■ Description

The CM1041-HT is a professional protection IC for 4 cell Li-Ion/Polymer battery packs, it works constantly to monitor each cell's voltage, the current of charge or discharge, and the temperature of the environment to provide overcharge, over-discharge, discharge overcurrent, short circuit, charge overcurrent and temperature protections, etc. Besides, it also can change the protection delay time of overcharge, over-discharge and discharge overcurrent by setting the external capacitors.

■ Features

1) **High accuracy voltage detection**

• Overcharge detection voltage	3.850 V	Accuracy ±25 mV
• Overcharge release voltage	3.760 V	Accuracy ±50 mV
• Over discharge detection voltage	2.200 V	Accuracy ±80 mV
• Over discharge release voltage	2.650 V	Accuracy ±100 mV

2) **Three grades voltage detection of discharge overcurrent**

• Discharge overcurrent 1	0.100 V	Accuracy ±15 mV
• Discharge overcurrent 2	0.200 V	Accuracy ±20%
• Short circuit	0.500 V	Accuracy ±20%

3) **Charge overcurrent detection** -0.100 V Accuracy ±30%

4) **Charger detection and load detection**

5) **Setting of output delay time**

- overcharge, over-discharge, discharge overcurrent protection delay time can be setting by external capacitors

6) **Over Temperature and Under Temperature Protection**

- Charge and discharge over temperature protection
- Charge under temperature protection

7) **Open-wire Detection**

8) **Low power dissipation**

• Normal mode	15 μA (TYP) (Ta = +25°C)
• Power-down mode	4.5 μA (TYP) (Ta = +25°C)

