D&W

DW_LP2
One-Cell Lithium-Ion Battery Protection IC

FEATURES

- Reduction in Board Size due to Miniature Package SOT-23-6.
- Ultra-Low Quiescent Current at 3 μA (Vcc=3.9V).
- Ultra-Low Power-Down Current at 0.1 μA (Vcc =2.0V).
- Precision Overcharge Protection Voltage 4.325V ± 50mV for the DW_LP2
- Load Detection Function during Overcharge Mode.
- Two Detection Levels for Overcurrent Protection.

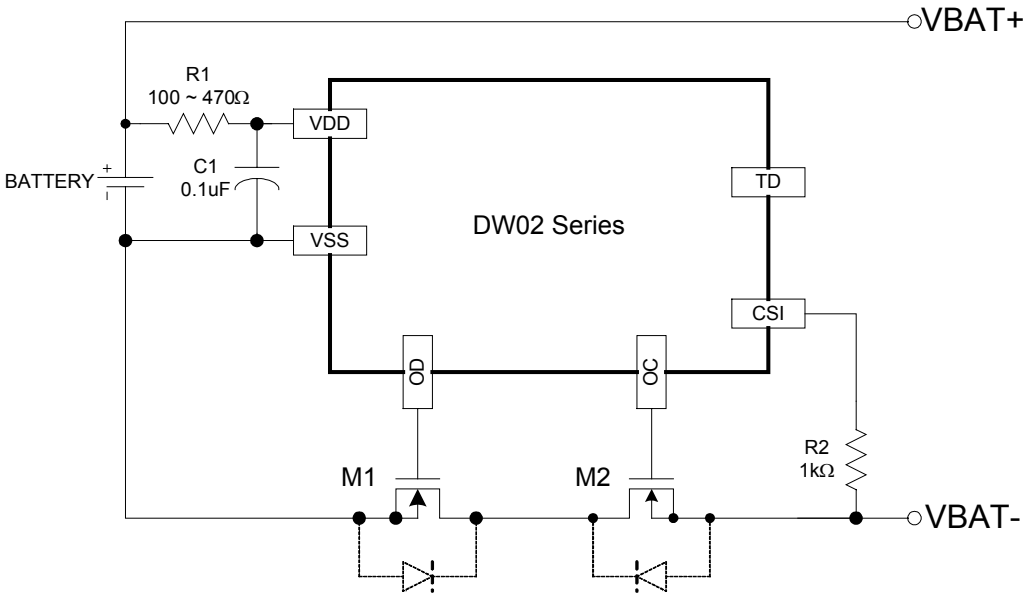
DESCRIPTION

The DW_LP2 battery protection IC is designed to protect lithium-ion battery from damage or degrading the lifetime due to overcharge, overdischarge, and/or overcurrent for one-cell lithium-ion battery powered systems, Such as cellular phones. The ultra-small package and less required external components make it ideal to integrate the DW_LP2 into the limited space of battery pack.
The accurate ±50mV overcharging detection voltage ensures Safe and full utilization charging. Three different specification values for overcharge protection voltage are provided for various protection requirements. The very low standby current drains little current from the cell while in storage.

APPLICATIONS

- Protection IC for One-Cell Lithium-Ion Battery Pack.

TYPICAL APPLICATION CIRCUIT



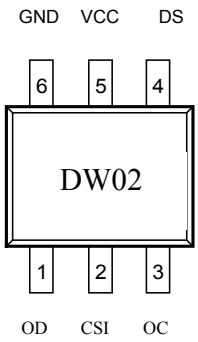
Protection Circuit for One-Cell Lithium-Ion Battery

