Datasheet

FS312MH

One Cell Lithium-ion/Polymer Battery Protection IC With Built-in MOSFET

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文管中心
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SEMICONDUCTOR CORPORATION

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1. General Description

The FS312MH battery protection IC with built-in N-MOSFET is designed to protect lithium-ion /polymer battery from damage or degrading the lifetime due to overcharge, overdischarge, and/ or overcurrent for one-cell lithium-ion/polymer battery powered systems, such as cellular phones.

The ultra-small package and less required external components make it ideal to integrate the FS312MH into the limited space of battery pack. The accurate ±30mV overcharging detection voltage ensures safe and full utilization charging. The very low standby current drains little current from the cell while in storage.

2. Features

- **Built-in N-MOSFET of low turn-on resistance.**
- **Reduction in Board Size due to Miniature Package SOT-23-6 or TSSOP-8.**
- **Protection IC：**
  - **Ultra-Low Quiescent Current at 3μA (Vcc=3.9V).**
  - **Overcharge Protection Voltage**

    4.25V ± 30mV
  - **Overdischarge Protection Voltage**

    2.9V ± 100mV
  - **Overcurrent Protection Voltage**

    150mV ± 30mV
- **MOSFET：**
  - **Rss(ON) ＜ 40mΩ**

    (V_{GS} = 3.7V , I_D = 1A)

    (FS312MH-T)
  - **Rss(ON) ＜ 50mΩ**

    (V_{GS} = 3.7V , I_D = 1A)

    (FS312MH-S)

3. Ordering Information

FS312MH-x
Serial code from S、T*

(S：SOT-23-6 Green-Package)

(T：TSSOP-8 Green-Package)

* Refer to the product name list on next page.

TEMPERATURE RANGE
-40°C~+85°C

4. Applications

- **Protection IC for One-Cell Lithium-Ion / Lithium-Polymer Battery Pack**

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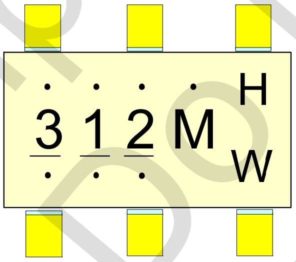
5. Product Name List

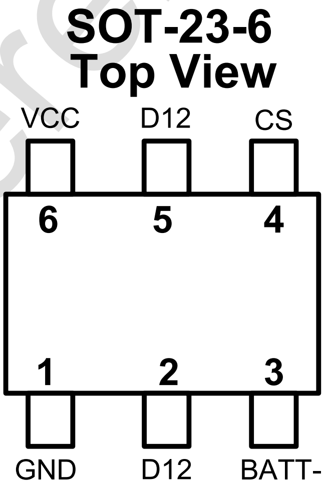
Model	Overcharge detection voltage [VOCP] (V)	Overcharge release voltage [VOCR] (V)	Overdischarge detection voltage [VODP] (V)	Overdischarge release voltage [VODR] (V)	Overcurrent detection voltage [VOI1] (mV)	0V change function	Standby function release
FS312MH-S	**4.25±0.030**	**4.145±0.050**	**2.90±0.100**	**3.00±0.100**	**150±30**	**YES**	**Auto Recovery**
FS312MH-T	**4.25±0.030**	**4.145±0.050**	**2.90±0.100**	**3.00±0.100**	**150±30**	**YES**	**Auto Recovery**

6. Pin Configuration and Package Marking Information

Pin No.	Symbol	Description
1	GND	Ground pin
2	D12	Two MOSFET common drain connection pin
3	BATT-	Connect to negative of charger or load
4	CS	Input pin for current sense, charger detect
5	D12	Two MOSFET common drain connection pin
6	VCC	Power supply, through a resistor (R1)



