



Description

The HX86308 is a complete constant-current/constant voltage linear charger for single LiFePO₄ battery with high input voltage rating and large current. The largest input voltage is up to 28V and charge current is up to 1A. The input over voltage protection threshold is 6.8V and the lowest input voltage is 3.75V, which can meet the requirement of voltage-adjustment to reduce charging power consumption and improve overall efficiency.

Thermal feedback regulates the charge current to limit the die temperature during high power operation or high ambient temperature. The charge voltage is fixed at 3.5V/3.6V/3.7V, and the charge current can be programmed externally with a single resistor.

The HX86308 automatically terminates the charge cycle when the charge current drops to 1/10 the programmed value after the final float voltage is reached. When the input voltage (supplied by AC adapter or USB power supply) is removed, the HX86308 automatically enters a low current state, decreasing the leakage current to less than 1μA.

Typical Application

Other features of HX86308 include over temperature protection, under voltage lockout, automatic recharge and charging state indication (two LED pins to show charge state and charge-ending state).

Features

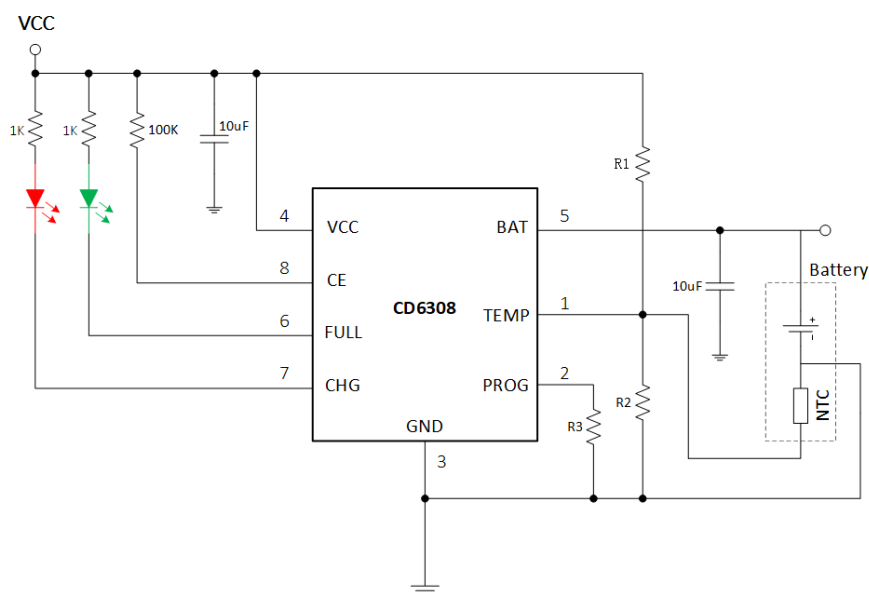
- Maximum Input Voltage Rating up to 28V
- Minimum Input Voltage: 3.75V (Typ.)
- Input Over Voltage Protection : 6.8V (Typ.)
- Maximum BAT withstand voltage up to 20V
- Battery reverse connection protection
- Programmable Charge Current up to 1A
- 1% Charge Voltage Accuracy
- 1/10C Termination Charge Current
- Float Charge Voltage : 3.5V, 3.6V, 3.7V
- Thermal Regulation to Maximize Charge Rate Without Risk of Overheating.
- Charging status and fault status indication
- Battery Temperature Monitoring.
- Chip Enable Input
- Trickle charge threshold: 1.9~2.1V
- Soft-start and surge current limit
- Available in SOT23-5L/ ESOP-8 / DFN2X2-8L / DFN3X3-8L package

Applications

- Cellular telephones
- Portable electronic devices
- Solar Lantern
- Low cost and small size chargers



Typical Application Circuit

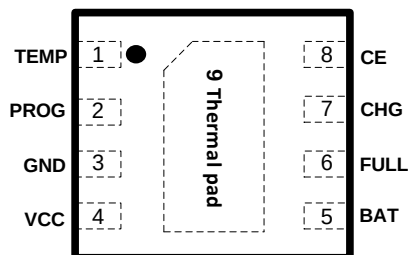


Order Information

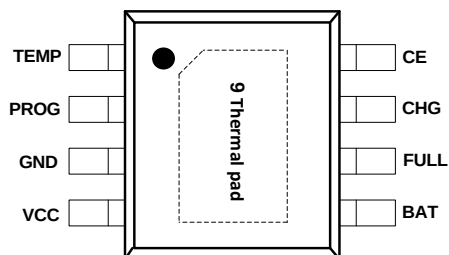
Part No.	Package	V _{FLOAT}	SPQ
HX86308-AARS	SOT23-5L	3.5V	3000
HX86308-ABRS	SOT23-5L	3.6V	3000
HX86308-ACRS	SOT23-5L	3.7V	3000
HX86308-BARS	ESOP-8	3.5V	4000
HX86308-BBRS	ESOP-8	3.6V	4000
HX86308-BCRS	ESOP-8	3.7V	4000
HX86308-DARS	DFN2X2-8L	3.5V	4000
HX86308-DBRS	DFN2X2-8L	3.6V	4000
HX86308-DCRS	DFN2X2-8L	3.7V	4000



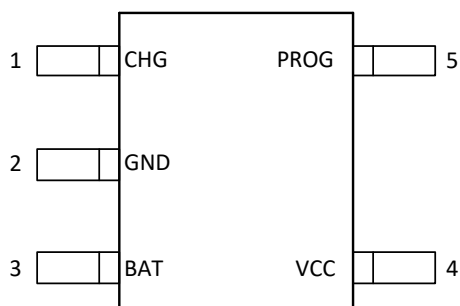
Pin Assignment And Description



DFN2X2-8L
(Top view)



