JW3313

3 Series Battery Protector

Preliminary Specifications Subject to Change without Notice

DESCRIPTION

JW®3313 is a low-power battery protection IC for the 3 series rechargeable lithium-ion battery pack.

JW3313 integrates high-accuracy voltage detection and temperature detection circuits, which realizes multiple protect functions including over-charge, over-discharge, over-current, over-temperature, under-temperature and open wire detection.

FEATURES

- Input voltage up to 30V
- High-accuracy voltage detection for each cell
  - Over-charge detection voltage V_{OC}:
    3.65V, 3.85V, 4.2~4.375V (25mV step)
    ±25mV (25℃)
  - Over-charge release hysteresis V_{OCRH}:
    0.1~0.4V (100mV step)
  - Over-discharge detection voltage V_{OD}:
    2.0V, 2.3V, 2.5V, 2.7V
    ±80mV (25℃)
  - Over-discharge release hysteresis V_{ODRH}:
    0.3~0.7V (200mV step)
- Discharge over-current detection in 3-step:
  - 1st detection voltage V_{DOI1}:
    50~150mV (25mV step) ±10mV
  - 2nd detection voltage V_{DOI2}:
    $2V_{DOI1}$ ±20mV
  - Short circuit detection voltage V_{SHT}:
    0.4V ±50mV
- Charge over-current detection voltage V_{COI}:
  - -20mV ±5mV,
  - -30mV ±10mV, -50mV ±10mV,
  - Disable
- High-accuracy battery temperature detection
  - Charging over-temperature protection threshold V_{COT}:
    0.206V (50 ±5°C) or 0.18V (55 ±5°C)
  - Charging under-temperature protection threshold V_{CUT}:
    0.815V (-10 ±5°C) or 0.692V (0 ±5°C)
  - Discharging over-temperature protection threshold V_{DOT}:
    0.12V (70 ±5°C)
  - Discharging under-temperature protection threshold V_{DUT}:
    0.926V (-20 ±5°C)
- 3-step discharge over-current protection
  - For 1st, t_{DOI1} : 0.2s, 0.5s, 1s, 2s
  - For 2nd, t_{DOI2} : t_{DOI1} ×10%
  - For 3rd, t_{SHT} : 300μs
- Open wire detection
- Wide range of operation temperature
  -40°C to +85°C
- Low current consumption (T=25°C)

Full power mode	10μA Typ.
Sleep mode	1.5μA Typ.
Shutdown mode	350nA Typ.

