One Cell Lithium-ion/Polymer Battery Protection IC

CJBM1A880E BMS-Protector

1 Introduction

The CJBM1A880E product is a high integration solution for lithium-ion/polymer battery protection. It contains advanced power MOSFET, high-accuracy voltage detection and delay circuits. With simple external component needed, it's an ideal solution for battery pack with limited space.

CJBM1A880E has all the protection functions required in the battery applications, including overcharging, overdischarging, overcurrent and load short circuit protection etc. Its accurate overcharging detection voltage ensures safe and full utilization of battery's charging capability.

Additionally, the device's low standby current feature minimizes battery drain during storage. It is designed not only for digital cellular phones but also for any Li-Ion and Li-Poly battery-powered information appliances that require long-term battery life.

2 Available Packages

PART NUMBER	PACKAGE
CJBM1A880E	SOT-23-5L

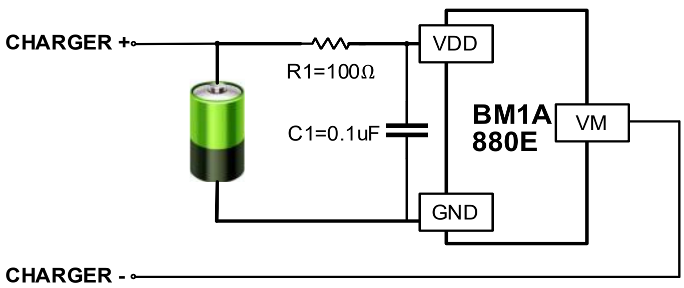
Note: For all available packages, please refer to the part Orderable Information.

3 Features

- Protection of Charger Reverse Connection
- Protection of Battery Cell Reverse Connection without external load
- Integrate Advanced Power MOSFET with Equivalent of 18mΩ $R_{SS(ON)}$
- Over-temperature Protection
- Overcharge Current Protection
- Two-step Overcurrent Detection
  - Overdischarge Current Protection
  - Load Short Circuiting Protection
- Low Current Consumption
  - Operation Mode: 3.9μA typ
  - Power-down Mode: 2.0μA typ
- Charger Detection Function
- 0V Battery Charging Function
- Delay Times are generated inside
- High-accuracy Voltage Detection
- Over-Discharge Self-recovery
- RoHS Compliant and Lead (Pb) Free

4 Applications

- One-Cell Lithium-ion Battery Pack
- Lithium-Polymer Battery Pack
- E-Smoke



Simplified Block Diagram

5 Orderable Information

DEVICE	PACKAGE	OP TEMP	ECO PLAN	MSL	PACKING OPTION	SORT
CJBM1A880E-M5N	SOT-23-5L	-40~85°C	RoHS & Green	Level 3 168HR	Tape and Reel 3000 Units / Reel	Active

Note:

ECO PLAN: For the RoHS and Green certification standards of this product, please refer to the official report provided by JSCJ.

MSL: Moisture Sensitivity Level. Determined according to JEDEC industry standard classification.

SORT: Specifically defined as follows:
Active: Recommended for new products;
Customized: Products manufactured to meet the specific needs of customers;
Preview: The device has been released and has not been fully mass produced. The sample may or may not be available;
NoRD: It is not recommended to use the device for new design. The device is only produced for the needs of existing customers;
Obsolete: The device has been discontinued.

6 Pin Configuration and Marking Information

6.1 Pin Configuration

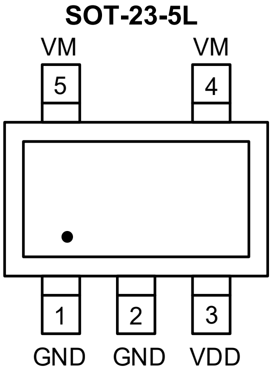


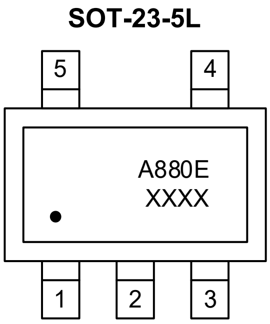
Figure 6-1 Pin Configuration

6.2 Pin Function

PIN		I/O(1)	DESCRIPTION
No.	NAME		
1,2	GND	G	Ground, connect the negative terminal of the battery to these pins.
3	VDD	P	Power Supply.
4,5	VM	O	The negative terminal of the battery pack. The internal FET switch connects this terminal to GND.

(1) I-Input, O-Output, P-Power, G-Ground

6.3 Marking Information



A880E: Device number.

XXXX: Code, indicates weekly record information.

