鸿芯科科技
Hxk Technology

HX8808E

High Efficiency, 3A, Multi-Cells Li-Ion Battery Charger

Parameters Subject to Change Without Notice

DESCRIPTION

The HX8808E is a buck boost converter targets HVDC fast charging system.

The HX8808E supports 1 to 4 cells Li-ion battery, the full charge voltage and charge current can be programmed through external resistor.

The HX8808E implements the Buck Boost converter with an H-bridge. The integrated low R_{DS}(on) MOSFET minimizes physical footprint, maximizescharge efficiency. Built-in loop compensation simplifies the circuit and design. PFM is engaged to maintain high efficiency at light load current.

HX8808E guarantees robustness with thermal protectionand battery under voltage lockout.

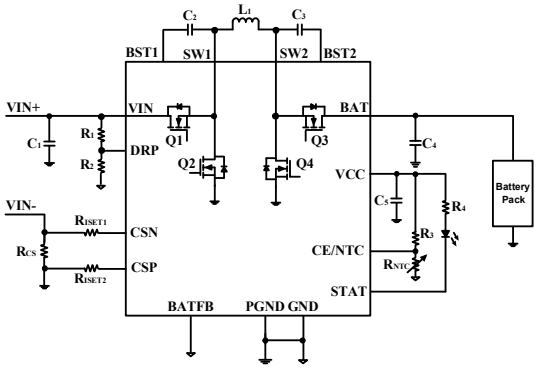
FEATURES

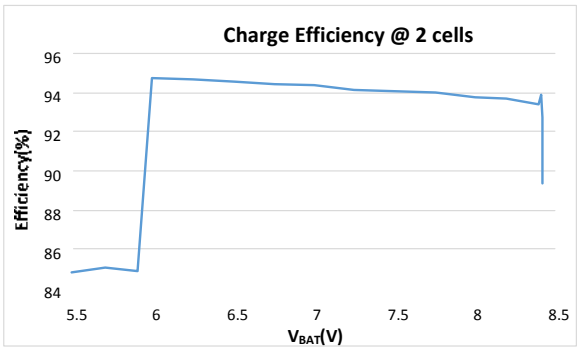
- Integrate low R_{DS}(on) power MOSFET
- Wide input range:4.2V-21.0V,support 1 to 4 cells battery charge
- Full charge voltage:1.2V-17V through external resistor or selectable by BATFB pin
- High efficiency buck-boost transition
- 450kHz Switching frequency
- Programmable charge current, up to 3A
- Quiescent current: <5uA
- Integrate batteryshort protection
- Integrate thermal protection
- QFN3*4 package

APPLICATIONS

- Power bank systems
- Battery and supercapacitor charging
- USB power delivery
- Industrial applications
- Automotive systems

TYPICAL APPLICATION





ORDER INFORMATION

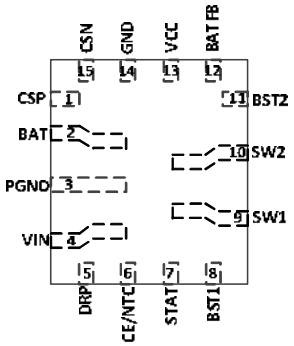
DEVICE[1)]	PACKAGE	TOP MARKING[2)]
HX8808E	DFN3X4-15	EEOEE XXXX

Notes: XX XX

Week code
Year code

PIN CONFIGURATION

TOP VIEW



ABSOLUTE MAXIMUM RATING[1)]

VIN,BAT, SW1, SW2 Pin .....-0.3V to24V
BST1-SW1, BST2-SW2 .....-0.3V to 6.5V
All Other Pins .....-0.3V to 6.5V
JunctionTemperature[2)3)] 150ºC
Lead Temperature 260ºC
Storage Temperature ..... -65ºC to +150ºC
ESD Susceptibility (Human Body Model) 2kV

RECOMMENDED OPERATING CONDITIONS

Input Voltage VIN .....4.2V to 21V
Battery Voltage VBAT .....3.0V to 17V
Operation Junction Temp (T_J) .....-40ºC to +125ºC

THERMAL PERFORMANCE[4)]

	θ_{JA}	θ_{JC}
QFN3X4-15	48	11ºC/W

Note：

1) Exceeding these ratings may damage the device.

