HYCON TECHNOLOGY

HY2112
Datasheet

1-Cell LiFePO4

Battery Packs Protection ICs

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1. General Description

The series of **HY2112** ICs is best created for single-cell LiFePO4 rechargeable battery protection and it also comprises high-accuracy voltage detectors and delay circuits.

These ICs are suitable for protecting single-cell rechargeable LiFePO4 battery packs against the problems of overcharge, overdischarge and overcurrent.

2. Features

The features that whole series of HY2112 comprised are as follows:

(1) High-accuracy voltage detection circuit

- Overcharge detection voltage 3.600 to 4.000V Accuracy: ±25mV
- Overcharge release voltage 3.400 to 4.000V Accuracy: ±50mV
- Overdischarge detection voltage 1.8 to 2.2V Accuracy: ±50mV
- Overdischarge release voltage 1.8 to 2.4V Accuracy: ±50mV
- Discharge overcurrent detection voltage (by option) Accuracy: ±15mV
- Charge overcurrent detection voltage (by option)
- Short-circuiting detection voltage 0.85V (fixed) Accuracy ±300mV

(2)Delay times are generated by an internal circuit (external capacitors are unnecessary).

(3) Low current consumption

- Operation mode 3.0μA typ., 6.0μA max. (VDD=3.2V)
- Ultra low power-down current at 0.1μA max.

(4) High-withstanding-voltage device is used for charger connection pins
(CS pin and OC pin: Absolute maximum rating = 20 V)

(5) 0 V battery charge function “available” / “unavailable” are selectable (See Model List)

(6) Wide operation temperature range −40°C to +85°C

(7) Small package SOT-23-6

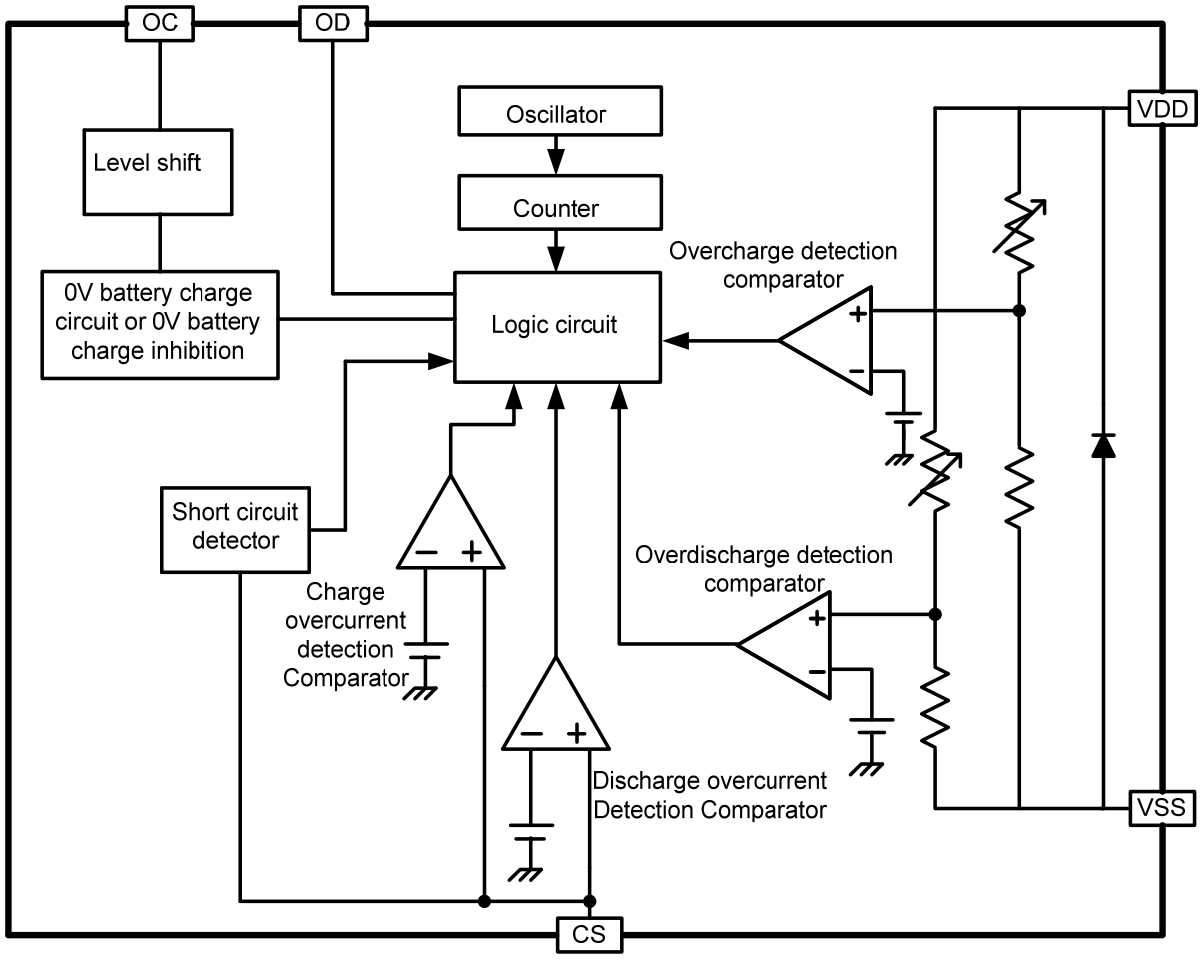
(8) The HY2112 series are Halogen-free, green package

