Datasheet

DW01H

One Cell Lithium-ion/Polymer Battery Protection IC

FORTUNE SEMICONDUCTOR CORPORATION

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1. General Description

The DW01H battery protection IC 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 DW01H into the limited space of battery pack. The accurate ±50mV 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

- **Reduction in Board Size due to Miniature Package SOT-23-6.**
- **Ultra-Low Quiescent Current at 2.5μA (Vcc=3.9V).**
- **Ultra-Low Overdischarge Current at 1.8μA (Vcc=2.0V).**
- **Precision Overcharge Protection Voltage 4.28V ± 25mV**
- **Load Detection Function during Overcharge Mode.**
- **Two Detection Levels for Overcurrent Protection.**
- **Charge Overcurrent Protection Function.**
- **Delay times are generated by internal circuits. No external capacitors required.**

3. Ordering Information

DW01H-G

PACKAGE TYPE
SOT-23-6 (G stands for Green-Package)

TEMPERATURE RANGE
-40°C~+85°C

4. Applications

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

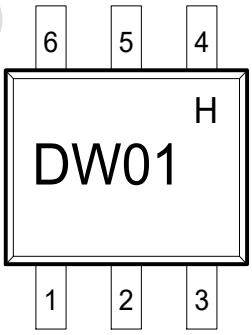
5. Product Name List

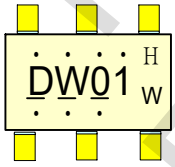
Model	Package	Overcharge detection voltage [VOCP] (V)	Overcharge release voltage [VOCR] (V)	Overdischarge detection voltage [VODP] (V)	Overdischarge release voltage [VODR] (V)	Overcurrent detection voltage [VOI1] (V)	Charge overcurrent detection voltage [VCOIP] (V)	0V charge function	Standby function release
DW01H	SOT-23-6	4.28±0.025	4.08±0.050	2.40±0.100	2.50±0.100	0.150±30mV	*-0.150±40mV	NO	AUTO recovery

*Test conditions: R2(CS)=1KΩ - VCOIP adjustable by R2(CS)

6. Pin Configuration and Package Marking Information

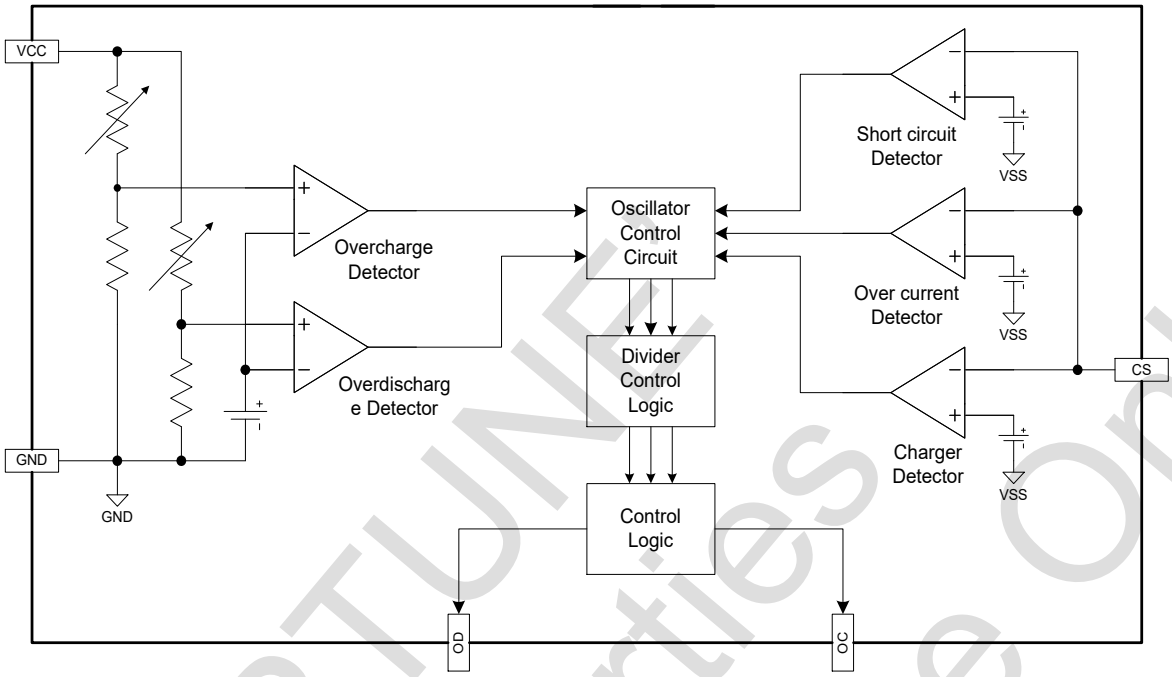
Pin No.	Symbol	Description
1	OD	MOSFET gate connection pin for discharge control
2	CS	Input pin for current sense, charger detect
3	OC	MOSFET gate connection pin for charge control
4	NC	NC
5	VCC	Power supply, through a resistor (R1)
6	GND	Ground pin



