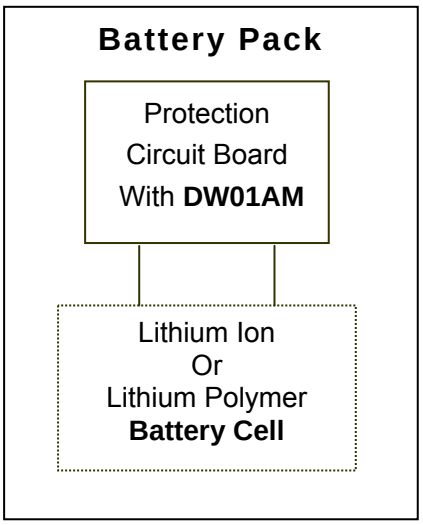
General Description

The DW01AM are protectors for lithium-ion and lithium polymer rechargeable battery with high accuracy voltage detection. They can be used for protecting single cell lithium-ion or/and lithium polymer battery packs from overcharge, over-discharge, excess current and short circuit. These ICs have suitable protection delay functions and low power consumption property.

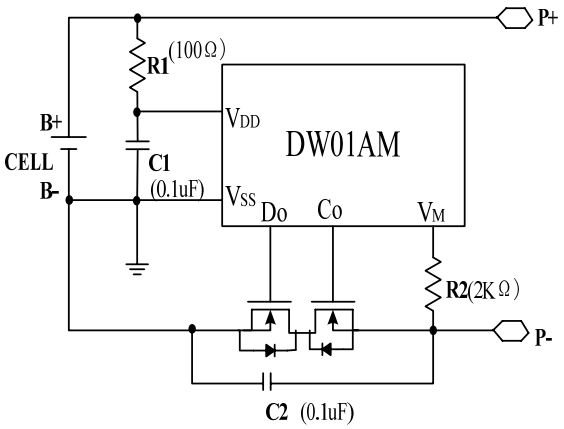
Applications



Features

- **Overcharge Threshold**
  - 4.300V
  - Accuracy ±50mV (25℃)
- **Over-discharge Threshold**
  - Typ. 2.40V
  - Accuracy ±100mV
- **Excess Current Protection Threshold**
  - Typ. 0.150V @ V_{DD} = 3.30V
  - Accuracy ±30mV
- **Short Circuit Protection Threshold**
  - Typ. 1.35V @ V_{DD} = 3.30V
  - Accuracy ±35mV
- **Low Supply Current**
  - Typ. 3.0uA @ V_{DD} = 3.9V (Standard working)
  - Typ. 1.6uA @ V_{DD} = 2.0V (With auto wake up)
- **Output Delay of Overcharge**
  - Typ.80ms @ V_{DD} = 4.4V
- **Output Delay of Over-discharge**
  - Typ. 40ms @ V_{DD} = 2.0V
- **Small Package**
  - SOT-23-6L

Typical Application Circuits



Notes

R_1 and C_1 are to stabilize the supply voltage of the DW01AM R_1 C_1 is hence regarded as the time constant for V_{DD} pin. C_2 is to stabilize the voltage of V_M pin. R_1 and R_2 can also be a part of current limit circuit for the DW01AM Recommended values of these elements are as follows:

- R_1＜1kΩ. A larger value of R1 results in higher detection voltage, introducing errors.
- R_2＜2.5kΩ. A larger value of R_2 possibly prevents resetting from over-discharge even with a charger.
- R_1+R_2＞1kΩ. Smaller values may lead to power consumption over the maximum dissipation rating of the DW01AM
- The above diagram and parameters can't insure the circuit work well, please choose the suitable parameters through test.