3. Applications

- 1-cell LiFePO4 rechargeable battery packs

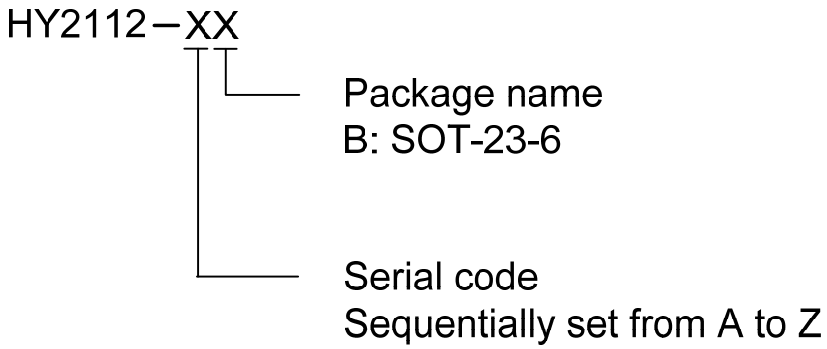
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4. Block Diagram



5. Ordering Information

■ Product Name Define



6. Model List

Table 1 Model list

Model	Overcharge detection voltage	Overcharge release voltage	Overdischarge detection voltage	Overdischarge release voltage	Discharge overcurrent detection voltage	Overcharge overcurrent detection voltage	0V battery charge function
	V_{CU}	V_{CR}	V_{DL}	V_{DR}	V_{DIP}	V_{CIP}	V_{0CH}
HY2112-AB	3.75±0.025V	3.60±0.05V	2.10±0.05V	2.30±0.05V	100±15mV	-200±30mV	available
HY2112-BB	3.75±0.025V	3.60±0.05V	2.10±0.05V	2.30±0.05V	150±15mV	-200±30mV	available
HY2112-CB	3.75±0.025V	3.60±0.05V	2.10±0.05V	2.30±0.05V	200±15mV	-200±30mV	available
HY2112-EB	3.90±0.025V	3.75±0.05V	2.10±0.05V	2.30±0.05V	200±15mV	-200±30mV	available
HY2112-GB	3.75±0.025V	3.25±0.05V	1.825±0.05V	2.37±0.05V	100±15mV	-100±20mV	available
HY2112-HB	3.65±0.025V	3.45±0.05V	2.50±0.05V	3.00±0.05V	200±15mV	-250±50mV	available

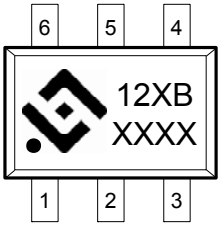
Remark: Please contact our sales office for the products with detection voltage value other than those specified above.