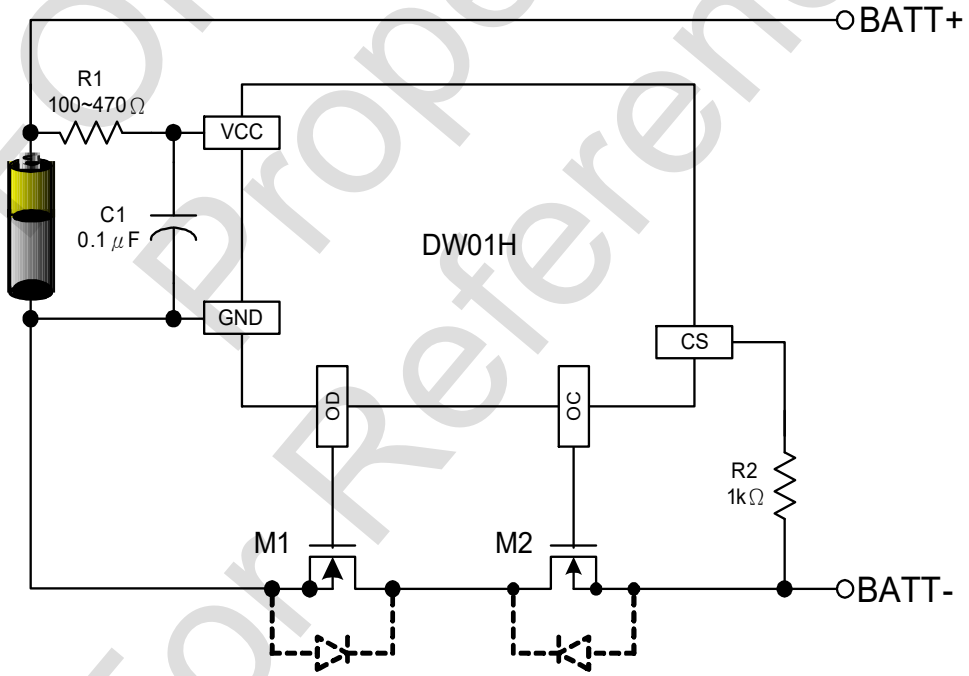


Top Point and Under_line：Lot No.
Bottom Point：Year
w : week, A~Z & A ~ Z

7. Functional Block Diagram



8. Typical Application Circuit



9. Absolute Maximum Ratings

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

Item	Symbol	Rating	Unit
Input voltage between VCC and GND *	VCC	GND-0.3 to GND+15	V
CS input pin voltage	VCS	VCC -30 to VCC +0.3	V
Operating Temperature Range	TOP	-40 to +85	°C
Storage Temperature Range	TST	-40 to +125	°C

Note: DW01H 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.