Product List

Table 1. **(@ 25℃)**

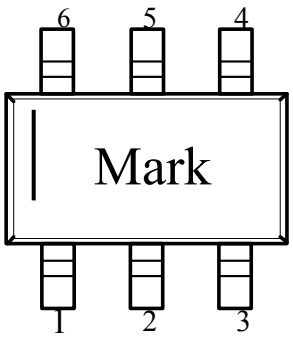
Type Number	Overcharge threshold (Vdet1)	Overcharge release hysteresis voltage (Vhc)	Overdischarge threshold (Vdet2)	Overdischarge release hysteresis voltage (Vhd)	Discharge Overcurrent threshold (Vdet3)	Auto wake up function	Mark (ST)
DW01AM	4.300V	0.200V	2.400V	0.600V	0.150V	Yes	/

Pin Description

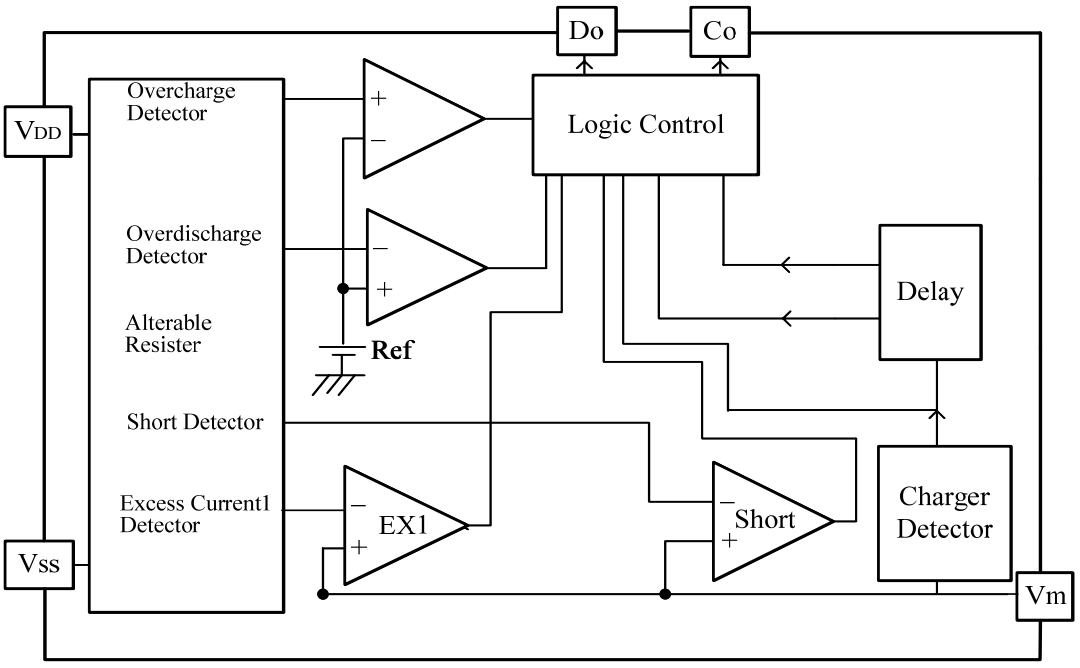
Table 2. SOT-23-6L

Pin	Symbol	Description
1	D_O	Overdischarge detection, CMOS output
2	V_M	Connected to charger's negative pin
3	C_O	Overcharge detection, CMOS output
4	NC	No connection
5	V_{DD}	Power supply
6	V_{SS}	Ground

SOT-23-6 (Top Side)



Block Diagram



Function Description

Normal Condition:

V_{DD} is between the Over-discharge Detection Threshold (Vdet2) and Overcharge Detection Threshold (Vdet1) and the V_M pad voltage is between Charger Detection Voltage (Vcha) and the Excess Current 1 Threshold Voltage (Vdet3), therefore the outputs of D_O pad and C_O pad are high and the MOSFETs of charge and discharge are all on. Charging and discharging can be carried out freely.

Overcharge Condition:

When V_{DD} increases and passes Vdet1 during charging under the normal condition, the output of Co pad will change from high to low after Overcharge Detection Delay Time (Tvdet1), turning off the charging control FET.

If, within Tvdet1, V_{DD} becomes lower than Vdet1 and stays for duration shorter than Overcharge Reset Delay Time (Treset) before rising up over Vdet1 again, this type of instantaneous falling of V_{DD} is ignored. Otherwise, if the time V_{DD} stays lower than Vdet1 is longer than Treset, the timing related to Tvdet1 shall be reset.

