Specification

1. Customer : _____

2. Product : **Lithium-Ion 2S2P Battery Pack (4,400mAh)**

3. Model : **Li 18S-44**

4.Reviewed By :

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1. Scope

This Product Specification ('Specification' hereinafter) covers the requirements for the rechargeable lithium-ion battery Hard Pack ('Pack' hereinafter) manufactured and supplied by Emerging Power, Inc.

The pack contains lithium-ion battery cells, safety devices, a gas gauge module, and protection circuit.

2. Description and Model

2.1. Description	Lithium-Ion rechargeable battery pack
2.2. Battery Cell Config.	2S – 2P
2.3. Model name	Li 18S-44

3. Ratings

3.1. Nominal Capacity	4,400mAh
3.2. Minimum Capacity	4,400mAh
3.3. Charging Voltage	8.4V ± 50mV
3.4. Nominal Voltage	7.4V (3.7V / 1Cell)
3.5. Charging Method	CC-CV (Constant-current and -Voltage with Limited current)
3.6. Standard Charging Current	2,000mA/200mA Cut-off
3.7. Continuous Discharge Current	2,000mA
3.8. Max. discharge current	4,000mA
3.9. Discharge cutoff voltage	6.0V
3.10 Internal Resistance	≤300mΩ
3.11. Weight	≤195g
3.12. Operating Temperature	
Standard Charge	0 to 45℃
Standard Discharge	-20 to 60℃
3.13. Storage Temperature	
-20 ~ 20℃	≤ 1 Year
-20 ~ 45℃	≤ 3 Months
-20 ~ 60℃	≤ 1 Month
3.14. Storage Humidity	20 ~ 85 % RH (not condensed)

4. Outline Dimension

W × D × H = 19.5±0.2 × 36.5±0.5 × 145.0±0.5 (mm)

Refer to attached drawings.

5. LED Display

RSOC	LED1	LED2	LED3	LED4
Voltage < EDVF	Off	Off	Off	Off
RC < RemainingCapacityAlarm	Blink	Off	Off	Off
1 ~ 24%	On	Off	Off	Off
25 ~ 49%	On	On	Off	Off
50 ~ 74%	On	On	On	Off
75 ~ 100%	On	On	On	On

6. Protection Circuit Module(PCM) Support

6.1. PCM Maximum Ratings

6.1.1	Input Voltage	10.0 V
6.1.2	Charging Current	5.00 A
6.1.3	Discharging Current	5.00 A

6.2. PCM Electrical Characteristics at 25 deg.C

6.2.1	Over-charge Prohibition Voltage	8.70 ± 0.10 V
6.2.2	Over-charge Release Voltage	8.10 ± 0.20 V
6.2.3	Over-charge Prohibition Delay Time	1.20 ± 0.60 sec.
6.2.4	Over-discharge Prohibition Voltage	4.80 ± 0.20 V
6.2.5	Over-discharge Release Voltage	5.60 ± 0.20 V
6.2.6	Over-discharge Delay Time	20 ~ 500 ms
6.2.7	Over-current Protection Current	5.0A~8.0A
6.2.8	Over-current Delay Time	10 ~ 60 ms

6.3. Power Consumption

6.3.1 Normal Mode	< 30 uA
6.3.2 Power Down	< 10 uA

7. Standard test condition

7.1. Test sample condition

The battery used for the test shall be manufactured and delivered no later than three months.

7.2. Environmental condition

Unless otherwise specified, all tests stated in this specification are conducted at temperature 25 ± 5℃ and humidity 65 ± 20%

in charged state.

7.3. Test equipment condition

The grade of voltmeter and ammeter used in the test shall be higher than class 0.5, a high impedance type.

8. Characteristics

8.1. Standard charge

"Standard charge" means charging the pack with a charge current **2,000mA with a constant voltage of 8.4V until charge current reach to 200mA at 25℃**

8.2. Initial capacity

"Initial capacity" is defined as the initial discharge capacity of the pack, which is measured with discharge current of 880mA with 6V cutoff at 25℃ 1 hour after the standard charge.

The Initial Discharge time shall be longer than 285 min.

8.3. Cycle Life

Cycle life is defined by the discharge time one day after 299 Cycles , measured under the same condition in 8.2

Each cycle has a period of:

charge with 2,000mA / 8.4V and 200mA cut-off,
rest time 10minutes,
discharge with 880mA with 6.0V cutoff, and
rest time 30 minutes.

Discharge time after 299 cycles ≥ 240 min.