10. Electrical Characteristics

(Ta=25°C unless otherwise specified)

PARAMETER	TEST CONDITIONS	SYMBOL	Min	Typ	Max	UNIT
Supply Current	VCC=3.9V	ICC		2.5	5.2	μA
Overdischarge Current	VCC=2.0V	IOD		1.8	4.5	μA
Overcharge Protection Voltage	DW01H	VOCP	4.255	4.280	4.305	V
Overcharge Release Voltage		VOCR	4.030	4.080	4.130	V
Overdischarge Protection Voltage		VODP	2.300	2.400	2.500	V
Overdischarge Release Voltage		VODR	2.400	2.500	2.600	V
Overcurrent Protection Voltage		VOIP (VOI1)	0.120	0.150	0.180	V
Short Current Protection Voltage	VCC=3.6V	VSIP (VOI2)	0.85	0.95	1.05	V
Charge Overcurrent Detection Voltage	VDD=3.6V, R2(CS)=1KΩ	VCOIP	-0.190	-0.150	-0.110	V
Overcharge Delay Time		TOC	130	200	280	ms
Overdischarge Delay Time	VCC=3.6V to 2.0V	TOD	65	100	140	ms
Overcurrent Delay Time (1)	VCC=3.6V	TOI1	13.3	20.0	26.5	ms
Overcurrent Delay Time (2)	VCC=3.6V	TOI2		1.0	1.80	ms
Charge Overcurrent Delay Time	VCC=3.6V	Tdet			32.0	ms
Charge Overcurrent Delay Time with MOSFET on PCM *1	VCC=3.6V	Tdet_PCM			64.0	ms

Note *1: If the charge overcurrent test current on PCM is increasing step by step and the ABS(voltage) across the MOSFET RSSON is near and lower than the ABS(VCOIP), the current flow through the MOSFET will heat and increase the MOSFET RSSON for a short time (delta_T) thus the increasing voltage across the MOSFET might trigger the VCOIP later. The Tdet_PCM ~= delta_T + Tdet. The delta_T depends on the current flow through the MOSFET and the MOSFET spec.

11. Description of Operation

Normal Condition

If VODP<VCC<VOCP and VCOIP<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 10ms. 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 DW01H 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 DW01H 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 Overcurrent Detection

When a battery in the normal status is in the status where the voltage of the CS pin is lower than the charge overcurrent detection voltage (VCOIP) because the charge current is higher than the specified value and the status lasts for the charge overcurrent delay time (Tdet), the charge control MOSFET is turning off and charging is stopped.

This IC (DW01H) will be restored to the normal status from the charge overcurrent status when, the voltage at the CS pin retums to charge overcurrent detection voltage (VCOIP) or higher by removing the charger.

Auto Power Down recovery

The IC 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.

12. Design Guide

Selection of External Control MOSFET

Because the overcurrent protection voltage is preset, the threshold current for overcurrent detection is determined by the turn-on resistance of the charge and discharge control MOSFETs. The turn-on resistance of the external control MOSFETs can be determined by the equation: RON=VOIP/ (2 x IT) (IT is the overcurrent threshold current). For example, if the overcurrent threshold current IT is designed to be 3A, the turn-on resistance of the external control MOSFET must be 25mΩ. 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).

As the turn-on resistance of the external MOSFET changes, the design of the overcurrent threshold current changes accordingly.

