General Description

The EC9529A series is a highly integrated solution for lithium- ion/polymer battery protection. It contains advanced power MOSFET, high-accuracy voltage detection circuits and delay circuits. EC9529A is performed in ultra- compact SOT23-5 package and only one external component required, making it an ideal solution in limited space of battery pack. EC9529A has all the protection functions required in the battery application including over- charging, over- discharging, over-current and load short circuiting protection etc. The accurate over- charging detection voltage ensures safe and full utilization charging. The low stand- by current drains little current from the cell while storage. The device is not only targeting digital cellular phones, but also for any other Li-Ion and Li-Poly battery-powered information appliances requiring long- term battery life

Features

- Protection of Charger Reverse Connection
- Protection of Battery Cell Reverse Connection
- Integrates Advanced Power MOSFET
- Ultra- compact SOT23-5 Package
- Only One External Capacitor Required
- Over-temperature Protection
- Overcharge Current Protection
- Two-step Overcurrent Detection:

-- Over- discharge Current

-- Load Short- Circuiting

- Charger Detection Function
- 0V Battery Charging Function
- Delay Times are generated inside
- High-accuracy Voltage Detection
- Low Current Consumption

- Operation Mode: 2.8μA typ.

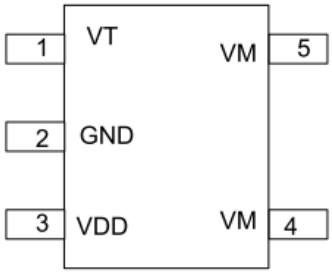
- Power- down Mode:1.5μA typ.

- RoHS Compliant and Lead (Pb) Free

Applications

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

Pin Assignments



Pin Description

PIN NUMBER	PIN NAME	PIN DESCRIPTION
1	VT	Test Pin； only for Just- link usage when FT, no function when application
2	GND	Ground Pin, connect the negative terminal of the battery to this pin
3	VDD	Power Supply Pin
4,5	VM	The Cathode terminal of the battery or charger, through internal MOSFET To the Ground

Ordering Information

PART NUMBER	Package Type	Over-charge Detection Voltage [VCU] (V)	Over-charge Release Voltage [VCL] (V)	Over-discharge Detection Voltage [VDL] (V)	Over-discharge Release Voltage [VDR] (V))	Over-current Detection Current [IOV1] (A	Top Mark
EC9529ANB2R	SOT23-5	4.30	4.10	2.40	3.0	3	03TYWW

Note: “YWW” is manufacturing codes, “Y” stands for year=>2015=5
“WW” means the week

Absolute Maximum Ratings

PARAMETER	VALUE	UNIT
VDD input pin voltage	-0.3~6	V
VM input pin voltage	-6~10	V
Operating Ambient Temperature	-40~+85	℃
Maximum Junction Temperature	125	℃
Storage Temperature	-55-150	℃
Lead Temperature (Soldering, 10 sec)	300	℃
Power Dissipation at T=25°C	0.4	W
Package Thermal Resistance (Junction to Ambient) θ_{JA}	250	℃/W
Package Thermal Resistance (Junction to Case) θ_{JC}	130	℃/W
Anti- ESD (HBM)	2000	V

(Note: Do not exceed limits to prevent damage to the device. Exposure to absolute maximum rating conditions for periods may affect device reliability.)

