MPPT Function for Tracking The Maximum Power Point of Solar Panel and NTC Functions, Charging Current 5A (Single Lithium Battery) 4A(Multi Section and Multi Type) Lithium Battery Charging Management IC

General Description

CS5363E is a 20V withstand voltage, 1-4 lithium batteries or 1-5 lithium iron phosphate batteries asynchronous buck charging management IC. Integrated power MOS, with the maximum 5A (single lithium battery) 4A (multi section and multi type) charging current capacity, and the charging current can be flexibly adjusted through external resistance. CS5363E when the solar panel is used for power supply, the internal circuit can automatically track the maximum power point of the solar panel. Users do not need to consider the worst case, and can maximize the output power of the solar panel, which is very suitable for the application of solar panel power supply. CS5363E can independently adjust the charging termination current and floating charge voltage through external resistors.

CS5363E has perfect protection functions, including input undervoltage and overvoltage protection, battery charging overvoltage and short circuit protection, battery temperature protection, chip over temperature protection, and charging timeout protection. In addition, the chip can monitor the whole charging process through the external LED indicator.

Features

- Wide Input Voltage Range: 3.6V~20V
- Solar Panel Maximum Power Point Tracking Function
- Maximum 5A Charging Current for Single Lithium Battery
- Maximum 4A Charging Current for Multiple Lithium Batteries
- Charging Termination Current Independently Adjustable
- CV Charging Voltage Independently Adjustable
- NTC Function
- ±1% Battery Constant Voltage Accuracy
- Support LED Charging Status Indication
- 400KHz Switching Frequency
- Battery SCP and OVP Protection
- Input Voltage UVLO and OVP Protection
- IC Temperature Adaptive Adjustment
- IC Over Temperature Protection

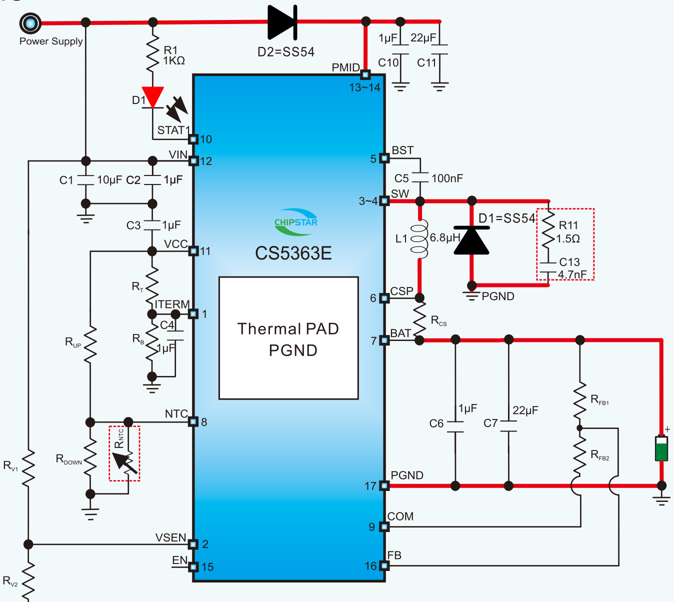
Applications

- Electric Tool
- Lithium Titanate Battery Pack
- Lithium Battery Pack
- Lithium Iron Phosphate Battery Pack
- Portable Industrial and Medical Instruments
- Charging with Solar Panels

Package

- ESOP16

Typical Applications

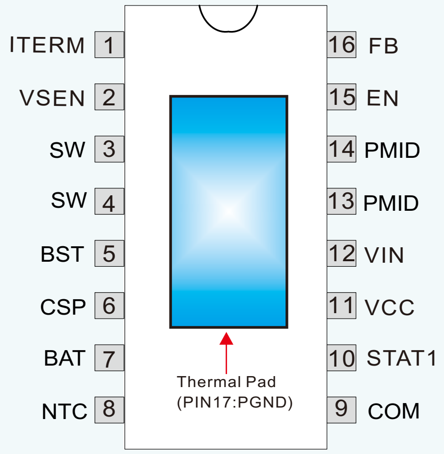


CS5363E Application Circuit

Note:

(1) L1 is a power inductor with a saturation current of 10A, and SS54 is a low-voltage drop Schottky diode.
(2) All chip capacitors need to be as close to the chip pin layout as possible.
(3) If the NTC function is not used, the NTC pin needs to be grounded.
(4) If the default 10%*ICC charging termination current is used, the first pin can be directly connected to the eleventh pin.
(5) The leads can only be tapped from both ends of the resistor R_{CS} to enter the 6th and 7th pins of the chip for sampling voltage respectively.
(6) Pins 1, 8 and 11 of the chip are low-voltage pins, and the withstand voltage is 6V.
(7) The solid red line in the figure is the path of high current.
(8) D1 and D2 in the figure can be connected in parallel with two diodes according to the actual current.
(9) When the power input is high, it is recommended to add RC absorbing circuit or electrolytic capacitor to prevent excessive voltage spikes.

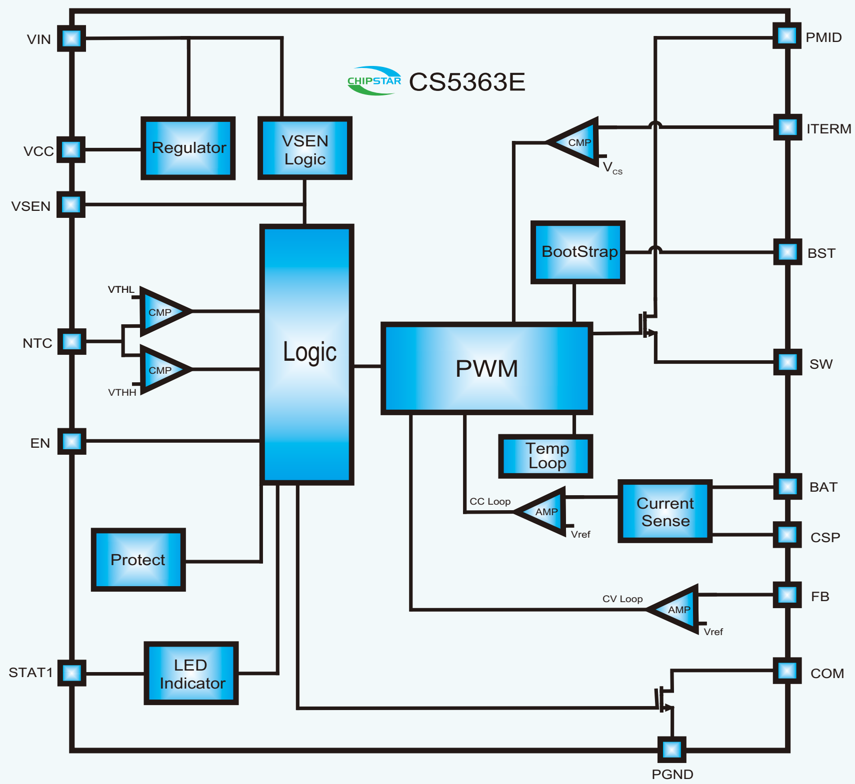
PIN Configuration and Functions



ESOP16L
(Top View)

PIN	NAME	TYPE	DESCRIPTION
1	ITERM	I	Charging termination current regulating terminal
2	VSEN	I	Vin voltage detection
3~4	SW	I	Switch node, inductor connector
5	BST	P	Bootstrap capacitor connector
6	CSP	I	Battery charging current detection positive input
7	BAT	P	Battery positive pin
8	NTC	I	Thermistor input pin, through the external thermistor to detect the battery temperature
9	COM	O	Battery voltage detection resistance and internal switch tube connection terminal of the chip
10	STAT1	O	Charging status indication port 1
11	VCC	P	Internal LDO output
12	VIN	P	Power supply
13~14	PMID	O	Intermediate node end of system power
15	EN	I	Chip enabler pin (EN connected with high potential or floating enabler chip, grounded to prohibit chip operation
16	FB	I	Battery voltage feedback terminal
17	PGND	-	Power ground

Functional Block Diagram



Absolute Maximum Ratings [1]