■ Applications

- Power Tools
- Backup power supply
- UPS

■ Packages

- TSSOP16

■ Block Diagram

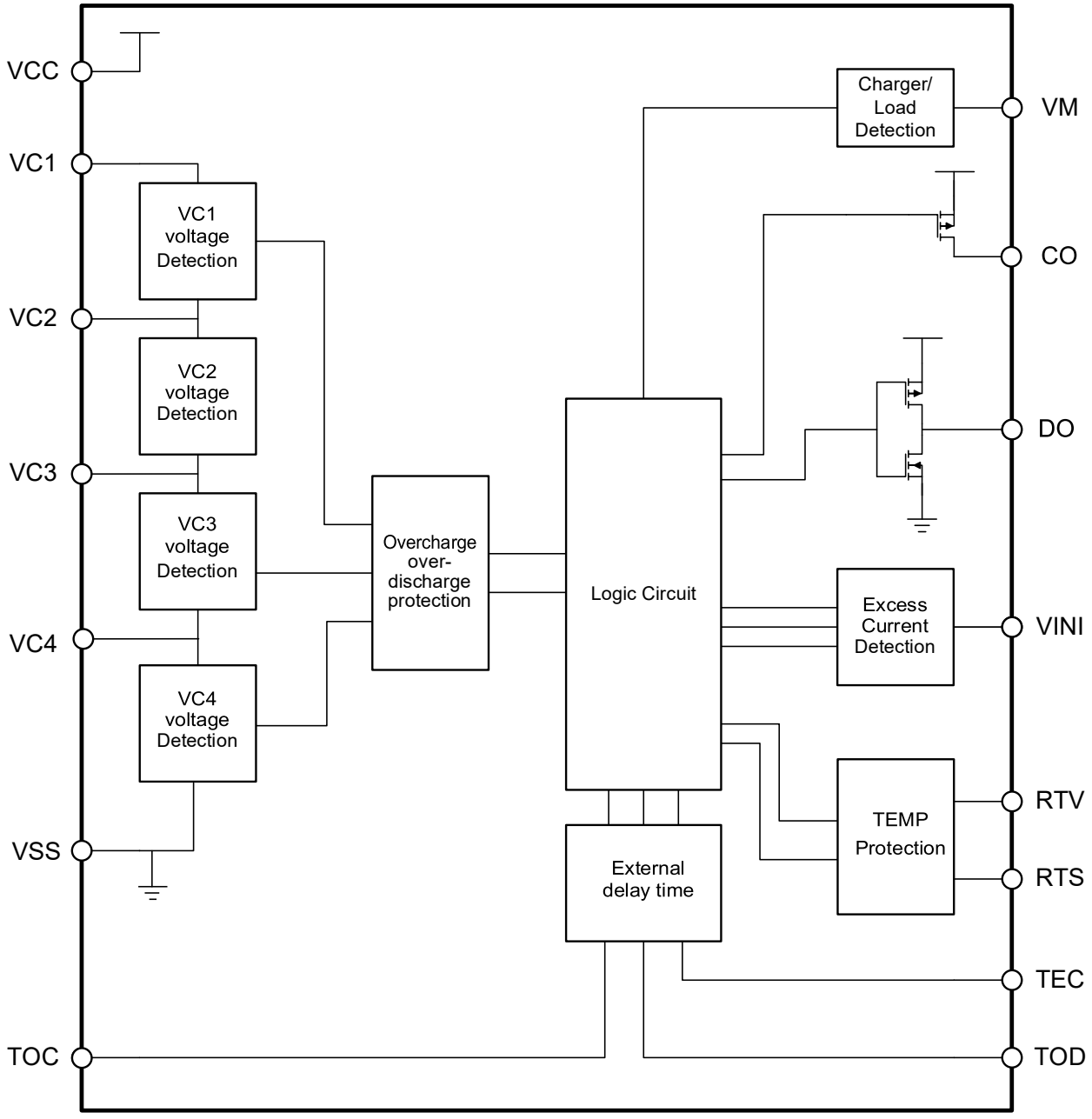


Figure 1

■ Naming rules

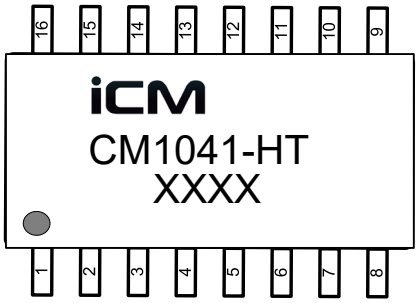
CM1041-HT

Package，T:TSSOP，S:SOP

Code， A ~ Z

Product Series

■ Marking



The first line: LOGO
The second line: Product code
The third line: Lot number

Figure 2

■ Products Catalogue

Part NO	Overcharge protection voltage [V_{OC}]	Overcharge release voltage [V_{OCR}]	Over-discharge protection voltage [V_{OD}]	Over-discharge release voltage [V_{ODR}]	Excess current1 detection voltage [V_{EC1}]	Excess current2 detection voltage [V_{EC2}]	Short circuit detection voltage [V_{SHORT}]	Charge overcurrent detection voltage [V_{CHA}]
CM1041-HT	3.850 V	3.760 V	2.200 V	2.650 V	0.100 V	0.200 V	0.500 V	-0.100 V

Table 1

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

■ Pin Configurations

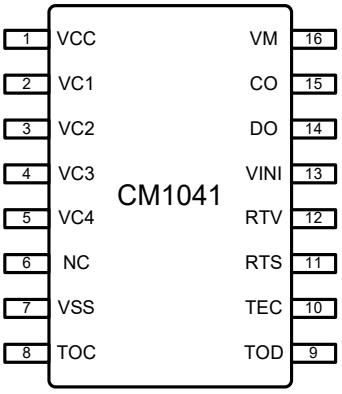


Figure 3

PIN	Symbol	Description
1	VCC	Power supply, Cell1 positive input
2	VC1	Cell1 positive input
3	VC2	Cell1 negative input, Cell2 positive input
4	VC3	Cell2 negative input, Cell3 positive input
5	VC4	Cell3 negative input, Cell4 positive input
6	NC	No Connection
7	VSS	Ground pin of the IC, Cell5 negative input
8	TOC	External capacitor for setting the delay time of overcharge protection
9	TOD	External capacitor for setting the delay time of over-discharge protection
10	TEC	External capacitor for setting the delay time of excess current protection
11	RTS	Cell temperature detection
12	RTV	Temperature protection reference
13	VINI	Charge and Discharge overcurrent Voltage detection terminal
14	DO	Discharge power mosfet control terminal
15	CO	Charge power mosfet control terminal
16	VM	Detecting load or charger

Table 2

■ Absolute Maximum Ratings

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

Item	Symbol	Description	Ratings	Unit
Power supply voltage	VCC	VCC	VSS-0.3 ~ VSS+30	V
Single cell input voltage	V_{CELL}	VC1-VC2, VC2-VC3, VC3-VC4, VC4-VSS	VSS-0.3 ~ VSS+5.5	V
Input pin voltage 1	V_{IN1}	TOC, TOD, TEC, RTS, RTV, VINI	VSS-0.3 ~ VSS+5.5	V
Input pin voltage 2	V_{IN2}	VM	VCC-30 ~ VCC+0.3	V
CO output voltage	V_{CO}	CO	VCC-30 ~ VCC+0.3	V
DO output voltage	V_{DO}	DO	VSS-0.3 ~ VCC+0.3	V
Operating temperature	T_{OPR}	–	-40 ~ +85	°C
Storage temperature	T_{STG}	–	-55 ~ +125	°C

