HB6292 Single-Cell/Two-Cell Linear Li-ion/Li Polymer Battery Charger

1、 HB6292 functions

1.1、Features

- Charger for single-cell/two-cell Li-ion/Li polymer battery
- Smart battery existence detection
- 0.8％ voltage accuracy
- Full charged voltage trimming by external resistors
- Integrated power MOSFET and current sensor
- No external blocking diode needed
- Programmable charge current up to 800mA
- Charge current thermal fold back
- NTC Thermistor interface for battery temperature monitor
- Short circuit protection
- Accepts multiple types of adapters or USB bus Power
- Ambient temperature range:-30℃～70℃
- Thin TSSOP-16 package

1.2、Applications

- Handheld devices, include medical handhelds
- PDA, cell phones and smart phones
- Portable instruments，MP3
- Stand alone chargers
- Self-Charging Battery Packs
- USB bus powered chargers
- Pb-free available

1.3、Introduction

The HB6292 is an integrated single cell/two cell Li-ion or Li polymer battery charger capable of operating with an input voltage as low as 3.6V, The maximum charging current is up to 800mA.The HB6292 can work with various AC adaptors or USB ports. A complete charge cycle includes constant current charge (CC) and constant voltage charge (CV). The charge current is programmable with an external resistor up to 800mA. The HB6292 can also work with a current-limited adaptor to minimize the thermal dissipation, in which case, the HB6292 combines the benefits of both a linear charger and a switching charger. The HB6292 features charge current thermal fold back and short circuit protection to guarantee safe operation. Additional features include preconditioning of an over-discharged battery、NTC thermistor interface and automatic recharge.

