One Cell Lithium-ion/Polymer Battery Protection IC

GENERAL DESCRIPTION

The XB4908VD product is a high integration solution for lithium-ion/polymer battery protection. XB4908VD contains advanced power MOSFET, high-accuracy voltage detection circuits and delay circuits. XB4908VD is put into an ultra-small ESN4 package and only one external component makes it an ideal solution in limited space of battery pack.

XB4908VD has all the protection functions required in the battery application including overcharging, over-discharging, overcurrent and load short circuiting protection etc. The accurate overcharging detection voltage ensures safe and full utilization charging. The power-down 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.

FEATURES

- Protection of Charger Reverse Connection
- Protection of Battery Cell Reverse Connection Without external load
- Integrated Advanced Power MOSFET with Equivalent of 16mΩ $R_{SS(ON)}$
- Ultra-small ESN4 Package
- Over-temperature Protection
- Overcharge Current Protection
- Two-step Overcurrent Detection
  -Over-discharge Current
  -Load Short Circuiting
- Low Current Consumption
  -Operation Mode: 3.5μA typ
  -Power-down Mode: 1.8μA typ
- Charger Detection Function
- 0V Battery Charging Function
- Delay Times are generated inside
- High-accuracy Voltage Detection
- RoHS Compliant and Lead (Pb) Free

APPLICATIONS

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

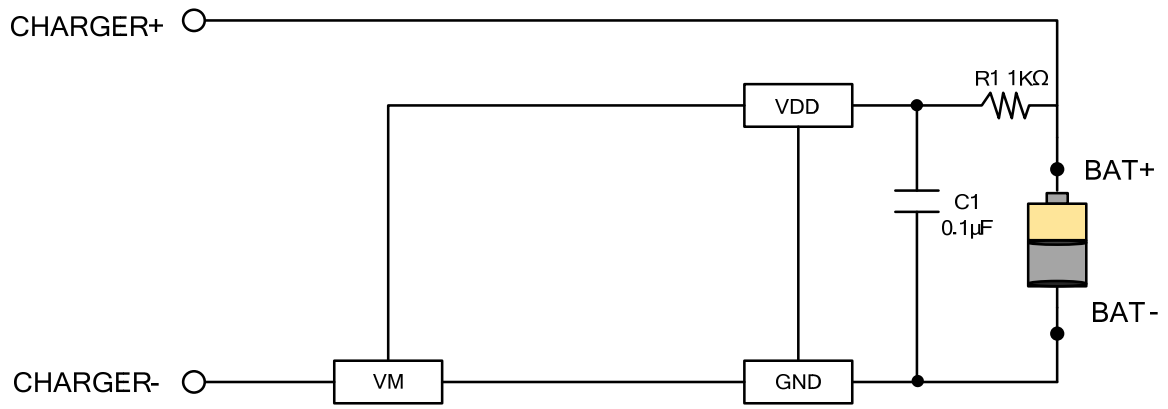


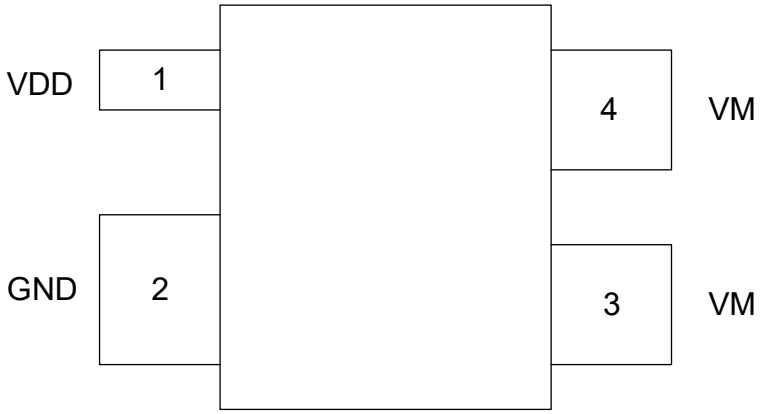
Figure 1. Typical Application Circuit

ORDERING INFORMATION

PART NUMBER	OCV [VCU] (V)	OCRV [VCL] (V)	ODV [VDL] (V)	ODRV [VDR] (V)	TOP MARK
XB4908VD	4.575±25mV	4.40±50mV	2.4±100mV	3.0±100mV	YWXXX(note)

Note: 1)“YW” is manufacture date code, “Y” means the year, “W” means the week.
2)“xxx” is internal product code of Xysemi.

PIN CONFIGURATION



TOP View

Figure 2. PIN Configuration

PIN DESCRIPTION

XB4908VD PIN NUMBER	PIN NAME	PIN DESCRIPTION
1	VDD	Positive power input,connected with battery cell’s positive pole.
2	GND	Ground, connect the negative terminal of the battery to this pin.
3,4	VM	The negative terminal of the battery pack. The internal FET switch connects this terminal to GND Please Connect these pins with mass metal.