Suppressing the Ripple and Disturbance from Charger

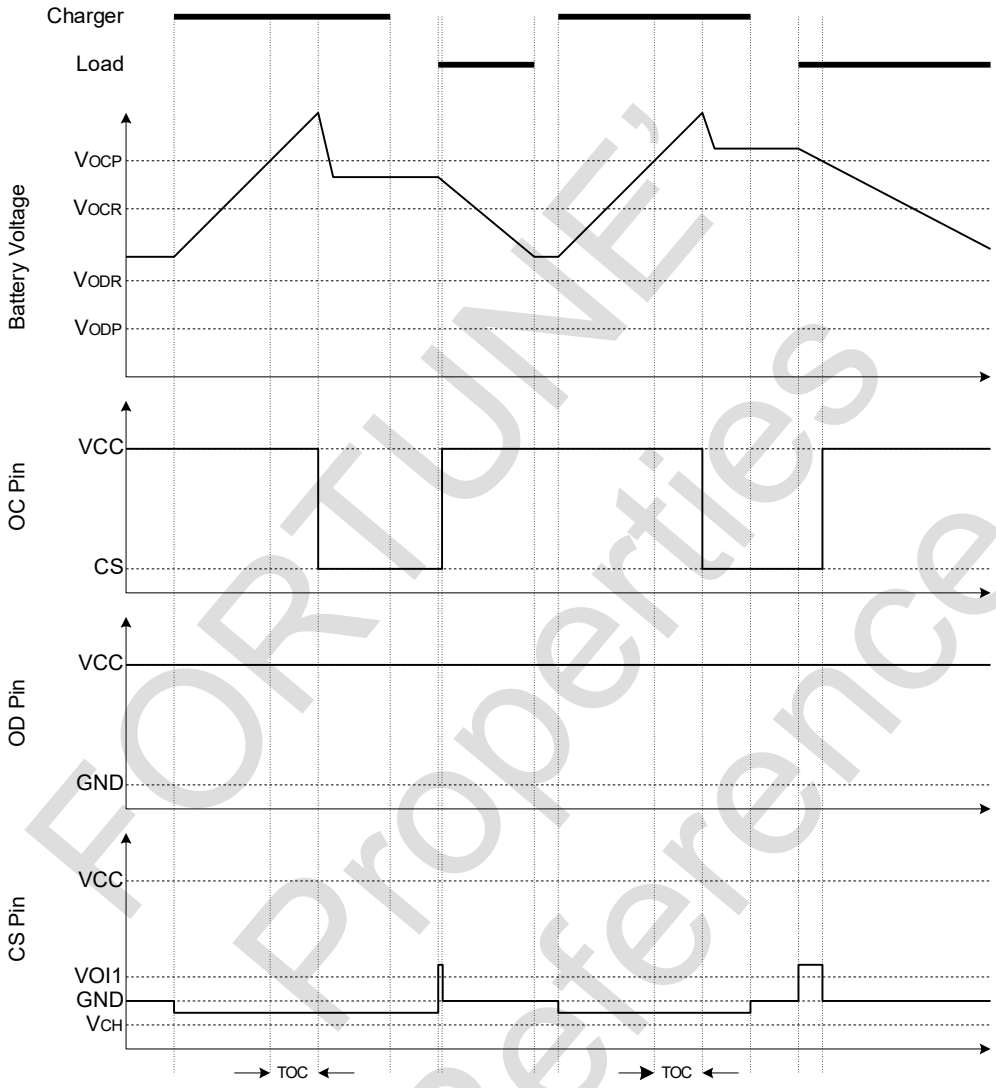
To suppress the ripple and disturbance from charger, connecting R1 and C1 to VCC is recommended.