2、 Typical application circuit

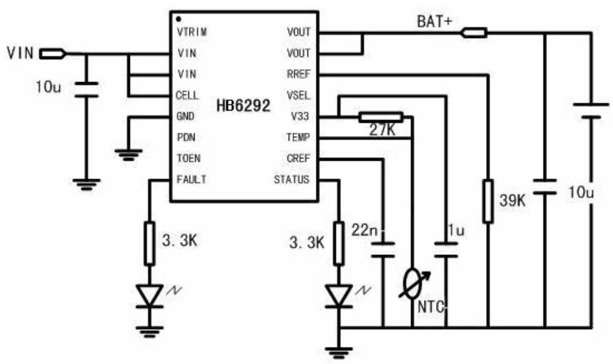

Figure2.1、single cell application

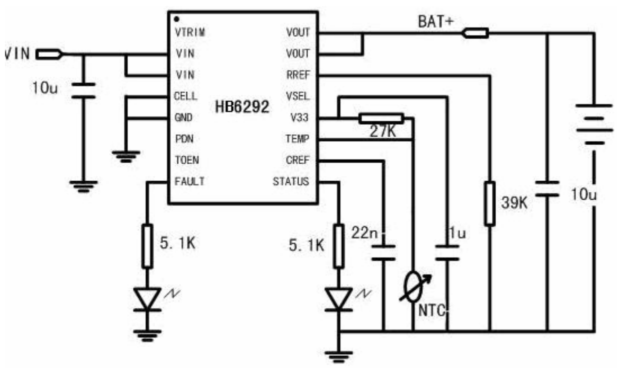

Figure2.2、two cell application

3、 HB6292 function block

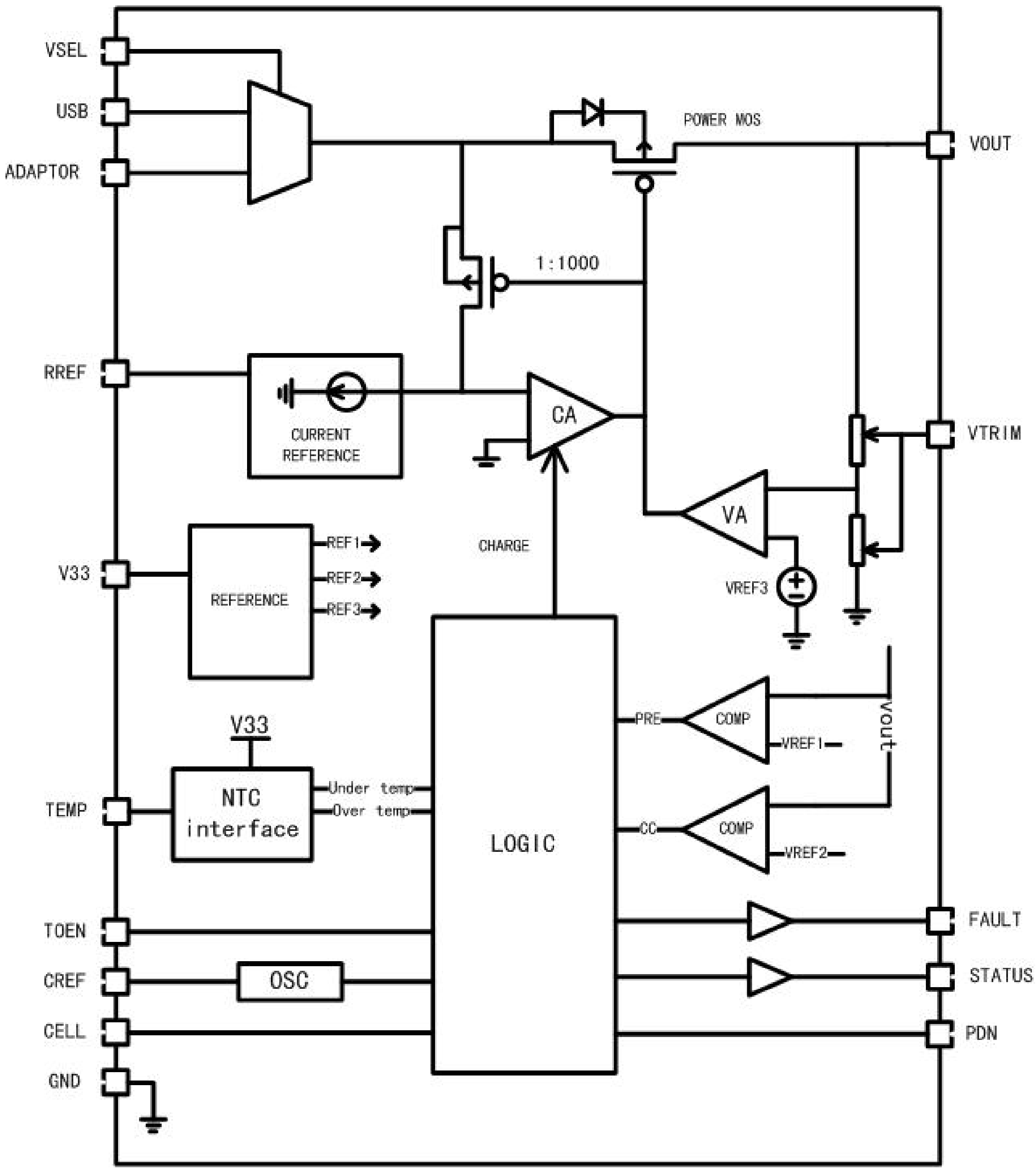

Figure3.1、HB6292 function block

4、 *Pin description*

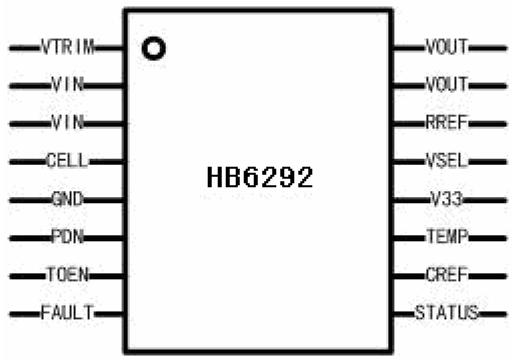

Figure4.1、HB6292 pin assignment

List4.1、HB6292 pin description

NO.	SYMBOL	I/O	DESCRIPTION		
1	VTRIM	-	Trimming of full charged voltage with external resistor		
2&3	VIN	I	Power supply input		
4	CELL	I	Low: two cell application High or unconnected: single cell charge		
5	GND	-	Ground		
6	PDN	I	Low: circuit disabled High or unconnected: circuit enabled		
7	TOEN	I	Low: time limitation disabled High or unconnected: time limitation enabled		
8	FAULT	O	FAULT(GREEN)	STATUS(RED)	DESCRIPTION
9	STATUS	O	0	0	No battery
			0	1	In charging
			1	0	End of charge
			0	PULSE1	Fault condition
			0	PULSE2	Battery temperature abnormal
10	CREF	-	Add external capacitor to determine the oscillation frequency，and provide timing clock		
11	TEMP	I	Feed back of battery temperature		
12	V33	O	3.3V voltage reference，capable of driving 10mA load		
13	VSEL	I	Low: USB input High or unconnected: AC adaptor input		
14	RREF	-	Add resistor to set the charge current		
15&16	VOUT	O	Output		

5、*Absolute maximum ratings*

Supply voltage (VIN)………………-0.3V to 15V

Signal input voltage…………-0.3V to VIN+0.3V

Charge current………………………………800mA

Maximum junction temperature…………+150℃

Maximum storage temperature range…-60℃to +150℃

6、Recommended operating condition

