



Single lithium battery protection

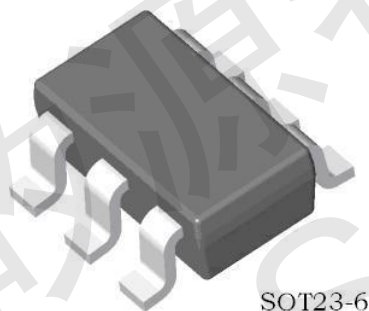
Overview

The IC is designed to protect lithium-ion battery from damage or degrading the lifetime due to overcharge, over discharge, and overcurrent for one-cell lithium-ion battery powered systems. The ultra-small package and less required external components make it ideal to integrate the DW01 into the limited space of battery pack. The very low standby current drains little current from the cell while in storage.

application

Single-cell lithium-ion battery/battery pack

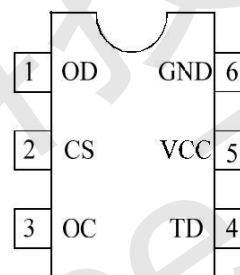
Pin description



SOT23-6

FEATURES

- 1).0V charging function
- 2).High-precision overcharge protection detection voltage ($\pm 50\text{mV}$)
- 3).Low quiescent current ($V_{CC}=3.9\text{V}$: $6\mu\text{A}$)
- 4).Low sleep current($V_{CC}=2.0\text{V}$: $0.6\mu\text{A}$)
- 5).Two-stage overcurrent protection detection voltage
- 6).Delay time built-in.



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Pin No.	Symbol	Description
1	OD	MOSFET gate connection pin for discharge control
2	CS	Input pin for current sense, charger detect
3	OC	MOSFET gate connection pin for charge control
4	TD	Test pin for reduce delay time
5	VCC	Power supply, through a resistor
6	GND	Ground

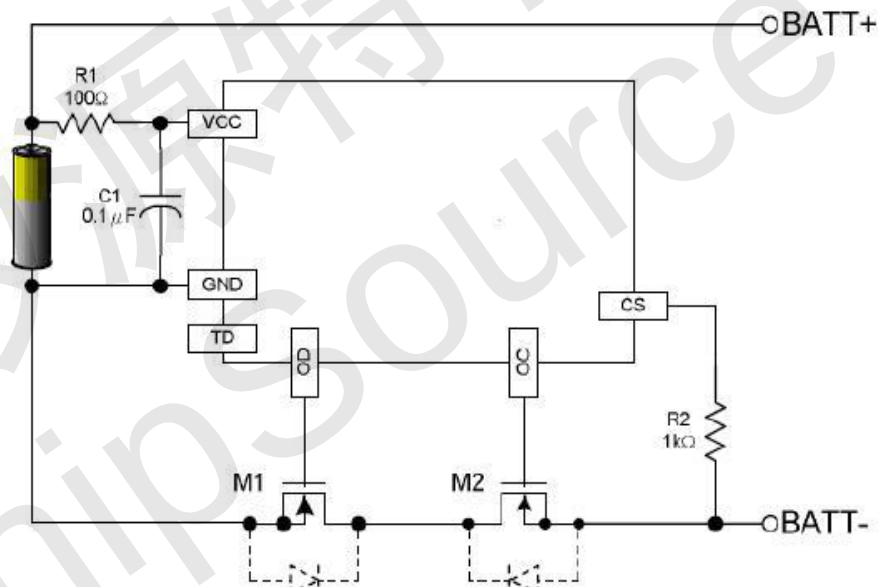


Single lithium battery protection

Absolute Maximum Ratings

Parameter	Symbol	Ratings	Unit
Input voltage between VCC and	VCC	GND-0.3 to GND+10	V
OC output pin voltage	VOC	VCC -24 to VCC +0.3	V
OD output pin voltage	VOD	GND-0.3 to VCC +0.3	V
CS input pin voltage	VCS	VCC -24 to VCC +0.3	V
Operating Temperature Range	TOP	-40 to +85	°C
Storage Temperature Range	TST	-40 to +125	°C