ORDERING INFORMATION

DW_LP2 PACKAGE TYPE
SOT-23-6

TEMPERATURE RANGE
-20°C~+85°C

OVERCHARGE PROTECTION
4.325V



ABSOLUTE MAXIMUM RATINGS

Supply Voltage……..……10V

DC Voltage Applied On Other Pins……...18V

Operating Temperature Range……..….-20℃~+85℃

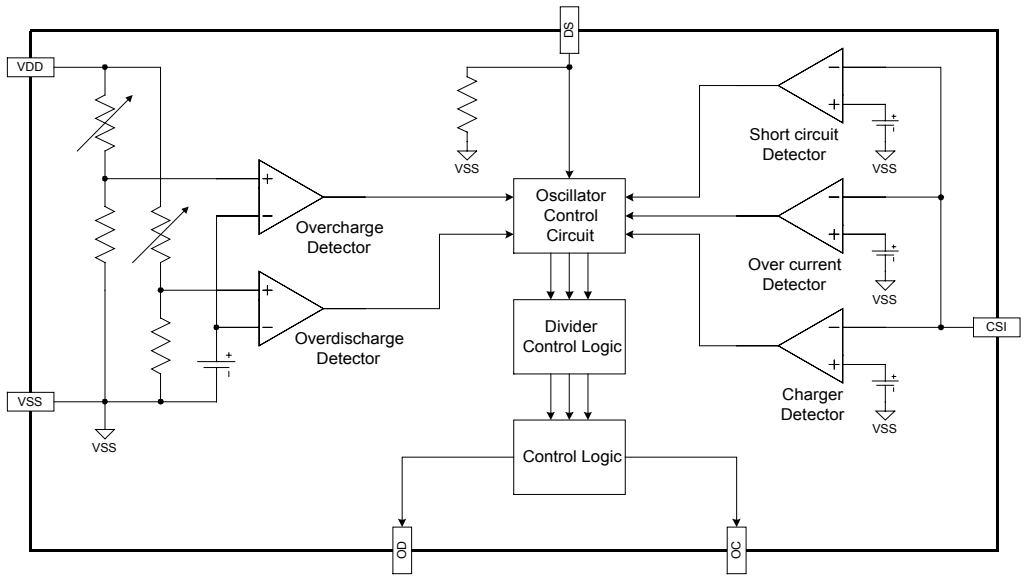
Storage Temperature Range……-40℃~+125℃

ELECTRICAL CHARACTERISTICS (Ta=25°C, unless otherwise specified.)

Model Name DW_LP2

PARAMETER	TEST CONDITIONS	SYMBOL	MIN.	TYP.	MAX.	UNIT
Supply Current	V_{CC}=3.9V	I_{CC}		3.0	6.0	uA
Power-Down Current	V_{CC}=2.0V	I_{PD}			0.1	uA
Overcharge Protection Voltage	DW_LP2	V_{OCP}	4.275	4.325	4.375	V
Overcharge Release Voltage		V_{OCR}	4.025	4.075	4.125	mV
Overdischarge Protection Voltage		V_{ODP}	2.42	2.50	2.58	V
Overdischarge Release Voltage		V_{ODR}	2.82	2.90	2.98	V
Overcurrent Protection Voltage		V_{OIP}（V_{OI1}）	120	150	180	mV
Short Current Protection Voltage	V_{CC}=3.6V	V_{SIP}（V_{OI2}）	1.00	1.35	1.70	V
Overcharge Delay Time	C_{TD}=0.01uF	T_{OC}	0.9	1.3	1.7	s
Overdischarge Delay Time	V_{CC}= $V_{ODP+0.2}$ to $V_{ODP-0.2}$	T_{OD}	130	180	230	ms
Overcurrent Delay Time（1）	V_{CC}=3.6V	T_{OI1}	5	10	15	ms
Overcurrent Delay Time（2）	V_{CC}=3.6V	T_{OI2}		10	50	us
Load Detection Threshold Voltage		V_{LD}	0.12	0.15	0.18	V
Charger Detection Threshold Voltage		V_{CH}	-0.8	-0.5	-0.2	V
OD Pin Output “H” Voltage	V_{CC}=3.9V, Ioh=-50uA	V_{DH}	3.4	3.7		V
OD Pin Output “L” Voltage	V_{CC}=2.0V, IoL=50uA	V_{DL}		0.1	0.5	V
OC Pin Output “H” Voltage	V_{CC}=3.9V, Ioh=-50uA	V_{CH}	3.4	3.7		V
OC Pin Output “L” Voltage	V_{CC}=4.5V, CSI=0V	V_{CL}		0.1	0.5	V

BLOCK DIAGRAM



PIN DESCRIPTIONS

PIN 1:OD - MOSFET gate connection pin for discharge control.