Top Point and Under_line：Lot No.
Bottom Point：Year
W : week, A~Z & A ~ Z



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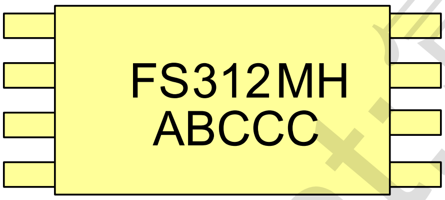
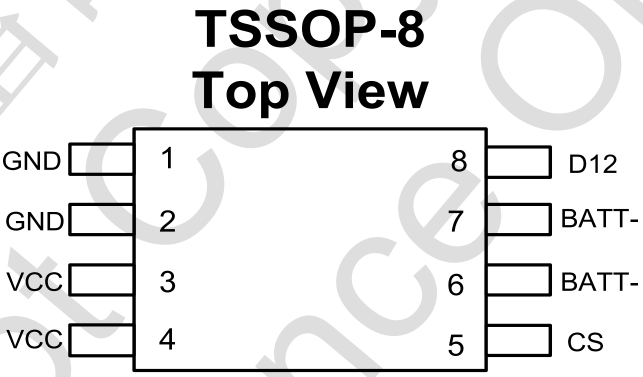
Pin No.	Symbol	Description
1	GND	Ground pin
2	GND	Ground pin
3	VCC	Power supply, through a resistor (R1)
4	VCC	Power supply, through a resistor (R1)
5	CS	Input pin for current sense, charger detect
6	BATT-	Connect to negative of charger or load
7	BATT-	Connect to negative of charger or load
8	D12	Two MOSFET common drain connection pin



A：Year Code, A~Z & A ~ Z.
B：Week Code, A~Z & A ~ Z
CCC：Lot Code



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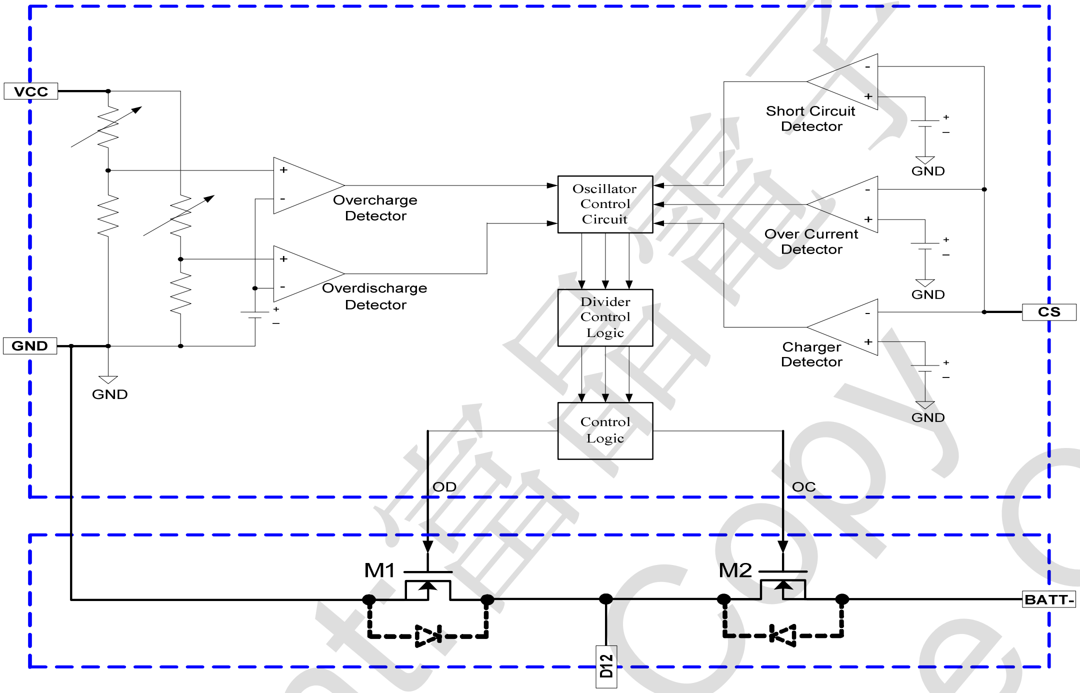
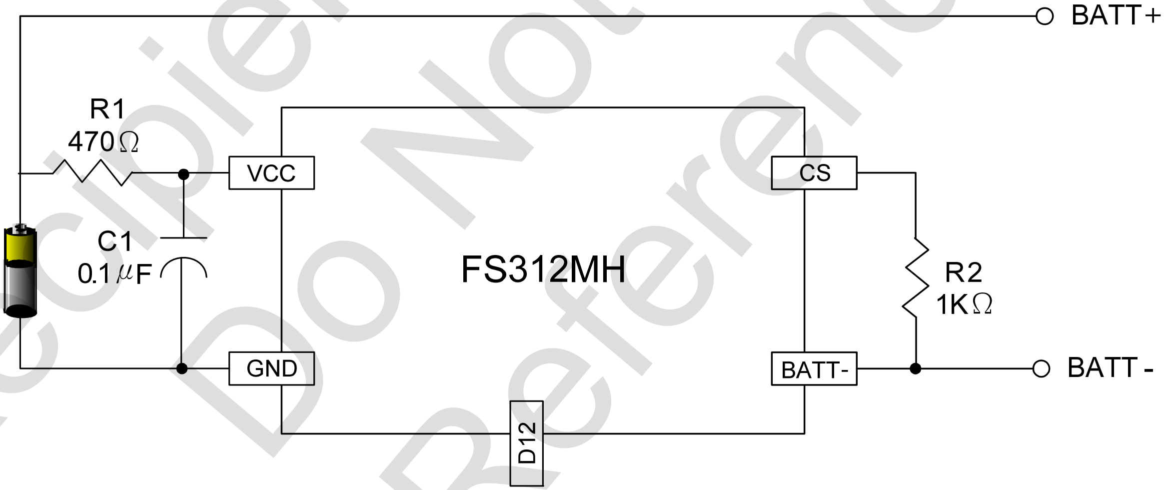
7. Functional Block Diagram



