One Cell Lithium-ion/Polymer Battery Protection Controller

Description

The SSC59XX series product is a high integration solution for lithium-ion/polymer battery protection. The controller contains advanced power MOSFET, integrated high-precision voltage detection circuit and delay circuit.

The 59XX series have low quiescent current and all the protection functions required in the battery application including overcharging, over-discharging, overcurrent, and load short circuiting protection etc. The accurate overcharging detection voltage ensure safe and full utilization charging.

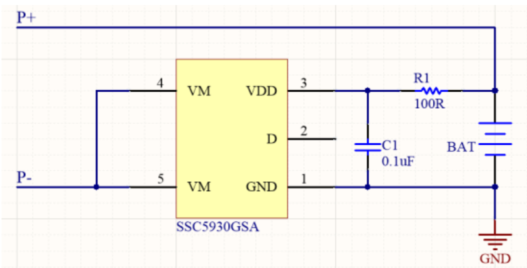
Feature

- Protection of Charger Reverse Connection
- Protection of Battery Cell Reverse Connection
- Over Charge Current Protection
- Over Discharge Current Protection
- Load Short Circuit Protection
- Over Temperature Protection
- Charger Detection Function
- 0V Battery Charging Function
- High Accuracy Voltage Detection: 150mV
- Low Current Consumption: 2.8uA
- Power MOSFET Impedance: 40mR

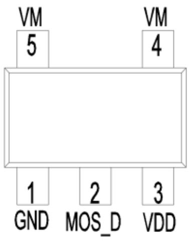
Application

- One-cell Lithium-ion Battery Pack
- Lithium-Polymer Battery Pack

Typical Circuit



Pin Configuration



SOT23-5L

GND	BAT Ground
MOS_D	Floating
VDD	Power Supply
VM	Power Ground

Ordering Information

Device	Overcharge Detection Voltage V_{CU}	Overcharge Release Voltage V_{CL}	Over-discharge Detection Voltage V_{DL}	Over-discharge Release Voltage V_{DR}	Overcurrent Detection Current I_{VO1}	Marking
SSC5930 GSA	4.30V± 50mV	4.10V± 50mV	2.40V± 100mV	3.0V± 100mV	3.5A	SS 5930

Device	Package	Shipping (Tape & Reel)
SSCXXXXGSA	SOT23-5L	3K

Absolute Maximum Ratings

Parameter	Symbol	Value	Unit
VDD Pin Input Voltage	V_{DD}	-0.3 ~ 8.0	V
VM Pin Input Voltage	V_{VM}	-6 ~ 10	V
Power Dissipation	P_D	0.4	W
Package Thermal Resistance	$R_{\theta JA}$	250	°C/W
ESD Rating	HBM	4	KV
Operating Temperature	T_{OPT}	-40~+85	°C
Storage Temperature	T_{ST}	-40~+125	°C
Lead Temperature	T_{LT}	260（10S）	°C

Note: Do not exceed these limits to prevent damage to the device. Exposure to the absolute maximum ratings conditions for long periods may affect device reliability.

Electrical Characteristics (unless otherwise specified, TA=25°C)

Parameter	Symbol	Test Condition	MIN	Typ.	MAX	Unit
Operating Voltage	V_{OPT}		2		6	V
Charger Detection Voltage	V_{CHA}		-0.07	-0.12	-0.2	V
Over-discharge Current Detection	I_{OV1}	VDD=3.6V	3.2	3.5	4.5	A
Overcharge Current Detection	I_{OV2}	VDD=3.6V	3.2	3.5	4.5	A
Load Short-circuiting Detection	I_{SHORT}	VDD=3.6V	10	20	30	A
Current Consumption IN Normal Operation	I_{OPT}	VDD=3.6V VM=0V		2.8	6	uA
Current Consumption IN Power Down	I_{SD}	VDD=2V VM Floating		1.5	2	uA
Discharge Over-current Detection Voltage	V_{DET}	VDD=3V		150		mV
FET On Resistance	R_{ON}	VDD=3.6V IVM=1A		40		mR
Internal Resistance Between VM and VDD	R_{VMD}	VDD=2V VM Floating		320		KR
Internal Resistance Between VM and GND	R_{VMS}	VDD=3.6V VM=1V		100		KR
Over Temperature Protection	T_{OPT}			120		°C
Over Temperature Protection Recovery	T_{RCY}			100		°C
Over-charge Voltage Detection Delay Time	t_{CU}			128		ms
Over-discharge Voltage Detection Time	t_{DL}			32		ms
Over-discharge Current Detection Time	t_{IOV}	VDD=3.6V		16		ms
Load Short-Circuiting Detection Time	t_{Short}	VDD=3.6V		75		us