DEVICE	PACKAGE	OV [VCU] (V)	OVR [VCL] (V)	UV [VDL] (V)	UVR [VDU] (V)	IOCD [IOV1] (A)	IOCC [ICHOC] (A)	Ishort [ISHORT] (A)	TOP MARK
CJBM1A880E-M5N	SOT-23-5L	4.30	4.10	2.40	3.0	8.8	6	35	A880E

7 Specifications

7.1 Absolute Maximum Ratings

Voltages are referenced to GND (ground=0V), unless otherwise specified.

SYMBOL	PARAMETER	MIN.	MAX.	UNIT
V_{DD}	VDD input pin voltage	-0.3	6	V
V_M	VM input pin voltage	-6	10	V
T_A	Operating Ambient Temperature	-40	85	°C
T_{J_MAX}	Maximum Junction Temperature	-	150	°C
T_{stg}	Storage temperature	-55	150	°C
T_{solder}	Lead Temperature (Soldering, 10 sec)	-	300	°C
P_{D_MAX}	Power Dissipation at T=25°C	-	0.4	W

Note: Absolute maximum ratings indicate sustained limits beyond which damage to the device may occur. All voltage parameters are absolute voltages referenced to GND. The thermal resistance and power dissipation ratings are measured under board mounted and still air conditions.

7.2 ESD Ratings

SYMBOL	ESD RATINGS		VALUE	UNIT
$V_{ESD\text{-}HBM}$	Electrostatic discharge	Human body model (HBM) (1)	±2000	V

(1) JEDEC document JEP155 states that 500-V H1BM allows safe manufacturing with a standard ESD control process.

7.3 Thermal Information

SYMBOL	THERMAL METRIC	SOT-23-5L	UNIT
$R_{\Theta JA}$	Junction-to-ambient thermal resistance	250	°C/W
$R_{\Theta JC}$	Junction-to-Case thermal resistance	130	°C/W

7.4 Electrical Characteristics

Typical and limits appearing in normal type apply for T_A = 25˚C, unless otherwise specified.

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
Detection Voltage						
V_{CU}	Overcharge Detection Voltage	-	4.25	4.30	4.35	V
V_{CL}	Overcharge Release Voltage	-	4.05	4.10	4.15	V
V_{DL}	Overdischarge Detection Voltage	-	2.3	2.4	2.5	V
V_{DU}	Overdischarge Release Voltage	-	2.9	3.0	3.1	V
V_{RIOV1}(1)	Discharge over-current release Voltage	-	0.3	0.5	0.7	V
Detection Current						
I_{IOV1}(1)	Overdischarge Current Detection	V_{DD}=3.6V	6	8.8	12	A
I_{CHOC}(1)	Overcharge Current Detection	V_{DD}=3.6V	4	6	8	A
I_{SHORT}(1)	Load Short-Circuiting Detection	V_{DD}=3.6V	18	35	52	A
Current Consumption						
I_{OPE}	Current Consumption in Normal Operation	V_{DD}=3.6V; VM pin floating	-	3.9	6	uA
I_{PDN}	Current Consumption in power Down	V_{DD}=2.0V; VM pin floating	-	2	4	uA
VM Internal Resistance						
R_{VMD}	Internal Resistance between VM and VDD	V_{DD}=2.0V; VM pin floating	200	300	400	kΩ
R_{VMS}	Internal Resistance between VM and GND	V_{DD}=3.6V; VM=1.0V	15	25	35	kΩ
FET on Resistance						
$R_{SS(ON)}$ (1)	Equivalent FET on Resistance	V_{DD}=3.6V; I_{VM} =1.0A	-	18	20	mΩ
Over Temperature Protection						
T_{SHD+}(1)	Over Temperature Protection	-	-	150	-	°C
T_{SHD-}(1)	Over Temperature Recovery Degree	-	-	110	-	°C
Detection Delay Time						
t_{CU}	Overcharge Voltage Detection Delay Time	-	80	160	250	ms
t_{DL}	Overdischarge Voltage Detection Delay Time	-	20	50	75	ms
t_{IOV1}	Overdischarge Current1 Detection Delay Time	V_{DD}=3.6V	5	10	20	ms
t_{CHOC}(1)	Overcharge Current Detection Delay Time	V_{DD}=3.6V	5	20	40	ms
t_{SHORT}(1)	Load Short-Circuiting Detection Delay Time	V_{DD}=3.6V	50	200	600	us

(1) The parameter is guaranteed by design

8 Detailed Description

8.1 Overview

The CJBM1A880E monitors the voltage and current of a battery and protects it from being damaged due to overcharge voltage, overdischarge voltage, overdischarge current, and short circuit conditions by disconnecting the battery from the load or charger. These functions are required to operate the battery cell within specified limits. The device requires only one external capacitor. The Rdson of integrated MOSFET is as low as 18mΩ typical.