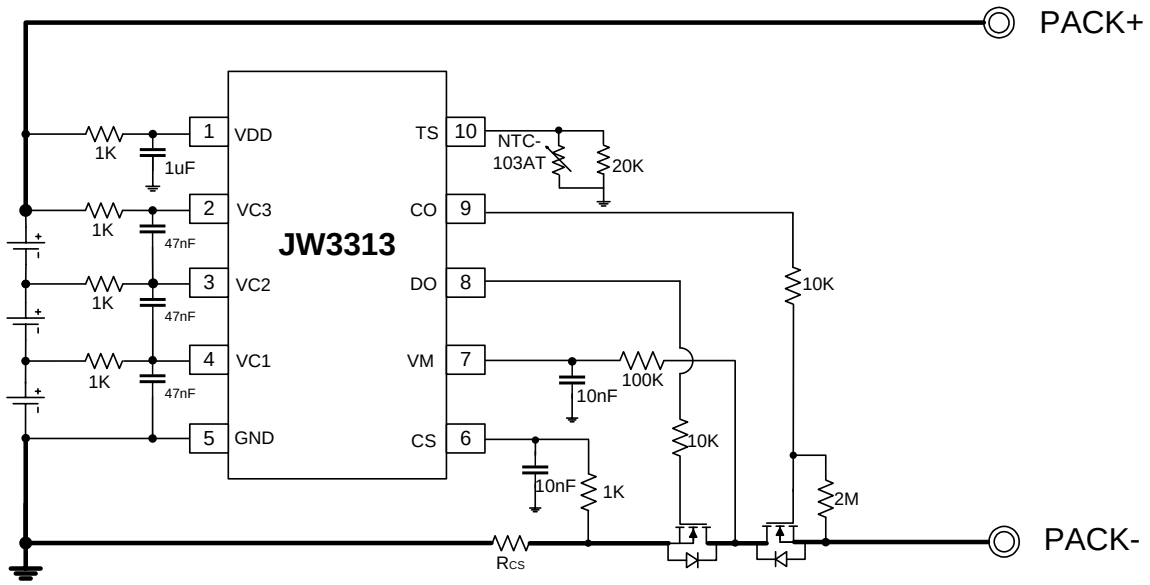
- Package: MSOP10

APPLICATIONS

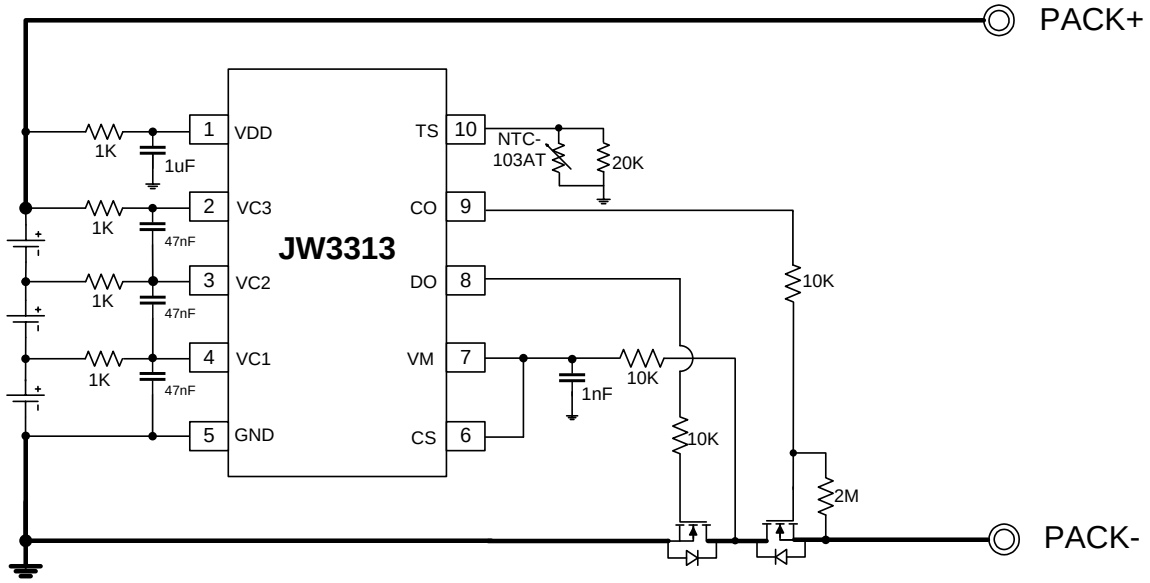
- Rechargeable Lithium-ion Battery Pack
- Power Tools, Garden Tools

TYPICAL APPLICATION

With Current Sense Resistance R_{CS}



Without Current Sense Resistance R_{CS}



Selection Guides

Production Name Structure

JW3313-XX

Series code[1)]
Sequentially set from AA to ZZ

Notes:

1): Relates to different detection threshold voltage

Products Series List[1)2)]

Part NO.	Over -charge detection voltage [V_{OC}]	Over -charge release voltage [V_{OCL}]	Over -discharge detection voltage [V_{OD}]	Over -discharge release voltage [V_{ODH}]	Charge over-current detection voltage [V_{COI}]	Discharge over-current 1 detection voltage [V_{DOI1}]	Discharge over-current 2 detection voltage [V_{DOI2}]	Short circuit detection voltage [V_{SHT}]	Charger lock after over-charge
JW3313-MC	4.250V	4.05V	2.7V	3.0V	50mV	100mV	200mV	400mV	N
JW3313-MB	4.225V	4.025V	2.7V	3.0V	20mV	100mV	200mV	400mV	N
JW3313-ME	4.250V	4.15V	2.5V	3.0V	50mV	100mV	200mV	400mV	N
JW3313-PA	3.65V	3.45V	2.3V	3.0V	50mV	100mV	200mV	400mV	N