2) The HX8808E guarantees robust performance from -40°Cto 150°C junction temperature.The junction temperature range specification is assured by design,characterization and correlation with statistical process controls.

3) The HX8808E includes thermal protection that isintendedto protect the device in overload conditions. Thermal protection is active when junctiontemperature exceedsthe maximum operating junction temperature. Continuous operation over the specified absolutemaximum operating junction temperature may damagethe device.

4) Measured on JESD51-7, 4-layer PCB.

ELECTRICAL CHARATERISTICS

VIN=5V, TA=25℃, unless otherwise stated

Item	Symbol	Condition	Min.	Typ.	Max.	Units
Power supply						
VBAT voltage range	V_{BAT}		3.0		21	V
VCC output voltage	V_{CC}		4.7	5.0	5.3	V
VCC output current limit	I_{VCC}	VCC>2.7V		50		mA
Supply current in shut-down mode	I_Q	V_{BAT}=8V, CE=0V		3	5	μA
Controller						
Switch frequency	F_{sw} [5)]		350	450	450	kHz
Switch minimum off time	T_{off_min} [5)]		80	100	120	ns
Charge enable Threshold	V_{CE}		14.7%	16.7%	18.7%	V_{CC}
Bucktop switch on-resistance	R_{dsbkTG} [5)]			20	28	mΩ
Buck bottom switchon-resistance	R_{dsbkBG} [5)]			20	28	mΩ
Boost top switch on-resistance	$R_{dsbstTG}$ [5)]			20	28	mΩ
Boost bottom switch on-resistance	$R_{dsbstBG}$ [5)]			20	28	mΩ
Charge						
Floating BAT Voltage	V_{CV}	V_{BATFB} =GND	8.358	8.4	8.442	V
		Set by divider resistor	3.0	-	17	
BAT feedback voltage	V_{BATFB}	External resistor divider	1.191	1.2	1.212	V
BAT Recharge threshold	V_{REC}	V_{BATFB} = GND	8.118	8.2	8.282	V
BAT recharge feedback threshold	V_{RECFB}	External resistor divider	1.159	1.171	1.183	V
CC mode charge current	I_{CC}	R_{CS}=10mΩ, R_{ISET1}=2K R_{ISET2}=1.5K	1.9	2	2.1	A
Charge termination current	I_{TER}	R_{CS}=10mΩ, R_{ISET1}=2K R_{ISET2}=1.5K		10%		I_{CC}
Battery full charge deglitch time	T_{FULL}	I_{CC}< I_{TER}		500		ms
Trickle mode charge current	I_{TRI}		10%	20%	30%	I_{CC}
Trickle mode battery threshold	V_{TRI}	V_{BATFB} = GND	5.9	6.0	6.1	V
Trickle mode feedback threshold	V_{TRIFB}			0.857		V
Trickle charge time-out duration	T_{TRI}			55		min
VIN UVP threshold	V_{IN_UVP}	VIN rising	4.0	4.2	4.3	V
		VIN falling	3.8	4.0	4.1	V
VIN delay to start charging	T_{chg_delay}			150		ms
DRP reference voltage for adaptive current limit	V_{DRP}		0.885	0.9	0.915	V
Protection						

Battery under temperature protection threshold	V_{UTP}		70.2%	72.2%	74.2%	V_{CC}
Battery over temperature protection threshold	V_{OTP}		27.2%	29.2%	31.2%	V_{CC}
Thermal shutdown threshold[5)]	T_{SHUT}[5)]			150		°C
Thermal recovery threshold[5)]	T_{REC}[5)]			130		°C

Notes:

5) Guaranteed by design.