ESOP-8
(Top view)



SOT23-5L
(Top view)

Pin No.		Name	Input/Output	Function
ESOP8 DFN2X2-8L	SOT23-5L			
1		TEMP	I	Battery temperature detection and protection input pin. The higher threshold is 0.8*VCC and lower threshold is 0.45*VCC. If it is not used, please pull it low to ground.
2	5	PROG	I	Charge current setting, charge current monitor, and shut down pin. The charging current is given by $I_{BAT} = 1000/R_{PROG}(A)$. Please choose 1% precision resistor for R_{PROG} .
3	2	GND	G	Ground
4	4	VCC	P	Power Supply
5	3	BAT	O	Charge Current Output. Provides charge current to the battery and regulates the final float voltage to 4.2V, 4.35V and 4.4V.
6		FULL	O	Open-Drain Charge termination indicated pin. When charge is terminated, it is pulled low, otherwise it is high impedance.
7	1	CHG	O	Open-Drain Charge Status Output. When the battery is charging, the CHG pin is pulled low. When the charge cycle is completed or VCC is removed, the CHG is forced high impedance.



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8		CE	I	Charge enable pin. High or floating is enabled, low is disabled.
9		Thermal pad	/	Connected to GND plane for heat sink function.

Absolute Maximum Ratings (at TA = 25°C)

SYMBOL	ITEMS		VALUE	UNIT
V _{CC}	Input voltage		-0.3~28	V
V _{BAT}	BAT voltage		-5~20	V
V _{PIN1}	CHG / FULL / CE voltage		-0.3~28	V
V _{PIN2}	TEMP / PROG voltage		-0.3~7	V
I _{BAT}	BAT Pin current		1200	mA
P _D	Maximum Power Dissipation	ESOP-8	1.8	W
		DFN2x2-8L	1	W
		SOT23-5L	0.5	W
R _{θJA}	Junction to Ambient Thermal Resistance	ESOP-8	55	°C/W
		DFN2x2-8L	100	°C/W
		SOT23-5L	270	°C/W
T _J	Junction Temperature		-40~150	°C
T _A	Ambient Temperature		-40~85	°C
T _{STG}	Storage Temperature		-55 to 150	°C
T _{SOLDER}	Package Lead Soldering Temperature		260°C, 10s	

Note 1: Stresses beyond those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

Recommended Operating Condition

Symbol	Description	Min.	Typical	Max	Units
V _{CC}	Input Voltage Range	3.75		25	V
I _{BAT}	Charge Current Range	100		1000	mA
R _{PROG}	CC mode charge current programming resistor	1		10	KΩ



Standalone LiFePO4 Battery Charger HX86308

Electrical Characteristics

The following specifications apply for $V_{CC}=5V$ $T_A=25^{\circ}C$, unless specified otherwise.

SYMBOL	PARAMETER	CONDITIONS	MIN	TYP.	MAX	UNITS
V_{CC}	Input voltage range		3.75	5	25	V
I_{CC}	Input Supply Current	Charge Mode, $R_{PROG} = 10K$		200		μA
		Standby Mode (Charge Termination) $V_{BAT}=4.0V$		150		μA
		Shutdown Mode ($CE=0$)		5		μA
V_{FLOAT}	Float Voltage	$I_{BAT} = 30mA$, $R_{PROG} = 10K$, $V_{FLOAT}=3.5V$	3.465	3.5	3.535	V
		$V_{FLOAT}=3.6V$	3.564	3.6	3.636	V
		$V_{FLOAT}=3.7V$	3.663	3.7	3.737	V
I_{BAT}	BAT Pin Current	Charge Mode ($R_{PROG}=2K$)	450	500	550	mA
		Charge Mode ($R_{PROG}=1K$)	900	1000	1100	mA
		Standby Mode (Charge Termination) $V_{BAT}=4.0V$		4		μA
		Shutdown Mode ($CE=0$)			1	μA
I_{TRIKL}	Trickle Charge Current	$V_{BAT}<V_{TRIKL}$, $R_{PROG}=2K$		50		mA
V_{TRIKL}	Trickle Charge Threshold Voltage	$R_{PROG}=2K$, V_{BAT} Rising, $V_{FLOAT}=3.5V$	1.7	1.9	2.1	V
		$V_{FLOAT}=3.6V$	1.8	2.0	2.2	V
		$V_{FLOAT}=3.7V$	1.89	2.1	2.31	V
V_{TRHYS}	Trickle Charge Hysteresis Voltage	$R_{PROG}=2K$		100		mV
V_{UV}	UVLO Threshold	V_{CC} from low to high		3.5	3.75	V
V_{UVHYS}	UVLO Hysteresis	V_{CC} from high to low		310		mV