Typical Application





Electrical Characteristics

Parameter	Symbol	Test Condition	Min.	Typ.	Max.	Unit
Overcharge Protection Voltage	VOCP	R=100 Ω	4.25	4.30	4.35	V
Overcharge Release Voltage	VOCR	R=100 Ω	4.05	4.1	4.15	V
Over Discharge Protection Voltage	VODP	VM=0V,R1=100 Ω	2.3	2.4	2.5	V
Over Discharge Release Voltage	VODR	R=100 Ω	2.9	3.0	3.1	V
Charger Detection Threshold Voltage	VCH	-	-1.2	-0.7	-0.2	V
Overcurrent Protection Voltage	VOIP	-	120	150	180	mV
Short Current Protection Voltage	VSIP	Vcc=3.6V	0.7	1.0	1.3	V
Quiescent Current	ICC	Vcc=3.6V	-	3.0	6	μ A
Power-Down Current	IPD	Vcc=2.0V	-	0.1	0.6	μ A
Overcharge Delay Time	TOC	-	-	100	200	ms
Over Discharge Delay Time	TOD	VCC=3.0V to 2V	-	50	100	ms
Overcurrent Delay Time	TOIP	VCC=3.6V	-	10	20	ms
Charging overcurrent delay time	TSIP	VCC=3.6V	-	5 50	400	μ S
OD Pin Output "H" Voltage	VDOH	IDH=10 μ A	VCC-0.2	VCC-0.1	0.2	V
OD Pin Output "L" Voltage	VDOL	IDL=10 μ A	-	0.1	0.5	V
OC Pin Output "H" Voltage	VCOH	ICH=10 μ A	VCC-0.2	VCC-0.1	-	V
OC Pin Output "L" Voltage	VCOL	ICL=10 μ A	-	0.1	0.5	V
0V battery charge inhibition charge voltage	V0CHA	VCC=0V	1.2	-	-	V



Detailed Description

(1) Normal working condition

This IC continuously detects the battery voltage connected between VCC and GND, and the voltage difference between CS and GND to control charging and discharging. When the battery voltage is above the over discharge detection voltage (VODP) and below the overcharge detection voltage (VOCP), and the CS terminal voltage is above the charger detection voltage (VCH) and below the discharge overcurrent detection voltage (VOI1), the IC Both the OC and OD terminals output a high level, so that the charge control MOSFET and the discharge control MOSFET are simultaneously turned on, and this state is called a normal operation state. In this state, both charging and discharging can be performed freely.

(2) Overcharge protection

When the battery voltage is higher than the overcharge protection voltage (VOCP) and exceeds the overcharge delay time (TOC) period, the charging action is disabled by turning off the charge control MOSFET. The overcharge delay time defaults to 100ms. Overcharge protection will be released in two cases:

- 1) The battery passes through self-discharge and the voltage drops below the overcharge release voltage (VOCR).
- 2) The battery voltage drops below the overcharge protection voltage (VOCP) and a load is connected. When the battery voltage is higher than VOCP, the overcharge protection will not be released even if one load is connected.

(3) Over discharge protection and sleep state

When the battery voltage is lower than the over discharge protection voltage (VODP) and exceeds the over discharge delay (TOD) period, the discharge action will be disabled by turning off the discharge control MOSFET. The over discharge delay time defaults to 50 ms.

When the MOSFET for discharge control is turned off, CS is pulled up to VCC by the internal resistor, so that the current consumption of the chip is reduced to the current consumption value during sleep. This state is called the sleep state.

The release of the over discharge state has the following two cases:

Connect the charger. If the CS terminal voltage is lower than the charger detection voltage (VCH), when the battery voltage is higher than the over-discharge detection voltage (VODP), the over-discharge state is released and the normal working state is restored.

- 2) Connect the charger. If the CS terminal voltage is higher than the charger detection voltage (VCH), when the battery voltage is higher than the over discharge release voltage (VODR), the over discharge state is released and returns to the normal working state.

The battery in normal operation, during the discharge process, when the battery voltage drops below the over discharge detection voltage (VODP), and the state exceeds the discharge detection delay time (TOD) or more, the IC will turn off the discharge control. The MOSFET (OD terminal) stops discharging. This state is called over discharge.

