Description

The CM1003-BQE is a protection IC for lithium-ion/lithium-polymer rechargeable batteries and includes high-accuracy voltage detection circuits and delay circuits. The overcharge, over discharge, discharging and charging overcurrent protection of the rechargeable one-cell lithium-ion or lithium-polymer battery can be detected.

Features

1) **High accuracy voltage detection**

• Overcharge detection voltage	4.590 V	Accuracy ±20 mV
• Overcharge release voltage	4.390 V	Accuracy ±45 mV
• Over discharge detection voltage	3.000 V	Accuracy ±30 mV
• Over discharge release voltage	3.000 V	Accuracy ±50 mV
• Discharging overcurrent detection voltage	0.020 V	Accuracy ±5 mV
• Short-circuit detection voltage	0.100 V	Accuracy ±20 mV
• Charging overcurrent detection voltage	-0.020 V	Accuracy ±5 mV

2) **Range of detection delay time**

• Overcharge detection delay time	1.0 s	Accuracy ±30%
• Over discharge detection delay time	64 ms	Accuracy ±30%
• Discharging overcurrent detection delay time	8 ms	Accuracy ±30%
• Charging overcurrent detection delay time	8 ms	Accuracy ±30%

3) **Charger & Load Detection function**

4) **0 V battery charge function** — Available

5) **Power-down function** — Available

6) **Release condition of discharge overcurrent status** — Load disconnection

7) **Discharge overcurrent release voltage** — V_{DIOV}

8) **RoHS, PB-Free, HF**

9) **Ultra-low power dissipation**

• Normal mode	1.5 μA (Typ.) (Ta = +25°C)
• Power-down mode	50 nA (Max.) (Ta = +25°C)

Application

• Lithium-ion/lithium-polymer rechargeable battery

Packages

• DFN1.2×1.2-6L

ESD

- HBM：4000 V
- CDM：1000 V

Block Diagram

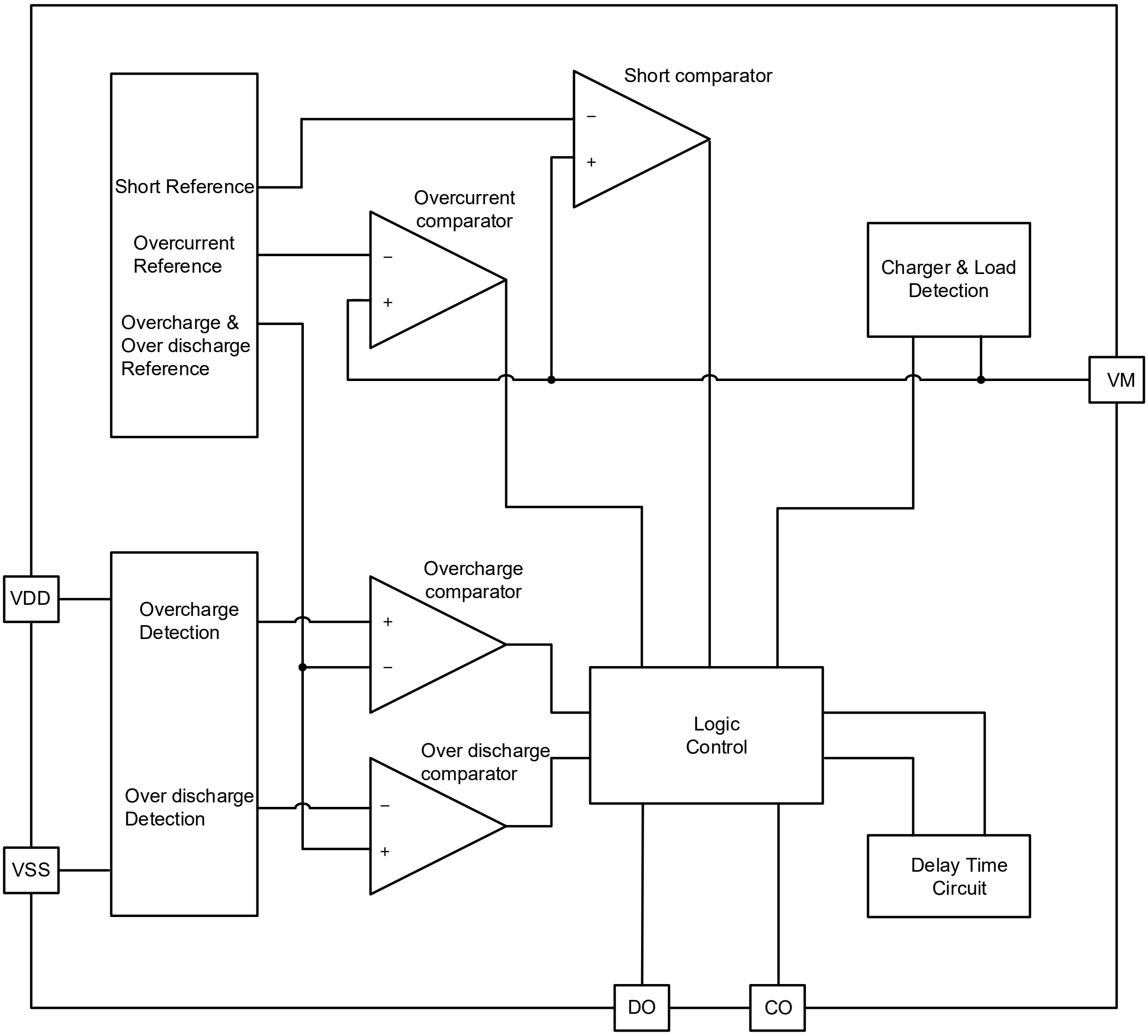


Figure 1

Pin Configurations

DFN1.2*1.2-6L

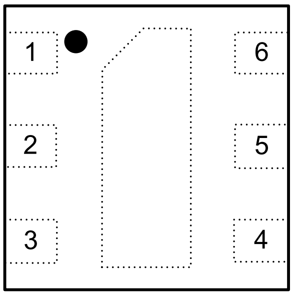


Figure 2 Top view

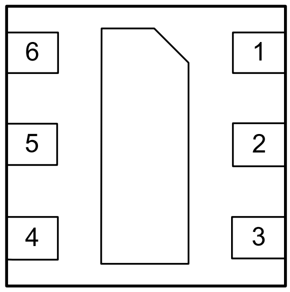


Figure 3 Bottom view

PIN	Symbol	Description
1	NC	No Connection.
2	CO	Charge power MOSFET control pin.
3	DO	Discharge power MOSFET control pin.
4	VSS	Negative power input pin.
5	VDD	Positive power input pin.
6	VM	Connected to charger negative voltage.