Protection the CS pin

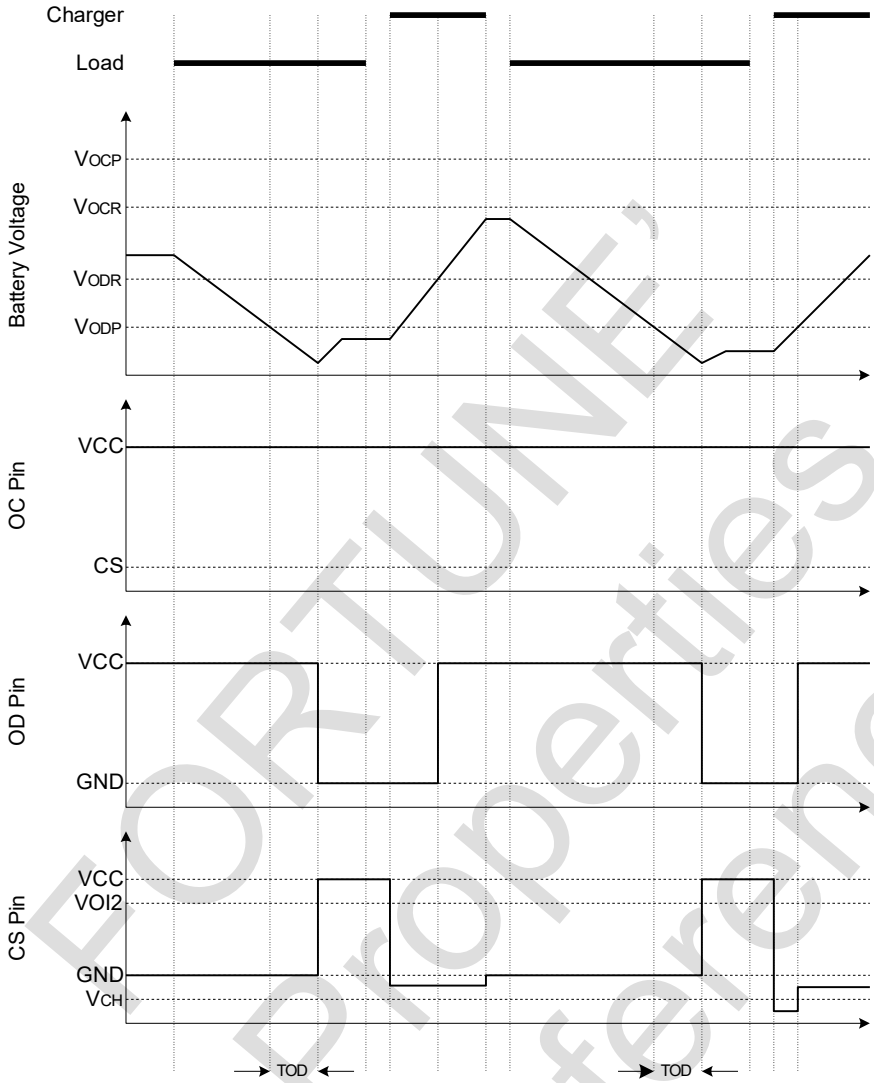
R2 is used for latch-up protection when charger is connected under overdischarge condition and overstress protection at reverse connecting of a charger.

13. Timing Diagram

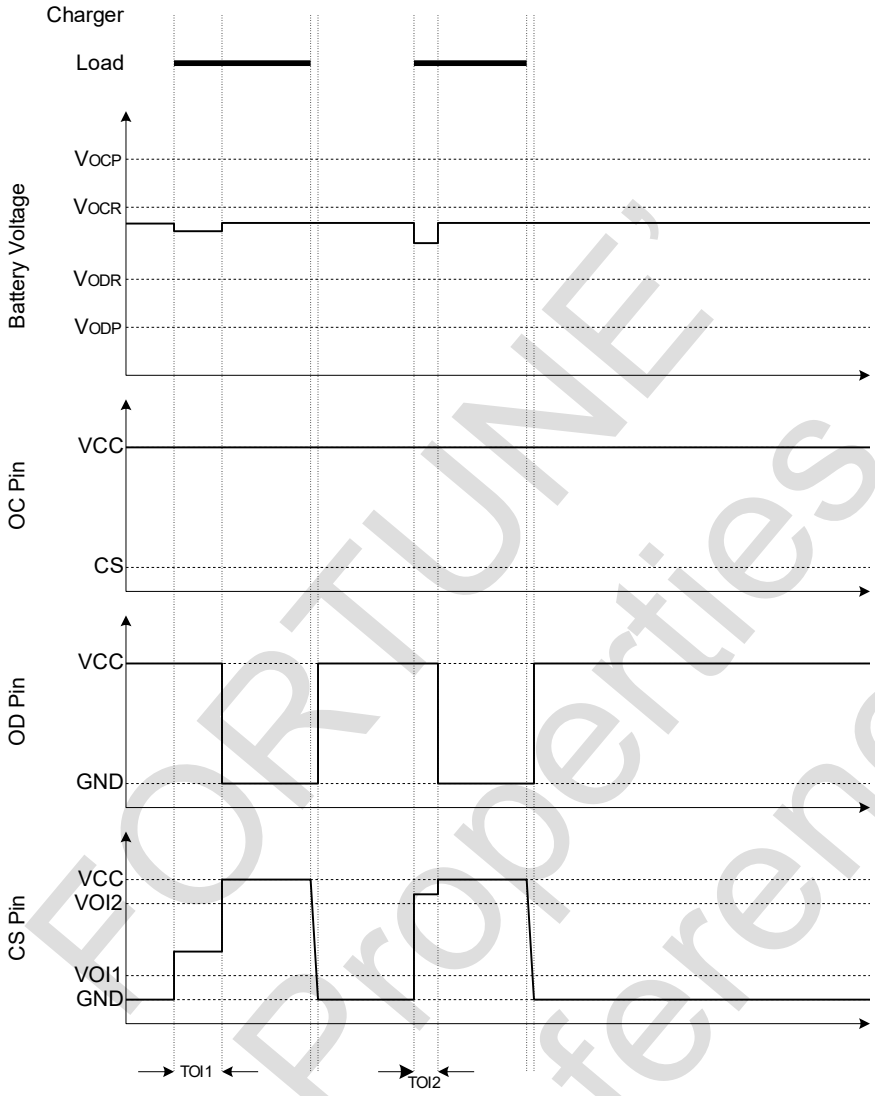
Overcharge Condition →Load Discharging → Normal Condition