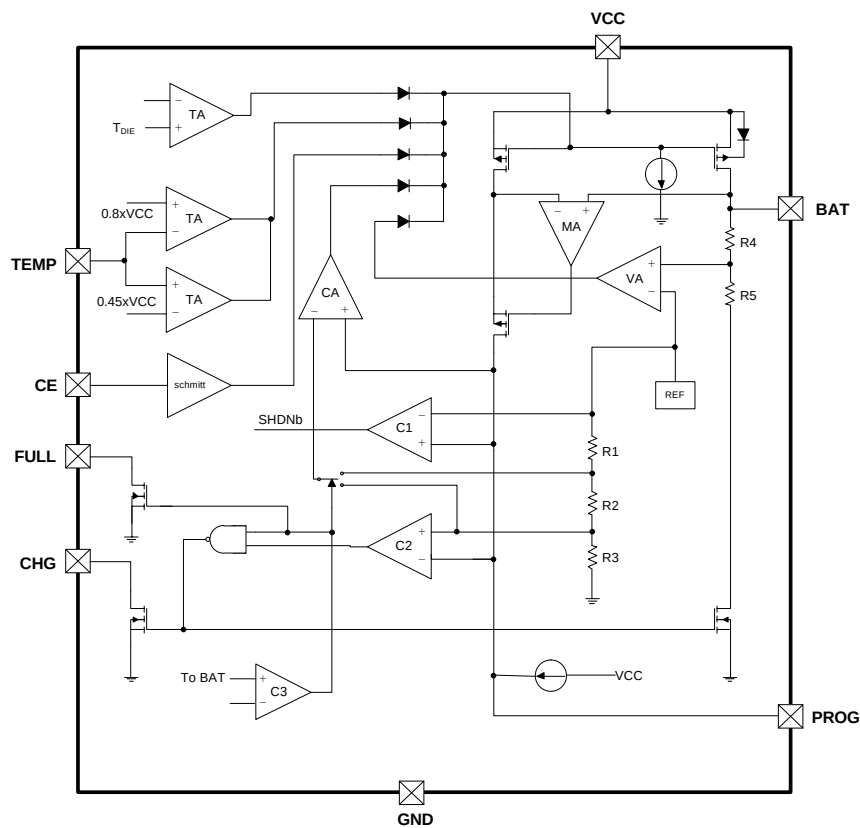
Electrical Characteristics (Continued)

The following specifications apply for $V_{CC}=5V$ $T_A=25^{\circ}C$, unless specified otherwise.

SYMBOL	PARAMETER	CONDITIONS	MIN	TYP.	MAX	UNITS
V_{ASD}	V _{CC} -V _{BAT} Lockout Threshold Voltage	V _{CC} Rising		320		mV
		V _{CC} Falling		130		mV
I_{TERM}	C/10 Termination Current Threshold	R _{PROG} =2K		50		mA
		R _{PROG} =1K		100		mA
V_{PROG}	PROG Pin Voltage	R _{PROG} =2K, CC Charge Mode		1.5		V
V_{CHG}	CHG Pin Output Low Voltage	I _{CHG} = 5mA			0.4	V
V_{FULL}	FULL Pin Output Low Voltage	I _{FULL} = 5mA			0.4	V
V_{CE-H}	CE Pin Input High Voltage	CE Rising	1.5			V
V_{CE-L}	CE Pin Input Low Voltage	CE Falling			0.4	V
V_{TEMP-H}	TEMP Pin High Turn Over Voltage			80		%VCC
V_{TEMP-L}	TEMP Pin Low Turn Over Voltage			45		%VCC
ΔV_{RECHRG}	Auto Recharge Battery Voltage	V _{FLOAT} - V _{RECHRG}		130		mV
T_{LIM}	Thermal regulation Mode			130		°C
V_{OVP}	OVP Threshold		6.7	6.8	7.1	V
	OVP Threshold Hysteresis			250		mV
$t_{RECHARGE}$	Recharge Comparator Filter Time	V _{BAT} High to Low		1		ms
t_{TERM}	Charge Terminated Filter Time	I _{BAT} drops below I _{CHG} /10		1		ms
t_{SS}	Soft-start Time			120		μs