Electrical Characteristics

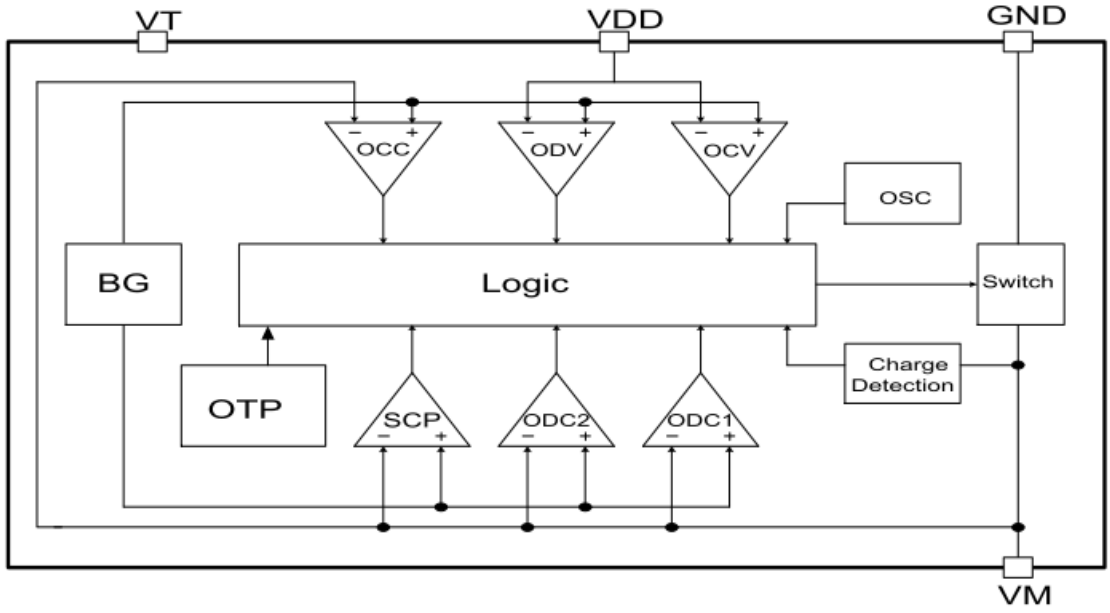
Typical and limits appearing in normal type apply for TA=25, unless otherwise specified

Parameter	Symbol	Test Condition	Min	Typ	Max	Unit
Detection Voltage						
Overcharge Detection Voltage	V_{CU}	--	4.25	4.3	4.35	V
Overcharge Release Voltage	V_{CL}	--	4.05	4.1	4.15	V
Over-discharge Detection Voltage	V_{DL}	--	2.3	2.4	2.5	V
Over-discharge Release Voltage	V_{DR}	--	2.9	3.0	3.1	V
Charger Detection Voltage	V_{CHA}	--		-0.12		V
Detection Current						
Over-discharge Current Detection	I_{IOV1}	Vdd=3.5V		3		A
Load Short-Circuiting Detection	I_{SHORT}	Vdd=3.5V		12		A
Current Consumption						
Current Consumption in Normal Operation	I_{OPE}	Vdd=3.5V, VM=0V		2.8	6	uA
Current Consumption in Power Down	I_{PDN}	Vdd=2V, VM Pin floating		1.5		uA
FET on Resistance						
Equivalent FET on Resistance	R_{DS}	Vdd=3.6V，IVM=1A		45		mΩ

Electrical Characteristics

Parameter	Symbol	Test Conditio	Min	Typ	Max	Unit
Over Temperature Protection						
Over Temperature Protection				120		℃
Over Temperature Recovery Degree				100		℃
Detection Delay Time						
Over-charge Voltage Detection Delay Time	T_{CU}	VDD=3.6V~4.4V		128		ms
Over-discharge Voltage Detection Delay Time	T_{DL}	VDD=3.6V~2.0V		32		ms
Over-discharge Current Detection Delay Time	T_{IOV1}	VDD=3.6V		8		ms
Load Short-Circuiting Detection Delay Time	T_{SHORT}	VDD=3.6V		32		us

Function Block



FUNCTIONAL DESCRIPTION

The EC9529A monitors the voltage and current of a battery and protects it from being damaged due to over-charge voltage, over- discharge voltage, over- discharge current, and short circuit conditions by disconnecting the battery from the load or charger. These functions are required in order to operate the battery cell within specified limits. The device requires only one external capacitor. The MOSFET is integrated and its RDS(ON)） is as low as 45mΩ typical