8.2 Functional Block Diagram

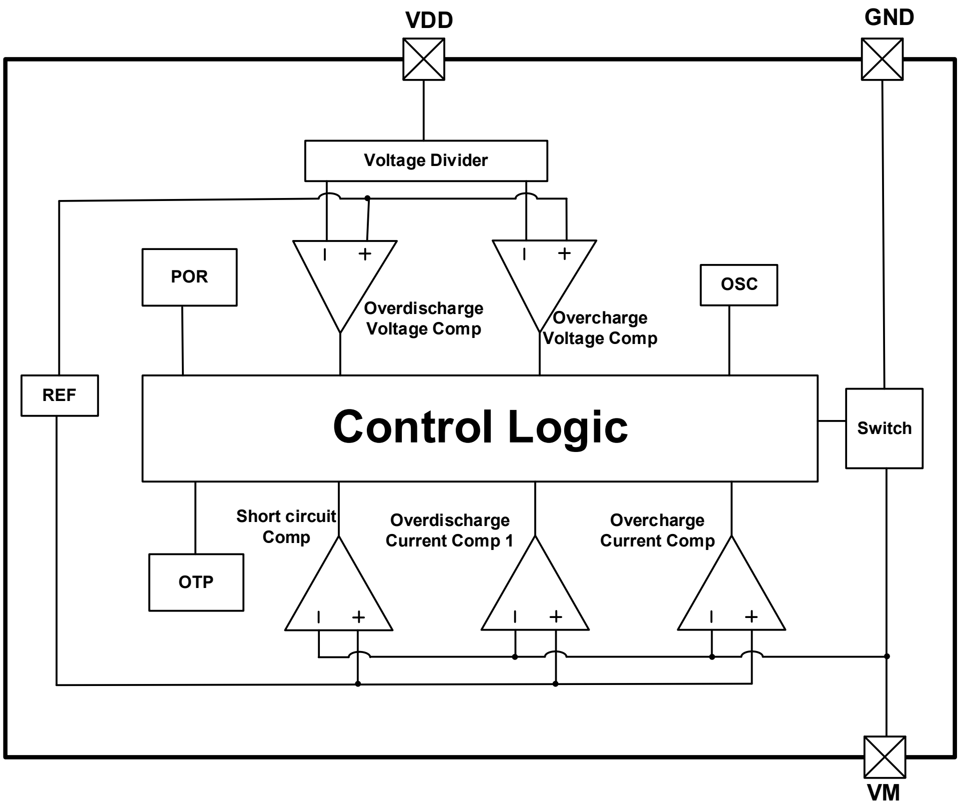


Figure 8-1 Logic Diagram

8.3 Feature Description

8.3.1 Normal Operation Mode

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

Remark：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.

8.3.2 Overcharge Condition

When the battery voltage becomes higher than the overcharge detection voltage (V_{CU}) during charging under normal condition and the state continues for the overcharge detection delay time (t_{CU}) or longer, the CJBM1A880E turns the charging control FET off to stop charging. This condition is called the overcharge condition. The overcharge condition is released in the following two cases:

1) When the battery voltage drops below the overcharge release voltage (V_{CL}), the CJBM1A880E turns the charging

control FET on and returns to the normal condition.

2) When a load is connected and discharging starts, the CJBM1A880E turns the charging control FET on and returns to normal condition. The release mechanism is as follows: the discharging current flows through an internal parasitic diode of the charging FET immediately after a load is connected and discharging starts, and the VM pin voltage increases about 0.7V (forward voltage of the diode) from the GND pin voltage momentarily. The CJBM1A880E detects this voltage and releases the overcharge condition. Consequently, in the case that the battery voltage is equal to or lower than the overcharge detection voltage (V_{CU}), the CJBM1A880E returns to the normal condition immediately, but in the case the battery voltage is higher than the overcharge detection voltage (V_{CU}), the chip does not return to the normal condition until the battery voltage drops below the overcharge detection voltage (V_{CU}) even if the load is connected. In addition, if the VM pin voltage is equal to or lower than the overcurrent detection voltage when a load is connected and discharging starts, the chip does not return to normal condition.

Remark: If the battery is charged to a voltage higher than the overcharge detection voltage (V_{CU}) and the battery voltage does not drop below the overcharge detection voltage (V_{CU}) even when a heavy load, which causes an overcurrent, is connected, the overcurrent does not work until the battery voltage drops below the overcharge 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 overcurrent is connected, the overcurrent work. Detection of load short-circuiting works regardless of the battery voltage.