List6.1、HB6292 recommended operating condition

PARAMETER	Min	Typical	Max	Unit	Notes
Supply voltage	4.5	5.0	6.5	V	Single cell
Supply voltage	8.8	10.0	12	V	Two cell
Ambient temperature	-20		70	℃	

7、HB6292 electrical specification

List7.1、HB6292 electrical specification(single cell, Ta=25℃)

PARAMETER	SYM	TEST CONDITION	MIN	TYP	MAX	UNITS
Power-on reset						
Power on voltage	VPOR			3.6		V
Standby model						
VOUT leakage current		VBAT=3.7V			20	uA
VIN supply current		VOUT unconnected、PDN=0		100		uA
		VOUT unconnected、PDN=1 or unconnected		1		mA
Voltage regulation						
Output voltage			4.158	4.20	4.242	V
Dropout voltage				200		mV
Charge current						
CC charge current A	Icc	VRREF>1.3V、VBAT=3.7V	540	600	660	mA
Precharge current A	Ipre	VRREF>1.3V、VBAT=2.0V		75		mA
CC charge current B	Icc	VRREF<0.4V、VBAT=3.7V			100	mA
Precharge current B	Ipre	VRREF<0.4V、VBAT=2.0V		12		mA
CC charge current C	Icc	RREF=35K、VBAT=3.7V		600		mA
Precharge current C	Ipre	RREF=35K、VBAT=2.0V		75		mA
Recharge、precharge threshold						
Precharge threshold	Vpre		2.8	3.0	3.2	V
Recharge threshold	Vrhg			4.10		V
Temperature monitor						
Lower temp threshold		V33=3.3V		1.65		V
Higher temp threshold		V33=3.3V		0.214		V
Foldback threshold			85	100	115	℃
Current foldback gain				100		mA/℃
Oscillator						
Oscillate frequency		CREF=20nF		333		Hz
Oscillate period		CREF=20nF	2.4	3.0	3.6	mS
Logic input and output						

Logic high voltage	VH		2			V
Logic low voltage	VL				0.8	V
STATUS/FAULT loading			5			mA

List7.2、HB6292 electrical specification(two cells, Ta=25℃)