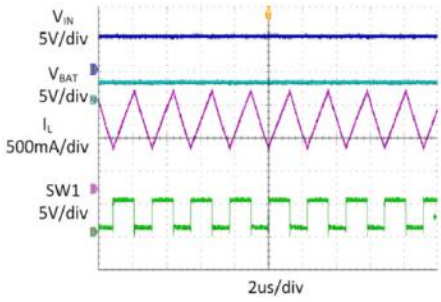
PIN DESCRIPTION

Pin No.	Name	Description
1	CSP	Positive terminal of battery charge current sense.
2	BAT	Battery positive terminal.
3	PGND	Power Ground.
4	VIN	Main supply pin, connect to adaptor.
5	DRP	VIN droop allowance program pin.
6	CE/NTC	This is a multi-purpose pin. 1. Charge enable pin. 2. Battery temperature protection pin.
7	STAT	Open-drain charge status output. Connect the STAT pin to a logic rail via 10kΩ resistor. The STAT pin indicates charger status. Connect a current limit resistor and a LED from VCC to this pin. Charge in progress: LOW Charge complete or charger in SLEEP mode: HIGH Charge suspend (fault response): 1-Hz, 50% duty cycle pulses.
8	BST1	VIN side bootstrap supply pin for top switch. 0.1uF capacitor is connected between BST1 and SW1 pins.
9	SW1	VIN side power switching node. connect to SW2 with inductor
10	SW2	BAT side power switching node.
11	BST2	BAT side bootstrap supply pin for top switch. 0.1uF capacitor is connected between BST2 and SW2 pins.
12	BATFB	Battery float voltage configuration pin. 1. This pin tied to GND, sets 2 cells float voltage. Pin short to GND: 8.4V. 2. And the float voltage could be set to any value (3.0V-17V) by the external divider resistor.
13	VCC	5V LDO for power driver and internal circuit. Must be bypassed to GNDwith a minimum of 10uF ceramic capacitor for stable operation.
14	GND	Signal GND.
15	CSN	Negative terminal of battery charge current sense.

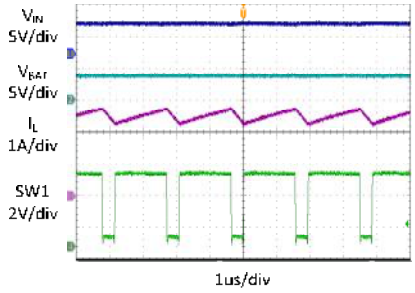
TYPICAL PERFORMANCE CHARACTERISTICS

V_{IN} =5V, L = 3.3μH, C_{IN}= 20μF, C_{OUT} = 20μF, TA = +25°C, unless otherwise noted