8.4. Initial internal impedance

This means AC impedance of the pack measured at 1kHz after standard charge

Initial internal impedance ≤ 300mΩ

8.5. Discharge capacity with temperature

This means relative value of discharge time at various temperature compared with the discharge time at 25℃ (100%)
Conditions are :

Standard charge at 25℃

Standard Discharge current 880mA with 6.0V cutoff

Relative capacity	70%	100%	100%	95%
At	-10℃	25℃	45℃	60℃

8.6. Storage characteristics

Remaining capacity of the pack which has been stored at 25℃ for 30 days must be measured by discharge capacity.

Conditions are :

Standard charge after/before storage

discharge current 880mA with 6.0V cutoff

Discharge Time (after the storage) ≥ 285 min.

9. Function of Protection Circuit Module (hereinafter PCM)

9.1. Overcharge protection

4.35 ± 0.05 V/cell with reset when reach 4.10 ± 0.05 V/cell

9.2. Overdischarge protection

2.30 ± 0.15 V/cell with reset when recharged to 2.90 ± 0.15 V/cell

9.3. Overcurrent protection

4.5A to 7.5A depending upon pack voltage, with reset when load is removed or pack is recharged.

8.4. Power dissipation

Run ;	<350㎂
Stanby ;	<100㎂
Shut down ;	<5㎂

10. Safety test

10.1. Overcharge test

Test method : Charge the battery pack to the voltage greater than 8.8V.

Criteria : PCM shall be activated and stop over-charging,
No damage such as leakage, flame, or fire is allowed.

10.2. External short circuit test

Test method : Short-circuit the pack with an 8.4V charged
by connecting positive and negative terminals
of the pack with 50mΩ wire for 1 hour.

Criteria : PCM shall be activated and stop discharging.
No damage such as leakage, flame, or fire is allowed.

10.3. Overdischarge test

Test method : Discharge the pack to the voltage less than 4.3V

Criteria : PCM shall be activated and stop over-discharging.
No damage such as leakage , flame, or fire is allowed.

11. Mechanical Characteristics

11.1. Drop Test

Test method: Drop the battery pack to the concrete floor from 0.76m in height at any directions for three times.

Criteria : No leakage , OCV ≥ 7.4V, and Internal impedance ≤ 300mΩ.

11.2. Vibration Test

Test method: Vibrate the battery pack with a frequency and an amplitude : 10Hz → 55Hz → 10Hz / 0.8mm. Sweep speed : 1 ±0.055Hz/min.

Criteria: No leakage , OCV ≥7.4V, and Internal impedance ≤ 300mΩ.

12. Shipment

The battery shall be shipped in about 30~80% charged state.

13. Caution and prohibition

Before using and handling the pack, see carefully attached "Handling Instruction For Lithium Ion Rechargeable Battery" & "Proper Use and Handling of Lithium Ion Cells".

14. Others

14.1. Storage for a long term

If the pack is kept for a long term (3 months or more), it is strongly recommended that the pack be preserved at a dry and low temperature atmosphere.

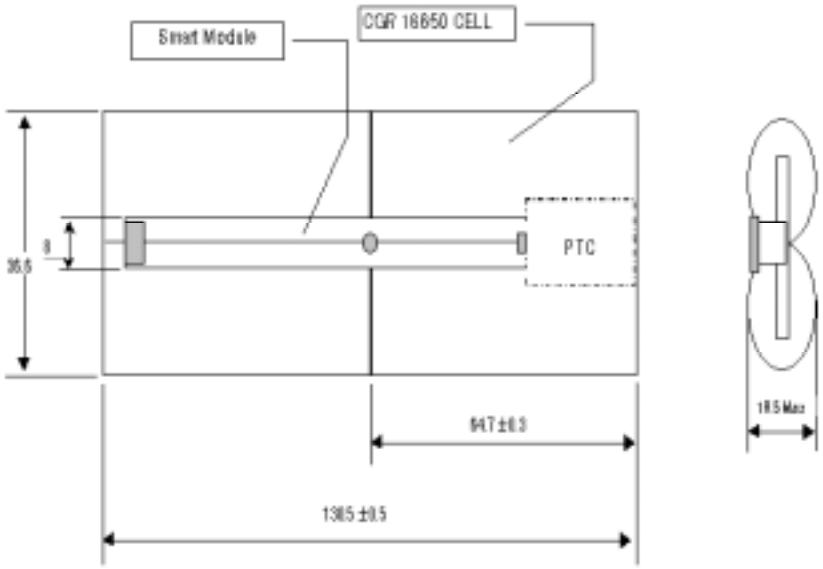
14.2. Warranty

Emerging Power, Inc. will be responsible for replacing the pack against defects or poor workmanship for 12 months from the date of shipping. Any other problems caused by malfunction of the equipments or misuse of the battery are not under this warranty.