8. Typical Application Circuit



Symbol	Purpose	Recommended	Remakes
R1	ESD protection. For power fluctuation.	100~470Ω	Resistance should be as small as possible to avoid lowering of the overcharge detection accuracy caused by VDD pin current. Use 470Ω for better ESD protection.
C1	For power fluctuation.	0.1μF	
R2	Protection for reverse connection of a charger.	1k~2kΩ	Select a resistance as large as possible to prevent large current when a charge is connected in reverse.

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9. Absolute Maximum Ratings

(GND=0V, Ta=25°C unless otherwise specified)

Item	Symbol	Rating	Unit
Input voltage between VCC and GND *Note1	VCC	GND-0.3 to GND+10	V
CS input pin voltage	VCS	VCC -20 to VCC +0.3	V
Operating Temperature Range	TOP	-40 to +85	°C
Storage Temperature Range	TST	-40 to +125	°C
Drain-Source Voltage	VDS	20	V
Gate-Source Voltage	VGS	±12	V
Continuous Drain Current3	ID @TA=25℃	6	A
Continuous Drain Current3	ID @TA=70℃	5	A
Pulsed Drain Current1	IDM	25	A
Total Power Dissipation	PD @TA=25℃	0.5	W
Linear Derating Factor		0.008	W/℃

Note1: FS312MH contains a circuit that will protect it from static discharge; but please take special care that no excessive static electricity or voltage which exceeds the limit of the protection circuit will be applied to it.

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10. Electrical Characteristics

(Ta=25°C unless otherwise specified)

PARAMETER	TEST CONDITIONS	SYMBOL	Min	Typ	Max	UNIT
Supply Current	VCC=3.9V	ICC		3.0	6.0	μA
Overdischarge Current	VCC=2.0V	IOD		1.5	3.5	μA
Overcharge Protection Voltage	FS312MH-S、 FS312MH-T	VOCP	4.22	4.25	4.28	V
Overcharge Release Voltage		VOCR	4.095	4.145	4.195	V
Overdischarge Protection Voltage		VODP	2.80	2.90	3.00	V
Overdischarge Release Voltage		VODR	2.90	3.00	3.10	V
Overcurrent Protection Voltage		VOIP （VOI1）	120	150	180	mV
Short Current Protection Voltage	VCC=3.6V	VSIP （VOI2）	1.00	1.35	1.70	V
0V Battery Charger Starting Charge Voltage	0V Battery Charging Available	V0CHA	1.5			V
Overcharge Delay Time		TOC		80	300	ms
Overdischarge Delay Time	VCC=3.6V to 2.0V	TOD		40	100	ms
Overcurrent Delay Time (1)	VCC=3.6V	TOI1		10	20	ms
Overcurrent Delay Time (2)	VCC=3.6V	TOI2		100	200	μs
Charger Detection Threshold Voltage		VCH	-1.2	-0.7	-0.2	V
N-MOSFET						
Drain-Source Breakdown Voltage (BATT- to D12 / D12 to GND)	VGS=0V,ID=250uA	BVDSS	20			V
Breakdown Voltage Temperature Coefficient	Reference to 25℃, I_D=1mA	$\Delta BV_{DSS}/\Delta T_j$		0.1		V/℃
Static Source-Source On-Resistance (BATT- to GND) for FS312MH-T	VGS=3.7V,ID=1A	RSS(ON)		35	40	mΩ
	VGS=3V,ID=1A			40	45	mΩ
Static Source-Source On-Resistance (BATT- to GND) for FS312MH-S	VGS=3.7V,ID=1A			45	50	mΩ
	VGS=3V,ID=1A			55	60	mΩ
Drain-Source Leakage Current (BATT- to D12 / D12 to GND)	VDS=16V,VGS=0V	IDSS (Tj=25℃)			1	uA
Drain-Source Leakage Current (BATT- to D12 / D12 to GND)	VDS=16V,VGS=0V	IDSS (Tj=70℃)			25	uA

