Battery Protection IC For 1-Cell Pack

DW01

■ Features

- Internal high accuracy voltage detection
  1. Overcharge detection voltage 4.30V Accuracy ± 50mV (25℃)
  2. Overcharge release voltage 4.10V Accuracy ± 50mV
  3. Overdischarge detection voltage 2.40V Accuracy ± 100mV
  4. Overdischarge release voltage 3.00V Accuracy ± 100mV
  5. Discharge overcurrent detection voltage 150mV Accuracy ± 30mV
  6. Short circuiting detection voltage 850mV Accuracy ± 300mV
  7. Charger detection voltage -0.7V
- Embedded oscillator with adjustable detection delay time
- High voltage device is used for charger connection in CO and VM
- Over-discharge current protection for high safety
- 0V battery charging function available
- Low current consumption 3.0 uA (Typ.)
- Low standby current consumption 0.1 uA (Max.)
- Wide operation temperature range -40°C to +85°C

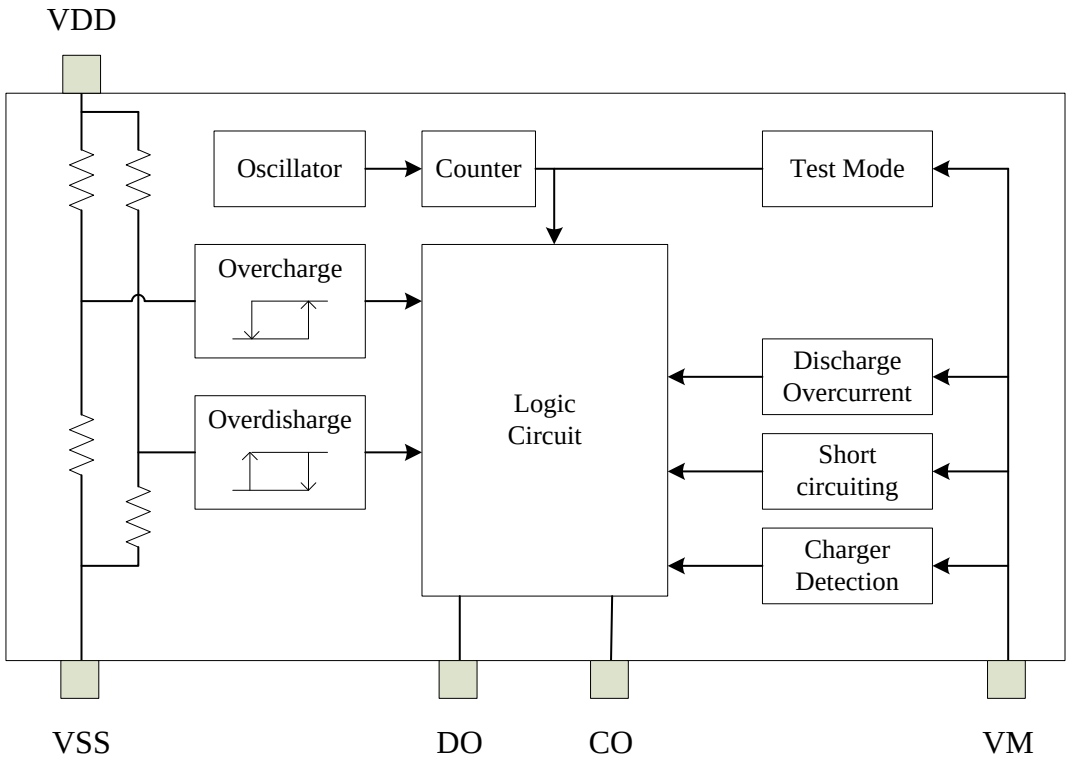
■ Application

- Lithium-ion rechargeable battery packs
- Lithium polymer rechargeable battery packs