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 input pin voltage	-0.3 to 6	V
VM input pin voltage	-6 to 10	V
Operating Ambient Temperature	-40 to 85	°C
Maximum Junction Temperature	150	°C
Storage Temperature	-55 to 150	°C
Lead Temperature (Soldering, 10 sec)	300	°C
Power Dissipation at T=25°C	0.6	W
Package Thermal Resistance (Junction to Ambient) θ_{JA}	165	°C/W
Package Thermal Resistance (Junction to Case) θ_{JC}	20	°C/W
HBM ESD	6000	V

ELECTRICAL CHARACTERISTICS

Typical and limits appearing in normal type apply for TA = 25˚C, unless otherwise specified.

PARAMETER	SYMBOL	TEST CONDITIONS	MIN	TYP	MAX	UNIT
Detection Voltage						
Discharge over-current release Voltage	*V_{RIOV1}		220	380	540	mV
Detection Current						
Overcharge Current Detection	*I_{CHOC}	V_{DD}=3.6V	4	6	8	A
Overdischarge Current Detection	*I_{IOV1}	V_{DD}=3.6V	6	9	12	A
Load Short-Circuiting Detection	*I_{SHORT}	V_{DD}=3.6V	20	40	60	A
Current Consumption						
Current Consumption in Normal Operation	I_{OPE}	VDD=3.6V VM pin floating		3.5	5	μA
Current Consumption in Power Down	I_{PD}	VDD=2.0V VM pin floating		1.8	3	μA
VM Internal Resistance						
Internal Resistance between VM and V_{DD}	*R_{VMD}	VDD=2.0V VM pin floating	200	300	400	kΩ
Internal Resistance between VM and GND	*R_{VMS}	VDD =3.6V VM=1.0V	15	25	35	kΩ
FET on Resistance						
Equivalent FET on Resistance	*$R_{SS(ON)}$	V_{DD}=3.6V,I_{VM} =1.0A		16		mΩ
Over Temperature Protection						
Over Temperature Protection	*T_{SHD+}			150		˚C
Over Temperature Recovery Degree	*T_{SHD-}			110		˚C
Detection Delay Time						
Overcharge Voltage Detection Delay Time	t_{CU}		80	160	250	mS
Overdischarge Voltage Detection Delay Time	t_{DL}		20	40	70	mS
Overcharge Current Detection Delay Time	t_{CHOC}	V_{DD}=3.6V	5	20	40	mS
Overdischarge Current Detection Delay Time	t_{IOV1}	V_{DD}=3.6V	5	10	20	mS
Load Short-Circuiting Detection Delay Time	*t_{SHORT}	V_{DD}=3.6V	50	110	600	μS

Note1: *---The parameter is guaranteed by design.

FUNCTIONAL BLOCK DIAGRAM

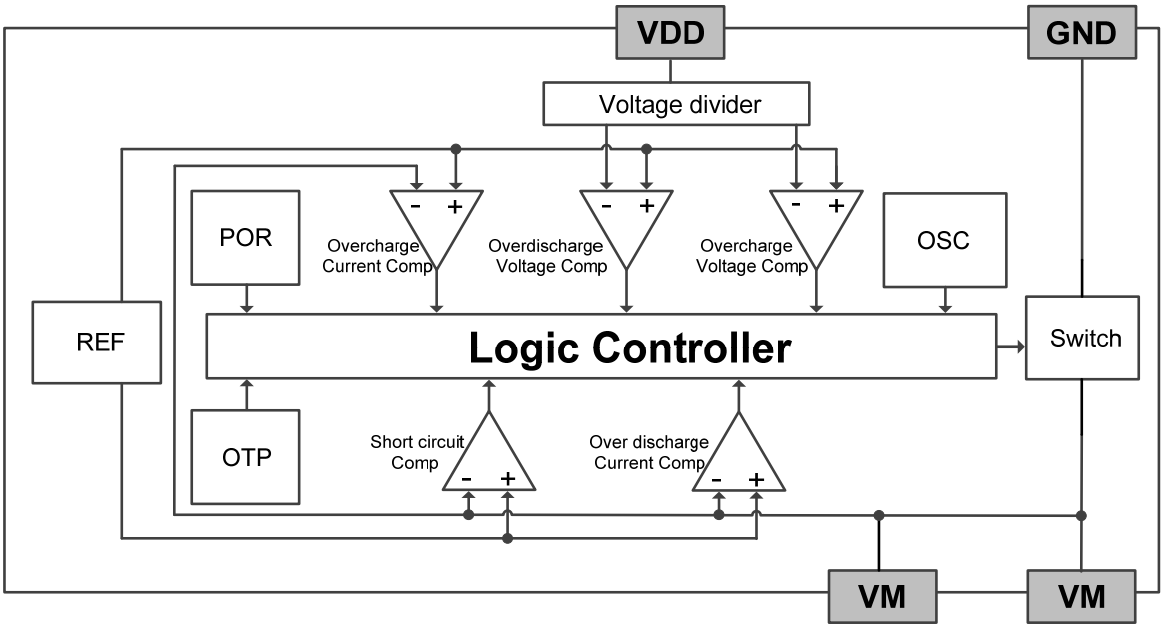


Figure 3. Functional Block Diagram

FUNCTIONAL DESCRIPTION

The XB4908VD 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 MOSFET is integrated and its $R_{SS(ON)}$ is as low as 16 mΩ typical.

