Overview

FM7021 is a built-in high-precision voltage detection circuit and delay circuit, suitable for C
Protection IC for 2-series Li-ion/Li-polymer rechargeable batteries. This IC is suitable for

For overcharge, over discharge,

Over-current and load short-circuit protection.

Application Areas

ÿ 2 series lithium-ion rechargeable battery pack

ÿ 2 series lithium polymer rechargeable battery pack

Package

ÿ SOT23-6

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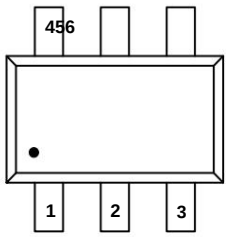


Features

(1) High-precision voltage detection circuit

ÿ Overcharge detection voltage VCUn (nÿ1, 2) 4.28V Accuracy ±25mV

ÿ Overcharge release voltage VCRn (nÿ1, 2) 4.08V Accuracy ±50mV

ÿ Over discharge detection voltage VDLn (nÿ1, 2) 2.90V Accuracy ±80mV

ÿ Over discharge release voltage VDRn (nÿ1, 2) 3.00V Accuracy ±100mV

ÿ Discharge overcurrent detection voltage 0.20V Accuracy ±30mV

ÿ Charging overcurrent detection voltage -0.17V Accuracy ±50mV

ÿ Load short circuit detection voltage 1.00V accuracy ±0.40V

(2) Each delay time is set by the internal circuit (no external capacitor is required)

ÿ Overcharge detection delay time Typical value 1.0s

ÿ Over discharge detection delay time Typical value 110ms

ÿ Discharge overcurrent detection delay time Typical value 10ms

ÿ Charge overcurrent detection delay time Typical value 7.0ms

ÿ Load short circuit detection delay time Typical value 250ÿs

(3) Low current consumption

ÿ Working Mode Typical value 4.0ÿA (VDD=7.8V)

ÿ Low power mode Typical value 1.9ÿA (VDD=4.0V)

(4) The terminals for connecting the charger are designed with high voltage resistance (CS terminal and OC terminal,
The absolute maximum rating is 25V);

(5) Allows charging of 0V batteries;

(6) Small package: SOT-23-6;

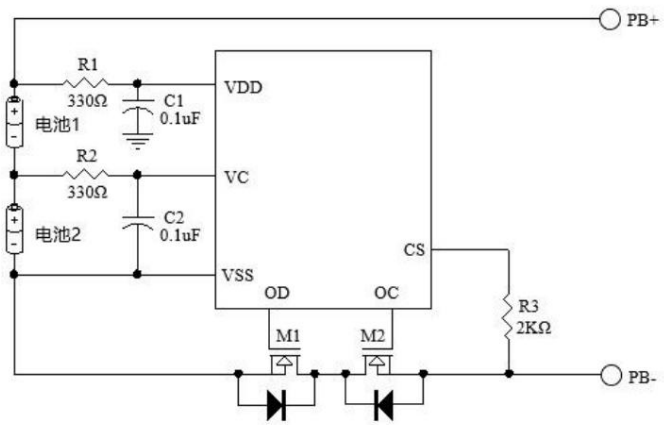
Product Parameters

A

parameter / model	Overcharge Detection voltage	Overcharge Release voltage	Over discharge Detection voltage	Over discharge Release voltage	Discharge overcurrent Detection voltage	Charging overcurrent Detection voltage	0V battery charging function
	VCUn	VCR	V D	VDR	VDIP	VCIP	V0H
FM7021CB	4.28±0.025V	4.08±0.05V	2.90±0.08V	3.00±0.1V	200±30mV	-170±50mV	allow
FM7021DB	4.28±0.025V	4.08±0.05V	2.25±0.08V	2.95±0.1V	200±30mV	-170±50mV	allow
FM7021NB	4.28±0.025V	4.08±0.05V	2.80±0.08V	3.00±0.1V	200±30mV	-170±50mV	allow
FM7021HB	4.40±0.025V	4.18±0.05V	3.00±0.08V	3.10±0.1V	200±30mV	-170±50mV	allow
FM7021LB	4.225±0.025V	4.10±0.05V	2.50±0.08V	3.00±0.1V	200±30mV	-170±50mV	allow