14.3. Note

Please contact us to get more detailed specification on the battery before you adapt the battery to your application.

[Mechanical Drawing]



[Appendix A. Proper Use and Handling of Lithium Ion Cells]

See Before Using lithium-ion cell

1. General

This Document is written to describe the cautions and appropriate actions whenever the customer handles the lithium ion battery packs in order to obtain optimum performance and safety. (Please, refer to the cell technical data and consult with cell engineers for more detailed information)

2. Charging

2.1. Charging current

Charging current should be less than maximum charging current in the Product Specification.

2.2. Charging voltage

Charging voltage should be less than maximum charging voltage in the Product Specification.

2.3. Charging time

Continuous charging state under appropriate voltage does not cause any loss of characteristics. However, the installation of charge timer is recommended for the safety consideration, which shuts off further charging at the specific time in the Product Specification.

2.4. Charging temperature

The Cell should be charged within a range of specified temperatures in the Product Specification.

2.5. Inverse charging

Inverse charging should be strictly prohibited. If the cells are connected improperly, they may be damaged.

3. Discharging

3.1. Discharging current

Discharging current should be less than maximum discharging current in the Product Specification.

3.2. Discharging temperature

The Cell should be discharged within a range of specified temperatures specified in the Product Specification.

3.2.2 Otherwise, it may cause loss of characteristics.

3.3. Over-discharging

3.3.1. The system should be equipped with a device to prevent further discharging exceeding discharging cut-off voltage specified in the Product Specification. (over-discharging)

3.3.2. Over-discharging may cause loss of performance and characteristics of battery functions.

3.3.3. Over-discharging may occur by self-discharge if the battery is left for a very long time without any use.

3.3.4. The charger should be equipped with a device to detect Cell's voltage and to determine recharging procedures.

4. Storage

4.1. Storage conditions

4.1.1. The Cell should be stored within a range of temperatures specified in the Product Specification.

4.1.2. Otherwise, it may cause loss of characteristics, leakage and/or rust.

4.2. Long-term storage

4.2.1. The Cell should be used within a short period after charging because long-term storage may cause loss of capacity by self-discharging.

4.2.2. if long-term storage is necessary, the Cell should be stored at lower voltage within a range specified in the Product Specification, because storage at higher voltage may cause loss of characteristics.

5. Cycle life

5.1 Cycle life performance

5.1.1. The cell can be charged/discharged repeatedly up to times specified in the Produce Specification with a certain level of capacity also specified in the Product Specification.

5.1.2. Cycle life may be determined by conditions of charging, discharging, operating temperature and/or storage.

6. Design of System

6.1. Connection between the Cell and the battery

6.1.1. The Cell should not be soldered directly with leads. Namely, the Cell should be welded with leads on its terminal and then be soldered with wire or leads to soldered lead.

6.1.2. Otherwise, it may cause damage of component, such as separator and insulator, by heat generation.

6.2. Positioning the battery in the System

6.2.1. The battery should be positioned as possible as far from heat sources and high temperature components.

6.2.2. Otherwise, it may cause loss of characteristics.

6.3. Mechanical shock protection of the battery

6.3.1. The battery should be equipped with appropriate shock absorbers in order to minimize shock.

6.3.2. Otherwise, it may cause shape distortion, leakage, heat generation and/or rupture.

6.4. Short-circuit protection of the Cell

6.4.1. The Cell is equipped with an insulating sleeve to protect short-circuit which may occur during transportation, battery assembly and /or system operation.

6.4.2. If the Cell's sleeve is damaged by some cause such as outside impact, it may cause short-circuit with some wiring inside the battery.

6.5. Connection between the battery and charger/system

6.5.1. The battery should be designed to be connected only to the specified charger and system.

6.5.2. A reverse connection of the battery, even in the specified system, should be avoided by employing a special battery design such as special terminals.

7. Battery Pack Assembly

7.1. Prohibition of usage of damaged Cell

7.1.1. The Cell should be inspected visually before battery assembly.

7.1.2. The Cell should not be used if sleeve-damage, can-distortion and/or electrolyte-smell is detected.

7.2. Terminals handling

7.2.1. Excessive force on the positive terminal of negative lead (PTC lead) should be avoided.

7.3. Transportation

7.3.1. If the Cell is to be transported to another place, such as the battery manufacturer, careful precautions should be taken into account to avoid Cell's damage.