Note: The V0CHA is defined as the voltage between VCC and VCS (VCC-VCS>1.5V) at which OC pin goes "H" when the voltage VCC is gradually increased to the VCC=1V and VCS=-0.5V.

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11. Description of Operation

Normal Condition

If VODP<VCC<VOCP and VCH<VCS<VOI1, M1 and M2 are both turned on. The charging and discharging processes can be operated normally.

Overcharge Protection

When the voltage of the battery cell exceeds the overcharge protection voltage (VOCP) beyond the overcharge delay time (TOC) period, charging is inhibited by turning off of the charge control MOSFET. The overcharge condition is released in two cases:

The voltage of the battery cell becomes lower than the overcharge release voltage (VOCR) through self-discharge.

The voltage of the battery cell falls below the overcharge protection voltage (VOCP) and a load is connected.
When the battery voltage is above VOCP, the overcharge condition will not release even a load is connected to the pack.

Overdischarge Protection

When the voltage of the battery cell goes below the overdischarge protection voltage (VODP) beyond the overdischarge delay time (TOD) period, discharging is inhibited by turning off the discharge control MOSFET.

The default of overdischarge delay time is 40ms. Inhibition of discharging is immediately released when the voltage of the battery cell becomes higher than overdischarge release voltage (VODR) through charging.

Overcurrent Protection

In normal mode, the FS312MH continuously monitors the discharge current by sensing the voltage of CS pin. If the voltage of CS pin exceeds the overcurrent protection voltage (VOIP) beyond the overcurrent delay time (TOI1) period, the overcurrent protection circuit operates and discharging is inhibited by turning off the discharge control MOSFET. The overcurrent condition returns to the normal mode when the load is released or the impedance between BATT+ and BATT- is larger than 500kΩ. The FS312MH provides two overcurrent detection levels (0.15V and 1.35V) with two overcurrent delay time (TOI1 and TOI2) corresponding to each overcurrent detection level.

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 FS312MH immediately turns on all the timing generation and detection circuitry. Charging progress is sensed if the voltage between CS and GND is below charge detection threshold voltage (VCH).

Auto Power Down Recovery

The FS312MH continues to operate even after the overdischarge state has been entered. The battery voltage rising to the overdischarge release voltage(VODR) or higher is the only required condition for the IC to return to the normal state

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12. Design Guide

Suppressing the Ripple and Disturbance from Charger

To suppress the ripple and disturbance from charger, connecting R1 and C1 to VCC is recommended.

Protection the 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.