8.3.3 Overdischarge Condition

When the battery voltage drops below the overdischarge detection voltage (V_{DL}) during discharging under normal condition and it continues for the overdischarge detection delay time (t_{DL}) or longer, the CJBM1A880E turns the discharging control FET off and stops discharging. This condition is called overdischarge condition. After the discharging control FET is turned off, the VM pin is pulled up by the R_{VMD} resistor between VM and VDD in CJBM1A880E. Meanwhile when VM is higher 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 R_{VMD} resistor in the IC under the overdischarge and power-down conditions.

The power-down condition is released when a charger is connected and the potential difference between VM and VDD becomes 1.3 V (typ.) or higher (load short-circuiting detection voltage). At this time, the FET is still off. When the battery voltage becomes the overdischarge detection voltage (V_{DL}) or higher (see note), the CJBM1A880E turns the FET on and changes to the normal condition from the overdischarge condition.

8.3.4 Charging Overcurrent Condition

When the charging current becomes equal to or higher than a specified value (the VM pin voltage is equal to or lower than the overcurrent detection voltage) during charging under normal condition and the state continues for the charging overcurrent detection delay time or longer, the CJBM1A880E turns off the charging control FET to stop charging. This condition is called charging overcurrent condition.

When the charger is removed, detecting that the VM pin voltage is higher than the charge overcurrent detection voltage ($-I_{CHOC}*R_{SSON}*0.75$), the IC returns to the normal condition.

8.3.5 Discharging Overcurrent Condition

When the discharging current becomes equal to or higher than a specified value (the VM pin voltage is equal to or higher than the overcurrent detection voltage) during discharging under normal condition and the state continues for the discharging overcurrent detection delay time or longer, the CJBM1A880E turns off the discharging control FET to stop discharging. This condition is called discharging overcurrent condition.

The VM and GND pins are shorted internally by the R_{VMS} resistor under the overcurrent condition. When a load is connected, the VM pin voltage equals the VDD voltage due to the load.

The discharge overcurrent condition returns to the normal condition when the load is released and the impedance between the B+ and B- 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 the R_{VMS} resistor. Detecting that the VM pin potential is lower than the discharge overcurrent release voltage (V_{RIOV1}), the IC returns to normal condition.

8.3.6 Load Short-Circuiting Condition

If voltage of VM pin is equal or below short circuit protection voltage (V_{SHORT}), the CJBM1A880E will stop discharging and battery is disconnected from load. The maximum delay time to switch current off is t_{SHORT}. This status is released when voltage of VM pin is lower than discharge overcurrent release voltage(V_{RIOV1}), such as when disconnecting the load.

8.3.7 0V Battery Charging Function [(1)] [(2)] [(3)]

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 VDD potential. When the voltage between the gate and the 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 overdischarge release voltage (V_{DU}), the normal condition returns.

Note:

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

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

8.4 Time Chart

8.4.1 Overcharge and Overdischarge Voltage Detection

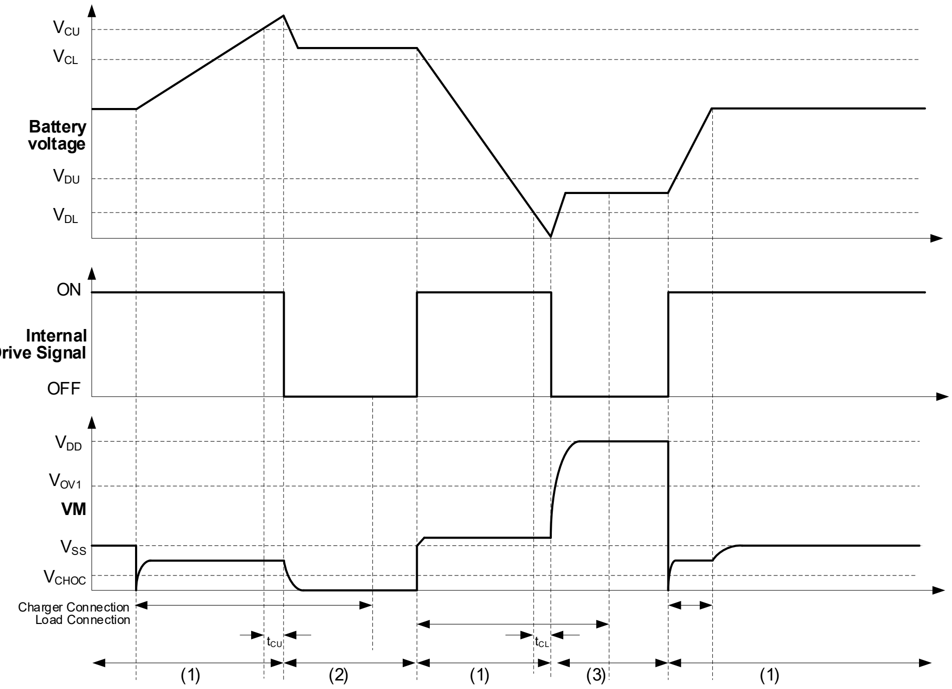


Figure 8-2 Overcharge and Overdischarge Voltage Detection

Remark: (1) Normal condition (2) Overcharge voltage condition (3) Overdischarge voltage condition

8.4.2 Overdischarge Current Detection

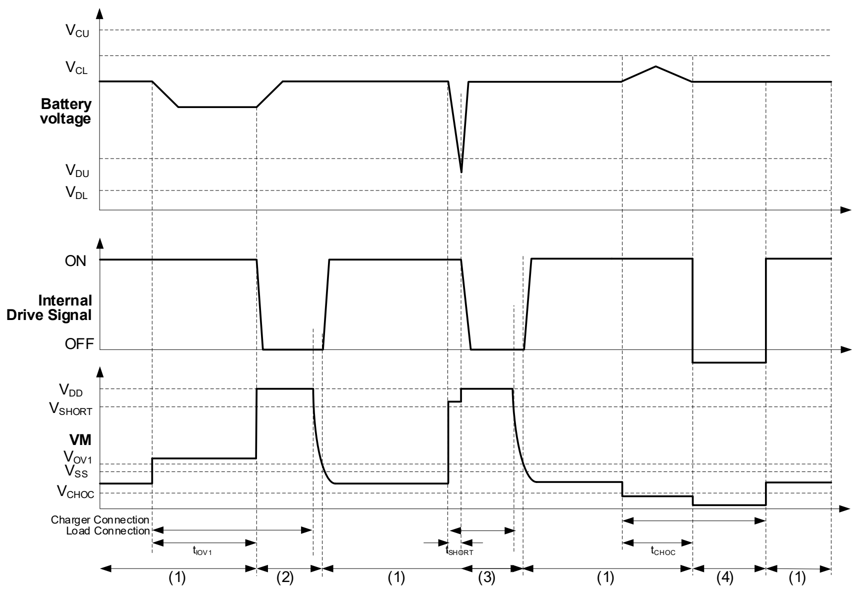


Figure 8-3 Overdischarge Current, Overcharge current and Short Detection

Remark: (1) Normal condition (2) Overdischarge current condition (3) Short current condition (4) Overcharge current condition

9 Typical Application and Layout Guideline

As shown in Figure 9-1the current path which must be kept as short as possible. For thermal management, ensure that these trace widths are adequate. C is a decoupling capacitor which should be placed as close as possible toCJBM1A880E.

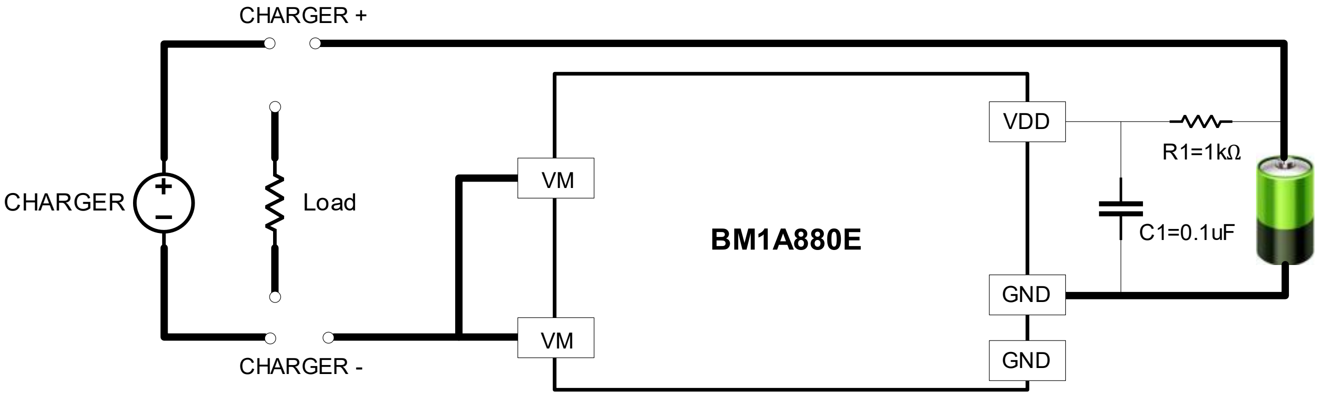


Figure 9-1 CJBM1A880E in a Typical Battery Protection Circuit

SYMBOL	TYP	VALUE RANGE	UNIT
C1	0.1	0.1~2.2	uF
R1	1	0.47~2	kΩ

Note:

(1) The above parameters may be changed without notice.
(2) The schematic diagram and parameters of the IC are not used as the basis to ensure the operation of the circuit. Please conduct full measurement on the actual application circuit before setting the parameters.
(3) If the resistance value is large, the overcharging voltage will be correspondingly larger by several mV.

Precautions

(1) Pay attention to the operating conditions for input/output voltage and load current so that the power loss in CJBM1A880E does not exceed the power dissipation of the package.
(2) Do not apply an electrostatic discharge to this CJBM1A880E that exceeds the performance ratings of the built-in electrostatic protection circuit.

10 Applied Measurement Method

10.1 Overcharge Characteristic Test Method

According to the Figure11-2, connect the power supply DC1 to the B + and GND pins of the system board and set the voltage to about 3.6V. Connect the DC2 power supply from VM to GND, set the 100mV current limiting 10mA, and observe the waveform.

Adjust the power supply voltage V1 and decrease it by 0.001V until the output level of VM pin changes from 0 to positive (100mV). Record the overdischarge protection voltage and measure the protection delay.

Adjust the power supply voltage V1 to increase by 0.001 V until the output voltage of VM pin is restored from positive (100 mV) to 0 level, and record the overdischarge recovery voltage.

10.2 Over Discharge Characteristic Test Method

According to the Figure11-2, connect the power supply DC1 to the B + and GND pins of the system board and set the voltage to about 3.6V. Connect the DC2 power supply from VM to GND, set the 100mV current limiting 10mA, and observe the waveform.

Adjust the power supply voltage V1 and decrease it by 0.001V until the output level of VM pin changes from 0 to positive (100mV). Record the overdischarge protection voltage and measure the protection delay.

Adjust the power supply voltage V1 to increase by 0.001 V until the output voltage of VM pin is restored from positive (100 mV) to 0 level, and record the overdischarge recovery voltage.

10.3 Charging Over Current Test Method

According to the Figure11-3, connect the DC1 power supply to the B + and GND pins of the system board and set the voltage to about 3.0V/3.6V/4.2V, and load DC2 power supply from GND to VM.

Adjust the current limiting value of DC2 power supply to increase by 0.1A step, detect that the current from GND to VM is turned off and meet the delay standard(about 10ms), and record the charging over-current delay time.

10.4 Discharge Over Current Test Method

According to the Figure11-4, connect the DC1 power supply to the B + and GND pins of the system board and set the voltage to about 3.0V/3.6V/4.2V. Connect the electronic load from B + to VM and observe the waveform.

Adjust the electronic load increase it by 0.1A step, detect that the current from B + to VM is turned off and meet the delay standard (about 10ms), and record the discharge delay time.

10.5 Iq Test Method

As shown in the Figure11-5, connect the positive pole of DC1 to B +, and the negative pole to GND, and set the voltage to 3.6V.

VM grounding, record the current passing through DC1 (I_q).

10.6 Isd Test Method

As shown in the Figure11-6, connect the positive pole of DC1 to B + and the negative pole to GND, and set the voltage to 2V.

VM is suspended and the current passing through DC1 is recorded as Isd.

