTERISTICS

Typical $T_A$ = 25 °C

| Parameter | Symbol | Test Condition | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| ***Detection Voltage*** | | | | | | |
| Overcharge Detection Voltage | $V_{CU}$ | | 4.370 | 4.420 | 4.470 | V |
| Overcharge Release Voltage | $V_{CL}$ | | 4.130 | 4.220 | 4.290 | V |
| Over-discharge Detection Voltage | $V_{DL}$ | | 2.40 | 2.50 | 2.60 | V |
| Over-discharge Release Voltage | $V_{DR}$ | | 2.75 | 2.90 | 3.05 | V |
| Charger Detection Voltage | $V_{CHA}$ | | -0.07 | -0.12 | -0.2 | V |
| ***Detection Current*** | | | | | | |
| Over-discharge Current Detection | $I_{IOV1}$ | $V_{DD}$=3.5V | 1.8 | 2.2 | 2.6 | A |
| ***Current Consumption*** | | | | | | |
| Current Consumption in Normal Operation | Iope | $V_{DD}$=3.5V, VM =0V | | 280 | | nA |
| Current Consumption in Protection | Ipro | $V_{DD}$=2.0V | | 180 | | nA |
| ***VM Internal Resistance*** | | | | | | |
| Internal Resistance between VM and $V_{DD}$ | $R_{VMD}$ | $V_{DD}$=3.5V, VM=1.0V | 150 | 320 | 600 | kΩ |
| Internal Resistance between VM and GND | $R_{VMS}$ | $V_{DD}$=2.0V, VM=1.0V | 50 | 100 | 200 | kΩ |

| | | | | | | |
|---|---|---|---|---|---|---|
| ***FET on Resistance*** | | | | | | |
| Equivalent FET on Resistance | Rss(on) | $V_{DD}$=3.5V $I_{VM}$ =1.0A | 45 | 55 | 70 | mΩ |
| ***Over Temperature Protection*** | | | | | | |
| Over Temperature Protection | $T_{OV}$ | | 100 | 120 | 140 | °C |
| Over Temperature Recovery Point | $T_{SHD}$ | | 90 | 100 | 110 | °C |
| ***Detection Delay Time*** | | | | | | |
| Overcharge Voltage Detection | $T_{CU}$ | | | 500 | | mS |
| Over-discharge Voltage Detection | $T_{DL}$ | | | 40 | | mS |
| Over-discharge Current Detection Delay Time | $T_{IOV}$ | $V_{DD}$=3.5V | | 6 | | mS |
| Load Short-Circuit Detection Delay Time | $T_{SHORT}$ | $V_{DD}$=3.5V | | 75 | | uS |

## FUNCTIONAL DESCRIPTION

BX100 monitors the voltage and current of a battery and protects it from being damaged due to overcharge voltage, overdischarge voltage, overdischarge current, and short circuit conditions by disconnecting the battery from the load or charger. These functions are required in order to operate the battery cell within specified limits.

The device requires only one external capacitor. The MOSFET is integrated and its $R_{SS}$(ON) is as low as 55 mΩ typical.

## NORMAL OPERATING MODE

If no exception condition is detected, charging and discharging can be carried out freely. This condition is called the normal operating mode.