Table 1

Marking

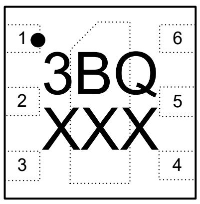
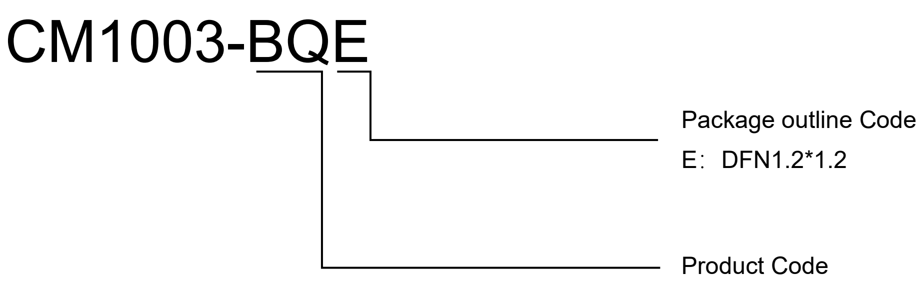


Figure 4

The first line: 3 is the product family code，BQ is the product code

The second line: Lot number

Naming rules



Products Catalogue

1. Detect Voltage List

Part No.	Overcharge detection voltage [V_{OC}]	Over-charge release voltage [V_{OCR}]	Over-discharge detection voltage [V_{OD}]	Over-discharge release voltage [V_{ODR}]	Discharge overcurrent detection [V_{EC}]	Short-circuit current detection [V_{SHORT}]	Charge overcurrent detection [V_{CHA}]
CM1003-BQE	4.590 V	4.390 V	3.000 V	3.000 V	0.020 V	0.100 V	-0.020 V

Table 2

2. Product Function List

Part No.	0 V Battery Charge Function	Release condition of discharge overcurrent status	Release Voltage of Discharge Overcurrent Status	Overcharge self-release Function	Power-down Function
CM1003-BQE	Available	Load disconnection	V_{DIOV}	Available	Available

Table 3

3. Delay Time

Overcharge detection delay time T_{OC}	Over discharge detection delay time T_{OD}	Discharge overcurrent detection delay time T_{EC}	Charge overcurrent detection delay time T_{CHA}	Load short-circuiting detection delay time T_{SHORT}
1000 ms	64 ms	8 ms	8 ms	280 μs

Table 4

Remark: For more product info, please contact iCM marketing department.

■ Absolute Maximum Ratings

(Unless otherwise specified: Ta = +25°C)

Item	Symbol	Ratings	Unit
Power supply voltage	VDD	VSS-0.3 ~ VSS+8.0	V
Input pin voltage for VM	V_{VM}	VDD-28 ~ VDD+0.3	V
CO output voltage	V_{CO}	V_{VM} -0.3 ~ VDD+0.3	V
DO output voltage	V_{DO}	VSS-0.3 ~ VDD+0.3	V
Operating temperature	T_{OPR}	-40 ~ +85	°C
Storage temperature	T_{STG}	-55 ~ +125	°C

Table 5

Caution: The absolute maximum ratings are rated values exceeding which the product could suffer physical damage. These values must therefore not be exceeded in any conditions.

■ Electrical Characteristics

(Unless otherwise specified: Ta = +25°C)

Item	Symbol	Test conditions	Min.	Typ.	Max.	Unit
[Consumption]						
Operating consumption	I_{OPE}	VDD=3.5V, V_{VM}=0V	0.9	1.5	3.0	μA
Power down consumption	I_{PDN}	VDD=V_{VM}=1.5V	-	-	50	nA
[Detection Voltage]						
Overcharge detection voltage	V_{OC}	VDD=3.5 → 4.8V	4.570	4.590	4.610	V
Overcharge release voltage	V_{OCR}	VDD=4.8 → 3.5V	4.345	4.390	4.435	V
Over discharge detection voltage	V_{OD}	VDD=3.5 → 2.0V	2.970	3.000	3.030	V
Over discharge release voltage	V_{ODR}	VDD=2.0 → 3.5V	2.950	3.000	3.050	V
Discharge overcurrent detection voltage	V_{EC}	VM-VSS=0 →0.30V	0.015	0.020	0.025	V
Load short-circuiting detection voltage	V_{SHORT}	VM-VSS=0 → 1.5V	0.080	0.100	0.120	V
Charge overcurrent detection voltage	V_{CHA}	VSS-VM=0 →0.30V	-0.025	-0.020	-0.015	V
Discharge overcurrent release voltage	V_{DIOV}	-	-	0.020	-	V
[Delay Time]						
Overcharge detection delay time	T_{OC}	VDD=3.5 → 4.8V	700	1000	1300	ms
Over discharge detection delay time	T_{OD}	VDD=3.5 → 2.0V	44.8	64	83.2	ms
Discharge overcurrent detection delay time	T_{EC}	VM-VSS=0 → V_{EC}+0.1V	5.6	8	10.4	ms
Charge overcurrent detection delay time	T_{CHA}	VSS-VM=0 →0.30V	5.6	8	10.4	ms
Load short-circuiting detection delay time	T_{SHORT}	VM-VSS=0 → 1.5V	140	280	504	μs
[Internal Resistance]						
Resistance between VDD pin and VM pin	R_{VMC}	VDD=1.8V, V_{VM}=0V	750	1500	3000	kΩ
Resistance between VM pin and VSS pin	R_{VMS}	VDD=3.5V,V_{VM}=1.0V	10	20	30	kΩ
[Output Resistance]						
CO pin resistance "H"	R_{COH}	-	5	10	20	kΩ
CO pin resistance "L"	R_{COL}	-	5	10	20	kΩ
DO pin resistance "H"	R_{DOH}	-	5	10	20	kΩ
DO pin resistance "L"	R_{DOL}	-	5	10	20	kΩ
[0 V Battery Charge Function]						
0 V battery charge "Available" starting charge voltage	V_{0CH}	0 V battery charging "Available"	0	0.7	1.5	V