Function Description

The product monitors the voltage and current of a battery and protects it from being damaged due to over-charge voltage, over-discharge voltage, over-discharge current, and short circuit conditions by disconnecting the battery from the load or charger. These functions are required in order to operate the battery cell with specified limits. The device requires only one resistance and one capacitor.

Normal Operating Mode

If no exception condition is detected, charging and discharging can be carried out freely. This condition called the normal operating mode.

Over-Charge Condition

When the battery voltage becomes higher than the over-charge detection voltage (V_{CU}) during charging under normal condition and the state continues for the over-charger detection delay time (t_{CU}) or longer, the IC turns the charging control FET off to stop charging. The condition is called the over-charge condition. The over-charge condition is released in the following two cases:

1) When the battery voltage drops below the over-charge release voltage (V_{CL}), the IC turns the charging control FET on and returns to the normal condition.

2）When a load is connected and discharging starts, the IC turns the charging control FET on and returns to the normal condition. The release mechanism is as follows: the dis-charging current flows through an internal parasitic diode of the charging FET immediately after a load is connected and dis-charging starts, and the VM pin voltage increases about 0.7V (forward voltage of the diode) from the GND pin voltage momentarily. The IC detects this voltage and releases the over-charge condition. Consequently, in the case that the battery voltage is equal to or lower than the over-charge detection voltage (V_{CU}), the IC returns to the normal condition immediately, but in the case the battery voltage is higher than the over-charge detection voltage (V_{CU}) , the chip does not return to the normal condition until the battery voltage drops below the over-charge detection voltage (V_{CU}) even if the load is connected. In addition, if the VM pin voltage is equal to or lower than the over-current 1 detection voltage when a load is connected and discharging starts, the chip does return to the normal condition.

Note: If the battery is charged to a voltage higher than the over-charge detection voltage (V_{CU}) and the battery voltage does drops below the over-charge detection voltage (V_{CU}) even when a heavy load, which causes an over-current, is connected, the over-current 1 and over-current 2 do not work until the battery voltage drops below the over-charge detection voltage (V_{CU}). Since an actual battery has, however, an internal impedance of several dozens of mΩ, and the battery voltage drops immediately after a heavy load which causes an over-current is connected, the over-current 1 and over-current 2 work. Detection of load short-circuiting works regardless of the battery voltage.

Over-discharge Condition

When the battery voltage drops below the over-discharge detection voltage (V_{DL}) during discharging under normal condition and it continues for the over-discharge detection delay time (t_{DL}) or longer, the IC turns the discharging control FET off and stops discharging. This condition is called over-discharge condition. After the discharging control FET is turned off, the VM pin is pulled up by the RVMD resistor between VM and VDD in IC. Meanwhile when VM is bigger than 1.5V (typ) (the load short-circuiting detection voltage), the current of the chip is reduced to the power-down current (I_{PDN}). This condition is called power-down condition. The VM and VDD pins are shorted by the RVDM resistor in the IC under the over-discharge and power-down conditions. The power-down condition is released when a charger is connected and the potential difference between VM and VDD becomes 1.3V (typ.) or higher (load short-circuiting detection voltage). At this time, the FET is still off. When the battery voltage becomes the over-discharge detection voltage (V_{DL}) or higher (see note), the IC turns the FET on and changes to the normal condition from the over-discharge condition.