Part NO.	Discharge over-current 1 detection delay time [t_{DOI1}]	Charging over-temperature threshold [T_{COT}]	Charging under-temperature threshold [T_{CUT}]	Discharging over-temperature threshold [T_{DOT}]	Discharging under-temperature threshold [T_{DUT}]
JW3313-MC	1s	50℃	-10℃	70℃	-20℃
JW3313-MB	1s	50℃	-10℃	70℃	-20℃
JW3313-ME	200ms	50℃	-10℃	70℃	-20℃
JW3313-PA	200ms	50℃	-10℃	70℃	-20℃

Notes:

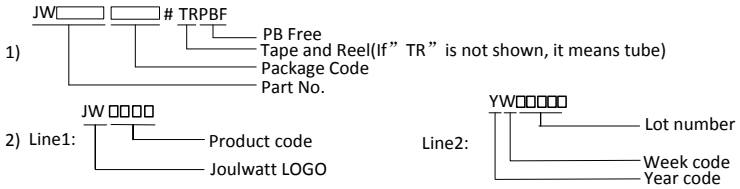
1) The temperature protection threshold depends on the external NTC (103AT β=3435) and bypass resistance.

2) Please contact our sales office for products with detection voltage values other than those specified above.

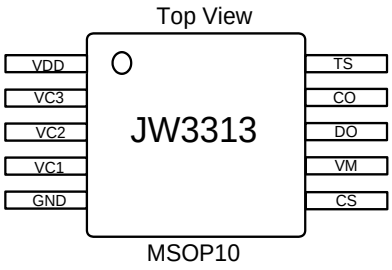
ORDER INFORMATION

DEVICE[1)]	PACKAGE	TOP MARKING[2)]
JW3313-MCMSOP#TRPBF	MSOP10	3313-MC YW□□□□□
JW3313-MBMSOP#TRPBF	MSOP10	3313-MB YW□□□□□
JW3313-MEMSOP#TRPBF	MSOP10	3313-ME YW□□□□□
JW3313-PAMSOP#TRPBF	MSOP10	3313-PA YW□□□□□

Notes:



PIN CONFIGURATION



ABSOLUTE MAXIMUM RATING[1)]

VDD……-0.3V to +30V
VC3, VC2, VC1, CS, VM, DO.....-0.3V to VDD+0.3V
VC(n)-VC(n-1) n=2,3…….....-0.3V to 20V
VDD-VC3……..…….....-0.3V to 20V
CO…….....VDD-30V to VDD+0.3V
TS ……..…….....-0.3V to +3.6V
Junction Temperature[2)] 150ºC
Lead Temperature 260ºC
Storage Temperature .....-65ºC to +150ºC

RECOMMENDED OPERATING CONDITIONS[3)]

Junction Temperature (T_J).....-40ºC to 85ºC
VC(n)-VC(n-1) n=2,3…….....0V to 5V

VDD-GND….....3V to 15V

THERMAL PERFORMANCE[4)]

	θ_{JA}	θ_{JC}
MSOP10	150	45ºC/W

Notes:

1) Exceeding these ratings may damage the device. These stress ratings do not imply function operation of the device at any other conditions beyond those indicated under RECOMMENDED OPERATING CONDITIONS.

2) The JW3313 includes thermal protection that is intended to protect the device in overload conditions. Continuous operation over the specified absolute maximum operating junction temperature may damage the device.

3) The device is not guaranteed to function outside of its operating conditions.

4) Measured on JESD51-7, 4-layer PCB.

ELECTRICAL CHARACTERISTICS

TA = 25ºC, unless otherwise stated.