Table 6

■ Electrical Characteristics

(Unless otherwise specified: Ta = -20°C ~ +60°C*1)

Item	Symbol	Test conditions	Min.	Typ.	Max.	Unit
[Consumption]						
Operating consumption	I_{OPE}	VDD=3.5V, V_{VM}=0V	0.6	1.5	5.0	μA
Power down consumption	I_{PDN}	VDD=V_{VM}=1.5V	-	-	150	nA
[Detection Voltage]						
Overcharge detection voltage	V_{OC}	VDD=3.5 → 4.8V	4.550	4.590	4.630	V
Overcharge release voltage	V_{OCR}	VDD=4.8 → 3.5V	4.315	4.390	4.465	V
Over discharge detection voltage	V_{OD}	VDD=3.5 → 2.0V	2.950	3.000	3.050	V
Over discharge release voltage	V_{ODR}	VDD=2.0 → 3.5V	2.920	3.000	3.080	V
Discharge overcurrent detection voltage	V_{EC}	VM-VSS=0 →0.30V	0.010	0.020	0.030	V
Load short-circuiting detection voltage	V_{SHORT}	VM-VSS=0 → 1.5V	0.060	0.100	0.140	V
Charge overcurrent detection voltage	V_{CHA}	VSS-VM=0 →0.30V	-0.030	-0.020	-0.010	V
Discharge overcurrent release voltage	V_{DIOV}	-	-	0.020	-	V
[Delay Time]						
Overcharge detection delay time	T_{OC}	VDD=3.5 → 4.8V	500	1000	2000	ms
Over discharge detection delay time	T_{OD}	VDD=3.5 → 2.0V	32	64	128	ms
Discharge overcurrent detection delay time	T_{EC}	VM-VSS=0 → V_{EC}+0.1V	4	8	16	ms
Charge overcurrent detection delay time	T_{CHA}	VSS-VM=0 →0.30V	4	8	16	ms
Load short-circuiting detection delay time	T_{SHORT}	VM-VSS=0 → 1.5V	112	280	616	μs
[Internal Resistance]						
Resistance between VDD pin and VM pin	R_{VMC}	VDD=1.8V, V_{VM}=0V	500	1500	6000	kΩ
Resistance between VM pin and VSS pin	R_{VMS}	VDD=3.5V,V_{VM}=1.0V	7.5	20	40	kΩ
[Output Resistance]						
CO pin resistance "H"	R_{COH}	-	2.5	10	30	kΩ
CO pin resistance "L"	R_{COL}	-	2.5	10	30	kΩ
DO pin resistance "H"	R_{DOH}	-	2.5	10	30	kΩ
DO pin resistance "L"	R_{DOL}	-	2.5	10	30	kΩ
[0 V Battery Charge Function]						
0 V battery charge “Available” starting charge voltage	V_{0CH}	0 V battery charging “Available”	0	0.7	1.8	V

Table 7

***1：Since products are not screened at high and low temperature, the specification for this temperature range is guaranteed by design, not tested in production.**

Function Description

1. Normal Condition

The CM1003-BQE monitors the voltage of the battery connected between VDD pin and VSS pin, the voltage between VM pin and VSS pin to control charging and discharging. When the battery voltage is in the range from the over discharge detection voltage (V_{OD}) to the overcharge detection voltage (V_{OC}), and the VM pin voltage is in the range from charging overcurrent detection voltage (V_{CHA}) to discharging overcurrent detection voltage (V_{EC}), the IC turns both the charging and discharging control MOSFETs on. This status is called the normal condition.

Caution: When connecting the cell for the first time, there will be the possibility of not discharging. At this time, short connect the VM pin and VSS pin, or connect the charger, can be restored to normal working condition.

2. Overcharge Condition

During charging, when the battery voltage connected between VDD and VSS pins exceeds the charging protection voltage (V_{OC}) and this state lasts for longer than the charging protection delay time (T_{OC}), the output voltage of IC CO pin changes from high level to low level, and the MOSFET used for charging control is closed, charging is stopped. This status is called the overcharge condition.

The overcharge protection state will be released if any of the next conditions occurs:

(1) VM < V_{EC}, When the battery voltage is reduced to below the overcharge relief voltage (V_{OCR}) due to self-discharge, the overcharge state is released， and the battery returns to the normal working state.

(2) VM> V_{EC} (connecting to the load), When the battery voltage is lower than V_{OC}, the overcharge state is released， and the battery returns to the normal working state.

3. Over discharge Condition

During discharging, when the battery voltage is lower than V_{OD} and lasts longer than T_{OD}. The output voltage of DO will reverse. The discharge MOSFET will be turned off and stop discharging. This condition is called the over discharge condition.

During discharging, If the voltage difference between the VDD pin and the VM pin drops below 1.0V (Typ), the current consumed is reduced to the current consumed during power down (I_{PDN}), This status is called the power down condition.

When the VM pin voltage ≥0.7V (Typ) is not connected to the charger., over discharge status is maintained even when the battery voltage is above V_{ODR}. The over discharge state can be released in the following two cases:

(1) Connecting to the charger VM ≤ 0V(Typ), the battery voltage is higher than V_{OD}.

(2) Connecting to the charger (0V(Typ) < VM < 0.7V), the battery voltage is higher than V_{ODR}.

4. Discharging Overcurrent Condition

During discharging, the voltage of VM becomes higher with the current increasing. When the voltage of VM is higher than V_{EC} and stays longer than T_{EC}, the discharge MOSFET will be turned off and stop discharging, this status is called the discharging overcurrent condition.

If VM pin voltage is higher than short-circuit voltage and stays longer than T_{SHORT}, The MOSFET will be turned off and stop discharging. This status is called the load short circuit condition

The release condition of discharge overcurrent status is “disconnect load” and discharge overcurrent release voltage “V_{DIOV}”.

When discharge overcurrent status, The VM pin inside the IC is connected to the VSS pin by R_{VMS} resistance, during the connection load, The VM pin voltage changes to the VDD pin voltage because it is connected to the load. If disconnected with the load, The VM pin returns to the VSS pin voltage. When the VM pin voltage drops below V_{DIOV}, the discharge overcurrent status can be released.