Normal Mode

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

Note:

When a battery is connected to the IC for the first time, the IC may not enter the normal condition in which discharging is possible. In this case, set the VM pin voltage equal to the GND voltage (short the VM and GND pins or connect a charger) to enter the normal condition.

Overcharge Condition

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, the XB4908VD 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 XB4908VD turns the charging control FET on and returns to the normal condition.
2. When a load is connected and discharging starts, the XB4908VD 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 XB4908VD detects this volt

age 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 XB4908VD returns to the norm-al 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 1 detection voltage when a load is connected and discharging starts, the chip does not return to the norm-al 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 1 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 1 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, the XB4908VD 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 XB4908VD. Meanwhile when VM is bigger than 1.5V (typ.) (t-he load short-circuiting detection voltage), t-he current of the chip is reduced to the power-down current (I_{PD}). 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, the XB4908VD turns the FET on and changes to the normal condition from the overdischarge condition.

Charging overcurrent Condition

When the charging current becomes equal to or higher than a specified value (the VM pin voltage is equal to or lower than the overcurrent detection voltage) during charging under normal condition and the state continues for the charging overcurrent detection delay time or longer, the XB4908VD turns off the charging control FET to stop charging. This condition is called charging overcurrent condition.

When the charger is removed, detecting that the VM pin voltage is higher than the charge overcurrent detection voltage ($-I_{CHOC}*R_{SS(ON)}*0.75$), the IC returns to the normal condition.

Discharge 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 discharge overcurrent detection delay time or longer, the XB4908VD turns off the discharging control FET to stop discharging. This condition is called discharge overcurrent condition

The VM and GND pins are shorted internally by the R_{VMS} resistor under the discharge overcurrent condition. When a load is connected, the VM pin voltage equals the VDD voltage due to the load.

The discharge overcurrent condition returns to the normal condition when the load is released and the VM pin is shorted the GND pin with the R_{VMS} resistor. Detecting that the VM pin voltage is lower than the discharge over-current release voltage(V_{RIOV1}), the IC returns to the normal condition.

Load Short-circuiting condition

If voltage of VM pin is equal or above short circuiting protection voltage, the XB4908VD 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 lower than Discharge over-current release Voltage(V_{RIOV1}).

0V Battery Charging Function (1) (2) (3)

This function enables the charging of a connected battery whose voltage is 0V by self-discharge. When a charger having 0V battery start charging charger voltage (V_{0CHA}) or higher is connected between B+ and B- pins, the charging control FET gate is fixed to VDD potential. When the voltage between the gate and the source of the charging control FET becomes equal to or higher than the turn-on voltage by the charger voltage, the charging control FET is turned on to start charging. At this time, the discharging control FET is off and the charging current flows through the internal parasitic diode in the discharging control FET. If the battery voltage becomes equal to or higher than the overdischarge release voltage (V_{DU}), the normal condition returns.

Note:

(**1**) Some battery providers do not recommend charging of completely discharged batteries. Please refer to battery providers before the selection of 0 V battery charging function.

(**2**) The 0V battery charging function has higher priority than the abnormal charge current detection function. Consequently, a product with the 0 V battery charging function charges a battery and abnormal charge current cannot be detected during the battery voltage is low (at most 1.8 V or lower).

TYPICAL APPLICATION

As shown in Figure 5 , the current path must be kept as short & heavy as possible. C1 is a filter decoupling circuit and should be as close as possible to VCC pin of XB4908 VD.