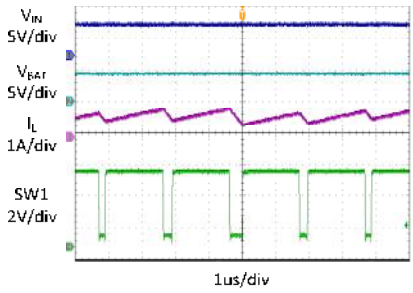
Tricklecharge @ 1 cell



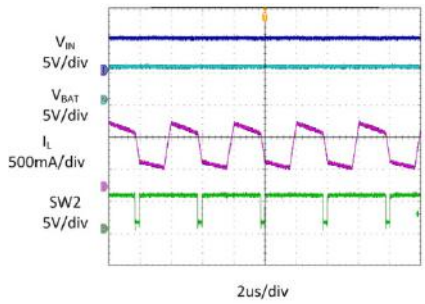
Constantcurrentcharge@ 1 cell



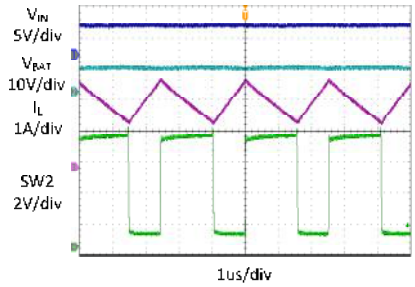
Constantvoltagecharge@ 1 cell



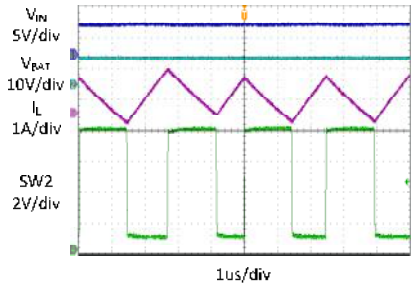
Tricklecharge @ 2 cells



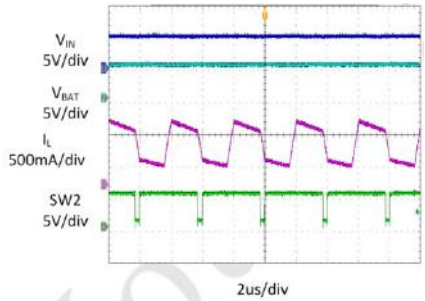
Constantcurrentcharge@ 2 cells



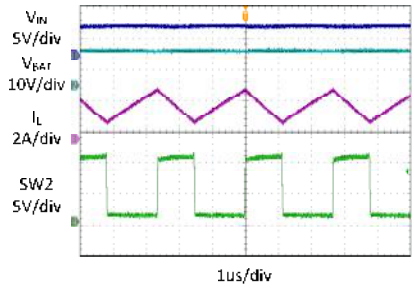
Constantvoltagecharge@ 2 cells



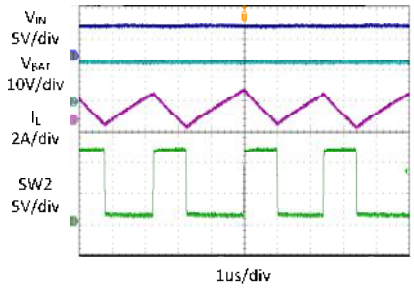
Tricklecharge @ 3 cells



Constantcurrentcharge@ 3 cells



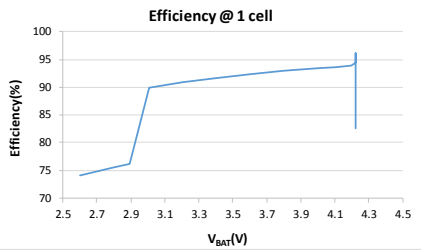
Constantvoltagecharge@ 3 cells



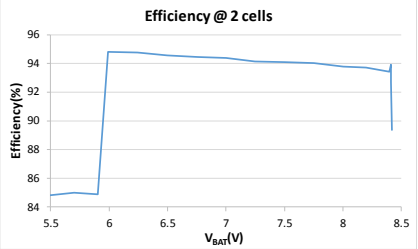
TYPICAL PERFORMANCE CHARACTERISTICS*(Continued)*

V_{IN} =5V, L = 3.3μH, C_{IN}= 20μF, C_{OUT} = 20μF, TA = +25°C, unless otherwise noted

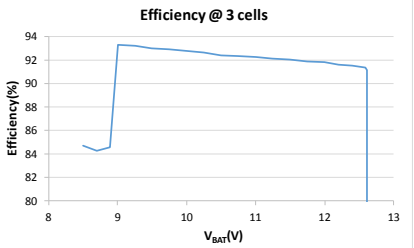
Charge efficiency @ 1 cell



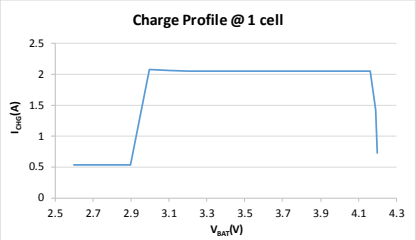
Charge efficiency @ 2 cells



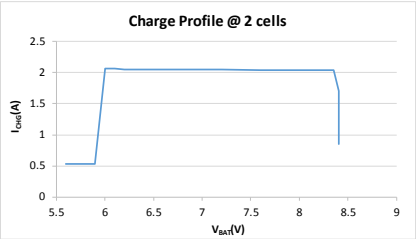
Charge efficiency @ 3 cells



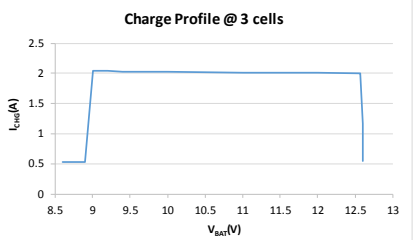
Charge current vs. VBAT@ 1 cell



Charge current vs. VBAT @ 2 cells



Charge current vs. VBAT @ 3 cells



FUNCTIONAL DESCRIPTION

HX8808E is a monolithic buck-boost charger that can operate over a wide input voltage range of 4.2V to 17V. The full chargevoltage and charge current can be programmable through external resistor. Low R_{DSON} N-channel power switches reduce the solution complexity and improve the efficiency.