5. Charging Overcurrent Condition

During charging, If the VM pin voltage falls below the charging overcurrent detection voltage (V_{CHA}) and stays longer than the charging overcurrent detection delay time (T_{CHA}) or longer, the charging control MOSFET turns off and charging stops. This status is called the charging overcurrent condition.

Note: The discharging voltage of charging overcurrent is 0V(Typ). If the charging overcurrent can be removed reliably, the voltage of VM pin needs ≥ 0.01V. After the actual charging overcurrent protection occurs, If disconnect the charger or connect the load, the VM pin will be pulled up by R_{VMC}. The voltage of the VM pin must be higher than 0.01V, and the overcurrent state of charging is removed and the VM pin will return to the normal working state.

6. 0 V Battery Charging Function "Available"

When the 0V battery charge starting charger voltage (V_{0CHA}) or higher is applied between P+ pin and P− pin by connecting a charger, the charging control MOSFET gate is fixed to VDD pin voltage. When the voltage between the gate and 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 start charging.

Note: Please ask the battery manufacturer if it is recommended to charge the 0V battery again after it has been fully discharged to determine whether charging the 0V battery is allowed or not.

Application Circuits

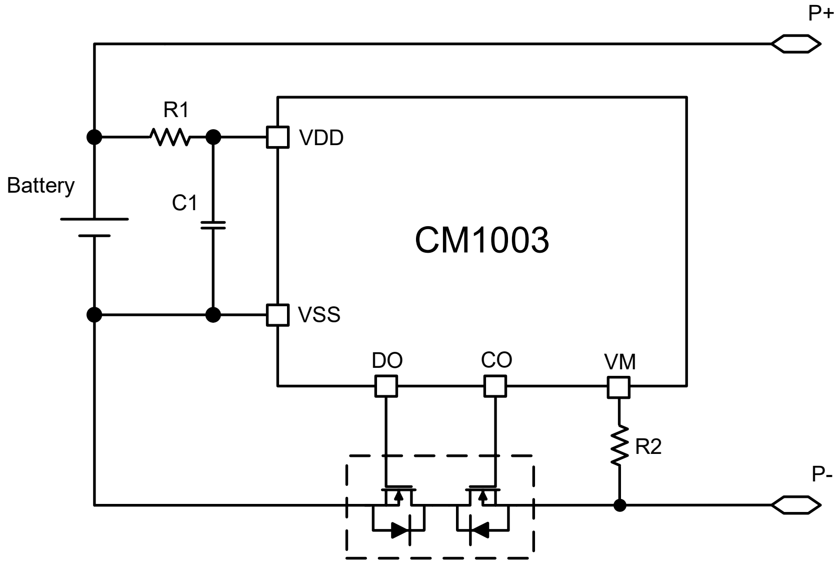


Figure 5

BOM List

Component Symbol	Type	Range	Unit
R1	470	470 ~ 1500	Ω
C1	0.1	0.047 ~ 0.220	μF
R2	2	1 ~ 3	kΩ

Table 8

Caution:

1. The above constants may be changed without notice.

2. The example of connection shown above and the constant do not guarantee proper operation. Perform thorough evaluation using the actual application to set the constant.