Normal operating Mode

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

Overcharge Condition

When the battery voltage becomes higher than the overcharge detection voltage (VCU) during charging under normal condition and the state continues for the overcharge detection delay time (tCU) or longer, the EC9529A 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 (VCL), the EC9529A turns the charging control FET on and returns to the normal condition.
2. When a load is connected and discharging starts, the EC9529A turns the charging control FET on and returns to the 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 0.7 V (forward voltage of the diode) from the GND pin voltage momentarily. The EC9529A 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 (VCU), the EC9529A returns to the normal condition immediately, but in the case the battery voltage is higher than the overcharge detection voltage (VCU),the chip does not return to the normal condition until the battery voltage drops below the overcharge detection voltage (VCU) even if the load is connected. In addition, if the VM pin voltage is equal to or lower than the overcurrent 1 detection voltage when a load is connected and discharging starts, the chip does not return to the normal condition.

Remark: If the battery is charged to a voltage higher than the overcharge detection voltage (VCU) and the battery voltage does not drops below the overcharge detection voltage (VCU) even when a heavy load, which causes an overcurrent, is connected, the overcurrent 1 and overcurrent 2 do not work until the battery voltage drops below the overcharge detection voltage (VCU). 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 1 and overcurrent 2 work. Detection of load short-circuiting works regardless of the battery voltage.

Over- discharge Condition

When the battery voltage drops below the over-discharge detection voltage (VDL) during discharging under normal condition and it continues for the over-discharge detection delay time (tDL) or longer, the EC9529A turns the discharging control FET off and stops discharging. This condition is called over-discharge condition. After the discharging control FET is turned off, the VM pin is pulled up by the RVMD resistor between VM and VDD in EC9529A. Meanwhile when VM is bigger than 1.5 V (typ.) (the load short-circuiting detection voltage), the current of the chip is reduced to the power-down current (IPDN). This condition is called power-down condition. The VM and VDD pins are shorted by the RVMD resistor in the IC under the over-discharge 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 MOSFET is still off. When the battery voltage becomes the over-discharge detection voltage (VDL) or higher (see note), the EC9529A turns MOSFET on and changes to the normal condition from the over-discharge condition.

Remark: If the VM pin voltage is no less than the charger detection voltage (VCHA), when the battery under over-discharge condition is connected to a charger, the over-discharge condition is released (the discharging control FET is turned on) as usual, provided that the battery voltage reaches the over-discharge release voltage (VDU) or higher.

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 overcurrent detection delay time or longer, the EC9529A turns off the discharging control FET to stop discharging. This condition is called overcurrent condition. (The overcurrent includes overcurrent, or load short-circuiting.) The VM and GND pins are shorted internally by the RVMS resistor under the overcurrent condition. When a load is connected, the VM pin voltage equals the VDD voltage due to the load. The overcurrent condition returns to the normal condition when the load is released and the impedance between the B+ and B- pins 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 RVMS resistor. Detecting that the VM pin potential is lower than the overcurrent detection voltage (VIOV1), the IC returns to the normal condition.

Abnormal Charge Current Detection

If the VM pin voltage drops below the charger detection voltage (VCHA) during charging under the normal condition and it continues for the overcharge detection delay time (tCU) or longer, the EC9529A turns the charging control FET off and stops charging. This action is called abnormal charge current detection.
Abnormal charge current detection works when the discharging control FET is on and the VM pin voltage drops below the charger detection voltage (VCHA). When an abnormal charge current flows into a battery in the over-discharge condition, the EC9529A consequently turns the charging control FET off and stops charging after the battery voltage becomes the over-discharge detection voltage and the overcharge detection delay time (tCU) elapses. Abnormal charge current detection is released when the voltage difference between VM pin and GND pin becomes lower than the charger detection voltage (VCHA) by separating the charger. Since the 0 V battery charging function has higher priority than the abnormal charge current detection function, abnormal charge current may not be detected by the product with the 0 V battery charging function while the battery voltage is low.