Item		Symbol	Condition	Min.	Typ.	Max.	Units
Power supply							
Power supply range[5]		V_{DD}		3		15	V
Power-on reset threshold		V_{POR}	Rising		1.6	2	V
			Falling		1.4	1.8	V
Current consumption during full power		I_{FP}	V_{DD} =9.9V		10	15	μA
Current consumption during sleep		I_{SLEEP}	V_{DD} =8V		1.5	3	μA
Current consumption during shutdown		I_{SD}	V_{DD}=0.8V		350	500	nA
VC3~VC1 pin current		$I_{VC3\sim1}$		-1.0	0	1.0	μA
Voltage/Current Protections							
Detection period time for OV, UV[5]		t_{DETV}		0.35	0.5	0.65	s
Over-charge	Detection voltage	V_{OC}		V_{OC}-0.025	V_{OC}	V_{OC}+0.025	V
	Release voltage	V_{OCL}		V_{OCL}-0.05	V_{OCL}	V_{OCL}+0.05	V
	Detection delay time[5]	t_{OC}		0.7	1	1.95	s
	Release delay time[5]	t_{OCL}		30	60	90	ms
Over-discharge	Detection voltage	V_{OD}		V_{OD}-0.08	V_{OD}	V_{OD}+0.08	V
	Release voltage	V_{ODH}	100mV /200mV /300mV Hysteresis	V_{ODH}-0.1	V_{ODH}	V_{ODH}+0.1	V
			others	V_{ODH}-0.13		V_{ODH}+0.13	
	Detection delay time[5]	t_{OD}		0.7	1	1.95	s
	Release delay time[5]	t_{ODH}		30	60	90	ms
1st Discharge over-current detection voltage		V_{DOI1}		V_{DOI1}-10	V_{DOI1}	V_{DOI1}+10	mV
1st Discharge over-current detection delay time[5]		t_{DOI1}		0.7*t_{DOI1}	t_{DOI1}	1.3*t_{DOI1}	s
2nd Discharge over-current detection voltage		V_{DOI2}		V_{DOI2}-20	V_{DOI2}	V_{DOI2}+20	mV

2nd Discharge over-current detection delay time[5]	t_{DOI2}		0.7*t_{DOI2}	t_{DOI2}	1.3*t_{DOI2}	s
Load short circuit detection voltage	V_{SHT}		350	400	450	mV
Load short circuit detection delay time[5]	t_{SHT}		200	300	360	μs
Discharge over-current release delay time[5]	t_{DOIR}		30	60	90	ms
Charge over-current detection voltage	V_{COI}	V_{COI}=-20mV	V_{COI}-5	V_{COI}	V_{COI}+5	mV
		V_{COI}=-30mV or -50mV	V_{COI}-10	V_{COI}	V_{COI}+10	mV
Charge over-current detection delay time[5]	t_{COI}		6	10	14	ms
Charge over-current release delay time[5]	t_{COIR}		1	2	2.6	s
Temperature Protection						
Temperature detection period time[5]	t_{DETT}		1.4	2	2.6	s
Temperature detection time[5]	t_{DET}		2.8	4	5.2	ms
Discharging detection threshold	V_{TH_DSG}		1.5	3	4.5	mV
Reference current for temperature detection[5]	I_{NTC}		58	60	62	μA
Charging over-temperature — Protection threshold	V_{COT}	50°C±5°C	184	206	238	mV
		55°C±5°C	161	180	202	
Charging over-temperature — Release threshold	V_{COTRT}	45°C±5°C	211	236	265	mV
		50°C±5°C	184	206	231	
Charging under-temperature — Protection threshold	V_{CUT}	-10°C±5°C	0.773	0.815	0.848	V
		0°C±5°C	0.642	0.692	0.735	
Charging under-temperature — Release threshold	V_{CUTRT}	-5°C±5°C	0.708	0.754	0.793	V
		5°C±5°C	0.578	0.629	0.675	
Discharging over-temperature — Protection threshold	V_{DOT}	70°C±5°C	108	120	133	mV
Discharging over-temperature — Release threshold	V_{DOTRT}	60°C±5°C	141	157	176	
Discharging under-temperature — Protection threshold	V_{DUT}	-20°C±5°C	0.897	0.926	0.945	V
Discharging under-temperature — Release threshold	V_{DUTRT}	-10°C±5°C	0.773	0.815	0.848	V
Temperature detection delay time[5]	t_{OT}		1	2	5.2	s
Temperature protection release delay time[5]	t_{OTR}		1	2	5.2	s