Table 3

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	Condition	Min	TYP	Max	Unit
Operating consumption		I_{VCC}	VC1=VC2=VC3=VC4=VC5=3.5V	-	15	30	μA
Sleeping consumption		I_{STB}	VC1=VC2=VC3=VC4=VC5=2.0V	-	4.5	9	μA
Overcharge	Protection threshold	V_{OC}	VC1=VC2=VC3=VC4=3.5V, VC5=3.5 → 4.4V	3.825	3.850	3.875	V
	Release threshold	V_{OCR}	VC1=VC2=VC3=VC4=3.5V, VC5=4.4 → 3.5V	3.710	3.760	3.810	V
	Protection delay time	T_{OC}	VC1=VC2=VC3=VC4=3.5V, VC5=3.5 → 4.4V C_{TOC}=0.1μF	0.5	1.0	1.5	s
Over-discharge	Protection threshold	V_{OD}	VC1=VC2=VC3=VC4=3.5V, VC5=3.5 → 2.0V	2.120	2.200	2.280	V
	Release threshold	V_{ODR}	VC1=VC2=VC3=VC4=3.5V, VC5=2.0 → 3.5V	2.550	2.650	2.750	V
	Protection delay time	T_{OD}	VC1=VC2=VC3=VC4=3.5V, VC5=3.5 → 2.0V C_{TOD}=0.1μF	0.5	1.0	1.5	s
Discharge overcurrent 1	Protection threshold	V_{EC1}	VC1=VC2=VC3=3.5V, VINI-VSS=0 → 0.12V	0.085	0.100	0.115	V
	Protection delay time	T_{EC1}	VC1=VC2=VC3=3.5V, VINI-VSS=0 → 0.12V C_{TEC}=0.1μF	0.5	1.0	1.5	s
	Release delay time	T_{EC1R}	VC1=VC2=VC3=3.5V, VINI-VSS=0.12 → 0V C_{TEC}=0.1μF	60	120	180	ms
Discharge overcurrent 2	Protection threshold	V_{EC2}	VC1=VC2=VC3=3.5V, VINI-VSS=0 → 0.35V	0.160	0.200	0.240	V
	Protection delay time	T_{EC2}	VC1=VC2=VC3=3.5V, VINI-VSS=0 → 0.35V C_{TEC}=0.1μF	50	100	200	ms
	Release delay time	T_{EC2R}	VC1=VC2=VC3=3.5V, VINI-VSS=0.35 → 0V C_{TEC}=0.1μF	60	120	180	ms
Short circuit	Protection threshold	V_{SHORT}	VC1=VC2=VC3=3.5V, VINI-VSS=0 → 0.8V	0.400	0.500	0.600	V
	Protection delay time	T_{SHORT}	VC1=VC2=VC3=3.5V, VINI-VSS=0 → 0.8V	100	300	600	μs
	Release delay time	T_{SHORTR}	VC1=VC2=VC3=3.5V, VINI-VSS=0.8 → 0V	60	120	180	ms
Charge overcurrent	Protection threshold	V_{CHA}	VC1=VC2=VC3=VC4=VC5=3.5V, VINI-VSS =0→ -1V	-0.130	-0.100	-0.070	V
	Protection delay time	T_{CHA}	VC1=VC2=VC3=VC4=VC5=3.5V, VINI-VSS =0→ -1V	6	12	24	ms
	Release delay time	T_{CHAR}	VC1=VC2=VC3=VC4=VC5=3.5V, VINI-VSS =-1V→0V	1	2	4	ms
Open-wire	Protection delay time	T_{OW}	-	5	10	15	ms
	Release delay time	T_{OWR}	-	1	2	3	ms

Table 4

■ Electrical Characteristics

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

Item		Symbol	Condition	Min	TYP	Max	Unit
Operating consumption		I_{VCC}	VC1=VC2=VC3=VC4=VC5=3.5V	-	15	45	μA
Sleeping consumption		I_{STB}	VC1=VC2=VC3=VC4=VC5=2.0V	-	4.5	13.5	μA
Overcharge	Protection threshold	V_{OC}	VC1=VC2=VC3=VC4=3.5V, VC5=3.5 → 4.4V	3.800	3.850	3.900	V
	Release threshold	V_{OCR}	VC1=VC2=VC3=VC4=3.5V, VC5=4.4 → 3.5V	3.660	3.760	3.860	V
	Protection delay time	T_{OC}	VC1=VC2=VC3=VC4=3.5V, VC5=3.5 → 4.4V C_{TOC}=0.1μF	0.25	1.0	1.75	s
Over-discharge	Protection threshold	V_{OD}	VC1=VC2=VC3=VC4=3.5V, VC5=3.5 → 2.0V	2.040	2.200	2.360	V
	Release threshold	V_{ODR}	VC1=VC2=VC3=VC4=3.5V, VC5=2.0 → 3.5V	2.450	2.650	2.850	V
	Protection delay time	T_{OD}	VC1=VC2=VC3=VC4=3.5V, VC5=3.5 → 2.0V C_{TOD}=0.1μF	0.25	1.0	1.75	s
Discharge overcurrent 1	Protection threshold	V_{EC1}	VC1=VC2=VC3=3.5V, VINI-VSS=0 → 0.12V	0.070	0.100	0.130	V
	Protection delay time	T_{EC1}	VC1=VC2=VC3=3.5V, VINI-VSS=0 → 0.12V C_{TEC}=0.1μF	0.25	1.0	1.75	s
	Release delay time	T_{EC1R}	VC1=VC2=VC3=3.5V, VINI-VSS=0.12 → 0V C_{TEC}=0.1μF	30	120	210	ms
Discharge overcurrent 2	Protection threshold	V_{EC2}	VC1=VC2=VC3=3.5V, VINI-VSS=0 → 0.35V	0.120	0.200	0.280	V
	Protection delay time	T_{EC2}	VC1=VC2=VC3=3.5V, VINI-VSS=0 → 0.35V C_{TEC}=0.1μF	25	100	300	ms
	Release delay time	T_{EC2R}	VC1=VC2=VC3=3.5V, VINI-VSS=0.35 → 0V C_{TEC}=0.1μF	30	120	210	ms
Short circuit	Protection threshold	V_{SHORT}	VC1=VC2=VC3=3.5V, VINI-VSS=0 → 0.8V	0.300	0.500	0.700	V
	Protection delay time	T_{SHORT}	VC1=VC2=VC3=3.5V, VINI-VSS=0 → 0.8V	50	300	900	μs
	Release delay time	T_{SHORTR}	VC1=VC2=VC3=3.5V, VINI-VSS=0.8 → 0V	30	120	210	ms
Charge overcurrent	Protection threshold	V_{CHA}	VC1=VC2=VC3=VC4=VC5=3.5V, VINI-VSS =0→ -1V	-0.160	-0.100	-0.040	V
	Protection delay time	T_{CHA}	VC1=VC2=VC3=VC4=VC5=3.5V, VINI-VSS =0→ -1V	3	12	36	ms
	Release delay time	T_{CHAR}	VC1=VC2=VC3=VC4=VC5=3.5V, VINI-VSS =-1V→0V	0.5	2	6	ms
Open-wire	Protection delay time	T_{OW}	-	2.5	10	17.5	ms
	Release delay time	T_{OWR}	-	0.5	2	5	ms