■ Operation Timing Chart

1. Overcharge and Charging Overcurrent Detection

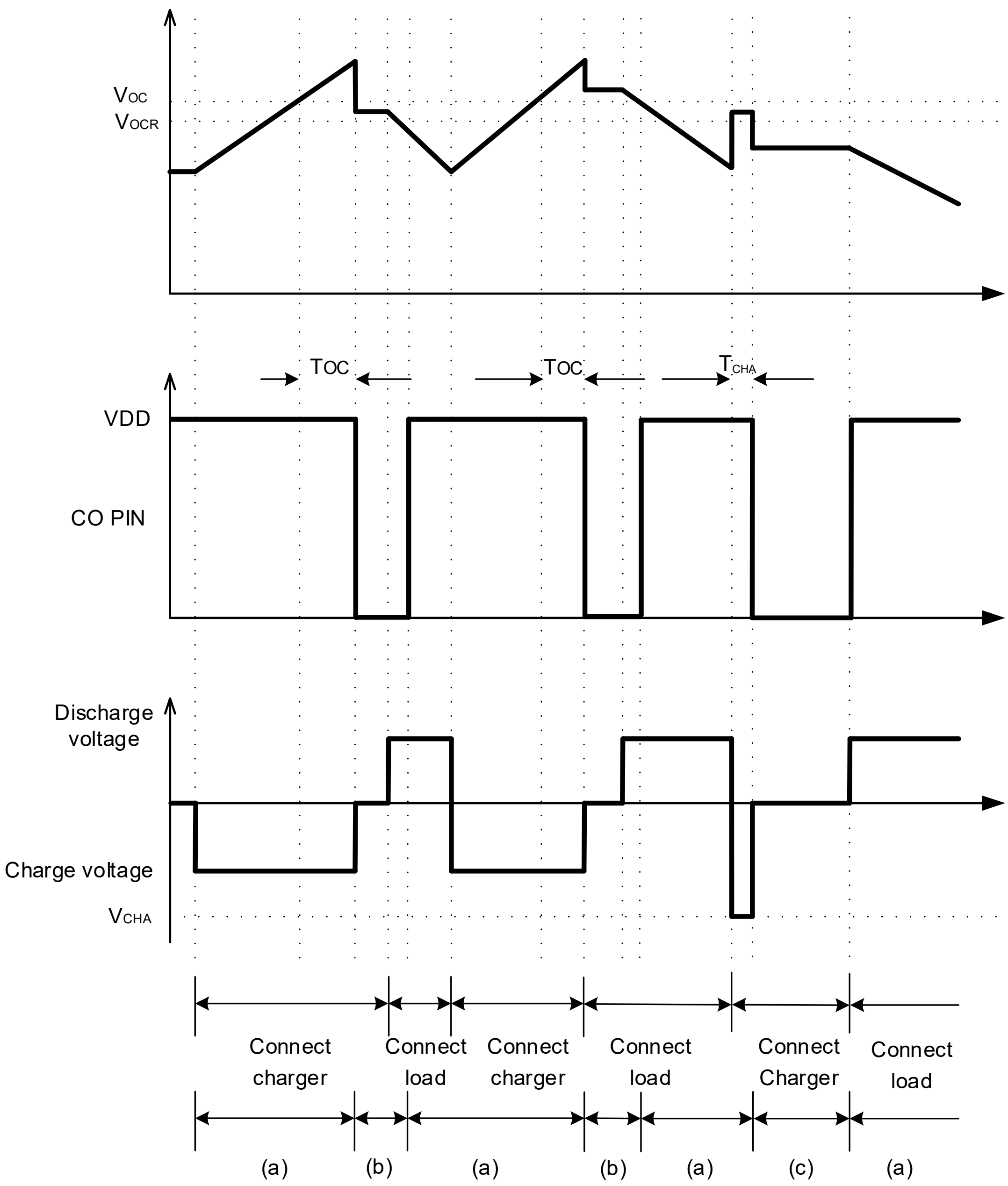


Figure 6

(a) Normal condition
(b) Overcharge condition
(c) Charging overcurrent condition

2. Over discharge and discharging Overcurrent Condition Detection

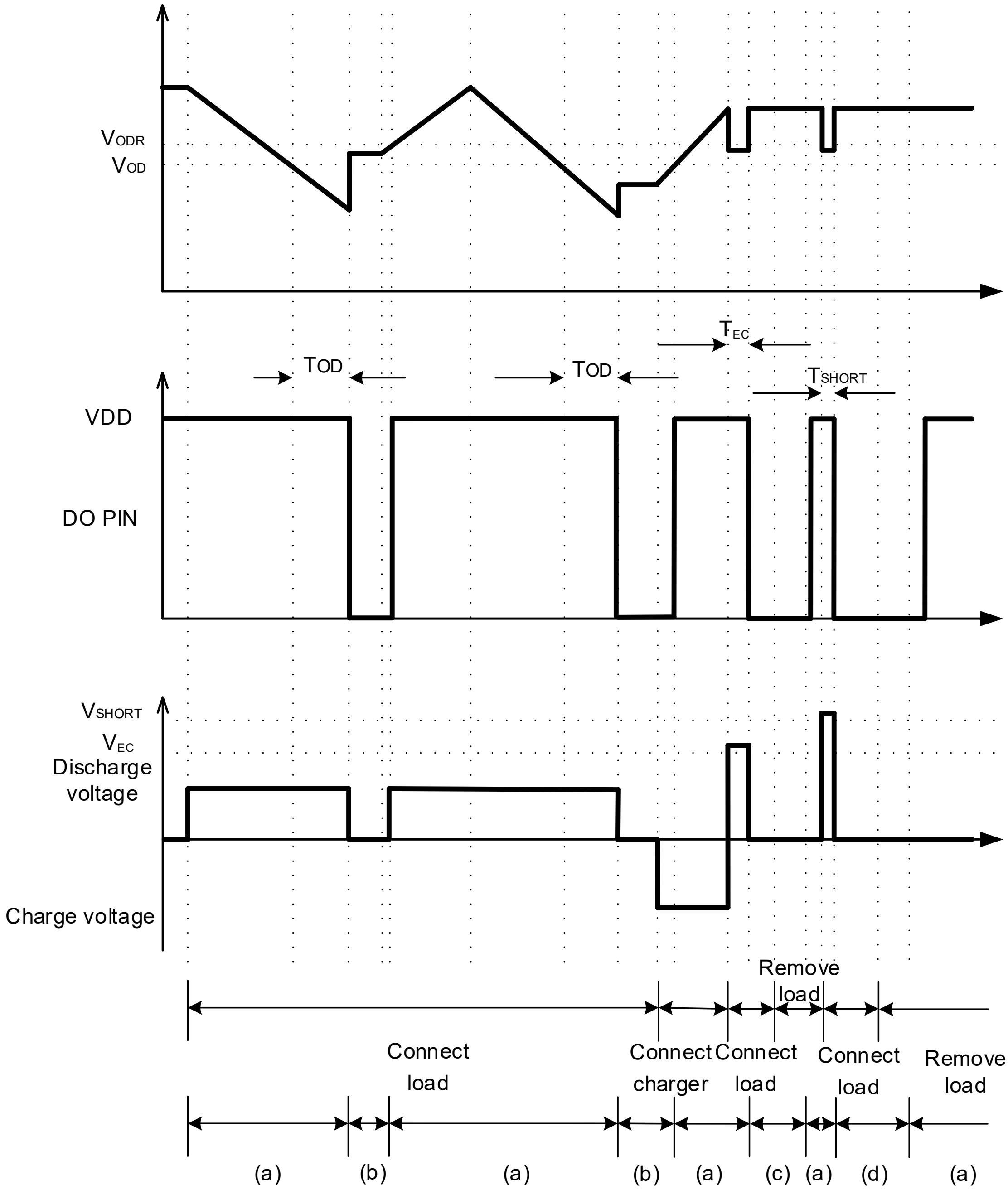


Figure 7

(a) Normal condition

(b) Over discharge condition

(c) Discharging overcurrent condition

(d) Load short circuit

■ Test Circuits

1. Overcharge protection voltage, Overcharge release voltage（Test Circuits 1）

When V1=3.5V and V2=0V are set, the voltage of V1 when V_{CO}="H" → "L" is slowly raised to V1, which is the overcharge protection voltage (V_{OC}). After that, V2 is set to 0.01V, and V1 is slowly lowered to V_{CO} = "L" → "H", and the voltage of V1 is called overcharge relief voltage (V_{OCR}).

2. Over discharge protection voltage, Over discharge release voltage（Test Circuits 2）

When V1=3.5V and V2=0V are set, the voltage of V1 when V_{DO}="H" → "L" is the over discharge protection voltage (V_{OD}). After that, V2 is set to 0.01V, and V1 is slowly raised to V_{DO} = "L" → "H" when the voltage of V1 is called over discharge voltage (V_{ODR}).

3. Over-discharge current protects voltage, Over-discharge current release voltage（Test Circuits 2）

When V1=3.5V and V2=0V are set, V2 is increased until V_{DO} = "H" → "L". At this time, the V2 voltage is the discharge over-current detection voltage (V_{EC}).
In the discharge overcurrent state, set V2=3.5V and slowly reduce V2 until VDO = "L" → and continue "H", the V2 voltage is the discharge overcurrent state relief voltage (V_{DIOV}).