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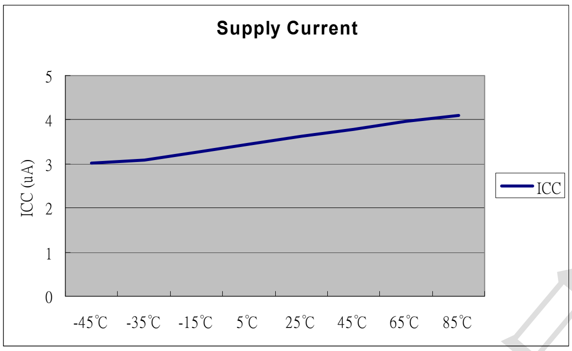
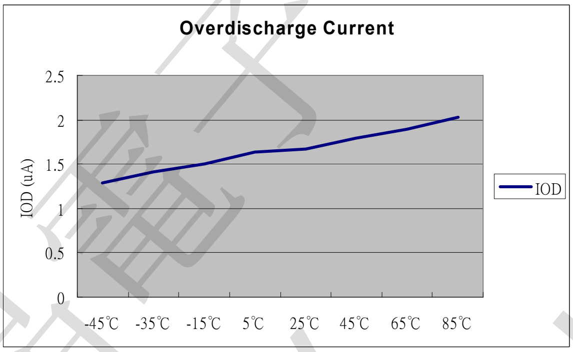
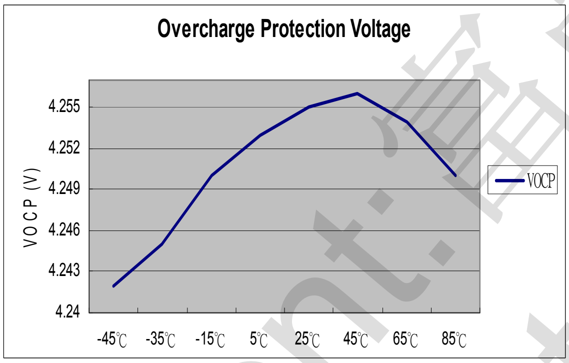
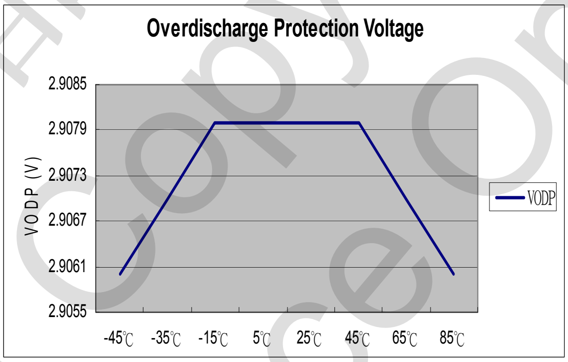
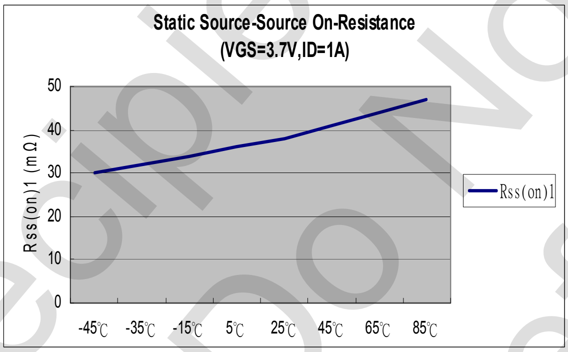
13. Typical Operating Characteristics