Table 5

***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.**

■ Electrical Characteristics

(Unless otherwise specified: Ta = -40°C ~ +85°C*1)

Item		Symbol	Condition	Min	TYP	Max	Unit
Operating consumption		I_{VCC}	VC1=VC2=VC3=VC4=VC5=3.5V	-	15	51	μA
Sleeping consumption		I_{STB}	VC1=VC2=VC3=VC4=VC5=2.0V	-	4.5	15.3	μA
Overcharge	Protection threshold	V_{OC}	VC1=VC2=VC3=VC4=3.5V, VC5=3.5 → 4.4V	3.790	3.850	3.910	V
	Release threshold	V_{OCR}	VC1=VC2=VC3=VC4=3.5V, VC5=4.4 → 3.5V	3.640	3.760	3.880	V
	Protection delay time	T_{OC}	VC1=VC2=VC3=VC4=3.5V, VC5=3.5 → 4.4V C_{TOC}=0.1μF	0.25	1.0	1.75	s
Over-discharge	Protection threshold	V_{OD}	VC1=VC2=VC3=VC4=3.5V, VC5=3.5 → 2.0V	2.008	2.200	2.392	V
	Release threshold	V_{ODR}	VC1=VC2=VC3=VC4=3.5V, VC5=2.0 → 3.5V	2.410	2.650	2.890	V
	Protection delay time	T_{OD}	VC1=VC2=VC3=VC4=3.5V, VC5=3.5 → 2.0V C_{TOD}=0.1μF	0.25	1.0	1.75	s
Discharge overcurrent 1	Protection threshold	V_{EC1}	VC1=VC2=VC3=3.5V, VINI-VSS=0 → 0.12V	0.064	0.100	0.136	V
	Protection delay time	T_{EC1}	VC1=VC2=VC3=3.5V, VINI-VSS=0 → 0.12V C_{TEC}=0.1μF	0.25	1.0	1.75	s
	Release delay time	T_{EC1R}	VC1=VC2=VC3=3.5V, VINI-VSS=0.12 → 0V C_{TEC}=0.1μF	30	120	210	ms
Discharge overcurrent 2	Protection threshold	V_{EC2}	VC1=VC2=VC3=3.5V, VINI-VSS=0 → 0.35V	0.104	0.200	0.296	V
	Protection delay time	T_{EC2}	VC1=VC2=VC3=3.5V, VINI-VSS=0 → 0.35V C_{TEC}=0.1μF	25	100	300	ms
	Release delay time	T_{EC2R}	VC1=VC2=VC3=3.5V, VINI-VSS=0.35 → 0V C_{TEC}=0.1μF	30	120	210	ms
Short circuit	Protection threshold	V_{SHORT}	VC1=VC2=VC3=3.5V, VINI-VSS=0 → 0.8V	0.260	0.500	0.740	V
	Protection delay time	T_{SHORT}	VC1=VC2=VC3=3.5V, VINI-VSS=0 → 0.8V	50	300	900	μs
	Release delay time	T_{SHORTR}	VC1=VC2=VC3=3.5V, VINI-VSS=0.8 → 0V	30	120	210	ms
Charge overcurrent	Protection threshold	V_{CHA}	VC1=VC2=VC3=VC4=VC5=3.5V, VINI-VSS =0→ -1V	-0.172	-0.100	-0.028	V
	Protection delay time	T_{CHA}	VC1=VC2=VC3=VC4=VC5=3.5V, VINI-VSS =0→ -1V	3	12	36	ms
	Release delay time	T_{CHAR}	VC1=VC2=VC3=VC4=VC5=3.5V, VINI-VSS =-1V→0V	0.5	2	6	ms
Open-wire	Protection delay time	T_{OW}	-	2.5	10	17.5	ms
	Release delay time	T_{OWR}	-	0.5	2	5	ms