SYMBOL	PARAMETER	VALUE	UNIT
V_{IN}	Input voltage	-0.3~30	V
T_J	Junction operating temperature range	-40~150	℃
T_{STG}	Storage temperature range	-60~150	℃
T_{SDR}	Lead temperature (Soldering, 10 sec.)	260	℃

Recommended Operating Conditions

SYMBOL	PARAMETER	VALUE	UNIT
V_{IN}	Input power supply voltage	3.8~20	V
T_J	Junction operating temperature range	-40~125	℃
T_A	Ambient temperature range	-40~85	℃

Thermal Information [2]

SYMBOL	PARAMETER	VALUE	UNIT
θ_{JA}(ESOP16)	Package thermal resistance - chip to environment thermal resistance	50	℃/W
θ_{JC}(ESOP16)	Package thermal resistance - chip to package surface thermal resistance	10	℃/W

Ordering Information

<table>
<tr><th>Product Name</th><th>Package Type</th><th>Device Marking</th><th>Reel Size (Inch)</th><th>Tape width</th><th>Quantity</th></tr>
<tr><td rowspan="2">CS5363E</td><td rowspan="2">ESOP16</td><td rowspan="2">
</td><td>13″</td><td>12mm</td><td>2500 per Reel</td></tr>
<tr><td colspan="2">Tube</td><td>50</td></tr>
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ESD Range

HBM (Human Body Model) -- ±4kV
MM (Machine model) -- ±400V

1. The above parameters are only the limit values of device operation. It is not recommended that the working conditions of the device exceed the limit values. Otherwise, the reliability and life of the device will be affected, and even permanent damage will be caused.

2. Where the PCB board is placed in CS5363E, a heat dissipation design is needed. The heat sink at the bottom of CS5363E is connected with the heat sink area of PCB board.

Electrical Characteristics (V_{IN}=18V，R_{CS}=12.5mΩ，L=6.8uH，unless otherwise noted)

SYMBOL	PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNIT
V_{IN}	Supply voltage		3.8		20	V
$V_{IN(UVLO)}$	VIN under voltage lockout threshold	VIN falling		3.6		V
$\Delta V_{IN(UVLO)}$	VIN under voltage lockout hysteresis			200		mV
$V_{IN(OVP)}$	VIN over voltage protection	VIN rising		28		V
$\Delta V_{IN(OVP)}$	VIN over voltage protection hysteresis			1.35		V
V_{ACOK}	ACOK voltage threshold	VIN rising, V_{IN} -V_{BAT}		370		mV
ΔV_{ACOK}	ACOK voltage hysteresis			140		mV
VCC	VCC output voltage			5		V
I_{SD}	Input shutdown current	V_{EN}=0		300		μA
I_{BAT}	Battery leakage current	Fully charged, V_{BAT}=12.6 V		16		μA
		V_{EN}=0 or NO V_{IN}, V_{BAT}=12.6V			500	nA
V_{SEN}	VSEN pin modulation voltage			1		V
V_{FB}	Feedback voltage modulation threshold		0.99	1	1.01	V
V_{CV}	Charging floating charge voltage	K=1+R_{B1}/R_{B2}		K*V_{FB}		V
$V_{BAT(SCP)}$	Battery short threshold	V_{BAT} falling		0.25V_{CV}		V
$V_{BAT(TC)}$	TC charge mode battery voltage threshold	V_{BAT} rising		0.6V_{CV}		V
$V_{BAT(RCH)}$	Recharge voltage	V_{BAT} falling		0.975V_{CV}		V
V_{OVPB}	BAT over voltage threshold	V_{BAT} rising		1.075 V_{CV}		V

Electrical Characteristics (V_{IN}=18V，R_{CS}=12.5mΩ，L=6.8uH，unless otherwise noted)