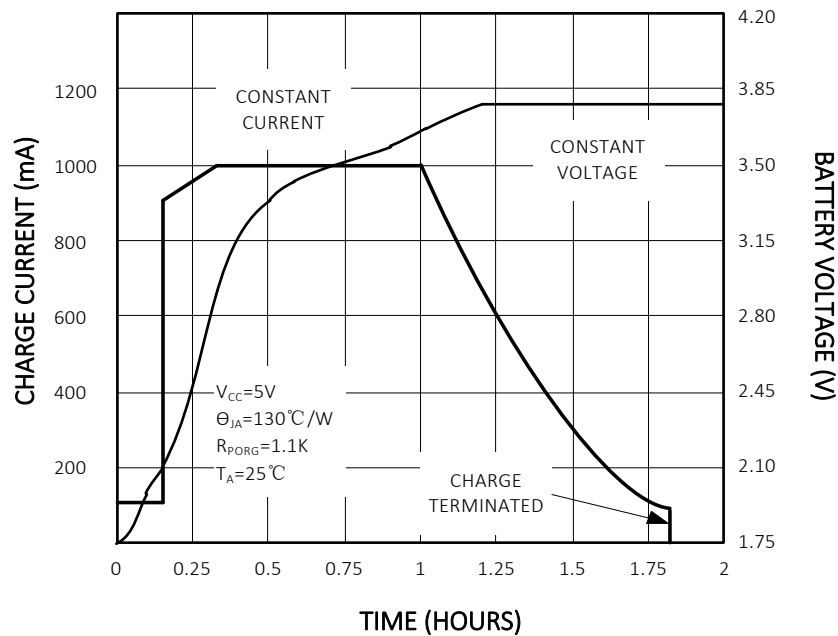


Block Diagram



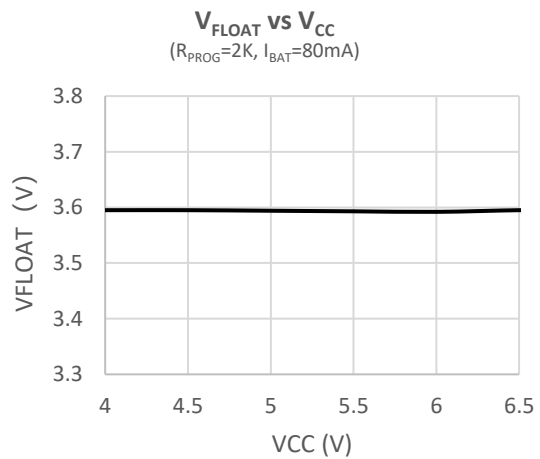
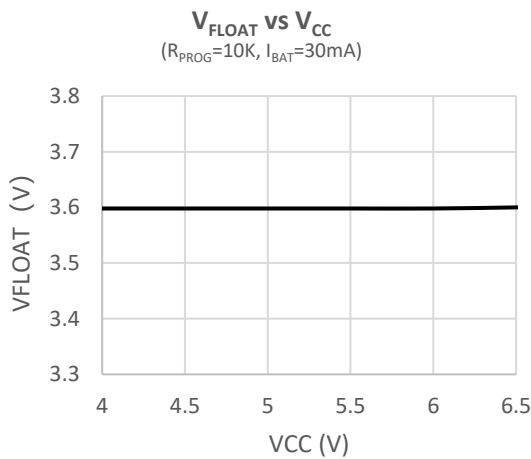
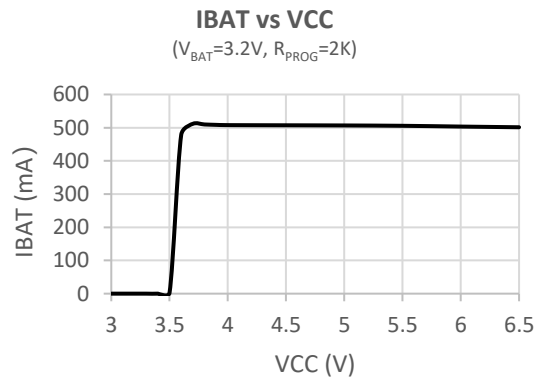
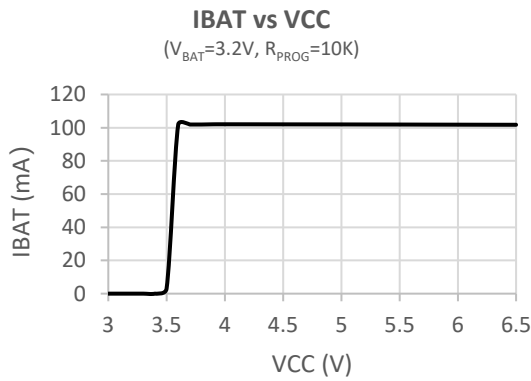
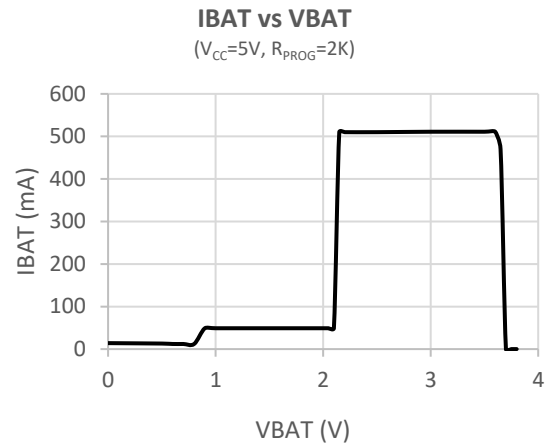
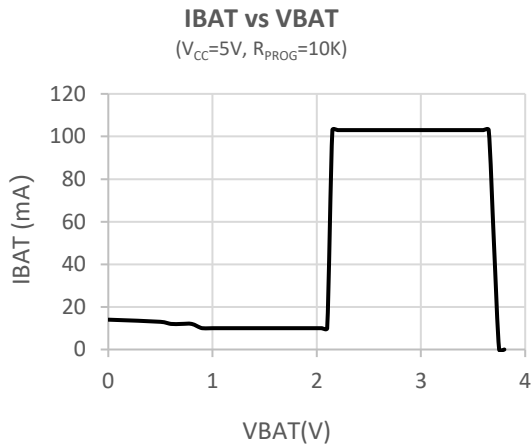
Typical Performance Curve

Typical Charging Curve





Typical Characteristics





Application Information

The HX86308 is a single cell LiFePO4 battery linear charger using a constant-current / constant-voltage algorithm. Charging current can be programmed with external resistor and maximum continuous charging current is up to 1A. The HX86308 contains two open-drain indicators for the charge status indicate, one is CHG (charging status), and the other is FULL (full-charged status). FULL can be also used to indicate status. Inner temperature management circuit can automatically decrease charging current when Junction Temperature is over T_{LIM} . This function can maximize the load capacity of the chip and prevent the damage to chip or external component caused by over-temperature.

The HX86308 begins a charge cycle when the voltage at the VCC pin rises above the UVLO threshold level. Thus, the CHG pin is pulled low, which means charging is in progress. If the BAT pin is less than the V_{TRIKL} , the charger enters trickle charge mode. In this mode, the HX86308 supplies approximately 1/10 the programmed charge current to bring the battery voltage up to a safe level for full current charging. When the BAT pin voltage rises above the V_{TRIKL} , the charger enters constant-current mode, where the programmed charge current is supplied to the battery. When the BAT pin approaches the final float voltage, the HX86308 enters constant-voltage mode and the charge current begins to decrease. The charging cycle terminates when the charging current drops to charging-over threshold. Under this condition, output of CHG is in high-impedance state while output of FULL is in low potential.

Charging-over threshold is 10% of constant charging current. A new charging cycle is started when battery voltage drops below recharging voltage threshold. High-accuracy inner reference voltage source makes sure a float voltage accuracy of 1%, which meets the requirements of Li-ion and Li-polymer battery. The charger enters sleeping mode with low power consumption when input voltage drops or lower than battery voltage. In this mode, current consumed by battery is lower than 1uA, which helps to increase standby time. The charger stops charging when enable input CE is connected to low level.