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7. Pin Configuration and Package Marking Information

Table 2 SOT-23-6

Pin No.	Symbol	Description
1	OD	MOSFET gate connection pin for discharge control
2	CS	Input pin for current sense, charger detect pin
3	OC	MOSFET gate connection pin for charge control
4	NC	No connection.
5	VDD	Power supply pin
6	VSS	Ground pin



12：Product Name
XB：Serial code and Package name
XXXX：Date code

8. Absolute Maximum Ratings

Table 3 Absolute Maximum Ratings (VSS=0V, Ta=25°C unless otherwise specified)

Item	Symbol	Rating	Unit
Input voltage between VDD and VSS pin	V_{DD}	VSS-0.3 to VSS+10	V
OC output pin voltage	V_{OC}	VDD -20 to VDD +0.3	V
OD output pin voltage	V_{OD}	VSS-0.3 to VDD +0.3	V
CS input pin voltage	V_{CS}	VDD -20 to VDD +0.3	V
Operating Temperature Range	T_{OP}	-40 to +85	°C
Storage Temperature Range	T_{ST}	-40 to +125	°C
Power dissipation	P_D	250	mW

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9. Electrical Characteristics

9.1. Electrical Characteristics (Except Delay Time Parameter)

Table 4 Electrical Characteristics (VSS=0V, Ta=25°C unless otherwise specified)

Item	Symbol	Condition	Min.	Typ.	Max.	Unit
SUPPLY POWER RANGE						
Operating voltage between VDD pin and VSS pin	V_{DSOP1}	-	1.5	-	8	V
Operating voltage between VDD pin and CS pin	V_{DSOP2}	-	1.5	-	20	V
INPUT CURRENT						
Supply Current	I_{DD}	VDD=3.2V	-	3.0	6.0	μA
Power-Down Current	I_{PD}		-	-	0.1	μA
DETECTION VOLTAGE						
Overcharge Detection Voltage	V_{CU}	3.6V to 4.0V adjustable	V_{CU} -0.025	V_{CU}	V_{CU} +0.025	V
Overcharge Release Voltage	V_{CR}	3.4V to 4.0V adjustable	V_{CR} -0.05	V_{CR}	V_{CR} +0.05	V
Overdischarge Detection Voltage	V_{DL}	1.8V to2.2V adjustable	V_{DL} -0.05	V_{DL}	V_{DL} +0.05	V
Overdischarge Release Voltage	V_{DR}	1.8V to2.4V adjustable	V_{DR} -0.05	V_{DR}	V_{DR} +0.05	V
Discharge Overcurrent Detection Voltage	V_{DIP}		V_{DIP} -15	V_{DIP}	V_{DIP} +15	mV
Charge Overcurrent Detection Voltage	V_{CIP}	V_{DD}=3.6V, 50mV＜V_{CIP}＜150mV	V_{CIP} -20	V_{CIP}	V_{CIP} +20	mV
		V_{DD}=3.6V, 150mV≤V_{CIP}＜250mV	V_{CIP} -30	V_{CIP}	V_{CIP} +30	mV
		V_{DD}=3.6V, V_{CIP}≥250mV	V_{CIP} -50	V_{CIP}	V_{CIP} +50	mV
Short Circuit Detection Voltage	V_{SIP}	VDD=3.0V	0.55	0.85	1.15	V
CONTROL OUTPUT VOLTAGE(OD&OC)						
OD Pin Output “H” Voltage	V_{DH}		VDD -0.1	VDD -0.02	-	V
OD Pin Output “L” Voltage	V_{DL}		-	0.1	0.5	V
OC Pin Output “H” Voltage	V_{CH}		VDD -0.1	VDD -0.02	-	V
OC Pin Output “L” Voltage	V_{CL}		-	0.1	0.5	V
0V BATTERY CHARGE FUNCTION						
0V battery charge starting charger voltage	V_{0CH}	0V battery charging function “available”	1.2	-	-	V
0V battery charge inhibition charger voltage	V_{0IN}	0V battery charging function “unavailable”	-	-	0.5	V

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9.2. Delay Time Combination

Table 5 Delay Time Parameter Combination of HY2112-AB, HY2112-BB, HY2112-CB, HY2112-EB, HY2112-GB