Note: if the VM pin voltage is no less than the charger detection voltage (V_{CHA}), when the battery under over-discharge condition is connected to ta charger, the over-discharge condition is released (the discharging control FET is turned on) as usual, provided that the battery voltage reached the over-discharge release voltage (V_{DR}) or higher.

Over-current Condition

When the discharging current becomes equal to tor higher than a specified value (the VM pin voltage is equal to or higher than the over-current detection voltage) during discharging under normal condition and the state continues for the over-current detection delay time or longer, the IC turns off the discharging control FET to stop discharging. The condition is called over-current condition. The VM and GND pins are shorted internally by the RVMS resistor under the over-current condition. When a load is connected, the VM pin voltage equals the VDD voltage due to the load.

The over-current condition returns to the normal condition when the load is released and the impedance between the B+ and B- pins becomes higher than the automatic recoverable impedance. When the load is removed, the VM pin goes back to the GND potential since the VM pin is shorted the GND pin with RVMS resistor.

Detecting that the VM pin potential is lower than the over-current detection voltage, the IC returns to the normal condition.

Abnormal Charge Current Detection

If the VM pin voltage drops below the charger detection voltage (V_{CHA}) during charging under the normal condition and it continues for the overcharge detection delay time (t_{CU}) or longer, the IC turns the charging control FET off and stops charging. The action is called abnormal charge current detection. Abnormal charge current detection. Abnormal charge current detection works when the discharging control FET is on the VM pin voltage drops below the charger detection voltage (V_{CHA}). When an abnormal charge current flows into a battery in the over-discharge condition, the IC consequently turns the charging control FET off and stops charging after the battery voltage becomes the over-discharge detection voltage and the overcharge detection delay time (t_{CU}) elapses.

Abnormal charge current detection is released when the voltage difference between VM pin and GND pin becomes lower than the charger detection voltage (V_{CHA}) by separating the charger, Since the 0V battery charging function while the battery voltage is low.

Load Short-circuiting Condition

If the voltage of VM pin is equal or below short-circuiting protection voltage (V_{SHORT}), the IC will stop discharging and battery the disconnected from load. The maximum delay time to switch current off is t_{SHORT}. This status is released when voltage of VM pin is higher than short protection voltage (V_{SHORT}), such as when disconnecting the load.

Delay Circuits

The detection delay time for over-discharge current 2 and load short-circuiting starts when over-discharge current 1 is detected. As soon as over-discharge current 2 or load short-circuiting is detected over detection delay time for over-discharge current 2 or load short-circuiting, the IC stops discharging. When battery voltage falls below over-discharge detection voltage due to over-discharge current, the IC stop discharging by over-discharge current detection. In this case the recovery of battery voltage is so slow that if battery voltage after over-discharge voltage detection delay time is still lower than over-discharge detection voltage, shifts to power down.

0V Battery Charging Function

This function enables the charging of a connected battery whose voltage is 0V by self-discharge. When a charger having 0V battery start charging charger voltage (V_{0CHA}) or higher is connected between B+ and B- pins, the charging control FET gate is fixed to V_{DD} potential. When the voltage between the gate and source of the charging control FET becomes equal to or higher than the turn-on voltage by 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. If the battery voltage becomes equal to or higher than the over-discharge release voltage (V_{DR}), the normal condition returns.

Note:

(1) Some battery provides do not recommend charging of completely discharged batteries. Please refer to battery providers before the selection of 0V battery charging function.

(2) The 0V battery charging function has higher priority than the abnormal charge current detection function. Consequently, a product with the 0V battery charging function charges a battery and abnormal charge current cannot be detected during the battery voltage is low (at most 1.8V or lower).

(3) When a battery is connected to the IC for the first time, the IC may not enter the normal condition in which discharging is possible. In this case, set the VM pin voltage equal to the GND voltage (short the VM and GND pins or connect a charger) to enter the normal condition.