4. Load short-circuit protection voltage（Test Circuits 2）

When V1=3.5V and V2=0V are set, V2 is lifted instantly and VDO = "H" → "L" occurs immediately after the load short circuit protection delay time (T_{SHORT}). At this time, the voltage of V2 is the load short circuit protection voltage (V_{SHORT}).

5. Charge overcurrent protection voltage（Test Circuits 2）

When V1=3.5V and V2=0V are set, V2 is lowered until V_{CO} = "H" →"L". At this time, the V2 voltage is the charging overcurrent protection voltage (V_{CHA}).

6. Operating consumption current（Test Circuits 3）

When V1=3.5V and V2=0V are set, the current I_{CC} flowing through the VDD pin is the current consumed while working (I_{OPE}).

7. Power down consumption current（Test Circuits 3）

When V1=V2=1.5V is set, the current I_{CC} flowing through the VDD pin is the current consumed while power down (I_{PDN}).

8. Resistance between VDD pin and VM pin（Test Circuits 3）

When V1=1.8V and V2=0V are set, the resistance between VDD pin and VM pin is R_{VMC}.

9. Resistance between VM pin and VSS pin（Test Circuits 3）

When V1=3.5V and V2=1.0V are set, the resistance between VM pin and VSS pin is R_{VMS}.

10. CO pin resistance "H"（Test Circuits 4）

When V1=3.5V, V2=0V, and V3=3.1V are set, the resistance between VDD pin and CO pin is the CO pin resistance "H" (R_{COH}).

11. CO pin resistance "L"（Test Circuits 4）

When V1=4.7V, V2=0V, and V3=0.4V are set, the resistance between VM pin and CO pin is the CO pin resistance "L" (R_{COL}).

12. DO pin resistance "H"（Test Circuits 4）

When V1=3.5V, V2=0V, and V4=3.1V are set, the resistance between VDD pin and DO pin is the DO pin resistance "H" (R_{DOH}).

13. DO pin resistance "L"（Test Circuits 4）

When V1=1.8V, V2=0V, and V4=0.4V are set, the resistance between VSS pin and DO pin is the DO pin resistance "L" (R_{DOL}).

14. Overcharge detection delay time（Test Circuits 5）

When V1=3.5V and V2=0V are set, V1 is pulled up and the time from V1 exceeding V_{OC} to V_{CO} = "L" is the overcharge protection delay time (T_{OC}).

15. Over discharge detection delay time（Test Circuits 5）

When V1=3.5V and V2=0V are set, V1 is lowered and the time from V1 exceeding V_{OD} to V_{CD} = "L" is the over discharge protection delay time (T_{OD}).

16. Discharge overcurrent detection delay time（Test Circuits 5）

When V1=3.5V and V2=0V are set, V2 is pulled up and the time from V2 exceeding V_{EC} to V_{DO} = "L" is the discharge overcurrent protection delay time (T_{EC}).

17. Load short-circuiting detection delay time（Test Circuits 5）

When V1=3.5V and V2=0V are set, V2 is pulled up and the time from V2 exceeding V_{SHORT} to V_{DO} = "L" is the Load short-circuiting detection delay time (T_{SHORT}).

18. Charge overcurrent detection delay time（Test Circuits 5）

When V1=3.5V and V2=0V are set, V2 is lowered and the time from V2 is lower than V_{CHA} to V_{CO} = "L" is the charge overcurrent protection delay time (T_{CHA}).

19. The charger voltage for starting 0V battery charging (0V battery charge function "Available") (Test Circuits 2)

When V1=V2=0V is set, V2 is lowered slowly. When V_{CO} = "H" (V_{CO} = VDD), the absolute value of the V2 voltage is the charger voltage (V_{0CHA}) that starts charging the 0V battery.