1 2 3

Typical application circuit



Pin Description

Serial number	symbol	illustrate
1	OD	Discharge Control MOSFET Gate Connection Terminal
2	OC	charging control MOSFET gate connection terminal
3	CS	Overcurrent detection input terminal, charger detection terminal
4	VC	Battery 1 negative terminal, battery 2 positive terminal connection terminal
5	VDD	Positive power input terminal, positive connection terminal of battery 1
6	VSS	ground terminal, negative power input terminal, battery 2 negative terminal

Components

mark	Device Name	use	Min.	Typ.	Max.	Description
R1	resistance	Current limiting, VDD stabilization, ESD enhancement	100ÿ	330ÿ	470ÿ	*1
R2	resistance	Current limiting, VC stabilization, ESD enhancement	100ÿ	330ÿ	470ÿ	*1
R3	resistance	Current Limitation	1 kÿ	2kÿ	4kÿ	*2
C1	Capacitor	Filtering, stabilizing VDD	0.01ÿF	0.1ÿF	1.0ÿF	*3
C2	Capacitor	Filtering, stabilizing VDD	0.01ÿF	0.1ÿF	1.0ÿF	*3
M1	N-MOSFET discharge control		-	-	-	*4
M2	N-MOSFET charging control		-	-	-	*5

*1. If R1 or R2 is connected with too large a resistor, the current consumed by the chip will cause a voltage drop on R1 or R2, affecting the accuracy of the detection voltage. For ICs, if R1 or R2 is too large, the voltage between the VDD and VSS terminals may exceed the absolute maximum rating.

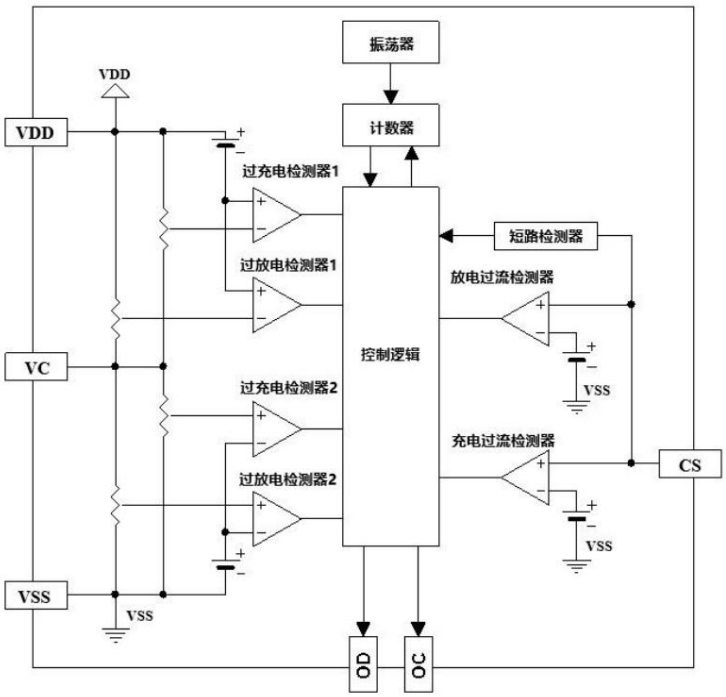
*2. If R3 is connected with too large a resistor, it may not be able to cut off the charging current when a high voltage charger is connected. However, in order to control the current when the charger is reversely connected, please Select a larger resistance value.

*3. C1 and C2 have the function of stabilizing the VDD voltage. Please do not connect capacitors below 0.01ÿF.

*4. When the threshold voltage of the used MOSFET is higher than the over-discharge detection voltage, discharge may stop before over-discharge protection occurs.

*5. When the withstand voltage between the gate and source is lower than the charger voltage, the N-MOSFET may be damaged.