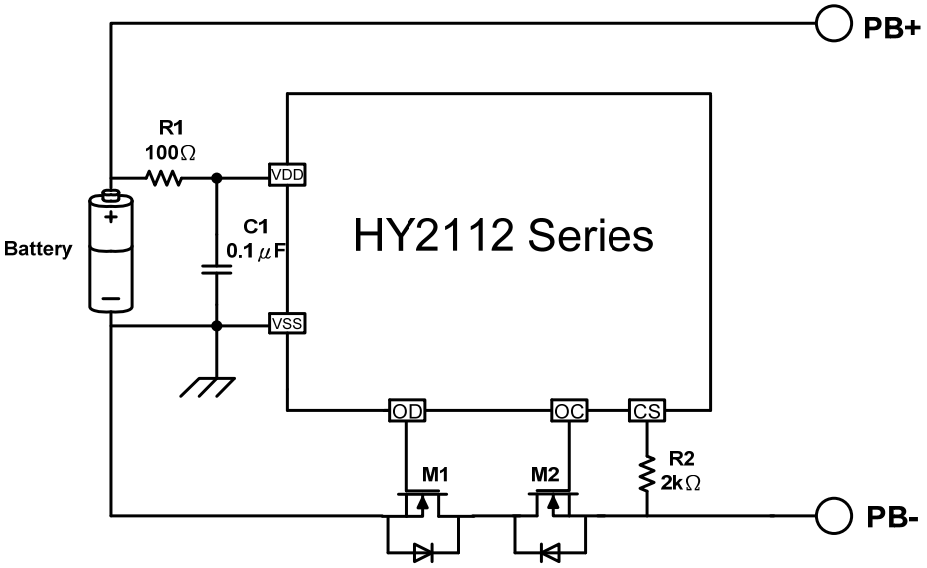
Item	Symbol	Condition	Min.	Typ.	Max.	Unit
Delay Time (Ta＝25℃)						
Overcharge Delay Time	T_{OC}	V_{DD}=3.2V→4.0V	1000	1300	1600	ms
Overdischarge Delay Time	T_{OD}	V_{DD}=3.2V→1.6V	115	145	175	ms
Discharge Overcurrent Delay Time	T_{DIP}	V_{DD}=3.2V, CS=0.4V	9	12	15	ms
Charge Overcurrent Delay Time	T_{CIP}	V_{DD}=3.2V, CS=-0.4V	6	8	10	ms
Short Circuit Delay Time	T_{SIP}	V_{DD}=3.0V, CS=1.3V	200	300	400	μs

Table 6 Delay Time Parameter Combination of HY2112-HB

Item	Symbol	Condition	Min.	Typ.	Max.	Unit
Delay Time (Ta＝25℃)						
Overcharge Delay Time	T_{OC}	V_{DD}=3.2V→4.0V	700	1000	1300	ms
Overdischarge Delay Time	T_{OD}	V_{DD}=3.2V→1.6V	115	145	175	ms
Discharge Overcurrent Delay Time	T_{DIP}	V_{DD}=3.2V, CS=0.4V	18	24	30	ms
Charge Overcurrent Delay Time	T_{CIP}	V_{DD}=3.2V, CS=-0.4V	12	16	20	ms
Short Circuit Delay Time	T_{SIP}	V_{DD}=3.0V, CS=1.3V	200	300	400	μs

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10. Example of Battery Protection IC Connection



Symbol	Device Name	Purpose	Min.	Typ.	Max.	Remark
R1	Resistor	Limiting current, stabilize VDD and strengthen ESD protection	100Ω	**100Ω**	470Ω	*1
R2	Resistor	Limiting current	300Ω	**2kΩ**	2kΩ	*2
C1	Capacitor	Stabilizing VDD	0.01μF	**0.1μF**	1.0μF	*3
M1	N-MOSFET	Discharge control	-	-	-	*4
M2	N-MOSFET	Charge control	-	-	-	*5

*1. R1 should be as small as possible to avoid lowering the overcharge detection accuracy due to current consumption. When a charger is connected in reversed, the current flows from the charger to the IC. At this time, if R1 is connected to high resistance, the voltage between VDD pin and VSS pin may exceed the absolute maximum rating.

*2. If R2 has a resistance higher than 2kΩ, the charging current may not be cut when a high-voltage charger is connected. Please select as large a resistance as possible to prevent current when a charger is connected in reversed.

*3. C1 will stabilize the supply voltage of VDD, the value of C1 should be equal to or more than 0.01μF.

*4. If a FET with a threshold voltage equal to or higher than the overdischarge detection voltage is applied, discharging may be stopped before overdischarge is detected.

*5. If the withstanding voltage between the gate and source is lower than the charger voltage, the FET may be destroyed.

Caution：

1. The above constants may be changed without notice, please download the most up-to-date datasheet on our website. http://www.hycontek.com
2. It is advised to perform thorough evaluation and test if peripheral devices need to be adjusted.

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11. Description of Operation

11.1. Normal Status

This IC monitors the voltage of the battery connected between the VDD pin and VSS pin and the voltage difference between the CS pin and VSS pin to control charging and discharging.