## OVERCHARGE CONDITION [12]

When the battery voltage becomes higher than the overcharge detection voltage ($V_{CU}$) during charging under normal condition and the state continues for the overcharge detection delay time ($t_{CU}$) or longer, BX100 turns the charging control FET off to stop charging. This condition is called the overcharge condition. The overcharge condition is released in the following two cases: 1, When the battery voltage drops below the overcharge release voltage ($V_{CL}$), the BX100 turns the charging control FET on and returns to the normal condition. 2, When a load is connected and discharging starts, the BX100 turns the charging control FET on and returns to the normal condition. The release mechanism is as follows: the discharging current flows through an internal parasitic diode of the charging FET immediately after a load is connected and discharging starts, and the VM pin voltage increases about 0.7 V (forward voltage of the diode) from the GND pin voltage momentarily. The BX100 detects this voltage and releases the overcharge condition. Consequently, in the case that the battery voltage is equal to or lower than the overcharge detection voltage ($V_{CU}$), the BX100 returns to the normal condition immediately, but in the case the battery voltage is higher than the overcharge detection voltage ($V_{CU}$),the chip does not return to the normal condition until the battery voltage drops below the overcharge detection voltage ($V_{CU}$) even if the load is connected. In addition, if the VM pin voltage is equal to or lower than the overcurrent detection voltage when a load is connected and discharging starts, the chip does not return to the normal condition.

Remark If the battery is charged to a voltage higher than the overcharge detection voltage ($V_{CU}$) and the battery voltage does not drops below the overcharge detection voltage ($V_{CU}$) even when a heavy load, which causes an overcurrent, is connected, the overcurrent do not work until the battery voltage drops below the overcharge detection voltage ($V_{CU}$). Since an actual battery has, however, an internal impedance of several dozens of mΩ , and the battery voltage drops immediately after a heavy load which causes an overcurrent is connected, the overcurrent work. Detection of load short-circuiting works regardless of the battery voltage.

## OVERDISCHARGE CONDITION

When the battery voltage drops below the overdischarge detection voltage ($V_{DL}$) during discharging under normal condition and it continues for the overdischarge detection delay time ($t_{DL}$) or longer, BX100 turns the discharging control FET off and stops discharging. This condition is called overdischarge condition. After the discharging control FET is turned off, the VM pin is pulled up by the $R_{VMD}$ resistor between VM and VDD in BX100. Meanwhile when VM is bigger than 1.5 V (typ.) (the load short-circuiting detection voltage), the current of the chip is reduced to the power-down current ($I_{PDN}$). This condition is called power-down condition. The VM and VDD pins are shorted by the $R_{VMD}$ resistor in the IC under the overdischarge and power-down conditions.

The power-down condition is released when a charger is connected and the potential difference between VM and VDD becomes 1.3 V (typ.) or higher (load short-circuiting detection voltage). At this time, the FET is still off. When the battery voltage becomes the overdischarge detection voltage ($V_{DL}$) or higher (see note), the BX100 turns the FET on and changes to the normal condition from the overdischarge condition.

Remark If the VM pin voltage is no less than the charger detection voltage ($V_{CHA}$), when the battery under overdischarge condition is connected to a charger, the overdischarge condition is released (the discharging control FET is turned on) as usual, provided that the battery voltage reaches the overdischarge release voltage ($V_{DU}$) or higher.

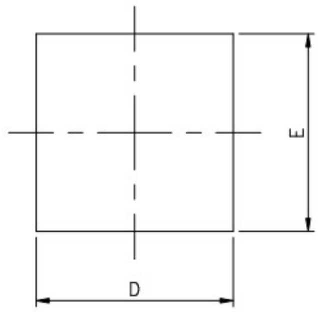
## OVERCURRENT CONDITION

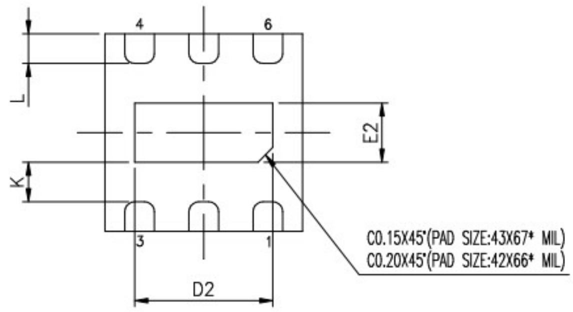
When the discharging current becomes equal to or higher than a specified value (the VM pin voltage is equal to or higher than the overcurrent detection voltage) during discharging under normal condition and the state continues for the overcurrent detection delay time or longer, the BX100 turns off the discharging control FET to stop discharging. This condition is called overcurrent condition. (The overcurrent includes overcurrent or load short-circuiting.) The VM and GND pins are shorted internally by the $R_{VMS}$ resistor under the overcurrent condition. When a load is connected, the VM pin voltage equals the VDD voltage due to the load. The overcurrent condition returns to the normal condition when the load is released and the impedance between the B+ and B- pins becomes higher than the automatic recoverable impedance. When the load is removed, the VM pin goes back to the GND potential since the VM pin is shorted the GND pin with the $R_{VMS}$ resistor. Detecting that the VM pin potential is lower than the overcurrent detection voltage ($V_{IOV1}$), the IC returns to the normal condition.