11 Schematic Diagram of Test Method

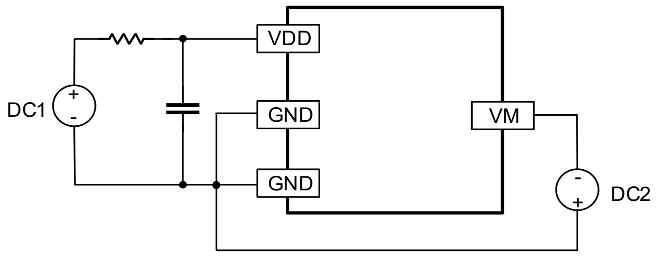


Figure 11-1

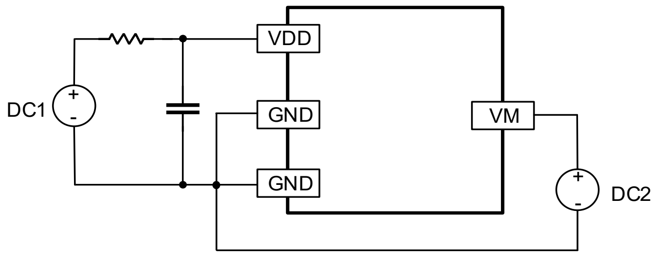


Figure 11-2

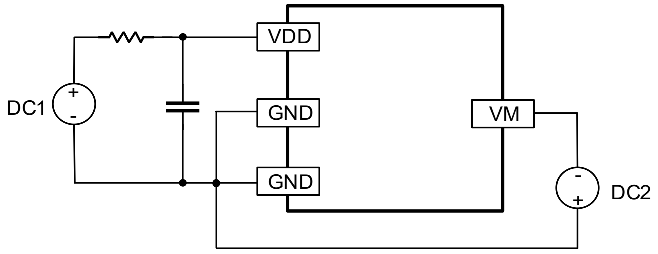


Figure 11-3

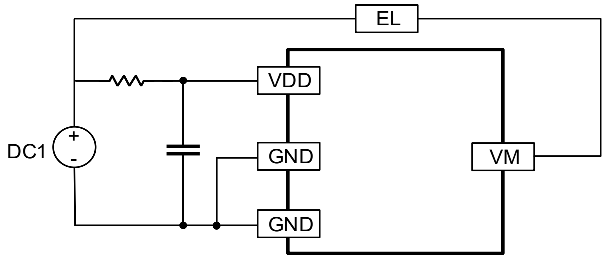


Figure 11-4

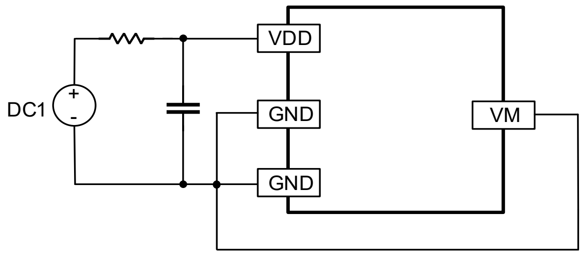


Figure 11-5

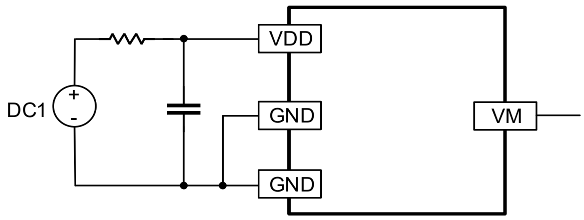
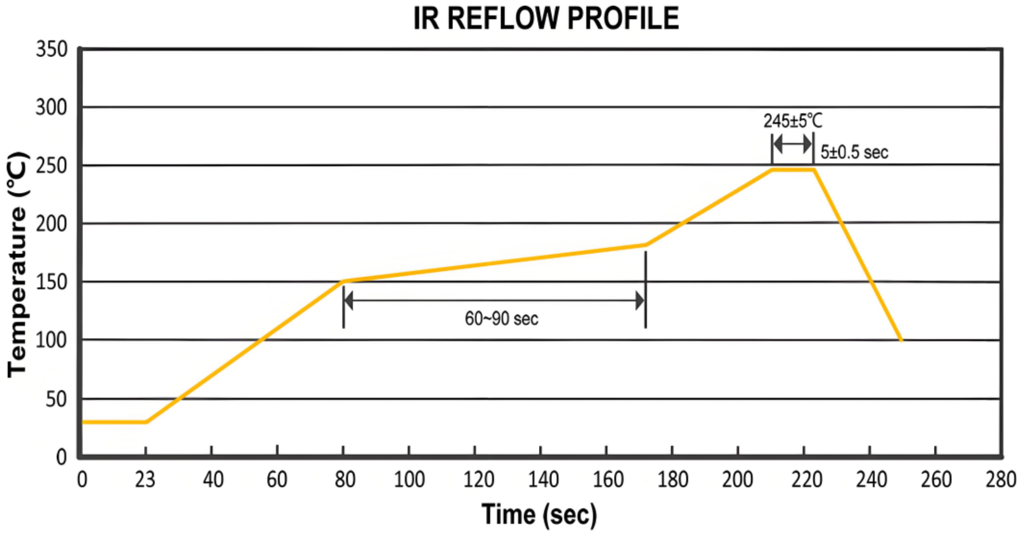