PIN 2:CSI - Input pin for current sense,charger detect.

PIN 3:OC - MOSFET gate connection pin for charge control.

PIN 4:DS – Test pin for reduce delay time

PIN 5:VCC - Power pin

PIN 6:GND - Ground pin.

APPLICATION INFORMATIONS
THE OPERATION

Overcharge Protection

When the voltage of the battery cell exceeds the overcharge protection voltage (V_{OCP}) beyond the overcharge delay time (T_{OC}) period, charging is inhibited by the turning-off of the charge control MOSFET. The overcharge delay time defaults to 100ms. The overcharge condition is released in two cases:

1. The voltage of the battery cell becomes lower than the overcharge release voltage (V_{OCR} or V_{OCP}- V_{HYS}) through self-discharge.
2. The voltage of the battery cell falls below the overcharge protection voltage (V_{OCP}) and a load is connected.

When the battery voltage is above V_{OCP}. the overcharge condition is never released even a load is connected to the pack.

Overdischarge Protection

When the voltage of the battery cell goes below the overdischarge protection voltage (V_{ODP}) beyond the overdischarge delay time (T_{OD}) period, discharging is inhibited by the turning-off of the discharge control MOSFET.The overdischarge delay time defaults to 10ms.

Inhibition of discharging is immediately released when the voltage of the battery cell becomes higher than overdischarge release voltage (V_{ODR}) through charging.

Overcurrent Protection

In normal mode,the DW_LP2 continuously monitors the discharge current by sensing the voltage of CS pin. If the voltage of CS pin exceeds the overcurrent protection voltage (V_{OIP}) beyond the overcurrent delay time (T_{OI}) period, the overcurrent protection circuit operates and discharging is inhibited by the turning-off of the discharge control MOSFET. The overcurrent condition returns to the normal mode when the load is released and the impedance between the BATT+ and BATT.

The DW_LP2 is provided with the two overcurrent detection levels (0.15V and 1.35V) and the two overcurrent delay time (T_{OI1} and T_{OI2}) corresponding to each overcurrent detection level.

Load Detection after Overcharge

The load detection function after overcharge is implemented by detecting the CS pin voltage. Once a load is connected to the battery pack after overcharge, discharge current flows through the parasitic diode of MOSFET and there is a diode voltage drop between CS and GND. Load is determined to be connected to the pack if the CS pin voltage is above load detection threshold voltage (V_{LD}).

Charge Detection after Overdischarge

When overdischarge occurs, the discharge control MOSFET turns off and discharging is inhibited. However, charging is still permitted through the parasitic diode of MOSFET. Once the charger is connected to the battery pack, the DW_LP2 immediately turns on all the timing generation and detection circuitry. Charging is determined to be in progress if the voltage between CS and GND is below charae detection threshold voltage (V_{CH}).

Power-Down after Overdischarge

When overdischarge occurs, the DW_LP2 will go into power-down mode, turning off all the timing generation and detection circuitry to reduce the quiescent current to 0.1uA (V_{CC}=2.0V). At the same time, the CS pin is pull-high to VCC through a high resistance resistor.

DESIGN GUIDE

Selection of External Control MOSFETs

Because the overcurrent protection voltage is preset, the threshold current for overcurrent detection is determined by the turn-on resistance of the discharge control MOSFET . The turn-on resistance of the external control MOSFETs can be determined by the equation: $R_{ON}=V_{OIP}/(2 \times I_T)$ (I_T is the overcurrent threshold current). For example, if the overcurrent threshold current I_T is designed to be 3A, the turn-on resistance of the external control MOSFETs must be 25mΩ. Users should be aware that turn-on resistance of the MOSFET changes with temperature variation due to heat dissipation. It changes with the voltage between gate and source as well. (Turn-on resistance of MOSFET increases as the voltage between gate and source decreases). Once the turn-on resistance of the external MOSFET changes, the overcurrent threshold current will change accordingly.