Table 6

***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. Overcharge

During charging, if any cell voltage is higher than V_{OC} and lasts longer than T_{OC}, the output voltage of CO will reverse, the charge MOSFET will be turned off and stop charging.

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

(1) All cells' voltage is less than the Overcharge release threshold V_{OCR} and stays longer than T_{OCR}.

(2) VM> V_{EC1} (connecting to the load), Battery voltage is lower than V_{OC} and stays longer than T_{OCR}.

2. Over-discharge

During discharging, if any cell 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.

The over-discharge protection state will be released if any of the next conditions occurs:

(1) VM =0mV, all cells' voltage is higher than V_{ODR}

(2) VM < V_{CHA} (connecting to the charger), All cells' voltage is higher than V_{OD}.

3. Discharge Overcurrent

During discharging, the voltage of VIN becomes higher with the current increasing. When the voltage of VIN is higher than V_{EC1} and stays longer than T_{EC1}, it works in the state of discharge overcurrent 1; When the voltage of VIN is higher than V_{EC2} and stays longer than T_{EC2}, it works in the state of discharge overcurrent 2; When the voltage of VIN is higher than V_{SHORT} and stays longer than T_{SHORT}, it works in the state of short circuit. When any of the three states occurs, the output voltage of DO changes to low level to turn off the discharge MOSFET and stop discharging. The over-current discharge protection state will be released when disconnect the load (VM<3V).

4. Delay Time Setting

Overcharge protection delay time, C_{TOC} = 0.1μF, T_{OC}=1.0s

Over-discharge protection delay time, C_{TOD} = 0.1μF, T_{OD}=1.0s

Discharge overcurrent 1 protection delay time, C_{TEC} = 0.1μF, T_{OD}=1.0s

Discharge overcurrent 2 protection delay time is one-tenth of discharge overcurrent 1 protection delay time

5. Over Temperature and Under Temperature Protection

Batteries should be prevented charging and discharging from over temperature and under temperature. The NTC resistor connect to R_{TS} terminal is used to detect the temperature of the pack. The resistor R_T which connect to RTV terminal is used to set the threshold of over temperature protection. The temperature of charge and discharge protection can be set by changing the value of R_T. When the voltage of VIN is higher than 4mV, the pack works in discharge state. When charging over temperature protection triggered in charging state, the charge MOSFET will be turned off. When discharging over temperature protection triggered in discharge state, both of the charge and discharge MOSFET will be turned off. When temperature is lower than -10℃, the charge MOSFET will be turned off.

The R_T resistance is three times bigger than R_{NTC}, NTC resistance is 100KΩ in normal temperature (25℃), and the temperature of charge over temperature protection is 50℃, as we know R_{NTC} is 35.88 KΩ, then R_T=107.64kΩ.

T_{CH} (°C)	T_{DH} (°C)	R_{NTC}(KΩ)	R_T (KΩ)
45	65	43.66	130
50	70	35.88	110
55	75	29.79	91
60	80	24.62	72

Table 7

CM1041-HT embedded NTC Open-wire Detection, when NTC wire disconnects, the charge and discharge MOSFET will be turned off.

6. Charge Overcurrent

During charging, When the voltage of VIN is lower than V_{CHA} and stays longer than T_{CHA}, the CM1051 series considers the batteries work in the state of charge overcurrent, the output voltage of CO will be pulled down to low level and the charge MOSFET will be turned off and stop charging. Charge overcurrent protection will be released when we disconnect the charger (VM>V_{CHA}).

7. Open-wire Detection

When the wire disconnects and maintains (T_{OW}) time, the CM1041-HT will enter to the open-wire protection state. The output of CO and DO will reverse and turn off the charge and discharge MOSFET

Open-wire protection will release when all wires reconnect and stay longer than the release delay time (T_{OWR}).