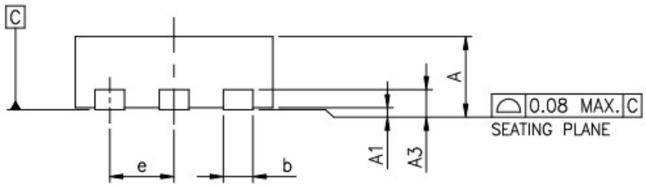
## LOAD SHORT-CIRCUITING CONDITION

If voltage of VM pin is equal or below short circuiting protection voltage ($V_{SHORT}$), the BX100 will stop discharging and battery is disconnected from load. The maximum delay time to switch current off is $t_{SHORT}$. This status is released when voltage of VM pin is higher than short protection voltage ($V_{SHORT}$), such as when disconnecting the load.

1C XXXX




NOTES :

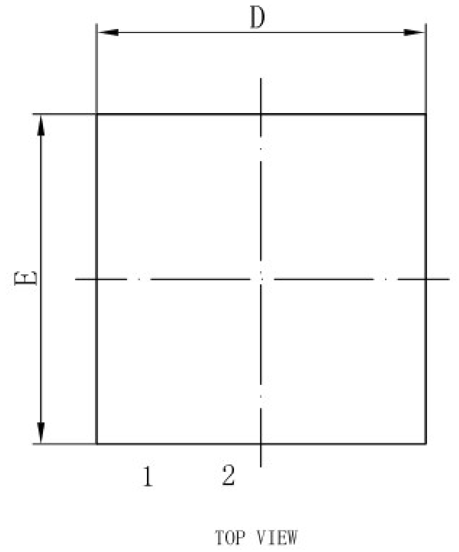
1. ALL DIMENSIONS ARE IN MILLIMETERS.
2. DIMENSION b APPLIES TO METALLIZED TERMINAL AND IS MEASURED BETWEEN 0.15mm AND 0.30mm FROM THE TERMINAL TIP. IF THE TERMINAL HAS THE OPTIONAL RADIUS ON THE OTHER END OF THE TERMINAL, THE DIMENSION b SHOULD NOT BE MEASURED IN THAT RADIUS AREA.
3. BILATERAL COPLANARITY ZONE APPLIES TO THE EXPOSED HEAT SINK SLUG AS WELL AS THE TERMINALS.