Suppressing the Ripple and Disturbance from Charger

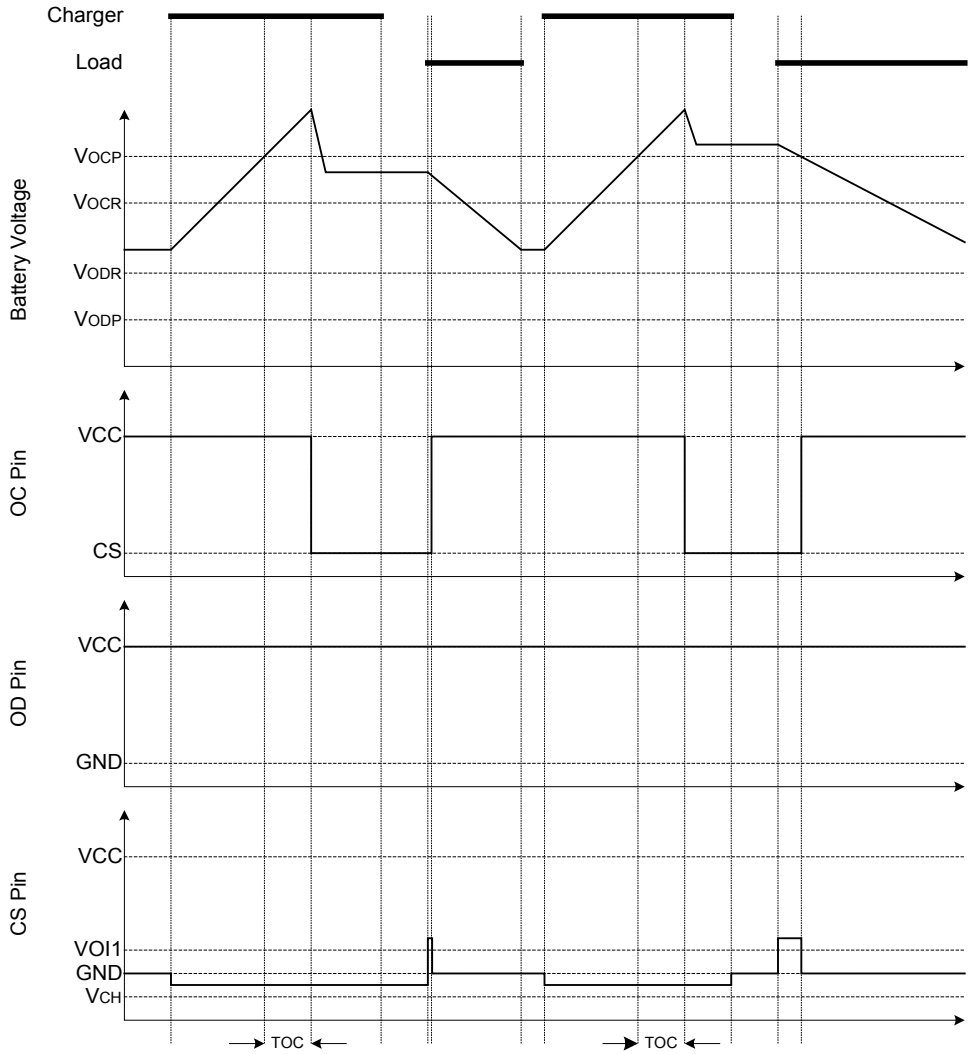
To suppress the ripple and disturbance from charger, connecting Rl,C1 to VCC pin is recommended.