Timing Chart

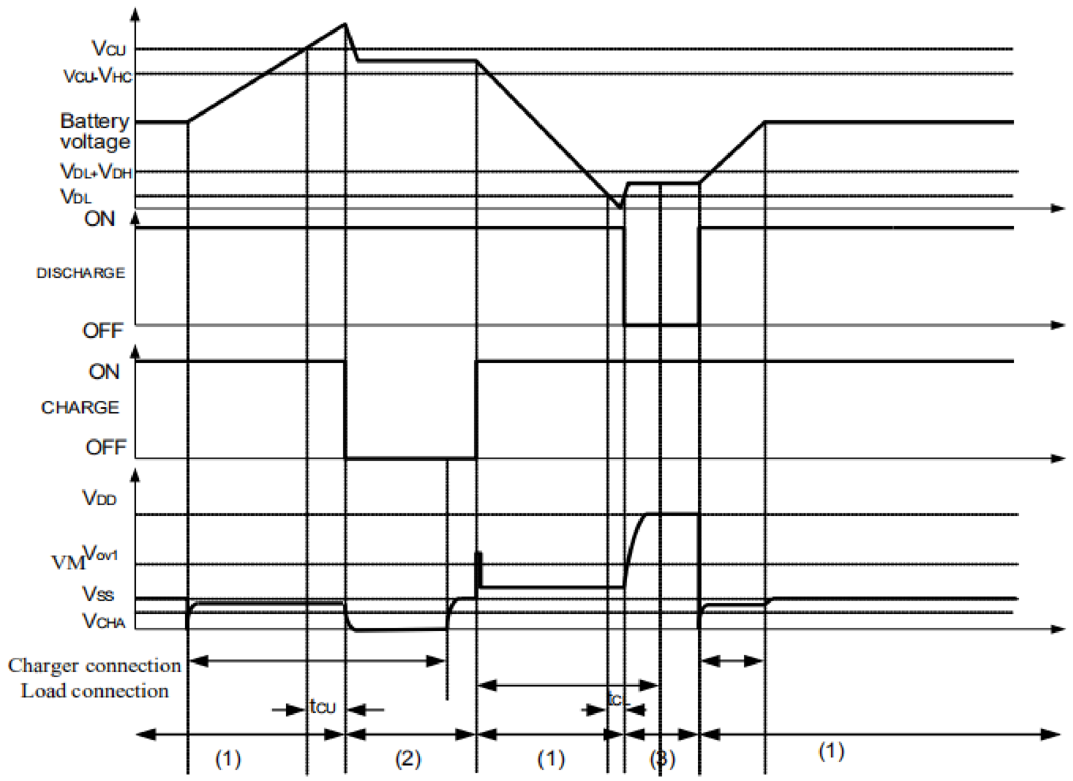


Figure 1: Over-charge and Over-discharge Detection

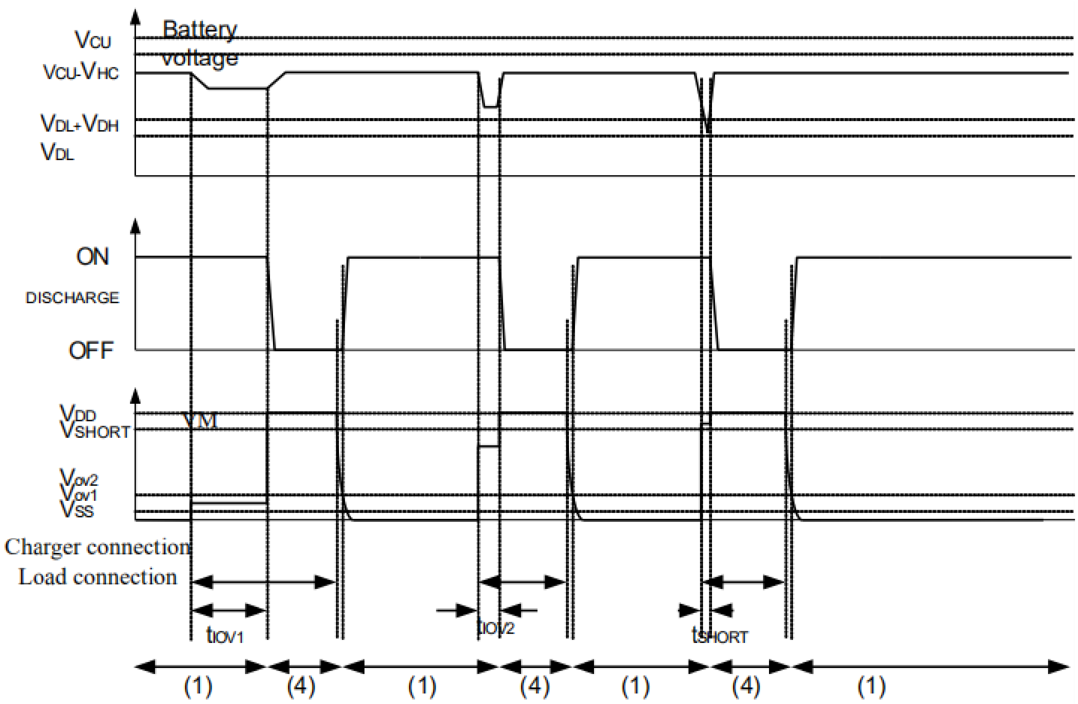


