One-Cell Li-Ion/Polymer Battery Pack Protection IC

DW01A is equipped with a high-precision voltage detection circuit and a delay circuit. By detecting the voltage and current of the battery, it achieves protection against overcharging, discharging, and overcurrent. Suitable for the protection circuit of single lithium ion/lithium polymer rechargeable batteries.

■ Features

1) **High accuracy voltage detection**
   - Overcharge detection voltage 4.300V
   - Overcharge release voltage 4.100V
   - Over discharge detection voltage 2.400V
   - Over discharge release voltage 3.000V
2) Discharge overcurrent detection function
   - Discharging overcurrent detection voltage 0.150V
   - Short-circuit detection voltage 1.000V
3) **Charging overcurrent detection voltage** -0.150V
4) **Load Detection function**
5) **Charger Detection function**
6) **0 V battery charge function**
7) **Ultra-low power dissipation**
   - Normal mode 1.5 μA (Typ.) (Ta = +25°C)
   - Overdischarge mode 0.7 μA (Typ.) (Ta = +25°C)
8) **RoHS, PB-Free, HF**

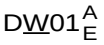
■ Application

- Lithium-ion/lithium-polymer rechargeable battery

■ Packages

- SOT23-6L

■ Marking



A & E for internal identification code

■ Block Diagram

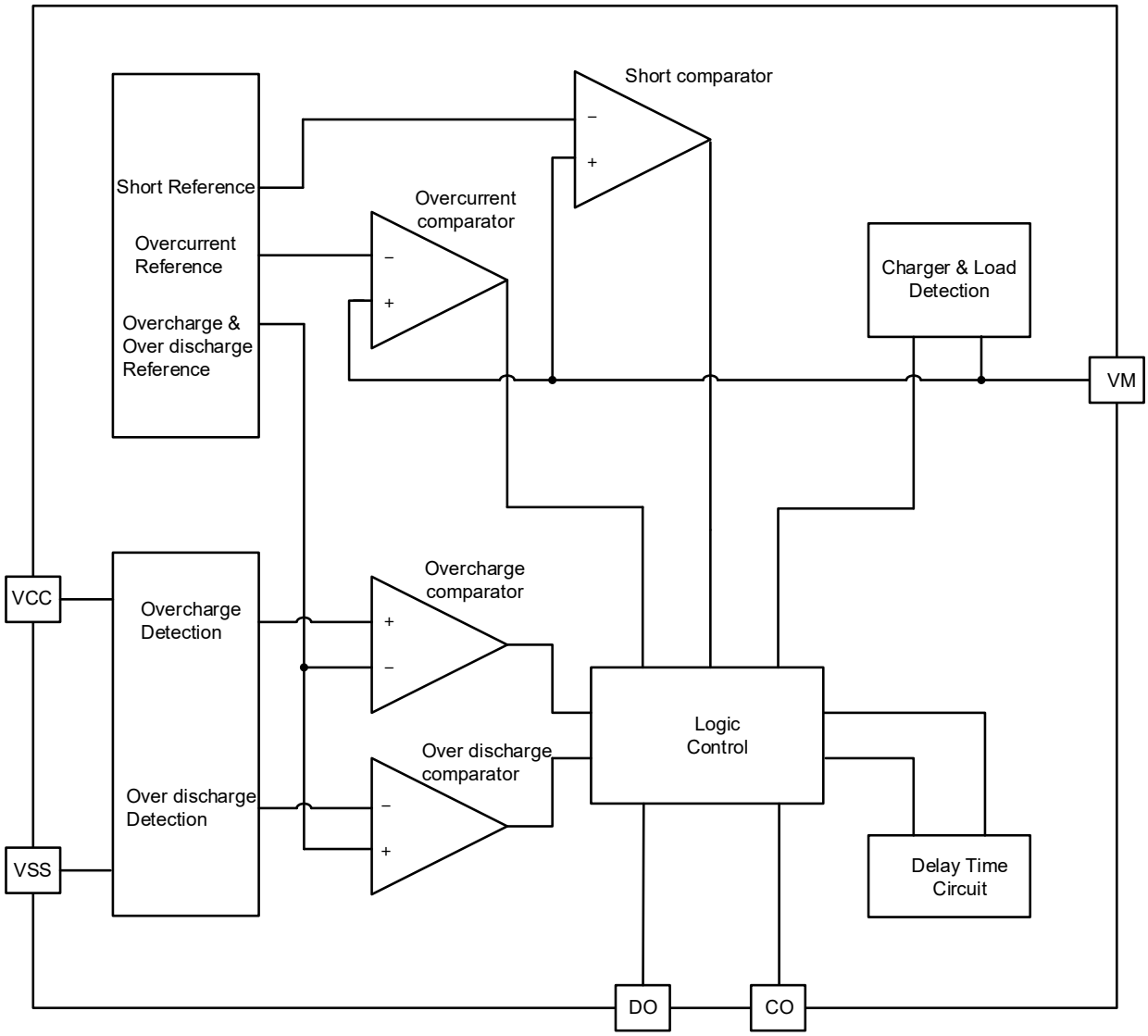


Figure 1

■ Products Catalogue

Part No.	Overcharge detection voltage [V_{OC}]	Over-charge release voltage [V_{OCR}]	Over-discharge detection voltage [V_{OD}]	Over-discharge release voltage [V_{ODR}]	Discharge overcurrent detection [V_{EC}]	Short-circuit current detection [V_{SHORT}]	Charge overcurrent detection [V_{CHA}]
DW01A	4.300 V	4.100 V	2.400 V	3.000 V	0.150 V	1.000 V	-0.150 V

Table 1

Part No.	0 V Battery Charge Function	Release condition of discharge overcurrent status	Release Voltage of Discharge Overcurrent Status	Overcharge locking	Overcharge locking
DW01A	Available	Load disconnection	V_{DIOV}	Available	Unavailable

Table 2

■ Pin Configurations

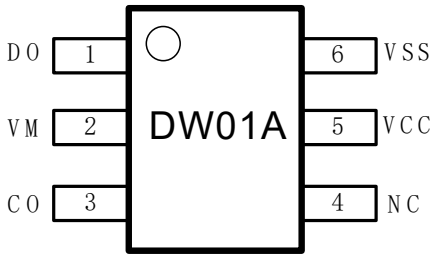


Figure 2

PIN	Symbol	Description
1	DO	Discharge power MOSFET control pin.