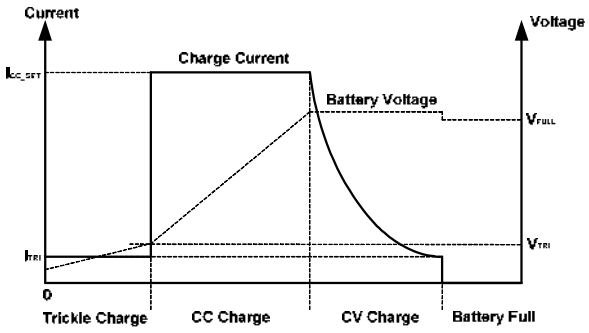
The DC-DC converter utilizes proprietary single inductorcurrent-mode control to guarantee smooth transitionbetween buck and boost operation with better dynamic response and cycle-by-cycle current protection.

Compensation is done internally onthe chip. The HX8808E operates in PFM mode at light load. In PFM mode, switching frequency is continuouslycontrolled in proportion to the load current, i.e. switch frequency is decreased when load current drops to boost power efficiency at light load by reducing switching-loss, minimizing the circuit.

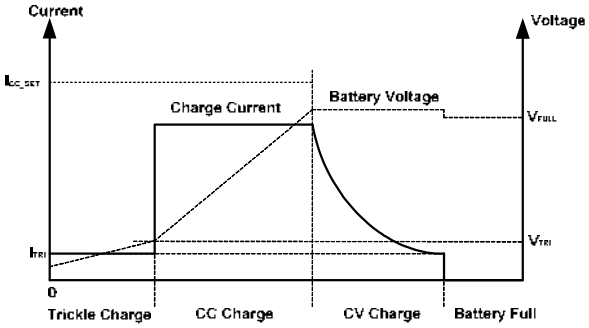
The HX8808E can operate in charge mode if a logic High is on CE pin. In charge mode, if the VIN voltage is lower than battery voltage，it is a boost converter. When the VIN voltage is higher than battery voltage, it is a buck converter.

Charge mode

In charge mode, HX8808E regulates the battery current according to input voltage and battery voltage. It charges battery with three phases: trickle charge, constant current charge, constant voltage charge and charge termination. Figure 1(a) is a typical charge profile. Figure 1(b) is a charge profile with input current limit. When the input current is limited, the system decreases the charge current.



a) Withoutinput current limit



b) With input current limit

Figure 1 Typical Charge Profile

Trickle charge

The HX8808E charges the battery with I_{TRI} when battery voltage is less than V_{TRI}. If charging remains in TC mode beyond the trickle-charge time T_{TRI}, charging terminates.

CC charge

When the battery is higher than V_{TRI}, the device charges the battery with I_{CC} if the input current is sufficient. When input current limit is hit, the device reduces the charge current automatically. The HX8808E can set the charge current through R_{ISET1} and R_{ISET2}, we recommend R_{ISET1}/R_{ISET2} is around 4/3.The maximum charge current is up to 3A.

$$I_{CC}(A) = \frac{10(A) R_{ISET1}(k\Omega)}{R_{CS}(m\Omega)}$$

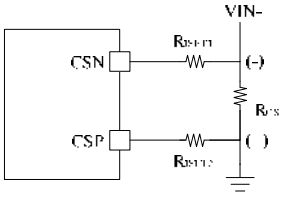


Figure 2 Typical Charge Profile

For 1A cc charge current, we recommend R_{ISET1}=2k, R_{ISET2}=1.5k, R_{CS}=20mΩ; and for 2A cc charge current, we recommend R_{ISET1}=2k, R_{ISET2}=1.5k, R_{CS}=10mΩ.

CV charge

When battery voltage equals to V_{CV}, the device regulates the battery voltage and reduces the charge current reduces automatically.

The customer can select 2 cells or program the V_{CV} through BATFB pin. Connect BATFB to GND selects 2 cells. The V_{CV} can also be programmable by resistor divider connected to BATFB, when the HX8808E detect a resistor connect to this pin. We recommend the 1‰ accuracy resistor should be used in order to achieve the accuracy of full charge voltage.The full charge voltage configuration shows in figure 3.

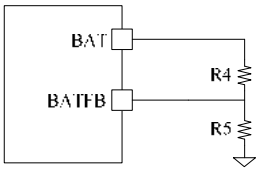


Figure 3 Full Charge Voltage Configure

$$V_{CV}(V) = \frac{1.2\,V \times (R_4 + R_5)}{R_5}$$

Charge termination

If the battery voltage is higher than V_{FULL}, and the charge current is less than charge termination current I_{TER} for T_{FULL}, the charge process terminates.