参数	描述	测试条件	最小值	典型值	最大值	单位
I_{CC}	CC charge mode current	R_{CS}=12.5mΩ	3.6	4	4.4	A
I_{TC}	TC charge mode current			0.1*I_{cc}		A
I_{TERM}	Terminate charge current	V_{ITERM}=VCC		0.1*I_{cc}		A
F_{SW}	Switching frequency			400		KHz
T_{DGL}	Charge state transition filter time			32		ms
$TMR_{(CC/CV)}$	CC/CV charge time limit			20		Hour
$TMR_{(TC)}$	Trick charge time limit			3.7		Hour
V_{cold}	NTC low temp falling threshold	Percentage of VCC		70		%
V_{cold_hys}	NTC low temperature protection hysteresis	Percentage of VCC		0.8		%
V_{hot}	NTC high temp rising threshold	Percentage of VCC		47.5		%
V_{hot_hys}	NTC high temperature protection hysteresis	Percentage of VCC		1.6		%
T_{REG}	Thermal regulation threshold			120		℃
T_{SD}	Thermal shutdown temperature			150		℃
ΔT	Thermal shutdown temperature hysteresis			20		℃

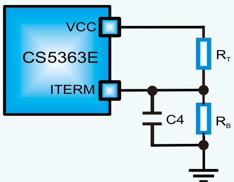
CS5363E Application Points

1. Charge Process

CS5363E adopts three complete processes of trickle charging, constant current charging and constant voltage charging. When the battery voltage is less than the trickle point, the system is charged with I_{CC}*10% charging current; When the voltage of the battery is greater than the trickle point, the system is charged with I_{CC} charging current; When the battery voltage reaches the set floating charge voltage value, the charging current gradually decreases. When the current decreases to the set charging termination current value, the charging is stopped. When the battery is fully charged, and the battery voltage drops below the set floating charge voltage value *97.5% due to self discharge or load power consumption, the system will restore the charging state.

2. Programmable Function of Charging Termination Current

CS5363E has the programmable function of charging termination current. By setting different external voltage dividing resistors, the size of the charging termination current can be easily adjusted. The voltage at the ITERM terminal can be adjusted between 50mV and 500mv. The relationship between the charging termination current ITERM and the two resistors is shown in the following formula: V_{CC} is the internal LDO output voltage, I_{CC} is the constant current charging current; When ITERM terminates V_{CC}, the charging termination current is the default internal setting value of 10%*I_{CC}。



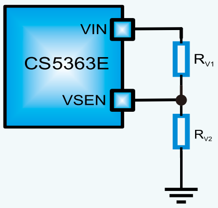
$$I_{TERM} = \frac{VCC*R_B}{(R_B+R_T)} * I_{CC}$$

3. MPPT Function of Solar Panel Maximum Power Point Tracking

CS5363E has a special built-in loop, which can automatically adjust the charging current to avoid the input DC power supply entering the overdrive state, so as to prevent the adapter from collapsing due to any improper setting.

In the volt ampere characteristic curve of the solar panel, when the ambient temperature is constant, the output voltage corresponding to the maximum power output point is basically the same under different sunlight intensity, that is, as long as the output voltage of the solar panel is kept constant, the maximum power output of the solar panel can be guaranteed when the illumination intensity is different at this temperature. According to the above principle, using the input adaptive function, the chip uses the solar panel as the input. According to the characteristics of different solar panels, the constant voltage method is used to track the maximum power point of the solar panel, so as to maximize the output power of the solar panel.

The voltage of VSEN pin at the maximum power point tracking end of CS5350E solar panel is modulated at 1V. By selecting R_{V1} andR_{V2} resistors, determine the lowest value V_{MPPT} to which the input voltage can be reduced. The specific calculation formula is as follows:



$$V_{MPPT} = \frac{1*(R_{V1}+R_{V2})}{R_{V2}}$$

To disable this function, just connect this pin to VIN or VCC.

4. Enable Function

The enable end en is a high-voltage pin with a built-in pull-up resistance of about 600K, which can be directly connected to the VIN end, VCC end or floating air to enable chip charging; If you want to turn off the charging function, just ground the pin.

5. Protection Function

CS5363E has perfect battery charging protection function. When the chip has input overvoltage, input undervoltage, battery overvoltage, chip overheating and abnormal battery temperature, the system charging will be prohibited until the protection state is released;

When the battery voltage is lower than 25% of the set floating charge voltage, the system frequency will gradually decrease from 400KHz of the normal value to about 100KHz;

When the input voltage is lower than the undervoltage protection threshold of 3.6V, the main functional modules of the chip will be closed to prevent the system from maloperation due to low power supply voltage; In addition, the system has the function of charging timeout protection. When the charging time in trickle stage is greater than 3.7 hours or the charging time in constant current charging/constant voltage charging stage is greater than 20 hours, the charging timeout protection function will start and forcibly terminate the charging process. The timing will be restarted only when the system is powered on again or the battery state changes.