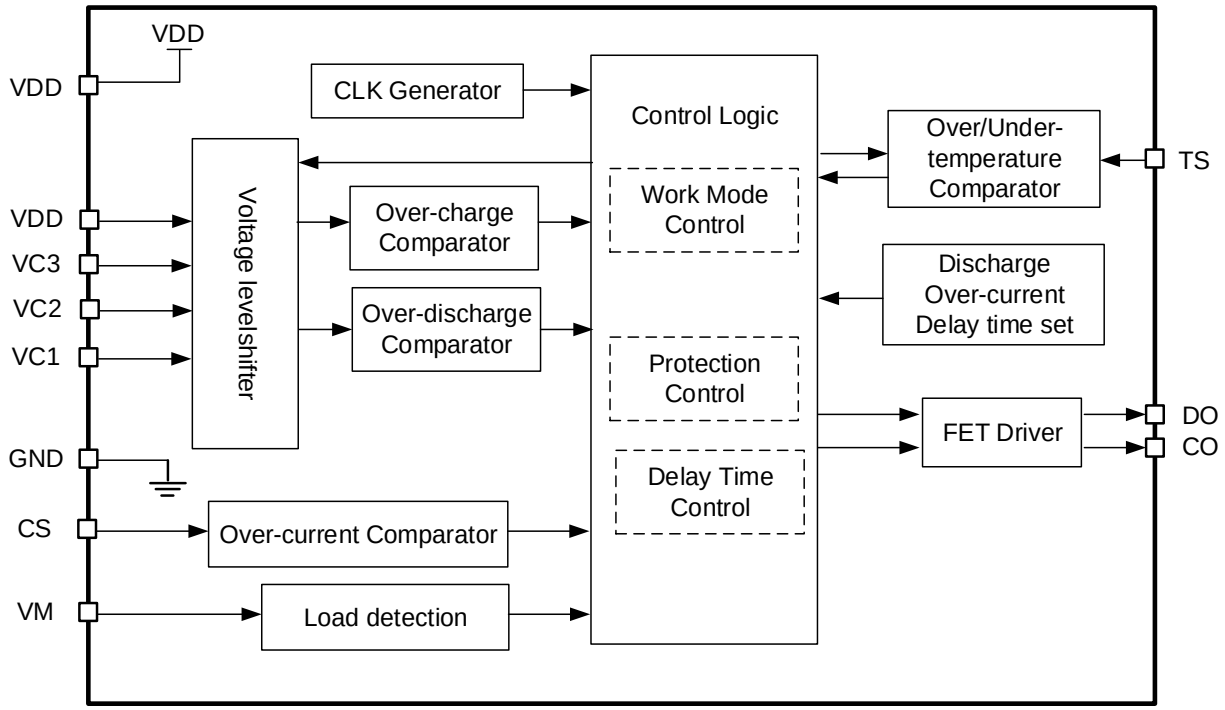
Chip over-temperature protection threshold[5)]	T_{CHIP}		130	150	170	ºC
Chip over-temperature protection release threshold[5)]	T_{CHIPR}		105	125	145	ºC
Output Voltage and Current						
CO output voltage “L”	V_{COL}			High_Z		
CO output voltage “H”	V_{COH}			V_{DD}		V
DO output voltage “L”	V_{DOL}			0	0.5	V
DO output voltage “H”	V_{DOH}			V_{DD}		V
CO pin source current	I_{COH}	V_{DD}=6V	0.7	1	1.3	mA
DO pin source current	I_{DOH}	V_{DD}=9V	0.7	1.7	2.7	mA
DO pin sink current	I_{DOL}	V_{DD}=6V	7	10	13	mA
Charger and Load detection function						
VM pull down resistance after discharge MOSFET turn off	R_{VMDN}		60	100	140	kΩ
Load detection threshold	V_{VMTH}		0.8	1	1.2	V
Charger detection current	I_{CO}	Charge over-current，Over-charge	50	100	170	nA
Charger detection threshold	V_{CHA}	Over-charge，Over-discharge，Charge over-current	20	70	120	mV
Other function						
Sleep status delay time[5)]	t_{SLP}		5	10	15	s
Sleep status exit delay time[5)]	t_{SLPR}		30	60	90	ms
Charge / Discharge mode change time[5)]	t_{CST}		30	60	90	ms
Test mode entry threshold[5)]	V_{ENTRY}				2	V
Test mode entry time[5)]	t_{ENTRY}		50	100	150	ms
Test mode exit time[5)]	t_{EXIT}		8	16	24	s

Note: 5) Guaranteed by design.