Auto recharge

Once the battery charge cycle completes, the charger remains off. A new charge cycle automatically begins when the battery voltage falls below the auto-recharge threshold V_{REC} if the input adaptor is present. The idle mode to charge mode transition also restarts the charge cycle.

Charging status indication

The HX8808E has open-drain output for charge status. Connect a current limit resistor and a LED from VCC to this pin can.
When charge is in progress, the STAT pin output LOW. When charge is completed or charger is in sleep mode, the STAT pin is output HIGH. When charge suspend at fault condition, the STAT pin blinks at 1Hz.

Dynamic input Current Tracking Scheme

HX8808E detects the VIN pin, if the VIN pin voltage is higher than V_{IN_UVP} rising threshold for 150ms, the HX8808E starts charging with a limited charging current. When the adaptor is over load, the DRP pin drops below the internal reference 0.9V, HX8808E will decrease the charging current. We recommend the ratio of R1/R2 is around 4.1. The input voltage sense shows in figure 4, choose R1, R2 to set the input voltage threshold.

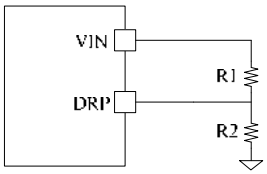


Figure 4 VIN Droop Voltage Configure

$$V_{IN\_ALLOWANCE}(V) = \frac{V_{DRP}(V) \times (R_1 + R_2)}{R_2}$$

Thermal Control

When the junction temperature of the HX8808E

rises above 135°C, it begins to reduce the output power to prevent the temperature from rising further. If the junction temperature of the HX8808E rises above 150°C, the discharging process stops.

Shut-down Mode

The HX8808E shuts down when voltage at CE pin is below charge enable threshold. The entire regulator is off.

Battery temperature protection

For battery protection during charge mode, the device monitors the battery temperature through NTC pin. When the voltage of the NTC pin is outside the thresholds, the charge progress is suspended. In additional, STAT pin blinks at 1Hz to inform fault condition. Once temperature returns within thresholds, the charge is recovered.

PCB Layout Note

For minimum noise problem and best operating performance, the PCB is preferred to following the guidelines as reference.

1. Placethe input decoupling capacitor as close to HX8808E (VIN pin and PGND) as possible to eliminate noise at the input pin. The loop area formed by input capacitor and GND must be minimized.
2. Put the current sense resistor R_{CS} as close as possible to the current set resistors R_{ISET} for better current accuracy.
3. The ground plane on the PCB should be as large as possible for better heat dissipation