Overdischarge Condition → Charging by a Charger →Normal Condition

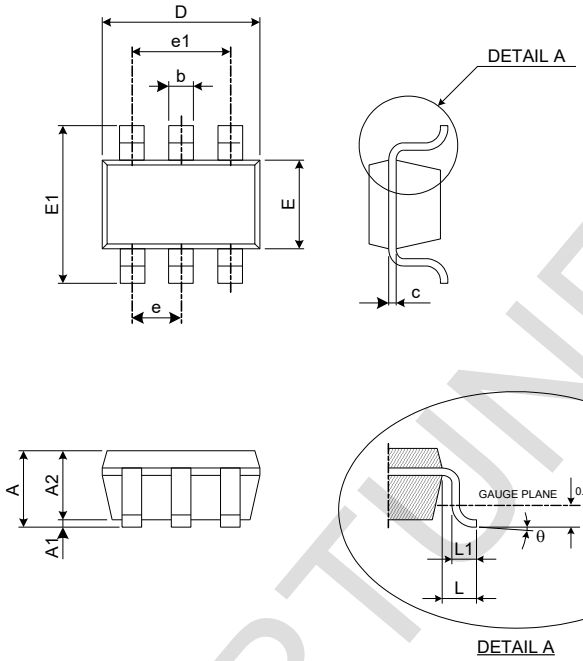


Over Current Condition → Normal Condition



14. Package Outline

Dimension



Unit : mm

SYMBOL	MIN.	TYP.	MAX.
A	1.050	-	1.250
A1	0.000	-	0.100
A2	1.050	-	1.150
b	0.300	-	0.400
c	0.100	-	0.200
D	2.820	-	3.020
E	1.500	-	1.700
E1	2.650	-	2.950
e	0.950 TYP		
e1	1.800	-	2.000
L	0.700REF		
L1	0.300	-	0.600
θ	0°	-	8°

15. Revision History

Version	Date	Page	Description
1.0	2010/04/14	ALL	New release
1.1	2014/01/09	4	Revise VOI1 Specified Unit
1.2	2016/03/28	3,4,7,8	Modify Charge Overcurrent Detection Voltage Spec
1.3	2020/09/30	4,7	VCOIP, VOI1 and VOI2 spec. renewed
1.4	2020/10/15	7	Modify Tdet delay time
1.5	2021/05/07	7	Revise typos