For ICs that equipped with discharge overcurrent detection voltage (V_{DIP}), when battery voltage is above overdischarge detection voltage (V_{DL}) and under overcharge detection voltage (V_{CU}) and CS pin voltage is under discharge overcurrent detection voltage (V_{DIP}), the OD and OC pin will output high potential difference, to turn both charging and discharging control MOSFET on. This condition is called “Normal Status”. Under this condition, charging and discharging can both be carried out freely.

Notice: Discharging may not be enacted when the battery is first time connected. To regain normal status, CS and VSS PIN must be shorted or the charger must be connected.

11.2. Overcharge Status

Under normal status, as soon as the battery voltage becomes higher than the overcharge detection voltage (V_{CU}) during charging and the detection continues longer than the overcharge detection delay time (T_{OC}), the **HY2112 Series** will turn the charging control MOSFET off (OC pin) to stop charging .This condition is called “Overcharge Status”.

The overcharge status can be released by two following cases:

Condition: disconnected charger

(1) The voltage of the battery cell is equal to or lowers than the overcharge release voltage (V_{CR}) due to self-discharge.

(2) When the load is connected, the discharge current will pass through parasitical diode of charging control MOSFET. At this time, CS pin will detect “Diode forward voltage drop”. When CS pin voltage rises higher than discharge overcurrent detection voltage (V_{DIP}) and battery voltage lowers than overcharge detection voltage (V_{CU}), the overcharge status will be released and back to normal status.

Caution:

(1) When a charger still is being connected to batteries that entered into overcharge status, even the battery voltage falls lowers than overcharge release voltage (V_{CR}), the overcharge status cannot be released. The overcharge status will be released when the CS pin voltage ascends higher than Charger Overcurrent detection Voltage (V_{CIP}) by removing the charger.

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11.3. Overdischarge Status

When the battery voltage falls below than that of overdischarge detection voltage (V_{DL}) during discharging in normal status and the detection continues longer than the overdischarge detection delay time (T_{OD}), the **HY2112 Series** will turn the discharging control MOSFET off (OD pin) so as to stop discharging. This condition is called "Overdischarge Status".

When the MOSFET is off, CS pin voltage is pulled high by internal resistor to VDD in the IC. At this time, the power consumption is reduced to minimum. This condition is called the "Sleep Mode".

The overdischarge status (OD pin) will be released by two cases:

(1) When CS pin voltage is equal to or lower than the charger overcurrent detection voltage (V_{CIP}) by charging and the VDD pin voltage is higher than V_{DL} voltage.

(2) When CS pin voltage is equal to or higher than the charger overcurrent detection voltage (V_{CIP}) by charging and the VDD pin voltage is higher than V_{DR} voltage.

11.4. Charger Detection Status

Under normal condition, the **HY2112** continuously monitors the discharge current by sensing the voltage of CS pin. If the voltage of CS pin exceeds the overcurrent detection voltage (V_{DIP}) and the condition lasts beyond the overcurrent delay time (T_{DIP}), discharging will be suspended by turning off the discharge control MOSFET (OD pin). This condition is called "Discharge Overcurrent Status".

Once the CS pin voltage surpasses short circuit detection voltage (V_{SIP}) and this status lasts beyond short circuit delay time (T_{SIP}), discharging will be suspended by turning off the discharge control MOSFET (OD pin). This condition is called "Short Circuit Status".

When the impedance between PB+ and PB- is higher than discharge overcurrent and short circuit release impedance, the discharge overcurrent status and short circuit status will be released and back to normal operation status. In addition, if the impedance between PB+ and PB- is less than discharge overcurrent and short circuit release impedance, CS pin voltage descends below than overcurrent detection voltage (V_{DIP}) after the charger is being connected, discharge overcurrent status and short circuit status will be released and back to normal operation status.

Caution:

(1) If the charger is connected incautiously in reversed, the current direction is the same as discharge current in the circuit. If CS pin voltage goes higher than overcurrent detection voltage (V_{DIP}), it will enter into discharge overcurrent protection status to block out in-circuit current.

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11.5. Discharge Overcurrent Status (Discharge Overcurrent & Short Circuit)

When CS pin voltage lowers than charge overcurrent detection voltage(V_{CIP}) and this status lasts longer than charge overcurrent delay time(T_{CIP}) during charge process of batteries under normal operation, OC pin voltage output will change from high potential to low potential. At this time, MOSFET (OC pin) is disabled and charge stopped. This status is called “Charge Overcurrent Status”.