PIN DESCRIPTION

Pin No.	Name	Description
1	VDD	Input pin for positive power supply.
2	VC3	Connection pin for battery 3's positive voltage.
3	VC2	Connection pin for battery 2's positive voltage.
4	VC1	Connection pin for battery 1's positive voltage.
5	GND	Input pin for negative power supply.
6	CS	Pin for charge and discharge current sensing.
7	VM	Pin for load and charger detection.
8	DO	Gate connection pin for discharge control MOSFET.
9	CO	This is a dual-purpose pin: 1) Gate connection pin for charge control MOSFET; 2) Pin for charger detection.
10	TS	Thermal sense input.

BLOCK DIAGRAM



FUNCTIONAL DESCRIPTION

Power on Reset

Battery cells can be connected in any order, but it is recommend that the GND and VDD pins are connected first, and then connection continues from lower to higher voltage cells.

When the battery is connected to JW3313, V_{DD} rises up. If $V_{DD}<V_{POR}$, all circuits power down and both charge and discharge MOSFETs turn off. When $V_{DD}>V_{POR}$, JW3313 enters initial status.

Normal Status

In the JW3313, both CO and DO pins output high level voltage when all battery voltages are between V_{OD} and V_{OC}, the battery temperature is between V_{COT} and $V_{CUT,}$ and the CS pin's voltage is between V_{COI} and V_{DOI1}. This is the normal status. At this time, the charge and discharge MOSFETs are on.

Over-Charge Status

JW3313 detects cell voltage once per t_{DETV}. When any battery voltage increases to V_{OC} or higher for longer than t_{OC}, the CO pin outputs "High_Z". Since the CO pin pulled down to the PACK- voltage by an external resistor, the charge MOSFET is turned off to stop charging. This is the over-charge status.

The over-charge status is released if either of the conditions mentioned below is satisfied:

(1) When the CO pin voltage is higher than V_{CHA} (optional by part number) and all battery voltage drops to V_{OCL} or lower for longer than t_{OCL}.

(2) When the CS pin voltage is higher than V_{TH_DSG} during discharging and all battery voltage drops to V_{OC} or lower for longer than 400μs.

(3) When the CS pin voltage is higher than V_{DOI1} during discharging and all battery voltage drops to V_{OC} or lower for longer than 60μs.

Over-Discharge Status

JW3313 detects cell voltage once per T_{DETV}. When any voltage of the batteries decreases to V_{OD} or lower for longer than t_{OD}, the DO pin outputs low level voltage. The discharge MOSFET is turned off and it stops discharging. This is the over-discharge status.

The over-discharge status is released if either condition mentioned below is satisfied:

(1) The VM pin voltage is lower than V_{VMTH}, and all battery voltages increase to V_{ODH} or higher for longer than t_{ODH}.

(2) The VM pin voltage is lower than V_{CHA}, and all battery voltages increase to V_{OD} or higher for longer than t_{ODH}.

Sleep Status

If JW3313 is in over-discharge status, and the sleep timer overflow, the JW3313 enters sleep status. At sleep status, the discharge MOSFET is turned off and the charge MOSFET is turned on. The total current consumption is 1.5μA in sleep status.

The sleep status is released if the following condition is satisfied:

The VM pin voltage is lower than V_{CHA} for longer than t_{SLPR}.

Discharge Over-Current Status

In the JW3313, if the CS pin voltage increases to the level of V_{DOI} or more for longer than t_{DOI}, the DO pin outputs low level voltage. The discharge MOSFET is turned off and it stops

discharging. This is the discharge over-current status.

The VM pin is pulled down to the GND level via R_{VMDN} internally.