Figure 2: Over-discharge Current Detection

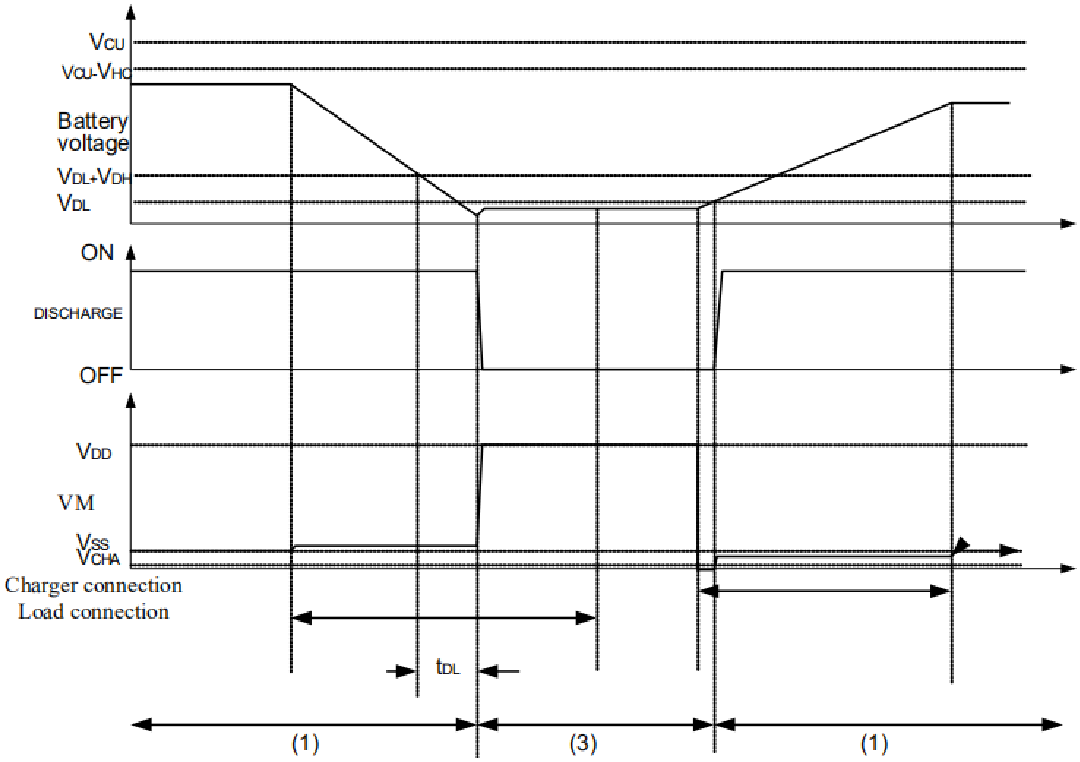


Figure 3: Charger Detection

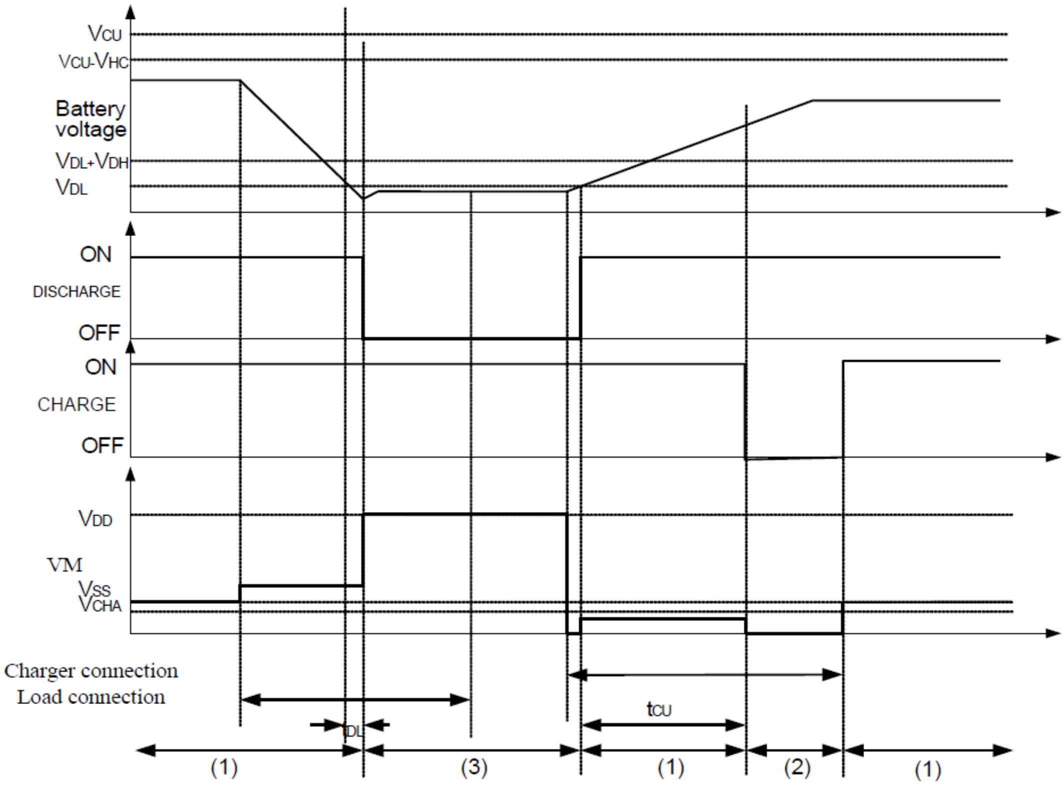