If CS pin voltage increases higher than charge overcurrent detection voltage(V_{CIP}) by disconnecting charger after enter charge overcurrent status, the charge overcurrent status will be released and restore to normal operation mode.

11.6. 0V Battery Charging Function “Available”

This function is used to recharge a connected battery which voltage is 0V due to self-discharge. When the 0V battery charge starting charger voltage (V_{0CH}) or a higher voltage is applied between the battery+ (PB+) and battery- (PB-) pins by connecting a charger, the charging control MOSFET gate is fixed to the VDD pin voltage.

When the voltage between the gate and the source of the charging control MOSFET becomes equal to or higher than the turn on voltage due to the charger voltage, the charging control MOSFET is turned on to initiate charging. At this time, the discharging control MOSFET is off and the charging current flows through the internal parasitic diode in the discharging control MOSFET. When the battery voltage becomes equal to or higher than overdischarge detection voltage (V_{DL}), the **HY2112 series** will enter into the normal status.

Caution:

(1) Some battery providers do not recommend charging for a completely self-discharged battery. Please ask the battery provider to determine whether to enable or prohibit the 0V battery charging function.

11.7. 0V Battery Charging Function “Unavailable”

When a battery which is internally short-circuited (0V battery) is connected, the unavailable 0V charging function will prohibit recharging. When the battery voltage equals to the 0V battery charge inhibition battery voltage (V_{0IN}) or lower, the charging control MOSFET gate is fixed to the PB- pin voltage to prohibit charging. When the battery voltage equals to the 0V battery charge inhibition battery voltage(V_{0IN}) or higher, charging can be implemented.

Caution:

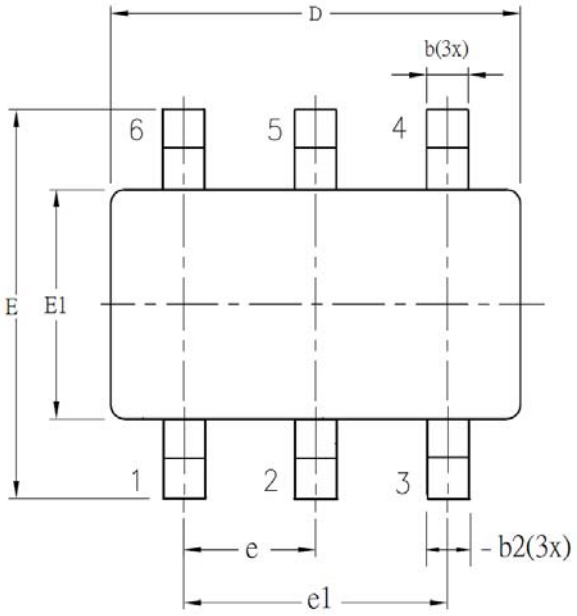
(1) Some battery providers do not recommend charging for a completely self-discharged battery. Please ask the battery provider to determine whether to enable or prohibit the 0V battery charging function.

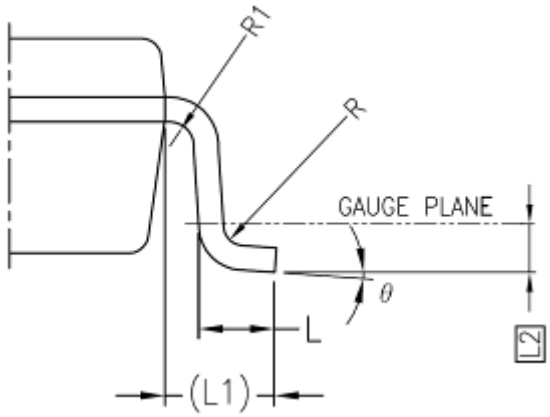
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12. Package information