2	VM	Connected to charger negative voltage.
3	CO	Charge power MOSFET control pin.
4	NC	No Connection.
5	VCC	Positive power input pin.
6	VSS	Negative power input pin.

Table 3

■ Absolute Maximum Ratings

(Unless otherwise specified: Ta = +25°C)

Item	Symbol	Ratings	Unit
Power supply voltage	VCC	-0.3 ~ 6	V
Input pin voltage for VM	VM	VCC-12 to VCC+0.3	V
Operating temperature	T_{OPR}	–40 ~ 85	°C
Storage temperature	T_{STG}	–55 ~ 125	°C

Table 4

Caution: The absolute maximum ratings are rated values exceeding which the product could suffer physical damage. These values must therefore not be exceeded in any conditions.

■ Electrical Characteristics

(Unless otherwise specified : Ta = +25°C)

Item		Symbol	Conditions	Min.	TYP.	Max.	Unit
power supply voltage		VCC	-	1.0	-	5.5	V
Normal operating current		I_{VCC}	VCC=3.5V	-	1.5	5.0	μA
over discharge consumption		I_{OPED}	VCC =1.5V	-	0.7	1.5	μA
Overcharge	detection voltage	V_{OC}	VCC =3.5→4.5V	4.250	4.300	4.350	V
	release voltage	V_{OCR}	VCC =4.5→3.5V	4.050	4.100	4.150	V
	detection delay time	T_{OC}	VCC =3.5→4.5V		80	160	ms
Overdischarge	detection voltage	V_{OD}	VC5=3.5→2.0V	2.300	2.400	2.500	V
	release voltage	V_{ODR}	VCC =2.0→3.5V	2.900	3.000	3.100	V
	detection delay time	T_{OD}	VCC =3.5→2.0V		40	80	ms
Discharge overcurrent	detection voltage	V_{EC}	VM-VSS=0→0.20V	0.120	0.150	0.180	V
	detection delay time	T_{EC}	VM-VSS=0→0.20V		10	20	ms
Charge overcurrent	detection voltage	V_{CHA}	VSS-VM=0→0.30V	-0.180	-0.150	-0.120	V
	detection delay time	T_{CHA}	VSS-VM=0→0.30V		10	20	ms
Load short-circuiting	detection voltage	V_{SHORT}	VM -VSS=0→1.5V	0.700	1.000	1.300	V
	detection delay time	T_{SHORT}	VM -VSS=0→1.5V		300	600	μs
0 V battery charge starting charger voltage		V_{0VCH}	0 V battery charge function "available"	1.2	-	-	V

Table 5

■ Function Description

1. Overcharge Condition

During charging, when the battery voltage is higher than V_{OC} and lasts longer than T_{OC}, the output voltage of CO will reverse, the charge MOSFET will be turned off and stop charging. This condition is called the overcharge condition.