There are three ways to release the over discharge state:

- 1) Connect the charger. If the CS terminal voltage is lower than the charger detection voltage (VCH), when the battery voltage is higher than the overdischarge detection voltage (VODP), the over discharge state is released and returns to the normal working state.



2) Connect the charger. If the CS terminal voltage is higher than the charger detection voltage (VCH), when the battery voltage is higher than the overdischarge release voltage (VODR), the overdischarge state is released and returns to the normal working state.

3) When the charger is not connected, if the battery voltage recovers above the overdischarge release voltage (VODR), the overdischarge status is released and returns to the normal working state, that is, there is a self-recovery function.

(4) Overcurrent protection

In normal mode, the IC continuously monitors the discharge current by detecting the voltage at the CS pin. If the voltage at the CS pin is higher than the overcurrent protection voltage and exceeds the overcurrent delay period, the overcurrent protection circuit is activated and the discharge action is disabled by turning off the discharge control MOSFET. When the load is removed and BATT+ and BATT- appear high impedance, the overcurrent protection is released and will return to normal mode.

(5) Load detection after overcharge

The load detection after overcharge is realized by detecting the voltage of the CS pin. When overcharged, a load is connected to the battery pack, and a discharge current flowing through the MOSFET's parasitic diode forms a diode voltage drop between CS and GND. If the CS pin voltage is higher than the load detection threshold voltage (VLD), the load is detected.

(6) Charger detection after overdischarge

When overdischarge occurs, the discharge control MOSFET is turned off and the discharge process is inhibited. However, the charging process through the parasitic diode of the MOSFET is allowed. Once the charger is connected to the battery pack, the DW01 immediately turns on all timing and monitoring circuitry. If the voltage between CS and GND is below the charger detection threshold (VCH), the charging process is detected.

(7) Charging overcurrent

The battery under normal working condition, during the charging process, if the CS terminal voltage is lower than the charging overcurrent detection voltage (VCIP), and the state lasts longer than the charging overcurrent detection delay time (TCIP), the charging control is turned off. The MOSFET (OC terminal) is used to stop charging. This state is called the charging overcurrent state. After entering the charging overcurrent detection state, if the charging is turned off and the CS terminal voltage is higher than the charging overcurrent detecting voltage (VCIP), the charging overcurrent state is released and the normal working state is restored.

(8) Charging function to 0V battery (allowed)

This feature is used to recharge a battery that has self-discharged to 0V. When the charger voltage connected between the battery positive terminal (BATT+) and the battery negative electrode (BATT-) is higher than the "charger starting voltage (V0V) charged to the 0V battery", the gate of the charge control MOSFET is fixed to VCC. The voltage at the terminal, due to the voltage of the charger, causes the voltage difference between the gate and the source of the MOSFET to be higher than its turn-on voltage, and the charge control MOSFET causes (OC terminal) to start charging. At this time, the discharge control MOSFET is still turned off, and the charging current flows through its internal parasitic diode. When the battery voltage is higher than the overdischarge detection voltage (VODP), the IC enters a normal operating state.

(9) Charging function to 0V battery (disabled)



When a battery that is internally short-circuited (0V battery) is connected, the function of disabling charging the 0V battery will prevent it from being recharged. When the battery voltage is lower than the "0V battery charge inhibited battery voltage (VOIN)", the gate of the charge control MOSFET is fixed to the BATT-voltage, and charging is prohibited. When the battery is higher than the "0V battery charge prohibited battery voltage (VOIN)", it can be charged.

(10) External control MOSFET selection

Since the overcurrent protection voltage is preset, the critical current value of the overcurrent detection is determined by the on-resistance of the discharge control MOSFET. The on-resistance of the externally controlled MOSFET can be calculated using the equation:

$R_{ON} = VOIX / (2 * I_T)$ (I_T is the overcurrent critical current). For example, if the overcurrent critical current I_T is designed to be 3A, the on-resistance of the external control MOSFET must be 25 mΩ. The user should be aware that the on-resistance of the MOSFET will change with temperature. It also changes as the gate-source voltage changes (the on-resistance of the MOSFET rises as the gate-source voltage drops). Once the on-resistance of the MOSFET changes, the overcurrent critical current will change .

SOT-23-6 PACKAGE INFORMATION