Over-discharge Condition:

While discharging, after V_{DD} lowers below Over-discharge Detection Threshold (Vdet2), Do pad goes low after Over-discharge Detection Delay Time (Tvdet2). The Do pad would switch off the discharging control FET and stop discharging.

Power-Down State:

When IC enter over-discharge state,all the detection circuity

And timing generation turn off, and the quiescent current reduce to 1.6 uA(V_{DD} = 2.0V). At the same time the Vm is pull-up to V_{DD} through an intemal resistor.

Excess Current 1 Protection:

During discharging, the current varies with load, and V_M increases with the rise of the discharging current. Once V_M rises up to the Excess Current 1 Threshold Voltage (Vdet3) or higher and stays longer than the Excess Current 1 Delay Time (Tvdet3), Do pad switches to low, turning off the discharging control FET. After that excess current state is removed, i.e. $V_M < V_{det3}$, and the circuit recovers to normal condition.

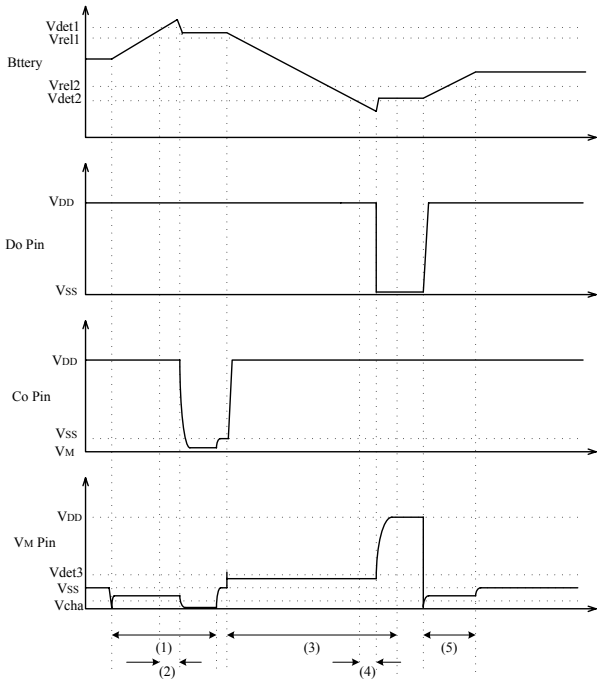
Short Circuit Protection:

This function has the same principle as the excess current protection. But, the delay time Tshort is far shorter than Tvdet3, and the threshold Vshort is far higher than Vdet3. When the circuit is shorted, V_M increases rapidly. Once $V_M \geqslant$ Vshort, Do pad switches to low, turning off the discharging control FET.

After the short circuit state is removed, i.e. $V_M < V_{det3}$, the circuit recovers to the normal condition. The short circuit peak current is related to Vshort and the ON resistance of the two FETs in series. Output types of Co and Do are CMOS level.

Operation Timing Chart (1)