■ Application Circuits

1. Shared charging and discharging circuits

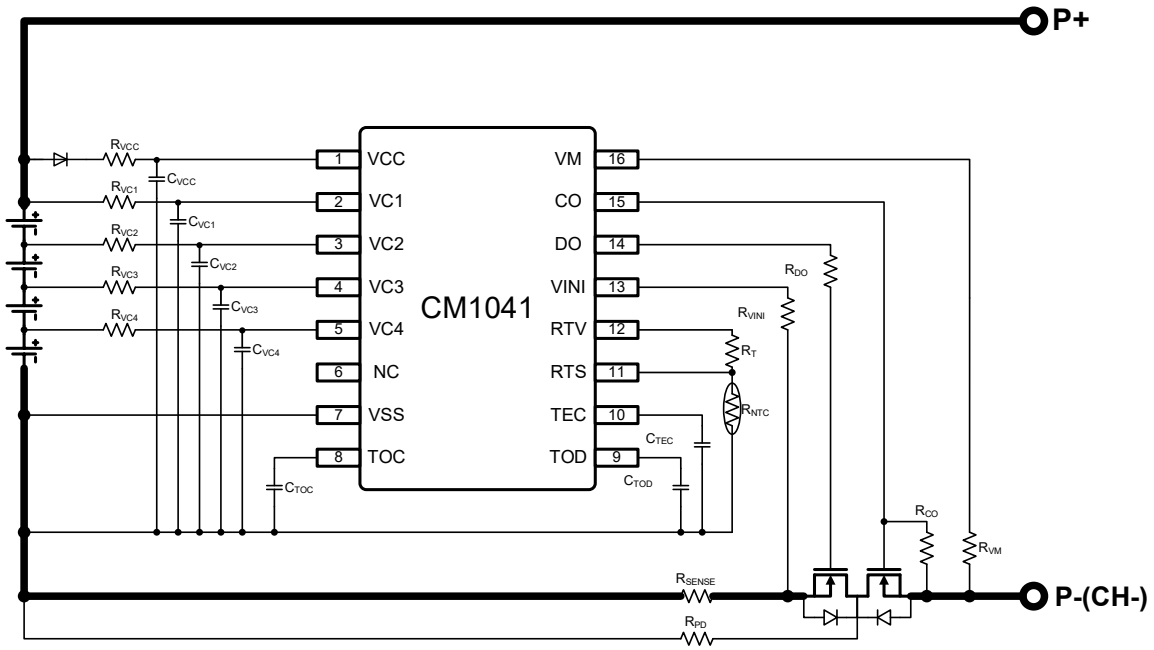


Figure 4

2. Separate charging and discharging circuits

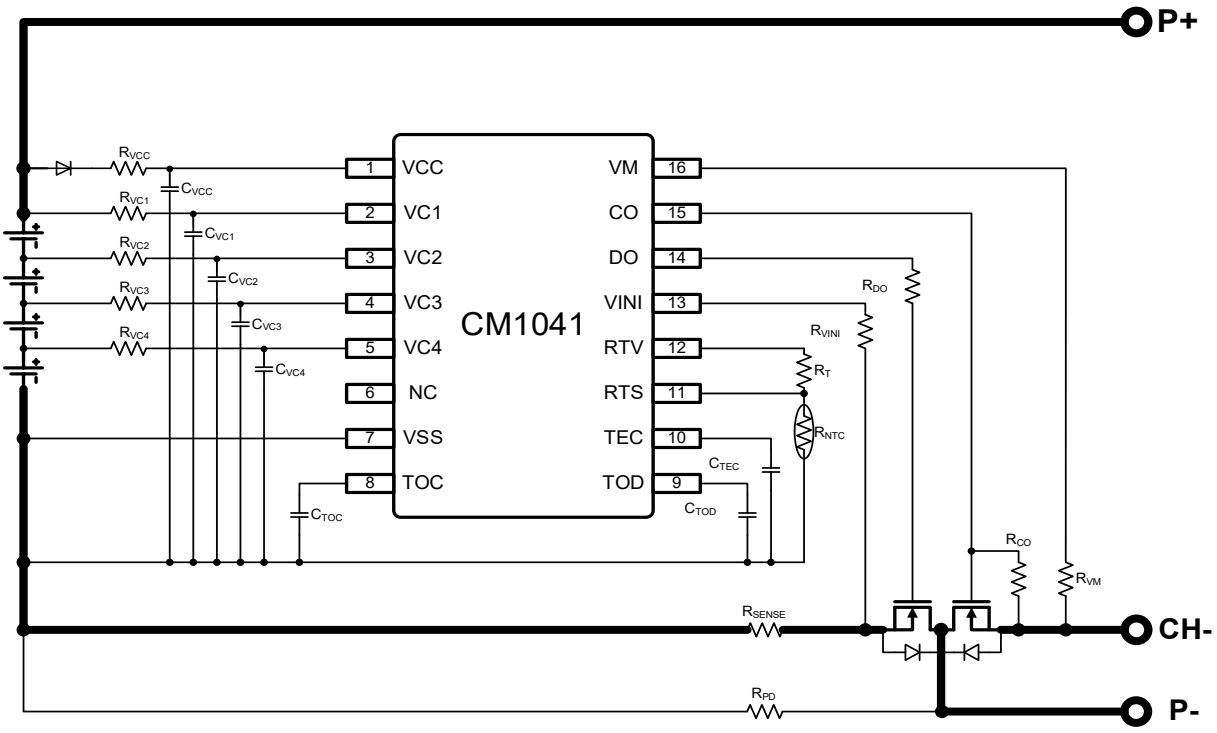


Figure 5

■ BOM List

Component Symbol	Type	Range	Unit
R_{VCC}、R_{VC1}、R_{VC2}、R_{VC3}、R_{VC4}	1	0.1 ~ 1	kΩ
R_{NTC}	100 @25°C	–	kΩ
R_T	3*R_{NTC}@T_{HCP}	–	kΩ
R_{VINI}	1	0.1 ~ 2	kΩ
R_{VM}	200	10 ~ 510	kΩ
R_{DO}	2	1 ~ 10	kΩ
R_{CO}	10	1 ~ 12	MΩ
R_{PD}	3	0.3 ~ 4	MΩ
R_{SENSE}	-	-	mΩ
C_{VCC}	2.2	1 ~ 10μF, BV≥25V	μF