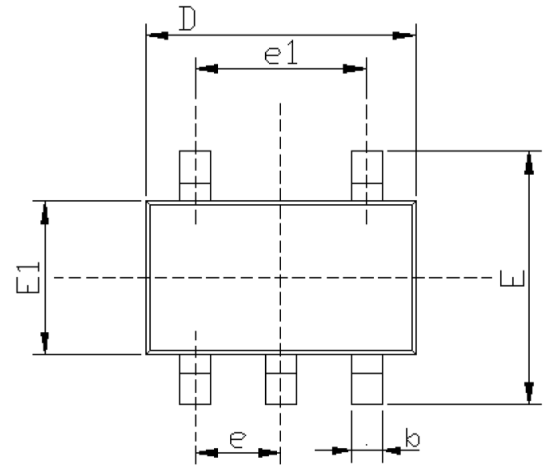
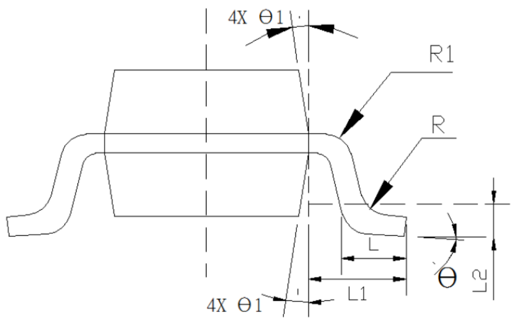
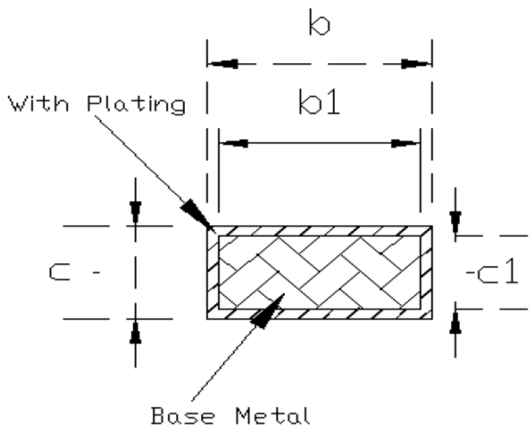