Input Overvoltage Protection

The HX86308 has built-in input voltage surge protection as high as +28V. The charger cycle will be automatically closed when the input voltage is higher than 6.8V to avoid high-voltage damage and reworks when input voltage is below 6.8V.

Setting of Charging Current

The charge current is set by a resistor connecting between the PROG pin and GND. The relationship of the charging current and the programming resistance is established by the following equations:

$$R_{PROG} = \frac{1000}{I_{BAT}}$$

In applications, R_{PROG} could be selected according to requirements. Relationship between R_{PROG} and charge current could be as follow:

R_{PROG} (K)	I_{BAT} (mA)
25	40
16.6	60
8.3	120
4.2	240
3.33	300



Standalone LiFePO4 Battery Charger HX86308

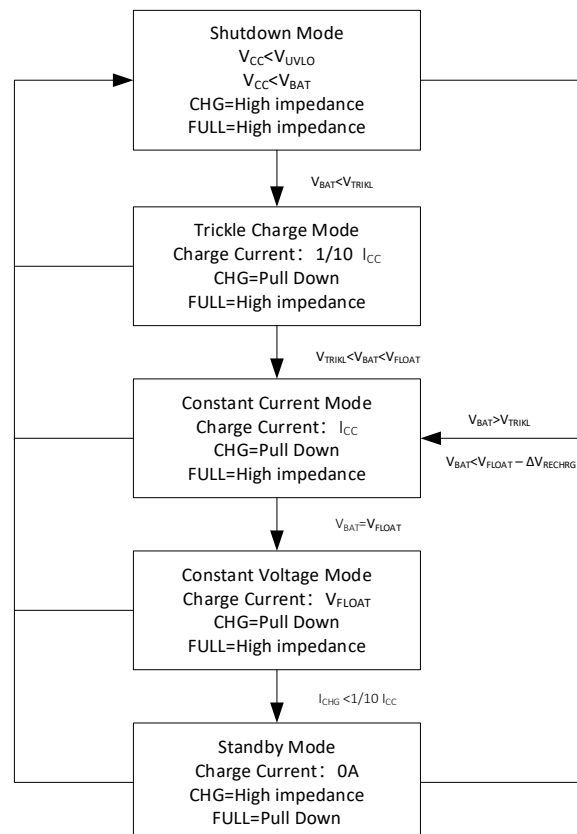
2.5	400
1.66	600
1.43	700
1.25	800
1.11	900
1	1000

Charging Termination

A charge cycle is terminated when the charge current falls to 1/10th the programmed value after the final float voltage is reached. When the time that PROG pin voltage falls below 150mV (typ.) is longer than T_{TERM} and charging cycle is terminated. Then HX86308 enters standby mode, and input current drops to 150uA (typ.).

The chip has designed the function of preventing the false turn off caused by the load transient jump. 1ms T_{TERM} on Terminating Comparator prevents the early termination caused by load transient. Once the average charging current drops to 1/10 of the preset value and ends the charge cycle. No more current is outputted to BAT. Under this state, all load of BAT is powered by battery.

In standby mode, HX86308 keeps monitoring voltage of BAT pin. When BAT pin voltage drops below V_{RECHRG} (recharge threshold Voltage), another charge cycle starts and supplies current to power again. PIC 1 shows a typical charging cycle.



PIC 1: A Typical Charging Cycle

Charge Status Indicator (CHG and FULL)

HX86308 has two different open-drain status outputs of charge status, one is CHR, and the other is FULL. If those two outputs are connected to LED light, light goes on when the pin to pull low and light goes off



when high impedance.

Battery temperature monitor works when typical connection of TEMP pin is used. No-battery pulse signal is outputted by CHG pin if battery is not connected to charger. CHG and FULL pin will be in high-impedance state if battery temperature is out of normal range.

Battery temperature monitor doesn't work if TEMP is connected to GND. No-battery pulse signal is outputted by CHG pin if battery is not connected to charger.

When the external capacitance of BAT pin is 10uF, flash frequency of CHG is 0.25Hz-1Hz. The output of status indicator should be connected to GND, when status indicator function is not used.

Refer to the following table for the function of status indication:

PIN	STATUS	FULL	CHG	Description
VCC	$V_{CC} < V_{UVLO}$	OFF	OFF	Fault
	$V_{CC} < V_{BAT} + V_{ASD}$	OFF	OFF	Fault
	$V_{BAT} + V_{ASD} \leq V_{CC} < OVP$	OFF	ON	Charging
	$V_{CC} \geq OVP$	OFF	OFF	Fault
	VCC Floating	OFF	OFF	No-charging
VBAT	$V_{BAT} < V_{TRIKL}$	OFF	ON	Charging
	$V_{BAT} \geq V_{TRIKL}$	OFF	ON	Charging
	$V_{BAT} > V_{CC} - V_{ASD}$	OFF	OFF	Fault
	BAT short-circuit	OFF	ON	Charging
	BAT Floating	Flash	Flash	No battery
IBAT	$I_{BAT} = 0$	ON	OFF	Charging End
	$0 < I_{BAT} < 1/10C$	Flash	Flash	No battery
	$I_{BAT} > 1/10C$	OFF	ON	Charging
PROG	PROG floating, then VCC powers on	OFF	ON	No-charging
	PROG floating when charging	OFF	ON	Current interruption
PROG	PROG short circuit, then VCC powers on	OFF	OFF	Fault
	PROG short circuit during charging	Slightly light	Slightly light	Charging
CE	CE=0	OFF	OFF	No-charging

Thermal Limit

If the chip temperature is above preset T_{LIM} , an inner thermal reflective circuit will decrease charging current. This function can prevent HX86308 from overheating and damage caused by increase load capacity.