PARAMETER	SYM	TEST CONDITION	MIN	TYP	MAX	UNITS
Power-on reset						
Power on voltage	VPOR			6.4		V
Standby model						
VOUT leakage current		VBAT=7.4V			40	uA
VIN supply current		VOUT unconnected、PDN=0		100		uA
		VOUT unconnected、PDN=1 or unconnected		1		mA
Voltage regulation						
Output voltage			8.316	8.40	8.484	V
Dropout voltage				200		mV
Charge current						
CC charge current A	Icc	VRREF>1.3V、VBAT=7.4V	540	600	660	mA
Precharge current A	Ipre	VRREF>1.3V、VBAT=4.0V		75		mA
CC charge current B	Icc	VRREF<0.4V、VBAT=7.4V			100	mA
Precharge current B	Ipre	VRREF<0.4V、VBAT=4.0V		12		mA
CC charge current C	Icc	RREF=35K、VBAT=7.4V		600		mA
Precharge current C	Ipre	RREF=35K、VBAT=4.0V		75		mA
Recharge、precharge threshold						
Precharge threshold	Vpre		5.6	6.0	6.4	V
Recharge threshold	Vrhg			8.2		V
Temperature monitor						
Lower temp threshold		V33=3.3V		1.65		V
Higher temp threshold		V33=3.3V		0.214		V
Foldback threshold			85	100	115	℃
Current foldback gain				100		mA/℃
Oscillator						
Oscillate frequency		CREF=20nF		333		Hz
Oscillate period		CREF=20nF	2.4	3.0	3.6	mS
Logic input and output						
Logic high voltage	VH		4			V
Logic low voltage	VL				0.4	V
STATUS/FAULT loading			5			mA

8、HB6292 function introduction and pin description

8.1、Introduction of Li-ion/Li polymer battery charge

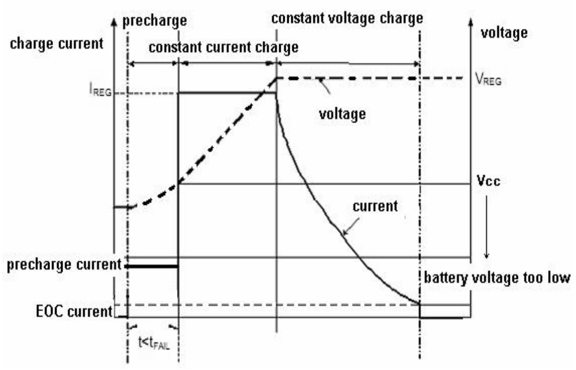

Figure8.1、diagram of Li-ion/Li polymer battery charge procedure

The complete charge cycle can be divided into two stages that is constant current(CC) charge and constant voltage(CV) charge. During CC stage, the charge current is constant, and the battery voltage keeps on rise. As battery voltage rises up to the set point(normally 4.2V), it goes into CV stage, the charge current will come down continually, until the current is below the end of charge(EOC) current. However, during CV charge stage, battery voltage will increase very slowly. If the battery voltage is too low, the HB6292 will provide a small current to pre-charge the battery, the pre-charge current is 1/5 of the CC charge current.

8.2、Charge current setting

RREF is used to set the charge current, the pre-charge current is 1/5 of CC charge current. The charge current is:

$$I_{CC}=\begin{cases}600\text{mA}------------(V_{RREF}>1.3V)\\ \dfrac{1.0V}{(R_{RREF}+5K)}\times 24000-----(R_{RREF})\\ 100\text{mA}------------(V_{RREF}<0.4V)\end{cases}$$

When use USB device as power supply，VSEL is set to low，the charge current is:

$$I_{CC}=\begin{cases}450\text{mA}------------(V_{RREF}>1.3V)\\ \dfrac{1.0V}{(R_{RREF}+5K)}\times 12000-----(R_{RREF})\\ 100\text{mA}------------(V_{RREF}<0.4V)\end{cases}$$

There are three types of current setting method with RREF, RREF can be connected to V33(>1.3V)、GND(<0.4V) and external resistor. The maximum CC charge current of HB6292 is 800mA.

8.3、Voltage setting of different charge stages

While battery voltage is below 3.0V (6.0V for two cell battery), it enters into pre-charge model, the charge current is 1/5 of CC charge current. The full charged battery voltage is 4.2V for one cell battery, and 8.4V for two cell battery. As the charge is done，if the battery voltage drops below 4.1V(8.2V for two cell battery), the charger will recharge the battery.