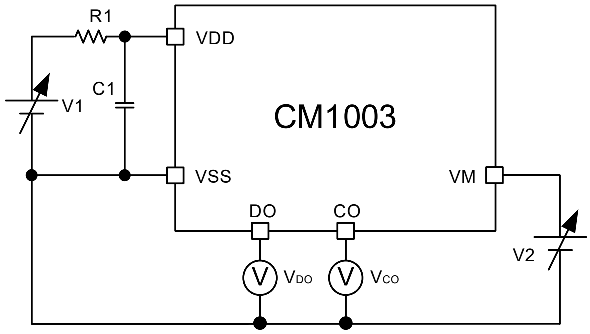


Figure 8 Test Circuits 1

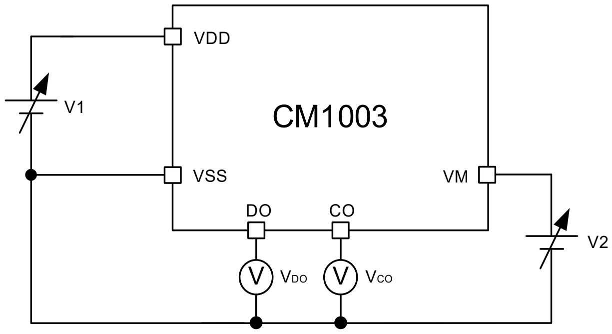


Figure 9 Test Circuits 2

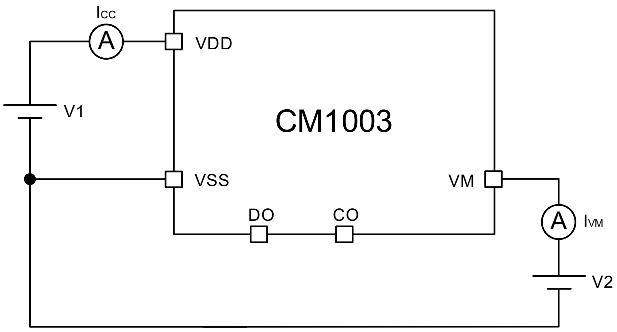


Figure 10 Test Circuits 3

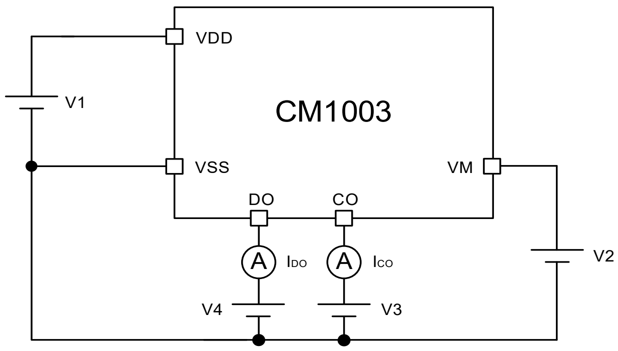


Figure 11 Test Circuits 4

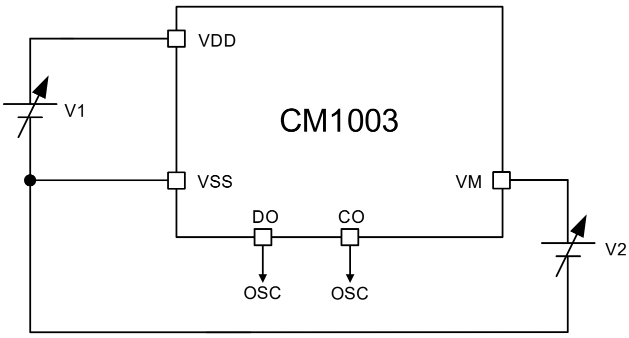


Figure 12 Test Circuits 5

■ Package

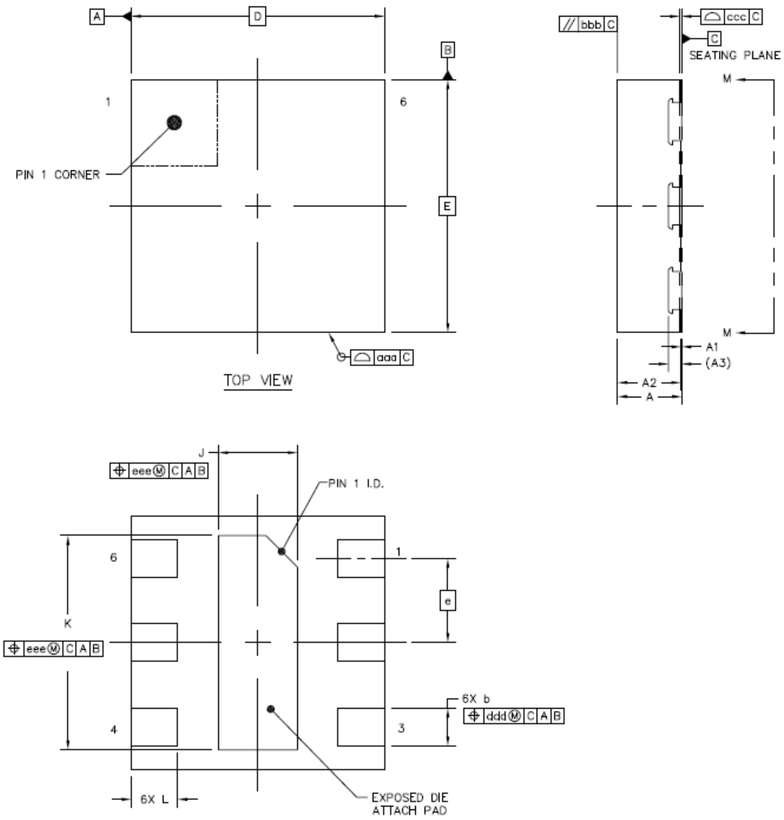


Figure 13

NOTE:ALL DIMENSIONS IN MM

SYMBOL	MIN	NOM	MAX
A	0.28	0.3	0.32
A1	0	0.005	0.01
A2	---	0.3	---
A3		0.06 REF	
b	0.13	0.18	0.23
D		1.2 BSC	
E		1.2 BSC	
e		0.4 BSC	
J	0.35	0.375	0.4
K	0.99	1.015	1.04
L	0.17	0.22	0.27