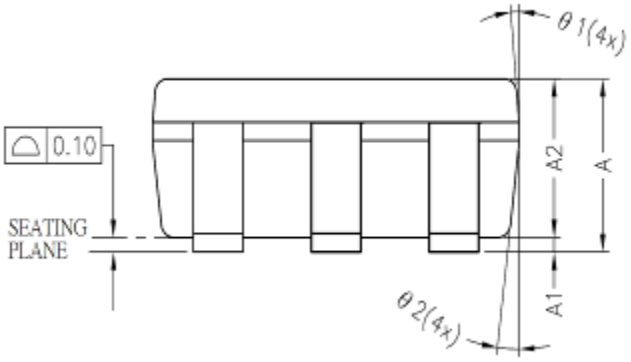
12.1. SOT-23-6

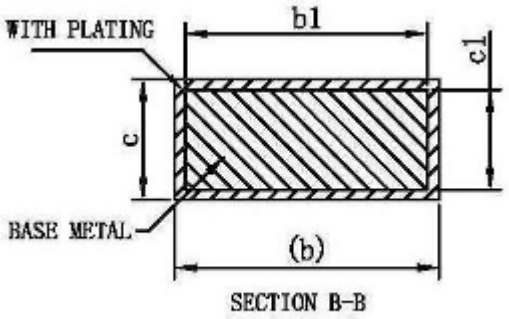
NOTE: All dimensions are in millimeters.





SYMBOL	ALL DIMENSIONS IN MILLIMETERS		
	MINIMUM	NOMINAL	MAXIMUM
A	-	1.30	1.40
A1	0	-	0.15
A2	0.90	1.20	1.30
b	0.30	-	0.50
b1	0.30	0.40	0.45
b2	0.30	0.40	0.50
c	0.08	-	0.22
c1	0.08	0.13	0.20
D	2.90 BSC		
E	2.80 BSC		
E1	1.60 BSC		
e	0.95 BSC		
e1	1.90 BSC		
L	0.30	0.45	0.60
L1	0.60 REF		
L2	0.25 BSC		
R	0.10	-	-
R1	0.10	-	0.25
θ	0°	4°	8°
θ1	5°	-	15°
θ2	5°	-	15°





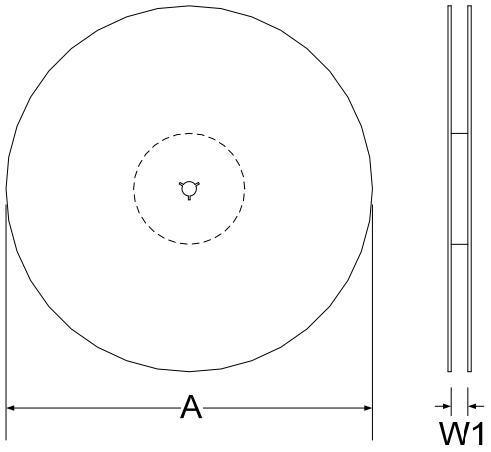
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13. Tape & Reel Information

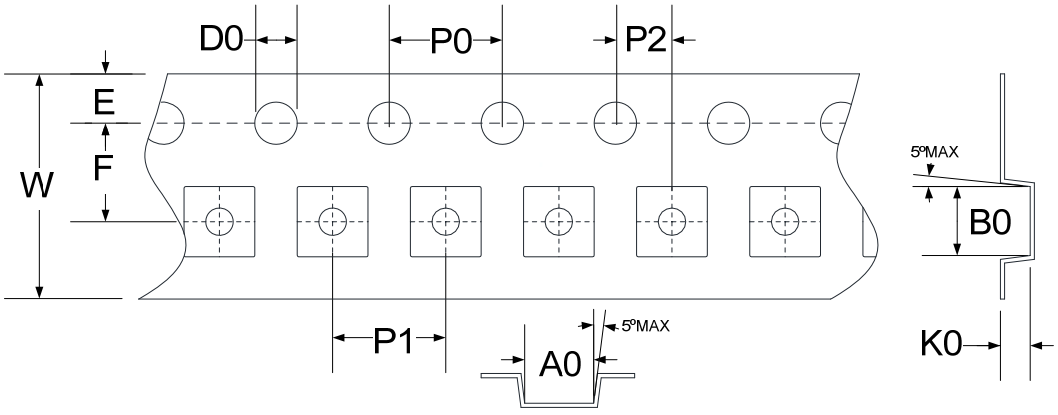
13.1. Tape & Reel Information---SOT-23-6（Type 1）

Unit : mm.