Functional Block Diagram



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

project	symbol	Specification	unit
Input voltage between VDD and VSS	VDD	VSS-0.3~VSS+10	V
OC output terminal voltage	VOC	VDD-25~VDD+0.3	V
OD output terminal voltage	VOD	VSS-0.3~VDD+0.3	V
CS input terminal voltage	VCS	VDD-25~VDD+0.3	V
Operating temperature range	TOP	-40~+85	ÿ
Storage temperature range	TST	-40~+125	ÿ
allowable power consumption	PD	250	mW

Note: Absolute maximum ratings are ratings that must not be exceeded under any conditions. Exceeding these ratings may cause physical damage such as product degradation.

Electrical characteristics (unless otherwise specified: TA = 25°C)

project	symbol		Min Typ Max Unit			
Conditional input voltage						
VDD-VSS operating voltage	VDSOP1	—	1.5	—	10	V
VDD-CS operating voltage	VDSOP2	—	1.5	—	25	V
Current consumption						
Working current	IDD	VDD=7.8V	—	4.0	8.0	uA
Standby current	IPD	VDD=4.0V	—	1.9	—	uA
Detection voltage						
Overcharge detection voltage (n=1,2)	VCUn	—	VCUn -0.025	VCUn	VCUn +0.025 V	
Overcharge release voltage (n=1,2)	VCR	—	VCRn -0.05	VCRn	VCRn +0.05 V	
Overdischarge detection voltage (n=1,2)	V D	—	VDLn -0.08	VDLn	VDLn +0.08 V	
Overdischarge release voltage (n=1,2)	VDR	—	VDRn -0.10	VDRn	VDRn +0.10 V	
Charge overcurrent detection	VCIP	—	VCIP -50	VCIP	VCIP +50 mV	
voltage Discharge overcurrent	VDIP	—	VDIP -30	VDIP	VDIP +30 mV	
detection voltage Load short-circuit detection voltage	VSIP	—	0.6	1.0	1.4	V
Delay time						
Overcharge detection delay time	TOC V1=3.5V,V2=3.5Vÿ4.5V TOD		0.7	1.0	1.3	s
Overdischarge detection delay time	V1=3.5V,V2=3.5Vÿ2.0V V1=V2=3.5V,		70	110	150	ms
Discharge overcurrent detection delay time	TDIP	VCS=0ÿ0.25V	6	10	14	ms
Charge overcurrent detection delay time	TCIP	V1=V2=3.5V, VCS=0ÿ-0.25V	4	7	10	ms
Load short circuit detection delay time	TSIP	V1=V2=3.5V, VCS=0ÿ2.0V	150	250	400	ÿs
Control terminal output voltage						
OD terminal outputs high voltage	VDH	—	VDD-0.1	VDD-0.02 —		V
OD terminal outputs low voltage	VDL	—	—	0.2	0.5	V
OC terminal outputs high voltage	VCH	—	VDD-0.1	VDD-0.02 —		V
OC terminal outputs low voltage	VCL	—	—	0.2	0.5	V
0V battery charging function (enable or disable)						
Charger start voltage (allows 0V battery charging function)	V0CH	allows 0V battery charging function	1.2	—	—	V
Battery voltage (disable 0V battery charging function)	V0IN	disables 0V battery charging function—		—	0.5	V

Job Description

ÿ Normal working state

FM7021 continuously detects the voltage of battery 1 connected between VDD and VC terminals, the voltage of battery 2 connected between VC and VSS terminals, and the voltage difference between CS and VSS terminals to control charging and discharging. When the voltages of battery 1 and battery 2 are both above the over-discharge detection voltage (VDLn) and below the over-charge detection voltage (VCUn), and the CS terminal voltage is above the charge over-current detection voltage (VCIP) and below the discharge over-current detection voltage (VDIP), the OC and OD terminals of FM7021 both output high levels, turning on the charge control MOSFET and the discharge control MOSFET at the same time. This state is called the "normal working state". In this state, both charging and discharging can be carried out freely.

ÿ Overcharge state: When the

voltage of battery 1 connected between VDD and VC terminals or the voltage of battery 2 connected between VC and VSS terminals exceeds the overcharge detection voltage (VCUn) during charging of the battery in normal working state, and this state lasts longer than the overcharge detection delay time (TOC), the output voltage of OC terminal of FM7021 changes from high level to low level, turning off the MOSFET (OC terminal) for charge control and stopping charging. This state is called "overcharge state".