Table 9

■ Carrier Tape information

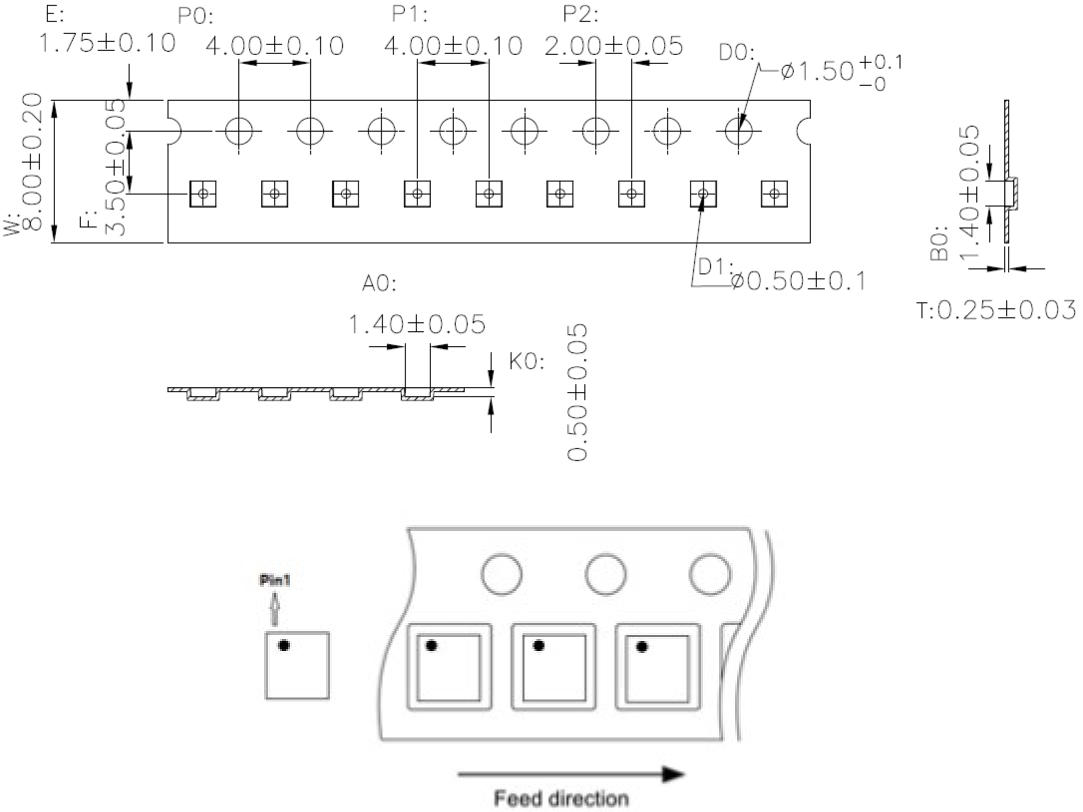
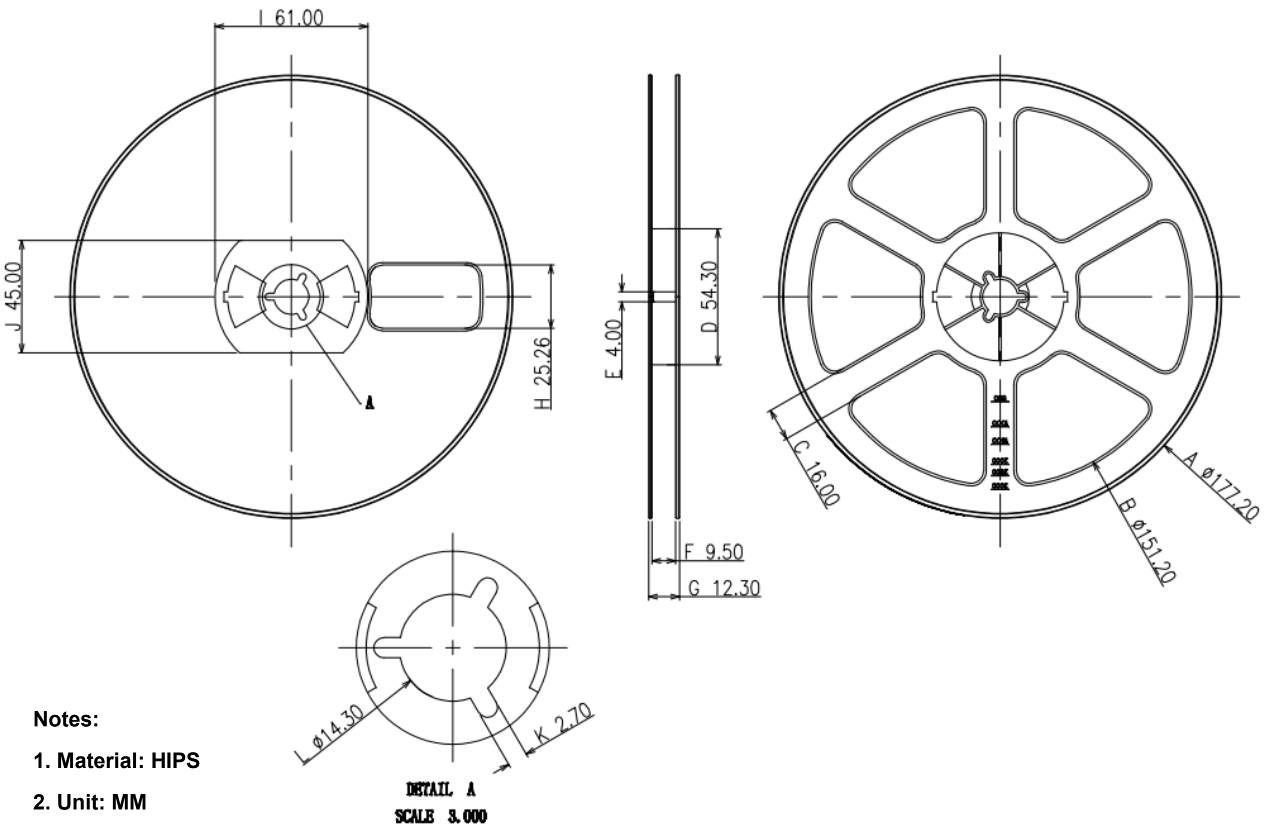


Figure 14

■ Reel information



Notes:

1. Material: HIPS

2. Unit: MM

Figure 15

■ Package information

Reel	PCS/Reel	Reel /Inner Box	Inner Box/Carton
7”	3000 PCS	10	4

Precautions for use

1. The content in this manual may be changed without notice as the product improves. For more detailed content, please contact our company's marketing department.
2. The circuit examples, usage methods, etc. in this specification are for reference only, and are not designed to guarantee mass production. The company does not assume any responsibility for problems caused by third-party ownership.
3. When this specification is used alone, our company guarantees that its performance, typical applications and functions meet the conditions in the specification. When using the customer's products or equipment, we do not guarantee the above conditions, we recommend that customers do adequate evaluation and testing.
4. Please pay attention to the use of the product within the conditions stated in the specification. Please pay special attention to the use conditions of input voltage, output voltage, and load current so that the power dissipation in the IC does not exceed the power dissipation of the package. The company will not be liable for any losses caused by customers using the product beyond the rated value specified in the specification, even if it is used instantaneously.
5. When using this product, please confirm the laws and regulations of the country, region and purpose of use, and test the ability and safety performance of the product.
6. The products in this specification, without written permission, cannot be used in high-reliability circuits of equipment or devices that may cause damage to the human body, life and property, such as: medical equipment, disaster prevention equipment, vehicle equipment, and vehicle Equipment, aviation equipment, space equipment, nuclear energy equipment, etc., shall not be used as their parts.
7. The company does not assume any responsibility for damages caused by using the products described in this specification for purposes other than those specified by the company.
8. The company has been committed to improving the quality and reliability of products, but all semiconductor products have a certain probability of failure.
9. In order to prevent personal accidents, fire accidents, social damages, etc. caused by the probabilistic failure of this product, customers are requested to fully evaluate the entire system and be responsible for redundant design, measures to prevent fire spread, and safety design to prevent mishandling, you can avoid accidents.
10. This product will not affect human health under normal conditions of use, but because it contains chemical substances and heavy metals, please do not put it in your mouth. In addition, the cracked surface of the package and chip may be sharp, so please protect it when touching it with bare hands to avoid injury.
11. When disposing of this product, please abide by the laws and regulations of the country and region of use and dispose of it reasonably.
12. The content in this specification is strictly prohibited from being reproduced or copied for other purposes without the permission of our company.