C_{VC1}、C_{VC2}、C_{VC3}、C_{VC4}、C_{VC5}	0.1	0.1 ~ 1μF, BV ≥25V	μF
C_{TOC}、C_{TOD}	0.1	BV≥10V	μF
C_{TEC}	0.1	BV≥10V	uF
D1	1N4148	If=1mA, Vf<0.75V	–

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.**

■ Package

• **TSSOP16**

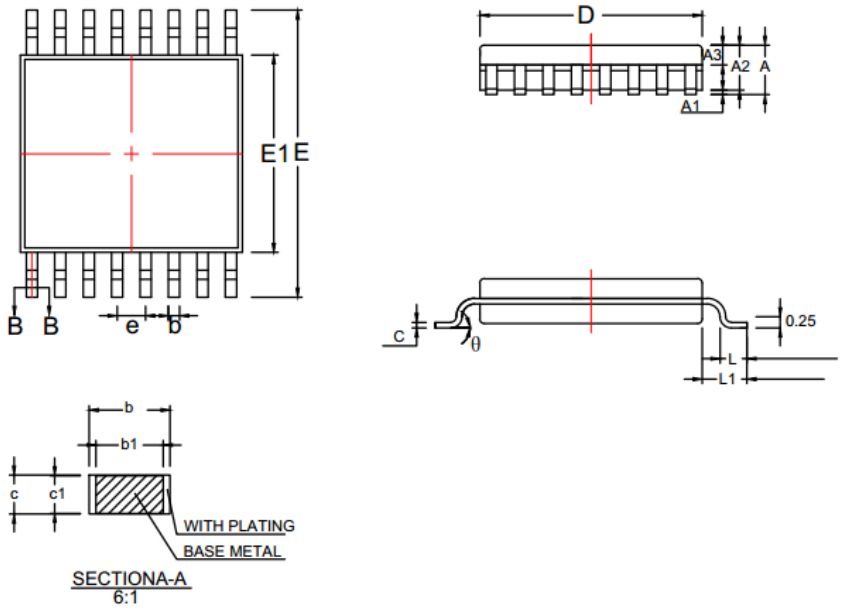


Figure 6

Symbol	Dimensions（mm）		
	Min(mm)	Typ(mm)	Max(mm)
A	---	---	1.20
A_1	0.05	---	0.15
A_2	0.90	1.00	1.05
A_3	0.39	0.44	0.49
b	0.20	---	0.30
b_1	0.19	0.22	0.25
c	0.110	0.127	0.145
c_1	0.12	0.13	0.14
D	4.90	5.10	5.30
E	6.20	6.40	6.60
E_1	4.20	4.40	4.60
e	0.65BSC		
L	0.45	0.60	0.75
L_1	1.00BSC		
θ	0		8°