8. Others

8.1. Disassembly

8.1.1. The Cell should not be dismantled from the battery pack.

8.1.2. Internal short-circuit caused by disassembly may lead to heat generation and/or venting.

8.1.3. When the electrolyte is coming in contact with the skin or eyes, flush immediately with fresh water and seek medical advice.

8.2. Short-circuiting

8.2.1. Short-circuit results in very high current which leads to heat generation.

8.2.3. An appropriate circuitry should be employed to protect accidental short-circuiting.

8.3. Incineration

8.3.1. Incinerating and disposing of the Cell in fire are strictly prohibited, because it may cause rupture.

8.4. Immersion

8.4.1. Soaking the Cell in water is strictly prohibited, because it may cause components to be melt and damaged to functions.

8.5. Mixing use

8.5.1. Different types of cell, or same types but different manufacturer's cell may lead to cell rupture or damage to system due to different cell's characteristics.

8.6. Battery exchange

8.6.1. Although the Cell contains no environmentally hazardous component, such as lead or cadmium, the battery should be disposed according to the local regulations when it is disposed.

8.6.2. The Cell should be disposed in a discharged state to avoid heat

[Appendix B: Technical Information for Fuel Gauge and Protection Layer]

1. Scope

This specifcation describes the requirements for Smart Battery Management Module for Smart Battery Pack "Li18S-44".

2. Smart Battery Specifications

The following specifications are compatible with our Standard Battery Products:

System Management Bus Specification v1.0 or v1.1
Smart Battery Data Specification v1.0 or v1.1
Smart Battery Charger Specification v1.0 or v1.1

Smart Battery System information contains additional document shown as follow:

SMBus BIOS Interface Specification
SMBus Device Address Addendum
Smart Battery Selector Specification
Intel SMBus/Smart Battery System Application Notes

3. Requirements

3.1 Features

(1) Report Battery Voltage, Charging and Discharging Current, Remaining Capacity, Remaining time, Cycles, Temperature, Manufacturing Data, and so on.
(2) Communication with Devices or Chargers by SMBus protocol
(3) Compensation Capability for Self-Discharge, Temperature, and Cycle Life.
(4) Gas Gauging Indicator.
(5) Alarm warning Capability.
(6)

3.2 Connector

Connector-pin descriptions

Five pins are used as shown below:

(+) Positive terminal of battery pack
(C) SBCLK
(D) SBDTA
(T) Thermistor
(-) Negative terminal of battery pack

4. Operation Mode

Run : Smart battery detects current more than 15mA or communication interrupt issued by Host or Smart charger (granularity).

Standby : Smart battery detects current less than 15mA and there is no communication interrupts.

Shut down : Minimum Cell Voltage below Vcells (usually 2.35 V)

5. Communication Protocol Between Battery and Device/Charger

5.1 Protocol and SMBus Command code

Protocol : SMBus (Version 1.0) Appendix A

SBD and SMBus Command code are shown in Appendix B

5.2 Communication Mode

5.2.1 Slave Mode (Host : Device)

Maximum Communication Speed : 80KHz

Maximum Data Delay Time : 5ms

5.2.2 Master Mode (Host : Battery)

Communication Speed : 10KHz to 80KHz

Interval Time :

Alarm to Device/Charger : 10 sec

Charge Request : 30 sec

5.3 Smart Battery Data

Default value of Smart Battery Data are shown in Appendix B

6. Battery Protection Specification

Battery Management Unit equipped with Protection algorithm for Battery protection from over-charging, over-discharging, and over-current.

Events & Parameters	Value with tolerance
Over Charge Inhibition Voltage	4.35 ± 0.085 V/Cell
Over Charge Inhibition Release	4.0 ± 0.085 V/Cell
Over Discharge Inhibition Voltage	2.4 ± 0.1 V/Cell
Over Discharge Inhibition Release	3.0 ± 0.1 V/Cell
Over current on discharging Inhibition	6 to 10 A
Over current on charging	6 to 10A
Over Current Inhibition Release	To be recharged

[Appendix C. SBD and SMBus Parameters]