The overcharge protection state will be released if any of the next conditions occurs:

(1) $V_{CHA} < VM < V_{EC}$, When the battery voltage is less than V_{OCR} and stays period of time T_{OCR}.

(2) $VM > V_{EC}$ (connecting to the load), Battery voltage is lower than V_{OC} and stays period of time T_{OCR}.

Caution: When a charger is connected after overcharge detection, the overcharge status is not released even if the battery voltage is below V_{OCR}. The overcharge status is released when the VM pin voltage goes over V_{CHA} typ. by removing the charger.

2. Over discharge Condition

During discharging, when the battery voltage is lower than V_{OD} and lasts longer than T_{OD}. The output voltage of DO will reverse. The discharge MOSFET will be turned off and stop discharging. This condition is called the over discharge condition.

During discharging, the over discharge state can be released in the following three cases:

1) Connecting to the charger $VM \leq V_{CHA}$, when the battery voltage is higher than V_{OD}.
2) Connecting to the charger ($V_{CHA} < VM < V_{EC}$), when the battery voltage is higher than V_{ODR}.
3) Disconnect the charger, when the battery voltage is higher than V_{ODR}.

3. Discharging Overcurrent Condition

During discharging, the voltage of VM becomes higher with the current increasing. When the voltage of VM is higher than V_{EC} and stays longer than T_{EC}, the discharge MOSFET will be turned off and stop discharging. This condition is called the discharging overcurrent state. If the voltage of VM is higher than V_{SHORT} and stays longer than T_{SHORT}, the discharge MOSFET will be turned off and stop discharging, and this state is called the "load short circuit state".

As long as the equivalent resistance value of the load increases or the load is disconnected, making VM<VEC, the discharge overcurrent state can be relieved and the normal state can be restored.

4. Charging Overcurrent Condition

During charging, If the VM pin voltage falls below the charging overcurrent detection voltage (V_{CHA}) and stays longer than the charging overcurrent detection delay time (T_{CHA}) or longer, the charging control FET turns off and charging stops. This action is called the charging overcurrent condition. Charging overcurrent protection will be released when we disconnect the charger ($VM > V_{CHA}$).

5. 0 V Battery Charging Function “Available”

This function is used to recharge batteries that have already self-discharged to 0V. When the 0 V battery charge starting charger voltage (V_{0CHA}) or higher is applied between P+ pin and P− pin by connecting a charger, the charging control FET gate is fixed to VCC pin voltage. When the voltage between the gate and source of the charging control FET becomes equal to or higher than the turn-on voltage (V_{th}) due to 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. When the battery voltage becomes equal to or higher than the overdischarge detection voltage (V_{OD}), IC enters the normal condition.