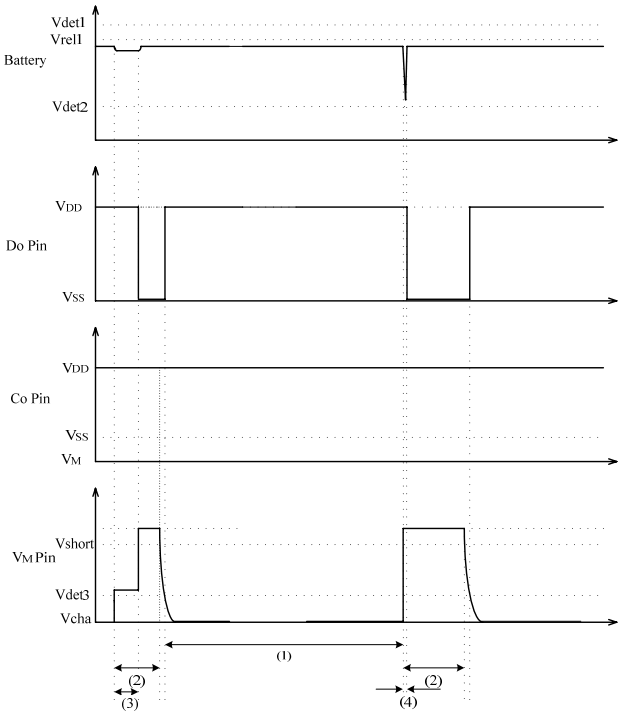
Overcharge/Over-discharge Detection



(1) Charger connected
(2) Overcharge Detection Delay Time (Tvdet1)
(3) Load connected
(4) Over-discharge Detection Delay Time (Tvdet2)
(5) Normal charging

Operation Timing Chart (2)

Excess Current and Short Protection



(1) Normal condition
(2) Load connection
(3) Excess Current 1 Delay Time (Tvdet3)
(4) Short Circuit Delay Time (Tshort)

Electrical Characteristics

(T_{OPT}=25℃ unless otherwise specified)

Symbol	Item	Conditions	Min.	TYP.	Max.	Unit
DETECTION VOLTAGE AND DELAY TIME						
Vdet1	Overcharge Threshold	VCC=3.9V	4.25	4.30	4.35	V
Vrel1	Release Voltage For Overcharge Detection		4.05	4.10	4.15	V
Vdet2	Overdischarge Threshold		2.30	2.40	2.50	V
Vrel2	Release Voltage For Over-discharge Detection		2.90	3.00	3.10	V
Vdet3	Excess Current 1 Threshold	V_{DD} = 3.30V	0.12	0.15	0.18	V
Vshort	Short Protection Voltage	V_{DD} = 3.30V	1.00	1.35	1.70	V
Tvdet1	Output Delay Of Overcharge	V_{DD} = 4.0V→4.4V	—	80	200	ms
Tvdet2	Output Delay Of Over-discharge	V_{DD} = 3.0→2.0V	—	40	100	ms
Tvdet3	Output Delay Of Excess Current 1	V_{DD} = 3.30V	—	10	20	ms
Tshort	Output Delay Of Short Protection	V_{DD} = 3.30V	—	5	50	us
OUTPUT VOLTAGE AND V_M INTERNAL RESISTANCE						
Vc_{OL}	CO Pin L Voltage	I_{OL}=50uA, V_{DD} =4.4V	0.15	0.20	0.25	V
Vc_{OH}	CO Pin H Voltage	I_{OH}=-50uA, V_{DD}=3.9V	3.75	3.70	3.65	V
V_{DOL}	DO Pin L Voltage	I_{OL}=50uA, V_{DD}=2.0V	0.05	0.07	0.09	V
V_{DOH}	DO Pin H Voltage	I_{OH} =-50uA, V_{DD} =3.9V	3.85	3.83	3.81	V
R_{VMD}	Resistance between V_M and V_{DD}	V_{DD}=2.0V, V_M =0V	150	300	600	kΩ
R_{VMS}	Resistance between V_M and V_{SS}	V_{DD}=3.3V, V_M =1V	60	130	260	kΩ
OPERRATION VOLTAGE AND CURRENT CONSUMPTION						
V_{DD}	Operating Input Voltage	V_{DD}-Vss	1.6	V_{DD}	8.0	V
V_M	Operating Input Voltage	V_{DD}-V_M	1.5	--	18	V
I_{DD}	Supply Current	V_{DD} = 3.9V, V_M = 0V		3.0	6.0	uA
$I_{STANDBY}$	Standby Current (for products with Auto wake up)	V_{DD} = 2.0V		1.6	3.0	uA