Table 9

■ Carrier Tape information

• **TSSOP16**

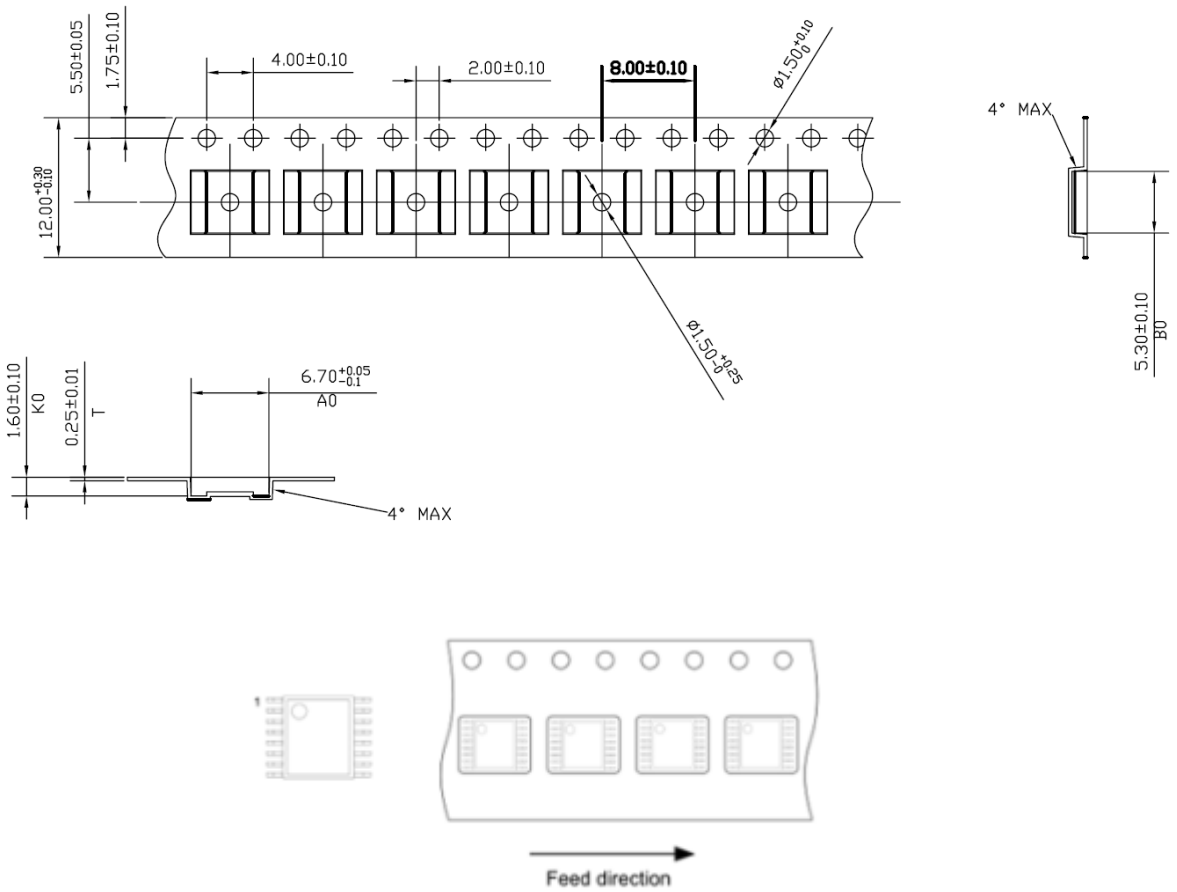
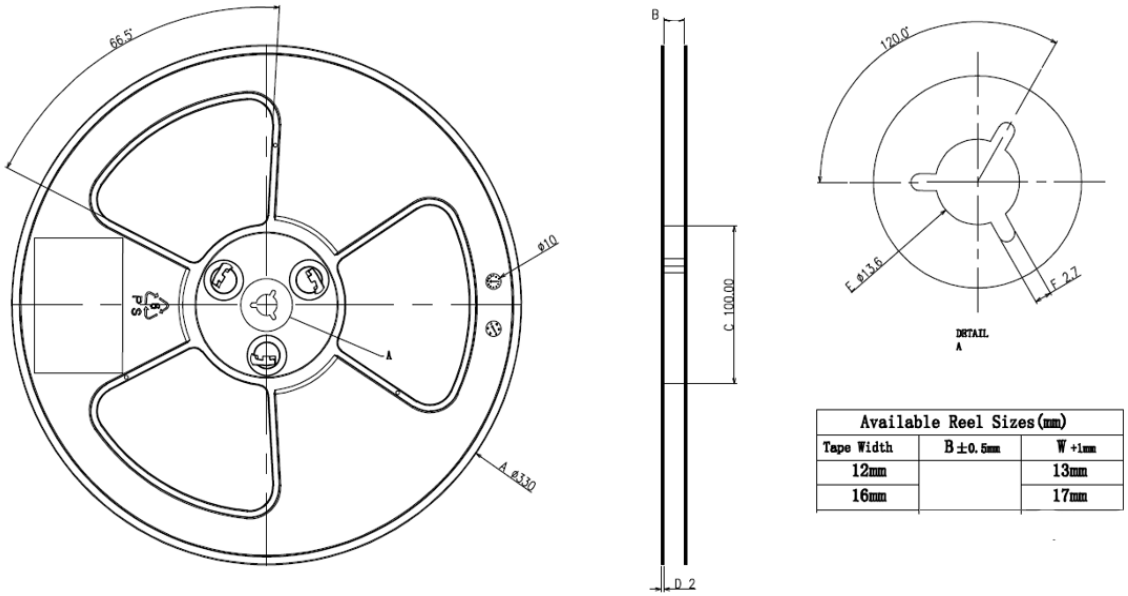


Figure 7

■ Reel information

TSSOP16



Available Reel Sizes(mm)		
Tape Width	B ±0.5mm	W +1mm
12mm		13mm
16mm		17mm

Figure 8

■ Package information

Package	Reel	PCS/Plate	Plate/Box	Box/Package
TSSOP16	13”×12mm	3000	2	8

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.