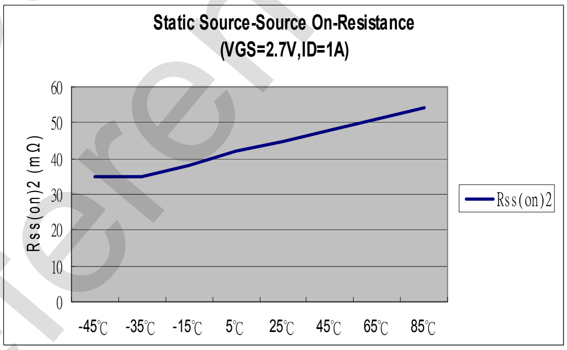


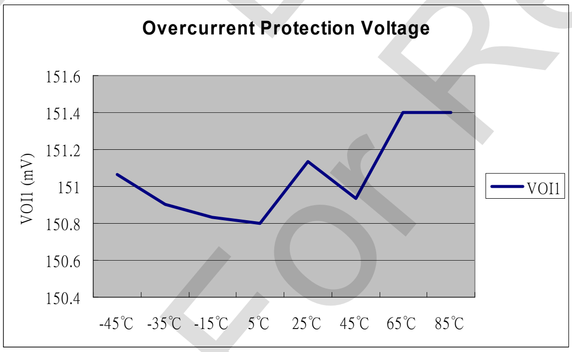












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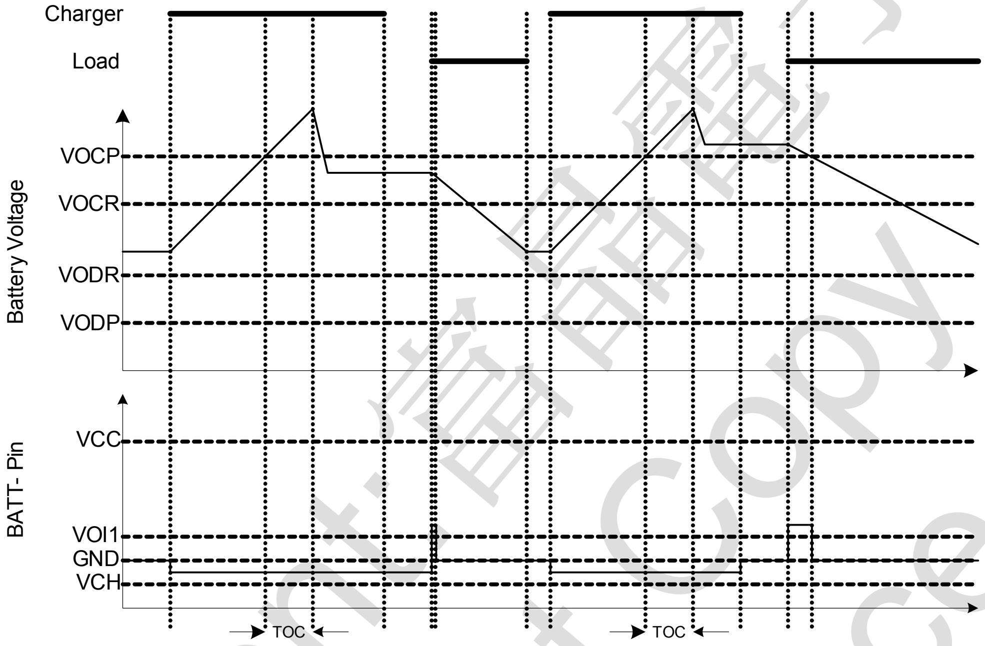
14. Timing Diagram

Overcharge Condition →Load Discharging → Normal Condition



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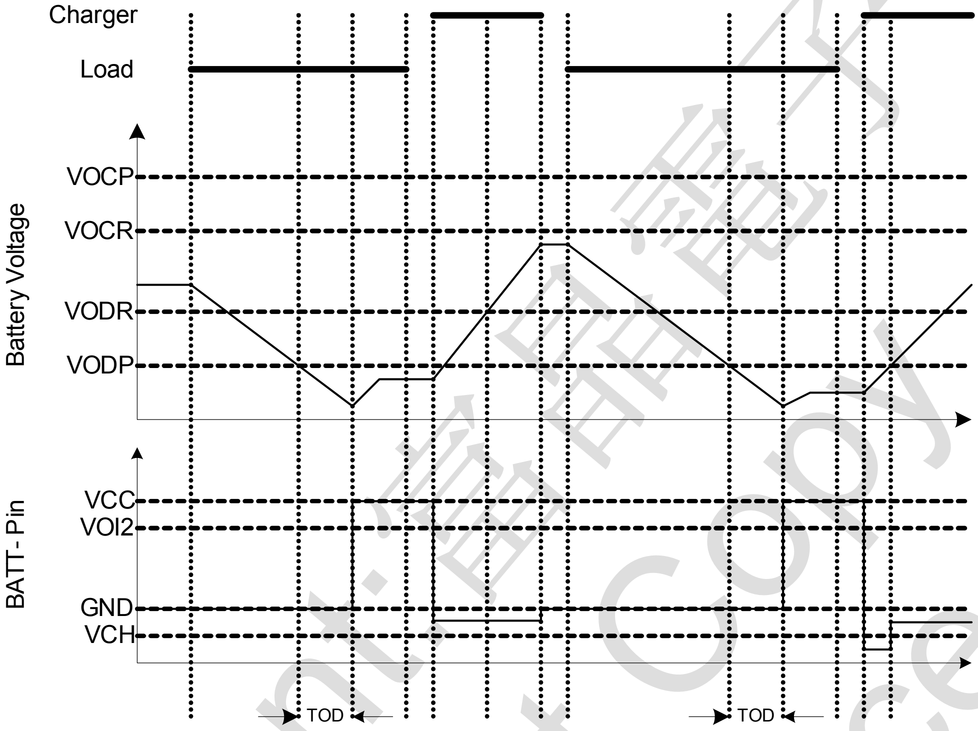
Overdischarge Condition → Charging by a Charger →Normal Condition