13.1.1. Reel Dimensions



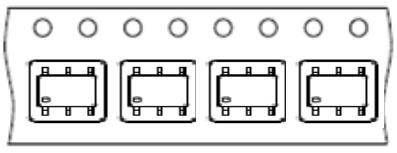
13.1.2. Carrier Tape Dimensions



SYMBOLS	Reel Dimensions		Carrier Tape Dimensions									
	A	W1	A0	B0	K0	P0	P1	P2	E	F	D0	W
Spec.	178	9.0	3.30	3.20	1.50	4.00	4.00	2.00	1.75	3.50	1.50	8.00
Tolerance	±0.50	+1.50/-0	±0.10	±0.10	±0.10	±0.10	±0.10	±0.05	±0.10	±0.05	+0.1/-0	±0.20

Note: 10 Sprocket hole pitch cumulative tolerance is ±0.20mm.

13.1.3. Pin1 direction

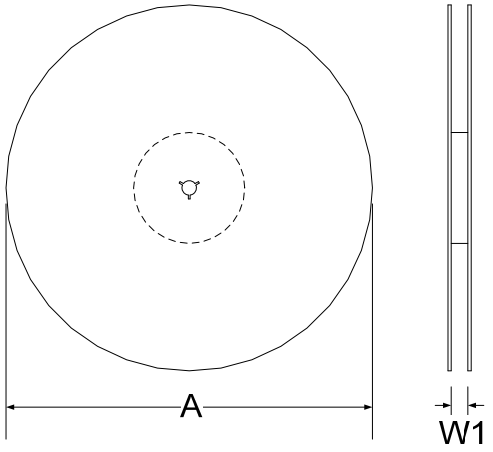


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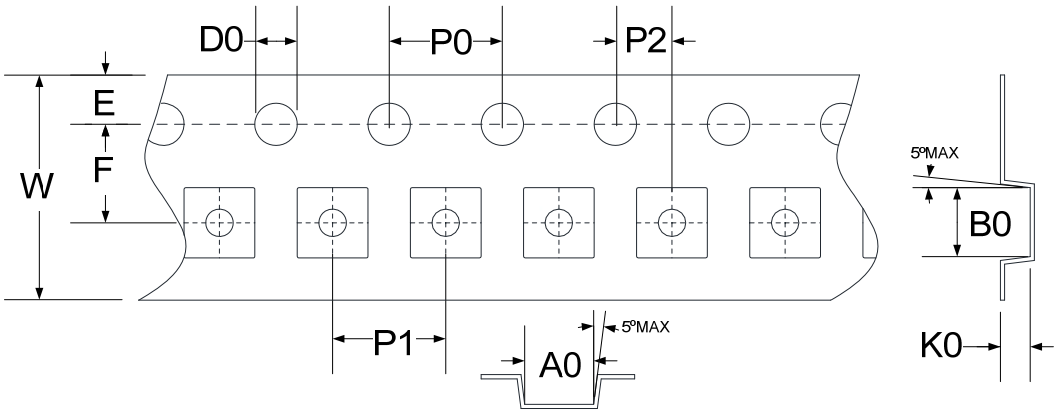
13.2. Tape & Reel Information---SOT-23-6 (Type 2)

Unit : mm.

13.2.1. Reel Dimensions



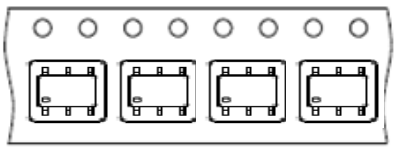
13.2.2. Carrier Tape Dimensions



SYMBOLS	Reel Dimensions		Carrier Tape Dimensions									
	A	W1	A0	B0	K0	P0	P1	P2	E	F	D0	W
Spec.	178	9.4	3.17	3.23	1.37	4.00	4.00	2.00	1.75	3.50	1.55	8.00
Tolerance	±2.00	±1.50	±0.10	±0.10	±0.10	±0.10	±0.10	±0.05	±0.10	±0.05	±0.05	+0.30/-0.10

Note: 10 Sprocket hole pitch cumulative tolerance is ±0.20mm.

13.2.3. Pin1 direction



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14. Revision record

Major differences are stated thereinafter:

Version	Page	Revision Summary
V01	-	First Edition.
V03	All	Add in new model no.: HY2112-EB.
	14,15	Revise package size.
V04	7	Revise SOT-23-6 package marking rule.
	14	Revise package size.
V05	All	Add in new model no.: HY2112-GB.
	All	Revise all model of VDIP accuracy and all model of delay time.
V06	All	Add in new model no.: HY2112-HB.
	All	Revise all model of VCIP typical and accuracy.
V07	14-15	Add in Tape & Reel information.
V08	All	Revise all model of TOC and TOD.
	All	Revise HY2112-HB of VDIP, TDIP and TCIP.

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