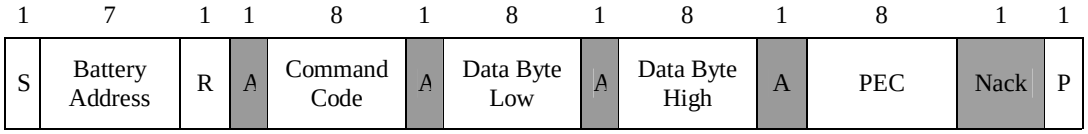
(1) SMBus Logic Levels

SMBUS-CLOCK and SMBUS-DATA Logic Thresholds
Input : Vlow = 0.6V or lower, Vhigh = 1.4V or higher
Output : Vlow = 0.4V or lower, Vhigh = 1.4V or higher

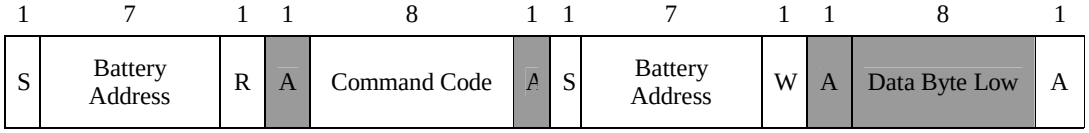
(2) SMBUS Communications Protocols

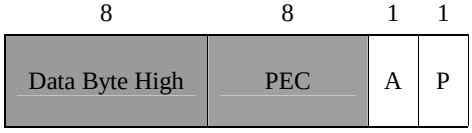
(PEC is for SMBus v1.1)

Write Word: (Host to Battery)

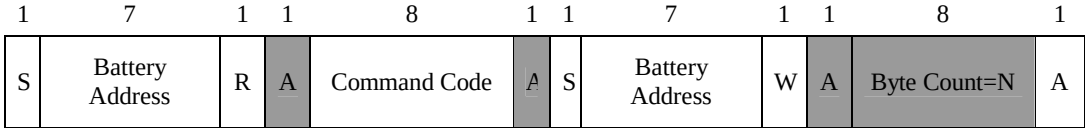


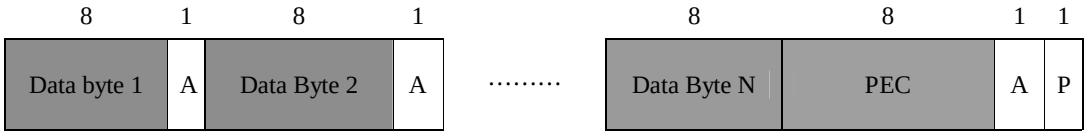
Read Word: (Host to Battery)





Read Block: (Host to Battery)





< Legend >

	From Smart Battery
	From Host System
A	Acknowledge
Nack	No Acknowledge
S	START condition
PEC	CRC-8 code
P	STOP condition

[Appendix D. Smart Battery Data Specification]

Function	Command Code	Access	Defaults (After Power On)	Unit	Remarks
Manufacturer Access	0x00	R/W	0x0018	Hex	C-FET/D-FET ON
Remaining Capacity Alarm	0x01	R/W	440	mAh	10% of Design Capacity
Remaining Time Aalrm	0x02	R/W	10	min	
Battery Mode	0x03	R/W	0x0000	Hex	
AtRate	0x04	R/W	0	mA	
AtRate Time to Full	0x05	R	0xffff	min	
AtRate Time To Empty	0x06	R	0xffff	min	
AtRate OK	0x07	R	1	Bool	
Temperature	0x08	R	0	K	
Voltage	0x09	R	0	mV	Total Cell voltage
Current	0x0a	R	0	mA	
Average Current	0x0b	R	0	mA	
Max Error	0x0c	R	100	%	
Relative State of Charge	0x0d	R	0	%	
Absolute State of Charge	0x0e	R	0	%	
Remaining Capacity	0x0f	R	Var.	mAh	
Full Charge Capacity	0x10	R	DC	mAh	
Run Time to Empty	0x11	R	0xffff	min	
Average Time to Empty	0x12	R	0xffff	min	
Average Time to Full	0x13	R	0xffff	min	
Charging Current	0x14	R	2000	mA	
Charging Voltage	0x15	R	8400	mV	
Battery Status	0x16	R	0x080		
Cycle count	0x17	R	0	Dec	
Design Capacity	0x18	R	4400	mAh	
Design Voltage	0x19	R	8400	mV	
Specification info	0x1a	R	R1.0	Hex	
Manufacturer Date	0x1b	R	Var.		
Serial number	0x1c	R	Var.	Int	
Manufacturer Name	0x20	R	SH EnerTech	String	
Device Name	0x21	R	Li18S	String	
Device Chemistry	0x22	R	LION	String	
Manufacturer Data	0x23	R	EP	string	