6. Charging LED Indication

1 Charging process: The STAT1 port outputs low level, and the LED is always on.

（2）Fully charged: STAT1 port outputs highresistance state, and the LED light goes out.
（3）In the case of input VIN end overvoltage, battery overvoltage, battery short circuit, abnormal battery temperature, chip overheating, and charging timeout, the STAT1 port LED flashes at a frequency of 1.5Hz.
（4）When the input VIN end is under voltage or the chip is in the non enable mode, the STAT1 port outputs a high resistance state and the LED light goes out.
（5）If no battery is detected after the system is powered on, the LED light flashes and turns off.

7. Charging Current Setting

The constant current charging current can be set through the resistance R_{CS}, and the specific calculation formula is as follows:

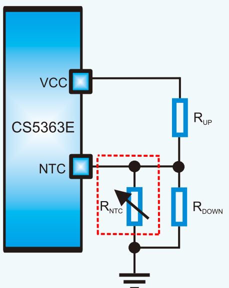
$$I_{CC}=\frac{50\ (mV)}{R_{CS}(m\Omega)}\ (A)$$

To obtain a 4A charging current, just select the detection resistance R_{CS} with a resistance value of 12.5mΩ. In the trickle stage, the charging current I_{TC} is determined by the following formula:

$$I_{TC}=I_{CC}*10\%=\frac{5\ (mV)}{R_{CS}(m\Omega)}\ (A)$$

8. NTC Resistance Setting

The battery charging supports the NTC protection function, and the battery temperature is detected through the NTC pin. When NTC detects that the battery temperature is within the set temperature window range, it will charge normally; When NTC detects that the battery temperature is lower than the set lowWhen the temperature protection point is higher than the set high temperature protection point, the charging will be stopped and an alarm will be given. If the NTC function is not used, the pin should be grounded.
The following figure shows the high-temperature reference point and low-temperature reference point set internally through the voltage dividing resistance, in which the low-temperature reference point is VCC*70%, and the high-temperature reference point is VCC*47.5%. Set the temperature range of NTC for normal operation by selecting appropriate external resistance.



$$\frac{R_{DOWN}//R_{NTC\_Cold}}{R_{UP}+R_{DOWN}//R_{NTC\_Cold}}=70\%$$

$$\frac{R_{DOWN}//R_{NTC\_Hot}}{R_{UP}+R_{DOWN}//R_{NTC\_Hot}}=47.5\%$$

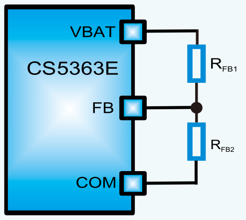
R_{NTC_Cold} in the above formula is the resistance value corresponding to the NTC resistance at the set low temperature point, while R_{NTC_Hot} is the resistance value of NTC resistance at the set high temperature point. Because R_{DOWN} and R_{UP} can set low temperature and high temperature windows independently, CS5363E can meet most NTC resistance models, which brings great convenience to applications. The relationship between resistance R_{DOWN} and R_{UP} and NTC resistance can be given by the following formula through the above definition:

$$R_{UP}=\frac{0.1183*R_{NTC\_Hot}*R_{NTC\_Hot}}{0.1742*(R_{NTC\_Cold}-R_{NTC\_Hot})}$$

$$R_{DOWN}=\frac{0.2249*R_{NTC\_Hot}*R_{NTC\_Hot}}{0.1427*R_{NTC\_Cold}-0.3677*R_{NTC\_Hot}}$$