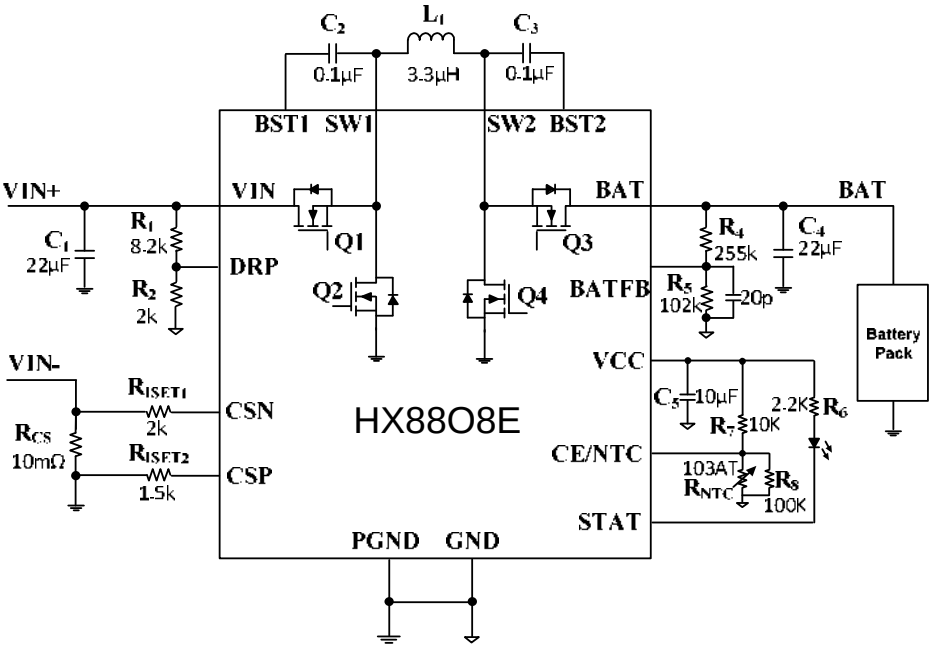
REFERENCE DESIGN

Reference 1：Single cell charge with input current limit

V_{IN}: 4.6V ~ 20V

V_{BAT}: 3V ~ 4.2V

I_{IN_LIM} : 2A

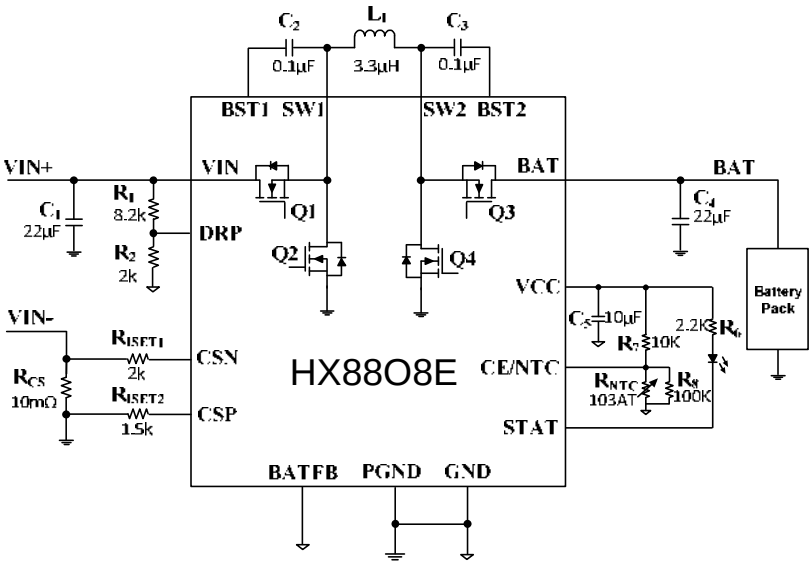


Reference 2：2 cells charge with input current limit

V_{IN}: 4.6V ~ 20V

V_{BAT}: 6V ~ 8.4V

I_{IN_LIM} : 2A

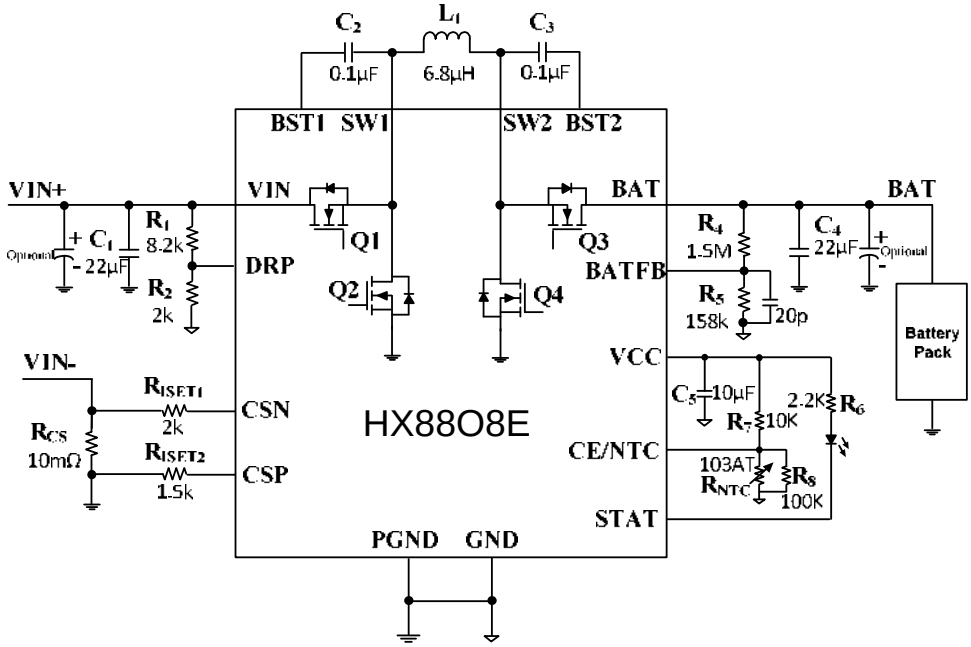


Reference 3：3 cells charge with input current limit

V_{IN}: 4.6V ~ 20V

V_{BAT}: 9V ~ 12.6V

I_{IN_LIM} : 2A

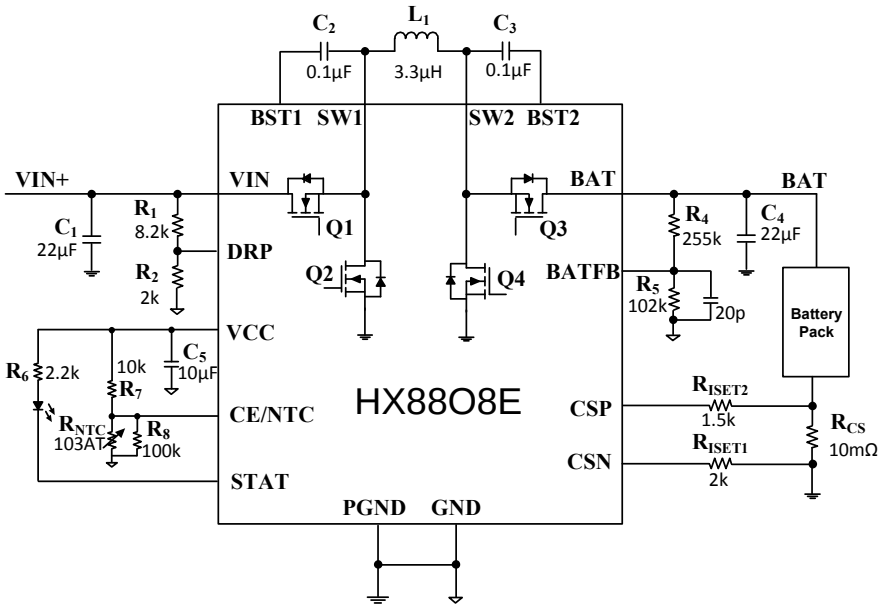