Load Short-circuiting condition

If voltage of VM pin is equal or below short circuiting protection voltage (VSHORT), the EC9529A will stop discharging and battery is disconnected from load. The maximum delay time to switch current off is tSHORT. This status is released when voltage of VM pin is higher than short protection voltage (VSHORT), such as when disconnecting the load.

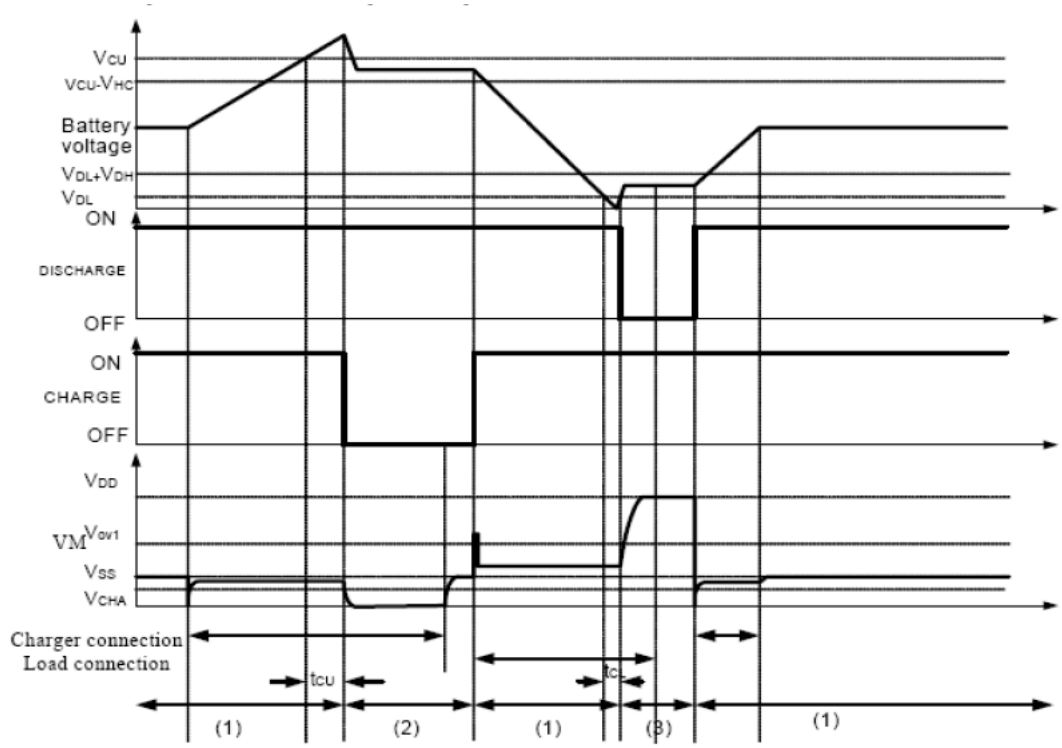
0V Battery Charging Function

This function enables the charging of a connected battery whose voltage is 0 V by self-discharge. When a charger having 0 V battery start charging charger voltage (V0CHA) 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 over-discharge release voltage (VDU), the normal condition returns.