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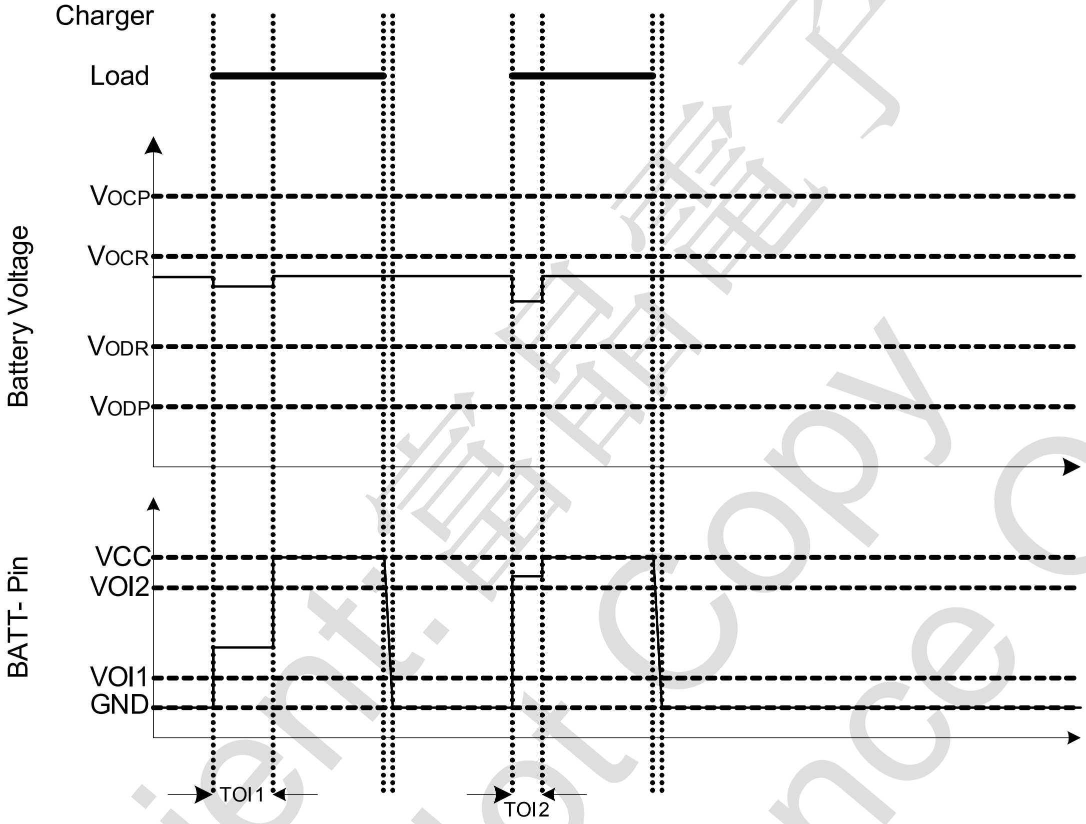
Over Current Condition → Normal Condition