■ Application Circuits

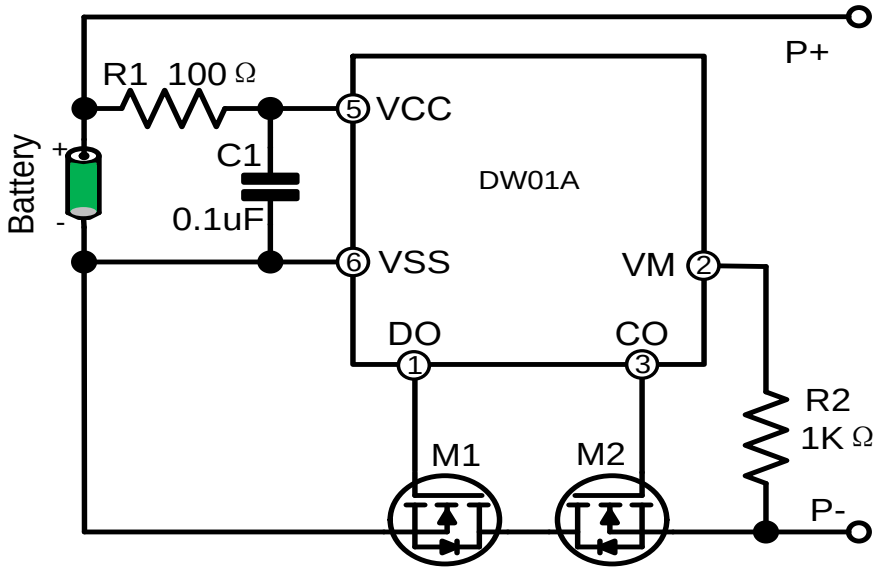
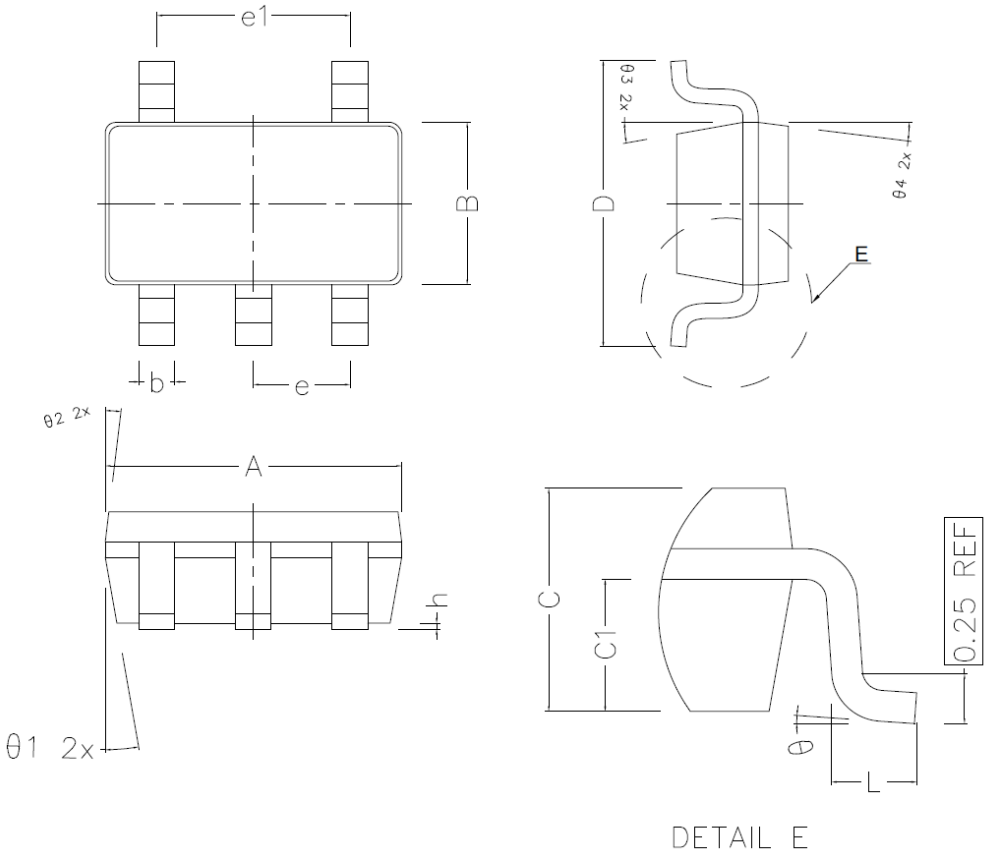


Figure 3

Component Symbol	Type	Range	Unit
R_1	100	100 ~ 1000	Ω
R_2	2	1 ~ 3	kΩ
C_1	0.1	≥ 0.1	μF

Note: R1, R2 cannot be omitted, and R1 must be greater than or equal to 100 ohms.

■ Package (SOT23-6L)



COMMON DIMENSIONS (UNITS OF MEASURE IS mm)			
	MIN	NORMAL	MAX
A	2.820	2.920	3.020
B	1.500	1.600	1.700
C	1.050	1.100	1.150
C1	0.600	0.650	0.700
D	2.650	2.800	2.950
L	0.300	0.450	0.600
b	0.280	0.350	0.420
h	0.020	0.050	0.100
e	0.950TYPE		
e1	1.900TYPE		
θ_1	10° TYPE		
θ_2	7° TYPE		
θ_3	10° TYPE		
θ_4	7° TYPE		
θ	0° ~ 8°		