8.4、Internal oscillator

The internal oscillator establishes a timing reference. The oscillate period is programmable with an external timing capacitor, CREF, as shown in Typical Applications. The oscillator charges the timing capacitor to 1.8V and then discharges it to 1.3V in one period. The period is:

$$T_{osc}=1.5\times 10^5\times C_{CREF}(s)$$

As a 10nF capacitor connected, the oscillation frequency is 666Hz. The accuracy of the period is determined by that of the internal charging current.

8.5、Charge time limitation

As TOEN is connected to high or just unconnected, the total charge time for the CC mode and CV mode is limited to a length of TIMEOUT，the TIMEOUT can be calculated as:

$$T_{timeout}=2^{23}\times T_{osc}$$

A 20nF capacitor leads to 7 hour of TIMEOUT, the charger has to reach the EOC condition before the TIMEOUT, otherwise, a TIMEOUT fault is issued. Two ways to release such condition: either to recycle the input power, or toggle the PDN to disable the charger and then enable it again. Time for TIMEOUT can be changed by connecting different capacitors to CREF. The pre-charge mode has a time limit of 1/8 TIMEOUT. To disable this time limitation, just connect TOEN to ground, but time for pre-charge mode is always limited.

8.6、End-of-charge(EOC) current

During CV mode, the charge current keeps on decrease. As the charge current reduce to 1/10 of CC charge current, an internal EOC signal will be generated, and charge ends.

8.7、Smart battery existence detection

If the battery is removed or just unconnected, the HB6292 will check the output status, and give a signal indicating no battery connected. Pin FAULT and STATUS will be pulled down. While the battery is properly connected again, the HB6292 will go back to the normal work condition.

8.8、Thermal foldback

Over heating is always a concern in a linear charger, the maximum power dissipation usually occurs at the beginning of a charge cycle when the battery voltage is at its minimum but the charge current is at its maximum. The charge current thermal foldback function in the HB6292 frees users from the over-heating concern. As the internal temperature reaches approximately 100℃, a certain amount current will be fed back to the current reference block, and the charge current will reduce at a rate of 100mA/℃.

8.9、Reference voltage

The HB6292 provides a 3.3V voltage for biasing the internal control and logic circuit. This voltage is also available for external circuits such as the NTC thermistor circuit. The maximum allowed external load is 10mA.

8.10、NTC thermistor

The HB6292 uses NTC thermistor to detect the battery temperature. The value of NTC resistor will change with the temperature. Connect the NTC thermistor series with a resistor as figure7.2, the feed back voltage from TEMP will change with the change of the NTC resistance. As the temperature of the battery pack is higher than 48℃, or lower than -10℃, a temperature abnormal indication signal is generated, and pin STATUS will export a periodic signal, the LED connected to STATUS will blink at a fixed frequency. If over temperature detection is not necessary, just replace the NTC thermistor with a normal resistor R2. The value of R2 can be 1/2 that of R1.

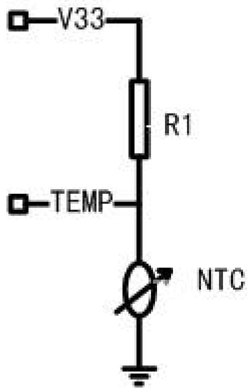

Figure 8.2、NTC application

8.11、Capacitor selection

10uF is recommended for input capacitor;

The output capacitor can range from 1uF to 10uF;

3.3V reference voltage output capacitor is recommended to be larger than 1uF considering the stability of the reference buffer.

9、PCB layout

The input and output capacitors should be put to the side of the input and output pads as close as possible. For area and cost consideration, it is recommended to reduce the PCB dimension. The metal line should be short and wide enough.