Reference 4：Single cell charge with battery current limit

V_{IN}: 4.6V ~ 20V

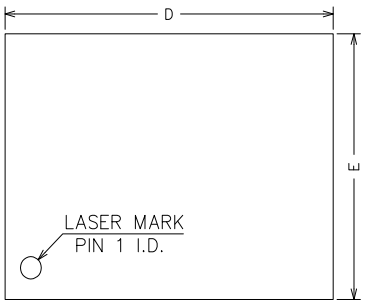
V_{BAT}: 3V ~ 4.2V

I_{BAT_LIM} : 2A

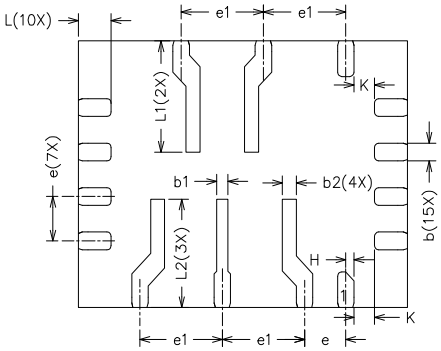


PACKAGE OUTLINE

QFN3X4-15 unit: mm

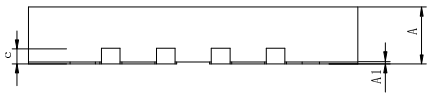


TOP VIEW



BOTTOM VIEW

	MIN	NOM	MAX
A	0.50	0.55	0.60
A1	0.00	0.02	0.05
c		0.15REF	
b	0.15	0.20	0.25
b1	0.09	0.14	0.19
b2	0.12	0.17	0.22
D	3.90	4.00	4.10
E	2.90	3.00	3.10
e	0.40	0.50	0.60
e1	0.90	1.00	1.10
H		0.10REF	
K	0.15	0.25	0.35
L	0.30	0.40	0.50
L1	1.15	1.25	1.35
L2	1.12	1.22	1.32



SIDE VIEW