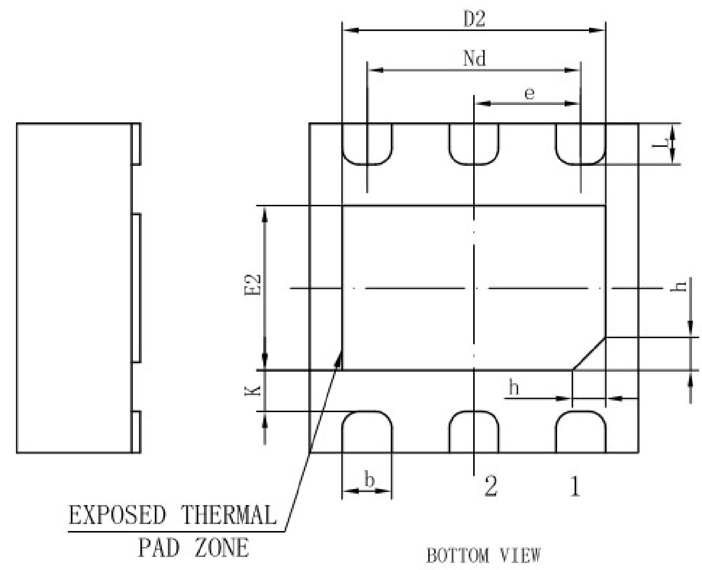
| | PACKAGE TYPE | | | | | |
|---|---|---|---|---|---|---|
| JEDEC OUTLINE | MO-229 | | | MO-229 | | |
| PKG CODE | WDFN(X206) | | | VDFN(Y206) | | |
| SYMBOLS | MIN. | NOM. | MAX. | MIN. | NOM. | MAX. |
| A | 0.70 | 0.75 | 0.80 | 0.80 | 0.85 | 0.90 |
| A1 | 0.00 | 0.02 | 0.05 | 0.00 | 0.02 | 0.05 |
| A3 | 0.20 REF. | | | 0.20 REF. | | |
| b | 0.25 | 0.30 | 0.35 | 0.25 | 0.30 | 0.35 |
| D | 2.00 BSC | | | 2.00 BSC | | |
| E | 2.00 BSC | | | 2.00 BSC | | |
| e | 0.65 BSC | | | 0.65 BSC | | |
| K | 0.20 | — | — | 0.20 | — | — |

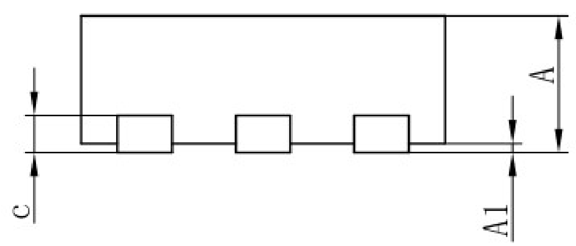
| PAD SIZE | E2 | | | D2 | | | L | | | LEAD FINISH | | JEDEC CODE |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | MIN. | NOM. | MAX. | MIN. | NOM. | MAX. | MIN. | NOM. | MAX. | Pure Tin | PPF | |
| ⚠ 42X66* MIL | 0.55 | 0.60 | 0.65 | 1.35 | 1.40 | 1.45 | 0.25 | 0.30 | 0.35 | V | V | V2020C |
| ⚠ 43X67* MIL | 0.95 | 1.00 | 1.05 | 1.55 | 1.60 | 1.65 | 0.20 | 0.25 | 0.30 | V | V | N/A |

⚠"*"表示汎用字元,此汎用字元可能被其它不同字元所取代,實際的字元請參照bonding diagram所示.
"*" is an universal character, which means maybe replaced by specific character, the actual character please refers to the bonding diagram.

## 1D XXXX




| SYMBOL | MILLIMETER | | |
|---|---|---|---|
| | MIN | NOM | MAX |
| A | 0. 70 | 0.75 | 0. 80 |
| A1 | 0 | 0. 02 | 0. 05 |
| b | 0. 25 | 0.30 | 0. 35 |
| c | 0.18 | 0.20 | 0.25 |
| D | 1. 90 | 2. 00 | 2. 10 |
| D2 | 1. 50 | 1. 60 | 1. 70 |
| e | 0. 65BSC | | |
| Nd | 1. 30BSC | | |
| E | 1. 90 | 2. 00 | 2. 10 |
| E2 | 0. 90 | 1. 00 | 1. 10 |
| K | 0. 20 | – | – |
| L | 0. 20 | 0.25 | 0. 30 |
| h | 0. 15 | 0. 20 | 0. 25 |
| L/F载体尺寸 (MIL) | 69X47 | | |