Protection at CS pin

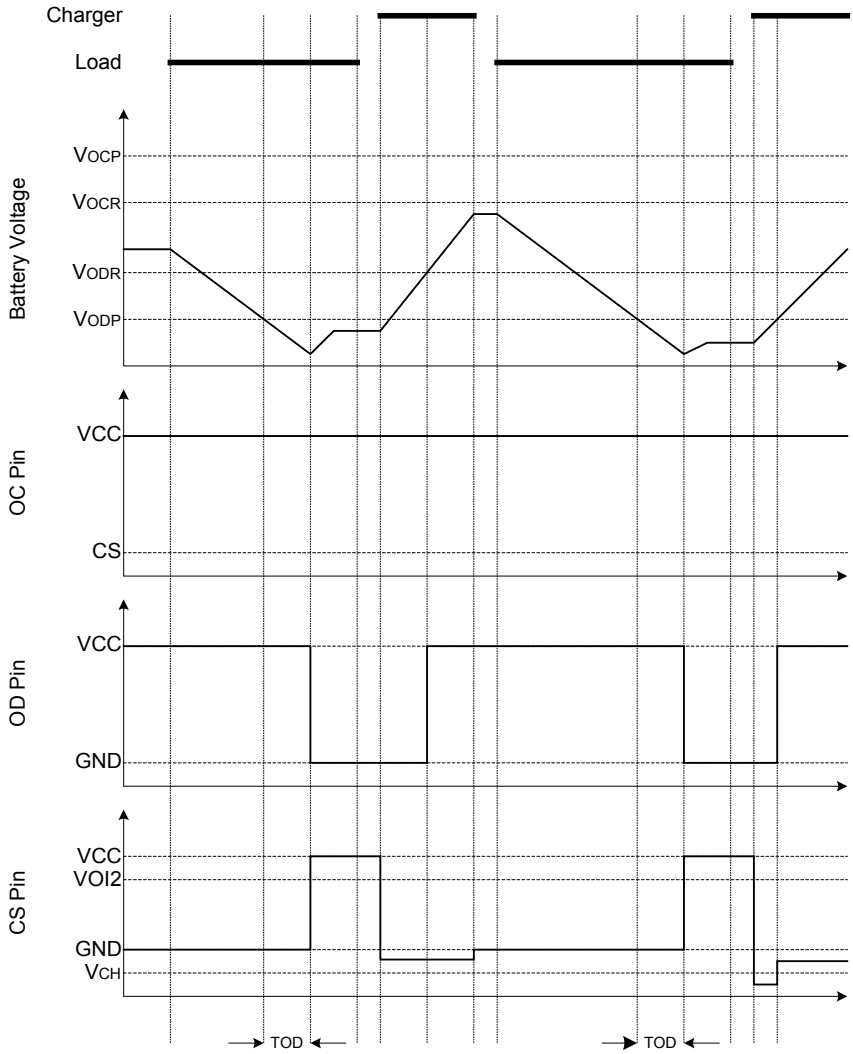
R2 is used for latch-up protection when charger is connected under overdischarge condition and overstress protection at reverse connecting of a charger.

TIMING DIAGRAM

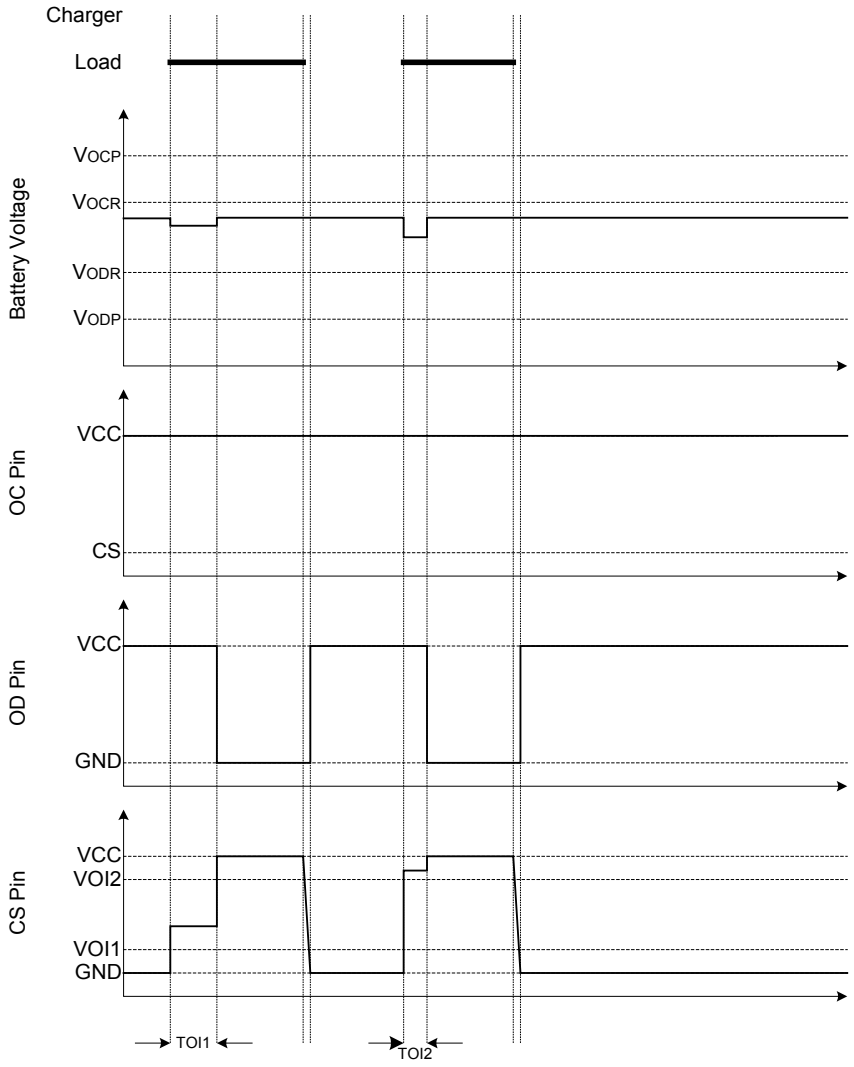
Overcharge Condition →Load Discharging → Normal Condition