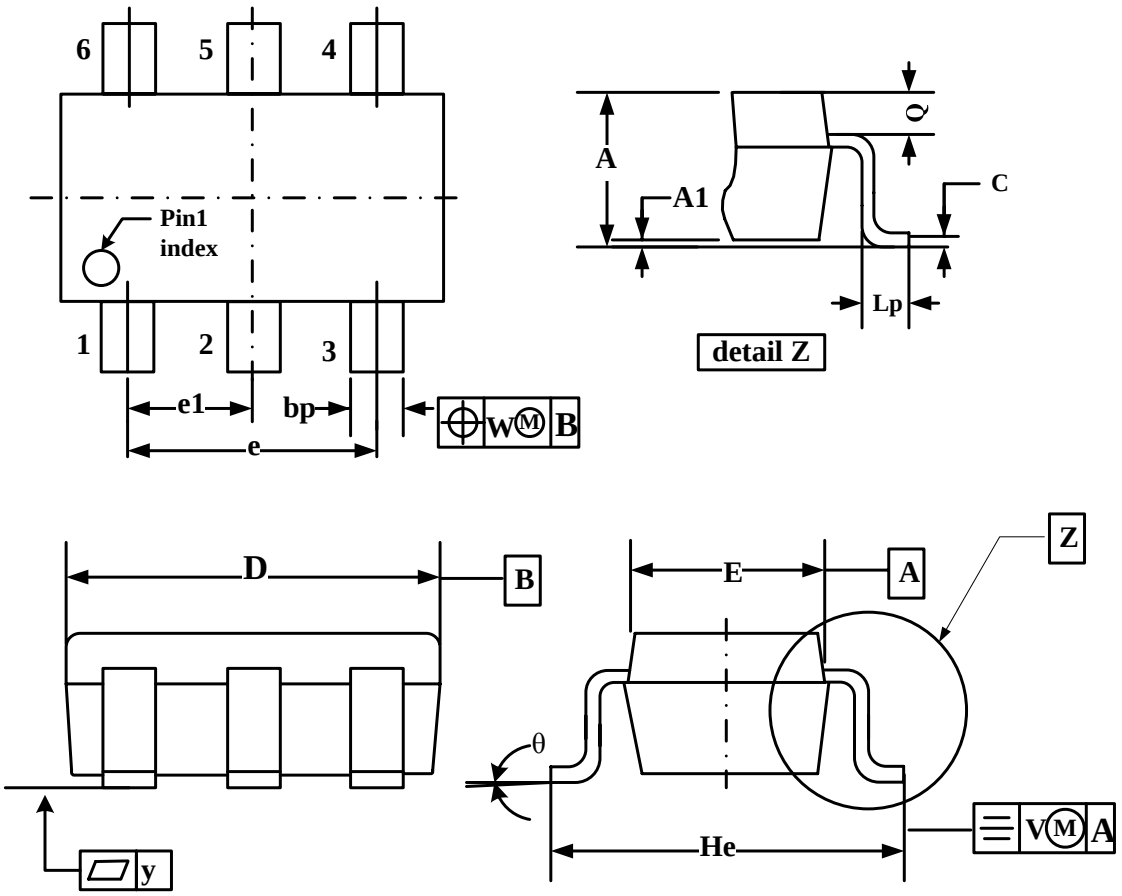
Absolute Maximum Ratings（Ta= 25 ºC　V_{SS}=0 V）

Symbol	Item	Ratings	Unit
V_{DD}	Supply Voltage	-0.3 to 8	V
V_M	V_M Pin Input Voltage	V_{DD} -18 to V_{DD} +0.3	V
V_{CO}	Co Pin Output Voltage	V_{DD} -18 to V_{DD} +0.3	V
V_{DO}	Do Pin Output Voltage	Vss-0.3 to V_{DD} +0.3	V
Pd	Power Dissipation	150	mW
Topt	Operating Temperature Range	-30 to 80	℃
Tstg	Storage Temperature Range	-55 to 125	℃

Caution: These values must not be exceeded under any conditions.

Package Outline

SOT-23-6L



Dimensions (mm)

A	A1	bp	c	D	E	e	e1	He	Lp	Q	v	w	y	θ
1.3	0.15	0.50	0.20	3.1	1.7	1.9	0.95	3.0	0.6	0.33	0.2	0.2	0.1	0^o
1.0	0.03	0.35	0.10	2.7	1.3			2.5	0.2	0.23				10^o

PCB Layout

SOT-23-6