Figure 11-6

12 Solderability Curve of Lead-Free Reflow Soldering (applicable to SMT tube)



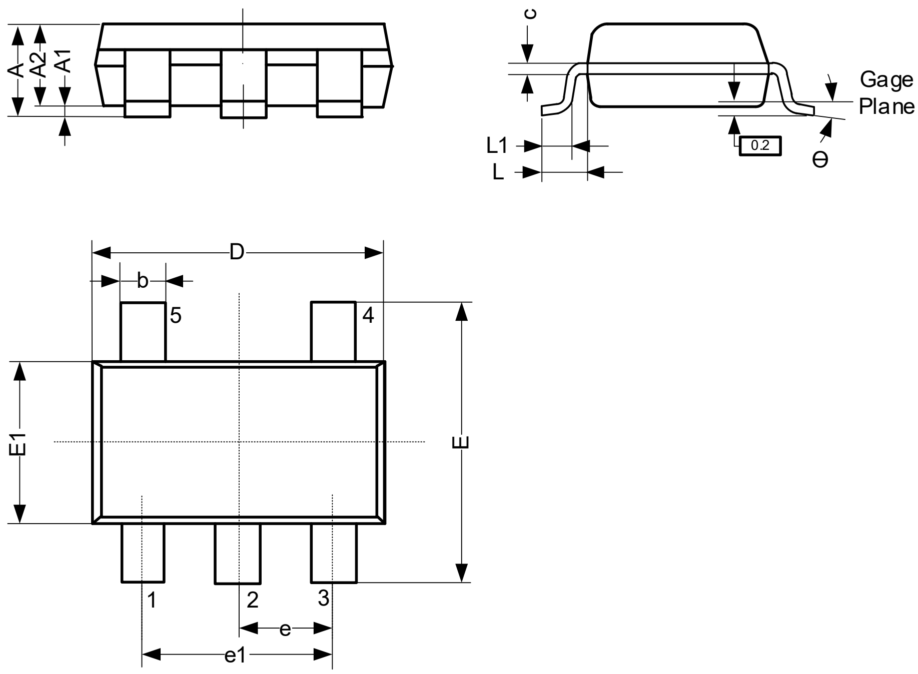
(1) Preheating temperature 25~150°C, duration 60~90sec;
(2) Peak temperature 245±5°C, duration 5±0.5sec;
(3) Cooling rate of welding process is 2~10°C/sec.

Resistance to Welding Heat Conditions: Temperature: 270±5°C; Time: 10±1sec.

13 Mechanical Information

13.1 SOT-23-5L Mechanical Information

13.1.1 SOT-23-5L Outline Dimensions



SYMBOL	Dimensions In Millimeters		
	Min.	Typ.	Max.
A	0.95	-	1.25
A1	0.00	-	0.10
A2	0.90	-	1.15
b	0.27	-	0.50
c	0.10	-	0.20
D	2.82	-	3.02
E	2.65	-	2.95
E1	1.50	-	1.70
e	0.95 BSC		
e1	1.80	-	2.00
L	0.70 REF		
L1	0.30	-	0.60
Θ	0°	-	8°
Unit: mm			

14 Notes and Revision History

14.1 Associated Product Family and Others

To view other products of the same type or IC products of other types, click the official website of JSCJ -- ***https:www.jscj-elec.com*** for more details.

14.2 Notes

Electrostatic Discharge Caution

This IC may be damaged by ESD. Relevant personnel shall comply with correct installation and use specifications to avoid ESD damage to the IC. If appropriate measures are not taken to prevent ESD damage, the hazards caused by ESD include but are not limited to degradation of integrated circuit performance or complete damage of integrated circuit. For some precision integrated circuits, a very small parameter change may cause the whole device to be inconsistent with its published specifications.

14.3 Revision History

May, 2025: rev - 1.4, Add applied Measurement Method chapter.

July, 2025: rev - 1.5, Change device name.

DISCLAIMER

IMPORTANT NOTICE, PLEASE READ CAREFULLY

The information in this data sheet is intended to describe the operation and characteristics of our products. JSCJ has the right to make any modification, enhancement, improvement, correction or other changes to any content in this data sheet, including but not limited to specification parameters, circuit design and application information, without prior notice.

Any person who purchases or uses JSCJ products for design shall: 1. Select products suitable for circuit application and design; 2. Design, verify and test the rationality of circuit design; 3. Procedures to ensure that the design complies with relevant laws and regulations and the requirements of such laws and regulations. JSCJ makes no warranty or representation as to the accuracy or completeness of the information contained in this data sheet and assumes no responsibility for the application or use of any of the products described in this data sheet.

Without the written consent of JSCJ, this product shall not be used in occasions requiring high quality or high reliability, including but not limited to the following occasions: medical equipment, military facilities and aerospace. JSCJ shall not be responsible for casualties or property losses caused by abnormal use or application of this product.

Official Website: www.jscj-elec.com