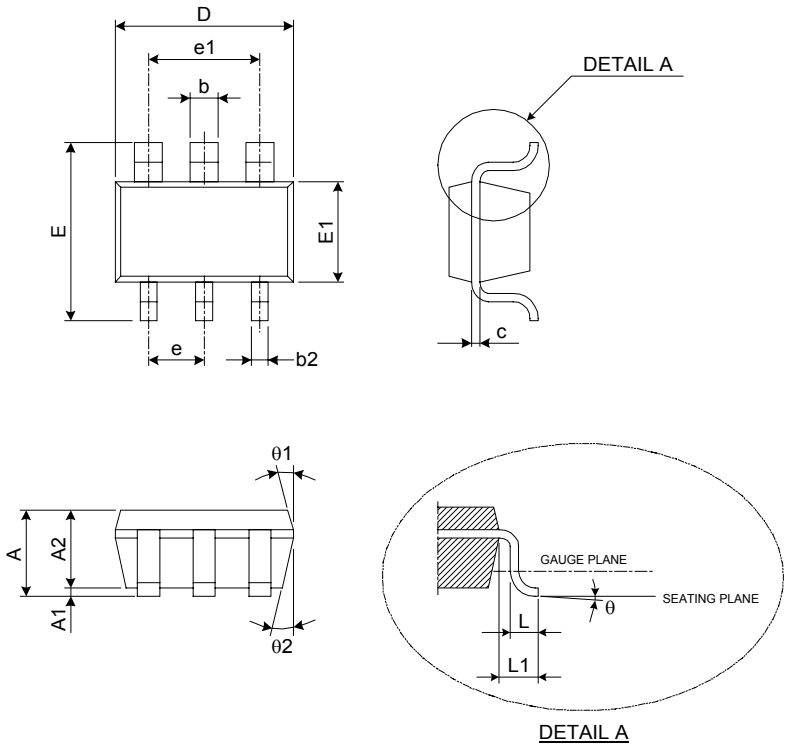
Overdischarge Condition → Charging by a Charger →Normal Condition



Over Current Condition → Normal Condition



PHYSICAL DIMENSIONS



Unit : mm

SYMBOL	MIN.	TYP.	MAX.
A	1.05	-	1.35
A1	0.05	-	0.15
A2	1.00	1.10	1.20
b	0.40	-	0.55
b2	0.25	-	0.40
c	0.08	-	0.20
D	2.70	2.90	3.00
E	2.60	2.80	3.00
E1	1.50	1.60	1.70
L	0.35	0.45	0.55
L1	0.60 REF.		
e	0.95 BSC.		
e1	1.90 BSC.		
θ	0°	5°	10°
θ1	3°	5°	7°
θ2	6°	8°	10°