Charging current can be set according to typical (not the worst) ambient temperature on the premise that the charger will automatically reduce the current under the worst conditions.



Battery Temperature Monitoring

To prevent damage to battery caused by too high or too low temperature, the HX86308 integrates battery temperature monitoring circuit. It monitors temperature by measuring the voltage of TEMP pin. The voltage is developed by a NTC thermistor and an external voltage divider, which is showed by typical application circuit.

HX86308 compares this voltage against its internal V_{LOW} and V_{HIGH} to make sure if the battery temperature exceeds normal range. Inner HX86308, V_{LOW} is fixed at $45\% \times V_{CC}$ (K_1) and V_{HIGH} is fixed at $80\% \times V_{CC}$ (K_2). The charging cycle will be suspended when $V_{TEMP} < V_{LOW}$ or $V_{TEMP} > V_{HIGH}$, which means battery temperature is too high or too low. The charging cycle will continue if V_{TEMP} is in the range of V_{LOW} and V_{HIGH} .

The battery temperature monitoring function will be forbidden if the TEMP pin is connected to ground.

Determining the Value of R_1 and R_2

The values of R_1 and R_2 shall be determined according to the temperature monitoring range of the battery and the resistance value of the thermistor. Examples are as follows: If the preset battery temperature is from T_L to T_H , ($T_L < T_H$) and the negative temperature coefficient (NTC) thermistor is used, R_{TL} means the resistance of T_L and R_{TH} means the resistance of T_H . Then $R_{TL} > R_{TH}$. Therefore, in T_L , the voltage of TEMP is:

$$V_{TEMP_L} = \frac{R_2 || R_{TL}}{R_1 + R_2 || R_{TL}} \times V_{IN}$$

In T_H , the voltage of TEMP is:

$$V_{TEMP_H} = \frac{R_2 || R_{TH}}{R_1 + R_2 || R_{TH}} \times V_{IN}$$

Then, according to

$$V_{TEMP_L} = V_{HIGH} = K_2 \times V_{CC} \quad (K_2 = 0.8)$$

$$V_{TEMP_H} = V_{LOW} = K_1 \times V_{CC} \quad (K_1 = 0.45)$$

We get equals below:

$$R_1 = \frac{R_{TL} R_{TH} (K_2 - K_1)}{(R_{TL} - R_{TH}) K_1 K_2}$$

$$R_2 = \frac{R_{TL} R_{TH} (K_2 - K_1)}{R_{TL} (K_1 - K_1 K_2) - R_{TH} (K_2 - K_1 K_2)}$$

Similarly, if there is a positive temperature coefficient (PTC) thermistor, according to $R_{TL} < R_{TH}$, we get the equals below:

$$R_1 = \frac{R_{TL} R_{TH} (K_2 - K_1)}{(R_{TH} - R_{TL}) K_1 K_2}$$

$$R_2 = \frac{R_{TL} R_{TH} (K_2 - K_1)}{R_{TH} (K_1 - K_1 K_2) - R_{TL} (K_2 - K_1 K_2)}$$

It can be seen from the above derivation that the temperature range to be set is independent of the power voltage V_{CC} . and only related to R_1 , R_2 , R_{TH} , R_{TL} . R_{TH} , R_{TL} can be obtained from relevant battery manual

or through experimental tests. In application, R_2 can be ignored if we only focus on temperature characteristics at one end, like over-heating protection. Then we will only focus on R_1 and the derivation of R_1 will be easier, which won't be given details.

Examples of TEMP Resistance Calculation:

TEMPL=-7°C, TEMPH=50°C, As known:

TS1 (K_1)	0.45	Inner Set
TS2 (K_2)	0.8	Inner Set

Entry the values of NTC resistance:

(Check the manual of MuRata NCP15XH103F03RC)

R_{TL}	37, 073.00	-7°C
R_{TH}	4, 161.00	50°C
$R_{25°C}$	10, 000.00	

Calculation Results:

R_1	4, 556.87
R_2	35, 857.20

Under-voltage Lockout

Build-in under voltage lockout circuit monitors the input voltage and keeps the charger in shutdown mode until VCC rises above the under-voltage lockout threshold. If the UVLO comparator is tripped, the charger will not come out of shutdown mode until VCC rises V_{ASD} above the battery voltage.

Automatic Recharge

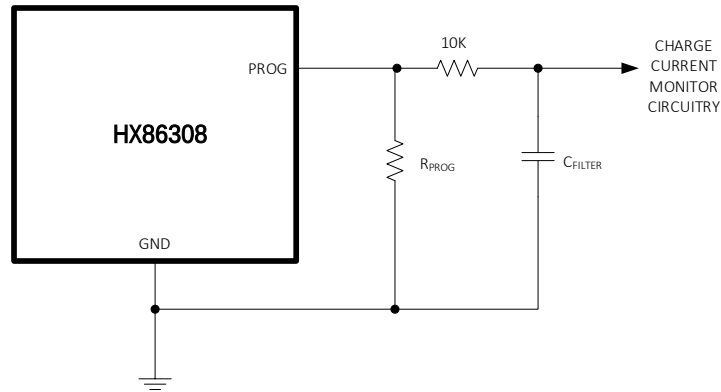
Once the charging cycle is terminated, the HX86308 uses a filtering time Comparator ($t_{RECHARGE}$) to monitor the voltage on the BAT pin. Once battery voltage drops below ΔV_{RECHRG} (Almost 80% to 90% of Battery capacity), charging cycle reworks, which makes sure the battery is kept in full-charged (or almost full-charged) state and avoids starting a periodic charging cycle. In recharging cycle, the output of CHG pin enters a strong pull-down state.