■ Ordering Information

Model	Over-charge Detection Voltage (V)	Over-charge Release Voltage (V)	Over-discharge Detection Voltage (V)	Over-discharge Release Voltage (V)	Discharge Overcurrent Detection Voltage (mV)	0V Charge	Package
DW01	4.30V ± 50mV	4.10V ± 50mV	2.4V ± 100mV	3.0V ± 100mV	150mV ± 30mV	YES	SOT23-6L

■ Block Diagram



■ Absolute Maximum Ratings

Parameter		Symbol	Ratings	Unit
Supply Voltage		V_{DD}	-0.3 to 9	V
Input Voltage	VM pin	VM	V_{DD} –37 to V_{DD} +0.3	V
Output Voltage	CO pin	V_{CO}	VM –0.3 to V_{DD} +0.3	V
	DO pin	V_{DO}	V_{SS} –0.3 to V_{DD} +0.3	V
Power Dissipation		P_D	150	mW
Operating Temperature Range		T_{OPT}	-40 to 125	°C
Storage Temperature Range		T_{STG}	-55 to 150	°C

NOTE: Absolute Maximum ratings are threshold limit values that must not be exceeded even for an instant under any conditions. Moreover, such values for any two items must not be reached simultaneously. Operation above these absolute maximum ratings may cause degradation or permanent damage to the device. These are stress ratings only and do not necessarily imply functional operation below these limits.

■ DC Electrical Characteristics (T_{OPT} = 25°C)

Parameter	Symbol	Min	Typ	Max	Unit	Test Conditions
Operating input voltage	V_{DD}	1.5	—	8	V	Voltage defined as V_{DD} -V_{SS}
Minimum operating voltage for 0V charging	Vst	—	—	1.2	V	Voltage defined as V_{DD} -VM, V_{DD} -V_{SS} = 0V
Over-charge detection voltage	V_{DET1}	4.25	4.30	4.35	V	Detect rising edge of supply voltage
Over-charge release voltage	V_{REL1}	4.05	4.10	4.15	V	—
Output delay time of over-charge	T_{VDET1}	100	130	180	ms	V_{DD} = 4.1V → 4.4V
Over-discharge detection voltage	V_{DET2}	2.30	2.40	2.50	V	
Over-discharge release voltage	V_{REL2}	2.90	3.00	3.10	V	
Output delay time of over-discharge	T_{VDET2}	20	35	60	ms	V_{DD} = 2.5V → 2.3V
Over-discharge current threshold voltage	V_{DET3}	120	150	180	mV	Detect rising edge of "VM" pin voltage
Output delay time of excess discharge current	T_{VDET3}	10	15	22	ms	V_{DD} = 3.6V
Short detection voltage	V_{SHORT}	0.55	0.85	1.15	V	V_{DD} = 3.0V
Output delay time of short detection	T_{SHORT}	—	500	750	μs	V_{DD} = 3.0V
Reset resistance for excess current protection	R_{SHORT}	30	50	100	kΩ	V_{DD} = 3.6V, VM = 1.0V
Charger detection voltage	V_{CHA}	-1.2	-0.7	-0.2	V	
Supply current	I_{OPE}	—	3.0	6.0	μA	V_{DD} = 3.6V, VM = 0V
Standby current	I_{OPED}	—	—	0.1	μA	V_{DD} = 2.0V
Cout NCH ON voltage	V_{COL}	—	0.1	0.5	V	V_{DD}=4.5V, VM=0V, I_{COL}=10uA
Cout PCH ON voltage	V_{COH}	VDD-0.1	VDD-0.02	—	V	V_{DD} =3.6V, VM=0V, I_{COH}=-10uA
Dout NCH ON voltage	V_{DOL}	—	0.1	0.5	V	V_{DD} =2.0V, VM=0V, I_{DOL}=10uA
Dout PCH ON voltage	V_{DOH}	VDD-0.1	VDD-0.02	—	V	V_{DD} =3.6V, VM=0V, I_{DOH}=-10uA

NOTE: Please refer to Test Circuit unless otherwise specified.