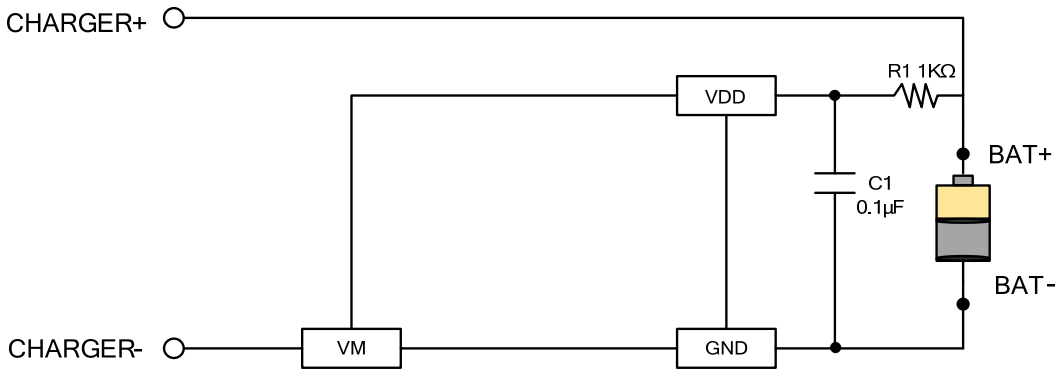


Figure 5 XB4908VD in a Typical Battery Protection Circuit

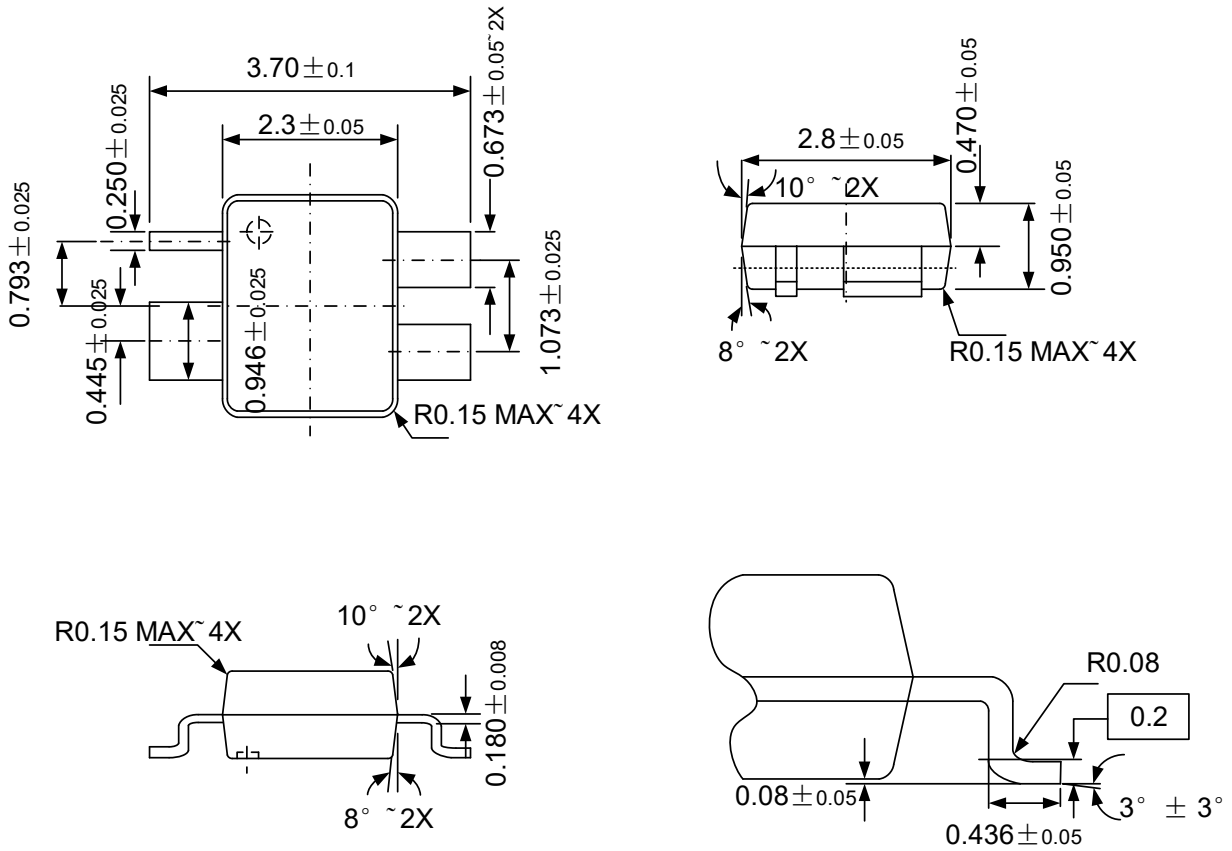
Symbol	Typ	Value range	Unit
C1	0.1	0.1~2.2	μF
R1	1	0.1~1	KΩ

Remark:
1.The above parameters may be changed without notice;
2.The schematic diagram and parameters of the IC are not used as the basis to ensure the operation of the circuit. Please conduct full measurement on the actual application circuit before setting the parameters.

Precautions

• Pay attention to the operating conditions for input/output voltage and load current so that the power loss in XB4908VD does not exceed the power dissipation of the package.
• Do not apply an electrostatic discharge to this XB4908VD that exceeds the performance ratings of the built-in electrostatic protection circuit.

PACKAGE OUTLINE(ESN4)



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