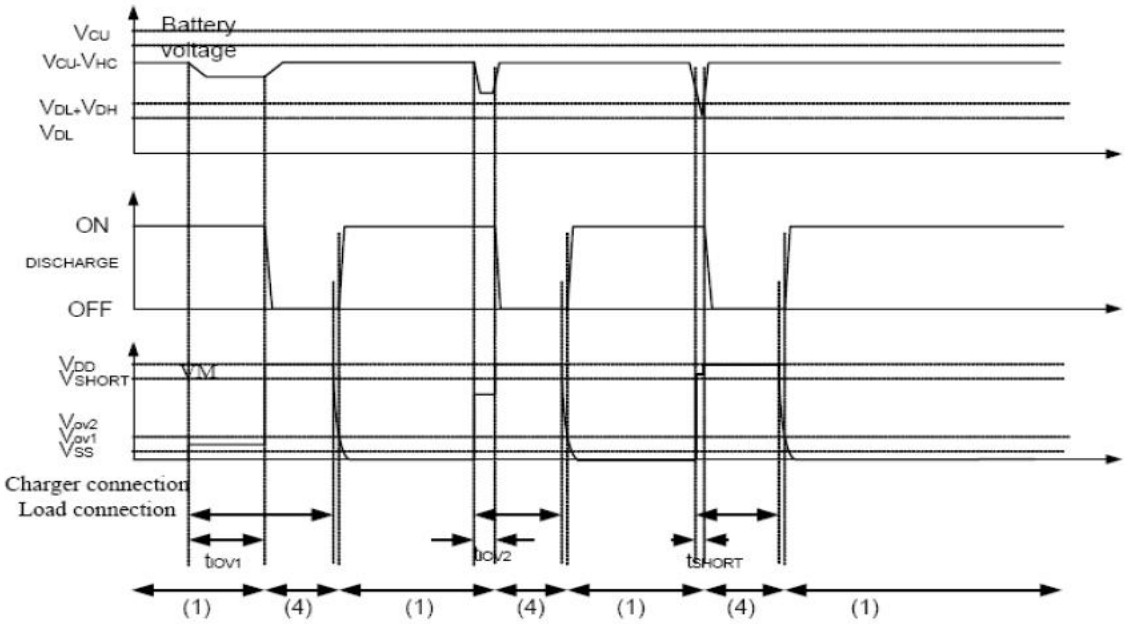
Note:
(1) Some battery providers do not recommend charging of completely discharged batteries. Please refer to battery providers before the selection of 0 V battery charging function.
(2) The 0V battery charging function has higher priority than the abnormal charge current detection function. Consequently, 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.

TIMING CHART

1 · Over- charge and over-discharge Voltage Detection:

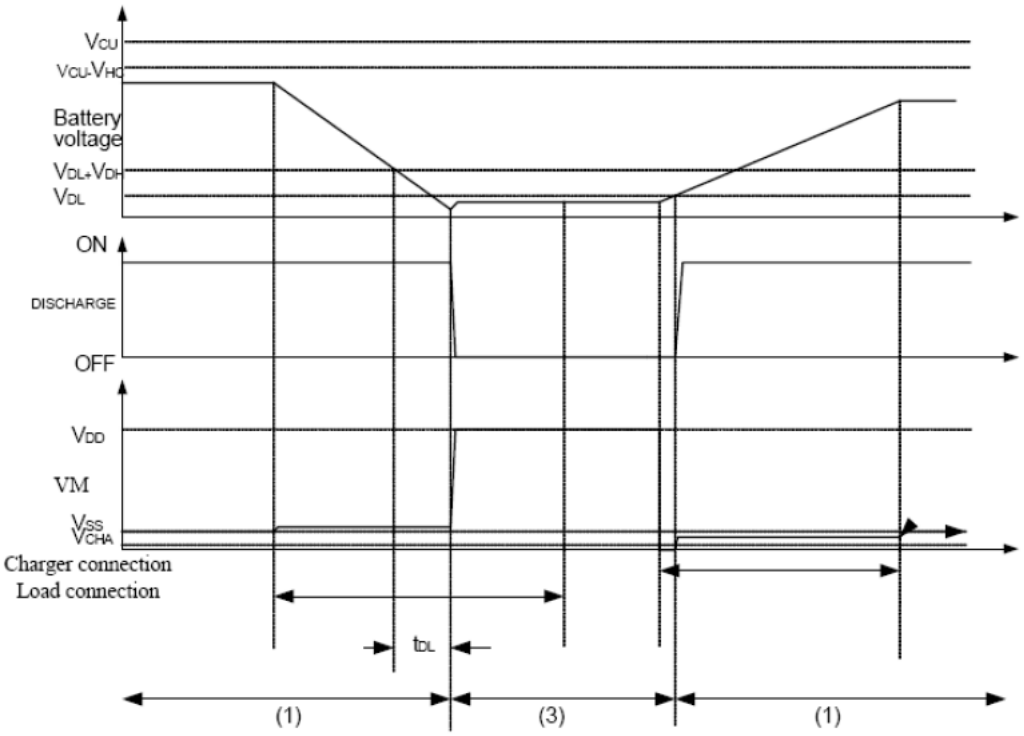


2 · Over-discharge Current Detection:

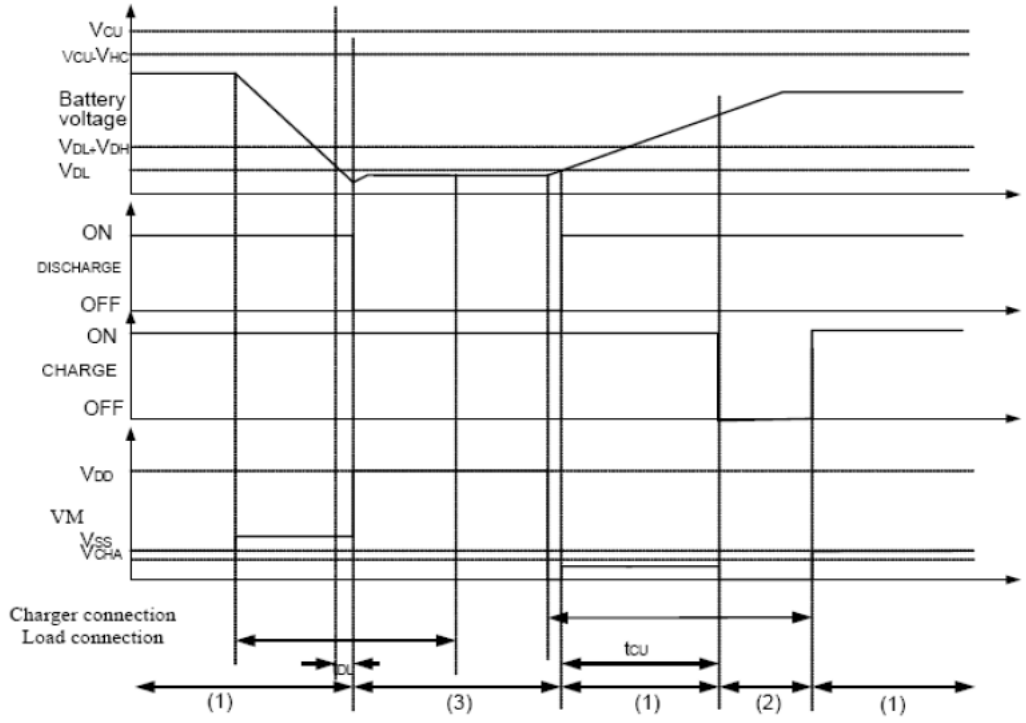


Remark: (1) Normal condition (2) Over- charge Voltage condition (3) Over-discharge Voltage condition (4) Over Current condition

3 · Charger Detection:



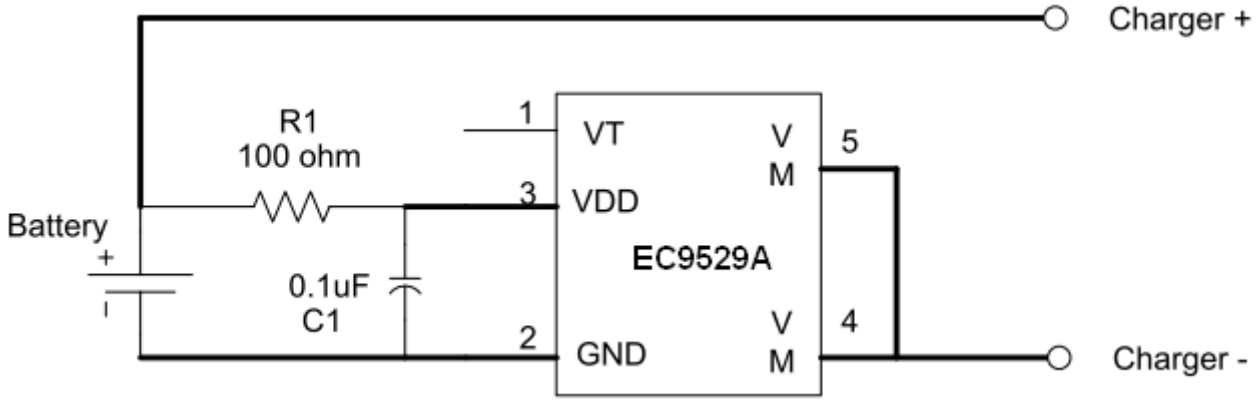
4 · Abnormal Charging Current Detection:



Remark: (1) Normal condition (2) Over-charge Voltage condition (3) Over-discharge Voltage condition (4) Over Current condition

TYPICAL APPLICATION SUGGESTION:

As shown in Figure below, the bold line is high density current path which must be kept as SHORT as possible. For thermal management, ensure that these trace WIDTH is adequate. C1 is a decoupling capacitor, which should be placed as CLOSE as possible to EC9529A.

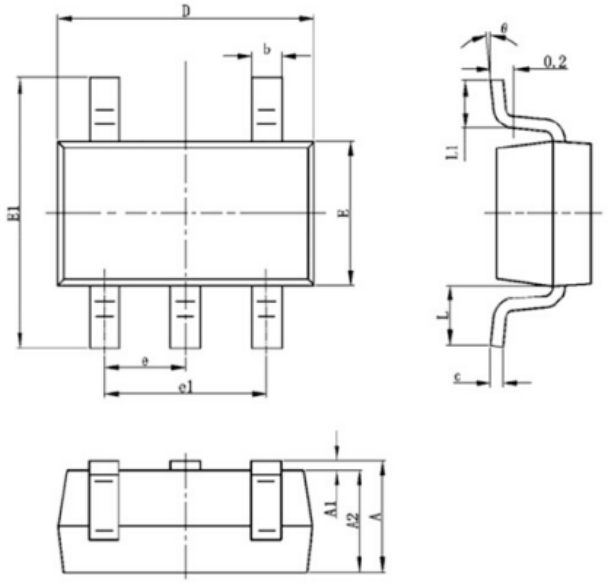


Precautions

- Pay attention to the operating conditions for input/output voltage and load current so that the power loss in EC9529A does not over- load the power dissipation of the package.
- Do not apply an Electro- static Discharge to this EC9529A that exceeds the performance ratings of the built-in electrostatic protection circuit.

Package Information

SOT23-5 PACKAGE OUTLINE AND DIMENSIONS



Symbol	Dimensions In Milimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	1.050	1.250	0.041	0.049
A1	0.000	0.100	0.000	0.004
A2	1.050	1.150	0.041	0.045
b	0.300	0.400	0.012	0.016
c	0.100	0.200	0.004	0.008
D	2.820	3.020	0.111	0.119
E	1.500	1.700	0.059	0.067
E1	2.650	2.950	0.104	0.116
e	0.950 TYP		0.037 TYP	
e1	2.695	3.050	0.106	0.120
L	0.700 REF		0.028 REF	
L1	0.400	0.800	0.016	0.031
θ	0°	8°	0°	8°