■ Operation

Normal Status

The 1-cell protection IC series monitor the VDD power supply voltage relative to VSS detecting the over-charge and over-discharge conditions. It also monitors the VM voltage to detect the discharge over-current and load short circuiting to protect the battery cell. In normal operation, the VDD should be in the range from the over-charge detection voltage V_{DET1} to the over-discharge voltage V_{REL1}, and the VM pin voltage is in the range from discharge over-current voltage V_{DET3} to charger detection voltage V_{CHA}. In normal condition, the internal pull-up resistor from VM pin to VDD（R_{VMD}）is disconnected and the internal pull-down resistor（R_{VMS}）from VM pin to VSS is also disconnected.

Over Current Status

There are 2 over-current conditions. One is the discharge over-current condition and another is the load short-circuiting condition. The series ICs monitor the VM pin voltage to detect the over-current and load short-circuiting condition. If VM pin voltage is greater than V_{DET3} and continues to discharge over-current delay time T_{VDET3}, the over-current condition enabled and the OD pin output logic “L” to disable the discharging path. At the same time, the discharging is stopped. In over-current condition, the internal pull-up resistor from VM pin to VDD（R_{VMD}）is disconnected and the VM pin is connected to VSS by internal pull-down resistor R_{VMS}. However, the VM pin is pull-up to VDD by external load resistor. When the load is disconnected, the VM pin is pull-down to VSS by internal resistor.

If the VM pin voltage falls below the charger detection voltage V_{CHA} under normal condition, and it continues and longer than the overcharge detection delay time T_{VDET1}, the OC pin will disable the charging path by disconnected the charge controlled MOSFET. The charge over-current detection is released when the voltage difference between VM pin and VSS becomes less than charger detection voltage V_{CHA}.

Over-Charge Status

When the battery voltage is greater than over-charge voltage（V_{DET1}）and have a T_{VDET1} time duration from a normal operation condition, the over-charge condition hold and the OC pin will output from logic “H” to logic “L” to disconnect the battery charging path. It will turn-off the external MOSFET and the charging status stopped.

It will release the over-charge condition in 2 conditions. First, if the battery voltage less than V_{REL1} from the over-charge condition, the OC will output logic “H” to turn on the external MOSFET to resume the charging path. Second, in the discharge over-current condition by a loading, the over-charge condition will be release if the battery voltage less than V_{DET1} from the over-charge condition. It is because that when a charger is connected in the over-charge condition, the parasitic diode in the over-charge control MOSFET will in a forward bias and the VM pin voltage will be a forward PN junction voltage higher than VSS.

In the over-charge condition, the discharge over-current and load short circuiting function will be disabled until the battery voltage falls below the overcharge detection voltage. It is because that the internal

resistance of battery which will trigger the discharge over-current and load short circuiting function in the time when over-charge condition enabled. In over-charge condition, the internal pull-up resistor from VM pin to VDD（R_{VMD}）is disconnected and the internal pull-down resistor（R_{VMS}）from VM pin to VSS is also disconnected.

Over-Discharge Status

The single-cell lithium protect IC, series, monitor the VDD voltage to detect the over-discharge state from normal operation condition. If the VDD voltage becomes lower than the V_{DET2} and continues for the over-discharge delay time T_{VDET2} from normal operation condition, the OD pin will output “L” to disable the external MOSFET and the discharging stopped. If a charger is connected and the VDD voltage is greater than over-discharge release voltage V_{REL2}, the over-discharge condition released. In over-discharge condition, the charging path is connected by the parasitic diode of discharge controlled MOSFET

When a battery in the over-discharge condition, if VDD is greater than V_{REL2} and the VM is higher than V_{CHA}, the over-discharge condition is released. When a battery in the over-discharge condition, if VDD is greater than V_{DET2} and the VM is lower than V_{CHA}, the over-discharge condition is released.