The overcharge state can be released in the following two cases. The OC terminal output voltage changes from low level to high level, turning on the charge control MOSFET. (1) Due to the battery "self-discharge", the voltage of battery 1 and battery 2 both drop below the overcharge release voltage (VCRn), and this state lasts longer than the overcharge release voltage. Delay time (TOCR).

(2) The battery is discharged through the load (note that although M2 is turned off at this time, the discharge circuit still exists due to the presence of its internal diode). When the voltage of battery 1 and battery 2 is lower than the overcharge detection voltage (VCUn), the CS terminal voltage exceeds the discharge overcurrent detection voltage (VDIP), and this state lasts longer than the overcharge release delay time (TOCR). (Before M2 is turned on, the CS terminal voltage will be higher than the VSS terminal by a diode conduction voltage drop).

After FM7021 returns to normal state, the MOSFET (OC terminal) used for charge control will output a high level and return to the on state.

ÿ Over-discharge state: For a

battery in normal working state, during the discharge process, when the voltage of battery 1 connected between VDD and VC terminals or the voltage of battery 2 connected between VC and VSS terminals drops below the over-discharge detection voltage (VDLn), and this state lasts longer than the over-discharge detection delay time (TOD), the OD terminal output voltage of FM7021 changes from high level to low level, turning off the MOSFET (OD terminal) for discharge control and stopping discharge. This state is called "over-discharge state".

The over-discharge state can be released in the following two cases. The output voltage of the OD terminal changes from low level to high level, turning on the discharge control MOSFET.

(1) When the charger is connected, if the voltage of battery 1 or battery 2 is still lower than the discharge detection voltage (VDLn), the output of the discharge control MOSFET (OD terminal) is still low level, M1 is in the off state, and the charger can form a charging circuit through the internal diode of the discharge control N-MOS tube M1 to increase the battery voltage. If the battery is still charged at this time, when the voltage of battery 1 and battery 2 exceeds the over-discharge detection voltage (VDLn), FM7021 can recover from the over-discharge state to the normal working state.

(2) Without connecting the charger, the voltage of battery 1 and battery 2 rises to above the over-discharge release voltage (VDRn) due to the "self-boosting" of the battery after the load is removed. If the over-discharge state lasts longer than the over-discharge release delay time (TODR), FM7021 returns to normal working state.

ÿ Discharge overcurrent state (discharge overcurrent detection function and load short-circuit detection function) Under

normal working conditions, FM7021 discharges the battery through the load, and the CS terminal voltage will increase with the increase of discharge current. If the discharge current increases and the CS terminal voltage exceeds the discharge overcurrent detection voltage (VDIP) and is lower than the load short-circuit detection voltage (VSIP), and this state lasts longer than the discharge overcurrent detection delay time (TDIP), the OD terminal output voltage changes from high level to low level, turning off the MOSFET (OD terminal) used for discharge control and stopping discharge. This state is called "discharge overcurrent state".

Once the CS pin voltage exceeds the load short circuit detection voltage (VSIP) and this state lasts longer than the load short circuit detection delay time (TSIP), the OD pin output The output voltage also changes from high level to low level, turning off the MOSFET (OD terminal) used for discharge control and stopping the discharge. This state is called "load short-circuit state".

If FM7021 is in the state of discharge overcurrent/load short circuit, the output voltage of OD terminal changes from high level to low level, turning off the MOSFET used for discharge control (OD terminal The discharge is stopped, and the CS terminal is connected to VSS through an internal resistor. After the discharge load is removed, the CS terminal level becomes the VSS terminal level.

In the discharge overcurrent/load short circuit state, when the CS terminal voltage drops from high to below the discharge overcurrent detection voltage (VDIP), and this state lasts longer than the discharge overcurrent release delay time (TDIPR), FM7021 returns to normal state. Therefore, in the discharge overcurrent/load short circuit state, FM7021 can "self-recover" only when all discharge loads are removed.