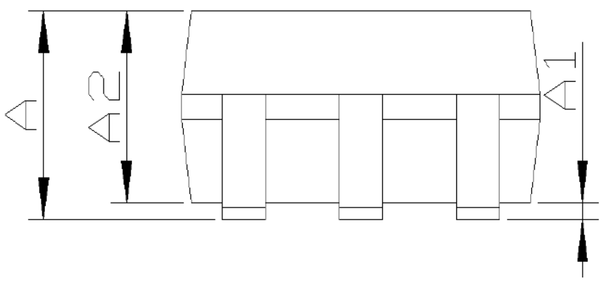
Figure 4: Abnormal Charger Detection

Package Information



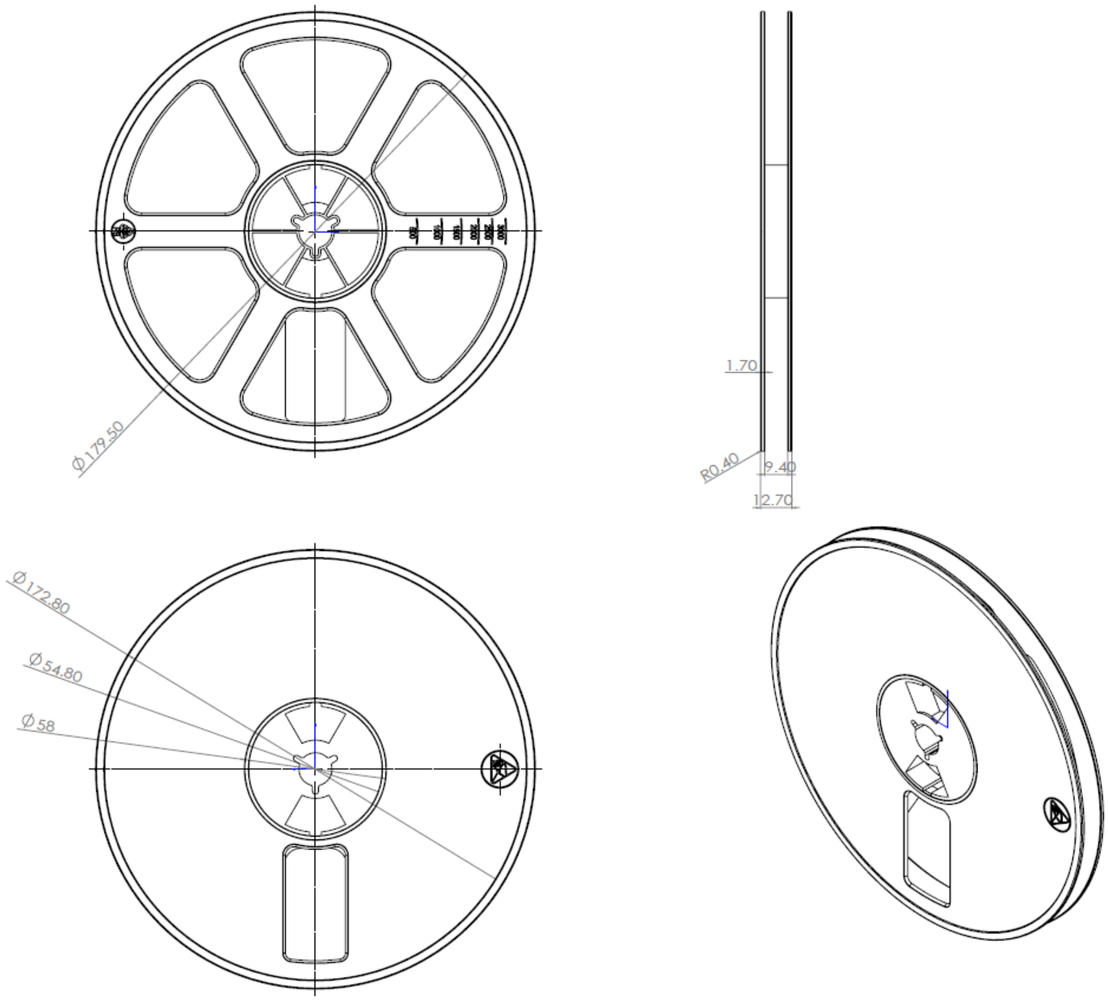


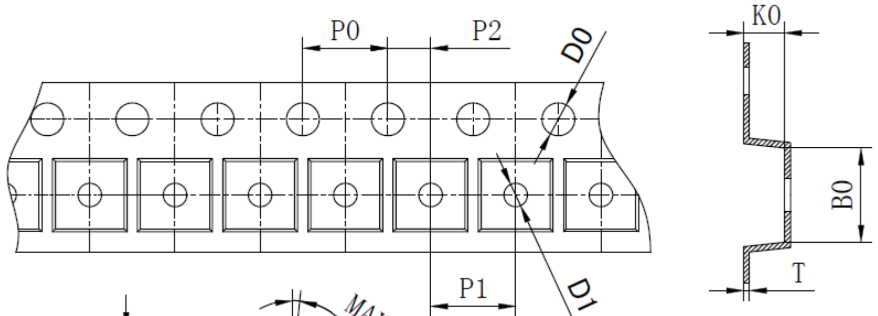


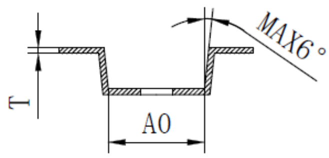


Common Dimensions (Units of Measure=Millimeter)			
SYMBOL	MINIMUM	NOMINAL	MAXIMUM
A	–	–	1.35
A1	0	–	0.15
A2	1.00	1.10	1.20
b	0.35	–	0.45
b1	0.32	–	0.38
c	0.14	–	0.20
c1	0.14	0.15	0.16
D	2.82	2.92	3.02
E	2.60	2.80	3.00
E1	1.526	1.626	1.726
e	0.90	0.95	1.00
e1	1.80	1.90	2.00
L	0.35	0.45	0.60
L1	0.6 REF		
L2	0.25 REF		
R	0.10	–	–
R1	0.10	–	0.25
θ	0°	4°	8°
θ 1	5°	10°	15°

Tape and Reel Data







NOTE:
1. 材料：黑色防静电材料；
2. 10个链孔的累积公差不能超过±0.2
3. 尺寸符合EIA-481-E的要求。

SYMBOL	A0	B0	K0	P0	P1	P2
SPEC	3.23±0.10	3.17±0.10	1.37±0.10	4.00±0.10	4.00±0.10	2.00±0.05
SYMBOL	T	E	F	D0	D1	W
SPEC	0.20±0.05	1.75±0.10	3.50±0.05	1.55±0.05	$1.10^{+0.10}_{-0}$	$8.00^{+0.2}_{-0.1}$

Revision History

Document ID	Change Description	Version	Release date
SSC59XX	New revision	V1.0	2020-11-27

DISCLAIMER