Consideration of Stability

Under constant current mode, it is the PROG pin not the battery that in the feedback loop. The stability of constant-current mode is affected by impedance of PROG pin. When there is no additional capacitance on the PROG pin, the maximum allowable resistance value of the preset resistance will be reduced. The maximum resistance value can be calculated by the equals below:

$$R_{PROG} \leq \frac{1}{2\pi \times 10^5 \times C_{PROG}}$$

For user, they are more interested in charging current instead of transient current. For example, if a switch power supply working in low current mode is parallel connected to battery, the average current flowing from the BAT pin is usually more important than the transient current. In this condition, a simple RC filter on prog PIN can be used to measure the average current (Showed by PIC 2). An additional 10k resistance is added between PROG pin and filter capacitor to ensure stability.



PIC 2: Charge current monitor circuit

Thermal Design

Due to the small package dimension of ESOP8, an elaborate thermal design of PCB layout, which is used for increasing usable charging current to maximum extent, is very important. The heat radiation circuit, used to dissipate the heat generated by IC, runs from chip to lead frame, and arrives PCB copper foil (which is an auxiliary radiator) through radiator below. The measure of copper foil, connected to radiator, should be as large as possible and stretch out to external larger copper foil to spread the heat to surrounding environment. The holes placed on the middle layer or back copper foil layer are also useful in improving the overall thermal performance of the charger. When designing PCB layout, other heat sources in the circuit board not related to the charger must also be considered. Because they will also have an impact on the overall temperature rise and the maximum charging current.

Soft start for charging current

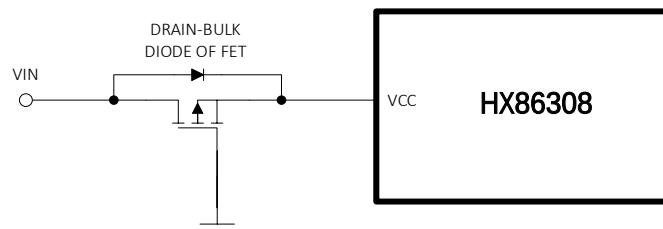
A soft-start circuit is designed to decrease inrush current to maximum extent at the beginning of charging cycle. When a charging cycle starts, the charging current will rise from 0 to the max in around 120 μ s(typ.), which can decrease the load of transient current to the maximum.

Protection of Reverse Connection of Battery

In HX86308, a reversed-connection protection circuit is designed to avoid the damage to chips caused by reverse connection of battery during production and assembly.

Reverse Polarity Input Voltage Protection

In some applications, reverse polarity voltage protection of VCC is necessary. A series isolating diode can be used if power voltage is high enough. Under other conditions that need to keep low voltage, a P channel MOSFET can be chose (Shown by PIC 3)..



PIC 3: VCC Reverse Protection

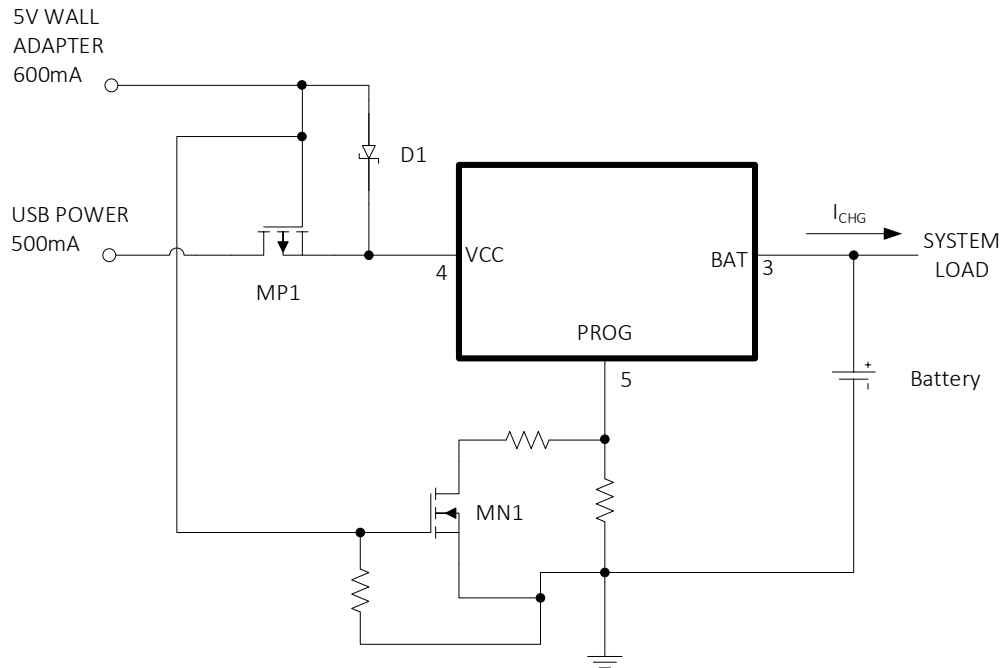


Standalone LiFePO4 Battery Charger HX86308

USB and AC adapter Power Supply

HX86308 allows charging from an AC adapter or an USB port. PIC 4 shows a real example of how to combine AC adapter with USB. A P channel MOSFET (MP1) is used to prevent signal enters USB port when AC adapter is connected. A Schottky diode is used to prevent USB power consumption when it passes 1K pull-down resistor.

Generally, current supplied by AC adapter is larger than that supplied by USB, which limiting value is 500mA. Therefore, when AC adapter is connected, a N channel MOSFET (MN1) and an additional 10K pre-set resistance are used to increase charging current to 600mA.