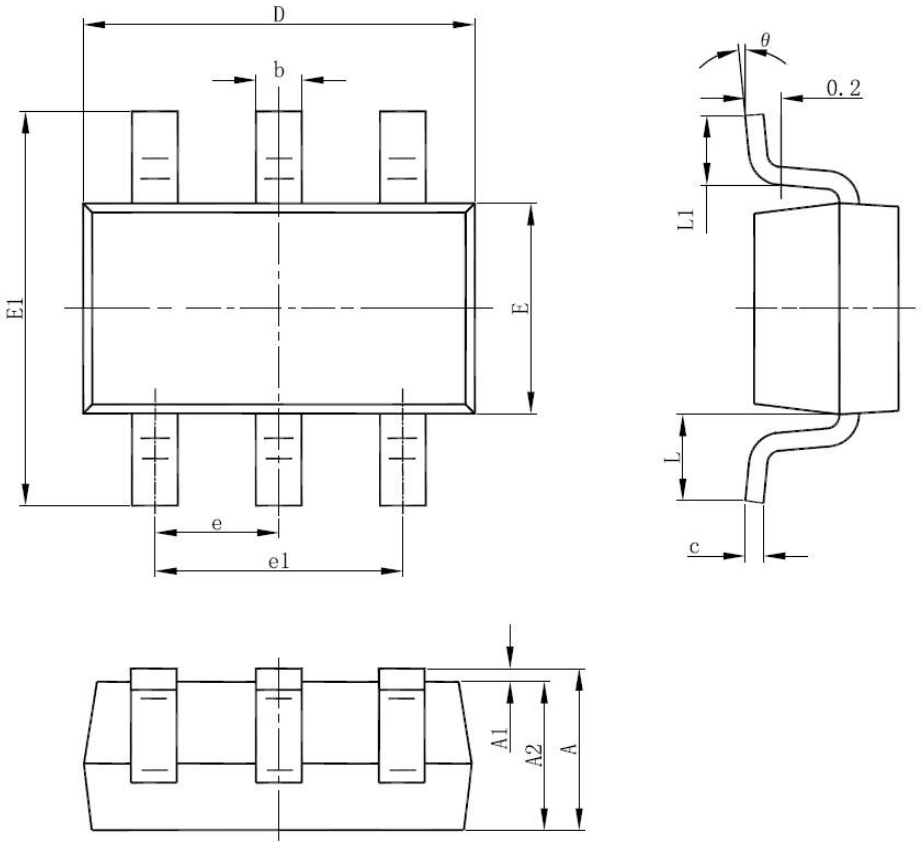
When the over-discharge condition hold, and the voltage difference between VM and VDD is less than 1.3V, the current consumption is reduced to the power-down current consumption 0.1μA in typical. In over-discharge condition, the VM pin is connected to VDD by internal pull-up resistor R_{VMD} and the internal pull-down resistor（R_{VMS}）from VM pin to VSS is disconnected.

Charger Detection

When a battery in the over-discharge status is connected to a charger and provided that the VM pin voltage is lower than the charger detection voltage V_{CHA}, the series IC releases the over-discharge status and turns the discharging control MOSFET on when the battery voltage becomes equal to or higher than the over-discharge detection voltage V_{DET2} since the charger detection function works. This action is called charger detection. When a battery in the over-discharge status is connected to a charger and provided that the VM pin voltage is not lower than the charger detection voltage V_{CHA}, the 1-cell protection IC releases the over-discharge status when the battery voltage reaches the over-discharge detection voltage V_{REL2} or higher.

■ Package Outline Dimension

SOT23-6L



Symbol	Dimensions in Millimeters		Dimensions in Inches	
	Min	Max	Min	Max
A	1.050	1.250	0.041	0.049
A1	0.000	0.100	0.000	0.004
A2	1.050	1.150	0.041	0.045
b	0.300	0.500	0.012	0.020
c	0.100	0.200	0.004	0.008
D	2.820	3.020	0.111	0.119
E	1.500	1.700	0.059	0.067
E1	2.650	2.950	0.104	0.116
e	0.950TYP		0.037TYP	
e1	1.800	2.950	0.071	0.079
L	0.600REF		0.024REF	
L1	0.300	0.600	0.012	0.024
θ	0°	8°	0°	8°