9. Battery Floating Charge Voltage Setting

The internal clamping voltage threshold corresponding to the FB pin of the chip is 1V. According to this voltage and the two external voltage dividing resistors rfb1 and rfb2, the floating charge voltage value of battery charging can be set. The specific formula is as follows:



$$V_{CV}=\frac{1*(R_{FB1}+R_{FB2})}{R_{FB2}}$$

10. Chip Temperature Regulation Function

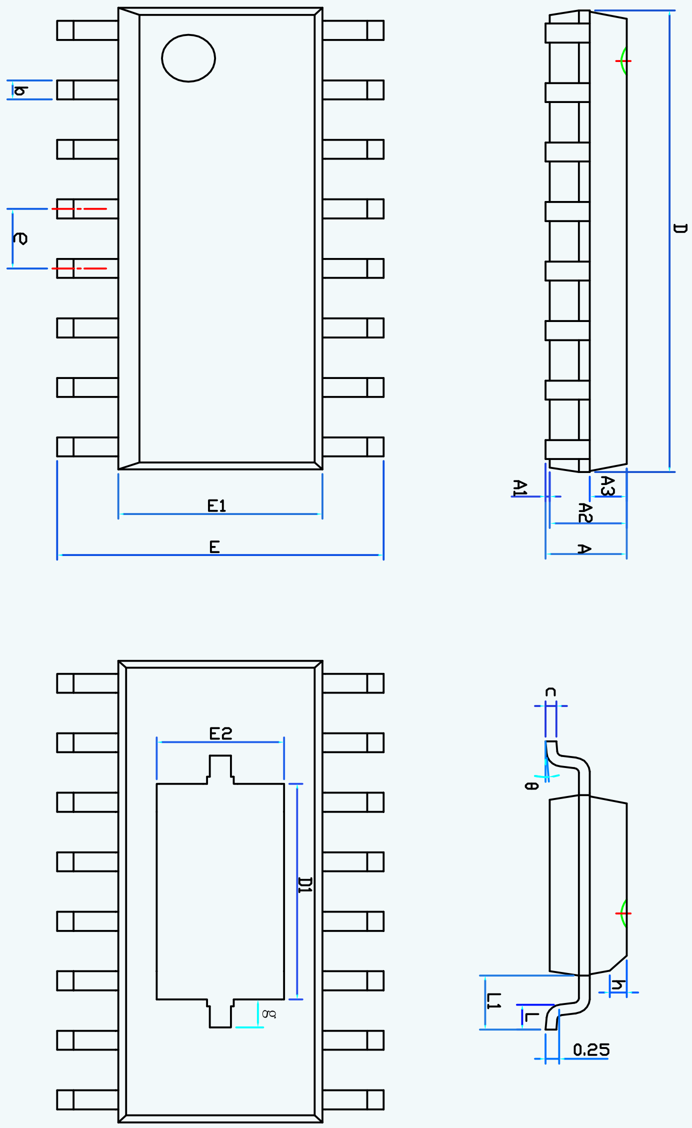
CS5363E has a built-in temperature regulation loop. When the chip is in the charging process, if the temperature rises to 120℃, the temperature control loop will start to work, the charging current will gradually decrease, and the chip temperature will drop accordingly. Finally, the chip temperature will stabilize at the set value, thus protecting the chip.

11. PCB Layout Precautions

For the heat dissipation of the chip, the layout of PCB needs special attention. Thus, the usable charging current can be increased to the greatest extent, which is very important. The heat dissipation path used to dissipate the heat generated by the IC is from the chip to the lead frame, and reaches the copper surface of the PCB through the heat sink at the bottom. As the main radiator of IC, the copper foil of PCB should be as wide as possible and extend outward to a larger copper foil area, so as to spread heat into the surrounding environment. When designing the PCB layout, other heat sources on the circuit board that are not related to the charging IC also need to be considered, because their own temperature will affect the overall temperature rise and the maximum charging current.

Package Information

CS5363E ESOP16L



SYMBOL	MILLMETER		
	MIN	NOM	MAX
A	—	—	1.55
A1	0.02	0.05	0.08
A2	1.40	1.45	1.50
A3	0.70	0.75	0.80
b	0.35	—	0.45
c	0.20	—	0.24
D	9.70	9.80	9.90
D1	4.60REF		
e	1.27BSC		
E	6.25	6.35	6.45
E1	3.70	3.80	3.90
E2	2.40REF		
L	0.50	—	0.70
L1	1.25REF		
h	0.25	0.35	0.45
θ	0	—	8°
g	0.60REF		