10、Package

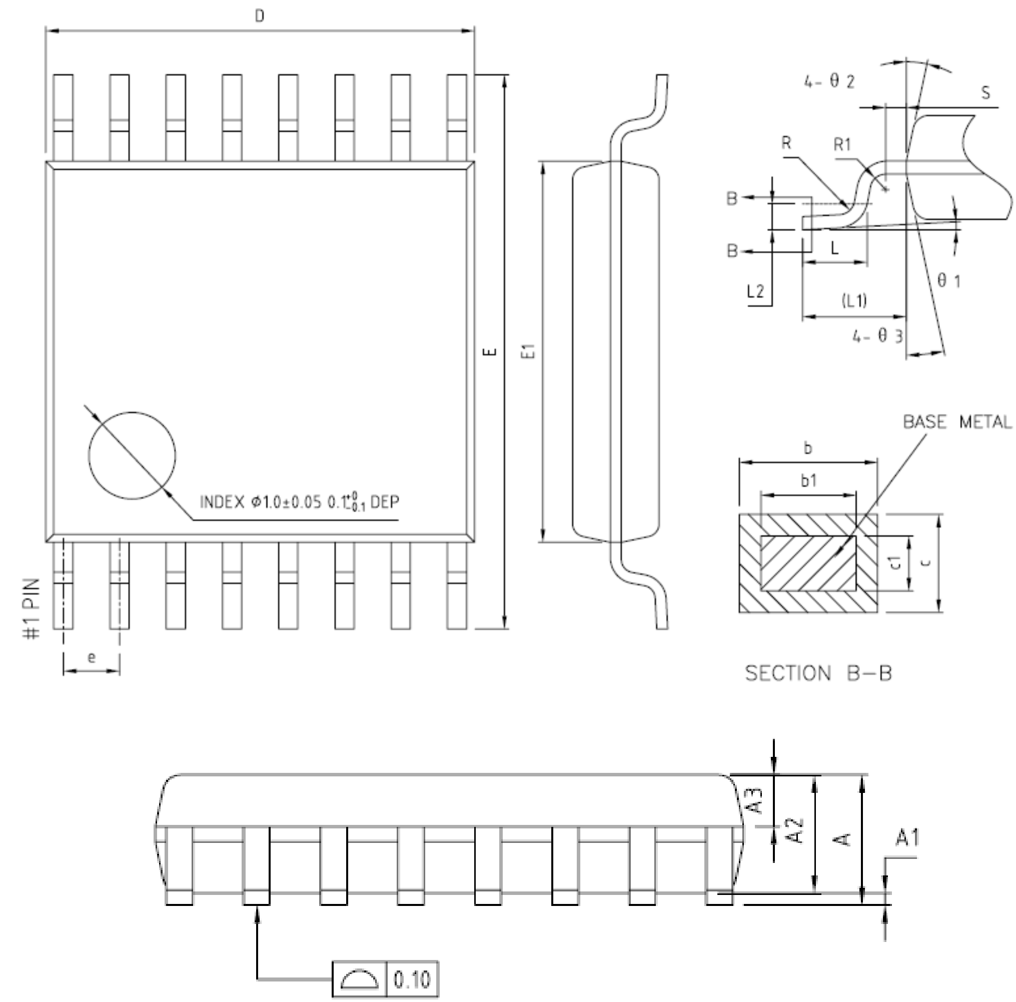

Figure10.1、TSSOP-16 package diagram

COMMON DIMENSIONS
(UNITS OF MEASURE=MILLIMETER)

SYMBOL	MIN	NOM	MAX
A	–	–	1.20
A1	0.05	–	0.15
A2	0.90	1.00	1.05
A3	0.34	0.44	0.54
b	0.20	–	0.28
b1	0.20	0.22	0.24
c	0.10	–	0.19
c1	0.10	0.13	0.15
D	4.86	4.96	5.06
E	6.20	6.40	6.60
E1	4.30	4.40	4.50
e	0.65BSC		
L	0.45	0.60	0.75
L1	1.00REF		
L2	0.25BSC		
R	0.09	–	–
R1	0.09	–	–
S	0.20	–	–
θ1	0°	–	8°
θ2	10°	12°	14°
θ3	10°	12°	14°

Figure10.2、List of TSSOP-16 dimensions