ÿ Charge overcurrent state For a

battery in normal working state, during the charging process, the CS terminal voltage will decrease as the charging current increases. If the charging current increases and the CS terminal voltage is lower than the charge overcurrent detection voltage (VCIP), and this state lasts longer than the charge overcurrent detection delay time (TCIP), FM7021 changes the OC terminal output voltage from high level to low level, turns off the MOSFET (OC terminal) used for charging control, and stops charging. This state is called "charge overcurrent state". After entering the charge overcurrent detection

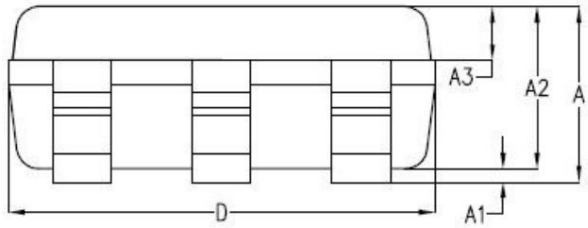
state, if the charger is disconnected and the CS terminal voltage is higher than the charge overcurrent detection voltage (VCIP), and this state lasts longer than the charger, the CS terminal voltage will decrease. Overcurrent detection release delay time (TCIPR), the charging overcurrent state is released and returns to normal working state.

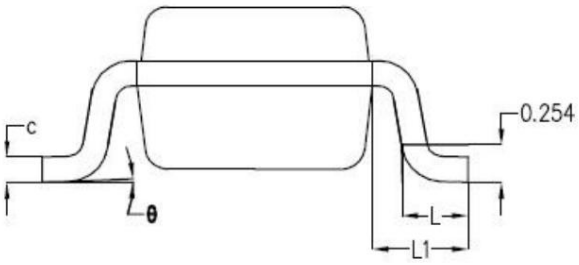
ÿ 0V battery charging is allowed For the

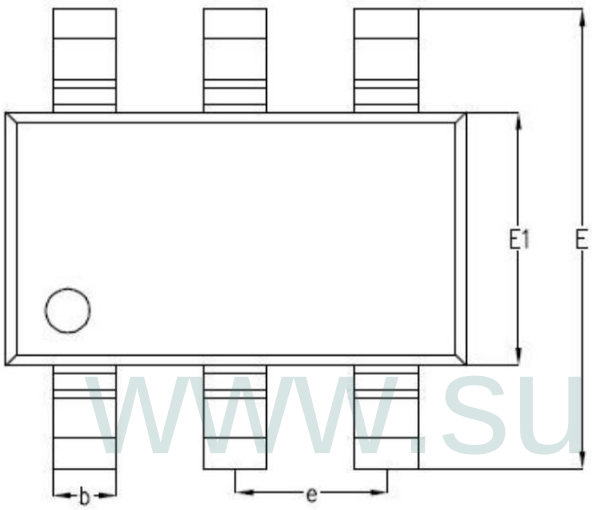
circuit that allows 0V battery charging, if the charger is used to charge the battery, so that the voltage of the VDD terminal of the FM7021 circuit relative to the CS terminal is greater than the 0V charging permission threshold, its charging control terminal OC will be connected to the VDD terminal. If this voltage can turn on the external charging control N-MOS tube M2, a charging loop can be formed through the internal diode of the discharge control N-MOS tube M1 to increase the battery voltage; when the battery voltage increases to make the VDD terminal voltage exceed the overvoltage discharge protection threshold VOD, FM7021 will return to normal state, and the discharge control terminal OD will output a high level, so that the external discharge control N-MOS tube is in the on state.

Packaging information

ÿ SOT23-6







symbol	Millimeters		
	Minimum	Typical	Maximum
A	-	1.19	1.24
A1	-	0.05	0.09
A2	1.05	1.10	1.15
A3	0.31	0.35	0.41
b	0.35	0.40	0.45
c	0.12	0.17	0.22
D	2.85	2.90	2.95
E	2.80	2.90	3.00
E1	1.55	1.60	1.65
e	0.95BSC		
L	0.37	0.45	0.53
L1	0.65BSC		
ÿ	0º	2º	8º