JW3313 has three thresholds for discharge over-current detection (V_{DOI1}, V_{DOI2}, V_{SHT}).

The discharge over-current status is released if the following condition is satisfied:

The VM pin voltage is lower than V_{VMTH} for longer than t_{DOIR}.

Charge Over-Current Status

In the JW3313, if the CS pin voltage decreases to the level of V_{COI} or lower for longer than t_{COI}, the CO pin outputs “High_Z” and the DO pin outputs low level voltage. The charge and discharge MOSFETs are turned off. This is the charge over-current status.

The charge over-current is released if the following condition is satisfied:

The CO pin voltage is higher than V_{CHA} for longer than t_{COIR}.

Charge Temperature Protection Status

The JW3313 detects the temperature every t_{DETT}, see Figure 1 for temperature detection timing chart. In normal status, the JW3313 continuously turns on TS output for t_{DET} every t_{DETT}. When the TS output turns on, the external temperature is monitored.

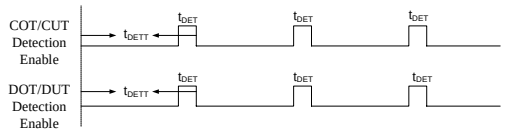


Figure 1 Temperature Detection Timing

In normal status, When the CS pin voltage is higher than V_{TH_DSG} for longer than t_{CST}, the battery pack is regarded as in discharging status. Otherwise, the battery pack is regarded as in charging status.

At normal status, if the system is in charging mode, once the battery temperature is out of the normal range of charging temperature and the state continues for longer than t_{OT}, JW3313 shuts down the charge MOSFET.

This status is released if either condition mentioned below is satisfied:

(1) When the system is in charging mode, the TS pin voltage is higher than V_{COTRT} and lower than V_{CUTRT} for longer than t_{OTR}.

(2) When the system is in discharging mode the CS pin voltage is higher than V_{TH_DSG} and lower than V_{DOI1} for longer than 400μs.

(3) When the system is in discharging mode the CS pin voltage is higher than V_{DOI1} for longer than 60μs.

Discharge Temperature Protection Status

At normal status, if the system is in discharging mode, once the battery temperature is out of the normal range of discharging temperature threshold and the state continues for t_{OT}, JW3313 shuts down the both charge and discharge MOSFETs, and enters discharge temperature protection status.

At charge temperature protection status, if the system is in charge mode, and the TS pin voltage is out of the normal range of discharging temperature threshold for longer than t_{OT}, JW3313 shuts down the both charge and discharge MOSFETs, enters discharge temperature protection status.

This status is released if either condition mentioned below is satisfied:

(1) When the system is in charging mode, the VM pin voltage is lower than V_{VMTH} and the TS pin voltage is higher than V_{DOTRT} and

lower than V_{COTRT}, this status is released to the charge temperature protection status. Similarly, the TS pin voltage is lower than V_{DUTRT} and higher than V_{CUTRT} for longer than t_{OTR}, this status is released to the charge temperature protection status

(2) When the system is in discharging mode, the VM pin voltage is lower than V_{VMTH} and the TS pin voltage is higher than V_{DOTRT} and lower than V_{DUTRT} for longer than t_{OTR}. This status is released to the normal status.

Open Wire Detection

JW3313 integrates open wire detection and protection. When any of VC3 to VC1 pin is open, it detects open wire, charging and discharging are prohibited after a delay time.

Test Mode

When DO pin voltage is a V_{ENTRY} higher than VDD pin voltage for longer than t_{ENTRY}, the JW3313 is in test mode. In this mode the delay time of all protection including over-charge, over-discharge and over-current is shortened, see Table 1. The chip can be quickly tested by the user in this mode.