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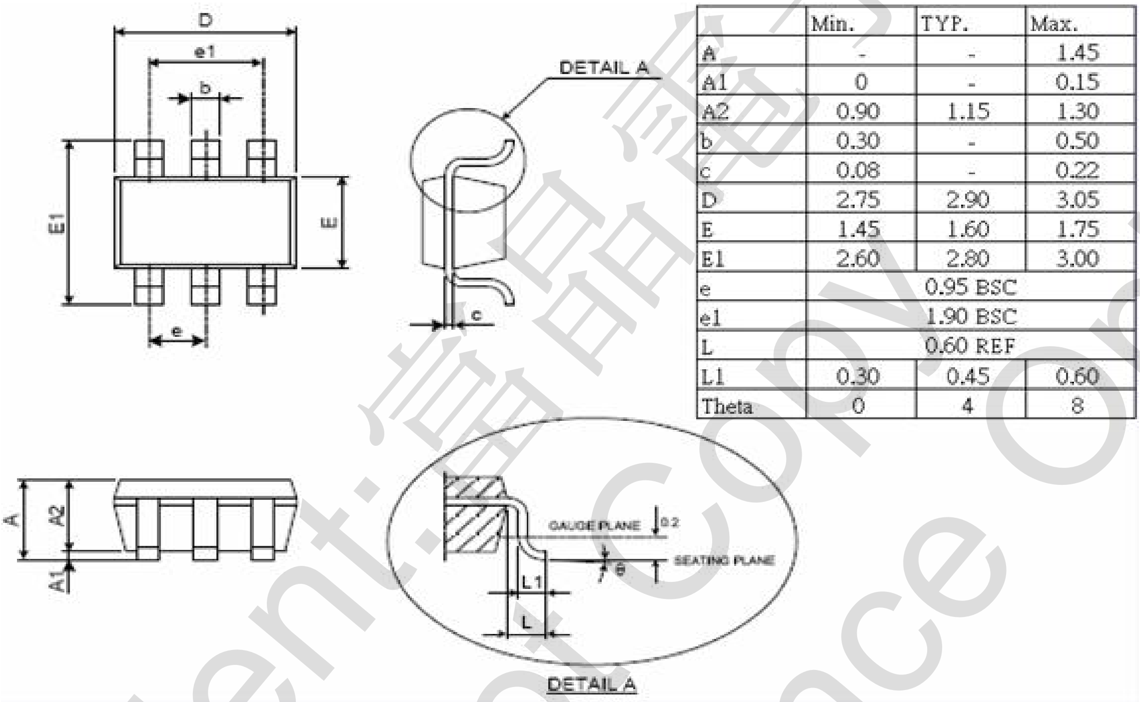
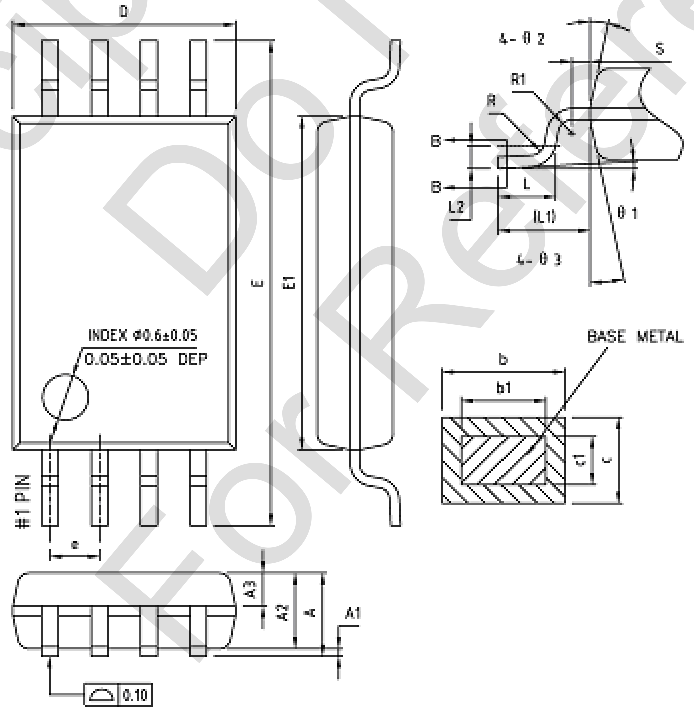
15. Package Outline

Dimension (SOT-23-6)



	Min.	TYP.	Max.
A	-	-	1.45
A1	0	-	0.15
A2	0.90	1.15	1.30
b	0.30	-	0.50
c	0.08	-	0.22
D	2.75	2.90	3.05
E	1.45	1.60	1.75
E1	2.60	2.80	3.00
e	0.95 BSC		
e1	1.90 BSC		
L	0.60 REF		
L1	0.30	0.45	0.60
Theta	0	4	8

Dimension (TSSOP-8)



COMMON DIMENSIONS
(UNITS OF MEASURE=MILLIMETER)

SYMBOL	MIN	NOM	MAX
A	–	–	1.20
A1	0.05	–	0.15
A2	0.90	1.00	1.05
A3	0.34	0.44	0.54
b	0.20	–	0.28
b1	0.20	0.22	0.24
c	0.10	–	0.19
c1	0.10	0.13	0.15
D	2.83	2.93	3.03
E	6.20	6.40	6.60
E1	4.30	4.40	4.50
e	0.65BSC		
L	0.45	0.60	0.75
L1	1.00REF		
L2	0.25BSC		
R	0.09	–	–
R1	0.09	–	–
S	0.20	–	–
θ 1	0°	–	8°
θ 2	10°	12°	14°
θ 3	10°	12°	14°

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16. Revision History

Version	Date	Page	Description
1.0	2013/02/04	All	New release
1.1	2013/05/02	3,8	Add FS312MH-S、FS312MH-T Rss(on) Specified
		11	Add VOCP、VODP、Rss(on)1、Rss(on)2 Operating Characteristics

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