PIC 4: Combination of AC adapter and USB power supply



Package Description

ESOP-8

Package	ESOP-8	Devices per reel	4000PCS	Unit	mm
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Package Dimension:

SECTION B-B

NOTES:
ALL DIMENSIONS REFER TO JEDEC STANDARD MS-012 AA
DO NOT INCLUDE MOLD FLASH OR PROTRUSIONS.

SYMBOL	MILLIMETER			SYMBOL	MILLIMETER		
	MIN	NOM	MAX		MIN	NOM	MAX
A	/	/	1.77	D	4.7	4.9	5.1
A1	0.08	0.18	0.28	E	5.8	6	6.2
A2	1.2	1.4	1.6	E1	3.7	3.9	4.1
A3	0.55	0.65	0.75	e	1.27BSC		
b	0.37	0.4	0.44	L	0.5	0.65	0.8
b1	0.36	0.39	0.43	L1	1.05BSC		
c	0.21	-	0.26	theta	0	-	8°
D1	3.1	3.3	3.5	E2	2.2	2.4	2.6

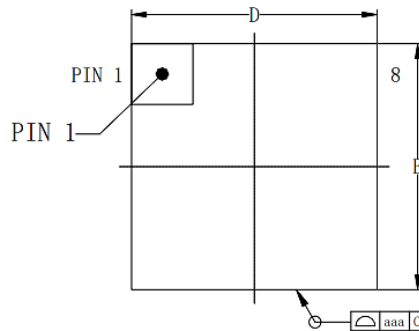


Standalone LiFePO4 Battery Charger HX86308

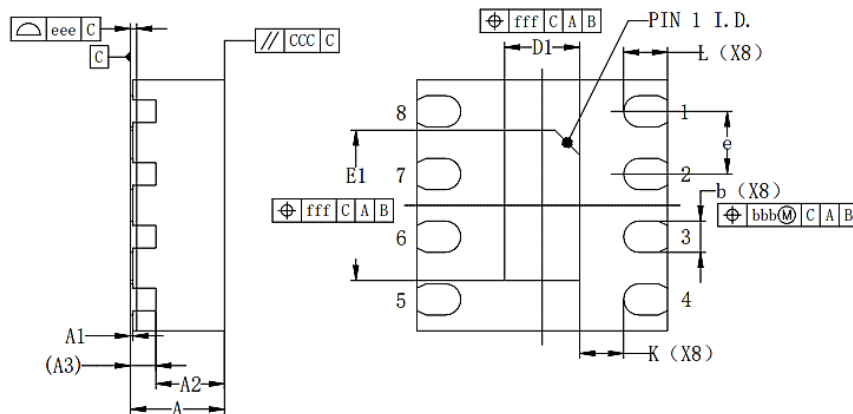
DFN2X2-8L

Package	DFN2x2-8L	Devices per reel	4000PCS	Unit	mm
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Package Dimension:



TOP VIEW



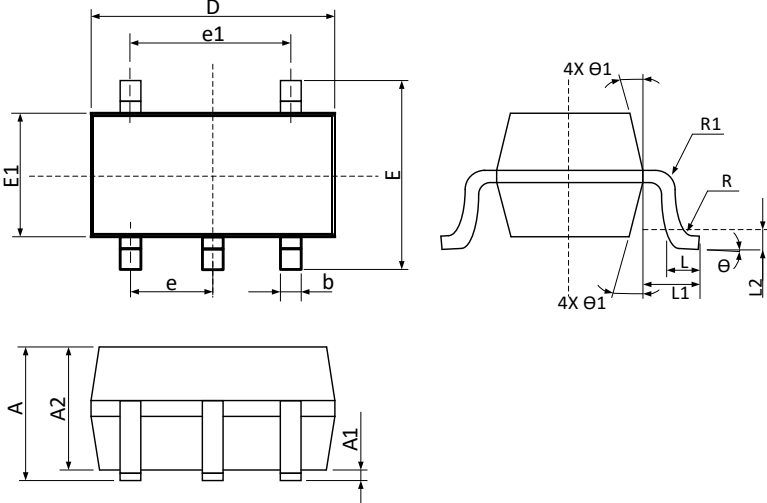
SIDE VIEW

BOTTOM VIEW

SYMBOL	MILLIMETER			SYMBOL	MILLIMETER		
	MIN	NOM	MAX		MIN	NOM	MAX
D	2.0 BSC			b	0.20	0.25	0.30
E	2.0 BSC			L	0.30	0.35	0.40
D1	0.50	0.60	0.70	e	0.50 BSC		
E1	1.10	1.20	1.30	K	0.35 REF		
A	0.70	0.75	0.80	aaa	0.10		
A1	0	0.02	0.05	bbb	0.10		
A2	/	0.55	/	ccc	0.10		
A3	0.203 REF			eee	0.05		
				fff	0.10		



SOT23-5L

Package	SOT23-5L	Devices per reel	3000Pcs	UNIT	mm
Package Dimension:					
					
UNIT: mm					
SYMBOL	MIN	TYP	MAX		
A	-	-	1.35		
A1	0.00	-	0.15		
A2	1.00	1.10	1.20		
b	0.35 REF				
D	2.82	2.92	3.02		
E	2.60	2.80	3.00		
E1	1.50	1.60	1.70		
e	0.95 REF				
e1	1.90 REF				
L	0.30	0.45	0.60		
L1	0.60 REF				
L2	0.25 REF				
R	0.10	-	-		
R1	0.10	-	0.25		
θ	0°	4°	8°		
θ1	5°	10°	15°		