Mode	t_{OC} (max)	t_{OD} (max)	t_{COI} (max)	t_{DOI1} (max)
Normal	1.95s	1.95s	10ms	t_{DOI1}
Test	10ms	10ms	600us	1.5ms

Mode	t_{DOI2} (max)	t_{OT} (max)	t_{SLP} (max)	
Normal	t_{DOI2}	5s	10s	
Test	1ms	12ms	2ms	

Table 1 The Delay Time of Different Mode

Package and Bag Caution

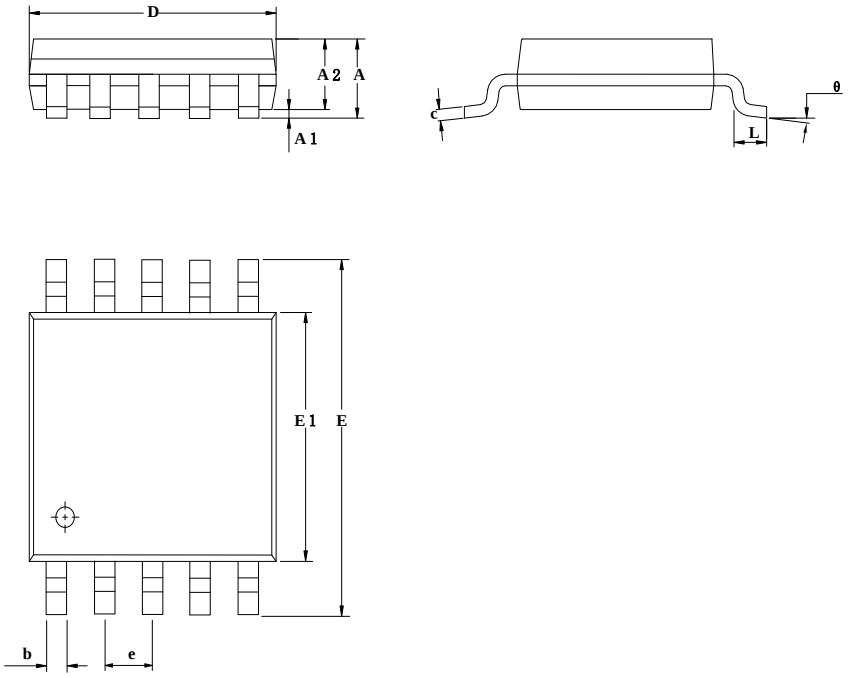
1. JW3313 is MSD (Moisture-Sensitive Devices) and its MSL[6)] (Moisture-Sensitive Level) is level-3.
2. Calculated shelf life in sealed bag is 12 months at <40℃ and <90%RH(Relative Humidity).
3. Peak package body temperature[1)] is 260℃.
4. After bag is opened, devices that will be subjected to reflow solder or other high temperature process must
   a) Mounted within 168 hours of factory at the condition ≤30℃/60%RH.
   b) Stored at <10%RH.
5. Devices require bake before mounting if Humidity Indicator Car(HIC) is >10%RH when read at 23±5℃.
6. If baking is required, devices may be baked for 48 hours at 125 ± 5 ℃. If device containers cannot be subjected to high temperature for shorter bake times are desired, reference IPC/JEDEC J-STD-033 for bake procedure.

Note:

6) Level and body temperature defined by IPC/JEDEC J-STD-020.

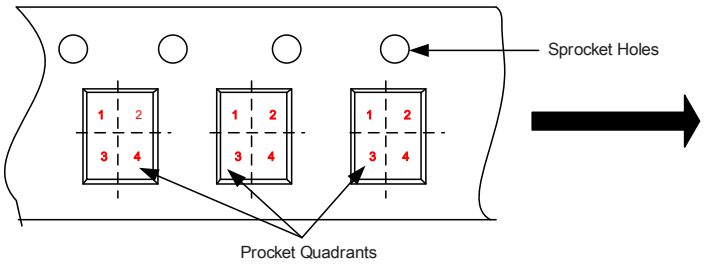
PACKAGE OUTLINE

MSOP10 UNIT: mm



Symbol	MILLIMETER		
	MIN	NOM	MAX
A	—	—	1.10
A1	0.02	—	0.15
A2	0.75	—	0.95
b	0.17	—	0.33
c	0.08	—	0.23
D	2.90	3.00	3.10
E	4.75	—	5.05
E1	2.90	—	3.10
e	0.50(BSC)		
L	0.40	—	0.80
θ	0°	—	8°

QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE



Package Type	Pin1 Quadrant
MSOP10	1

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